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Corrosion Maintenance

COATINGS

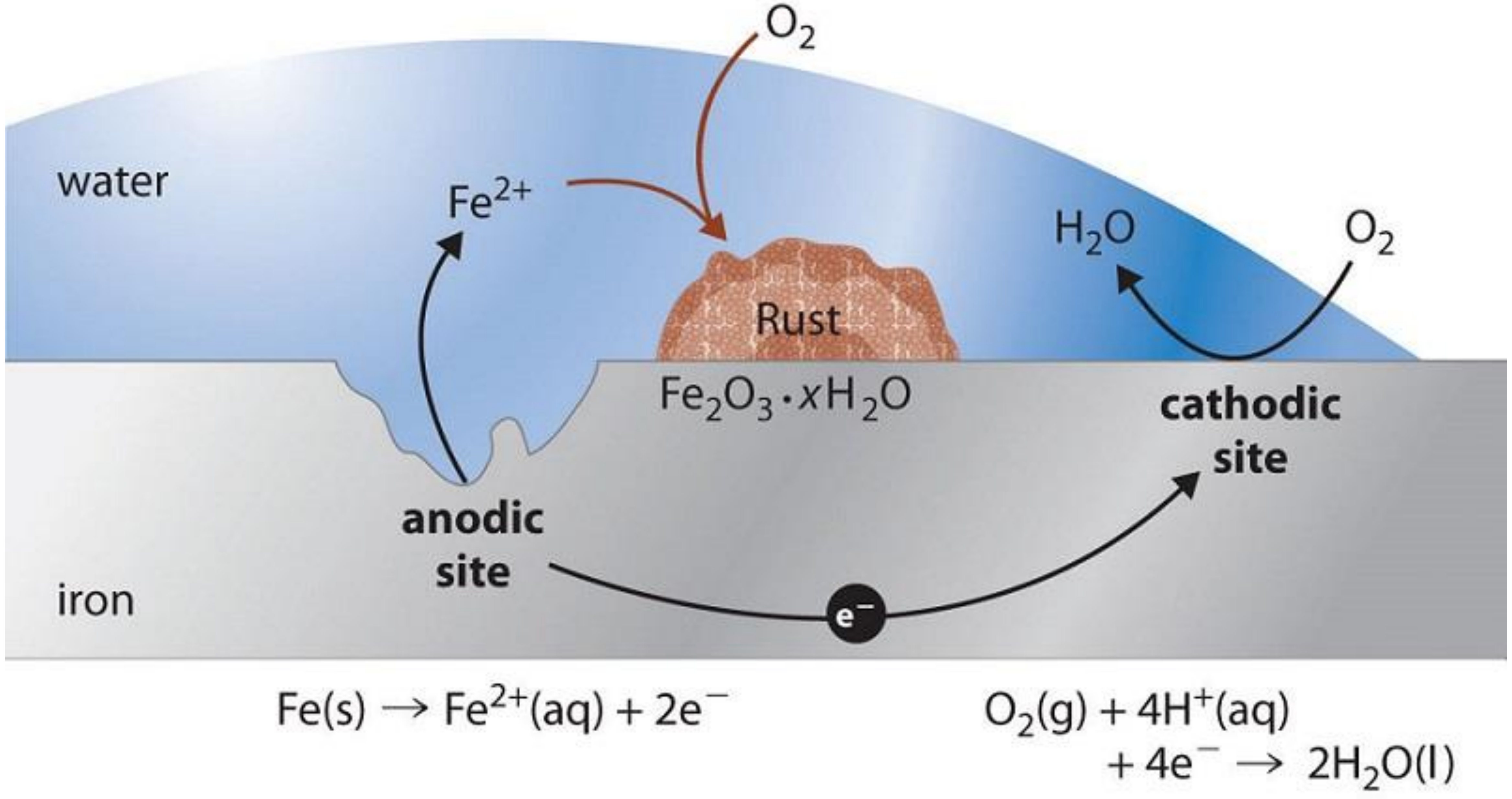
What is Corrosion?

It is the enemy of all metal

- Corrosion is the electrochemical reaction between metal and atmospheric oxygen, called oxidation
- Redox potential of the metal determines the tendency of the metal towards oxidation
- Moisture and atmospheric oxygen in contact with metal initiate oxidation of the metal
- Brown rust (metal oxide) is the product of corrosion
- Corrosion will disintegrate the metal and thus compromise the strength of the metal structure

What is Corrosion?

It is the enemy of all metal



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How to Protect Metal from Corrosion

- *Create a protective barrier between metal and the surrounding corrosive environment, such as moisture, salt and oxygen.*
- *A protective coating can serve as a barrier between substrate and the atmosphere*

Conventional Protective Coating Systems

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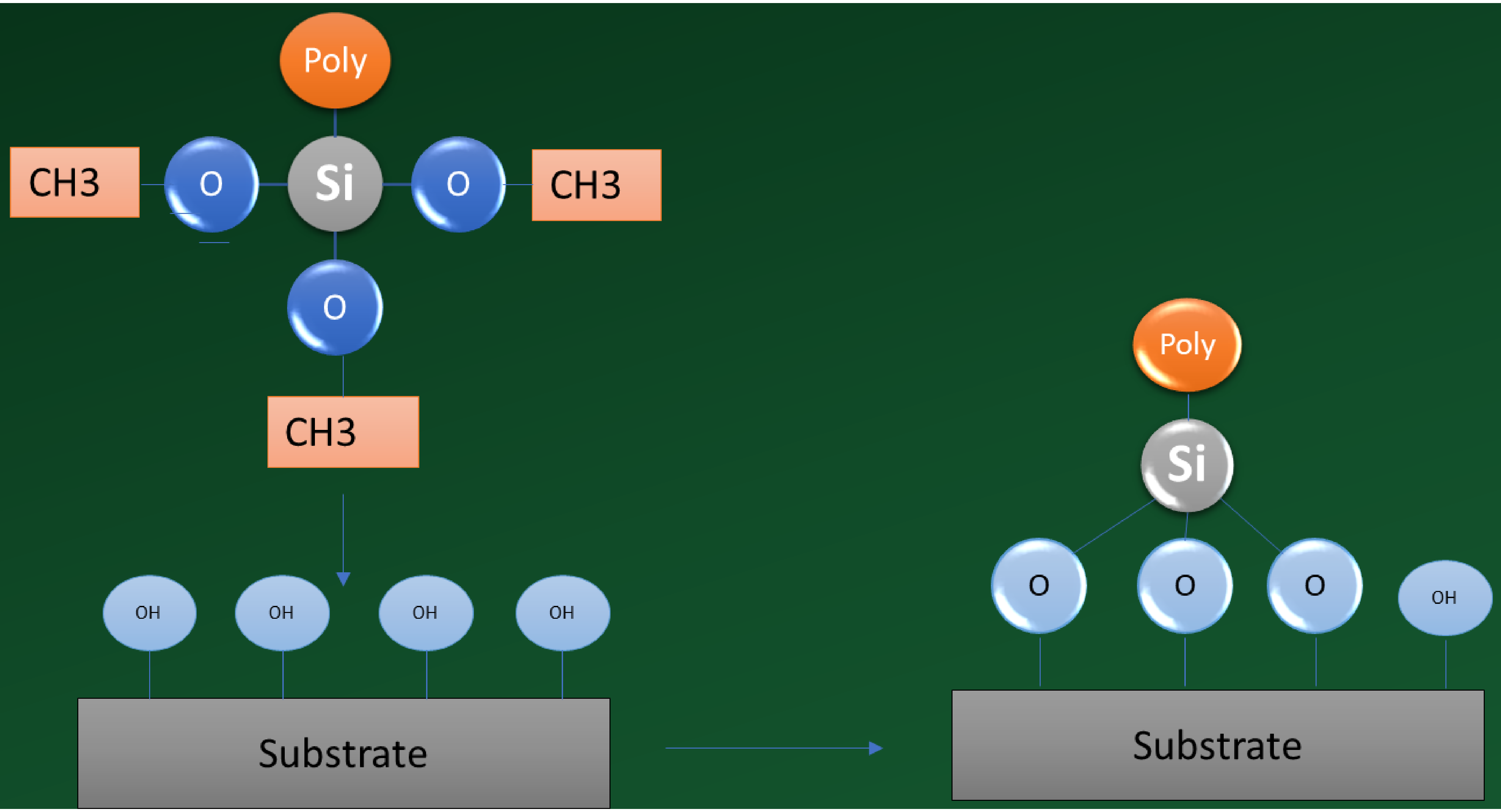
- Substrate is prepared by sandblasting to remove any corrosion and mill scale that could attract the moisture.
- Multiple coat system consisting of a Zinc rich primer, an intermediate coat and a topcoat.
- Zinc rich primer reverses the oxidation reaction.
- Intermediate coat, commonly an epoxy coating, covers and protects Zinc rich primer
- Topcoat is normally loaded with anti-oxidants and UV stabilizers and protects underlying intermediate coating

RTV Silicone Technology

- Forms a stable and flexible barrier between substrate and corrosive environment
- Does not require exhaustive surface preparation, such as sand blasting
- Excellent resistance to UV and high temperature, thus provide longer service life than conventional coating system
- Requires minimal surface preparation and provide excellent primer-less adhesion
- Single coat application that saves cost of application
- Highly resistant to environmental weathering
- Low energy hydrophobic surface

RTV Silicone Technology



Adhesive bonding through chemical reaction with the substrate ensure strong adhesion for better protection

RTV Silicone Technology

Si-Coat® CM – Corrosion Maintenance Coating

Si-COAT® CM™ Corrosion Maintenance are a line of silicone coatings designed to withstand harsh climates and service environments for long-term protection. All Si-COAT® CM™ coatings are naturally hydrophobic, flexible, and UV stable, combining to create long-term protection. Its superior performance reduces your maintenance costs and lengthens your asset's life.

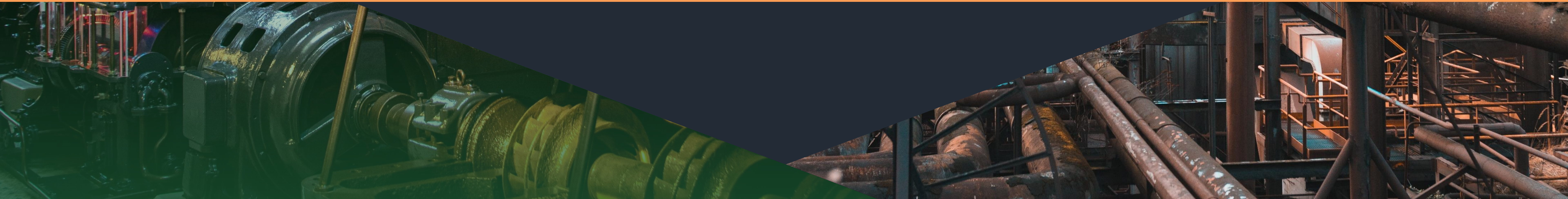
Si-Coat® 579™

Solvent borne

Si-Coat® 580™ Low VOC

Solvent free low VOC coating

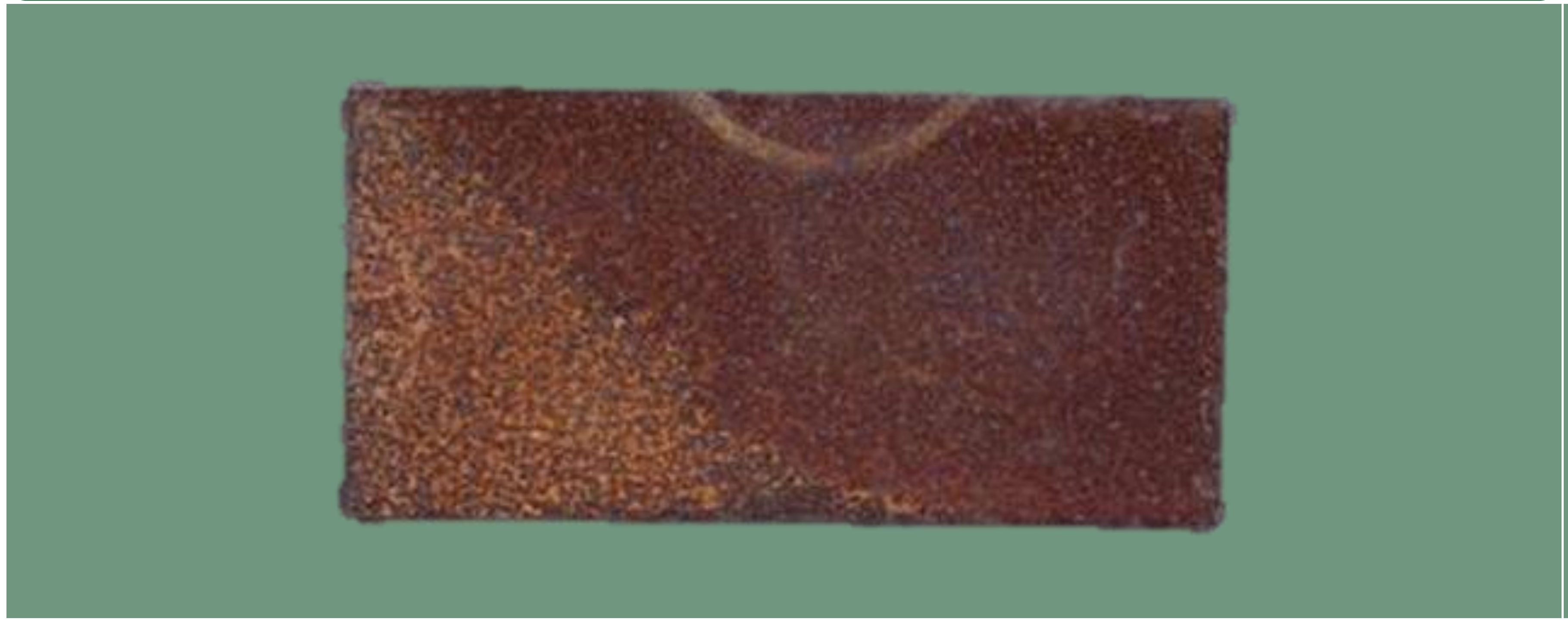
Available in various stable colours that have passed 5000 hours of UV weathering test



Performance Testing Data

FLORIDA EXPOSURE TEST *(3 YEARS)*	**VOM GROUP** *THE NETHERLANDS*

Florida Fence Test

STEEL WAS RUSTED	PREPARED TO SSPC-SP2 STANDARDS
	

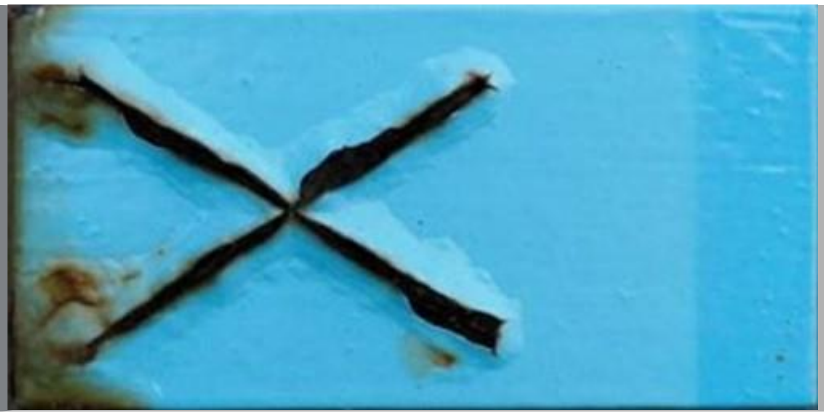
Panels were then coated with various protective coatings and exposed on a 45° incline, south facing for 3 years in Melbourne Beach, FL, USA (identical to NASA test).

Florida Fence Test

EPOXY

Epoxy three-coat (IOZ/epoxy/PU) system on abrasive blasted steel:
heavy corrosion creep and corrosion bleed-through, with adhesive failure

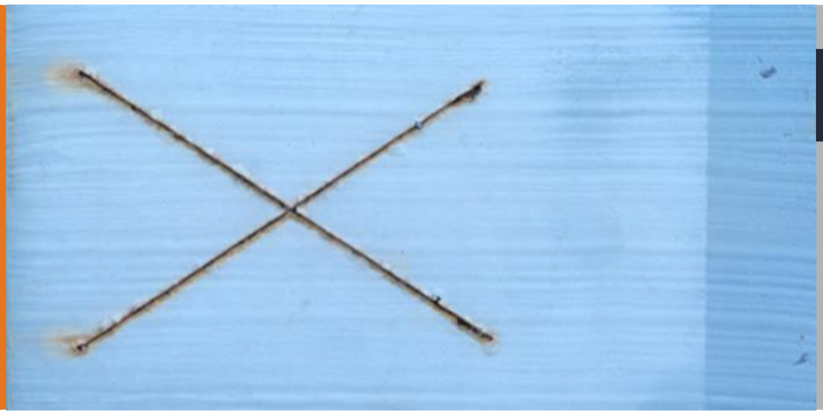
EPOXY



Epoxy-Silicone copolymer two-coat (primer plus coating) system on abrasive blasted steel:

heavy corrosion creep and blistering, with adhesive failure

RTV
SILICONE



Si-COAT 579

no corrosion creep, no blistering, no adhesive failures

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VOM Group – The Netherlands

In 1997, on behalf of The ministry of transport, public works & Water Management department, the VOM Group tested Si-Coat 579 attempting to find a solution for corrosion protection of the retractable steel floodgates positioned in Rotherham Harbour.

The test conducted were:

- Recoat ability, adhesion & deformability.
- Resistance to mechanical damage when applied over original TCP (Glass flaked epoxy coating).
- Resistance to high pressure washing up to 200 bars (2900 psi).
- UVA resistance
- Abrasion resistance
- Saltwater immersion

Recoatability, Adhesion and Deformability

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CSL coating produces good results as maintenance system on top of old TCP coating with regards to adhesion and deformability.

During bending TCP coating shows cracks, but the CSL coating applied on top bridges these cracks.

Test Description:

Objective	To determine if the CSL coating is fit for use as a maintenance product
Description	Apply two layers of CSL on top of old TCP system (existing aged sheets) to a film thickness [DFT] of 1,000 micrometers
Procedure/standards	Ageing for 3 days @ 60°C, no standard Adhesion in accordance with ISO 2409 (cross-cut test) Adhesion in accordance with ISO 4624 (dolly test) Deformability (cylindrical mandrel)
Requirements	Adhesion of at least class 2 (ISO 2409), Minimum 1.5 N/mm² (ISO 4624)
Deformability	Minimum mandrel diameter 10 mm
Duration	1 week

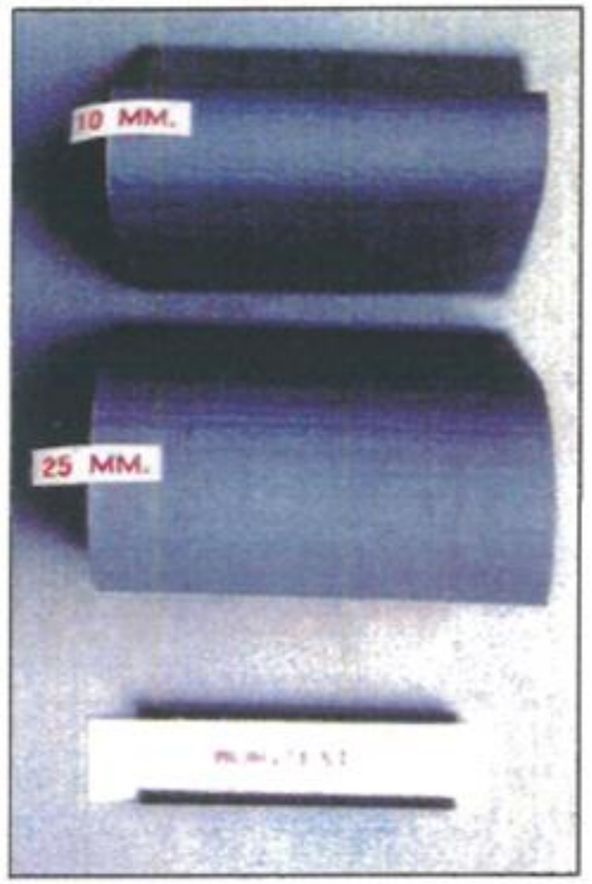

Figure 1: Si-COAT shows no damage in 180° bend test at bend radii or 10 mm and 25 mm

Results:

Adhesion	Class 0 (ISO 2409) 1.2 N/mm², 1.0 N/mm², 1.4 N/mm² (ISO 4624)

Several bonding techniques have been used because almost nothing adheres to the CSL coating. Eventually the dolly was placed in the wet CSL coating. After curing and ageing the test was executed. The fracture surface is for 90% the dolly and for 10% the CSL coating.

Deformability	Ø 10 mm	- TCP many cracks - TCP + CSL no cracks
	Ø 25 mm	- TCP many cracks - TCP + CSL no cracks

Resistance to Mechanical Damage

Resistance to Mechanical Damage when Applied over Original TCP

Test Description:

Objective	To determine resistance of the CSL coating against mechanical damage during maintenance activities
Description	Apply CSL coating on top of aged TCP system (film thickness 450 micrometers [DFT]). Subsequently carry out nuts dropping test and impact resistance test
Procedure/standards	Ageing for 3 days @ 60°C, no standard Nuts dropping test in accordance with NEN 5335 Slagvastheidsproef in accordance with ECCA T5
Requirements	Nuts dropping test: no damages up to substrate Slagvastheid: minimum 1 N/m

Results:

Nuts dropping test	TCP 20 impressions in the coating and 0 impressions up to substrate TCP + CSL no impressions
Impact resistance reverse 2.5 – 5 and 10 N/m	TCP all specimens cracked TCP + CSL all specimens undamaged
Impact resistance forward 2.5 – 5 and 10 N/m	TCP all specimens cracked TCP + CSL all specimens undamaged

See photographs

Conclusion:

CSL coating produces excellent results on old TCP coating with regards to resistance against mechanical damage. During the impact resistance test the TCP coating cracks, but the CSL coating applied on top of it bridges these cracks.

Figure 2: Si-COAT applied over TCP shows no damage upon impact testing, and bridges all cracks of the underlying TCP

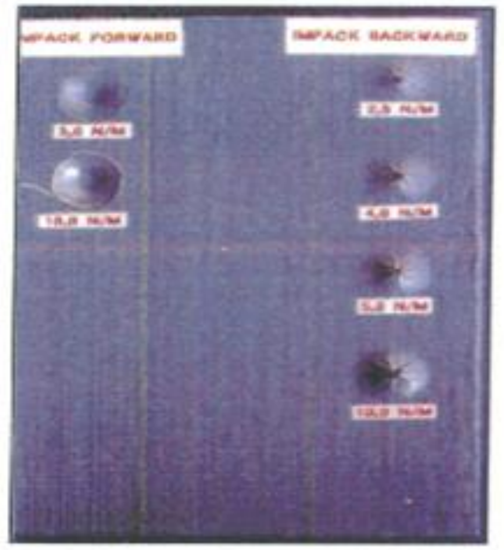

Figure 3: TCP coating alone shows heavy damage upon forward and reverse impact testing

Resistance to High Pressure Washing

Resistance to High Pressure Water Washing

Test Description:

Objective	To determine during high pressure cleaning, at which pressure damage will occur to the CSL coating
Description	Apply CSL in two layers on aged TCP system (thickness 450 micrometers [DFT])
Procedure/standards	Ageing for 3 days @ 60°C, no standard Cleaning test, no standard, distance to test panel 30 cm with rotating nozzle
Requirements	At least 100 bar without damage
Duration	1 week

Results:

Cleaning test	50 bar no damage 100 bar no damage 150 bar no damage 200 bar damaged coating

See photographs

Conclusion:

Up to 100 bar the CSL coating can be cleaned without problems. At pressures above 150 bar, problems can occur.

Figure 4: Cleaning with high pressure water at 100 bar shows no damage to Si-COAT

Figure 5: Cleaning with high pressure water at 200 bar begins to show slight damage to Si-COAT

UV Resistance

Ultraviolet (UV) Radiation Resistance

Test Description:

Objective	To determine the resistance against UV-load by accelerated weather testing
Description	Apply CSL in two layers on aged TCP system (thickness 450 micrometers [DFT])
Procedure/standards	Ageing for 3 days @ 60°C, no standard Accelerated testing by Suntest in accordance with DIN 50017
Requirements	No discoloring, loss of gloss or other damage after 1,000 hours load
Duration	6 weeks

Results:

Suntest	After 1,000 hours Suntest the CSL coating does not show discoloring, loss of gloss or other damage

See photograph

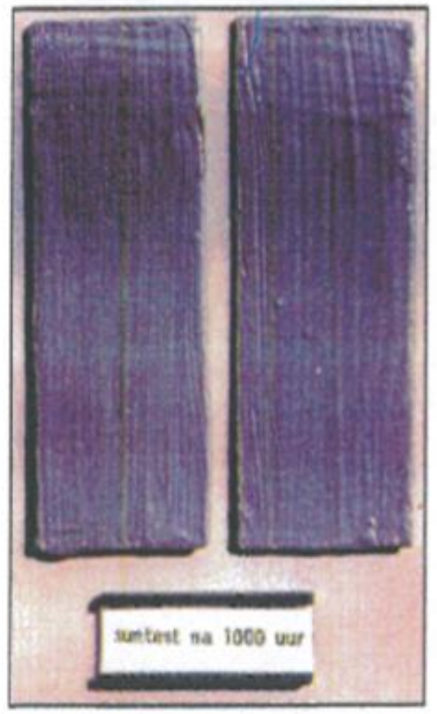

Figure 7: After 1,000 hours of accelerated UV testing, Si-COAT shows no loss of gloss, color or other damage

Conclusion:

CSL coating has a good outdoor durability.

Sand Drop Abrasion

Abrasion Resistance by Sand Drop Method (modified)

Test Description:

Objective	To determine the resistance to abrasion of the CSL coating
Description	Apply CSL on top of aged TCP system
Procedure/standards	Ageing for 3 days @ 60°C, no standard Abrasion resistance with sand drop test in accordance with ASTM D968-93
Requirements	At least equal to epoxy coating
Duration	1 week

Results:

Abrasion resistance		Average DFT (micrometers)	
	System	Prior to Testing	After 100 liters Sand
	TCP 1	603	519
	TCP 2	793	738
	TCP + CSL 1	1127	*
	TCP + CSL 2	972	*

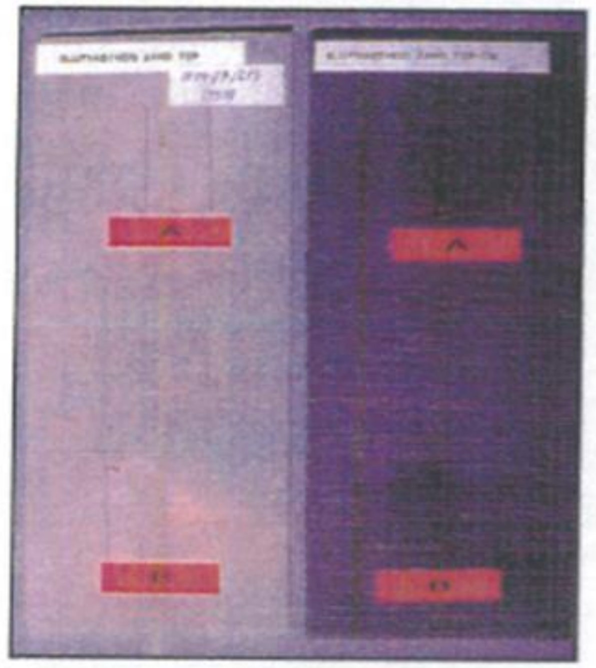

Figure 8: Si-COAT's elasticity prevents damage to the coating from abrasion by the sand drop method

* Due to the elasticity of the coating, the dropping sand does not cause wear effects. Therefore it is hardly or not at all possible to determine a reduction in film thickness.

Saltwater Immersion

Salt Water Immersion

Test Description:

Objective	To determine the resistance against salt water of the CSL coating
Description	Apply two layers CSL on top of old TCP system (film thickness 450 micrometers [DFT])
Procedure/standards	Ageing for 3 days @ 60°C, no standard Immersion in 5% NaCl salt water solution
Requirements	No damage after 1,000 hours
Duration	6 weeks

Results:

Salt water immersion	After 1,000 hours immersion in a 5% salt solution the CSL coating shows no damage

See photograph

Conclusion:

CSL coating is fit for use in salt water.

Figure 9: After 1,000 hours of salt water immersion, Si-COAT shows no damage

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1.0 Case History

Solves Widespread Corrosion Issues on 10-Month Old OEM Pipe Coating

Product

Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating

Colour

Blue Steel

Location

De Bary, FL, USA

Date Installed

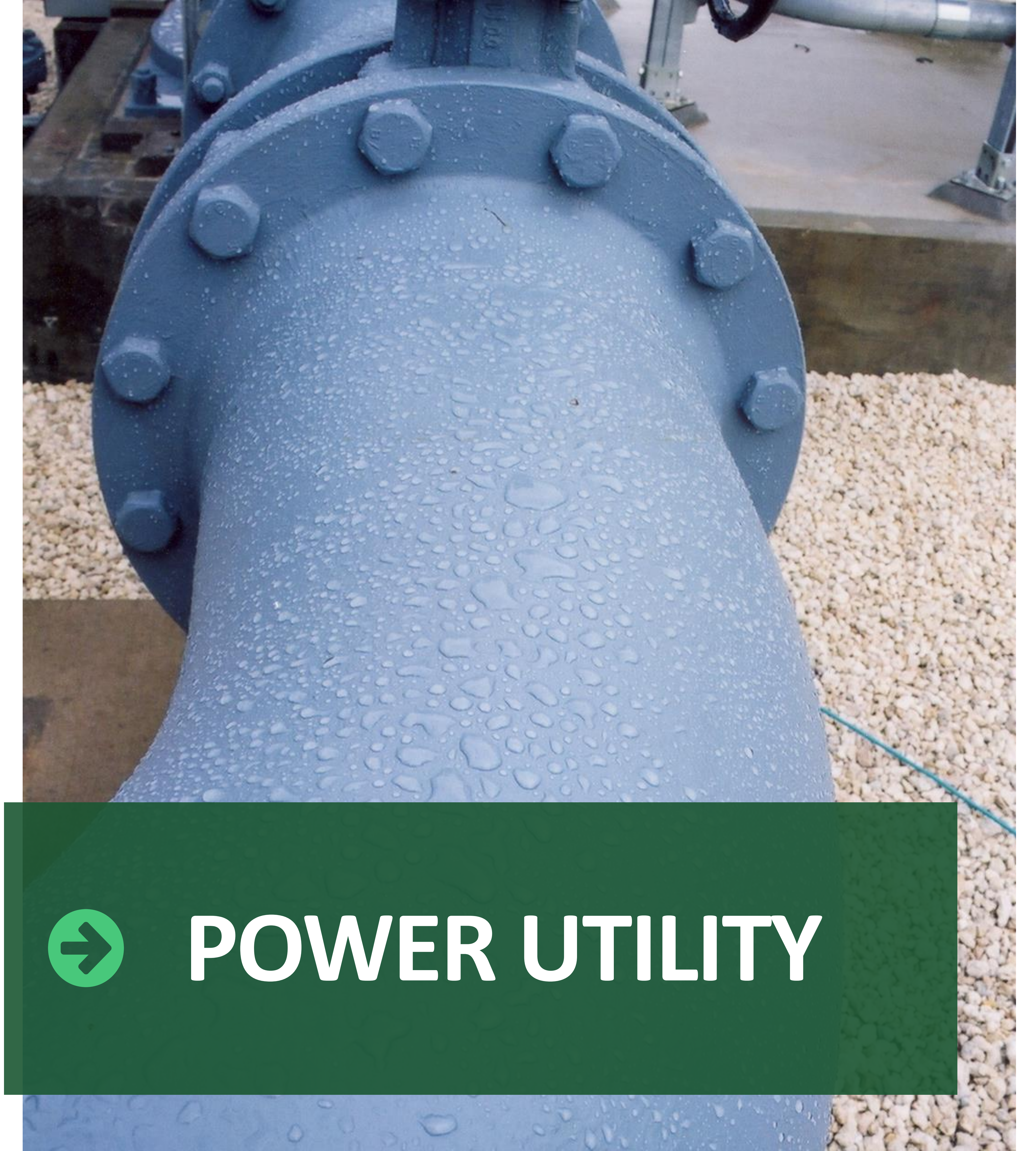
February to September 2003

Environment

High temperatures, high humidity, high UV exposure

Issues

Breakout rusting on 15 miles of process piping from alkyd coating in under 10 months of service



1.0 Case History

Solves Widespread Corrosion Issues on 10-Month Old OEM Pipe Coating

It's what nightmares are made of for corrosion engineers – the 15 miles of newly ordered process piping begins to show widespread breakout rusting in less than ten months of service. Sounds like a headache? It's exactly the scenario faced by the Lead Corrosion Engineer of a major Florida, USA power utility.

The oil-fired power plant located in De Bary, Florida had undergone some routine maintenance of process pipe replacement in 2001. Approximately 15 miles of piping plus associated instrumentation and fittings had been slated for replacement due to various reasons.

The piping that was ordered was of various diameters and configurations, manufactured of carbon steel.

The environment in which the plant is situated is one of high corrosion activity, attributable to the high temperatures and humidity. De Bary, Florida is also only 35 miles (56 km) from the Atlantic Coast. So, some salt contamination is also a factor contributing to the corrosive environment. In addition, materials in are stressed by the high ultraviolet (UV) radiation experienced in the region; Florida, USA receives over 3,000 hours of sunlight per year out of a maximum possible 4,456 hours.

Because of the aggressive service environment, the piping had been specified by the customer to be blasted to white metal and coated with an inorganic zinc rich coating. Unfortunately, there was some confusion at the shop. The piping never did get its specified coating but was instead coated with an alkyd coating.

Figure 1: Heavy rusting around welds were cleaned by power tools to tightly bound rust

Figure 2: Weld joints were spot primed with Si-COAT 579 for added protection

1.0 Case History

Solves Widespread Corrosion Issues on 10-Month Old OEM Pipe Coating

To make matters worse, the error slipped by the customers' eye and was installed as supplied.

The mistake was, in fact, not readily apparent until the piping started rusting within a very short time. It took less than ten months for the problem to be widespread as breakout rusting had occurred along nearly every foot of piping. The problem was especially severe at the weld joints between pipe sections and near fittings and instrumentation.

Clearly, repairs were going to be an onerous and expensive task. But, further complicating the matter were the limitations of budget, the prohibition of spraying coatings within the plant and the mandate of keeping the plant looking new and in excellent repair.

The practice of rolling or brushing a coating is an expensive proposition compared to spraying given the greater labor hours required. Hence, a coating had to be sourced that could not only be rolled on in as few a number of coats as possible, but that would also offer extreme corrosion protection and UV resistance all with minimal surface preparation.

Based on the outcome of testing that had previously been conducted by the Corrosion Research & Evaluation Laboratory of the utility, the Lead Corrosion Engineer chose Si-COAT 579 to solve the problem.

The outstanding adhesive characteristics of
Si-COAT meant that abrasive blasting was not necessary in preparing the pipe surface. As well, Si-COAT's ability to adhere as well to tightly bound rust as to abrasive blasted steel meant extensive preparation around the weld joints was not necessary.

Application of the Si-COAT 579 coating was carried out by Williams Specialty Services of Atlanta, Georgia, USA.

To prepare the piping for Si-COAT, water blasting at 5,000 psi (352 kg/cm2) with a turbo tip was all that was used for a vast majority of the piping. The weld joints, all of which were very heavily rusted, were prepared to the SSPC-SP3 standard by power tool cleaning of all rusty areas followed by a solvent wipe down. All surfaces, whether blasted with water or power tool cleaned, were brought down to tightly bound rust.

1.0 Case History

Solves Widespread Corrosion Issues on 10-Month Old OEM Pipe Coating

For extra protection, all weld areas were first spot primed with 6 mils (152 microns) dry film thickness (DFT) of Si-COAT 579. Following that, all surfaces were coated, by roller, with 9 mils (229 microns) DFT of Si-COAT 579.

Except for the extra precautions taken around the weld areas, the Si-COAT coating was a one-coat system.

For the simple facts that abrasive blasting of the piping was not necessary, and that Si-COAT is a one-coat system, the overall project by using Si-COAT was far more cost-effective than had a conventional coating system (such as a three-coat epoxy/epoxy/urethane) been specified. Material and labor savings both contributed to the economics of the project.

Furthermore, Si-COAT 579 has an expected service life of well over 30 years in this type of environment. Hence, if the project cost is annualized to a dollar per square foot per year basis, the figure will be even further attractive when compared to the same figure for a conventional coating system which may achieve, at the very best, a 15-year life span in the case environment.

2.0 Case History

Finds Long-Term Solution to Corrosion Protection and Color Retention

Product

Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating chosen for tested colours, long life, application ease, colour retention

Colour

Custom colour match

Location

Florida Power & Light, West Palm Beach, FL, USA

Date Installed

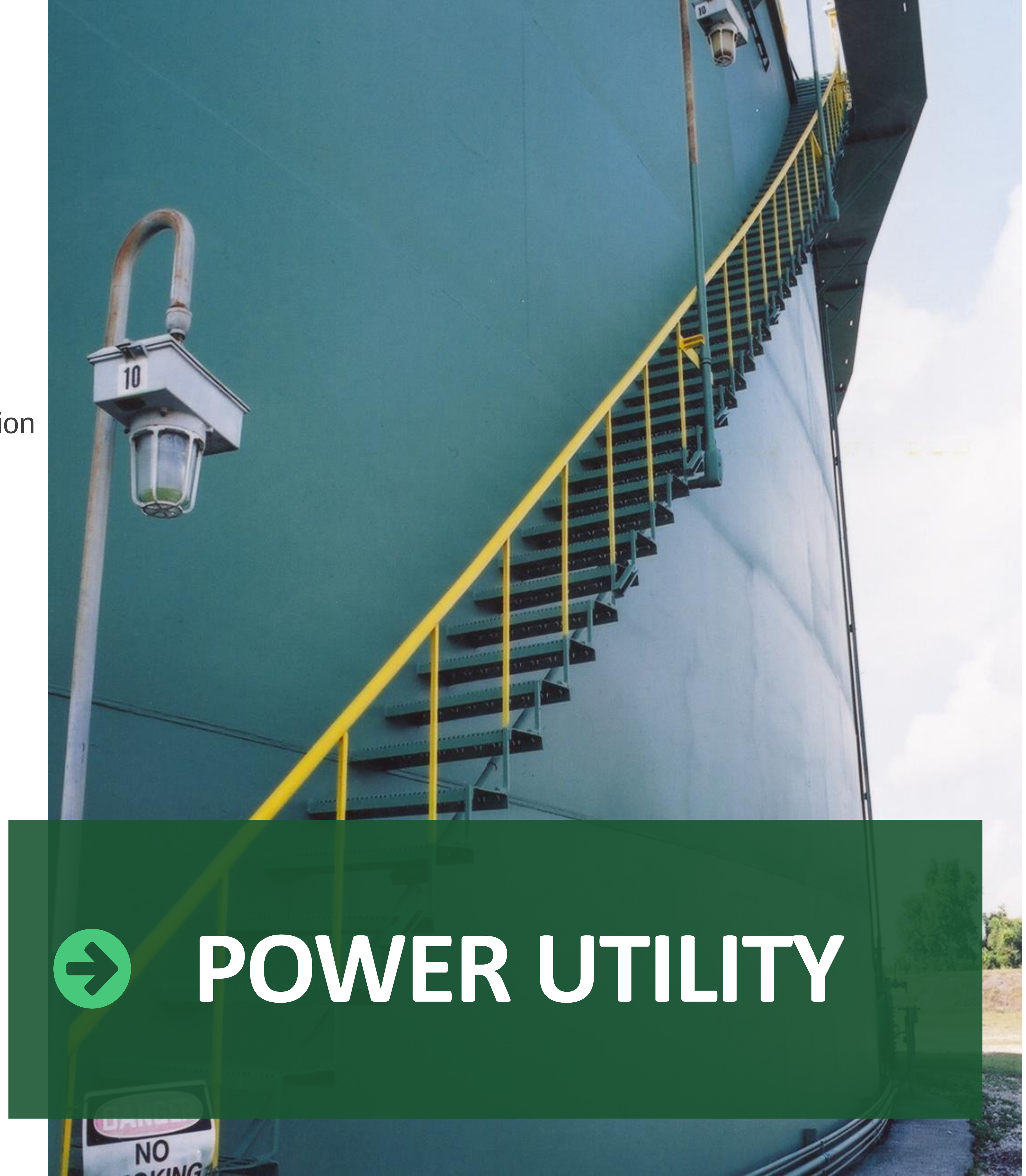
December 2002

Environment

High temperatures, high humidity, high salt fog, high UV exposure

Issues

Peeling and pit-rusting with existing five-year old acrylic coating; color/gloss retention, heavy fading



2.0 Case History

Finds Long-Term Solution to Corrosion Protection and Color Retention

If it were never cloudy in Florida during daylight hours, the state could receive a maximum possible 4,456 hours of sunshine. Naturally, cloud cover is to be expected. But even then, the state of Florida, USA receives, on average, about 3,000 hours of sunlight a year. When the depleted level of ozone over North America is considered, the sum is a great deal of ultraviolet (UV) radiation exposure.

We've all seen the effects of UV exposure – sunburns, ageing skin, and fading colors to name a few. Thus, for the Lead Corrosion Engineer at this Florida power utility whose mandate is, in part, to keep the facilities looking fresh and new, the excessive levels of UV play real havoc. It would be simple enough to recoat the infrastructure every couple of years, but cost is always an issue.

And so the search began to find a coating that would exhibit not only long-term UV resistance, but also excellent corrosion performance and favorable economics.

The testing employed by the company's Corrosion Research & Evaluation Laboratory is the same testing used by NASA in their corrosion testing.

The 'Three-Year Florida Fence Test' performed by the utility took place at Melbourne Beach, Florida, known notoriously as the second most corrosive environment in the world. The test station was, in fact, located only 45 miles south of NASA's Cape Canaveral corrosion test station, on the same beach. All test parameters were identical to those of the NASA testing program (same exposure angle, same exposure duration, same wave break action, same salt spray exposure, same sample preparation, etc.).

From the extensive research and investigation into coatings from around the world, the Corrosion Research & Evaluation Laboratory of the utility short-listed 29 different coatings to be tested. The selected coating systems included three-coat epoxy/urethane systems, two-coat epoxy/urethane systems, polysiloxane-epoxy copolymer coatings, alkyds, organic zincs and more. The panels to be coated were pre-rusted in a salt fog chamber and prepared to the SSPC-SP2 standard with zero chloride contamination on the surface. After surface preparation, the panels were coated as per the manufacturer's instructions and included priming, where specified.

2.0 Case History

Finds Long-Term Solution to Corrosion Protection and Color Retention

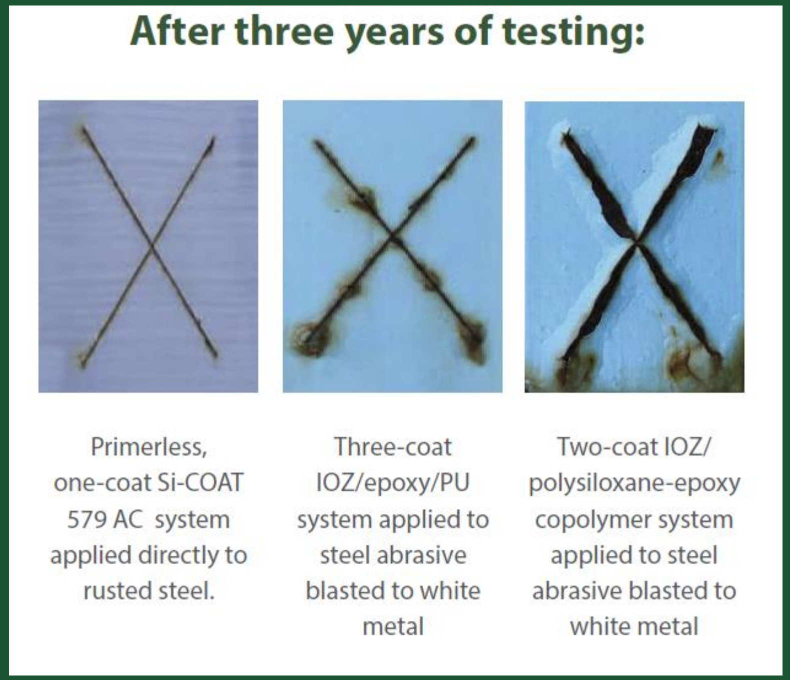
Of all the coatings tested, only the Si-COAT 579™ Elastomeric Corrosion Maintenance Coating was a one-coat system. It was applied to a dry film thickness (DFT) of 7 mils (178 microns), which required 10 mils (254 microns) wet film thickness (WFT).

Upon coating and drying of all the panels, they were scribed with an 'X' to bare metal and exposed at the test site for a three-year period. Measurements taken at the completion of the test included color/gloss retention and corrosion creep under the coating surface at the scribe.

The results of the test were dramatic. Three coatings showed a virtual day and night difference from the other 26. These coatings were the one-coat Si-COAT system, and two alkyd coatings from different manufacturers. The two alkyd coatings were identified because they displayed good resistance to corrosion creep at the scribe. Despite this, they also displayed heavy loss of color/gloss and a high degree of bleed-through rusting and staining.

Comparatively, the Si-COAT coating showed no corrosion creep and no bleed-through rusting or discoloration. The coating did collect salt spray residue that was easily wiped away to reveal no loss of color or gloss.

The other 26 coating systems showed exceptionally high levels of corrosion creep and/or loss of color/gloss. Even the polysiloxane-epoxy copolymer coatings, which are being touted as the latest in coating technology, failed the test.



2.0 Case History

Finds Long-Term Solution to Corrosion Protection and Color Retention

Based on the outcome of the test, the Lead Corrosion Engineer implemented the utility's first large-scale application of Si-COAT; the exterior wall of a 279-foot (85 meter) diameter, 55 foot (17 meter) high, heated fuel oil storage tank at the company's West Palm Beach, Florida fuel terminal. The total surface coated was 48,200 square feet (4,500 square meters).

The problem experienced on this tank was that high coastal humidity led to a very corrosive environment. Combined with the heavy UV exposure, the existing water-based acrylic paint was peeling and leaving isolated, deep pit-rusting within five years of its application. As well, the issue included an aesthetics problem with lack of color retention in the acrylic paint.

Si-COAT 579 was specified for the job by virtue of several its attributes:

- UV resistance,
- cost-effective one-coat application,
- elimination of sandblasting,
- custom color matching capability and
- extremely long service life.

The need for a custom color match was essential so that the tank would blend in well with its neighboring tanks.

Application work was carried out by the Kenny Manta Company of Lakeland, Florida (a Kenny Industrial Services Company) over the Christmas period of 2002. All heavy pit-rusting was abrasive blasted, and spot primed with 6 mils (152 microns) DFT of Si-COAT 579. The rest of the tank was simply pressure washed at 5,000 psi (352 kg/cm2) with a turbo tip to clean the surface and remove any of the old paint that may have been loosely adhered.

The coating was applied by airless spray to a final 7 mils (178 microns) DFT. On areas where pit-rusting had previously occurred, the coating was applied to 12 mils (microns) DFT. Except for the extra precautions taken on the areas of pit-rusting, the Si-COAT coating was a one-coat system.

2.0 Case History

Finds Long-Term Solution to Corrosion Protection and Color Retention

For the simple facts that abrasive blasting of the entire tank was not necessary, and that Si-COAT is a one-coat system, the budgeted project timeline was one week. Due to unfavorable weather conditions during the course of the project, the work extended to three weeks, which is still considerably less than the minimum two months that would have been required if a conventional coating system had been specified. As well, the overall project cost was approximately 50% of the cost of using a traditional coating system. Material and labor savings both contributed to the economics of the project.

Si-COAT 579 has an expected service life of well over 30 years in this type of environment. Hence, if the project cost is annualized to a dollar per square foot per year basis, the figure will be even further attractive when compared to the same figure for a conventional coating system which may achieve, at the very best, a 15-year life span in the case environment.

3.0 Case History

Addresses Short Coating Life Spans and Graffiti Issues

- **Product**

  Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating for long life & easy touch-up properties

- **Colour**

  Florida Blue

- **Location**

  Golden Water Supply Corporation, Golden, TX, USA

- **Date Installed**

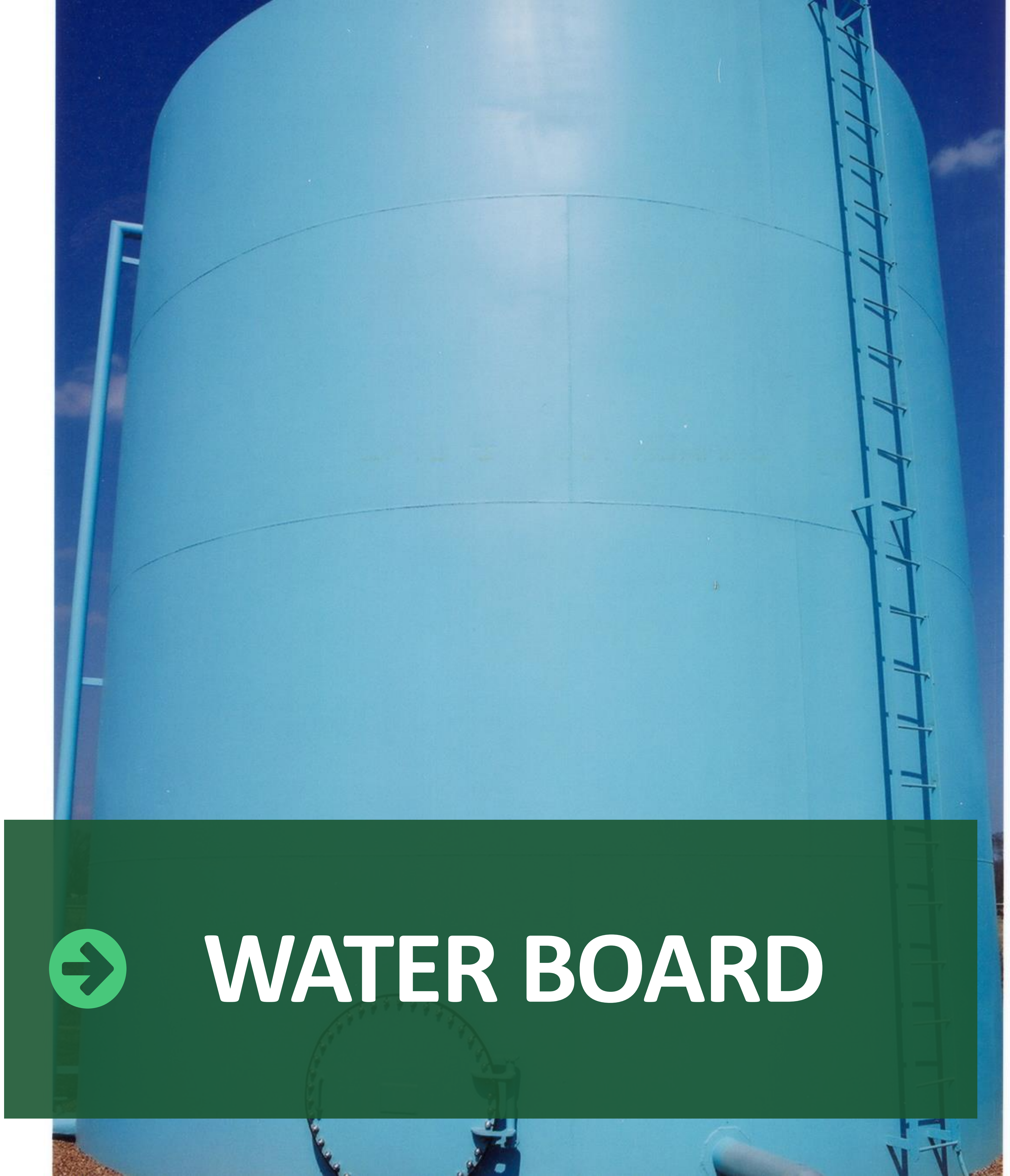
  November 2002

- **Environment**

  High UV exposure, close proximity to residential zone

- **Issues**

  Short service life and fading/chalking of acrylic system within 3 years.



3.0 Case History

Addresses Short Coating Life Spans and Graffiti Issues

Kids will be kids – especially if they live in the middle of rural Texas, USA. Amongst the slightly rolling landscape about 60 miles (100 km) east of the metropolis of Dallas sits the little town of Golden – just far enough from the big city for a more relaxed pace of life… but perhaps a little too relaxed for youthful energy.

This, largely, has been the contributing factor to the challenge faced by the Golden Water Supply Corporation of Golden, Texas.

When the kids of Golden got bored, they seemed to gravitate towards the big blue water storage tank of the water supply company, cans of spray paint in hand; the large tank walls were an ideal canvas.

Overall, the tank was 20 feet (6 meters) in diameter and 30 feet (9 meters) tall, for a total 'canvas' size of 2,200 square feet (204 square meters).

The graffiti had to cleaned off the tank so frequently that the expense was getting out of hand. In addition, with each removal effort, the graffiti would leave behind a shadow. As a result, the acrylic coating system the water supply company had employed was accumulating graffiti stains to the point that the aesthetics of the tank were unsightly.

This posed a further problem for Golden Water Supply since an unsightly tank received increased complaints from the residents who lived within viewing distance of the tank.

But the issues with the tank did not stop there. Texas is a state with a high number of sunshine hours per year. With the heavy dose of ultraviolet (UV) radiation received over the course of a year, the solvent-based acrylic system used to protect the tank was deteriorating sooner than stated by the paint manufacturer. Common symptoms included color-fading, loss of gloss, and because of the scrubbing of graffiti on a regular basis, to some degree, peeling.

As a result, this particular tank and others in the area were being recoated with a five-year frequency – well shy of the 10-year service life claimed by the manufacturer.

When introduced to Si-COAT 579 Elastomeric Corrosion Maintenance Coating, the Golden Water Supply Company was skeptical the product would live up to its claims. But a simple demonstration was all that was necessary to create a convincing case.

3.0 Case History

Addresses Short Coating Life Spans and Graffiti Issues

A large piece of carbon steel plate had been brought into the customer and coated on site, by roller, with Si-COAT 579 in Florida Blue. A day later, after the coating had ample time to cure, the coated panel was marked up with spray paint sourced from a hardware store in order to mimic the effects of graffiti. What was observed was that the spray paint had difficulty forming a solid film over the Si-COAT coating.

After the spray paint was allowed to cure for number of hours, a simple wipe with a wet rag was all it took to remove any trace of the graffiti. Not even a shadow was left behind.

Given the nuisance of constantly scrubbing the graffiti off the old acrylic paint and the convincing demonstration, the people at the Golden Water Supply Company were eager to try out Si-COAT on their tank.

All coating work was carried out by Rubber Coating Systems, Inc. of San Marcos, Texas, USA, under the supervision of Windell Baker, General Manager.

The tank surface was prepared by pressure washing at 5,000 psi (352 kg/cm2) to remove any surface contamination and loosely adhered paint. The Si-COAT 579 in Florida Blue was sprayed on using an airless spray setup to give a semi-gloss finish.

The first true test of the product came later that night. The day after coating the tank with Si-COAT 579, a large amount of graffiti was found on the tank walls. But what was different this time is that the graffiti artists didn't seem to have finished their work. The paint lines weren't solid, and the effort seemed to have been abandoned out of frustration.

Armed with rags and a pail of water, the maintenance crew from the water company went to work to remove the graffiti. To their astonishment, what once would have taken upwards of three hours to fully remove was easily cleaned up in less than ten minutes. All that was required was a simple wipe with a water-soaked rag.

3.0 Case History

Addresses Short Coating Life Spans and Graffiti Issues

The Golden Water Supply Company states that after a year of Si-COAT 579 service, the frustration encountered in trying to spray paint onto the coating has discouraged the graffiti artists to the point they no longer attempt to deface the tank. The water supply company plans to extend the use of Si-COAT 579 onto other tanks once they are due for recoating.

Furthermore, because of the total UV resistance of Si-COAT 579, the product has shown no loss of gloss or color. The old acrylic paint showed visible degradation in 12 months. Si-COAT 579 is expected to last well over 30 years in the environment of Golden, Texas.

4.0 Case History

Resolves Issues of Coating Failure and Equipment Trouble in Marine Environment

Product

Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating

Colour

Galvanic Metallic

Location

Atlantic & Gulf Coasts, FL, USA

Date Installed

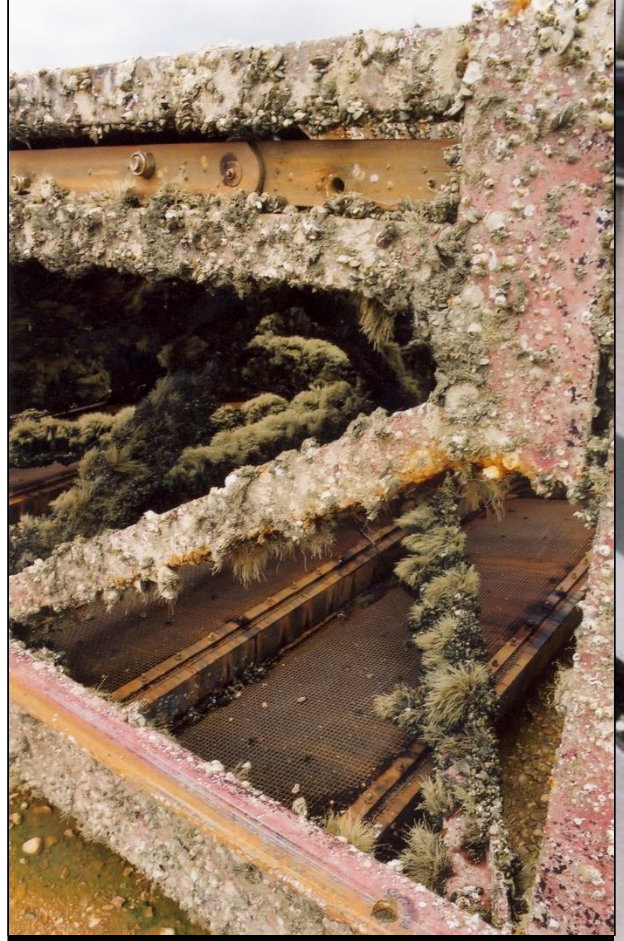
January 2003

Environment

High UV exposure; sea water immersion; wave splash zone

Issues

Epoxy coatings failing within three years; heavy corrosion at splash zone; marine growth impeding equipment operation



BEFORE

AFTER

4.0 Case History

Resolves Issues of Coating Failure and Equipment Trouble in Marine Environment

A vast number of power plants are operated by this power utility, which is the largest in the state of Florida, USA. Of these power plants, a large number are situated along the perimeter of the state at the coast lines, both Atlantic and Gulf. Situating these plants at such locations is strategic for several reasons, one of which being the supply of cooling water.

But drawing cooling water from an open body of water such as the Atlantic Ocean or Gulf of Mexico poses several issues with debris. Debris encountered in the system has ranged anywhere from chunks of wood to carcasses of sharks to old automobiles. If such debris can enter the cooling water system, exceptional amounts of damage to the plant machinery is possible.

So, to avoid such problems, screens were installed at the mouth of the large water intake pipes. The mesh of the screens themselves was made of stainless steel, but all structural framework was made of galvanized steel coated with a multiple layer epoxy system for added protection.

To avoid frequent removal of debris from the screen, traveling screens were used. These screens operate by intermittently rotating the mesh to its next position, thus exposing a clean mesh surface and dumping the debris that had previously collected.

The mesh rotates in a closed loop around pivots at either end as depicted in figure 1.

By virtue of its 'self-cleaning' operation, it was envisioned the installations should require relatively low maintenance. This, unfortunately, did not prove to be the case. It was found that within a rather short three-year period, the epoxy coating system intended to protect the structural steel was chalking, peeling, blistering and experiencing massive corrosion creep under its surface.

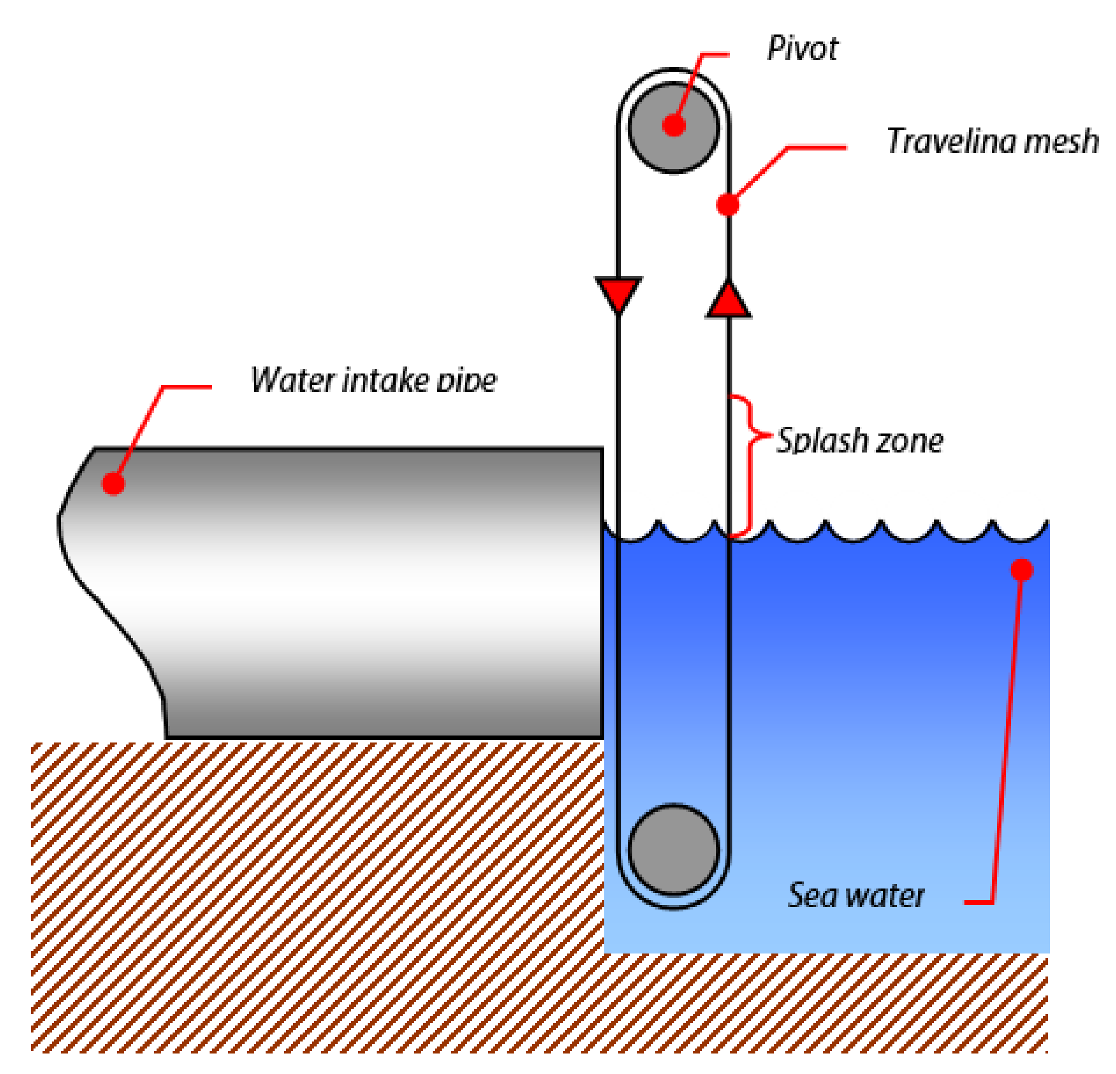


Figure 1: Schematic of traveling screen

4.0 Case History

Resolves Issues of Coating Failure and Equipment Trouble in Marine Environment

The problems were especially pronounced in the splash zone where saltwater spray evaporates under the sun to leave solutions of higher salt concentration on the structure. To compound the issue, the epoxy coating presented itself as an ideal host surface for marine growth. Barnacles, mussels, algae, urchins and other forms of marine life grew on the coating and eventually impeded the rotation of the mesh.

Based on the exceptional performance of Si-COAT in the utility's Corrosion Research & Evaluation Laboratory 'Three-year Florida Fence Test', the Lead Corrosion Engineer for the utility specified Si-COAT 579 to protect the new screens he was ordering. With his knowledge that Si-COAT 579 also has exceptional non-stick properties due to its very low surface tension, the corrosion engineer was confident Si-COAT would eliminate the issue of marine growth.

The new traveling screens were ordered from Screening Systems International, Inc. of Slaughter, LA, USA and all coating of the screens was performed by Steven Cupit of Screening Systems.

Since the structural steel to be coated was new steel, the manufacturer took the extra precaution of hot dip galvanizing.

Special care had to be taken in removing the oily residue left behind by the galvanizing process. The surface was wiped down with acetone solvent as per the SSPC-SP1 surface preparation standard. In addition, any loose flakes of galvanized steel were blown off the surface using 120 psi (8.4 kg/cm2) factory air.

Coating was performed in a one-coat application to 12 mils (305 microns) dry film thickness (DFT) using a Graco® 80:1 airless spray system, tips ranging in size from 17 to 19 thou (430 to 480 microns) and an inline filter.

The coating was force-cured for two hours at an elevated temperature of 140°F (60°C) so that transportation of the structure within the factory was possible. The coating was then allowed to fully cure overnight under ambient conditions.

With their new screens coated with Si-COAT 579, the result for the utility was significant. Marine life, unable to adhere to the Si-COAT surface, no longer presented an issue to the operation of the screens. Furthermore, the corrosion protection afforded by Si-COAT has been unsurpassed and all new screens are specified to be coated with Si-COAT.

5.0 Case History

Saves Time & Money and Gets Outstanding Corrosion Protection on Transmission Tower Legs

- **Product**

  Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating

- **Colour**

  Gray

- **Location**

  Reliant Energy (Houston Light & Power), Galveston Bay, TX, USA

- **Date Installed**

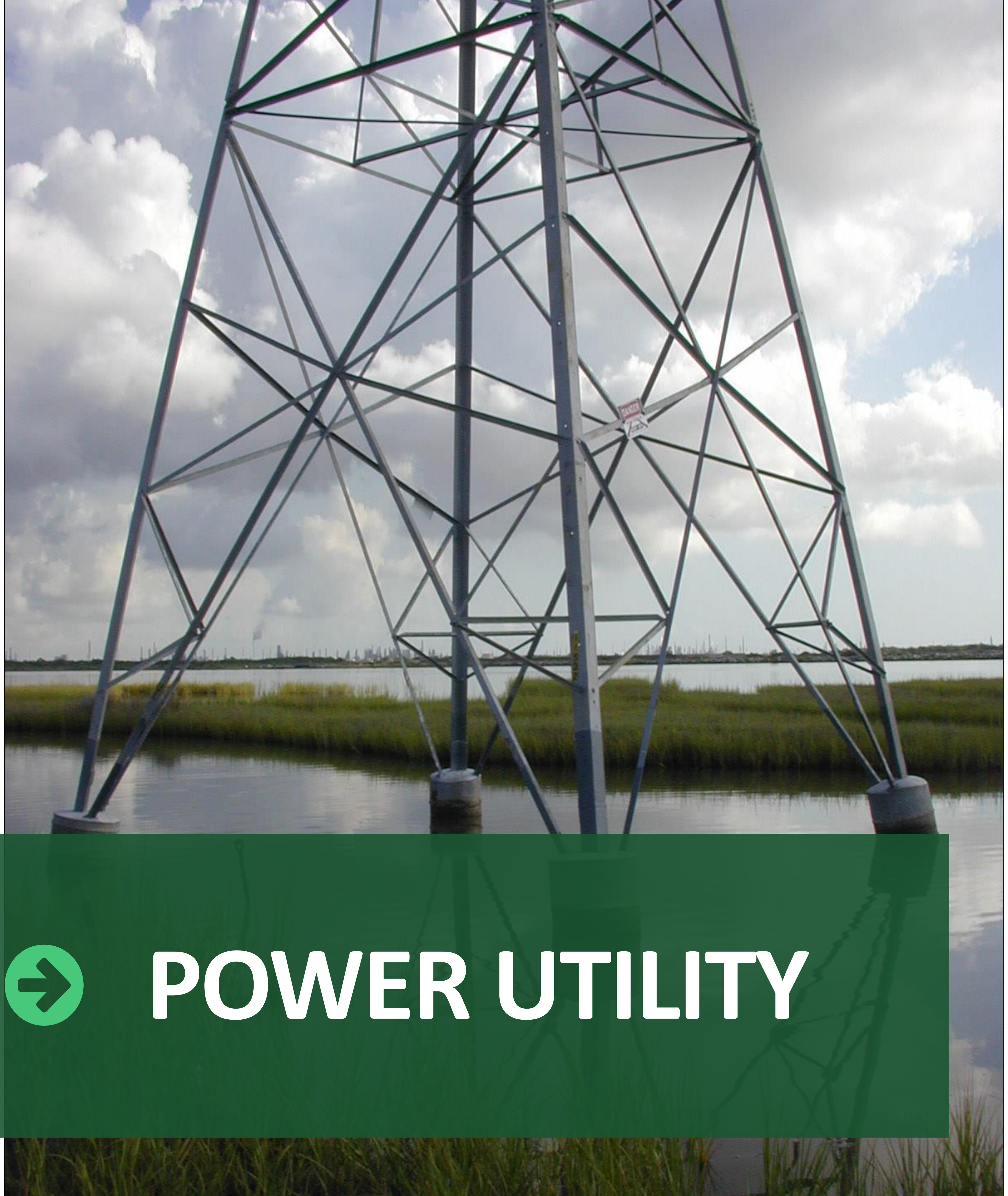
  Winter 1999/2000

- **Environment**

  High UV exposure, saltwater immersion, salt spray

- **Issues**

  Quickly corroding galvanized steel; short service life of other coatings



POWER UTILITY

5.0 Case History

Saves Time & Money and Gets Outstanding Corrosion Protection on Transmission Tower Legs

Natural salt fog contamination leading to corrosion of steel structures is perhaps most notorious in the Galveston Bay area of Texas, USA. Imagine, then, the frustrations when even bare galvanized steel was corroding within four months.

This was the main source of aggravation for Sonny Black, Superintendent of Tower Maintenance for the Reliant Energy Company of Texas, USA. In Galveston Bay, TX, the power utility had over 8,000 electrical transmission towers. Most of these towers sat in a swampy area. When the tide from the Gulf of Mexico would come in, the area would flood with sea water and immerse the towers to a depth of up to four feet.

Not only was sea water immersion wreaking havoc on the structures, but wave action due to recreational boating in the swamp led to salt spray in the splash zone just above the water line.

As the tide receded, the swampy area remained flooded and as the water evaporated under the heat of the Texas sun, higher salt concentrations remained, creating an even more corrosive mixture.

All this, combined with a constant salt fog from the Gulf, led to one of the most corrosive environments in the USA.

Corrosion control and tower maintenance had been an ongoing battle for Reliant Energy, one of the largest utilities in the United States. Their efforts were wasted in using conventional, supposed ‘high performance’, coatings based on epoxy or alkyd technology. With use of those products, their budgets were being overrun due to frequent product replacement (i.e. short service life) and personnel were experiencing health issues because the epoxy mastics required hand application.

Figure 1: A representative state of the galvanized steel from which other coating were repeatedly applied on a 12-month cycle

Figure 2: A tower leg ready for application of Si-COAT 579 after surface preparation by hand using wire brush and solvent wipe

5.0 Case History

Saves Time & Money and Gets Outstanding Corrosion Protection on Transmission Tower Legs

Sonny Black and the rest of the Reliant Energy crew assumed this was the status quo until they were introduced to Si-COAT 579 Corrosion Maintenance Coating.

Given the futility of all past efforts, Reliant Energy decided to test the Si-COAT product. The results were immediate and extremely positive. Not only did the maintenance workers find the product to be the simplest to work with, but also all health issues were eliminated.

Preparation of the tower legs was basic. All loose rust and other contaminants were cleaned off with a wire brush. Following this, the legs were wiped down with a solvent-soaked rag.

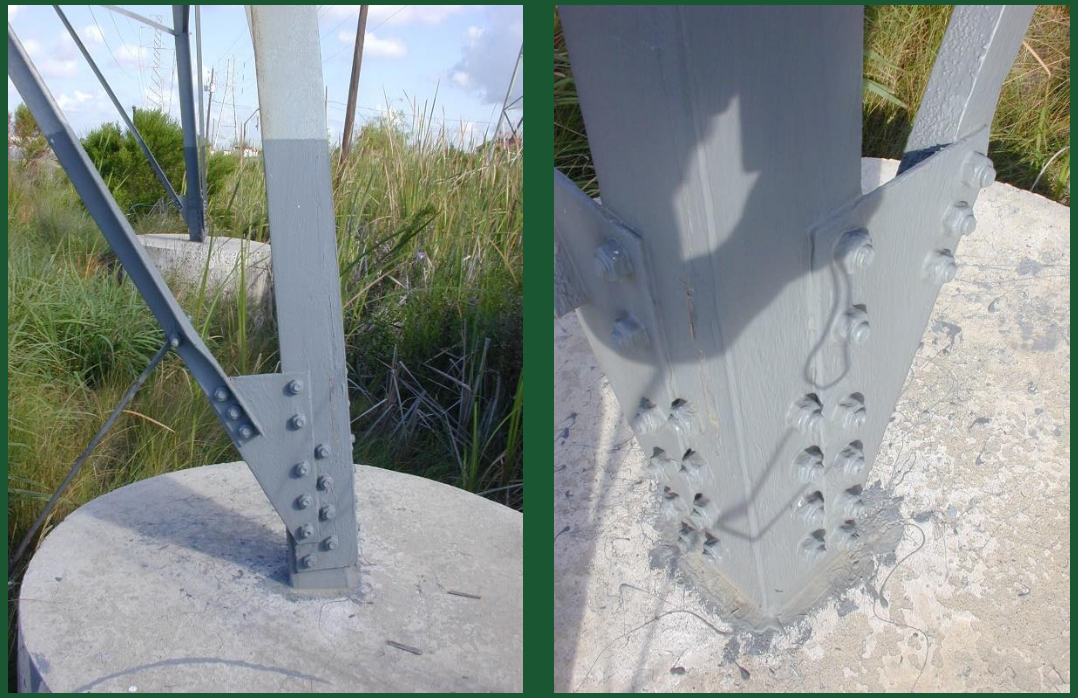
Si-COAT 579 was then applied, by brush, to a final thickness of 15 mils (380 microns) dry film thickness (DFT).

The scope of the project was to coat all tower legs in the Galveston Bay area that needed immediate attention.

The benefits of using Si-COAT continued to show themselves even after the project was completed. Because of the minimal surface preparation and ease of use involved with Si-COAT, project costs were coming under budget and former four-month project timelines were being shortened to six weeks.

Even after over 36 months of service, Reliant Energy continues to be amazed by Si-COAT. The product looks as new and fresh as the day it was installed and has experienced no signs of wear or weathering.

Reliant Energy has made the move to coat, over the next number of years, all of their towers with Si-COAT 579 – not just the tower legs, but also the entire structure. In fact, they were so impressed, they have decided to also coat the concrete bases with Si-COAT 579.



Figures 3 to 5: Tower legs after more than 36 months of service with Si-COAT

CSL's Si-COAT 579 has made our job easier by being a single component product plus the protection it has offered for our towers in saltwater areas. Crews like the fact that it is easy to apply and if they have not used the entire can of the coating, they can reseal and use it later." *(SONNY BLACK)*

6.0 Case History

Major Economic Benefits Reaped with Minimal Environmental Impact at Tank Farm

Product

Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating

Colour

White

Location

Hellenic Petroleum (HP), Athens, Greece

Date Installed

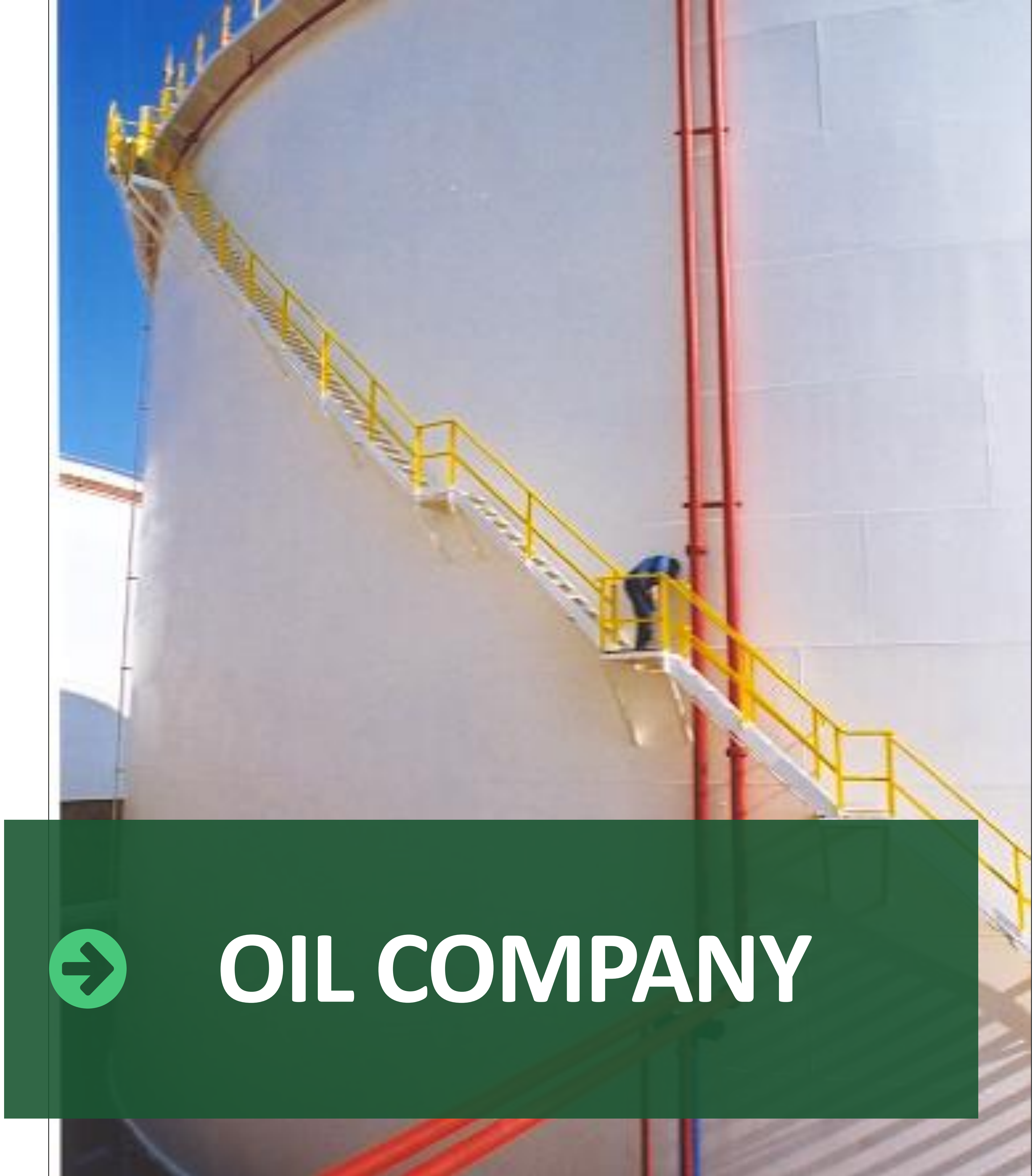
May 2004

Environment

Industrial with heavy salt-fog and high UV exposure, and wide temperature fluctuations

Issues

Proximity to seacoast was causing rapid failure of three-coat epoxy systems, neighbouring town strongly objected to abrasive blasting of tanks due to related health issues



6.0 Case History

Major Economic Benefits Reaped with Minimal Environmental Impact at Tank Farm

Hellenic Petroleum (HP) is a Greek national oil company with a tank farm located on the outskirts of Athens. The farm is comprised of 16 tanks, with a total storage capacity of 1,200,000 m3 of crude oil. It is in close proximity to the seacoast (300m from the water), and, as a result, the tanks are exposed to salt contamination and regular rusting.

The original coating employed was a three-coat epoxy system, applied in 1997. Despite all appropriate application practices, the epoxy coating proved inadequate as the tanks began to show pinhole rusting within just six months. This performance was the best HP could hope for from all the coating systems they had tested. An economic decision was made to allot a seven-year service cycle to the coatings before recoating. By the end of the seven-year cycle, the exterior of the tanks were in a dismal condition. The tanks displayed heavy pitting and rust staining. As well, rust blisters were numerous and roughly 12 inches in diameter.

Beyond just its poor performance, the epoxy system posed another major headache for HP. Within just a one-kilometer radius of the tank farm are several villages and small towns. When preparing the tanks for application of the epoxy coatings, HP would receive countless complaints and heavy petitioning against the painting of the tanks due to the negative aesthetic and health effects from abrasive blast media that was carried into the populated areas. HP clearly had a difficult situation to balance – on the one hand they needed to maintain their assets while on the other not affect the local population, all the while bearing cost in mind.

In 2000, Si-COAT was introduced to HP as an alternate, more viable solution to their coating dilemmas. Requiring only high-pressure water washing to prepare the surface, Si-COAT eliminated any need for HP to abrasive blast their tanks. This was unheard of in the coatings industry, particularly when the condition of the tank was taken into consideration. Hence, CSL’s claims were met with much skepticism. HP conceded they would test the product and after nearly four years of evaluation on small test patches and trial applications, were convinced of Si-COAT’s merits and the positive economics it could offer them.

6.0 Case History

Major Economic Benefits Reaped with Minimal Environmental Impact at Tank Farm

In Spring 2004, Si-COAT was awarded its first major application at HP. Tank P-701C, which was the tank in the worst condition and also the most publicly visible, was to be coated. From the start, the management at HP had confidence in CSL – the project was awarded directly to CSL as a turnkey job without formal tender procedures, in appreciation of the merits of Si-COAT's patented technology and the absence of any similar product on the market.

Tank P-701C measured 141 feet (43 meters) in diameter and 75 feet (23 meters) in height, with a total surface area of 64,560 square feet (6,000 square meters), including the exterior of the floating roof.

Based on their high level of professionalism and unique µ-jet® water blasting technology, CSL subcontracted Mühlhan Hellas, S.A., the Greek division of Mühlhan GmbH headquartered in Hamburg, Germany to do the actual field work under supervision of CSL.

Despite the severe conditions of the tank, surface preparation required only a pressure-wash at 11,600 psi (800 bar). The average waiting time between pressure-washing and application of Si-COAT was one day. In total, the project consumed 706 US gallons (3,200 kg) of Si-COAT 579 at a dry film thickness (DFT) of 14 mils (350 microns). The coating was applied in one single coat.

6.0 Case History

Major Economic Benefits Reaped with Minimal Environmental Impact at Tank Farm

The benefits, both economic and otherwise, were immediately obvious and undeniable. Due to Si-COAT's elimination of abrasive blasting, the local population was entirely unaffected by the project. But perhaps even more striking, because Si-COAT could be applied in a single coat after a simple pressure-wash, the project timeline and size of the crew were greatly reduced compared to the application of a conventional coating system. This saved labor dollars and allowed the tank to be put into service much more quickly. As well, because abrasive blasting was not required, hot work precautions were unnecessary. The duration of the project was only 12 days from start to finish, with a crew of only 6 people. From previous experience in coating tank P-701C and other identical tanks in the tank farm, use of a conventional coating system would have required 16 people working for 42 days. This translates to 720 total working hours with Si-COAT versus 6,720 total working hours with a conventional coating system.

Following the exceedingly positive outcome of the project, HP is considering applying Si-COAT 579 Corrosion Maintenance Coating technology, exclusively, to the remaining uncoated tanks on their farm, as well as to their main installations in Aspropyrgos, Athens.

7.0 Case History

Durable coating to endure such aggressive environmental conditions

Product

Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating

Colour

Tennis Court Green

Location

BHP Billiton Copper Mine, Escondida, Antofagasta, Chile

Date Installed

November 2016

Environment

High and low humidity, desert conditions, high altitude, high UV exposure, dry and extreme temperatures, high salinity.

Issues

OEM-coated structures with epoxy ended their service life cycle and need a more durable coating to endure such aggressive environmental conditions

MINING

7.0 Case History

Durable coating to endure such aggressive environmental conditions

In Chile's Antofagasta Region, the climate can be so hostile that miners must be regularly tested to be apt for the job before going to work. In particular, the Atacama Desert is home to Escondida, a mine which is exposed to extreme UV (8-10 UVA index), extreme weather, extreme humidity, and extreme temperature fluctuations, ranging daily between -5°C and 28°C. If that's not extreme enough, this environment is prone to such high salinity and acidity that, when combined with the drastic changes in temperature and humidity, produces a cocktail of condensation that sits on the surface of metals. The result is a highly corrosive environment.

These are the circumstances under which the supporting super structures at the mineral processing plant operate. Originally coated 25 years ago with an OEM epoxy system, the structures were brought onto the mining site after passing initial quality control. Eventually, the epoxy coating neared the end of its design life, as evidenced by peeling off, cracking, and blistering. Soon enough, it was time to recoat these structures which had experienced very serious corrosion. The harsh environmental conditions were no match for the OEM coating, as the epoxy coating failed a reapplication effort in 2016. Thus, a suitable alternative for this field application needed to be found.

Conventional coatings such as epoxies cannot be re-coated with another conventional coating unless a proper surface treatment is used, such as sandblasting and/or high-pressure water jetting. As one can imagine, water is not a commodity in the North of Chile, and in such a confined and dusty space, sandblasting or water blasting are far from ideal treatment options. Due to these limitations, a much more durable and surface tolerant coating was required. Industry conditions have emphasized the importance of asset rehabilitation, versus asset replacement. Although the epoxy coating met its design life, the need to extend the service life of the structures in the mine site required the use of Si-COAT®.

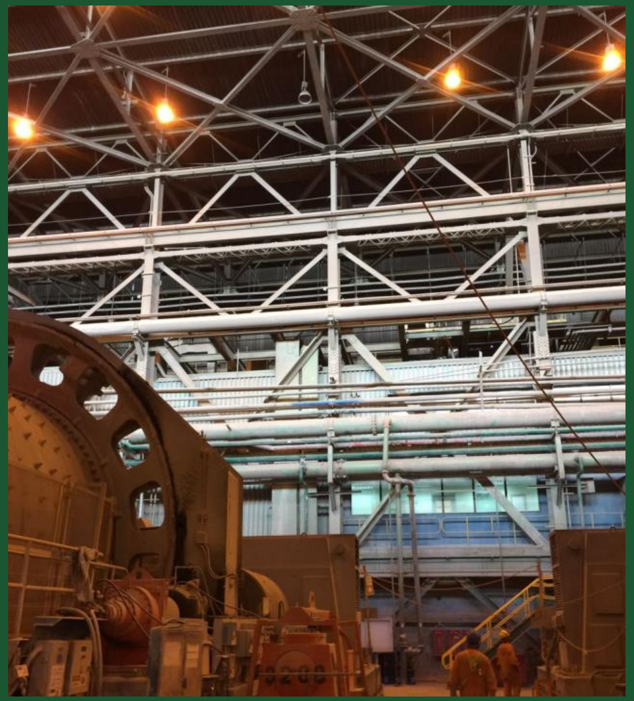
7.0 Case History

Durable coating to endure such aggressive environmental conditions

This is when Nexo, a subcontracting company of BHP Billiton, contacted our distributors in Chile. One of the main reasons why they preferred Si-COAT® over a conventional coating was their preference for a surface-tolerant Corrosion Maintenance coating that would meet the mining site application restrictions. On November 2016, Nexo successfully coated over 3,500 m2 of structures with Si-COAT® 579® AC without the need for sandblasting or water jetting.

Si-COAT®'s surface preparation has simple requirements: ensure that the surface is free of oils, resins, dust or any loose pre-existing coating. Any salt accumulation over top of the coating or metal also needs to be removed. To do so, Si-COAT® only requires SSPC-SP1 – solvent cleaning. After the surface preparation was completed, Si-COAT® was applied and successfully adhered to the epoxy and any exposed metal.

The application of Si-COAT® 579® AC in Tennis Court Green was done primarily using airless spray and brushing in areas that were difficult to access. Nexo, the application contractor, was supervised, inspected and advised by CSL Silicones on the best practice and methodology to apply our Si-COAT® 579® AC Corrosion Maintenance Protective Coating. All in all, surface preparation was minimized, and our customer's cost efficiencies were maximized.



8.0 Case History

Pollution Management on High Voltage Systems

Product

Si-COAT® 579™ Elastomeric Corrosion Maintenance Coating

Colour

White

Location

Dungeness, South East England (400kV sub)

Date Installed

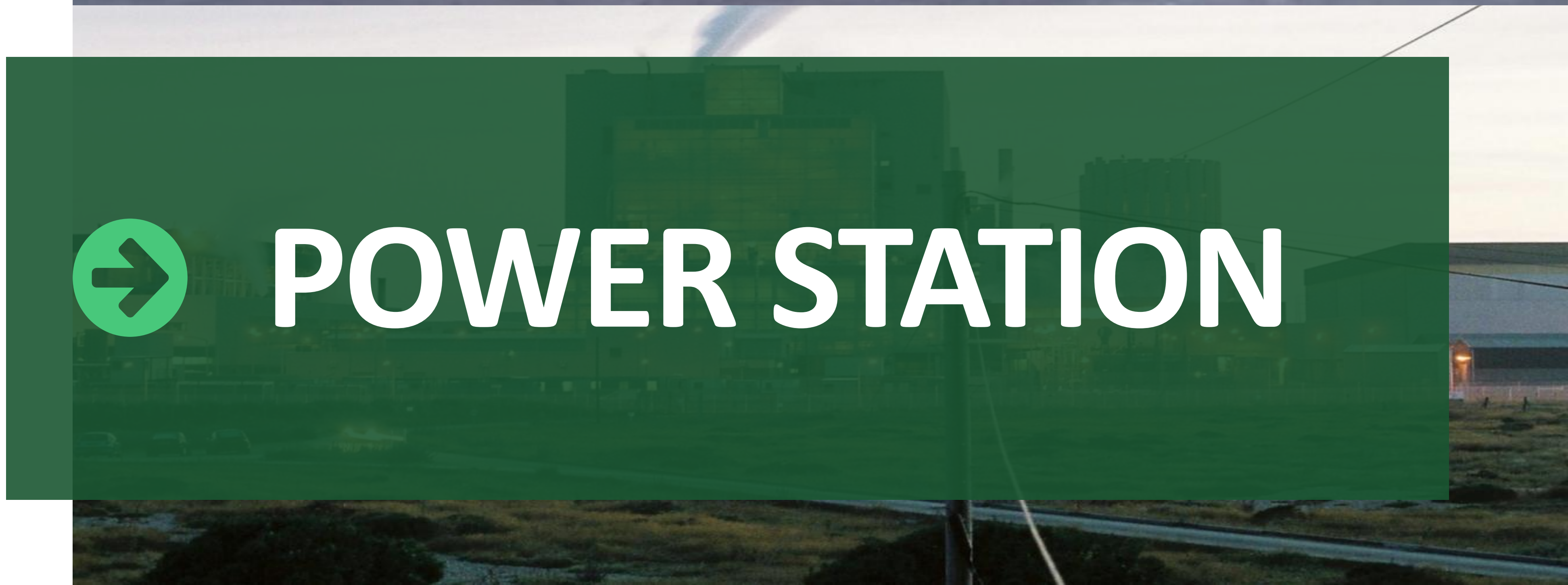
June 2020

Environment

Water & Saline

Issues

Current protection is a traditional Corrosion Maintenance paint that is estimated to be last maintained over 10 years ago.



8.0 Case History

Pollution Management on High Voltage Systems

The painted metalwork at Dungeness Power Station is subject to a harsh corrosive environment.

The original coating has become weakened by UV and cracked by movement or damage in places which has al lowed ingress of moisture and oxygen causing rusting to the metal.

Traditional Corrosion Maintenance coatings provide excellent protection and can last in excess of 10 years. Effective re-application often requires complete removal of rust and old paint, profiling of the surface and priming prior to coating. This can be a lengthy process which leads to long periods of disruption and high labour costs.

A cost-effective and long-term solution is needed to extend the life of the rusted assets.

OBSERVATIONS

8.0 Case History

Pollution Management on High Voltage Systems

Si-COAT® 579™ AC Corrosion Maintenance Protective Coating

A one coat, self-priming, corrosion management coating.

Si-COAT 579 CM is a single component, moisture cure, room temperature vulcanizing (RTV) coating that provides long-lasting protection from corrosion in above grade atmospheric applications in retrofit projects.

<u>Key Features:</u>

- One-Coat Application: Self-priming single coat with minimal surface preparation (no abrasive blasting or profiling required) therefore - less time and labour costs.
- Advanced Performance: Long-lasting protection from corrosion (stops rust creep).
- UV Performance: All colours are tested to withstand 5,000 hours of Accelerated Weathering (QUV): Colour change <1 delta E CIE * Lab.
- Flexibility: High elasticity allows for flexibility of coating and allows for thermal expansion and contraction of surfaces.

SOLUTION

8.0 Case History

Pollution Management on High Voltage Systems

Two test locations were selected at the 400kV sub. A section of roller shutter door on the North side of the sub and a section of gutter on the South side which faces the sea.

The rusted metalwork was prepared by simply removing loose rust and paint from the surfaces using paint scrapers and wire brushes. Then the surfaces were wiped over with a cloth soaked in solvent to remove any greasy residues.

Si-COAT 579 CM was applied by air-assisted spray system to the manufacturers specification.

The application was successful, and it is expected that the coating will provide good results in this extreme environment where the metalwork is heavily corroded.

The RTV silicone coating at the test locations will be monitored and inspected after 1 year by CCS to check the condition and if any rust creep has occurred.

TRIAL

Other Case Histories

ALGORTA Lodium-Mine
Antofagasta –CHILE

- Coating of metal structure and transformers housing
- 2016-2018

www.cslsilicones.com

CSL is ISO 9001:2015 Registered

Other Case Histories

CODELCO (Copper Concentrate Holding Tanks)
Antofagasta - CHILE

- Coating of mining equipment and heavy machinery parts exposed to acidic environment
- 2016-2018

Other Case Histories

GEOROCK (Mining Equipment)
Antofagasta - CHILE

- Coating of mining equipment and heavy machinery parts exposed to acidic environment
- 2016-2018

Other Case Histories

CODELCO (Sulphuric Acid Tanks)
Antofagasta - CHILE

- Coating of Sulphuric Acid Transporting tanks
- 2016-2018

Uses

Above-grade applications

- New Applications
- Retrofit Locations

Wherever corrosion is a problem

- industrial pollution & weathering
- storage tanks, process lines, etc.
- salt fog environments
- transmission towers, etc.
- road salt environments
- bridges, overpasses, etc.
- environmental conditions
- metal roofs, cladding, etc.

Conditions for Application

Surface Preparation

- Surfaces should be clean and dry.
- Temperature of surfaces should be between:

5°-60°C (41°–140° F)

Environmental temperature should be at least 5°F (3°C) above the dew point prior to and during application www.cslsilicones.com

THANK YOU