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Features

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Also This Month

From the Offices of SSPC

Staff

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How Good is a Certification?

A colleague of mine recently returned from a meeting in California and told me a story that should bother us all.

He was in a meeting and a discussion about a particular inspection training course came up. In this course, a student must pass a test, and if they show they have the required work experience, they may then receive the designation as a certified coatings inspector. This program is a one-week, very intense course.

I want to make it clear up front that the course I am referring to is not an SSPC course. An individual who was at the meeting said to my colleague that this particular course was too hard and that it was much easier to get a certification through another organization, which was where they were sending their people. The person also said that this organization's test was easier to pass and did not require experience.

That affirmed to my colleague and me that people are more interested in doing things the simple way and supervisors are willing to take the easy way out. This would result in unqualified people checking coatings jobs that might be worth millions of dollars who are not in fact knowledgeable enough to do so.

What is the long-term effect to the coatings industry and its reputation? Does this not cause bigger problems between owners and contractors when folks who are "certified" coatings inspectors don't really know what they are doing?

There is an SSPC contractor member, whom I know quite well, and one of the things he always talks about is certified inspectors who have no experience telling him how to do his work. This contractor's company is not a "fly by night" and has been in business for over 25 years. According to him, some inspectors are no longer documenting and reporting but causing unnecessary delays, confusion and arguments because they don't have the experience. They cause rework when it may be totally unrealistic to do so. I call this failing the "common sense test" as they may have overstepped their scope of duties.

We should make an effort to ensure that those getting certified have the knowledge and especially the experience to do the job we say they are specialists in. Is SSPC perfect at this and the way we administer our programs? Hell no! We put a lot of time and effort into ensuring that we do the best job possible to make sure the people we do certify do not let their employers or others they may be working for down. By checking their experience level when the certification program we administer requires it, we are able to uphold that standard.

I keep mentioning experience. I think this is critical to any certification process. I was an Armor/Cavalry officer in the Army. I went to my "basic course" and because I was in a branch that had big machines with big cannons, I decided to stay at Ft. Knox after that initial armor training and move on to the Motor Officer Course. In this program we went over forms and records and because I did not have the experience, it was difficult. I passed because I knew how to study. Did I really know what I was doing in the maintenance field? Again, hell no! I went to my first assignment and after four years in an armor unit in Germany I came back for another course that included additional maintenance forms and records and only then I could put the pieces together.

In our corporate certification programs, we require a company to have six months of production history to apply for certification. We want to ensure that they have had industrial coatings experience before we even start the certification process. So after you look at a piece of paper that says someone is certified, you might want to ask questions about their experience and really find out what they know, where they have been and what kind of jobs they have been involved in. It might just tell you how good their certification really is.

Bill Shoup
Executive Director, SSPC

Free Webinar on Prepping, Painting Pipe Girth Welds Offered

Webinar Education Series

Another new, free webinar will be offered this month as part of the 2014 SSPC/JPCL Webinar Education Series.

"Quality Control of Surface Preparation & Coating Installation/Pipe Girth Welds" will be offered on Wednesday, November 19, from 11:00 a.m. to 12:00 noon, EST.

Field coating of pipe includes surface preparation and application of coatings at the girth weld during installation of new pipe or replacement of existing coatings after excavation of existing pipe. Similar to any project involving coatings on steel, quality control of surface preparation and coating installation is paramount to the integrity of the pipeline. This webinar will describe the common methods of field surface preparation, as well as the quality control procedures and instrumentation associated with surface preparation inspection. The webinar also describes common methods of coating application in the field, along with the quality control procedures and instrumentation associated with verifying the proper installation of protective coating materials. Final quality control inspections performed prior to backfilling will also be described.

E. Bud Senkowski

This webinar will be presented by E. Bud Senkowski, P.E., a senior consultant at KTA-Tator, Inc. Senkowski holds a Bachelor of Science degree in fuel technology/fuel engineering from the Pennsylvania State University and an MBA from Drexel University. He is a registered professional engineer in eight states, a Certified Level 3 Nuclear Coatings Inspector under ANSI Code 45.2.6, a NACE Level 3-certified Coating Inspector and an SSPC-certified Coatings Specifier.

Senkowski has had 30 years of engineering experience with the Philadelphia Electric Company where he served as a principal consultant on the failure analysis, testing and specification of underground pipeline coating systems. He also directed a coatings test laboratory, supervised field coating inspection teams, recommended coating systems, prepared coating specifications and trained coating inspection personnel. He has an extensive background in the engineering, application and inspection of pipeline coating systems and joint repair materials. During 18 years at KTA-Tator, he has consulted on gas transmission projects and has both written and presented a training course entitled "The Selection, Installation, and Inspection of Pipeline Coating Systems".

Senkowski serves as an instructor in KTA coatings-related training programs, and has taught courses for the Electric Power Research Institute (EPRI) on Protective Coatings. He has served as the Chairman of ASTM Sub-Committee G3.06 on Pipeline Coating and Linings, and Vice-Chairman of ASTM Committee G3 on the Durability of Non-Metallic Materials. He has presented and published more than 28 coating-related technical papers to such diverse groups as the United Nations/EEC, NACE, EPRI and the American Gas Association. He also is a contributing editor for *JPCL*.

This webinar is sponsored by DeFelsko Corporation and Montipower, Inc.

Registration, CEU Credits

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

SSPC is an accredited training provider for the Florida Board of Professional Engineers (FBPE), and Professional Engineers in Florida may submit SSPC Webinar Continuing Education Units to the board. To do so, applicants must download the FBPE CEU form and pass the Webinar Exam, which costs $25.

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

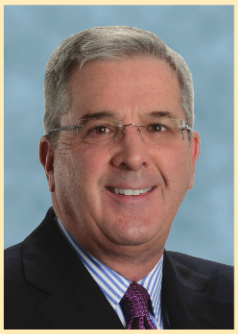
PPG Finalizes Comex Acquisition

Less than a week after PPG Industries announced that Mexican regulators had approved its $2.3 billion purchase of Consorcio Comex, the deal is done.

The Pittsburgh-based manufacturer announced late Wednesday (Nov. 5) that it had finalized the acquisition of Mexico's largest paint manufacturer—the second-largest acquisition in PPG's history.

The announcement came just days after PPG said that the Federal Economic Competition Commission of Mexico had green-lighted the deal, clearing the way for completion.

The deal gives PPG, already the world's largest paint and coating maker, a huge foothold in the booming Latin American coatings market—a rare area where the Pittsburgh company had had little presence.



Both PPG President and CEO Charles E. Bunch (left) and Comex CEO Marcos Archar Levy saw major benefits for their companies in the $2.3 billion acquisition. Photos courtesy of PPG.

Comex Clout

Founded in 1952, Comex manufactures coatings and related products in Mexico and sells them in Mexico and Central America through more than 3,700 stores that are independently owned and operated by more than 700 concessionaires.

Comex also sells its products through regional retailers and wholesalers, and directly to customers. The company has approximately 3,900 employees, eight manufacturing facilities, and six distribution centers. Comex reported about $1 billion in sales in 2013.

"We are pleased to have successfully completed this acquisition, the second-largest in our company's history, as it adds a leading architectural coatings business in Mexico and Central America to our portfolio," said Charles E. Bunch, PPG chairman and CEO. "We look forward to working with the Comex team as we integrate the business into PPG." - See more at: http://corporate.ppg.com/Media/Newsroom/2014/PPG-completes-acquisition-of-Comex#sthash.NXD9KyEI.dpuf

Fast Track

The massive PPG deal sailed through without a hitch in just four months, after The Sherwin-Williams Co. struggled for nearly two years to make the same deal.

PPG first announced its bid for Comex on June 30. In October, the company said antitrust regulators needed more time to review the deal. On Friday (Oct. 31), however, PPG announced that Mexico had blessed the deal.

And by Wednesday, the ink was dry.

By contrast, Sherwin-Williams announced its $2.34 billion bid for Comex in November 2012.

Over the next 16 months, Mexican regulators twice shot down the biggest part of the deal: the purchase of Comex's Latin American business. (Sherwin-Williams, the largest U.S. paint retailer, completed the acquisition of Comex's North American business last year.)

Finally, in April, Sherwin-Williams gave up on the deal, quickly spurring a lawsuit by Comex shareholders.

It may never be clear why the PPG bid did not raise the same concerns with Mexican regulators that the Sherwin-Williams proposal did. In any case, PPG was jubilant over the deal, said Charles E. Bunch, PPG chairman and CEO.

"We are pleased to have successfully completed this acquisition, the second-largest in our company's history, as it adds a leading architectural coatings business in Mexico and Central America to our portfolio," said Bunch.

"We look forward to working with the Comex team as we integrate the business into PPG."

The Buzz on PaintSquare.com

Hot! This Month

Painters Serve a Storied Battleship *(Oct. 9)*

The International Union of Painters and Allied Trades District Council 711 of New Jersey has volunteered painters and materials to paint the *USS New Jersey*, the most decorated battleship in U.S. history.

The so-called "Firepower for Freedom Restoration Project" on the 45,000-ton *Iowa* class battleship has been underway since Sept. 29 in Camden, NJ, the ship's home.

Four painters, rotating in teams of two, are working on the ship, power washing and applying new base coats and top coats. The Haze Gray coating system was donated by Sherwin-Williams. Additionally, IUPAT is working with the AFL-CIO's Union Organization for Social Services on potentially identifying and hiring a local resident for repainting work. The project got another boost Oct. 2, when 27 employees from New Jersey American Water's Delaware River Region Water Treatment Plant and its Delran Operations Center volunteered to help.

PSN TOP 10 *(as of Sept. 28)*

- Water Tower Painters Killed in Fall
- Fatality, Wind Close OR Bridge
- Victim's Kin Fights for Minimum Fine
- Probe: Attitudes Doomed Mall
- U.S.-Ordered Sale to Profit Graco
- Military Coatings Mission Accomplished
- Storm-Damaged Tunnels Need $689M
- Bridge Engineer Impostor Fined
- New Water Issues Bedevil Bay Bridge
- A Plant to Capture, Clean and Convert

Now Buzzing on PaintSquare. . .

Storm Damaged Tunnels Need $689M *(Oct. 8)*

Amtrak tunnels in New York City will require $689 million to repair corrosion and cracking caused by Superstorm Sandy in 2012, according to a new engineering report.

Andrew Piedl: *"So the most used rail line in the country … will be a single track for a year? And it took almost two years to complete an assessment report? How many vice presidents does Amtrak have?"*

Four Plead Guilty in TBT Paint Scam *(Oct. 7)*

Four Florida men and two companies have pleaded guilty to selling toxic boat paint they had previously agreed to stop manufacturing.

David Fernee: *"Not a bad trade. $2 million profit, $1.2 million fine."*

Students Tackle Corrosion in 2 Contests *(Oct. 10)*

NACE is challenging students to solve this country's corrosion problems, from bridges to defense systems, in a pair of competitions. Corrosion In Motion is a global video competition that invites high school and college students to educate others about corrosion and how it affects society. NACE has also teamed up with the U.S. Department of Defense to launch the University Student Design and Applied Solutions Competition — the first competition focused on finding groundbreaking corrosion control solutions, according to the association.

David Reynolds: *"As you throw your weight into these worthwhile and enjoyable competitions, keep a view toward how we allow corrosion of capital assets … to progress so far. … Best wishes to you and a hearty thanks to your sponsors."*

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Problem Solving Forum

On Surface Prep in Non-Sparking Environments

How should surface preparation be conducted in non-sparking atmospheres?

Francis Goss
Weserwind Offshore Construction
I am assuming that the danger of explosion has to do with the mixture of chemical fumes and oxygen. In a confined space (for example, a large tank) there may be chemical remains on the surface you will be working on. These must be removed. Ventilation alone is not the answer. Be careful! Gather all necessary information possible about the chemical. Inform your local or state officials. Let them decide how the removal/cleaning should be done. After the cleaning, let them decide when it is safe to work. This process will probably cost you a lot more money. But please don't put a price tag on the life that could be lost just to save a few dollars.

Om Prakash Jat
Self-Employed
Prior to starting surface preparation, especially in confined spaces such as vessels, stacks and tanks, we have to check and confirm there are no toxic gases through a Dräger test and air ventilation, and have a hole watcher, a fireman and an in-out attendant to be 100 percent sure there are no life-threatening hazards. Scaffolding also must be checked prior to use. Using power tool cleaning or blasting with metallic abrasive increases the danger of working in confined spaces. After all precautions are taken, we can start surface preparation.

Gavin Gooden
Blast-One
The sparks produced by blasting are called "cold sparks," meaning they are caused by friction and you are more likely to have a problem with static electricity. We refer to the report done by Thornton Laboratories, Shell Research Ltd, UK, and other studies that have examined the occurrence of sparks produced during abrasive blasting. All studies have shown that abrasive blasting using compressed air as the propellant produces "cold sparks," which are incapable of igniting hazardous combustible atmospheres. These studies have been done using different abrasives such as copper slag and steel grit (Thornton/Shell UK), as well as silica

sand (Bradley, National Safety Council Congress, USA). Chemically, garnet and copper slag are both inert silicates, containing iron and aluminum in different proportions. Copper slag has a higher iron content while garnet has more aluminum. However, sparks are the result of friction and not material chemical composition. Smaller particles produce less friction than coarse particles, which explains why there are only smaller sparks when using garnet at 30/60 mesh, compared to a coarser copper slag of 12/40 mesh. Obviously, because of the high iron content in steel grit, it will produce a higher intensity spark. Two common abrasives used in explosive atmospheres are a natural garnet mineral abrasive or a bicarb soda abrasive.

Gilbert Urma
HHIC-Phil

Waterjetting, if appropriate to the area and the surface preparation grade, does not create sparks that can lead to an explosion.

M. Haliwell
Thurber Engineering Ltd.

Forgive my ignorance here. I do not usually work on the technical aspects of coatings (usually the environmental aspects of the same jobs), but would dry ice blasting (get rid of the spark source) or atmospheric inerting (get rid of the non-spark atmosphere) be options?

Aldrin Cordovez
Kuwait Oil Company

If the area where you are working requires no sparks allowed, the most suitable type of surface preparation is wet abrasive blasting, preferably using garnet as abrasive. Alternatively, ultra-high-pressure water jetting may be considered.

SSPC PROTECTIVE COATINGS SPECIALIST

Q&A with Lisa Houpe

Charleston Marine Containers

By Charles Lange, *JPCL*

Lisa Houpe is the paint process engineer at Charleston Marine Containers, a manufacturer of intermodal, modular intermodal and specialty container systems for the U.S. Military and other clients. Based in Charleston, S.C., the company provides containers ranging in size from 6 feet to 40 feet, as well as refrigerated containers field-proven in combat zones to highly integrated containerized solutions for the commercial industry.

She is responsible for all management aspects within the company's paint department, including specifying coatings to meet military and commercial standards, environmental documentation and reporting, ISO quality documentation and training. She holds certificates for SSPC's C1, C2 and C3 courses and SSCP certifications for Abrasive Blasting (C7), Paint Application (C12), Waterjetting (C13), NBPI Basic Paint Inspector and the PCS. She is also an instructor of several SSPC courses.

JPCL: How did you get your start in the industry?
LH: I started in the coatings industry right out of high school in 1988, painting special clear coats on military aircraft components with an airbrush gun, and loved it. I got a job with a new manufacturing plant building semi trucks. During the eight-week training period, I was asked if I wanted to be in the paint department. I had never used anything other than an airbrush gun, but I was willing to learn and said yes. They sent the paint department to the Dupont Paint School in Atlanta for a week for training. At the end of the course, I actually ended up winning $20 for best overall spray out of a class of 16 men and two women. I really enjoyed automotive painting and learned quite a bit. I painted a truck for a friend, as well as my brother's Jeep.

In November of 2000, I received a call from my ex-supervisor asking me to visit his place of employment. When I got there I found out the visit was actually an interview. The company was having a lot of paint problems and was in need of painters. I got a call from the plant manager three days later offering me a painter position. I was a little nervous because they were using industrial paint and high-pressure paint equipment, which I had never used before. I jumped right in bound and determined to learn as much as I could, and after three days as a painter I was promoted to paint trainer. A couple of months later, I was promoted to paint supervisor. It was then that I met my mentor, Earl Bowery, the technical sales rep for one of our paint suppliers. Earl, who is also an instructor for SSPC and NACE, taught me a lot and encouraged me to take the SSPC training classes.

JPCL: Your company manufactures specialty container systems for the U.S. military, among other commercial clients. How do you go about making sure that your products meet the needs, requirements and specifications for such important, high-stakes clients such as the military? What are some of the considerations you need to take into account?
LH: I quickly learned that industrial painting and automotive painting are very different. Taking what I've learned in automotive painting and incorporating it into industrial application worked well in setting up a standardized paint process. I worked with the painters on their paint technique and implemented a start-and-stop spray pattern, which they use to paint every container. In doing this approach, we've improved the overall quality of the paint application and greatly reduced the risk of some of the most common defects such as overspray, dry spray, holidays and paint runs.

If you think about it, no matter what the paint system is, the same basic steps are always done: clean, prep, clean, prime, stripe and topcoat. The only thing that changes

from one paint system to another is the type or degree of surface prep and the type of paints being used or the number of coats. Each station has written work instructions as well as documented quality inspection requirements and critical quality checks that must be met before moving to the next station. Following this process ensures that we are putting out a quality product.

JPCL: As an SSPC instructor, can you talk about the importance of making sure that industry professionals are receiving the proper training and certifications for the work that they are doing? How have your certifications helped you in your work?

LH: Receiving proper training is so crucial in this industry. So many times in my career, I've interviewed painter candidates that have had years of painting experience but couldn't tell you what pot life is or even know what a wet film thickness reading is or what it is used for. Having the proper training is the only way to completely have confidence that the job is being done correctly.

The certifications I have and being an instructor for SSPC have helped me tremendously. Having the knowledge to train your own painters or blasters saves a lot of time and the headache of trying to set up classes. I am able to troubleshoot issues on the line myself and don't need to wait for the paint manufacturer to send their technical representative to evaluate the problem.

Houpe painted this Jeep for her brother, a senior chief in the U.S. Navy.

JPCL: Have you seen any changes in the roles that women play in protective coatings over the course of your career? Do you think that the future is brighter for female protective coatings professionals than it might have been when you first started in the industry?

LH: I will tell you starting out, especially in the industrial paint industry, I was very intimidated talking to vendors and asking questions as most of them felt like they had to give a "paint lesson" before talking to me. Once they saw that I knew what I was talking about and really understood, that quickly went away.

I have seen more women in the training classes and even instructing the classes for SSPC. I believe women are accepted more now than they were when I first started out. I've actually trained several women painters in my facility, and most of them run circles around the male painters.

JPCL: What has been the highlight or proudest moment of your career thus far?

LH: I would have to say receiving my PCS certification was one of the proudest moments of my career. Achieving that, in my opinion, has given me the greatest sense of accomplishment. I've had the opportunity to travel to China a couple of times to help set up a documented paint process there. As an instructor for SSPC, I've been able to travel to a lot of very cool places, but the best one was instructing a couple of classes in Hawaii.

My brother is a senior chief in the Navy and has been stationed away from home more than 22 years out of his 24-year career, and being able to spend time with him and show him what I've learned by painting his Jeep was by far my proudest moment. It's hard to compete with a career like that, but I think he was impressed.

JPCL: What are some of your interests outside of coatings? How do you like to spend your free time?

LH: One of my favorite things to do is spending all the time I can with my fiancé, Denny, and our beautiful kids, Michael, 24; Trey, 21; Drayton, 9 and Emory, 7. Denny always has something cooking on the grill and we love to hang out and spend time with family and friends. When we aren't cooking, we are on the water fishing or crabbing every chance we get. Denny and I painted our 14-foot aluminum boat in a digital camouflage pattern, which goes to show that even in free time, it seems like I'm always painting something.

Fig. 1: This tank lining showed insufficient resistance to the acidic tank contents. Photos courtesy of KTA-Tator, Inc.

Oops, Wrong Paint!

What Can Happen When the Service Environment Isn't Characterized or the Wrong Coating is Selected

By Rick A. Huntley, PCS, Senior Coatings Consultant, KTA-Tator, Inc.
Richard Burgess, PCS, KTA-Tator, Inc., Series Editor

Typically when a premature coating failure is encountered, it is assumed that either there was a mistake made during the surface preparation and/or the application of the coating, or that there was something seriously wrong with the formulation of the coating. In fact, in the majority of cases, one or more of these circumstances is exactly what happened. Sometimes, though, the surface preparation and the application are top-notch, and the coating is a quality product that was formulated and manufactured to exacting standards, and yet the coating still fails prematurely. In these cases one has to look elsewhere to determine the cause of the coating failure and ask the question, "Was this the right coating for the job?"

There are literally thousands of different coating products, each appropriate for some type of service environment. When a coating system is specified for a project, much effort is taken to assure that the surface preparation is adequate and the thickness of the coating is appropriate. Yet, in some cases, not enough thought is given to whether the coating system itself is appropriate for the service environment to which it will be exposed and the surface to which it will be applied, and both must be considered when a coating system is chosen.

Fig. 2: Peeling resulted after application of this white coating, which was incompatible with the factory-applied gray coat.

Given the vast number of coating products available and the multitude of different service environments to which they can be exposed, there are probably hundreds of different ways that a coating can fail if the wrong coating is selected for a particular environment. These failure mechanisms include, but are not limited to, rust-through, peeling, chemical degradation, chalking and cracking.

Substrate Consideration

Several years ago, a large warehouse was newly constructed, and the warehouse floor was to consist of coated poured concrete. The original specification called for an epoxy floor coating to be applied, but the engineer asked for an alternate system based on cost. Ultimately, an equipment enamel was chosen to coat the floor. The floor was well-prepared using a portable centrifugal

Fig. 3: The coating used on this metal roof had poor UV resistance and degraded significantly.

blast unit and the coating was applied to the recommended thickness, yet one month later the applied coating began to soften and deteriorate. The equipment enamel was based on alkyd resin, which deteriorated due to the presence of moisture and alkalinity in the concrete in a process known as saponification. This failure was described in further detail in a previous F-Files article, "Saponification: From Paint to the Grave." (*JPCL,* May, 2014).

This alkyd coating, while perfectly suitable for its intended purpose of coating metal surfaces of equipment, was clearly the wrong product for this concrete substrate. Similar problems could arise if the same alkyd coating was applied to galvanized steel surfaces (even if those surfaces were on equipment), because zinc corrosion products are alkaline and will similarly deteriorate the alkyd paint in the presence of moisture.

Other coating failures can occur if a coating is not well-suited for the substrate. For example, coatings for wood can be problematic, especially on exterior exposure environments. Wood expands and contracts cyclically upon exposure to moisture. Coatings that are applied to wood must have sufficient flexibility to resist cracking when the substrate underneath is expanding and contracting. Applying a hard brittle coating to wood in this exposure environment will ultimately lead to premature cracking of the coating.

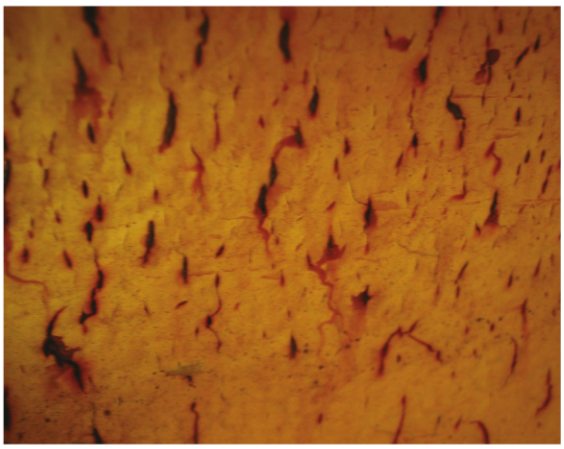


Fig. 4: This failure was caused by an epoxy coating that was not intended for immersion service.

Surfaces that have been previously coated should also be considered, including when items are supplied with the shop primer or the OEM coat of the wrong type or color, or when surfaces are being recoated. In any case, the newly applied coating must be compatible with the existing coating. Peeling is the most common type of coating failure that can occur when previously applied coatings are overcoated. This problem can be avoided by choosing a compatible coating that is known to achieve sufficient adhesion to the previous coat or sometimes by roughening the surface of the previously applied coat. Roughening the surface may also be necessary when the recoat window has been exceeded.

Another type of failure can occur when a relatively hard, brittle coating is applied over a soft, flexible coating. One such example occurred at an iconic midwestern Major League Baseball stadium. Structural steel columns at the stadium had previously been coated with a soft black bitumen coating. As part of a renovation project, the columns were painted with a white epoxy topcoat. Although this coating had been used successfully on many tons of structural steel, it quickly cracked over the bitumen coating. Solvents from the epoxy had softened the bitumen coating, and when the epoxy cured, it developed cohesive stresses. Because the bitumen coating underneath the epoxy was soft enough

to move slightly under the stress, the epoxy coating cracked, creating an alligator skin pattern also known as "alligatoring."

Service Environment Consideration

A more common mistake associated with choosing the wrong coating system is the failure to properly characterize the service environment to which the coating will be exposed, or simply choosing the wrong coating system for a known environment. There are several environmental factors that affect a coating's ability to perform. These factors include, but are not limited to, temperature extremes, pH, solar radiation (sunlight), chemicals, solvents, immersion or splash and physical damage.

Exposure to temperature extremes can cause a coating system to deteriorate quickly. In chemical plants and other manufacturing facilities, the normal operating temperature range of the equipment used in the process is typically determined before a coating system is selected for that equipment. There have been many instances where either the temperature range was not well understood during the design phase, or upset conditions occurred where the temperatures rose above expected operating temperatures. Coating systems must be planned to withstand the highest temperatures to which they may be exposed. It is not uncommon for an industrial coating to have a temperature limitation of 250 F or 300 F. Once the temperature increases above this level, the resin in the coating will begin to char as chemical bonds in the coating begin to break. Eventually the coating deteriorates, usually turning dark brown, and coating failures such as cracking and peeling often follow.

Failure to choose a coating that adequately resists exposure to sunlight on exterior substrates can lead to premature failure of the coating. This type of failure is commonly found even with consumer paints. Different types of coatings have varying resistances to solar radiation. Latex paints that are commonly purchased by homeowners in paint stores or home remodeling stores generally come in interior and exterior versions. The exterior latexes are generally based on acrylic resin technology and have good resistance

to the ultraviolet (UV) spectrum in sunlight while the interior latexes are based on polyvinyl acetate (PVA) and have poor resistance to both UV light and water. The UV light will degrade this resin system and the interior paint will chalk severely if exposed.

Epoxies have notoriously poor resistance to the UV spectrum in sunlight and chalk readily upon exterior exposure. The aesthetic issues associated with the chalking may not be a problem when the structure is not in an area where the public can see it, but sometimes the chalking is so severe that the coating loses thickness in a process known as erosion. The coating chalks and rain washes the chalk away, exposing more coating. The newly exposed coating chalks and the deterioration continues until most or all of the coating is eroded away. The coating is then no longer able to protect the substrate from corrosion.

When a PVA block filler is used on exterior concrete block, the block filler will deteriorate in areas where moisture is prevalent. This is a common occurrence especially in areas with significant amounts of rainfall. The PVA block filler is well suited for interior applications but is prone to premature failure on exterior exposures.

Sometimes the severity of the environment is not understood well enough or is underestimated. This can happen in coastal areas where metal structures are frequently exposed to airborne salt mist, regardless of whether or not they are located directly on the coastline. Coating systems that are designed to protect inland metal structures are often inadequate to protect the metal near saltwater coasts. For example, an alkyd system may be sufficient to protect steel in inland areas as long as the steel is not exposed to other corrosion-producing elements. On the seacoast, application of the same alkyd coating as the primary barrier coat will likely lead to premature rusting and rapid deterioration of the steel.

Coatings that are exposed to immersion in water or a water solution can fail catastrophically if the wrong coating is selected for that application. If the coating is generically unsuitable for constant immersion, the failure can be almost 100 percent. Even if the coating has a resin type that is generally considered to be compatible with immer-

sion service, it is important to choose a coating that is formulated specifically for immersion. For example, epoxy coatings are generally suitable for immersion, but there are specific products that are formulated with appropriate solvents and pigments to perform well in immersion. An epoxy coating not specifically formulated for immersion may absorb and transfer too much water to perform adequately and rusting and/or delamination may occur.

Condensation can cause similar failures as well. This has occurred on tank exteriors where groundwater was being transferred to the tanks almost constantly. During the summer months the temperature of the groundwater was consistently less than the exterior air temperature resulting in continuous condensation on the exterior of the tank. The exterior coating was in constant contact with this water, similar to the immersion service on the inside of the tank. The exterior coating blistered and delaminated as if it had been put directly into immersion service.

Conclusion

The list of failures that can occur if the wrong coating system is selected and installed is almost endless. Care should be taken to choose a coating system that will perform in the most severe scenario of the intended service environment and to clearly convey that information to the coating manufacturer so that appropriate recommendations can be made. There are plenty of opportunities for something to go wrong on a coatings project without allowing coating selection to be among them. Spend adequate time evaluating the substrate and service environment. After all, you don't want to be the one to say, "Oops, wrong paint."

About the Author

Rick Huntley is the technical manager of consulting services and a senior coatings consultant for KTA-Tator, Inc. He is a NACE-certified Coating Inspector Level 3 (Peer Review) and an SSPC-certified Protective Coatings Specialist. He is a primary instructor for various KTA training courses and holds a Bachelor of Science degree in chemical engineering from Washington State University.

Records of Work and Working Conditions

With the world becoming more and more complicated, you may not be receptive to the idea that more and more records will make your life easier.

However, if some very stern-faced people were to ask you, "Where were you on the night of August 30, 2014?" or if tax officials were to "invite" you and all your recent tax records down for an office visit, you would be keenly aware of how important good records can be.

You or your supervisor must keep records of work and working conditions to acquire cost accounting and bidding information, to guard against unwarranted claims of faulty workmanship and to assure the quality control of your work and its compliance with specifications.

This article gives an overview of the type of work records that should be kept for any blasting and painting project. It is not claimed to be a definitive list, but highlights the majority of often-overlooked areas.

Editor's note: This Applicator Training Bulletin is an update of an article written by Merce Gordon of Advantage Inspection Company that was originally published in the September 1989 issue of JPCL. *It was revised for the January 1999 issue of* Protective Coatings Europe (PCE) *by Brian Connell of Anti-Corrosion Inspection Services and was then updated for this issue by Brian Goldie, technical editor,* JPCL.

Photo: iStockphoto.com/rappensuncle

Kinds of Records

Prior to the start of any project, there are a number of initial records or documents that you should have, maintain or be able to refer to either at a central location or at the job site. Equally important are the records that you create of the actual work progress and of the working conditions.

Keeping Existing Records

Already existing records will include job specifications and change orders to the specifications; work orders; application data sheets and material safety data sheets (MSDS) for the paint or linings being used; pertinent standards such as visual standards (SSPC-VIS 1), surface preparation standards (SSPC-SP 1, 2, 3/NACE No. 1, 2, 3; SSPC/NACE WJ-1, 2, etc.) paint application standards (SSPC-PA 1, 2, 3/NACE No. 10, 11, etc.), job-prepared visual standards, if any; other standards that may be necessary; MSDSs for materials to which painters and blasters might be exposed on the worksite (other than coating or lining materials); and pre-job meeting notes.

When it is necessary for workers or supervisors to read any of these documents, the records should be signed and kept to show that they have received and read the material. When it is necessary to explain and discuss any of these documents, records should be kept of the meetings. Such records should include the date, time and location of the meeting, and the signatures of the attendees.

Creating In-Process Records

As you work, it is necessary to follow specification requirements. It is good practice to document that you have met these requirements for two main

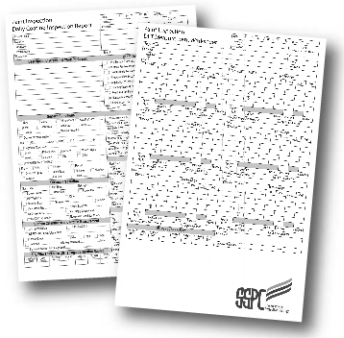


Fig. 1: Contractors can use these documents, taken from SSPC's Quality Control Supervisor (QCS) course, to record daily coatings inspections and dry film thickness measurements from the field. Courtesy of SSPC.

reasons. First, it verifies your quality control checks of the work. Second, the documentation can help you make your case in a dispute.

If you check the quality of the work as the various steps are carried out, then whatever corrections are necessary to the work can be made immediately rather than at a final inspection, when corrections are likely to be very costly and time-consuming.

In other words, you should be your own inspector, and not rely on the inspection of the owner or his representatives, even though the owner will certainly want to have his employees or representatives inspect the work. In this way, you take responsibility for the quality of your work.

Records can be kept in the format of a daily diary, or they can be kept on preprinted forms, which might be preferable because they are more organized and they have labeled spaces for recording all the kinds of information required. Figure 1 shows examples of forms that contractors can use to record daily coatings inspections and dry film thickness measurements.

In recent years, some companies have also developed new digital record-keeping software and applications for contractors to utilize on jobsites. These new programs cut down on paperwork and allow contractors to organize and store records in one digital location.

General information required in preparing records on a given day of work includes the date, report number, location of the work, job number, contractor's employees at the worksite, and the unit or structure on which work is being conducted. Specific information that may need to be recorded relates to the work being conducted and the nature of the day's operations (i.e., hand tool cleaning, water washing or abrasive blasting).

In-process records must be kept to include the following steps:

- Assessing the appropriateness of environmental conditions for work to commence;

- Maintaining, setting up and operating blasting and other cleaning equipment;
- Cleaning or preparing surfaces;
- Mixing and thinning coatings;
- Applying coatings; and
- Assuring the safety of personnel.

Each of these items will be discussed with respect to records that should be maintained.

Environmental Conditions

You should record environmental conditions before you begin work to determine if they are within the parameters established by the specification and/or by the application data sheets for the coating material. In most instances this will include, but may not be limited to, air temperature, temperature of the substrate surface, humidity and dew point. If there are substantial changes in weather once the work begins, the time and nature of the changes should also be recorded.

Blasting Equipment

When quality control checks are made on blasting equipment, such as needle gage readings of pressure at the nozzle, blotter tests for cleanliness of compressed air, moisture checks on the air supply, sieve tests and contaminant tests for abrasives or other similar tests to assure compliance with project specifications, the method of test and results should be recorded.

Surface Preparation

The contractor or his or her personnel should record the pre-surface preparation condition of the structure to be treated, as well as the degree of preparation achieved after the work is done and the method by which it is verified. These methods include visual observation for compliance with the written words of the appropriate standard, as well as the use of NACE coupons, SSPC visual standards or job-prepared standards. In addition, he or she should record checks for compliance with surface profile requirements in the specification along with the testing method used (i.e., surface profile comparator or replica tape). In some instances, tests may also be required to determine the chemical cleanliness of a steel surface.

Mixing and Thinning

To record compliance with job specifications and application data sheets, the contractor or his or her personnel should record the kind and amount of thinners used for

each batch of paint mixed, and the induction time allowed for two-component materials.

Batch numbers of paint material as well as the generic type, proprietary name and amount used should always be recorded. Applicators get blamed enough when failures occur, but the fault may lie with an improperly formulated batch of paint. If adequate records of paint batches are kept, this possibility can be checked. The shelf life of the paint material should also be noted, and storage requirements as described in application data sheets should be observed.

Applying Coatings

In the process of applying coating materials, applicators should be trained to take wet film thickness readings, as required, to assure that dry film thicknesses will be in compliance with specifications. Once a coating has dried sufficiently, the applicator should take dry film thickness readings and record them. SSPC-PA 2 gives guidance on the number and locations of dry film thickness readings required. Records of any other testing required in the specification, such as holiday and gloss testing, must also be kept.

Personnel Safety

Last but certainly not least, records should be kept of how various health and safety regulations for a particular job were met, including the use of personal protective equipment (PPE) and access equipment. Also important is the recording of personnel training in the use of dangerous tools, such as ultra-high-pressure waterjetting (UHP WJ) equipment, and in safety procedures involving dangerous work practices, such as accessing confined spaces. Detailed information of this kind will prove to be most valuable in the unfortunate event of a job-site accident.

Conclusion

For contractors, the recording of in-process inspection is necessary to assure compliance with specifications and to control the quality of work. Records also provide historical information on the amount of labor required for specific tasks and therefore can be used as a basis for bidding future work. The contractor who keeps thorough and accurate records also has a basis for presenting his case in the event of a dispute.

JPCL

Machinery Foundation Grouting

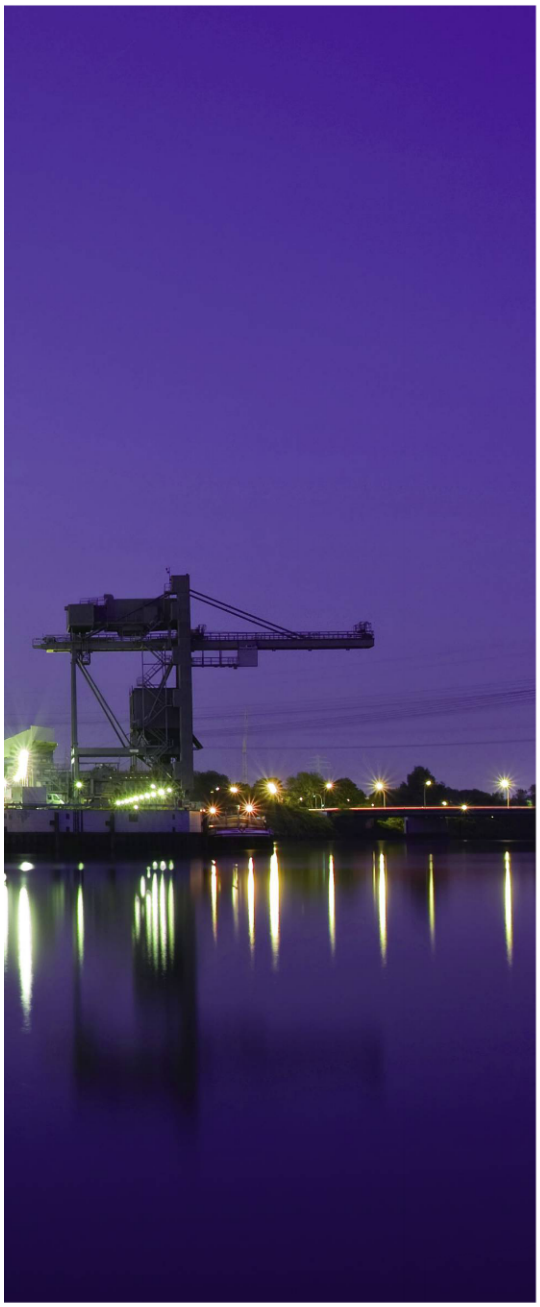
Performance Solutions that Challenge Movement

By Fred Goodwin & Frank Apicella, BASF Construction Chemicals

Rotating equipment and heavy machinery cannot simply be installed on a concrete foundation since irregularities in both the machine base and concrete surface will create load-bearing issues and alignment difficulties. Additionally, a concrete foundation is not tough enough to withstand the compressive and dynamic loading needed to support the heavy machinery. For this reason, machinery bases are aligned and leveled by shims or jack bolts above the mechanically prepared concrete foundation and the resulting space between the machine base. This space is filled with a machinery grout for load and energy transfer from the equipment into the foundation.

The grout must be fluid enough to be poured or pumped under the baseplate to completely fill this space and must also maintain its volume throughout the service life of the equipment to ensure intimate contact between these surfaces for maximum load-bearing capability. Additionally, the grout must exhibit the necessary mechanical properties such as high ultimate compressive strengths over a variety of application and service temperatures.

One of the challenges of quality machinery grouting is proper material selection for lasting security, stability and alignment of the critical equipment it supports. All grout manufacturers publish physical properties of their products, determined either from tests performed in-house or by an independent testing laboratory. But these properties are not uniformly reported, as many of these tests are modified and different



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test methods are used depending on the grout composition (i.e., epoxy or cement). There is no clear justification for using different test methods to measure the same performance properties between grouts when determining suitability of use. The test methods specified to determine the critical performance properties of any grout should be dictated by the function and not by the grout chemistry.

This article compares the key performance properties of two types of grout using identical testing methods so that a comparison of performance properties can be made on an apples-to-apples basis to aid in selection of the best grout for a particular application. Results are presented for an epoxy grout and an ultra-high strength hydraulic grout (known as hybrid performance grout in this article). Interviews conducted with design professionals and contractors provided identification of the following critical performance factors for machinery grouts:

- Compressive Strength
- Creep Resistance
- Modulus of Elasticity
- Fatigue Resistance
- Impact Resistance
- Coefficient of Thermal Expansion
- Flowability and Bearing Area

Compressive strength ranked as the most important property in material selection, but flowability and bearing area are just as critical. If the grout can't be placed properly under the base plate to support the machinery, does it really matter what the compressive strength of the grout is? Therefore, the combination of factors of compressive strength, flowability and bearing area together, are critical for overall long-term performance. In addition, for the grout to be durable, it must be able to withstand the fatigue from repeated loading, resist impact and have a compatible coefficient of thermal expansion to the surrounding materials.

Compressive Strength

Compressive strength is a measure of the maximum load the grout can withstand and is a significant predictor for many of the other critical performance parameters. Most machinery grouts will exhibit compressive strengths of 5,000 to 18,000 psi (34.5 to 124 MPa) to bear the weight of the particular equipment they support.

There are many ways to test for a material's compressive strength.

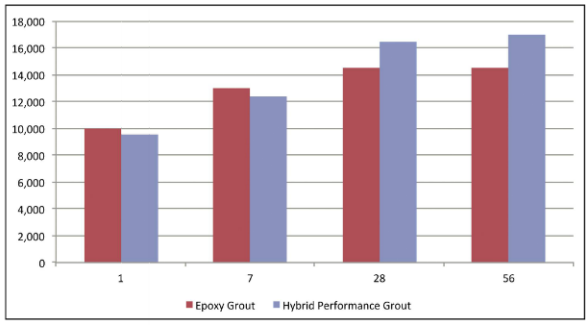


Fig. 1: This graph shows the compressive strength of both grout types at 70 F as per ASTM C579, "Standard Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes."

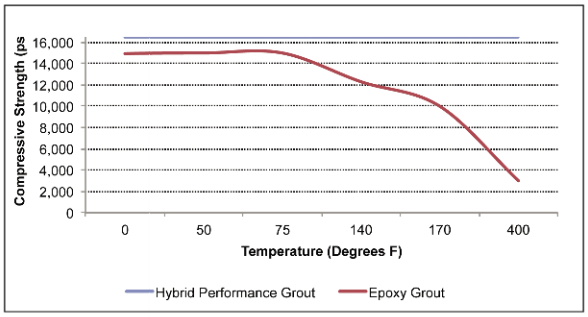


Fig. 2: This graph describes compressive strength affected by temperature. The hybrid performance grout was cured for 28 days at 73 F and the epoxy grout for 24 hours at 73 F, and then post cured 16 hours at 140 F. Both grouts were then conditioned for 24 hours at test temperature.

Different test methods and protocols yield different results, so it is important to specify a standard method to make a fair comparison between different grouts. These differences are due to geometries of the test specimens, such as aspect ratio (ratio of the test specimen's length to the area loaded), and to the rate of loading.

The ASTM test method for determining compressive strength in this study is ASTM C579, "Standard Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes." There are three different methods for determining compressive strength in ASTM C579. Method B for 2-inch (50-mm) cubes should be used, as this method is for the size of the aggregate commonly used in these grouts. The testing equipment should be properly set for the travel rate of 0.2 inches per minute (5 mm per minute). Using travel rates higher than this can result in artificially high compressive strength values and create a risk of selecting a grout that may have inadequate compressive strength. Rigid metal molds should always be used when casting specimens. Avoid plastic inserts as the surfaces are not planar and can result in reduction of the tested strength.

As Figure 1 (p. 29) illustrates, epoxy grouts can reach over 12,000 psi (83 MPa) after a few days of cure. The hybrid performance grout has similar strength development compared to an epoxy grout, but with a higher ultimate strength.

Having compressive strength properties greater than the concrete foundation, does not guarantee satisfactory performance. The selection process must take into account the service operating temperature conditions of the grout.

Very few large machines operate at ambient conditions. The heat generated by the equipment ultimately affects the foundation grout. The compressive strength reported at laboratory conditions does not always reflect the compressive strength at operating temperatures, as shown in Figure 2 (p. 29).

The epoxy grouts have reduced compressive strength as the temperature increases while the hybrid performance grout maintains its compressive strength even at much higher temperatures.

As an industrial machine warms up to its operating temperature, its alignment can be altered if the grout loses strength with higher temperatures. Therefore the engineer should specify the compressive strength of the foundation grout at the operating temperature of the equipment.

Table 1: Creep resistance tested using ASTM C1181

Epoxy Grout	Hybrid Performance Grout
0.0035 in/in	0.0023 in/in
(3,500 microstrains)	(2,300 microstrains)
ASTM C1181	
600 psi, 140 F (4.1 Mpa, 60 C)	

Creep Resistance

Creep resistance is a time-dependent measure of the dimensional change of the grout under constant load. It is a permanent, long-term deformation that a grout experiences over time. Excessive creep can cause equipment misalignment and loss of torque in anchor bolts. Creep is measured in microstrains where 1 microstrain equals 1 millionth of a unit length of deflection occurring in 1 unit length of material (i.e., 1 microstrain equals 1 millionth of an inch, per inch). Creep can ultimately cause enough deflection in a grouted baseplate to adversely affect machinery alignment resulting in premature wear or failure of bearings and other rotating parts.

There are several methods to determine the creep behavior of materials such as bricks, lumber, and concrete. Compressive creep for grouts should be tested per ASTM C1181, "Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts." When specifying creep properties, it is necessary to include the temperature and loading requirements as these properties are not part of the test method and changing them can affect the reported results. This way, materials can be selected based on an equivalent comparison
(Table 1).

The hybrid performance grout exhibits extremely low creep compared to an epoxy grout due to its high strength and modulus over a wide range of temperature extremes.

As operating temperatures increase, so does creep. The same forces that result in lower compressive strength also accelerate permanent deformation of the grout under applied loads. High creep resistance at equipment operating temperatures is essential to maintaining critical equipment alignment and long-term service life.

Modulus of Elasticity (MOE)

Different types of testing methods are used to determine the modulus of a material. Selection of the right method depends on what type of stress is acting on the material. Shear stress should use modulus of rigidity; volumetric stress should be reported as bulk modulus, and direct stress as modulus of elasticity. The modulus of elasticity measures the ability of the grout to resist deflection under load and is the measure of the "stiffness" of a grout. A higher modulus material produces less deflection under a given load.

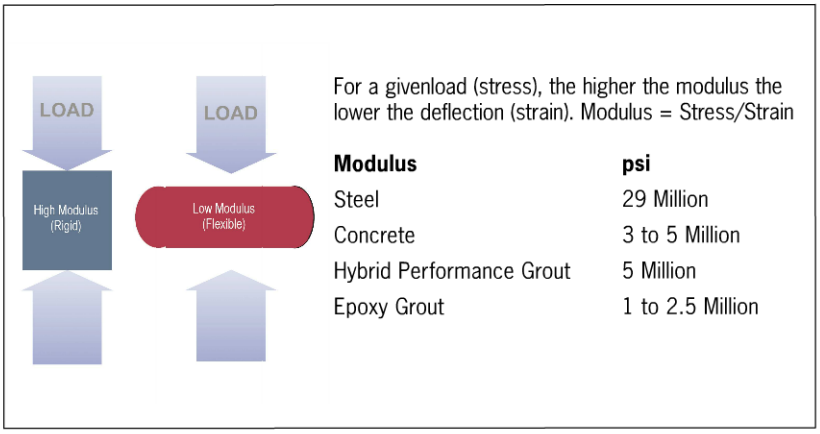


Fig. 3: Modulus of elasticity can be measured using ASTM C580, "Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes." This test determines the ability of the grout to resist deflection under load. Too low of a modulus can result in excess deflection.

MOE is tested per ASTM C580, "Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes." Typical modulus values for steel, concrete, epoxy grout and the hybrid performance grout are compared in Figure 3. The hybrid performance grout values are very close to the modulus of concrete. Epoxy grouts have a modulus of elasticity lower than concrete and will exhibit more deflection than the hybrid performance grout under the same loading conditions.

As an industrial machine warms up to its operating temperature, its alignment can be altered as the grout modulus decreases with higher temperatures for epoxy grouts. To some extent, a reduced modulus helps grout absorb and dissipate forces from operating conditions; however a significant reduction of modulus will adversely affect the equipment as dynamic forces occur. Therefore grouts should be specified that retain modulus at the highest expected operating temperatures.

Fatigue Resistance

During their lifetime, grouts are exposed to millions of dynamic load cycles that need to be transferred or absorbed by the grout. Fatigue resistance determines the ability of the grout to resist cyclical loading under simulated conditions of service for rotating or reciprocating equipment. Fatigue occurs when a material is subjected to repeat loading and unloading. If the loads are above a certain threshold, microscopic cracks will begin to form. Eventually these cracks will grow to a critical size leading to fracture and reliability issues.

The only standardized test to measure fatigue performance of grouting materials is the Det Norske Veritas:

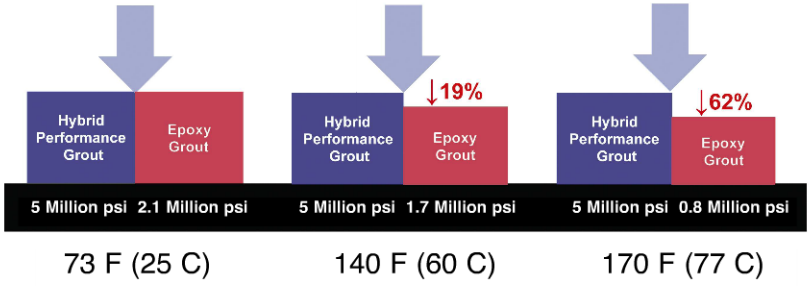


Fig. 4: This figure shows modulus of elasticity affected by temperature. Epoxy grout was cured for 24 hours at room temperature and post cured 16 hours at 140 F. Hybrid performance grout was cured for 28 days at 73 F. Both grouts were then conditioned for 24 hours at test temperature.

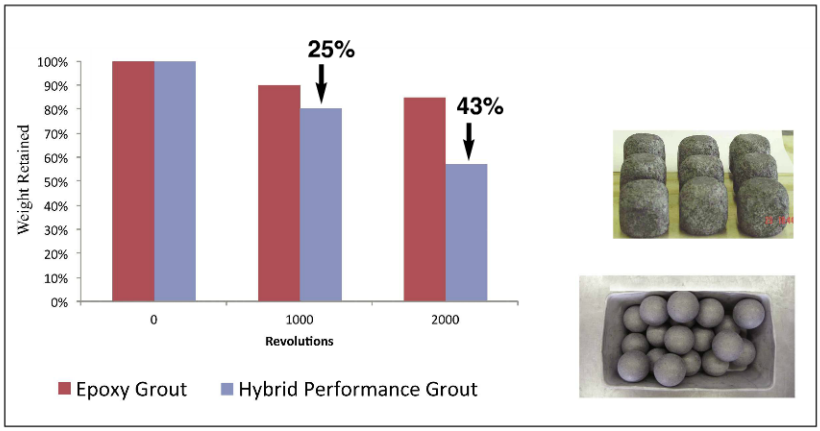


Fig. 5: This figure displays the results of the impact resistance test performed as per ASTM C535 with the hybrid performance grout after 2,000 cylcles (top) and the steel impact balls used in the test.

Concrete	6.5x10-6 in/in/F
Steel	6.5x10-6 in/in/F
Hybrid Performance Grout	5.7x10-6 in/in/F
Epoxy Grout	19x10-6 in/in/F

Fig. 6: Coefficient of linear thermal expansion was tested using ASTM C 531 and recorded results of a temperature change from 73 F to 210 F.

DNV-OS-C502, "Offshore Concrete Structures (DNV)" used in offshore wind turbine structures. The DNV method uses specimens cyclically loaded at 5 Hz for 2,000,000 cycles.

The epoxy and hybrid performance grout were cyclically loaded at 40 percent of their ultimate compressive strength with no damage.

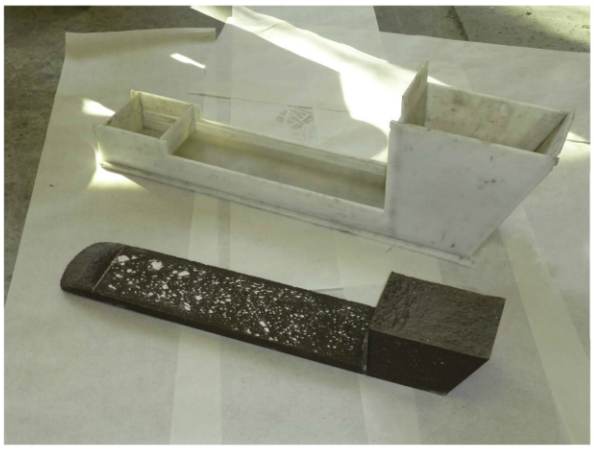
Impact Resistance

The impact resistance of grouts can be measured with the equipment of ASTM C131, "Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine" or ASTM C535 for coarse aggregate. When evaluating the impact resistance of grouts, 2-inch (50-mm) cube specimens are prepared, weighed and placed into a rotating steel drum containing 2-inch diameter steel ball bearings, and rotated at a speed of 32 rpm. A shelf within the rotating drum creates a crushing impact effect while the tumbling of the cubes with the ball bearings creates abrasion. After every 500 revolutions the cubes are removed, weighed, and the drum is cleaned. This process is repeated for a total of 2,000 revolutions.

The epoxy grout lost 25 percent mass while the hybrid performance grout lost 43 percent mass. The results indicate that the epoxy grout has higher impact resistance and toughness than hybrid performance grout (Fig. 5, p. 31).

Coefficient of Thermal Expansion

The coefficient of linear thermal expansion (CTE) measures a length change of a material as the temperature changes. Temperature changes in a grout occur diurnally, seasonally and from ambient-to-equipment operating temperatures. The CTE value represents the amount each material will expand or contract when a one-degree increase or decrease in temperature occurs. The CTE is expressed in units comparing the length change per degree of temperature change (i.e., inches per inch per degree F) of the material. The closer the CTE between two materials, the more compatible they become over a wide range of temperature changes. This is because they will tend to grow and shrink at the same rate as the temperature changes. Materials in contact with each other with significantly different



	Hybrid Performance Grout	Epoxy Grout
Flowability (fill time)	<1 minute	15-60 min
Effective Bearing Area	95-98%	40-95%

Fig. 7: Flowability and bearing area were tested using a head box (left) as per ASTM C1339.

CTEs experience stresses at the interface, which can lead to cracking or loss of bond. The hybrid performance grout is much more dimensionally compatible with steel and concrete over a wide range of temperatures compared to the epoxy grout (Fig. 6, p. 32).

Flowability and Bearing Area

The objective of foundation grouting is to achieve ease of placement and flowability in order to properly reach all areas to be grouted while the grout remains in contact with the baseplate.

By obtaining maximum contact underneath a baseplate, the grouted equipment is stable and any imposed loads are evenly distributed to the foundation. This lengthens the life of the equipment, the grout and the foundation. Bearing area and flowability are determined by ASTM C1339, "Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts." In this test, the grout is poured through a head box, a type of funnel that creates hydraulic head to assist gravity flow into the defined grout cavity.

The measured flow time is the length of time that the grout takes to flow the length of the box and the fill time is how long the grout takes to completely fill the area under the simulated baseplate. Once hardened, the baseplate is removed and the grout surface is abraded to open air bubbles and voids formed under the baseplate. The amount of effective bearing area is determined by visual comparison to a standard to estimate what percentage of the grout would actually be supporting the baseplate (known as effective bearing area, or EBA). The hybrid performance grout's flow characteristics and EBA are superior to an epoxy grout (Fig. 7, p. 32)

Summary

One of the challenges of grouting is the material selection based on critical performance properties. Many of the tests used to generate performance properties are commonly modified making the values not uniformly reported. This creates difficulty when design professionals must make informed decisions regarding grout selection. Comparing key performance properties generated with the same testing protocols, one can readily see where both the hybrid performance grout and epoxy grouts perform well.

Epoxy grouts offer excellent strength development, durability and impact resistance but can have performance gaps in creep resistance

and elevated temperature service. A hybrid performance grout can bridge this performance gap in many situations; as well as offer simplicity of packaging, mixing and cleanup.

From a chemistry standpoint, hybrid performance grouts are based on hydraulically active minerals and additives that provide for ultra-high strength development with desirable placement characteristics and performance in severe service environments required for today's grouting of industrial equipment.

Fred Goodwin, fellow scientist, product development BASF Construction Chemicals, is a chemist with over 30 years of experience in the construction chemicals industry, including cement manufacture, research, development and technical support of grouts, adhesives, coatings, shotcrete, stucco, flooring and concrete repair materials. He has been with BASF and its predecessors for 25 years and is an active member of ICRI, ACI, ASTM, NACE, SDC and SSPC. Goodwin is a fellow of ACI and ICRI, an Honorary Member of ASTM C1 + C9, current chair of the ICRI Technical Activities Committee (TAC), ACI 515 Protective Systems, ASTM C09.41 Cement Based Grouts, SSPC 8.3 Commercial Floor Coatings and a member of ACI TAC. Goodwin is also a guest lecturer for the Grouting Fundamentals short course (Colorado School of Mines) and was awarded the *JPCL* Editors Award in 2006, 2010, and 2012 as well as the ACI 2011 Delmar Bloem Distinguished Service Award. He is a NACE Corrosion Technologist, holds four U.S. patents and was named a Top Thinker in *JPCL*'s Annual Bonus issue of 2012. Goodwin also frequently speaks at national conventions.

Frank Apicella is the research and development manager for inorganic chemistry at BASF Construction Chemicals. He has over 25 years of experience in the development of hydraulic and polymer-based protection and repair products for the construction industry including adhesives, coatings, concrete repair mortars, floors, composite systems, and machinery grouts. He is an active member of the ACI, SSPC, NACE and ICRI. JPCL

Gaining Traction

By Erick Iezzi, James Tagert, James Martin, Paul Slebodnick and John Wegand,
U.S. Naval Research Laboratory
Center for Corrosion Science and Engineering

Low VOC and Sprayable Siloxane Non-Skid/Non-Slip Coating for the U.S. Navy & Non-Military Markets

The Navy has need for non-skid coatings so that sailors can maneuver on a ship's deck and equipment, machinery and aircraft do not slide when operating at sea. Non-skid coatings for Navy use must be qualified by military standard MIL-PRF-24667C, "Performance Specification: Coating System, Non-Skid, for Roll, Spray, or Self-Adhering Applications." Currently in compliance are two-component epoxies with various sizes of aggregate. The vast majority of these non-skid coatings are qualified as either MIL-PRF-24667C, Type I (high-durability, rollable deck coating) or Type V (extended durability, rollable deck coating), which provide up to 12 or 36 months of service life, respectively.

Since the inception of this standard these non-skid coatings have been applied with a napless roller to generate a rough "peak and valley" profile (Fig. 1, p. 37) thereby providing a skid/slip-resistant surface once cured. The roll application of non-skid coatings is a slow, manual process and the appearance of the peak and valley profile has subtle variations over the deck. Inadequate profile and appearance, such as slumped peaks, can lead to reduced traction for maneuvering on decks under wet and dry conditions, whereas non-skid with thin, sharp peaks can injure sailors and easily tear the suits of divers when used on the turtlebacks of submarines. Non-skid coatings that are roll applied too thin on decks, or where coverage in the valleys is of insufficient film thickness, can also lead to the early onset of corrosion, thereby resulting in an unsightly appearance and premature replacement of the non-skid before the service life has been reached.

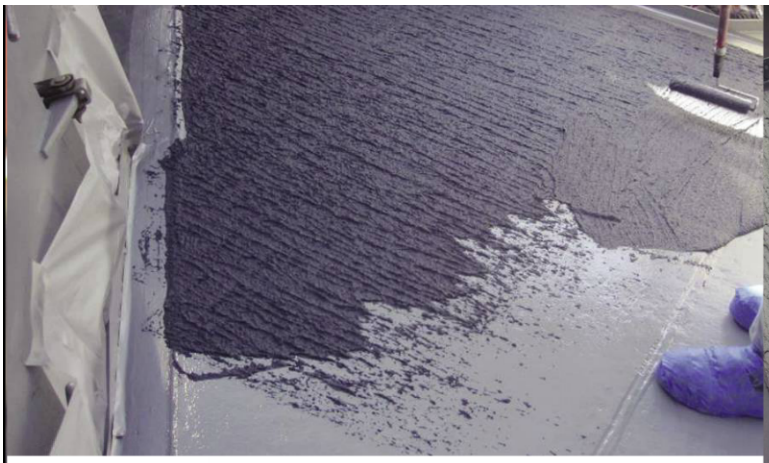


Fig. 1: This images displays the generation of a "peak and valley" profile via roll application of non-skid coating.
All photos courtesy of the U.S. Naval Research Laboratory

Epoxy-based non-skids, which contain aromatic epoxy resins, are chemical resistant and durable systems. However, these aromatic molecules suffer from degradation due to sunlight, thereby resulting in chalking and loss of profile within a few months after application (Fig. 2). Degradation from chalking can require overcoating with a dark gray or black colored silicone alkyd topcoat in order to maintain the appearance of a non-degraded and slip-resistant surface. Application of these "color-toppings" significantly reduces the coefficient of friction of the non-skids by filling in the valleys and reducing the peak-to-valley ratio. Coefficient of friction (CoF) is a value representing the resistance to sliding of two surfaces in contact with each other. Higher values indicate greater resistance to sliding.

In 2007, a modified Type I epoxy non-skid was spray-applied on the flight deck of the *USS Ross (DDG-71)* using a commercial spray gun, large fluid passageways and a conventional bottom-feed pressure pot. The modified non-skid contained smaller aggregate to reduce the viscosity and allow for spraying without clogging, however, these modifications resulted in a surface with CoF values that were lower than those obtained with the unmodified roll-applied version. Furthermore, the CoF values of the sprayed non-skid decreased by approximately 15 percent over a period of less than one year due to the UV degradation of the epoxy-based non-skid. It should be noted that the sprayed non-skid coating did demonstrate enhanced corrosion resistance due to the more homogeneous surface.

Spray-applied non-skid coatings have been proposed as a method of extending service life on decks and addressing profile generation due to variations in roll applications. However, several technical challenges have prevented implementation from occurring, such as the lack of commercially viable spray equipment for applying these viscous coatings and the difficulty in spraying qualified epoxy non-skid coatings without modifying the formulations to reduce the viscosity.

To take advantage of the standardized surface capability of a spray-applied coating while maintaining an acceptable CoF value, the United States Naval Research Laboratory (NRL) has developed a siloxane-based non-skid/nonslip coating that provides enhanced color and profile retention in sunlight, is low in volatile organic compounds (VOCs), lower in viscosity than epoxy-based non-skids, and can be applied using commercial pressure-pot spray equipment. NRL has also partnered with a small company to develop new spray equipment that is capable of applying the siloxane non-skid with large aggregate for generating surface CoF values that are equivalent to those found with rolled non-skids. Spray demonstrations of the siloxane non-skid coating have been performed on Navy surface ships and submarines

Fig. 2: This image depicts a color-faded and degraded epoxy non-skid on the deck surface of a ship less than six months after installation.

that operate in unique environments, yet both the coating and equipment are applicable to non-military markets where non-slip coatings are currently utilized.

Sprayable Siloxane Non-Skid Coating

The coating developed by the NRL is a two-component, siloxane-based non-skid coating suitable for the decks of Navy surface ships and submarines. The coating possesses silicon-oxygen (Si–O) bonds, which have greater bond strength than the carbon-carbon (C–C) bonds found in epoxy coatings, thereby providing greater exterior durability against UV degradation from sunlight. In addition, the siloxane non-skid coating is lower in VOCs, repels hydrocarbons and detergents, and does not blush or bloom after application (Fig. 3, p. 38). The siloxane non-skid is formulated as a 4:1 mix ratio (by volume) and the same formulation can be rolled or sprayed without the need for additional modifications. The NRL has licensed the non-skid technology to a coating manufacturer to advance the process to commercialization level, and multi-gallon quantities have been roll-applied on the decks of Navy surface ships in Norfolk, Virginia and San Diego. This siloxane non-skid coating is currently being qualified to MIL-PRF-24667C, Type V requirements (Fig. 4, p. 38).

The NRL's coating possesses a lower viscosity than traditional epoxy-based non-skid coatings due to its unique composition, which enables the coating to be more easily sprayed than MIL-PRF-24667C, Type I and V qualified epoxy non-skids that must be modified for spray application. In 2010, NRL spray-applied the siloxane non-skid coating in the mooring station of the *USS Oak Hill (LSD-51)* using traditional pressure pot spray equipment (Fig. 5, p. 39). The coating sprayed easily but blockage within the spray gun occurred due to clustering of the aggregate. To address this issue, the NRL began working with a small company to develop a specialized spray gun and pressure pot that allows

Fig. 3: This photo shows a qualified MIL-PRF-24667C, Type I epoxy non-skid that has become white due to blooming.

the siloxane non-skid coating to be easily spray-applied without clogging, even when utilizing larger sized aggregate than that found in rolled versions of qualified epoxy non-skid coatings.

Laboratory Testing versus MIL-PRF-24667 Qualified Non-Skids

Although originally designed for the siloxane non-skid, this newly developed equipment was able to spray a modified (with smaller aggregate) Type I epoxy and an unmodified Type V epoxy non-skid for comparison to the sprayed siloxane non-skid. All coatings were applied over epoxy-primed steel panels. The siloxane and modified Type I epoxy non-skid coatings sprayed easily and both provided full coverage of the substrate with uniform grit distribution.

CoF values of rolled-on non-skid coatings typically range from 1.40 to 1.70 at 75 F. The larger-sized aggregate in the siloxane non-skid provided a cured coating with CoF values of 1.47 to 1.59 at 75 F versus those of 1.26 to 1.40 at 75 F for the modified Type I epoxy. Atomization of the unmodified Type V epoxy non-skid remained an issue due to its higher viscosity, which resulted in a non-homogeneous surface appearance and CoF values of 1.35 to 1.45 at 75 F. A Type XI (temporary repair, self-adhering deck covering) non-skid appliqué was also applied over epoxy-primed steel panels and the CoF values were recorded as 1.20 to 1.30 at 75 F for comparison. It should be noted that CoF values were obtained using ASTM G133, "Standard Test Method for Linearly Reciprocating Ball-on-Flat Sliding Wear."

The sprayed coatings and appliqué were evaluated for chemical resistance, impact resistance, wear resistance and resistance to accelerated weathering according to MIL-PRF-24667C (Table 1). For chemical resistance, the sprayed siloxane and epoxy-based non-skids were unaffected by immersion in hydrocarbons such as jet fuel, grease, hydraulic fluid; detergent; aqueous firefighting foam (AFFF) in seawater; deicing fluid and ethyl alcohol. The non-skid appliqué was also unaffected by the immersion tests, although the adhesive under the appliqué was softened by nearly all the fluids, especially when immersed in hydraulic fluid and ethyl alcohol This resulted in the ability to easily peel-off and remove the appliqué from the epoxy primer. Use of a sealer around the edges of the appliqué improved the immersion resistance although several tests, such as jet fuel immersion, still resulted in up to 40 percent delamination. It should be noted that NAVSEA prohibits the use of appliqués on deck areas that are frequently contaminated with hydraulic fluids.

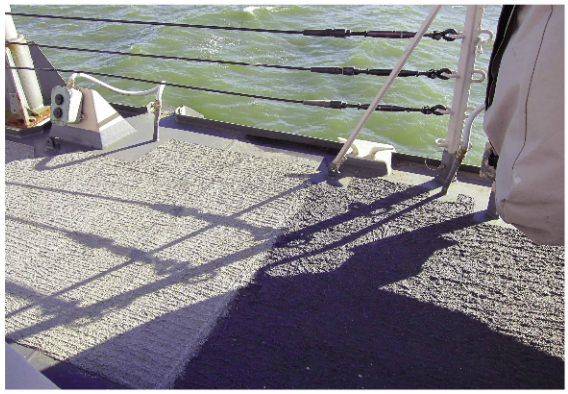


Fig 4: This picture depicts a qualified Type V epoxy non-skid (left) compared to the siloxane non-skid (right) after six months of exterior exposure on the USS MASON (DDG-87).

Table 1: Performance Evaluation

Non-Skid Coating	Chemical Resistance	Impact Resistance	Wear Resistance	Accelerated Weathering – Color Stability
Sprayed Modified Type I Epoxy	Unaffected	Passed	Passed at 500 cycles	Fading & noticeable color change
Sprayed Type V Epoxy	Unaffected	Passed	Passed at 500 cycles	Fading & noticeable color change
Sprayed NRL Siloxane	Unaffected	Passed	Passed at 500 cycles	No fading or color change
Type XI Appliqué	Adhesive softened by several fluids	Passed	Significant damage after 150 cycles	Minor fading

Fig. 5: This image shows sprayed siloxane non-skid aboard the USS OAK HILL (LSD-51).

All sprayed non-skid coatings and the appliqué passed the impact resistance test, as the homogenous surface did not present thick peaks or areas that might otherwise be broken off during impact, unlike the rolled versions. As for the resistance-to-wear test via cable abrasion, after 50 cycles, none of the surfaces lost enough mass to produce a notable decrease in CoF values and both the sprayed siloxane and the epoxy non-skid coatings were not significantly affected even after 500 cycles. However, testing of the appliqués with and without a sealer was ceased after 150 cycles, as the material was either severely torn or completely worn through to the underlying primer. The reduced-wear resistance of appliqués prohibits them from being used on ship decks where hand trucks, pallet jacks and fork lifts routinely operate.

A comparison of the sprayed non-skid coatings and non-skid appliqué in accelerated weathering tests showed visible differences in color stability. For instance, exposure of the materials to UVB radiation for 400 hours, according to ASTM G154, "Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials," resulted in color fading of the epoxy-based materials, although the change was more noticeable with the modified Type I and unmodified Type V sprayed non-skids than with the appliqué. The color of the siloxane non-skid coating was unchanged after 400 hours of UVB exposure. The non-skids were also exposed to artificial sunlight for 1,000 hours using a xenon arc light source, also known as Weather-Ometer (WOM), according to ASTM G155-13, "Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials," and once again the Type I and Type V epoxy non-skids demonstrated a noticeable color change. The exact color change of the non-skids could not be

Fig. 6: This photo shows sprayed siloxane non-skid on the boat deck of the USS LABOON (DDG-58).

determined due to the inability to achieve flush contact between the non-skid surfaces and a color meter.

Demonstrations on Navy Platforms

The siloxane non-skid has been spray-applied to the decks of several more Navy surface ships during the past four years including the *USS Mason (DDG-87)*, the *USS Ramage (DDG-61)*, the *USS Whidbey Island (LSD-41)* and the *USS Laboon (DDG-58)* (Fig. 6). The cured coatings all provided initial CoF values of 1.31 to 1.49 at 75 F and after two years of service the values aboard the *USS Mason* and *USS Whidbey Island* were 1.21 to 1.46 at 75 F and 1.23 to 1.32 at 75 F, respectively. The sprayed siloxane non-skid has not yet been utilized on a flight deck; however, the NRL is working with multiple systems commands to pursue such test opportunities. The sprayed siloxane non-skid has shown to wear evenly through the coating, unlike rolled non-skids that lose their peaks as they wear.

As a result of the performance of the sprayed siloxane non-skid on Navy surface ships, a black-colored version of the material was spray-applied on the steel turtleback of the *USS Michigan (SSGN-727)* submarine in 2011. After three years of service, the siloxane non-skid had retained its color and sufficient slip resistance for walking in wet and dry conditions, and color-topping of the non-skid has not been required. The sprayed siloxane non-skid also provided greater corrosion resistance when compared to a neighboring rolled Type I epoxy (applied as a control) due to the more homogenous surface obtained from the spray application.

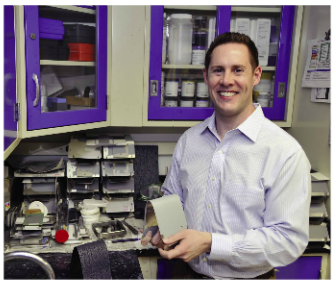
In all demonstrations, the siloxane non-skid coating was spray-applied in less than half the time of a typical roll application and generation of a more uniform coating thickness provided for greater spread rates (for example 30 to 40 square feet per gallon for spray versus 18 to 30 square feet per gallon when rolled) due to the elimination of the thick peaks that are typically produced during the roll process.

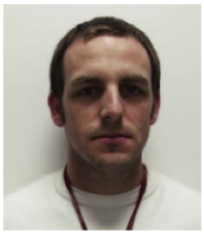
Conclusion

The NRL sprayable siloxane non-skid coating has shown to provide greater exterior color stability, CoF values and chemical resistance than sprayed, modified Type I epoxy non-skid with reduced aggregate size, sprayed, unmodified Type V epoxy non-skid, and a Type XI non-skid appliqué. This siloxane coating is also lower in viscosity and VOCs compared to unmodified epoxy non-skids, which provides for a coating that is easier to spray apply even though it contains larger-sized aggregate. Furthermore, the sprayed siloxane non-skid has shown to provide greater corrosion resistance than rolled epoxy non-skids because of the absence of areas with lesser-than-adequate coating thickness. The coating also has applications in numerous non-military markets where non-skid/nonslip coatings are currently utilized, such as on oil rigs, commercial ships, factory floors, ramps and walkways.

About the Authors

Erick Iezzi obtained his Ph.D. in organic chemistry from Virginia Tech in 2003 where he was an ACS Division of Organic Chemistry graduate fellow, followed by a National Institutes of Health (NIH) postdoctoral fellowship in natural product synthesis at the University of Pittsburgh. Iezzi joined PPG Industries, Inc. in 2006 where he worked on developing UV-curable and low-VOC coatings for the aerospace and automotive refinish groups. In 2008 he moved to the Naval Research Laboratory (NRL) where he's been synthesizing new resin/polymers and formulating novel coating systems for U.S. Navy ships, submarines, aircraft and Marine Corps vehicles. Iezzi has developed nonskid, topside and rudder coating technologies that are currently being demonstrated on active Navy platforms.





James Tagert graduated from the University of Maryland, College Park in 2004 with a bachelor of science degree in mechanical engineering. He received his engineer-in-training certificate from the state of Maryland and has worked for the Naval Research Laboratory since 2008, involved in research and engineering programs related to materials science with an emphasis on the development and transition of advanced topside and nonskid coating systems for the fleet. Tagert is a member of both the American Society of Naval Engineers (ASNE) and the National Association of Corrosion Engineers (NACE) and participates regularly with both groups informing them of ongoing research at the NRL.

James Martin has been with the Naval Research Laboratory for 13 years. He is the section head of the marine coatings technology and systems group. Martin is responsible for introducing coatings technology to the fleet through development, testing and demonstrations. Nearly all aspects of coatings transition is addressed including surface preparation and application processes and equipment, specifications, analytical and failure analysis, testing and evaluation for

qualification and new chemistry development, novel removal methods, and field support. He has been active in addressing fleet concerns from both maintenance and new construction with respects to coatings.

Paul Slebodnick is currently employed at the Naval Research Laboratory in Washington D.C., Center for Corrosion Science & Engineering under the marine engineering section. Slebodnick currently leads research programs in developing technologies for the United States Naval Fleet that create maintenance reductions and reduce ship's force

workload. He is also responsible for demonstrating new technologies aboard fleet combatants to determine readiness with in-service evaluation of technologies prior to transitioning to the fleet, many of which are developed at NRL and have demonstrated maintenance reductions aboard ships and submarines. Slebodnick is also an engineering manager for research and development of tank coatings for the Naval Sea Systems Command, Technical Warrant Holder, SEA-05.

John Wegand is a senior engineer at NRL within the Center of Corrosion Science and Engineering. Wegand has a bachelor of science in mechanical engineering from the University of Maryland and has nearly thirty years of experience working with the U.S. Navy executing and managing various research, development, test and evaluation

technical programs. His experience ranges from development in the laboratory to implementation in the fleet, including policy and requirements development for the Naval Sea Systems Command. JPCL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PIPELINE INDUCTION HEAT

Fig. 2: Automated MCL coating application.
All photos courtesy of Pipeline Induction Heat Ltd.

Pipeline Field Joints

Exploring the Coating Technologies that Protect Against "Weak Links"

By Adam Wynne Hughes
Pipeline Induction Heat Ltd, UK

In conventional transmission pipeline construction, pipe lengths are first coated in a plant and then shipped to the onshore pipeline site (Fig. 1, p. 44) or, for offshore installation, to either the dockside for loading onto a lay-barge or to a spoolbase for assembly into a pipeline for reel barge laying. Both ends of the pipe are left uncoated to a length of 150 mm (5.9 inches) to allow the individual pipes to be welded together onsite to form the pipeline. These uncoated areas — field joints — need to be protected from corrosion, heat loss and mechanical damage, and there is a range of different technologies used to do it. To ensure that the field joint is not a weak point in the protection of the pipeline, the coating system selected must also be compatible with, and match as closely as possible, the properties of the factory-applied mainline pipe coating.

Pipeline laying is a continuous process and any field joint system must be able to be applied quickly so as not to slow down progress. In addition to the various coating solutions available, tailored application equipment is commonly used to provide high speed and repeatable application of the field joint materials. The automated equipment is designed to reduce material waste and therefore, limit environmental damage. Automated application methods minimize risk to the health and safety of the operator by both reducing exposure to harmful materials and mitigating the fatigue that can lead to errors or accidents. This article takes a brief look at some of the different field joint coating technologies available.

Fused Field Joint Coating or Heat-Assisted Tape Wrap

Heat-assisted helically wrapped tape, or fused field joint coating, can provide a totally compatible field joint coating system for three-layer polyolefin coated pipelines. In the field, the system uses existing equipment for abrasive blasting/surface preparation, and for the application of a fusion bonded epoxy (FBE) and chemically modified polypropylene (CMPP)

Fig. 1: Onshore field joint coating

or polyethylene (CMPE) dual-powder base layers. Immediately following is the machine-applied polypropylene (PP) or polyethylene (PE) tape, involving a series of heating processes. The use of heat ensures that there is total integration between factory and field joint coatings, and thus comparable performance. In other words, there is no "weak link."

The fused field joint results from complete fusion between both the individual layers of helically wrapped tape to one another and to the factory coating overlap so that there is no discernible interface between the factory and field joint coatings. This type of system has an extensive track record of use on overland and offshore pipelines, as well as in spoolbases.

Fusion Bonded Epoxy

Fusion bonded epoxy (FBE) is a one-part, heat-curing (thermosetting) powder. Its use as a mainline pipe coating has been established for many years, and the application of a comparable FBE material at the field joint area ensures compatible anticorrosion protection for the entire pipeline length. Using automatic machines guarantees that each field joint will be coated consistently, in accordance with the requirements of the specification.

FBE-coated field joints offer superior adhesion to the pipe substrate, greater stability and resilience against higher pipeline operating temperatures and chemical contaminants in sub-soil or sub-sea environments. Any holidays in the field-applied coating can be easily detected and repaired. There is no shielding of the cathodic protection (CP) system, good resistance to cathodic disbondment and total compatibility with the factory-applied FBE coating.

FBE can be applied as either a single layer or dual layer, with the dual layer offering greater mechanical abrasion resistance. In single-layer systems, the powder is applied to the pipe by an " on-pipe" rotating machine, in a fixed number of passes, to a thickness of up to 800 microns (.03 inches) and a bandwidth of up to 750 mm (29.5 inches).

For dual-layer systems, the second layer is applied during the gel time of the first layer of FBE with the same on-pipe rotating machine but via a different feed. A permanent chemical bond is established between the two layers of FBE, offering the best possible field joint characteristics. Typical thickness of the dual-layer system is up to 1,000 microns (.04 inches) and the bandwidths are the same as those for a single-layer system.

Particularly for offshore and spoolbase applications (Fig. 3), closed-cycle abra-

sive blasting and a vacuum recovery system on the FBE application machines are used to ensure a clean and healthy environment in the vicinity of the coating stations.

Multi-Component Liquid

As a result of the need to produce repeatable, high-quality and reliable field joint coating systems, multi-component liquid (MCL) coatings have become the coating system of choice for multilayer and fusion bonded epoxy-coated pipelines in the international onshore pipeline construction industry (Fig. 2, p. 42). An MCL field joint coating system offers compatibility with the factory-applied coating, excellent adhesive bond to the factory coating overlap areas and consistent onsite application. The system offers a short application cycle time (high daily production rates) with fast cure times.

Fig. 3: Spool base operations.

Another advantage of the liquid system is that the CP system will not be compromised, ensuring a continuous flow of current to any defect. Many other field joint coating systems "shield" the CP system, and as a result, defects may go undetected, leading to serious failure in the anticorrosion coating system.

There are many different urethane- and epoxy-based MCL coatings that offer particular properties appropriate to the pipeline parameters. Material selection is based on a number of factors, including parent coating type, climatic conditions, operating temperature and pipeline handling conditions during construction.

In order to make the most of the technical benefits of the MCL coatings that are available in the market, there are specially designed and developed automatic coating application machines. Not only does the equipment meter the individual liquid components to the spray head in the correct ratio, but the on-pipe rotating spray ring applies the material in a consistently even and repeatable manner to the specified thickness and band width. Liquid coating consumption is reduced to the absolute minimum since overspray and waste is virtually eliminated, with obvious HSE benefits.

The application thickness is directly related to the number of rotations of the machine; therefore, once preproduction testing has proven the procedure, the machine can be preprogrammed for the project. It can then be operated by supervised local personnel, which makes the use of MCL field joint coating systems commercially attractive. The equipment can also be insulated and trace-heated to assist with application in low ambient temperature conditions.

Injection Molded Polyurethane

In order to provide an alternative, yet compatible, field joint coating system for

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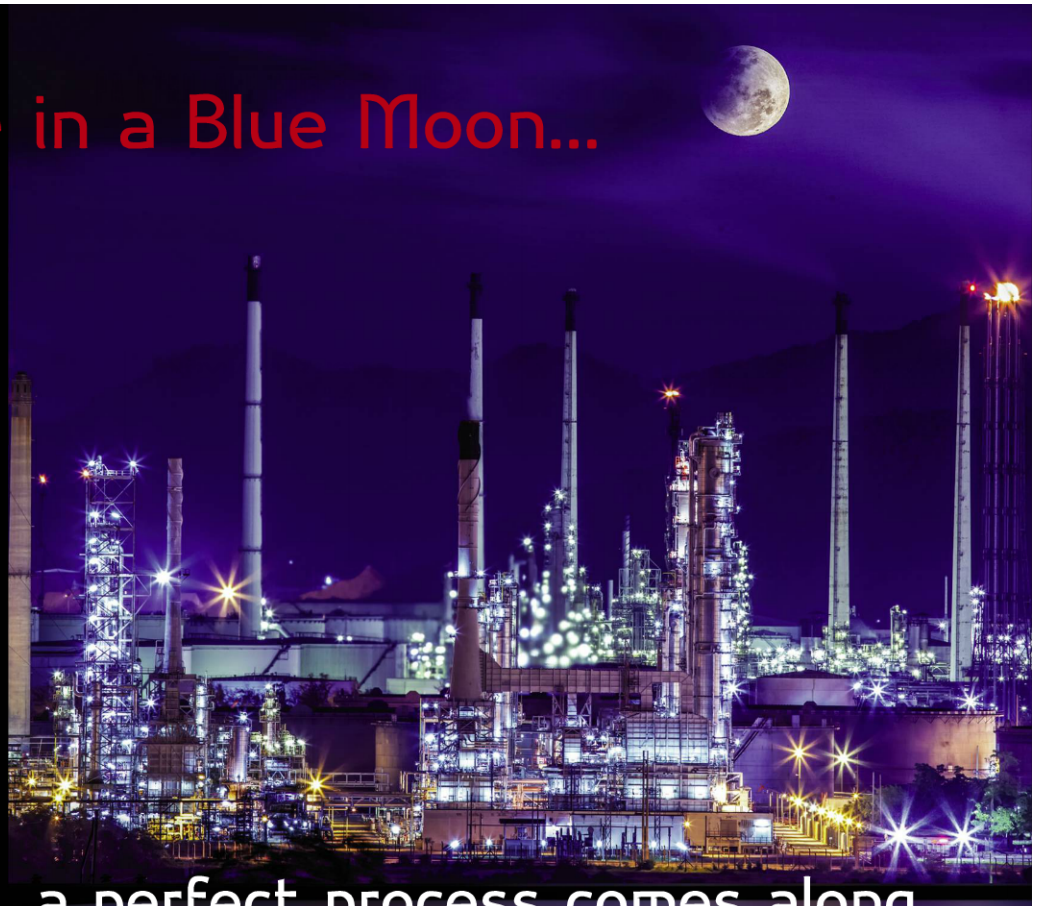

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Fig. 4: Injection molded polypropylene

three-layer polypropylene (3LPP) anti-corrosion coated pipelines as well as a versatile solution for multilayer polypropylene (MPP) and syntactic polyurethane (SPU) insulated pipelines, specially developed and refined injection molded polyurethane (IMPU) processes are available (Fig. 4).

These field joint coating systems provide anticorrosion and where necessary, thermal insulation similar to the mainline factory coating, while allowing routine application within the rapid production cycle times demanded by today's pipeline construction industry. Similar performance to that of the parent coating can consistently be achieved using state-of-the-art solid or SPU injection molded coatings. These combine a low overall heat transfer coefficient (OHTC) with the ability to perform at elevated operating temperatures, while also providing excellent stand-alone anticorrosion properties.

Portable containerized IMPU coating modules which house purpose-built dispensing equipment can easily be transported to the job site by conventional shipping methods, facilitating rapid setup and deployment alongside the pipeline welded joints at site.

IMPU field joint systems are now available offering total compatibility with the following factory-applied coatings:

- Standard thin-film, typically 1.5- to 4.5-mm thickness (.06- to .18-inch), three-layer polypropylene or polyethylene external anticorrosion coating systems.
- Multilayer fusion bonded epoxy powder (FBE)/solid polyurethane elastomer systems.
- Solid or syntactic polyurethane systems for pipelines where a very low OHTC (low "K" factor) is necessary. Multilayer composite coatings incorporating an FBE base coat, copolymer layer, a thick foamed polypropylene, plus a solid polypropylene sleeve (topcoat).

In addition to offshore laybarge production, the IMPU system is suited to onshore spoolbase operations. The IMPU field joint coating offers these benefits:

- High compatibility with thin-film and

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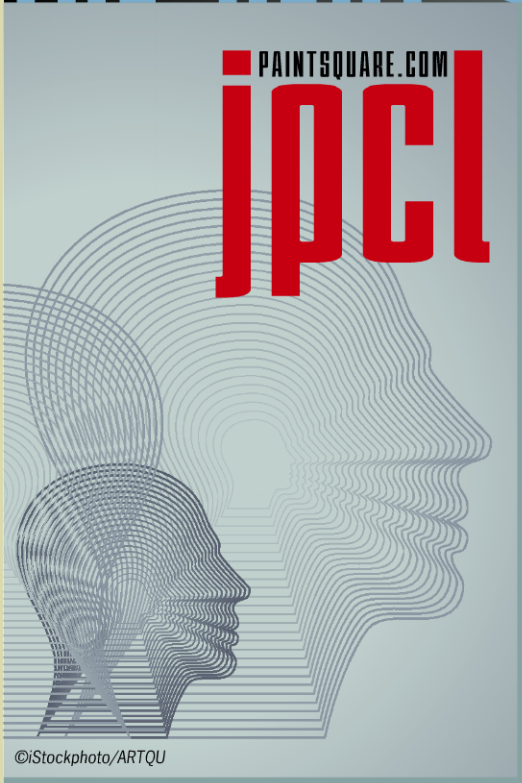

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multilayer polypropylene or polyethylene line pipe coatings.

- Incompressible polyurethane material suitable for deep-water applications. Comparable thermal performance to factory-applied insulation coating.
- Moderate preheat requirement used only to accelerate the curing process. Suitability for field joints, including J-Lay collars.
- Little requirement for diameter-specific equipment.
- Fast application and cure times.

Injection Molded Polypropylene

Newer, deeper oil and gas fields produce hydrocarbons at higher temperatures and thermal insulation is installed to hydrocarbon transmission pipes in order to maintain the required flow rates, optimize productivity and reduce processing costs. This has led to the development of new and innovative thermal insulation systems, which in addition to improved thermal efficiencies, can lead to greater energy savings and reduced environmental impact.

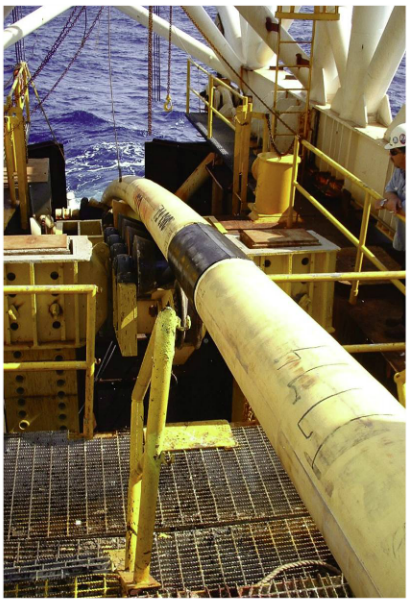


Fig. 5: Laying an offshore pipeline.

An injection molded polypropylene coating system (IMPP) has been developed based on proven technology, providing excellent thermal insulation values and offering the same overall U-value as the factory coating. Following the welding of thermally insulated pipes at the project location, IMPP thermal insulation is then applied to the welded joint area in order to maintain the integrity and thermal properties of the pipe system. The IMPP system has been designed to be fully compatible with the

line pipe coating and the injection molding process can be applied both in spoolbase and offshore environments, both in S-lay and J-lay configurations.

Polyurethane Foam Field Joint Infill

Infilling the field joint void on concrete weight-coated pipe has traditionally been performed by pouring hot marine mastic into a mold around the joint. The mold is usually left in place when overboarded by the laybarge. The mastic needs to be heated to melt it prior to pouring — a process that consumes a large amount of energy. Furthermore, the mastic is poured hot, at approximately 200 C (392 F), and is therefore hazardous to handle.

In response to this, an alternative PU-based infill system is available, offering improved HSE security as well as the following beneficial features:

- Rapid cycle times.
- Reusable or expendable/disposable (metallic or plastic) mold systems.
- Compact, reliable application equipment.
- Compatibility with all conventional anticorrosion field joint coating systems.
- Freedom from any ozone depleting blowing agents.
- Air/water-purged equipment requiring no solvents.
- Range of foam densities.

The custom-designed high-density polyurethane foam (HDPF) has a typical unsaturated molded density between 90 to 160 kg. per cubic meter (5.6 to 10 lbs. per cubic feet). Formulated specifically for pipeline field joint applications, the HDPF system develops a rigid, open-cell structure. Upon immersion, the open cells absorb water, thereby increasing in overall density to approximately 1,025 kg. per cubic meter (64 lbs. per cubic feet), similar to seawater itself.

The low-viscosity product formulation of the HDPF system allows "free-flow" of chemicals to assure quick and complete filling of the mold within the cycle times demanded by today's laybarge operators.

The infilling system can incorporate reusable or permanent molds. Reusable molding is used in conjunction with a cardboard fiber liner to create a superior, high-strength composite skin. This system will allow the demolded field joint to pass over the

laybarge rollers and stinger without damage due to the fiber liner becoming embedded in the surface of the foam, creating a resilient outer skin to the joint.

Permanent plastic or metal molds can be used as required by environmental and operational demands. The application equipment is neat and compact, consisting of little more than two holding tanks, small pumping equipment, dispensing hoses and nozzles.

Polypropylene Flame Spray

In order to provide a totally compatible field joint coating system for 3LPP- or 3LPE-coated pipelines, PP or PE powder can be applied by the flame-spray technique. Powder is carried in a stream of air and is fed into the center of an annular combustion flame where it is heated. A second outer annular nozzle feeds a stream of air around the powder stream that accelerates the spray particles toward the substrate and prevents burning of the powder.

The system uses existing equipment for abrasive blasting/surface preparation and application of fusion bonded epoxy (FBE) plus chemically modified polypropylene or polyethylene dual-powder base layers. The overall thickness required is then achieved by applying powder via a flame-spray gun.

The flame-spray field joint coating system provides a full three-layer system, which is highly adjustable to field conditions where coating thicknesses of up to 5 mm (.19 inches) are required. While the flame-spray system can also provide a useful service for tie-ins or as a back up for a polypropylene or polyethylene fused field joint system, it is a thoroughbred field joint coating system by itself.

The PP powder system has an extensive track record of use on overland and offshore pipelines, as well as in spoolbases.

Conclusion

The common, high-performance field joint coating systems covered here are by no means an exhaustive list. There are also simple "tape-wrap" systems, such as PVC and petrolatum, heat-shrink tape systems and non-hardening viscoelastic products.

Whether onshore or offshore in the world of pipeline construction, no two operations are exactly the same. With this in mind, specialist field joint coating contractors design customized solutions that address every aspect of the field joint coating requirements for each specific project. JPCL

Awards and Events Planned for SSPC 2015

During SSPC 2015 featuring GreenCOAT, which will take place Feb. 3 through 6, 2015, at the Westgate Las Vegas Resort, attendees and their guests will have the opportunity to take in a number of scheduled special events and awards ceremonies.

For complete details on the conference, including the technical program, workshops, training and certification programs and exhibition, visit www.sspc2015.com, and watch for the SSPC 2015 Advance Program in the December 2014 *JPCL*.

ANNUAL BUSINESS MEETING AND AWARDS LUNCHEON

On Tuesday, Feb. 3, from 11:30 a.m. to 1:00 p.m., join SSPC President Jim King, Executive Director Bill Shoup and the Board of Governors to hear SSPC's Annual Report and to honor the 2014 award recipients at the Annual Business Meeting and Awards Luncheon. Among the awards to be presented at this year's luncheon are the ninth annual SSPC Structure Awards, the SSPC Honorary Life Member Award, the John D. Keane Award of Merit, the SSPC Coatings Education Award, the SSPC Technical Achievement Award, the Women in Coatings Impact Award, the SSPC Outstanding Chapter Awards, the President's Lecture Series Award, the SSPC Outstanding Publication Award and the *JPCL* Editors' Awards.

SSPC Honorary Life Member

This honor is presented to an individual by the Board of Governors for extraordinary con-

SSPC Executive Director Bill Shoup read the Annual Report at the SSPC 2014 Business Meeting and Awards Luncheon. Photo courtesy of SSPC.

tribution and long-term activity on behalf of SSPC. To become an honorary life member, an individual must be nominated by a Board member and approved by two-thirds of the Board. Only one honorary life membership is awarded each year.

This year's Honorary Life Member is Kenneth Trimber, president of KTA-Tator, Inc.

John D. Keane Award of Merit

Named for SSPC's executive director from 1957 to 1984, this award acknowledges outstanding leadership and significant contribution to the development of the protective coatings industry and to SSPC.

The recipients of this year's John D. Keane Awards of Merit are Lydia Frenzel, Advisory Council; and Alfred D. Beitelman, retired from the U.S. Army Corps of Engineers (USACE).

SSPC Coatings Education Award
This award is given for significant development and dissemination of education material and technical information relating to protective coatings and their application.

SSPC Technical Achievement Award
This award recognizes outstanding service, leadership and contribution to the SSPC technical committees.

Women in Coatings Impact Award
Awarded for the first time last year, this award was established to recognize women in the coatings industry whose contributions have created a positive impact on the culture of the industry.

SSPC Outstanding Publication Award
This award is given annually to the author(s) of the best technical paper or presentation from the SSPC International Conference and Exhibition or from *JPCL* that scores the highest in the following categories:

- Clarity of expression and organization;
- Originality of content or presentation;
- Importance to the protective coatings industry; and
- Effectiveness of figures or tables.

SSPC selects a panel of judges from SSPC and *JPCL* to vote on the award.

JPCL Editors' Awards
The same panel of judges selects the recipients of the *JPCL* Editors' Awards, which also recognize excellence in technical writing. Winners are selected from a field of more than 100 eligible papers from SSPC 2014 and from *JPCL* articles published between May 2013 and July 2014. Awards are also based on clarity, originality, significance to the industry and effective use of illustrations.

President's Lecture Series Award
This award honors a technical presentation that is handpicked by the SSPC president

Guests enjoyed food, drinks and a live band at the SSPC 2014 Welcome Party, which was sponsored by Carboline. Photo courtesy of SSPC.

and chosen for its reflection of the coatings industry and profession. The presentation will be highlighted in the SSPC 2015 Onsite Guide, and the winner will be recognized at the Awards Luncheon.

SSPC Outstanding Chapter Awards

Each year, SSPC presents awards to the Outstanding North America Chapter and the Outstanding International Chapter. Chapters are evaluated on their overall operation and the creativity and quality of the events held each year.

SSPC Structure Awards

The ninth annual SSPC Structure Awards will honor teams of contractors, designers, end users and other personnel for excellence and expertise demonstrated on industrial and commercial coatings projects. Awards to be presented are:

• The William Johnson Award for outstanding achievement demonstrating aesthetic merit in industrial coatings work;
• The E. Crone Knoy Award, recognizing outstanding achievement in commercial coatings work;
• The Charles G. Munger Award for an industrial or commercial project demonstrating longevity of the original coating;
• The George Campbell Award, recognizing the completion of a difficult or complex industrial coatings project; and
• The Military Coatings Award of Excellence for exceptional coatings work performed on U.S. military ships, structures or facilities.

JPCL will feature this year's Structure Awards recipients in a photo essay next spring.

OPENING CELEBRATIONS

Welcome Reception — Welcome to the Magic
Tuesday, Feb. 3, 5:30 to 7:30 p.m.
Sponsored by Carboline, this welcome reception allows guests to enjoy hors d'oeuvres and cocktails with SSPC Board members, staff, colleagues and business acquaintances.

Exhibit Hall Opening Reception
Wednesday, Feb. 4, 5:00 to 8:00 p.m.
The ribbon cutting and opening of the SSPC 2015 exhibit hall will take place amid great celebration. Food and beverage stations, sponsored by Sherwin-Williams, will be available as guests are free to roam the hall and check out the more than 100 exhibitors.

The Exhibit Hall After Party — The King & You
Wednesday, Feb. 4, 8:00 to 10:00 p.m.
After the exhibit hall opening, head next door to the After Party Lounge for more food and drinks, sponsored by Jotun.

Elvis will be on hand, and a DJ will feature his music.

CLOSING CELEBRATIONS

Exhibit Hall Closing Blast
Friday, Feb. 6, 1:30 to 3:00 p.m.
With no technical presentations scheduled in opposition, take a "brain break" and make one last run through the exhibit hall while enjoying dessert and drinks.

SSPC 2015 Closing Party
Friday, Feb. 6, 7:00 to 9:00 p.m.
Say goodbye to Las Vegas and get ready for SSPC 2016 in San Antonio at this final, low-key get-together, sponsored by The Brock Group, the SSPC Northern California/Nevada Chapter and the SSPC Hampton Roads Chapter.

Hundreds of companies showcased their products and services in the SSPC 2014 exhibit hall. Photo courtesy of SSPC.

A lunch cruise aboard the Desert Princess on Lake Mead is available for spouses and guests of SSPC 2015 attendees. Photo courtesy of Lake Mead Cruises.

SPOUSE AND GUEST TOURS

Two optional tours are available for attendees' spouses and guests. The costs of these tours are not included in the conference registration; tickets for each tour must be purchased separately.

These tours were arranged through Hosts Las Vegas, a member of the Hosts Global Alliance and one of the largest and longest operating destination management companies (DMCs) in Las Vegas. Their award-winning programs have been recognized both locally and globally for their creativity, budget-awareness and sophisticated logistics. They were honored to be chosen by SSPC as their tour provider.

Lake Mead Lunch Cruise
Wednesday, Feb. 4, 10:30 a.m. to 1:30 p.m.

Only minutes from the glitter and glamour of Las Vegas lies another world — Lake Mead and the mighty Hoover Dam. The waters of Lake Mead are home to the beautiful, roomy, comfortable, smooth excursion vessel of Lake Mead Cruises, the delightful paddle-wheel vessel, the *Desert Princess*. The *Desert Princess* was built especially to cruise the clean, blue waters of picturesque Lake Mead. Visitors and locals alike can enjoy a fun combination of spectacular scenery, good food and "Outrageously Great Tours!" on beautiful Lake Mead aboard the *Desert*

SSPC 2015 featuring GREENCOAT
FEBRUARY 3-6, 2015
WESTGATE LAS VEGAS RESORT, LAS VEGAS, NV
www.sspc2015.com

EXHIBITORS AT SSPC 2015

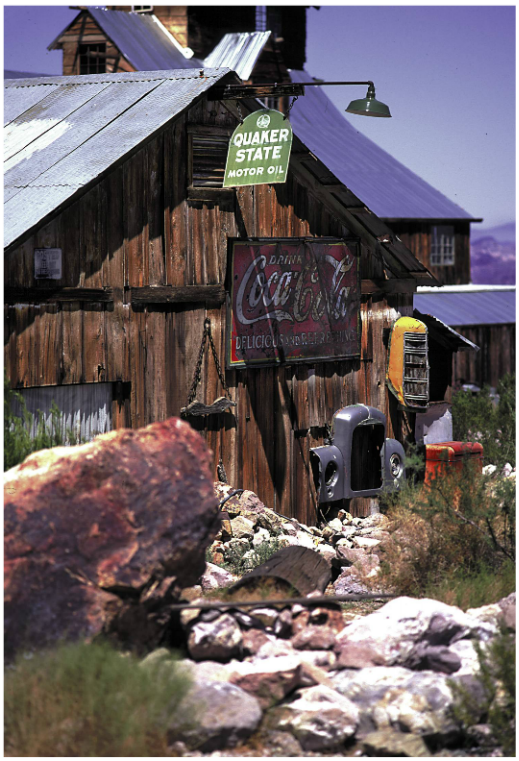
The following is a list of companies planning to exhibit at SSPC 2015 featuring GreenCOAT, current as of press time. For information on exhibiting, please contact Kate Jurik, SSPC Event Manager & Exhibit Sales Specialist, at jurik@sspc.org, or 877-281-7772, ext. 2211.

Abrasives Inc.
ABSS
Air Systems International, Inc.
Allnex
ARID-DRY
ArmaKleen
ARS Recycling Systems LLC
Atlantic Design Inc.
Barton International
Bellemare Group
Binks
Blastrac
Bullard
Carboline Company
CESCO/Aqua Miser
Chlor*Rid International Inc.
CJ Spray
Clemco Industries Corp.
CoatingsPro Magazine
Cold Jet
CSI Services
Dampney Co. Inc.
DeFelsko Corporation
Dehumidification Technologies
Denso NA
Desco Manufacturing Co., Inc.
Detroit Tarp
Dex-O-Tex by Crossfield Products
DoD, Corrosion Policy and Oversight
Doosan Portable Power
DRYCO, LLC
Dumond Chemicals
Dustless Blasting
DUSTNET
Eagle Industries
Elcometer
EnTech Industries
Ervin Industries
Fischer Technology
FS Solutions
Geoblaster Equipment
GMA Garnet (USA) Corp.
Greenman-Pedersen Inc.
Grace Distributing
Graco Inc.
Green Diamond Sand Products
Greener Blast Technologies
Harsco
HippWrap Containment
HoldTight Solutions Inc.
HRV Conformance Verification Associates
Indian Valley Industries
Industrial Vacuum Equipment Corp.
International Marine & Industrial Applicators
International Paint
JAD Equipment Co.
Jotun
Kennametal
Kleen Blast Abrasives & Equipment
KTA-Tator, Inc.
Larson Electronics
Luoyang Hong Feng Abrasives
Marco
Max Access, Inc.
MetalCrafts, LLC
Minerals Research, Inc.
Mohawk Garnet, Inc.
Moisture Control Company
Monarflex
MONTI Tools Inc.
Montipower, Inc.
NACE International
National Equipment Corp
NASA-Kennedy Space Center
NCERCAMP – Univ. of Akron
Nextec Inc./PreTox
Novatek Corp.
Olimag Sand
OPTA Minerals, Inc.
Pacific Dust Collectors
Painters and Allied Trades LMCI
Polygon
Polyurea Development Association (PDA)
PPG Protective & Marine Coatings
Pro-Tect Plastic & Supply, Inc.
PTQ Safety
Rapid Prep
Raven Lining Systems
Rhino Linings Corporation
Ring Power
RotoTexx
Rustibus Inc.
SAFE Systems Inc.
Safety Lamp of Houston
Safway Services, LLC
Sand Express
Sauereisen
Schmidt Engineered Abrasive Systems
Sherwin-Williams Company
Ship-2-Shore Corrosion Preventive Coatings
Simpson Strong-Tie
Specialty Products Inc.
Spider
Sponge-Jet, Inc.
SSPC: The Society for Protective Coatings
Sulzer Mixpac USA, Inc.
Sunbelt Rentals Inc.
Tarps Manufacturing, Inc.
Tesla NanoCoatings
Thomas Industrial Coatings
Tnemec Company
Technology Publishing/PaintSquare
Tractel Inc. Griphoist Division
Trask-Decrow Machinery
TruQC LLC
U.S. Coatings
U.S. Minerals
Uni-Ram Corporation
Van Air Systems
VersaFlex Inc.
Vitro Minerals
W Abrasives
The Warehouse Rentals & Supply
Wasser Coatings
Western Technology
WIWA LP

Princess. Join us for a delightful luncheon cruise, departing the Westgate at 10:30 AM and returning by 2:30 PM.

Eldorado Canyon Mine Tour
Thursday, Feb. 5, 8:00 a.m. to 12:00 noon

Take a step back in time touring the Eldorado Canyon, home to the famed Techatticup Mine. The Salvage vein, a rich vein of gold that ran in the hills above the Colorado River, was discovered in Eldorado Canyon and from there, the Techatticup Mine was built. The mine just wasn't a gold mine though; it went on to be one of the most successful mines in the region, turning out gold, silver, copper and lead.



Spouses and guests can also take a tour of the historic Eldorado Canyon Mine. Photo courtesy of Eldorado Canyon Mine Tours.

Enjoy a short journey in the comfort of a Tour Trekker to the rustic site. Along the way enjoy the spectacular scenery — fields of teddy bear cholla, rare geological formations and a stop along the banks of Lake Mojave — the blue jewel of this isolated desert terrain.

Upon arrival to Eldorado Canyon and the Techatticup Mine, a professional tour guide will take you into the mine, where you will learn about the mine and envision the back-breaking work done by the miners over a century ago as they chased the gold veins deep into the rugged mountain side.

Photo courtesy of the New Orleans Ernest N. Morial Convention Center.

New Orleans Welcomes WorkBoat Show, Conference

The 2014 International WorkBoat Show & Annual Conference, billed as the largest North American commercial marine trade show, will be held December 3–5 at the Ernest N. Morial Convention Center in New Orleans.

This event, sponsored by *WorkBoat* magazine, gathers owners, operators and representatives working on the coastal, inland and offshore waters. It is comprised of keynote speeches, technical presentations and an exhibit hall with more than 1,000 marine product and service suppliers. Its intended audience includes shipyard personnel and commercial boatbuilders, marine engineers and architects, equipment manufacturers and distributors, port authorities and port engineers, marine surveyors, military buyers and government officials, oil exploration and production representatives and others.

For complete information on the show and conference, visit workboatshow.com.

2014 WorkBoat Annual Conference Program

The following is a list of keynote speeches and presentations that will be given at the 2014 WorkBoat Show & Annual Conference. All information is current as of press time.

Wednesday, Dec. 3

- "Keynote: Captain Richard Phillips," sponsored by RSC Bio Solutions, 11:30 a.m. to 12:30 p.m.
- "Marine LNG Fuel Series," speaker TBA, part of the WorkBoat Professional Series; 1:00 to 2:00 p.m.
- "Inland Waters Rescue and Survival," by Haas McMillan, Falck Safety Services Canada; 1:00 to 2:00 p.m.
- "Think You're Prepared for Disaster? Think Again," by Gene McKeever, Allen Insurance and Financial and *WorkBoat* magazine; 2:30 to 3:30 p.m.
- "Meeting USCG Medical Certificate Requirements: What to Know," by Brian Bourgeois, West Jefferson Industrial Medicine; 2:30 to 3:30 p.m.
- "International Regulatory Creep: How Do U.S. and International Regulations Compare?" by Sarah K. Branch and Richard Wells, Offshore Marine Service Association; 2:30 to 3:30 p.m.
- "SubChapter M: Top 10 Things You Need to Know," by Kevin Gilheany, Maritime Compliance International LLC; Marc C. Hebert, Jones Walker LLP; Erich Ellender, Unlimited Control & Supply; and Brian Khey, U.S. Coat Guard Sector New Orleans; 4:00 to 5:00 p.m.
- "Effective Outfitting to Meet Comfort Class Rules," by Steve Hadik, Polar Star Maritime LLC; and Publio Beltrán, TSI; 4:00 to 5:00 p.m.

Thursday, Dec. 4

- "Shipyard Day Keynote: Frank Foti, Vigor Industrial," 11:30 a.m. to 12:30 p.m.
- "Reaching the Size Limit: Challenges for Small to Medium Yards," by Krishna Karri and Anil Raj, P.E., Technology Associates, Inc.; 1:00 to 2:00 p.m.
- "Reducing Your Fleet's Carbon Footprint," by Matthew Payne, SmartWay Transport Partnership, U.S. Environmental Protection Agency; 1:00 to 2:00 p.m.
- "Keynote: Paul N. Jaenichen, Sr., U.S. Department of Transportation, Maritime Division," 2:30 to 3:30 p.m.
- "The Evolution of DP Training," by Aaron Smith, Offshore Service Vessel Dynamic Positioning Authority (OSVSPA); 2:30 to 3:30 p.m.
- "Understanding Ballast Water Treatment Systems," by Birgir Nilsen, Optimarin AS, USA Local Office; 2:30 to 3:30 p.m.
- "Shipyard Project Planning," by Justin Huff, Dauntless Maritime; 4:00 to 5:00 p.m.
- "Financing Jones Act Vessel Assets," by Clayton Cook, Seward & Kissel LLP; and Matt Miller and Leon Rittenberg, Baldwin Haspel Burke & Mayer, LLC; 4:00 to 5:00 p.m.
- "Vessel Efficiency and Your Operations: Incorporating the Right Power Solutions to Improve Your Bottom Line," by Jim Mundth, Caterpillar; and Richard Kimball, Maine Maritime Academy (MMA); 4:00 to 5:00 p.m.

Friday, Dec. 5

- "USCG AIS Carriage Regulation Update," by Jose Arroyo, USCG; 11:00 a.m. to 12:00 noon
- "Training for Mariners," by Steven Hearn, West Kentucky Community & Technical College; Duane Darcey, Moxie Media Inc.; and Glen Paine, MITAGS-PMI-CCMIT; 11:00 a.m. to 12:00 noon
- "Doing Business with the United States Navy — How to Improve Your Chances for Award," by Jean-Michel Coughlin, Alan Cummings, Doug Dallhoff, Chris Rozicer, Dan Shimooka and Roxie Thomas, Support Ships, Boats and Craft Program Office (PMS 325); 11:00 a.m. to 1:00 p.m.

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COMING UP

Courses

**Course information available at sspc.org*

Dec 6–7 SSPC C13 Water Jetting, Norfolk, Va. *

Dec. 8 SSPC Contract, Portland, Ore. *

Dec. 8 SSPC Using PA 2, Houston, Texas *

Dec. 8–13 SSPC BCI Bridge Ctg Insp Levels 1 /2, Southbridge, Mass. *

Dec. 8-13 SSPC PCI Prot Ctgs Insp Levels 1/2, Newington, N.H.

Dec. 8-13 SSPC PCI Prot Ctgs Insp Levels 1/2, Newington, N.H.

Dec. 8–19 SSPC PCI Levels 1/2, Singapore *

Dec. 9–12 KTA-Tator Basic Coatings Inspection, Pittsburgh, Pa., kta.com

Dec. 13–14 SSPC C12 Airless Spray, Norfolk, Va. *

Dec. 14 SSPC PCI Level 3, Newington, N.H.

Dec. 20 SSPC PCI Level 3, Singapore *

Conferences

Dec. 3–5 International WorkBoat Show & Annual Conference, New Orleans, La., workboatshow.com

Dec. 3–5 CHINACOAT 2014, Guangzhou, China, chinacoat.net

Dec. 9–11 POWER-GEN International, Orlando, Fla., power-gen.com

FOR A LIST OF MORE EVENTS, VISIT WWW.PAINTSQUARE.COM