

STEEL

OTHER

EPOXY

The Nuclear Option: Coating a Power Plant

BY **CLAIRE TRAGESER**
PHOTOS COURTESY **THIN FILM TECHNOLOGY, INC.**

Imagine, if you can, one of the most difficult and dangerous places to apply a coating. A place with extremely tight quality assurance and quality control requirements that are subject to strict government regulations. A place where each drum of coating has to be inspected by a security team and shipped in a sealed truck to a sealed location. A place where a subpar coating application job could cause something of a nuclear meltdown.

There are a few places that might come to mind, such as inside the international space station or around a tank holding great white sharks. But if underneath a nuclear reactor wasn't on the list, it should be.

That's the job that Jeff Longmore from South Houston, Texas-based Thin Film Technology, Inc., and the coatings contracting team from Williams Specialty Services were called to do. To describe the job, it'll take a very short physics lesson. Stay with it, because then the story gets good.

To the Depths

A group of nuclear reactors are called boiling water reactors. They use a nuclear reactor core to heat water, which then turns to steam. The steam drives a steam turbine, which is where the reactor's power comes from. The Fukushima Daiichi reactor, which suffered a nuclear disaster after the Japanese earthquake and tsunami in 2011, was a boiling water reactor. These nuclear reactors need containment systems, which include a pool of water contained in a doughnut-shaped vessel called a torus. The torus is actually the mathematical name for anything in this specific doughnut shape.

These water-filled tori are very large, are made of steel, and serve a very important purpose in nuclear reactor safety: Among other things, they provide emergency cooling water in case something goes wrong and the reactor overheats. And a torus is what brought Longmore and the coatings crew to this job at a North American nuclear power plant.

Longmore came by the job because of a long-standing relationship with Underwater Construction Corporation, an Essex, Connecticut-based diving company. Underwater Construction Corporation employs divers for a number of jobs, and one of them is to dive into nuclear reactors to weld, inspect, and apply coating.

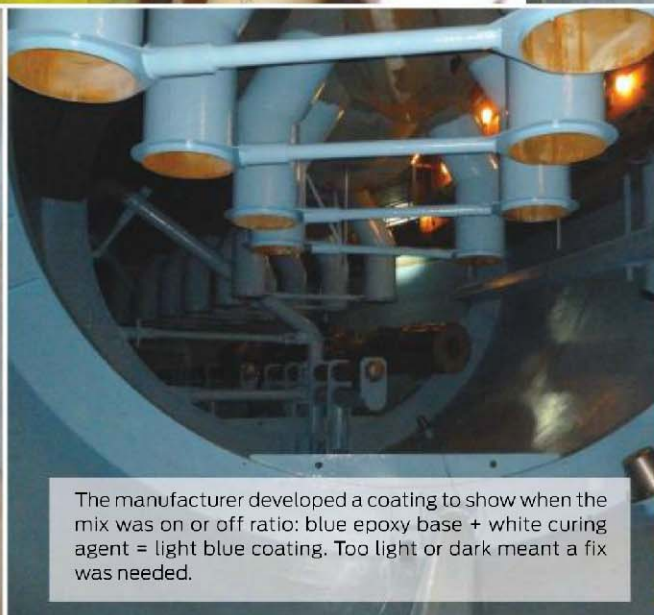


Williams Specialty Services was called in to re-line 32,000 square feet (2,973 m²) of a North American power plant. It had a remote location and angled surfaces: complications this 40-person crew could handle.





The project took place inside of a torus, which is a donut-shaped vessel used to hold cooling water in case of an emergency. The only ways to access the inside were two 54-inch (137 cm) manholes.



The manufacturer developed a coating to show when the mix was on or off ratio: blue epoxy base + white curing agent = light blue coating. Too light or dark meant a fix was needed.



The Nuclear Option

"They are the world's largest nuclear divers, which is a highly competent and technical job," Longmore said. "They regularly dive in tori under 15 feet [4.6 m] or 16 feet [4.9 m] of water, and inspect for corrosion. They've been doing it for forever."

About 15 years ago, Underwater Construction Corporation found Longmore's Thin Film Technology because it makes underwater epoxies.

"We started selling to them because their divers would do spot repair under water using our product," Longmore said. "We have a tremendous relationship. When they did spot repairs, they called it finger painting, because what they'd do is they'd find a quarter-inch [6 mm] hole, clean it up with sandpaper, put a dab of our stuff on, and spread it around. They didn't use much of our epoxy; they'd maybe buy 5–10 gallons [19–38 L] a year."

But Longmore kept selling to them, and he is certainly glad he did because this job is a complete relining — all 32,000 square feet (2,973 m²) of the internal surface of carbon steel of a large torus pressure vessel. "As time went on, they got more and more entrenched in the business," Longmore said. "Eventually they had this client that had a major recoat to do — it was long past touchups. It was on a torus that had inorganic zinc coating that was exhausted. It needed a major repaint. Our product is specialized, it sprays easily, and it cures under water. So they



After abrasive blasting the steel, the crew applied a stripe coat and then a minimum of 30 mils (762 microns). They applied the epoxy with plural component airless spray and 400-foot-long (122 m) hose.

came to us for this job."

The substrate had remains of worn inorganic zinc-rich coating with some rust and rust staining present. They'd need something unusual for the solution. "To cure something like that, it would be almost impossible to do it well, because you'd have to cure it by putting hot air in, and it doesn't cure well down below. It would take several days," Longmore said.

INDUSTRIAL BRISTLE BLASTER SYSTEM

Innovative Power Tool Surface Preparation

Clean and Profile in a Single Step

Near White/White Metal Clean

2.7 – 3.3 mil Profile

Pneumatic & Electric Tools



877 629-8777 • info@mbxit.com • www.mbxit.com



Scan or Visit www.mbxit.com/blaster
to see the Bristle Blaster in action!



Write in Reader Inquiry #266

JOB AT A GLANCE

PROJECT:

Re-line a pressure vessel under the nuclear reactor in a North American nuclear power plant.

COATINGS CONTRACTOR:

Williams Specialty Services
100 Crescent Centre Parkway, Suite 1240
Tucker, GA 30084
(866) 851-4077
www.wisgrp.com

SIZE OF CONTRACTOR:

About 700

SIZE OF CREW:

40

PRIME CLIENT:

A North American nuclear power plant that wishes to remain unnamed

SUBSTRATE:

Internal carbon steel surface of a large pressure vessel

CONDITION OF SUBSTRATE:

Used; the substrate had remains of worn inorganic zinc-rich coating with some rust and rust staining present.

SIZE OF JOB:

32,000 sq. ft. (2,973 m²)

DURATION:

Less than one week

UNUSUAL FACTORS/CHALLENGES:

- » Pumping equipment had to be situated outside the facility, so coating was applied using heated, plural component airless spray fed by hose packs over 400 feet (122 m) long.
- » Spraying area accessible only through two 54-inch (137 cm) manholes, so a solvent-free coating was used.
- » All material had to be quality assurance/quality controlled (QA/QC) certified months before use. Security had to be present during job; coating had to be inspected and delivered in secure trucks.
- » BIO-DUR 560 Blue 1/1 volume ratio epoxy coating was specifically developed by Thin Film Technology for nuclear service. The epoxy base is ink blue and the curing agent is snow white; when mixed in the application equipment the coating is a light blue, which ensures that the applicator is instantly aware of any "off-ratio" problem by a change in color.

MATERIALS/PROCESSES:

- » Used coating that was supplied in 55-gallon (208 L) open-head drums, which dispensed automatically through large rams into heated auto-level reservoirs on the plural pump equipment
- » Stripe-coated sharp edges and wells
- » Spray-applied the coating in one pass at a minimum of 30 mils (762 microns) thickness using custom-manufactured spray equipment

SAFETY CONSIDERATIONS:

- » Almost no volatile organic compounds (VOCs) were emitted by the coating, but carbon cartridge respiratory protection was used to guard against particulates.
- » Impervious protective clothing and gloves were used to protect against both coating contact and possible slight background radiation.
- » Splash-proof goggles were used by all applicators.



The crew wore carbon cartridge respiratory protection, impervious protective clothing and gloves, and splash-proof goggles. And the coatings were safe too. They were inspected and sealed before arriving at the site.

Luckily, Longmore had experience with coating that would do this type of job. "Our product, you literally spray it, and a few hours later you can fill the torus with water," he said.

Coatings Mixology

Thin Film Technology makes a sprayable coating product called BIO-DUR that seemed right for the job. It's a blend of liquid epoxy polymer and curing agents that's solvent-free and uses Kevlar fibers to reinforce and manage viscosity, which means it can be applied easily under water.

There was just one problem: BIO-DUR was light grey, and the client wanted blue.

But this color choice ended up giving Longmore a chance to innovate, with amazing results. "Plural equipment today — the component airless spray — is pretty reliable," he said. "But you have to heat it so it sprays, because it's 100 percent solvent-free, so you have to heat it to make it thin. But once you mix it together, you have about 5 minutes to apply it, because without heat it hardens up too quickly. So you keep the components separate all the way until the spray gun."

But there was no way to know if something goes wrong with the mixture, Longmore said, and that's where his innovation comes in. "In the old days, if you had a problem, the operator wouldn't know what was wrong," he said. "In the meantime, he's applied 2,000–3,000 square feet (186–279 m²) of coating that's never cured, because he didn't know what the problem was."

So Longmore developed BIO-DUR 560 Blue, a 1/1 volume ratio epoxy. "The epoxy base is ink blue and the curing agent is snow white, so when mixed in the application equipment, the coating is a light blue," he said. "As the guy was spraying, if it begins to get very light or very dark, he knows it's a problem, and he can stop spraying right then before damage is done."

Longmore used the mix on a few other jobs before this one, so he had a chance to refine it. But there were still complications. "The coating material had to be made under supervision, because we're under strict QA/QC from another company," he said of the quality assurance/quality control.

The coating was made in July 2013, months before the job

The Nuclear Option

began in September 2013. It was made in a manufacturing plant in South Houston, Texas, and then had to undergo inspection before it could be shipped.

"They even sent security to the plant just to make sure when we put stuff in the drums it was paint and nothing but paint, if you catch my drift," Longmore said. "It was going to be shipped into a secure area. We also sent it in a sealed truck to a sealed location."

"We have made nuclear coating for years and years, but this was the first time we made it in such volume," Longmore added.

All Access Pass

Once the coating was given the OK and it arrived on site, the team of about 40 from coatings contactor Williams Specialty Services could get to work. But they also had lots of complicated challenges ahead of them.

"A torus recoat project is very, very complex, and all of the departments of the nuclear plant from security to operations have to be closely coordinated to successfully plan and execute the work," said Arthur Kenworthy, the vice president and general manager of Williams Specialty Services. "When a utility hasn't done a torus project in several years, it is difficult for them to understand the amount of additional equipment and personnel required and to coordinate all the torus activities with the normal refueling outage activities. The ventilation equipment and the duct work alone is a tremendous disruption to their normal traffic flow path during the outage."

There were also operational challenges, including emptying the torus of water before the coatings application. "The torus is where many critical plant systems drain water to and take water from, so when the torus is drained for recoat, the



It took this seasoned coatings crew less than one week to complete this important project. As Jeff Longmore of Thin Film Technology, Inc., the coatings manufacturer, said, "It was picture perfect."

plant operators have to make changes to the normal refueling procedures to allow for that," Kenworthy said. "So it's very, very complicated from any viewpoint."

The design of the torus also brought challenges for Kenworthy's team: It has two hatches as the only access points. "We have to make thousands of trips in and out of the torus during a recoat project; we took almost 1,000 pieces of equipment in there — access platforms, blast, power tool, and spray equipment, as well as ventilation, decontamination, and inspection equipment. It's hugely complicated logistically to get everything in and out."

The circular donut shape of the torus was also a hassle. "We coated the torus from the center line down, and it's a very complicated shape," Kenworthy said. "You're not dealing with flat surfaces and square corners. Getting access to all the surfaces is very challenging. It's like working in a circular tunnel with lots of structures and components inside. We utilized custom access platforms for this project because typical scaffolding would not work effectively in this situation. It's difficult to apply any coating to that kind of complex geometry."

The shape and limited access points also made the coatings process complicated. "We had to ventilate the entire torus, remove dust while we're blasting, and maintain a certain temperature and humidity while we're coating," Kenworthy said. "We also have to get hundreds of people in and out of the hatches daily, but at the same time maintain environmental conditions in the torus."

Because the torus usually stores water for many systems in the nuclear plant drain to it, it's difficult to completely isolate from leaks, Kenworthy added. "A slow leak from a valve or two, and we have to re-blast the area." The team was doing a white metal blast, and water does not mix with it. "The surface can flash back to rust if the ventilation is not carefully controlled," Kenworthy said. "We had a complex geometry, exacting quality requirements, a tight schedule, some very tight spaces that were inaccessible really for normal application methods, and work that had to be closely coordinated with the plant. Getting this project done successfully was truly a team effort with the coating manufacturer, the plant

VENDOR TEAM

DuPont

Safety equipment manufacturer
1007 Market St.
Wilmington, DE 19898
(800) 441-7515
www.dupont.com

Graco Inc.

Equipment supplier
88 11th Ave. NE
Minneapolis, MN 55413
(612) 623-6000
www.graco.com

Spray-Quip Inc.

Equipment manufacturer
754 Des Jardines St.
Houston, TX 77023
(713) 923-2771
www.sprayquip.com

Thin Film Technology, Inc.

Coatings manufacturer
802 Utah St.
South Houston, TX 77587
(713) 910-6200
www.thinfilmtex.net

Underwater Construction Corporation

Quality control
110 Plains Rd.
Essex, CT 06426
(860) 767-8256
www.uccdive.com

personnel, and all the vendors and contractors who supported the project refueling activities.”

But deal with it they did. First the crew abrasive blasted the substrate over about a week under dehumidification. Then the coating application could finally begin. After all the preparation and build up, application only took two days, followed by inspection and minor touchups over an additional few days.

To apply the coating, they used custom-made spray equipment manufactured by Spray-Quip of Houston, Texas, using Graco parts.

But the location of the torus brought another challenge.

“The actual torus was deep inside the plant, and the pumping equipment had to be situated outside the facility,” Longmore said. So they used heated, plural component airless spray fed by hose packs that were more than 400 feet (122 m) long. “That’s almost unheard of,” Longmore said. They wrapped the hose pack with a heat trace and insulation to keep it hot.

The coating was supplied in 55-gallon (208 L) open-head drums that dispensed automatically through large rams into heated auto-level reservoirs on the plural pump equipment.

Another access problem was the fact that although the torus was really large — about 143 feet (44 m) across the doughnut with a cross section diameter of about 33 feet (10 m)

— the only way to get inside was through two 54-inch (137 cm) manholes. That meant all power, personnel, ventilation, and material had to go in and out through those holes, which made the solvent-free coating even more practical.

The crew applied an initial stripe coat on all the sharp edges and wells. They followed that with one single coat sprayed at a minimum of a 30-mil (762 microns) thickness.

Because almost no volatile organic compounds (VOCs) were emitted by the coating, the team used carbon cartridge respiratory protection, mostly to guard against particulates. They also wore impervious protective clothing and gloves to guard against both coating contact and possible slight background radiation. All applicators also wore splash-proof goggles.

Positive Reaction

Despite all the complications, Longmore was very pleased with the results. “It was picture perfect,” he said. His specially made blue BIO-DUR sprayed on beautifully and cured just as it was supposed to.

Longmore said the entire team learned a lot during the job and worked through several complicated wrinkles, which means they’ll be even better prepared for the next job, wherever that might be. **CP**



Jotamastic Smart Pack



Outstanding
brush and roller properties

Simply better corrosion protection. For the smaller maintenance jobs.
Easy to get right. Tough to get wrong.

jotun.com

Tel: (800) 229-3538

Write in Reader Inquiry #336