AMPP Annual Conference + Expo in New Orleans

PHOTO: JEREMY WOODHOUSE/ GETTY IMAGES

2024 Coatings Industry Event Planner

Mark your calendars for the following protective coatings industry events scheduled throughout 2024. For more details and updates, visit the conference and organization websites listed below.

World of Concrete 2024
Jan. 22–25, Las Vegas
worldofconcrete.com

51st Annual Waterborne Symposium
(University of Southern Mississippi)
Feb. 4–9, New Orleans
waterbornesymposium.com

AMPP Annual Conference + Expo
March 3–7, New Orleans
ace.ampp.org

PCI Powder Coating Week 2024
(Powder Coating Institute)
March 11–13, Orlando
conference.powdercoating.org

NASCC: The Steel Conference
(American Institute of Steel Construction)
March 20–22, San Antonio
nascc.aisc.org

CONT. P. 24

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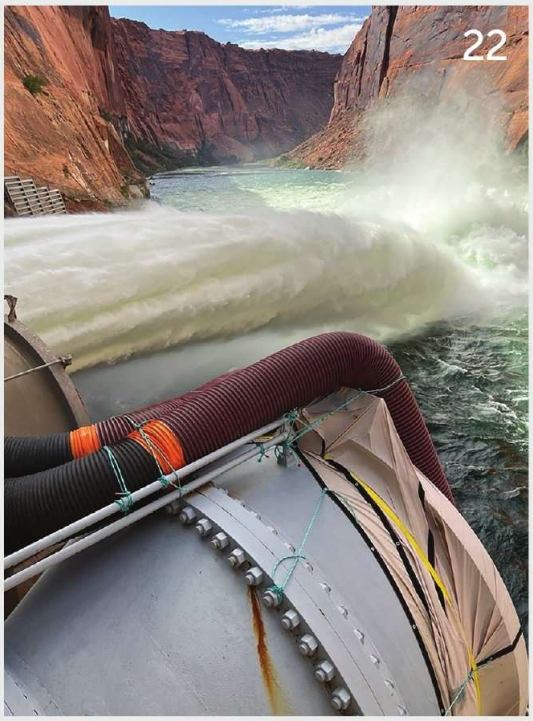

FEATURES

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ON THE COVER
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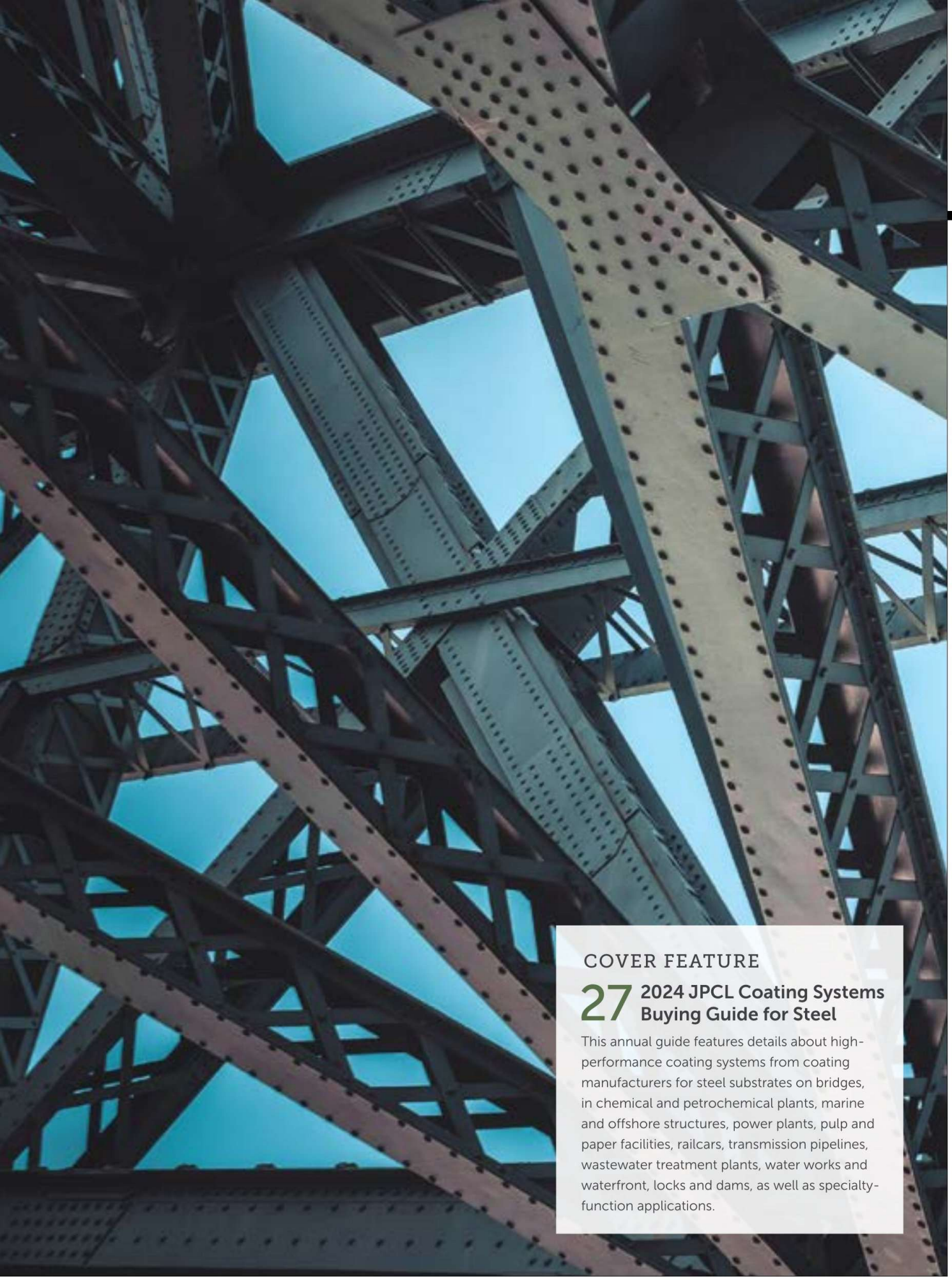
PHOTOS: (LEFT) U.S. BUREAU OF RECLAMATION; (TOP) SCOTT SIMMONS, THOUVENOT, WADE & MOERCHEN, INC. / VILLAGE OF CASEYVILLE; (FACING PAGE) DVOEVNORE / GETTY IMAGES



COVER FEATURE

Hempel Adds to Hull Protection Coating Line

At the end of August, Hempel introduced a new two-layer hull protection coating system, Hempaguard Ultima, to help the maritime industry meet its decarbonization goals.

According to the company, Hempaguard Ultima combines the performance of Hempaguard X7 with Hempel's new biocide-free silicone top-coat, Hempaguard XL, to prevent growth of marine organisms while also ensuring hull protection.

"Hempaguard Ultima is our most significant innovation in a decade and an important step forward in our ability to protect and improve our customers' most important assets," said Alexander Enström, Executive Vice President and Head of Marine at Hempel A/S, in an emailed press release.

"It has been designed to safeguard vessels from fouling with a unique two-layer system, enabling our customers to reach their sustainability objectives while also achieving operational excellence. I am excited to introduce this ground-breaking innovation to our customers and look forward to following its success and impact in the market."

Hempel says that the coating system has the potential to provide:

- Up to 21% fuel savings;
- 160 fouling-free idle days;
- Only 0.9% speed loss on average; and
- A 6% immediate out-of-dock performance increase.

"With Hempaguard Ultima, a vessel's hull is able to achieve a more stable surface smoothness, even into the fourth or fifth year of the docking cycle," commented Diego Meseguer Yebra, R&D Director Marine at Hempel A/S.

"This reduces the risk of fouling after long service periods, even when the coating's hydrogel and biocide can start losing some effectiveness. At the same time, the Hempaguard XL topcoat acts as a modulator for the release of biocide from Hempaguard X7, allowing a lower biocide amount per square meter to last longer."

PHOTO: COURTESY OF HEMPEL

PPG Introduces Steel Primer, Spray-On Insulation Coating

In early August, PPG introduced a new zinc epoxy powder primer to protect steel structures against corrosion in high humidity and aggressive environments.

PPG Primeron Optimal primer is a patent-pending product formulated with an optimized amount of zinc to provide better transfer efficiency and corrosion protection that meets ISO C5 corrosivity specifications. It is suitable for applications such as trailers, gas tanks, pipes, automotive parts and machinery.

The primer has a lower specific gravity than standard zinc-rich primers at 2.0 versus 3.6. This reportedly makes it less dense and easier to apply, with a transfer efficiency of 85%. Additionally, it is made without solvents that release volatile organic compounds

"Corrosion protection is a decisive factor in the durability of a part and one of the most significant challenges for the coating industry," said Paul Bradley, PPG Manager, Product Development, Industrial Coatings. "PPG Primeron Optimal primer offers improved adhesion and corrosion resistance, even in coastal environments, and has a better overall balance of properties than traditional zinc-rich primers."

According to the company, other benefits of the primer include edge, face and scribe corrosion resistance, as well as adhesion on both smooth and blasted steel to resist peeling, chipping and degradation.

The primer reportedly surpassed 10,000 hours of salt spray performance on blasted steel in lab testing. It is also engineered for use on steel, hot-dip galvanized steel, metallized steel and aluminum.

In terms of sustainability, PPG Primeron Optimal primer can be gelled (partially cured), or used in a two-coat, one-bake process. This allows for faster, more sustainable and energy-efficient finishing to reduce greenhouse gas emissions by up to 50%.

Also that month, PPG launched a silicone-based spray-on insulation coating for high-heat environments

CONT. NEXT PAGE

PHOTO: COURTESY OF PPG

PPG, CONT. FROM P. 5

in the oil and gas, chemical, petrochemical and other critical infrastructure industries.

PPG Pitt-Therm 909 reportedly offers greater temperature resistance than conventional waterborne acrylic or epoxy-based SOI coatings, which cannot be used on equipment operating above 350 degrees Fahrenheit (177 degrees Celsius).

The company says that thermal testing showed it endures continuous and cyclic temperatures as high as 500 F, and by reducing heat transfer, external surfaces remain safe to touch at up to 310 F, significantly reducing the risk of burns.

According to PPG, application testing of the coating has also shown that fewer coats are necessary compared to traditional SOI coatings, providing operational efficiency benefits for customers. It can be applied in thicknesses of up to 250 mils (6.35 mm) per coat and, depending on the specific application requirements, only one or two coats are needed.

Despite the reduced number of layers, it can reportedly achieve a higher total coating thickness of up to 500 mils with cure times comparable to competing products. Additionally, application is viable on both hot and cold substrates, allowing assets to remain in service during application.

The water-repellent coating has also reportedly demonstrated "exceptional" corrosion resistance in rigorous testing. Results found that it is an optimal solution for corrosion under insulation prevention for reduced maintenance costs, operational shutdowns and safety incidents.

PPG Pitt-Therm 909 meets requirements for ASTM International's E84 Class A fire rating.

Sherwin Launches EV Facility Flooring System

In July, Sherwin-Williams Protective & Marine launched a new line of flooring systems engineered for electric vehicle battery manufacturing.

The company explains in an emailed release that with continued growth and investment in EV battery production, the need for protective coatings is "paramount" to ensure product, process and personnel safety. Standard epoxy floors are subjected to N-Methyl-2-pyrrolidone (NMP), potentially resulting in the full deterioration of the coating. Additionally, a lack of static control and slip resistance can increase the risk of damage to the workers and electronic components during production.

As a result, Sherwin is offering advanced NMP systems and an electrostatic discharge (ESD) and conductive protection system. These systems are reportedly designed for both clean and dry rooms within EV battery manufacturing facilities.

According to Sherwin, the new portfolio offers key features such as:

- Resistance to corrosive chemicals commonly used in battery manufacturing processes, like NMP, and tested to ASTM D1308 for up to 14 days under glass;
- Ability to dissipate static electricity safely, according to the ESD Association Standard for the Protection of Electrostatic Discharge Susceptible Items;

- Inclusion of specialty primers and basecoats that prevent concrete moisture vapor from entering the environment to maintain the tight relative humidity standards of clean rooms and dry rooms;
- Application to green concrete, reducing the required substrate cure time from 28 to seven days, allowing for earlier installation and quicker site access to other trades; and
- A slip coefficient rating that is reportedly 70% higher than the industry standard balanced to enable cleanability and guard against many spill hazards.

The new flooring systems for EV battery manufacturing facility currently available include Sherwin-Williams Resuflor Advanced NMP Performance EV, FasTop Advanced NMP Performance EV and Resuflor Screed TG46 AGV EV.

PHOTOS: (LEFT) COURTESY OF SHERWIN-WILLIAMS PROTECTIVE & MARINE; (RIGHT) COURTESY OF INDURON PROTECTIVE COATINGS

Induron Appoints New Technical Director

Chase Murphy

Induron Protective Coatings recently announced that it has promoted Chase Murphy to Technical Director, following the retirement of coatings industry veteran Jeff Lackey. Effective Aug. 14, Murphy will manage the company's technical operations, including the research and development team and all the chemical aspects of Induron products, according to Induron's press release. Additionally, Murphy will oversee the approval of any new raw material to be utilized in Induron's process, develop and maintain relationships with distributors and suppliers, and hold responsibility for all environmental and regulatory testing and reporting.

"Chase's promotion to Technical Director is a testament to his hard work, dedication, and the significant impact he has made during his time with us," said Davies Hood, President of Induron. "Equipped with chemistry-based acumen and a hands-on approach to solving problems as well as his positive contribution to the overall culture of the R&D team, Chase is a tremendous addition to our Technical Department."

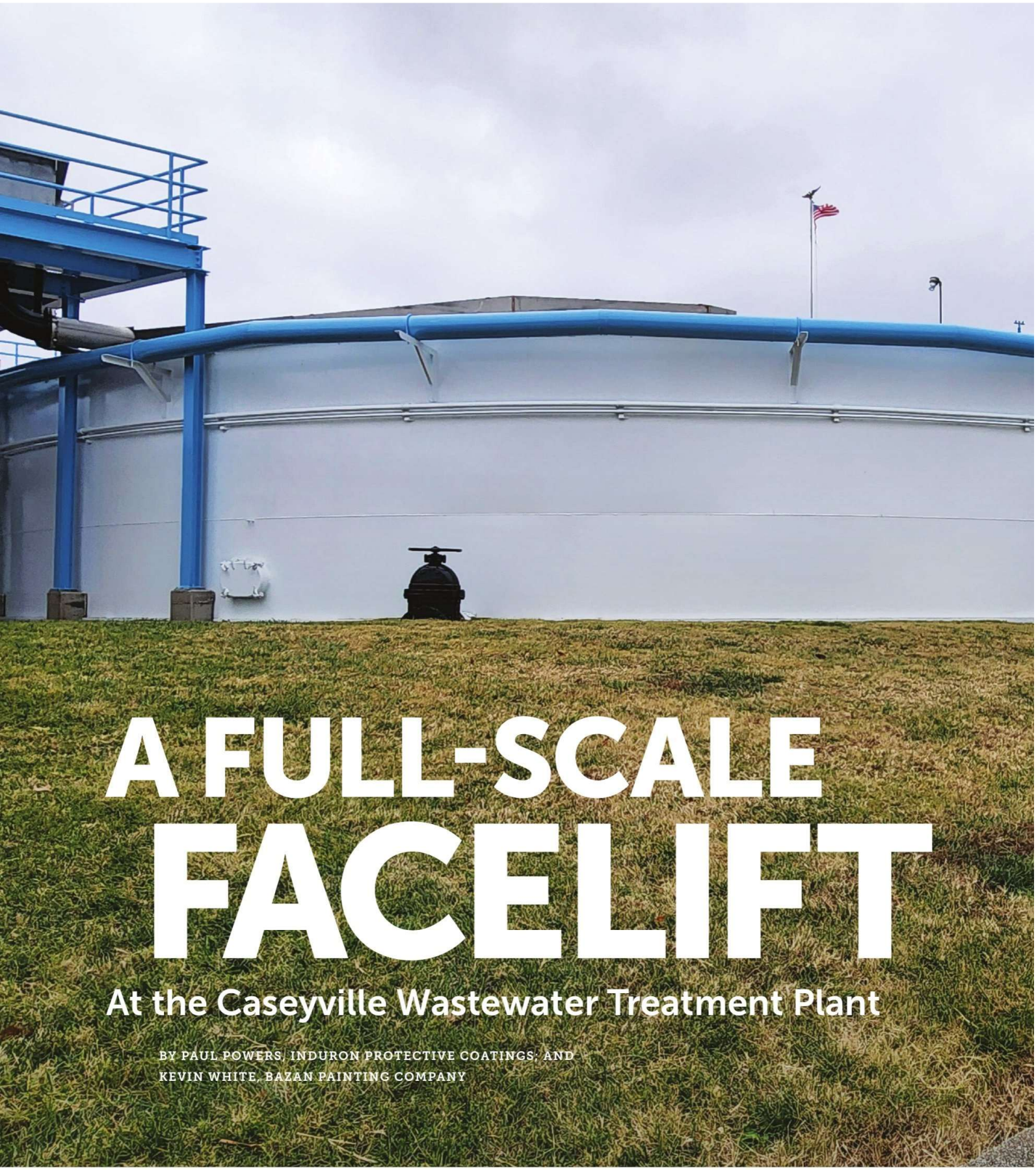
According to the emailed press release, Murphy had joined the company as a lead chemist in the research and development team. Induron says that he "quickly established himself as a key contributor to the company's innovation and product development efforts." His expertise in protective coatings, combined with his leadership abilities, has reportedly played a crucial role in the advancement of the product line. He has also ensured the company's continued commitment to delivering solutions to the marketplace.

> "Equipped with chemistry-based acumen and a hands-on approach to solving problems ... Chase is a tremendous addition to our Technical Department."

Murphy will succeed Lackey, who has been with Induron for the past four years. Lackey's retirement "marks the end of an era at Induron," where he has been considered a "driving force" behind many of the company's most successful projects and innovations.

"Jeff Lackey's contributions to Induron and the industry as a whole are immeasurable. His leadership, vision, and expertise have left an indelible mark on our company, and we are grateful for his years of service. We wish Jeff all the best in his well-deserved retirement," said Hood.

"I am honored to take on this new challenge and lead Induron's technical team," said Murphy. "I look forward to building on the strong foundation that Lackey has laid and continuing to innovate and deliver the high-quality protective coatings that our customers expect from Induron."



A FULL-SCALE FACELIFT

At the Caseyville Wastewater Treatment Plant

BY PAUL POWERS, INDURON PROTECTIVE COATINGS; AND KEVIN WHITE, BAZAN PAINTING COMPANY

FIG. 1: The clarifier, structural steel and catwalks were finished with a gloss urethane topcoat, colored according to safety and specific color codes for piping and mechanical identification.

FIGS. 2 AND 3 *(right)*: These show the condition of some of the facility's piping systems before and after cleaning and coating application.

PHOTOS: SCOTT SIMMONS, THOUVENOT, WADE & MOERCHEN, INC. / VILLAGE OF CASEYVILLE

By the summer of 2022, the coatings protecting the Village of Caseyville, Illinois' Wastewater Treatment Plant assets had reached their performance life expectancy. The protective coatings on the critical infrastructure substrates were spent, worn and some assets were beginning to show signs of corrosion. Within the plant, assets requiring refurbishment included clarifiers, pipes and racks, stairs and catwalks, structural steel, rails and miscellaneous metals, doors and generators, as well as block and pre-cast concrete buildings. In summation, the whole facility needed a fresh coatings job.

Along with Caseyville's hired engineering firm, the painting contractor teamed up with the coating manufacturer to specify the optimal coating solutions for each substrate, with performance, project timing and weather conditions in mind.

Scope of Work

The surface preparation and coatings work at the facility began in September of 2022. According to the specification prepared by the engineering team, the following sequence of work was completed. The exteriors of the steel clarifier tanks were abrasive blast-cleaned to an SSPC-SP 6/NACE No. 3 Commercial finish. The

FIGS. 4-7: Various catwalks, stairways railing, piping and structural steel were recoated in the facility's exterior storage area and concrete basins.

contractor then applied one prime coat of a thick-film ceramic epoxy, selected to replace more costly traditional zinc primers without sacrificing performance. This coating also allows for a 45-minute time-to-recoat, a one-year maximum recoat window and low moisture vapor permeability. After primer application, an intermediate coat of a high build, surface-tolerant epoxy chosen for its adhesion properties on overcoating jobs was applied, followed by a urethane finish coat ***(Fig. 1, p. 8)***.

The steel catwalks, stairs, structural steel, railings, pipe, pipe supports and other miscellaneous steel received a 5,000 psi pressure wash according to SSPC WJ-4, as well as hand- and power-tool cleaning according to SSPC-SP 2 and -SP 3. The contractor then applied a prime coat of high build, surface-tolerant epoxy and two coats of urethane finish, with both offering color and gloss retention characteristics in extended UV exposure ***(Figs. 2-7, pp. 9-10)***.

The CMU block and cast concrete structures also received a 5,000 psi pressure wash according to SSPC WJ-4, and two coats of a low-odor, water-borne acrylic epoxy formulated for toughness, stain resistance and waterproofing characteristics ***(Fig. 8)***.

Finally, the doors and facility generator received a pressure wash, a SSPC-SP 2 hand tool clean, a prime coat and two coats of an acrylic polysiloxane for durability and color retention properties ***(Fig. 9)***.

Conclusion

All in all, this project was another example of all the parties working together toward one goal – an issue-free application that extended the service life of the treatment plant assets for the owner. The contractor credited proper product selection and technical service received from the coating manufacturer, as well as the field performance of the project superintendent, site foreman and coating applicators. JPCL

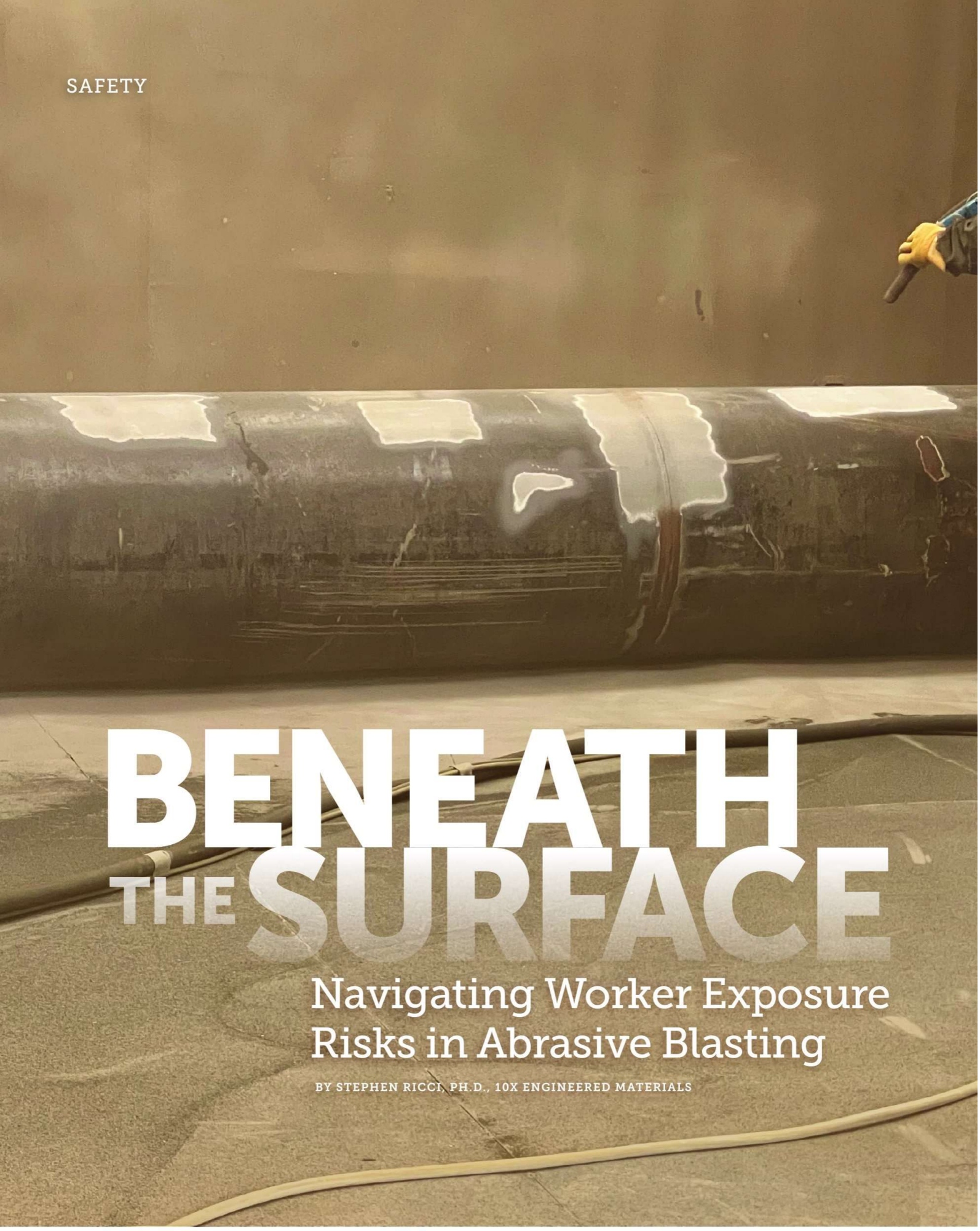
FIGS. 8 AND 9: Cementitious building surfaces and the facility generator were also coated to refurbish the facility's previously deteriorating conditions.

PHOTOS: SCOTT SIMMONS, THOUVENOT, WADE & MOERCHEN, INC. / VILLAGE OF CASEYVILLE

ABOUT THE AUTHORS

Paul Powers is the Mid-Central Regional Manager for Induron Protective Coatings. He is a NACE-certified Coating Inspector (Level 3) with more than 40 years of coatings industry experience. Powers joined Induron as a sales and service representative in 2016 and has held his current position since 2022.

Kevin White is the Senior Vice President of Bazan Painting Company in St. Louis. He has almost 30 years of experience as an industrial painting contractor, previously holding superintendent, project manager and estimator positions within the company. White is a NACE-certified Coating Inspector.



BENEATH THE SURFACE

Navigating Worker Exposure Risks in Abrasive Blasting

BY STEPHEN RICCI, PH.D., 10X ENGINEERED MATERIALS

FIG. 1. Abrasive blast-cleaning carries inherent risks, including long-term health risks tied to exposure to abrasive dusts.

PHOTO: COURTESY OF THE AUTHOR

PART 1: The Science of Exposure Risk

The hiss of abrasive blasting is a familiar sound in shipyards, construction sites and industrial facilities worldwide. However, amidst this din of productivity, an important question often goes either unasked or without a satisfactory answer: How can workers and employers truly know if their blasting environment is safe? As a manufacturer of blasting abrasive products, our company is challenged with the same question. Are our abrasives safe? We've researched the toxicology of abrasives extensively because our customers deserve the best answer that we can provide.

Abrasive blasting, while essential in many industries, carries inherent risks that extend beyond the immediate physical hazards of high-pressure equipment, high-speed abrasive jets, and working at heights or in enclosed spaces. The abrasive materials used to clean, profile and prepare surfaces can themselves pose long-term health risks to workers. This is why it is important to understand the science behind toxicity assessments and how they can and should be used to inform our decision-making.

In this article, we will delve into the science of abrasive toxicity, exploring the fundamental principles that govern toxicity assessments, the regulatory frameworks shaping industry practices, the toxicology research that has been published, and how it all can be used to make decisions that will ultimately keep the workers we all care about as free from harm as possible.

The Fundamentals of Toxicity Assessment

The science of toxicity assessment forms the foundation upon which all safety standards, regulations, and best practices are built. To grasp the complexities of properly defining and measuring exposure risk in abrasive blasting, it is first necessary to understand the fundamental principles of how the response of biological systems to various levels of a substance over different time periods is studied and quantified.

Perhaps the most important concept in toxicology is the dose-response relationship, first articulated by Paracelsus in the 16th century, which posits that "the dose makes the poison." This means any substance can be harmful if the exposure is high enough, and conversely, even traditionally "toxic" substances may have no adverse effects at sufficiently low doses.

FIG. 2. **Each abrasive material type has a unique and often complex material composition and exposure risk profile.**

This principle is particularly relevant in abrasive blasting, where the concentration of airborne particles and the duration of exposure can vary widely based on the materials being used and the specifics of the application.

Dose-response relationships are established through carefully controlled studies, often beginning with laboratory studies and animal exposure testing. Human epidemiological studies that document the health outcomes of workers exposed to specific substances at various levels over varying time frames are also extremely valuable, although they are expensive and often require years or decades to complete. It can also be quite difficult to isolate the effects of the substance being evaluated from human epidemiological data. These foundational studies are performed by scientists in a wide variety of organizations, including universities, government institutes, private laboratories, and industry research associations, among many others.

The aim of these exposure studies is to identify the threshold dose at which a substance begins to produce adverse effects, as well as the nature and severity of those effects at different exposure levels. For abrasives, this might involve examining lung function changes, cellular damage, or long-term lung health outcomes in animals or in human populations with varying levels of occupational exposure to inhalable and respirable abrasive dusts.

Understanding these fundamentals of toxicity testing moves us well along the path toward answering the question posed at the beginning of this article. As you will see, it is this fundamental exposure data that provides the best answer to whether an abrasive material or blasting work environment is causing health risks for workers.

PHOTO: FUNTAY / GETTY IMAGES

How the Science Drives Regulatory Frameworks

In the United States, the Department of Labor's Occupational Safety and Health Administration (OSHA) plays a pivotal role in setting and enforcing standards that directly impact the abrasive blasting industry, primarily through the Hazard Communication Standard and the Toxic and Hazardous Substances Standards. The Hazard Communication Standard (HCS), codified in 29 CFR 1910.1200, is often referred to as the "Right to Know" law. It ensures that information about the hazards of substances in the workplace is communicated to workers and is based on available scientific evidence, including especially the laboratory, animal, and human studies discussed previously. The HCS bridges the gap between scientific knowledge and practical workplace safety.

As a general rule, the HCS requires employers to classify hazards based on toxicological exposure data for the substance or mixture as a whole if such data is available. If it is not, then available exposure data for individual components of the substance or mixture must be considered. A key exception to this primacy of exposure data for a mixture over data for individual ingredients is made for classification as to the carcinogenicity of a substance in humans. If a component chemical or metal in a substance or mixture is a known carcinogen, then that component must be considered in classification of a mixture for carcinogenicity.

Assessing the exposure risk of abrasives by merely examining their individual components is insufficient. The importance of **whole-mixture exposure testing** cannot be overstated.

FIG. 3. **Some exposure to abrasive dust in a blasting workspace is inevitable and the toxic effects depend on the chemistry of the material, dust levels and the duration of exposure. Human, animal and laboratory studies of material dusts themselves provide the best assessment of the risks to workers.**

PHOTO: COURTESY OF THE AUTHOR

The question then becomes, how is the carcinogenicity of a substance or mixture established? Who reviews the exposure study results and makes the decision about whether the substance, mixture, or component of a mixture is carcinogenic in humans? That role is filled by authoritative bodies around the world like the U.S. National Toxicology Program (NTP), the American Conference of Governmental Industrial Hygienists (ACGIH), and the World Health Organization's International Agency for Research on Cancer (IARC). Regulatory agencies like OSHA use the data, lists of carcinogens, publications, and conclusions of these organizations to set rules and standards concerning the communication of hazards and allowable exposure levels in the workplace.

The conclusions of these organizations are critically important. They form the basis for regulations and policy worldwide, including in the United States. The experts at these agencies understand how to interpret the foundational exposure data and dose-response relationships produced by scientists all over the world. Their working groups of trained and experienced scientists review the studies and are able to draw sound conclusions based on the best available data. In fact, Section 6.4 of Appendix A of the OSHA Hazard Communication Standard states that when classifying for carcinogenicity, the conclusions of NTP and IARC can be considered as having established the carcinogenicity of a substance.

A major challenge in the abrasives industry is that blasting materials are complex mixtures containing trace quantities of a variety of component metals, some of which are listed by NTP and IARC as human carcinogens. Does the presence of those trace metals in the workplace, particularly in the dust floating in the air, create an unsafe environment? Is there a way to know for sure?

The Complexity of Abrasive Materials

When considering worker safety while using abrasive materials, it is important to recognize that we are rarely dealing with simple, single-component substances. Most abrasives used in industrial applications are comprised of various

mineral oxides, metals, and other compounds. This complexity presents unique challenges in assessing and minimizing exposure risk.

Abrasives can be broadly categorized into natural, synthetic and recycled materials. Natural abrasives mined directly from the earth include silica sand, garnet, and staurolite. Aluminum oxide, silicon carbide, ceramics, and steel abrasives are considered manufactured or synthetic abrasives, although steel is often recycled as well. Recycled abrasives, increasingly popular for their sustainability benefits, include materials like coal slag, copper slag, nickel slag, crushed glass, and proprietary superoxalloy abrasives. Each of these categories, and indeed each specific type of abrasive within them, has a unique chemical composition and risk profile.

The challenge lies in the fact that the toxicological exposure risk of a complex mixture is not necessarily driven by the presence of trace hazardous ingredients. Interactions between components and the behavior of the material as a whole can alter toxicity in ways that are not always predictable from studying the individual constituents. For instance, one component might enhance or inhibit the bioavailability of another, potentially increasing or decreasing a constituent's toxic effects. Some constituent combinations in an abrasive might result in reduced or increased overall toxicity compared to individual components by virtue of the material's unique chemistry. Further, exposure is not solely determined by the composition of the material. Dose, or dust level, along with exposure duration matter as well. Some abrasives produce more dust during blasting than others.

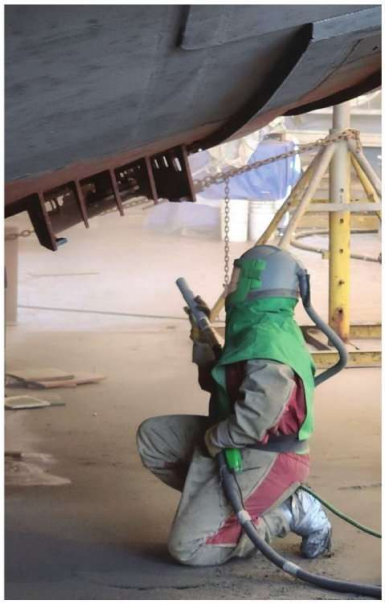


FIG. 4. Personal protective equipment can limit exposure to harmful contaminants, but workplace monitoring should also be employed.

FIG. 5. **The defense mechanisms of living lungs are amazing and complex. Lung toxicity comes down to whether dusts can be cleared by these mechanisms without excessive inflammation and cell damage.**

Moreover, the physical properties of the abrasive mixture – such as particle size distribution, shape, surface characteristics, and immunological clearance rate in living organisms – can significantly influence its potential health impacts. These properties affect how the material behaves when airborne, how deeply it can penetrate the respiratory system, its duration in the body, and how it interacts with biological tissues.

Toxicology is an immensely complex subject that cannot and should not be reduced to an elemental analysis of a material to measure trace quantities of listed metals and other substances. The results of such an assessment do little to properly inform employers or exposed workers who are concerned and uncertain as they face these exposure risks on a daily basis. The risks that worry them are real and the decisions they make have real health consequences.

Exposure Testing: The Gold Standard

Assessing the exposure risk of abrasives by merely examining their individual components is insufficient. The importance of whole-mixture exposure testing cannot be overstated. It allows for an evaluation of the combined effects of all components, including the effects of trace hazardous constituents and any synergistic or antagonistic interactions. It also accounts for the physical characteristics

PHOTO: KATERYNA KON/SCIENCE PHOTO LIBRARY / GETTY IMAGES

of the abrasive as they are actually present in a workplace, providing a more accurate picture of potential exposure risks.

This has long been well understood in the world of toxicology. Back in the 1980s and 1990s, silica sand was widely used as a blasting abrasive. There were growing concerns about exposure to the crystalline forms of silicon dioxide (quartz, cristobalite, and tridymite) in inhalable and respirable silica sand dusts, which were known to persist in the lungs and cause lung silicosis and sometimes cancer. There are documented cases of workers who ultimately died from the effects of long-term exposure to the dust from silica sand.

This led to a major push for alternative abrasives that contained little or no crystalline silica. Among these emerging substitutes were coal, copper, and nickel slag, staurolite, crushed glass, olivine, garnet, specular hematite, and steel grit. Because of the lack of available exposure data on abrasive materials other than silica sand as whole mixtures, in 2001 and 2002 the National Institute for Occupational Safety and Health (NIOSH) funded a series of short-term exposure studies in rats,[1,2] whose immunological reactions to toxic pulmonary agents were known to be similar to those in humans. These exposure studies included silica sand as a control, or as a basis for comparison, because similar exposure studies of silica sand dust had resulted in lung damage and fibrotic lung scarring in rats.

NIOSH funded the studies because there was no better way, outside of longer-term exposure testing, to make a valid assessment of whether these emerging substitute materials were any safer than silica sand. It was implicitly understood

The abrasive materials used to clean, profile and prepare surfaces can themselves pose long-term health risks to workers. This is why it is important to **understand the science** behind toxicity assessments and how they can and should be used to inform our decision-making.

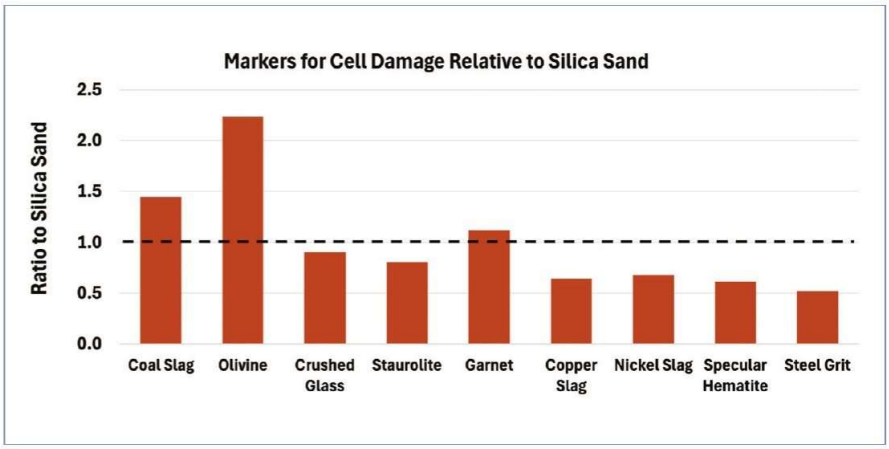


FIG. 6. The bars show the markers for cell damage from each of the nine alternative abrasives included in the NIOSH studies[1,2] as a ratio to the measured cell damage from silica sand. Some degree of lung damage was observed within four weeks of a single exposure to the dusts of all nine alternative abrasives.

that measurements of crystalline silica or the presence of any other toxic substances in the substitute materials could not be used on their own to provide a scientifically sufficient evaluation of their toxicity. It was presumed necessary to evaluate the substitute materials on the basis of exposure to the material dusts as a whole. The compositions of the individual abrasives were neither measured nor reported in these studies. The outcomes of interest were toxicological measurements in the lungs of the animals, which included biochemical markers for chronic inflammation and cell damage, along with pathological assessment of the animals' lungs for evidence of fibrosis.

Strikingly, after comparing the results of exposure to the dusts of the alternative abrasives with the results of exposure to silica dust, seven out of the nine abrasive substitutes studied, were shown to induce chronic inflammation, cell damage, and lung fibrosis similar to or worse than silica sand, despite having widely varying chemical compositions and containing little to no crystalline silica. The chart in **Figure 6** shows measured markers for lung cell damage relative to silica sand. The authors concluded that the persistent pulmonary inflammation and damage caused by the first seven abrasive blasting substitutes in Figure 6 suggest that they are not

CHART: COURTESY OF THE AUTHOR

nontoxic alternatives to blasting sand. A follow-up exposure study of a subset of these alternative abrasives by the National Toxicology Program in 2020[3] confirmed the results of the earlier NIOSH studies.

Exposure studies like these remain the gold standard for evaluating, quantifying, and confirming the toxicity of substances and mixtures. They provide the best possible data for evaluating whether an abrasive material dust is either toxic or could potentially cause cancer in workers from sustained exposure. The best way to know something is to measure it directly, which is what these exposure studies do.

Much More Work is Needed

While the results of the NIOSH and NTP exposure studies are certainly valid and informative, they were by no means extensive enough to develop dose-response relationships or to support conclusions about the toxicity or carcinogenicity of the alternative abrasives by agencies like ACGIH or IARC. The authors of these studies could only state that more exposure testing is needed.

It is for this reason that compliance with OSHA's Toxic and Hazardous Substances Standards for monitoring and quantifying air concentrations of listed hazardous substances is still required. We have historically been and are still today left with the inferior method of monitoring workplaces for hazardous abrasive ingredients in the air. As we discussed in this article, and as the vast majority of toxicologists know, and as the NIOSH and NTP exposure studies clearly showed, the toxicity of the constituents of a complex mixture are not necessarily indicative of the toxicity of the mixture as a whole.

Workplace monitoring using air sampling and concentration measurements of listed, regulated substances can also be misleading for reasons beyond those discussed in this article. Published data and peer reviewed studies have uncovered fundamental flaws in the methods used for workplace air sampling that are specific to abrasive blasting environments. These flaws render air concentration measurements invalid and vastly inaccurate, yielding misinformation that has the unintended consequence of driving decisions that may not be in the best interests of workers.

The next article in this series will provide an overview of the published research, quantify the inaccuracies, and discuss the implications in both regulatory policymaking and workplace decision-making. JPCL

ABOUT THE AUTHOR

PHOTO: COURTESY OF THE AUTHOR

Stephen Ricci is the Chief Executive Officer of 10X Engineered Materials and the inventor of the company's patented abrasives. He joined 10X as a partner and Chief Technology Officer in 2018. Prior to that, he was a director of R&D and new technology commercialization with Battelle Memorial Institute and Waste Hub for more than 25 years. Ricci earned a bachelor's degree in chemical engineering from the University of Pittsburgh and a Ph.D. in chemical engineering from Purdue University.

REFERENCES

1. Hubbs, et al. *Toxicological Sciences*, Vol. 61, pp. 135-143 (2001).
2. Porter et al. *Toxicology & Environmental Health*, Part A, 65, pp. 1121-1140 (2002).
3. NTP Technical Report on the Toxicity Studies of Abrasive Blasting Agents Administered by Inhalation to Rats, NTP Tox 91, July 2020.

FLOWING INTO THE FUTURE

Glen Canyon Dam Project Shows Evolution of Methods, Materials

At the beginning of September, the U.S. Bureau of Reclamation announced that a project involving the relining of four river outlet works at Glen Canyon Dam in Page, Arizona, had commenced – the first relining of the outlet structures since the dam was initially constructed 60 years ago. However, while the original coal-tar epoxy lining system on the four outlet works – also known as bypass tubes – were originally applied with brush and roller and touched up by hand over the decades, the current undertaking is employing an optimized lining system backed by laboratory testing and case histories on other Reclamation infrastructure, applied via robotic method.

This article outlines the scope of work and how this important piece of infrastructure is getting its own state-of-the-art upgrades that will improve its efficiency in delivering water and power, just in time for its 60th birthday.

FIG. 1: **The relining of the Glen Canyon Dam's four outlet structures *(bottom right)* recently commenced to coincide with the dam's 60th anniversary.**

FIG. 2: ***(Facing page)*** **Exterior view of the outlet structures, also known as bypass tubes.**

Project Background

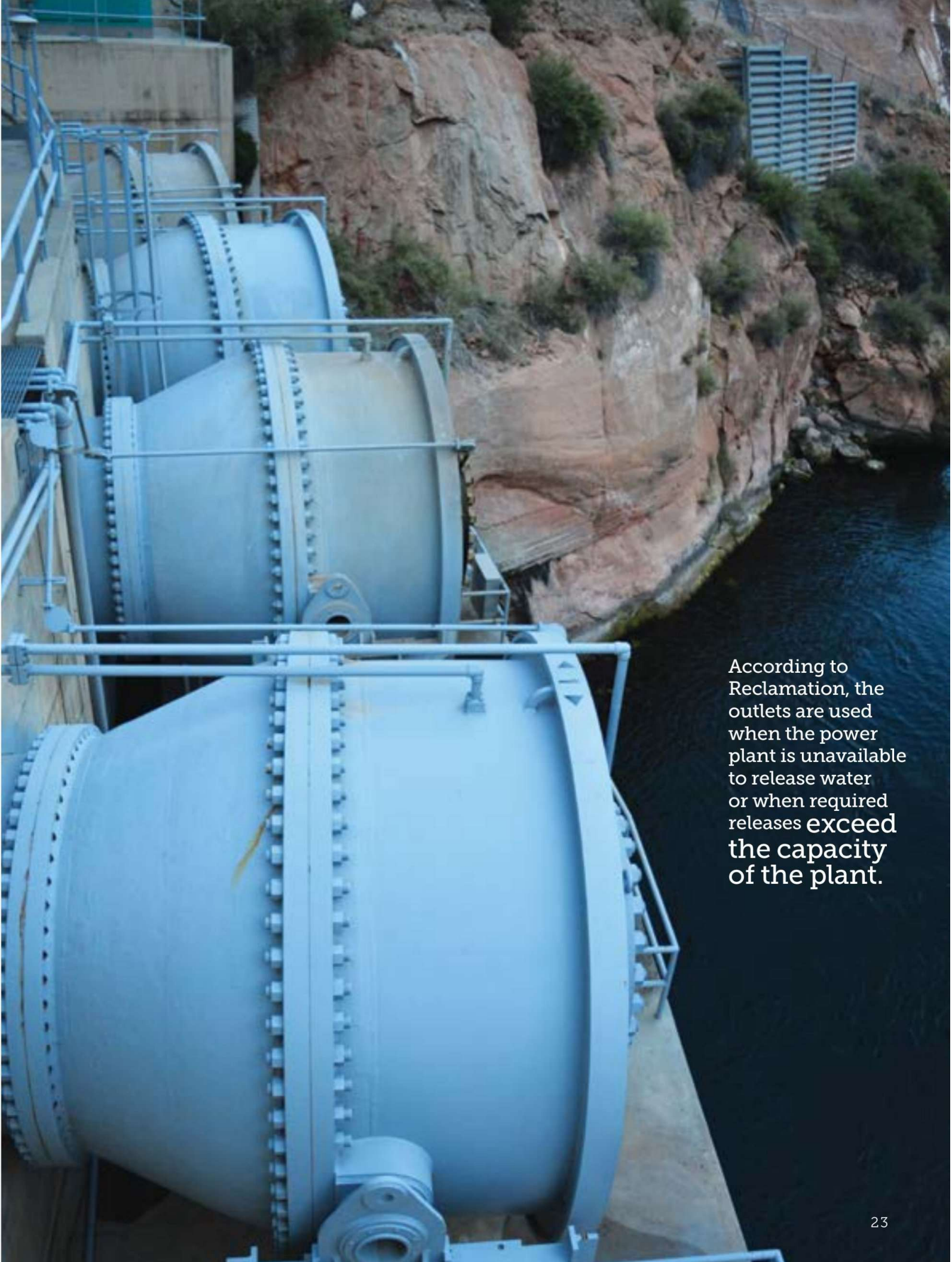
Construction for Glen Canyon Dam kicked off in 1956, with the authorization of the Eisenhower administration and the Colorado River Storage Project. By September of 1964, the project was completed, and the dam's power plant generated its first watts of hydropower.

Located in northern Arizona on the Colorado River, Glen Canyon Dam today impounds Lake Powell, the second-largest man made reservoir in the United States and the largest storage unit in the Upper Colorado Basin. It is an important water source for Nevada and other Colorado River states, as well as a source of hydropower for nearly 500,000 households in the U.S.

The outlets consist of four steel pipes that move water from Lake Powell directly downstream into the Colorado River, bypassing the hydropower generating units. According to Reclamation, the outlets are used when the power plant is unavailable to release water or when required releases exceed the capacity of the power plant. Over the years, the dam's outlets have not been used frequently, as water is almost always conveyed through the penstocks to produce hydropower before it is released downstream.

While Lake Powell was officially considered full for the first time in 1980 and saw record water levels in the ensuing years, by the 2000s the region started to experience a prolonged drought, and lake levels shrunk. These conditions presented

PHOTOS (THIS AND FACING PAGE): U.S. BUREAU OF RECLAMATION, CC BY-SA 2.0, VIA FLICKR.COM



According to Reclamation, the outlets are used when the power plant is unavailable to release water or when required releases exceed the capacity of the plant.

FIG. 3: **The outlets are most commonly opened during periodic high-flow experiments conducted by Reclamation.**

FIG. 4: **One of the four bypass tubes currently under containment while robotic blast-cleaning takes place in the interior.**

operational challenges as the dam's team worked to optimize power generation despite the reduced water levels.

As such, the outlets could be used more frequently, as experienced with the recent implementation of cool-mix flows, which release water from both the penstocks and river outlet works to send cooler water downstream and disrupt the spawning of nonnative fish below the dam.

Advanced Coating System

When constructed, the Glen Canyon Dam bypass tubes were coated with a coal-tar epoxy, which for many decades was considered one of the most effective and widely used coating systems for protecting steel infrastructure from corrosion. However, in recent decades, health safety and environmental issues associated with their application have led to a decline in – and in some cases, prohibition of – their usage.

Most recently, the outlet works' original coal-tar coating had been showing normal signs of wear and tear, and while spot repairs had been completed as needed over the years, the lining was finally due for a full replacement.

As such, the current project includes removing the old lining via abrasive blast-cleaning with a robotic blasting system. The blasting process is reportedly contained, with spent abrasive being vacuumed and recycled.

Next, the outlets will be relined with an epoxy primer and polysiloxane topcoat, applied via a robotic sprayer that lines pipes by traveling in a circuitous route along their interior. This lining system has been extensively studied in various laboratory tests and successfully applied to numerous infrastructure, including Fontana Dam in North Carolina), Pineview Dam in Utah and Grand Coulee Dam in Washington. The epoxy-polysiloxane system will reportedly provide corrosion protection, as well as abrasion and impact resistance for the tube interiors.

The contractor will reportedly work on one outlet work at a time, allowing the other three to operate as needed to continue sending cooler water downstream during the cool-mix flows.

Project Funding, Future

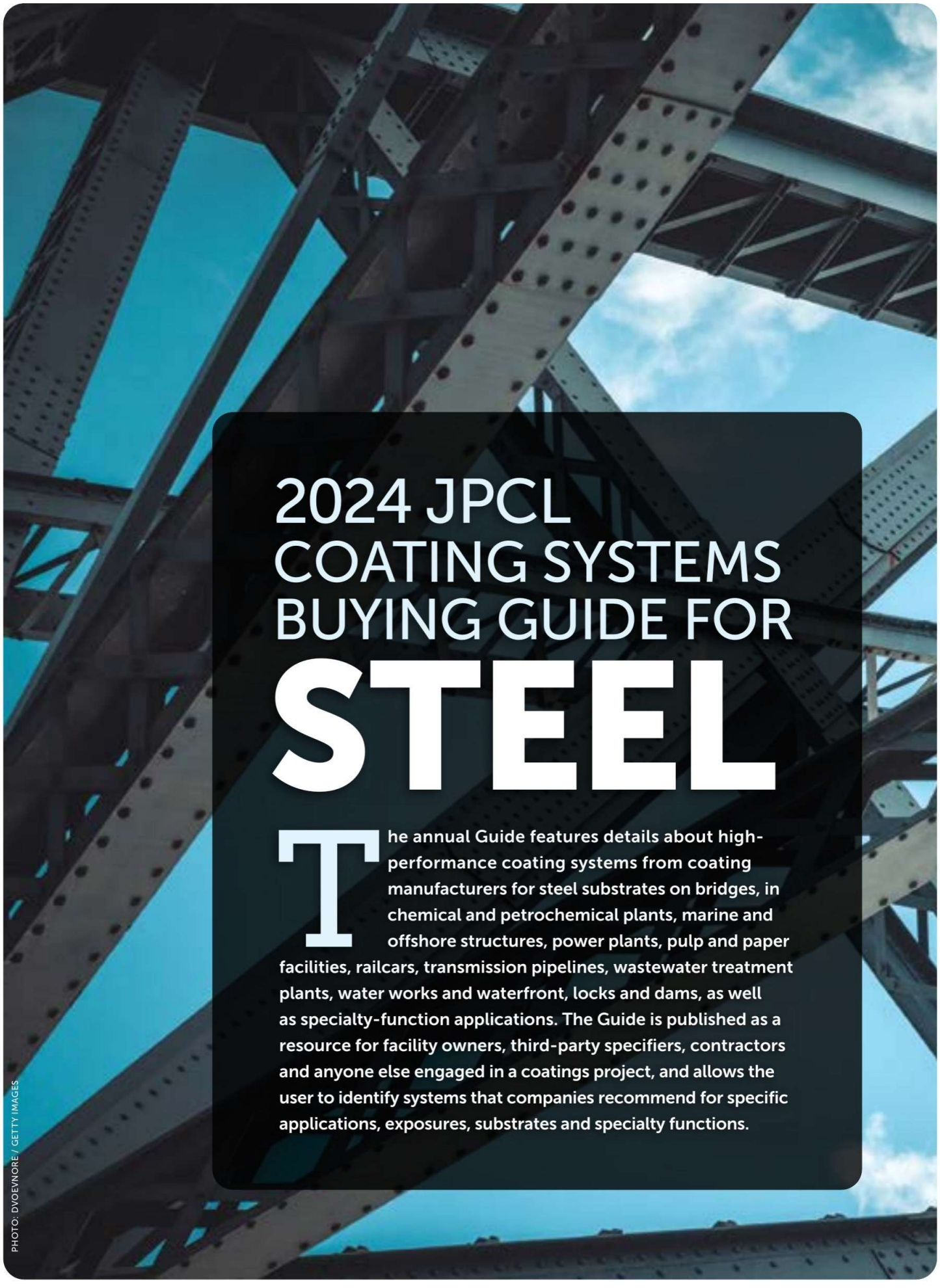
While outlet works maintenance was recommended after inspections in 2017, lower water levels in recent years created the potential for increased use of the outlets in coming years, making the relining project a more urgent priority, according to Reclamation.

The current outlet relining project, funded through an $8.9 million investment from the Bipartisan Infrastructure Law as part of the Biden-Harris administration's Investing in America agenda, will reportedly take one year to complete.

"It is Reclamation's duty and obligation to operate all of our facilities — including Glen Canyon Dam — in a safe manner and to maintain reliable downstream releases to meet the nation's water and energy needs," said Wayne Pullan, Reclamation's Upper Colorado Basin Regional Director. "The relining of the outlets ensures Glen Canyon Dam continues to operate in a manner that meets its congressionally authorized purposes safely and efficiently well into the future."

Reclamation also reported that it recently found new and minor cavitation damage during a high-flow experiment in April 2023. While they stipulated that relining the outlets won't prevent the risk of additional cavitation when operating at low reservoir levels, its recently developed interim operating guidance and additional analyses for the outlets will reportedly help Reclamation in reducing further risk. JPCL

Lower water levels in recent years created the potential for increased use of the outlets in coming years, making the relining project a more urgent priority.



2024 JPCL COATING SYSTEMS BUYING GUIDE FOR STEEL

The annual Guide features details about high-performance coating systems from coating manufacturers for steel substrates on bridges, in chemical and petrochemical plants, marine and offshore structures, power plants, pulp and paper facilities, railcars, transmission pipelines, wastewater treatment plants, water works and waterfront, locks and dams, as well as specialty-function applications. The Guide is published as a resource for facility owners, third-party specifiers, contractors and anyone else engaged in a coatings project, and allows the user to identify systems that companies recommend for specific applications, exposures, substrates and specialty functions.

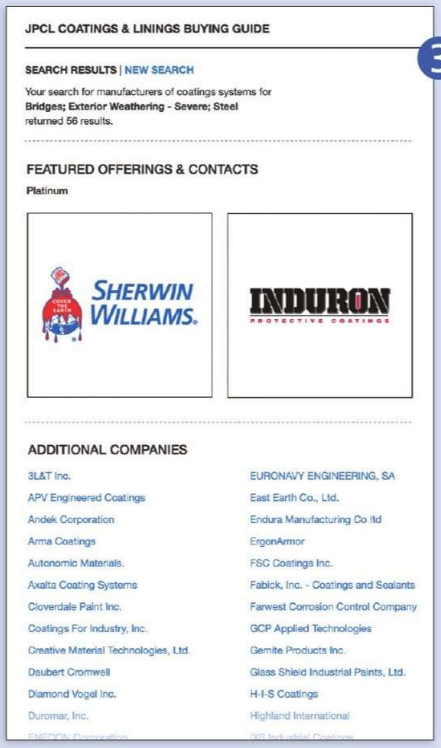
PHOTO: DVOEVNORE / GETTY IMAGES

In This Guide

How to Use the Online JPCL Buying Guides

1. Go to paintsquare.com/bg and click "SEARCH DIRECTORY"

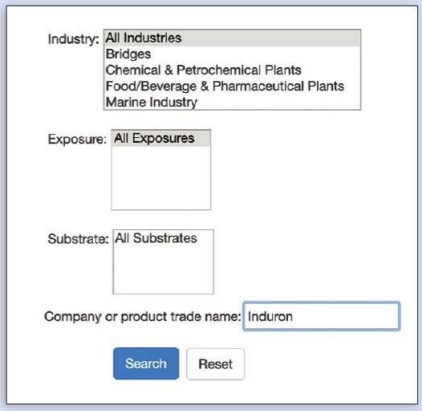
2. Choose desired categories and click "SEARCH" to return only those companies that offer what you need



3. Select a company name from the resulting list to view the supplier's profile, products and contact information. Featured suppliers offer additional content, including photos, videos, downloads and more!

OR

To search for a specific company or product, type the name into the "COMPANY OR PRODUCT TRADE NAME" field and click "SEARCH"



Bridges

EXTERIOR WEATHERING, MILD/MODERATE

Advanced Polymerics, Inc.
Anodeflex
APV Engineered Coatings
Arma Coatings
Carboline
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Fabick, Inc. – Coatings and Sealants
Farwest Corrosion Control Company
GCP
Gemite Products
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
Kaufman Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Rhino Flooring by Rhino Linings
Seal for Life Industries
Sherwin-Williams
Superior Corrosion Control
Termarust Technologies Inc.
Thermal-Chem Corp.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

EXTERIOR WEATHERING, SEVERE

Protek Paint Ltd
3L&T Inc.
Advanced Polymerics, Inc.
APV Engineered Coatings
Arma Coatings
Carboline
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Fabick, Inc. – Coatings and Sealants
Farwest Corrosion Control Company
GCP
Gemite Products
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
Kaufman Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Superior Corrosion Control
Termarust Technologies Inc.
Thermal-Chem Corp.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

Chemical & Petrochemical Plants

EXTERIOR PLANT EXPOSURE, MODERATE TO SEVERE (Chemical, Weathering & UV)

3L&T Inc.
Advanced Polymerics, Inc.
Andek Corporation
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
H&H Painting Co.
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
Kaufman Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermal-Chem Corp.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

LININGS FOR STEEL STORAGE TANKS & VESSELS (Solvents, Jet Fuel, Diesel, Gasoline, Crude Oil)

Anodeflex
Arma Coatings
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life
Sherwin-Williams
Thermal-Chem Corp.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings

LININGS FOR STEEL STORAGE TANKS & VESSELS (Acid, Oxidizer, Alkali)

Anodeflex
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings

LININGS FOR STEEL STORAGE TANKS & VESSELS (Process Water, Brine, Wastewater)

Anodeflex
Arma Coatings
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Fabick, Inc. – Coatings and Sealants
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC

LININGS FOR STEEL ... BRINE, WASTEWATER, CONT.

International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings

Marine Industry

EXTERIOR SUPERSTRUCTURES (Marine, Weathering & UV)

Advanced Polymerics, Inc.
APV Engineered Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
H&H Painting Co.
Highland International
Induron Coatings, LLC
International Metalizing Corporation
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Rhino Flooring by Rhino Linings
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

EXTERIOR DECK PLATE (Abrasion, Marine, Weathering & UV)

Advanced Polymerics, Inc.
Arma Coatings
Carboline
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
H&H Painting Co.
Induron Coatings, LLC
International Metalizing Corporation
Key Resin Company/FlowResin
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Rhino Flooring by Rhino Linings
Seal for Life Industries
Sherwin-Williams
SpeedCove, Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY

INTERIOR MILD

Advanced Polymerics, Inc.

INTERIOR MILD, CONT.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
Key Resin Company/FlowResin
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Rhino Flooring by Rhino Linings
Seal for Life Industries
Sherwin-Williams
SpeedCove, Inc.
Termarust Technologies Inc.
Thermion
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

BELOW WATER LINE

Anodeflex
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
Kaufman Products
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY

BALLAST TANK LININGS

Anodeflex
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Euronavy Coatings
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY

CARGO TANK LININGS

Anodeflex
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Fabick, Inc. – Coatings and Sealants
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Sherwin-Williams
SpeedCove, Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings

CARGO HOLD LININGS

Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Fabick, Inc. – Coatings and Sealants
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Sherwin-Williams
SpeedCove, Inc.
Thermion
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

Offshore Industry

JACKET, IMMERSED AREA

Anodeflex
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Duromar, Inc.
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
International Metalizing Corporation
Kaufman Products
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Seal For Life Industries BVBA
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.

JACKET, SPLASH ZONE

Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
International Metalizing Corporation
Kaufman Products
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Vertic Zinc Wire OY

JACKET, ATMOSPHERIC ZONE

Advanced Polymerics, Inc.
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell

JACKET, ATMOSPHERIC ZONE, CONT.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
International Metalizing Corporation
Kaufman Products
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Vertic Zinc Wire OY

TOPSIDES, SEVERE MARINE EXPOSURE

Acrymax Technologies, Inc.
Advanced Polymerics, Inc.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
International Metalizing Corporation
Kaufman Products
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
SpeedCove, Inc.
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Vertic Zinc Wire OY
ZRC Worldwide

Power Plants

CHEMICAL/WATER EXPOSURE (Caustic or Acid)

3L&T Inc.
Advanced Polymerics, Inc.
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Seal for Life Industries
Sherwin-Williams
Thermal-Chem Corp.
Thermion
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

CHEMICAL/WATER EXPOSURE (Wet Fly Ash)

Advanced Polymerics, Inc.
Arma Coatings
Blome International
Carboline
Cortec Corporation
Daubert Cromwell
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
US Coatings
ZRC Worldwide

CIRCULATING WATER PIPE

Anodeflex
Blome International
Carboline
Cortec Corporation
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation

CIRCULATING WATER PIPE, CONT.

NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPG
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings

FGD STACK INTERIORS

3L&T Inc.
Carboline
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Gemite Products
Highland International
International Metalizing Corporation
Key Resin Company/FlowResin
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPG
Sherwin-Williams
Thermion
US Coatings

FGD INTERIORS

3L&T Inc.
Blome International
Carboline
Duromar, Inc.
Enecon Corporation
Euronavy Coatings
Gemite Products
Highland International
International Metalizing Corporation
Key Resin Company/FlowResin
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPG
Sherwin-Williams
Thermion
US Coatings

Pulp & Paper

INTERIOR, NORMAL WET EXPOSURE

Advanced Polymerics, Inc.
Arma Coatings
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Sherwin-Williams
SpeedCove, Inc.
Termarust Technologies Inc.
Thermal-Chem Corp.
Thermion
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

INTERIOR, SEVERE WET END EXPOSURE (Paper Machines)

Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Sherwin-Williams
Termarust Technologies Inc.
Thermal-Chem Corp.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

INTERIOR, DRY EXPOSURE

Advanced Polymerics, Inc.
Arma Coatings
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
National Polymers Inc.
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Sherwin-Williams
Termarust Technologies Inc.
Thermal-Chem Corp.
Thermion
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

CHEMICAL EXPOSURE (Caustic)

Advanced Polymerics, Inc.
Arma Coatings
Blome International
Carboline
Cortec Corporation
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Sherwin-Williams
Thermal-Chem Corp.
Thermion
US Coatings
ZRC Worldwide

CHEMICAL EXPOSURE (Acid)

3L&T Inc.
Blome International
Carboline
Cortec Corporation
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Sherwin-Williams
Thermal-Chem Corp.
Thermion
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

Railcar Industry

EXTERIOR WEATHERING (UV, General Industrial)

Acrymax Technologies, Inc.
Advanced Polymerics, Inc.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Davis Paint Company
Duromar, Inc.
Highland International
International Metalizing Corporation
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPG

Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Thermal-Chem Corp.
Thermion
TMS Metalizing Systems, Ltd.
US Coatings
ZRC Worldwide

EXTERIOR WEATHERING (Railcar)

Acrymax Technologies, Inc.
Advanced Polymerics, Inc.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Davis Paint Company
Duromar, Inc.
Enecon Corporation
Highland International
International Metalizing Corporation
Oak Ridge Foam & Coating Systems, Inc.
Peerless Industrial Systems
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Thermal-Chem Corp.
Thermion
TMS Metalizing Systems, Ltd.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

LININGS FOR RAIL CAR INTERIORS (Acids)

Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Highland International
International Metalizing Corporation
Peerless Industrial Systems
PPG
Seal for Life Industries
Sherwin-Williams
Thermion
US Coatings

LININGS FOR RAIL CAR INTERIORS (Alkalis)

Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Highland International
International Metalizing Corporation
Peerless Industrial Systems
PPG
Seal for Life Industries
Sherwin-Williams
Thermion
US Coatings

LININGS FOR RAIL CAR INTERIORS (Bulk Solids)

Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Fabick, Inc. – Coatings and Sealants
Highland International
International Metalizing Corporation
Peerless Industrial Systems
PPG
Seal for Life Industries
Sherwin-Williams
SpeedCove, Inc.
Thermion
US Coatings

LININGS FOR RAIL CAR INTERIORS (Dairy)

Arma Coatings
Carboline
Cortec Corporation
Duromar, Inc.
Enecon Corporation
Highland International
International Metalizing Corporation
Peerless Industrial Systems
PPG
Sherwin-Williams
SpeedCove, Inc.
Thermion
US Coatings

LININGS FOR RAIL CAR INTERIORS (Hydrocarbons)

Carboline
Cortec Corporation
Duromar, Inc.
Enecon Corporation
Highland International
International Metalizing Corporation
Peerless Industrial Systems
PPG
Sherwin-Williams
Thermion
US Coatings

LININGS FOR RAIL CAR INTERIORS (Livestock Carriers)

Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Duromar, Inc.
Enecon Corporation
Highland International
International Metalizing Corporation
Peerless Industrial Systems
PPG
Sherwin-Williams
SpeedCove, Inc.
Thermion
US Coatings
Vertic Zinc Wire OY

Transmission Pipeline

EXTERNAL OF BURIED PIPE

Advanced Polymerics, Inc.
Anodeflex
Arma Coatings
Carboline
Cortec Corporation
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPG
Premier Coating Systems Inc
Seal for Life
Seal for Life Industries
Seal For Life Industries BVBA
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

INTERNAL OF BURIED PIPE

Anodeflex
Carboline
Cortec Corporation
Duromar, Inc.
Enecon Corporation
Gemite Products
Highland International
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPG
Seal for Life
Seal For Life Industries BVBA
Sherwin-Williams
Thermion
Tnemec Company, Inc.
US Coatings

FIELD JOINT COATING OF BURIED PIPE

Arma Coatings
Carboline
Cortec Corporation
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Farwest Corrosion Control Company
Gemite Products
Highland International
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPG

FIELD JOINT COATING OF BURIED PIPE, CONT.
Seal for Life
Seal for Life Industries
Seal For Life Industries BVBA
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

ABOVE GROUND PIPE EXTERIORS

Acrymax Technologies, Inc.
Advanced Polymerics, Inc.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
H&H Painting Co.
Highland International
H-I-S Coatings
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPG
Premier Coating Systems Inc
Seal for Life
Seal for Life Industries
Seal For Life Industries BVBA
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

Wastewater Treatment Plants, Municipal

EXTERIOR WEATHERING (UV & Mild Chemical)

Advanced Polymerics, Inc.
Arma Coatings
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
H&H Painting Co.
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
Kaufman Products
Oak Ridge Foam & Coating Systems, Inc.
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

INTERIOR EXPOSURE ENVIRONMENT

3L&T Inc.
Advanced Polymerics, Inc.
Arma Coatings
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
H&H Painting Co.
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Oak Ridge Foam & Coating Systems, Inc.
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Sherwin-Williams
Termarust Technologies Inc.
Thermion
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

IMMERSION (Wastewater Collection, Primary Treatment, Secondary Treatment)

Anodeflex
Arma Coatings
Blome International
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
Key Resin Company/FlowResin
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Seal for Life
Seal for Life Industries
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
ZRC Worldwide

IMMERSION (Tertiary Treatment)

Anodeflex
Arma Coatings
Blome International
Carboline
Cortec Corporation
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
Key Resin Company/FlowResin
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Seal for Life Industries
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings

Waterfront, Lock & Dam Industry

ONSHORE ATMOSPHERIC EXPOSURE (Weathering & UV, Airborne Salt)

Advanced Polymerics, Inc.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Daubert Cromwell
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.

Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

SPLASH ZONE EXPOSURE (Weathering & UV, Fresh or Saltwater Splash & Abrasion)

Advanced Polymerics, Inc.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
Kaufman Products
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

IMMERSION EXPOSURE (Seawater)

Anodeflex
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

IMMERSION EXPOSURE (Freshwater)

Anodeflex
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc

IMMERSION EXPOSURE (FRESH WATER), CONT.
Seal for Life Industries
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

Water Works

EXTERIOR EXPOSURE (Weathering & UV)

Advanced Polymerics, Inc.
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Seal For Life Industries BVBA
Sherwin-Williams
Termarust Technologies Inc.
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

IMMERSION EXPOSURE (Potable Water Approved)

Anodeflex
Arma Coatings
Carboline
Cortec Corporation
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Highland International
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPG
Seal for Life Industries
Sherwin-Williams
Thermion
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY

IMMERSION EXPOSURE (Non-Potable Water)

Anodeflex
Arma Coatings
Carboline
Cortec Corporation
Creative Material Technologies, Ltd.
Diamond Vogel Inc.
Duromar, Inc.
Enecon Corporation
Farwest Corrosion Control Company
Gemite Products
Highland International
H-I-S Coatings
Induron Coatings, LLC
International Metalizing Corporation
NSP Specialty Products
Peerless Industrial Systems
PPC Coatings (MTR)
PPG
Premier Coating Systems Inc
Seal for Life Industries
Sherwin-Williams
Thermion
TMS Metalizing Systems, Ltd.
Tnemec Company, Inc.
US Coatings
Vertic Zinc Wire OY
ZRC Worldwide

Specialty Functions

ANTI-GRAFFITI

Cortec Corporation
Duromar, Inc.
Highland International
H-I-S Coatings
Induron Coatings, LLC
Peerless Industrial Systems
PPG
Sherwin-Williams
Tnemec Company, Inc.

FIRE-RESISTIVE COATINGS: FIRE RESISTANCE UP TO 4 HOURS (UL1709 Rating)

Carboline
Peerless Industrial Systems
PPG
Sherwin-Williams

FIRE-RESISTIVE COATINGS: FIRE RESISTANCE FROM 1 TO 2 HOURS (UL1709 Rating)

Carboline
Peerless Industrial Systems
PPG
Sherwin-Williams

HEAT-RESISTANT COATINGS: DRY HEAT RESISTANCE FROM 201 F TO 450 F (99 C to 233 C)

3L&T Inc.
Carboline
Cortec Corporation
Diamond Vogel Inc.
Duromar, Inc.
Euronavy Coatings
Highland International
H-I-S Coatings
Peerless Industrial Systems
PPG
Sherwin-Williams
US Coatings

HEAT-RESISTANT COATINGS: DRY HEAT RESISTANCE FROM 451 F TO 800 F (234 C to 427 C)

3L&T Inc.
Carboline
Cortec Corporation
Diamond Vogel Inc.
Duromar, Inc.
Euronavy Coatings
Highland International
H-I-S Coatings
Peerless Industrial Systems
PPG
Sherwin-Williams
US Coatings

HEAT-RESISTANT COATINGS: DRY HEAT RESISTANCE FROM 801 F TO 1200 F (428 C to 649 C)

Carboline
Cortec Corporation
Diamond Vogel Inc.
Duromar, Inc.
Euronavy Coatings
Highland International
H-I-S Coatings
Peerless Industrial Systems
PPG
Sherwin-Williams
US Coatings

HEAT-RESISTANT COATINGS: UNDER INSULATION, WET HEAT RESISTANCE UP TO 300 F (149 C)

3L&T Inc.
Carboline
Cortec Corporation
Duromar, Inc.
Euronavy Coatings
Highland International
H-I-S Coatings
Peerless Industrial Systems
PPG
Sherwin-Williams
US Coatings

ANTIFOULANT & FOULANT RELEASE COATINGS

Carboline
Creative Material Technologies, Ltd.
Duromar, Inc.
Euronavy Coatings
International Metalizing Corporation
Peerless Industrial Systems
PPG
Sherwin-Williams

PAINT BY NUMBERS

310°F

The reported safe-to-touch temperature of external processing equipment surfaces coated with a new spray-on insulation coating from PPG. P4

200 GALS.

The approximate volume of protective coatings that were applied in total during a wastewater treatment plant rehabilitation project in the Village of Caseyville, Illinois. P8

29 CFR 1910.1200

The OSHA regulation outlining the agency's Hazard Communication Standard, which uses science-based evidence to outline workplace hazards. P12

4

The number of bypass tubes in the Glen Canyon Dam that are currently being abrasive blast-cleaned and relined using robotic equipment and novel coatings. P22

58

The number of product categories in the 2024 Coating Systems Buying Guide for Steel. P27

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