Vol. 3 Issue 4 | 2017

Corrosion Exclusively

INSIDE:

- Retrofitting wind turbine monopiles with CP.
- AC Mitigation – Are you affected by "Stray?"
- Serving the corrosion industry for 75 years
- The determination of "Salts" in the inspection game
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Corrosion Institute Southern Africa

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Transvaal Galvanizers was founded in 1984 by the Managing Director of Imab Engineering with the vision of creating a full turnkey operation when it came to the need for supply of corrosion protected steel articles. With Imab Engineering at the forefront, this expansion into the galvanizing industry would one day become the biggest galvanizing plant in Africa.

With Transvaal Galvanizers celebrating their 33rd birthday this year, it is time to look back, standing on the threshold of this milestone, to the journey that has led us here.

Over the last 33 years, Transvaal Galvanizers has galvanized over a million tonnes of steel. This is equivalent to 165 000 Bull Elephants OR 3 676 Boeing 747's OR 137 Eiffel Towers OR 68 Brooklyn Bridges.

While looking back we are extremely proud of our history and our heritage, but looking forward is much more important to us. One man that is always looking forward is the Director of Transvaal Galvanizers, Francesco Indiveri. With Mr Indiveri at the helm, Transvaal Galvanizers has expanded into new markets focusing extensively on renewable energy projects.

With this in mind as well as the need for a larger galvanizing kettle in the industry, Transvaal Galvanizers has commissioned the biggest galvanizing plant in Africa in 2017. The size of the kettle is 15.5m L x 2m W x 3.2m D. This will provide steel manufacturers in the industry the flexibility of manufacturing larger items whether it be structural, solar, piping, reinforcing to name a few, without the cost implications of double dipping, forcing costs of projects to rise.

Not only will our upgraded facilities provide for a much greater capacity being 10 000 tonnes per month, but they incorporate state of the art equipment aiding in a greener, more environmentally friendly galvanizing process from start to finish. The upgrade incorporates 16tonne crane capacity with the advantage of crane off loading and loading of trucks, to ensure more efficient deliveries and dispatches for our customers.

Our facilities also include a shot blasting workshop, painting workshop, pre and post inspection, multiple approved repair processes, onsite offices for larger projects as well as an onsite boiler workshop where we manufacture and design new methods of dipping and jigging customer steel.

We constantly aim to continually improve ourselves by adapting to changing times and markets whilst ensuring that we always stay focused on client satisfaction. It is this focus that has brought us to where we are today, and we know that this focus will take us to even greater heights over the next 33 years.

With qualified, experienced and driven personnel at our forefront, we are your one stop shop when it comes to corrosion protection.

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Corrosion Exclusively

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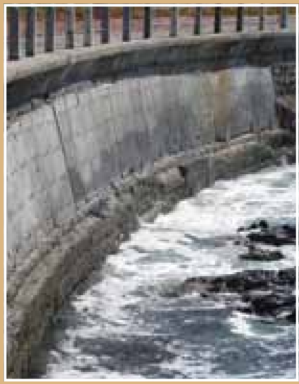

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President's Comment

After two whole years, Pharaoh dreamed that he was standing by the Nile, and behold, there came up out of the Nile seven cows, attractive and plump and they fed in the reed grass.

Behold seven other cows, ugly and thin, came up out of the Nile after them and stood by the other cows on the bank of the Nile. The ugly thin cows ate up the seven attractive plump cows... and Pharaoh awoke.

He fell asleep and dreamed a second time and behold seven ears of grain, plump and good, were growing on a stalk. Behold after the sprouted seven ears, thin and blighted by the east wind and the thin ears swallowed up the seven plump, full ears and Pharaoh awoke, and behold, it was a dream.

I am not one to quote the Bible however, the story is one that I remember the most from my Catechism classes as a young boy. The stories meaning has rung true into my adult life. Prepare during the good times to be financially sound in the bad times. This could also be said that prepare in the lean years and be ready for the good years.

In the spirit of the above The Corrosion Institute of Southern Africa has been hard at work over the last few months preparing the institute for the "plump" years.

The Director of Operations of NACE International, Mr Tommy Tam, visited us on Saturday 14 October to sign a partnership agreement for our Africorr Conference 2018.

With NACE's global and African marketing reach, we hope to make the 2018 Africorr conference larger, more popular and the premium corrosion academic event on the African continent. Additional details on the venue and dates will be advised via CorrISA's communication channels, including CE. We are expecting many top African corrosion academics to attend.

The Corrosion Institute of Southern Africa also signed a "Global Partnership" agreement with NACE. CorrISA is one of few recognised global partners to sign such an agreement. The outline of the agreement is for each organisation to assist one another in the combined effort of fighting corrosion.

In September we held our Gauteng awards breakfast which was well supported. The award of Honorary Life Member was given to Mr Braam Bosman. We thank Mr Bosman for his contribution to CorrISA.

Our Cape Town region had their AGM in September which was a huge success and attended by our many Cape Town colleagues. In August the initial mini-expo was held in Cape Town and proved to be very successful. A huge thank you to the Cape Town planning committee.

Our Durban region hosted an interesting presentation on a BBBEE workshop presented by Dr Ivan Blumenthal and the feedback from those who attended that the presentation was very useful and thought provoking.

Petra from Artep Solutions has been hard at work preparing CorrISA for our SAQA approval and pending facility audit. I am pleased to report this effort is going well.

The National AGM was held in Gauteng with many points debated amongst members regarding future initiatives and it has been agreed that a business plan will be presented to members by Dr Ivor Blumethal from ArkKonsult with the overall plan in forming a Professional Body for CorrISA.

Following a presentation on Professionalism a formal secret ballot will be taken by our members. The presentation will take place in Johannesburg, Durban and Cape Town.

To all I wish a restful holiday period which I am sure is well deserved.

In finality I would like to thank CorrISA staff and a number of members for the immense effort put in in our lean years which I am convinced will bear fruit in our pending plump years.

Yours Sincerely

Donavan Slade, CorrISA – President

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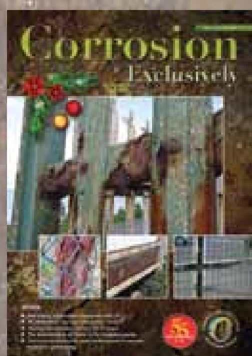


Cover: A corroded palisade fence, information sign and a security enhanced gate in aggressive coastal conditions.

Editorial Comment

On behalf of Corrosion Exclusively we wish to officially welcome Donovan Slade of NUI into the chair of the Presidency for the next two years where through the medium of this publication we hope to align with the medium to long term goals of CorrISA.

Furthermore, we want to thank Ed Livesey for his enthusiasm and advice over the last two years and wish him well as he continues to serve on council as Immediate Past President (IPP) for the next two years.

Further thanks must go to Bruce Trembling who two and a half years ago as President had the insight to resuscitate the official mouthpiece of CorrISA. "Corrosion Exclusively" (CE) was born and now is on its 9th edition, Bruce's tenure as IPP is over and unwillingly he has stepped away from the activities of Council.

Through CE we have in the past been fortunate enough to be supported by the ACA (Australian Corrosion Association) with corrosion related articles. Going forward we will be reciprocating activities, the first being Africorr 2018, which will also be advertised in ACA news.

NACE who also has been supportive of CE, is celebrating 75 years of existence, we congratulate them on this achievement and highlight some of their activities over the years.

Also from NACE (Materials Pro) the article – Retrofitting Wind Turbine Monopiles with Cathodic Protection, by Kathy Larsen.

Prof Stephen Yeomans has responded to the review of the PIANC Report No 162 of 2016, published in the previous edition, with respect to the omission of hot dip galvanized reinforcement.

In "SPOTLIGHT" we interview Denis Peart, an experienced consulting engineer for Aurecon who gives us insight as to why he and his staff regularly attend the technical evenings at CorrISA in Cape Town. We hope by this to encourage other consulting engineers and specifiers to attend these evenings.

We report on many of the CorrISA activities, including the Awards Breakfast; CIP 1 & 2; AGM; Technical evenings & Golf Day (Gauteng), Mini Corrosion Exhibition & Technical evenings (CT) and Professionalising Seminar (KZN).

Graham Duk and Mark Terblanche together with Karyn Albrecht the Western Cape and KZN joint chairmen respectively give account of their activities.

From the KETTLE, a regular contribution discusses the difference between zinc electroplating and hot dip galvanized fasteners.

Francesco Indiveri of Transvaal Galvanizers (TG), gives us an account of his life at TG in preventing corrosion in "The RUST Spot".

We wish to thank both our loyal advertisers, contributors and readers for their support, without whom the magazine would not be successful.

Should a reader wish to comment on any of the previously published articles or select a specific subject for discussion in a future edition of the magazine, kindly contact me.

Lastly it gives me great pleasure to wish all our readers Good Rest, Good Health, Peace and Happiness in the year-end holidays that will soon be here.

Terry Smith

OBJECTIVE OF THE MAGAZINE

"The objective of *'Corrosion Exclusively'* is to highlight CORRISA activities, raise and debate corrosion related issues, including circumstances where inappropriate material and/or coatings have been incorrectly specified, or have degraded due to excessive service life. Furthermore, it shall ensure that appropriate materials or coatings, be they metallic or otherwise, get equal exposure opportunity to the selected readers, provided these are appropriate for the specified exposure conditions on hand."

Retrofitting wind turbine monopiles with cathodic protection

By Kathy Riggs Larsen, Editor Materials Performance magazine, NACE International

Offshore wind power has gone from a marginal industry to a major renewable energy source in Northern Europe within the last decade. According to the latest offshore wind operational report prepared by The Crown Estate,[1] the technology that barely existed 10 years ago in the United Kingdom has multiplied 10-fold, with over 30 wind farms supplying ~5.4% of the United Kingdom's total estimated electricity consumption in 2016. At the end of December 2016 there were 29 offshore wind farms with a total of 1 463 fully operational offshore wind turbines on the U.K. seabed that generated over 5.1 GW of operational capacity. An additional 14 offshore wind farms with a total of 830 wind turbines are now under construction in the United Kingdom and expected to add new operational capacity of 5.3 GW.

Lynn and Inner Dowsing (LID) is a combination of two wind farms located off United Kingdom's East Lincolnshire coastline in the North Sea. Project construction started in 2006 and the wind farms became operational in 2009. LID is comprised of 54 monopile foundation wind turbines with an output capacity of 3.6 MW each for a total maximum output of 194 MW. The monopiles and their steel transition pieces were installed in 2007 and the turbines in 2008.[2]

The monopile foundation is currently the most common type used on wind turbines due to its ease of installation in shallow to medium water depths (up to 30m deep).[3] A typical monopile foundation consists of a hollow, ~4- to 6-m diameter steel pile with ~50-mm thick walls that is driven ~25m into the seabed. Usually 1 to 2m of the pile structure is above the water line and a portion of the monopile's interior remains flooded.

The transition piece, which supports steel components such as boat landings, ladders, and platforms required for accessing the wind turbine, is installed over the top of the monopile with an overlap of ~6 to 9m. The annular space between the monopile and the transition piece is then filled with high-strength grout that cements the two pipes together. While in service, the transition piece will settle slightly from vibration of the turbine or broken bonds between the steel and the grout. The bottom end of the transition piece (called the lower platform) is sealed, and sits inside the top of the monopile. For a large number of designs, internal J-tubes are used to house the turbine's electrical connection cables. They enter the base of the monopile near the sea floor and run up the inside of the pile into the transition piece. Specially designed seals are used at the interface between the monopile wall and the J-tubes to create an airtight space within the monopile.

According to NACE International member Alex Delwiche with Deepwater EU, Ltd. (Surrey, United Kingdom) and Isaac Tavares with Centrica plc (Windsor, United Kingdom), the early version of a design standard for offshore wind turbines prepared by DNV[4] noted that corrosion protection on the inside of the monopile is not required if the pile is airtight (i.e., there is no or very low oxygen content) and the structure is non-corroding. Construction of the LID structures followed this design standard, Delwiche notes, so cathodic protection (CP) or any type of coating was not applied inside the LID monopiles or the transition pieces below the sealed lower platform.

Since the area underneath the lower platform was considered to be a sealed environment, DNV's early guidance indicated that oxygen ingress would not occur if the water inside the monopile was not refreshed, Delwiche says. The expectation was that corrosion would not take place in the submerged or dry portion of the monopile because existing oxygen would become depleted over time, and new oxygen would not enter the structure.

Operators, however, were reporting concerns of a potential corrosion risk inside the sealed monopile compartment, Delwiche adds, commenting that DNV later revised its standard with a statement that monopiles should have CP with coating around the splash zone. In 2011, inspection

Lynn and Inner Dowsing is a combination of two wind farms located off United Kingdom's East Lincolnshire coastline in the North Sea.

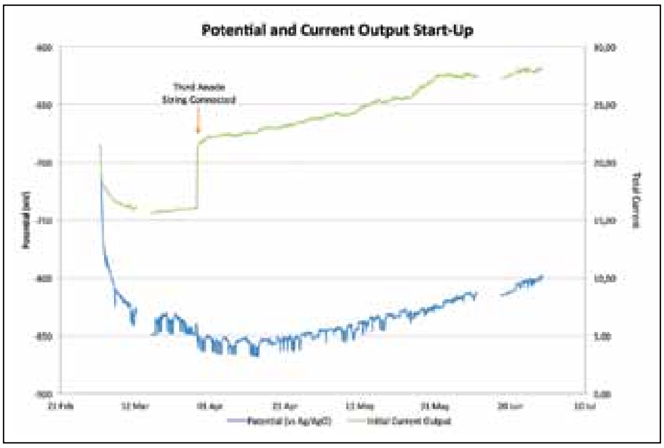
Photo by Rob Farrow, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=30784200

A crew prepares to offload anodes for a cathodic protection system designed to protect the interior of the wind turbine's monopile.

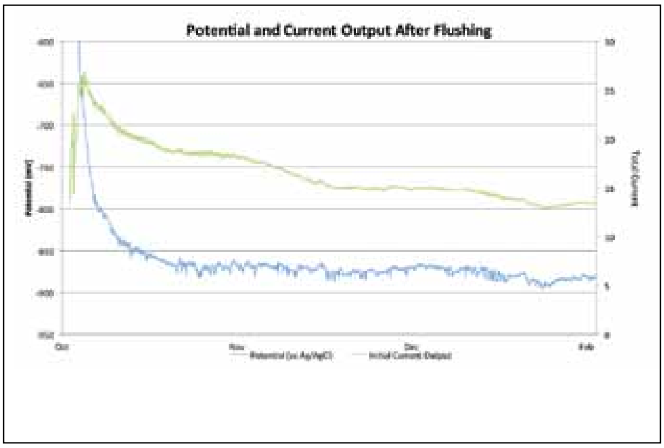
The wind turbine monopile – galvanic anodes were installed inside the sealed portion of the monopile below the lower platform.

Photo courtesy of Alex Delwiche

The sealed portion of the monopile below the lower platform.



Potential and current output both started to increase about two weeks after CP start-up, which was surprising and a sign that there was a problem with the CP system.



Potential becomes more negative and current output is reduced after flushing with fresh seawater, indications that the CP system is functioning as it should.

of the wind turbines at LID determined that corrosion was occurring inside the monopiles, particularly below the water line. He comments that some of the monopiles had not stayed airtight. In these instances, the transition piece had settled, and the resulting motion exerted enough force on the J-tubes to push out the seals around them and allow seawater – and oxygen – to enter the monopile.

Coupons were used on the wind turbine structures at LID to measure the severity of the corrosion both above and below the water line in the sealed monopiles as well as the monopiles that were no longer airtight. For all monopiles tested, the results indicated that corrosion rates were minimal near the sealed lower platform at the top of the monopile, became increasingly larger closer to the water line, and were most significant in the submerged areas. In the monopiles that had remained sealed, general corrosion was detected, but the corrosion rates were generally less than those found in the unsealed monopiles that were being flushed with fresh seawater, Delwiche says. For those no longer sealed, corrosion levels were higher than expected for the design, Tavares adds.

Although the corrosion rates were within the range suggested by the standard and didn't pose a failure concern, they indicated that the structures were freely corroding and action needed to be taken. Fatigue curves used to calculate the life expectancy of the monopile were based on a corrosion-free state, Delwiche explains. Since this was no longer the situation, leaving the monopiles without any corrosion prevention system would greatly reduce the theoretical service life.

A strategy was pushed forward to provide the monopiles with a corrosion prevention system, which included resealing the J-tubes to prevent seawater flushing and installing a galvanic CP system inside the submerged section of the monopile.

A galvanic anode system was preferred over an impressed current CP system based on practicality and safety. Although designing a CP system can be relatively straightforward, Delwiche notes there were no specific standards or published guides available at the time that addressed the application of CP inside offshore monopile structures. Because so many questions regarding a retrofit CP design for this type of application were unanswered, a trial design was developed and implemented on one monopile in the LID wind farms. This project is one of the first galvanic CP installations inside a submerged section of a wind turbine monopile.

The Cathodic Protection System Design

The CP design had to consider several issues, including the weight and manageability of the anodes for offshore installation, options for mounting the anodes, and hydrogen evolution in a sealed environment. Anode weight was a key concern for the CP system

Above left and centre: A trial anode string is lowered into the monopile's contained water.

Two months after CP commissioning, the water had a blue sheen.

from a personnel-handling standpoint because this installation would require loading anodes onto a sea vessel; lifting them onto the wind turbine's transition piece by a davit crane; placing them inside the monopile; and lowering them into position from the hang-off location on the lower platform. Aluminum alloy (Al-Zn-In) anodes were selected because they have two to three times more electrochemical capacity (i.e., the amount of material consumed over time as electric current flows) than zinc anodes – up to 2 500 ampere hours per kilogram.

Since one aspect of the trial was to determine the total anode weight needed to meet the CP minimum protection requirement of –800 mV or more negative vs. a silver/silver chloride (Ag/AgCl) reference electrode, four anode strings comprised of six 55-lb (25-kg) aluminum alloy anodes cast on galvanized steel wire rope were installed. Although the CP designers expected that two anode strings would produce the necessary current for CP protection, the other pair of anode strings would be readily available during the trial if needed. For safety reasons, connections between the anode strings and structure were made in a junction box located above the sealed lower platform so the anode connections could be made without entering the airtight column. Initially, only two anode strings were connected to the structure.

Six Ag/AgCl dual reference electrodes, located in two positions at three elevations in the monopile, monitored the structure-to-seawater potential. An additional reference electrode monitored an anode string. Hydrogen sensors and a 1- by 1-m steel plate to measure current density (CD) were installed at the top of the sealed monopile column. The monitoring system also included a pH probe, dissolved oxygen probe, remotely accessible datalogger, and current input monitor to confirm the operation of a ventilation system, which was switched off after a short time period to determine the presence of accumulated hydrogen, one of the major concerns with installing a CP system in an airtight environment.

Trial results

According to Delwiche and Tavares, a high cathode CD is expected when the CP system is first initialized, then over time the current output from the anodes is reduced and the CD decreases as the structure polarizes. For this CP system, the structure started to polarize as expected, with a high current output initially and then a reduction in current output as the structure achieved more protection (as measured by the CD plate, which was a clean sheet of steel vs. the uncoated, corroded monopile structure).

After two weeks of operation, however, the structure unexpectedly started to depolarize and the structure-to-electrolyte potentials became less negative, which meant the structure was no longer adequately protected. The anode current output and CD also increased, which was unusual because the anode current output and CD were expected to show a time-dependent decrease as gradual structure polarization occurred. The ventilation system had been switched off so hydrogen levels could be monitored, and only insignificant changes in hydrogen were detected. At this stage, a risk of hydrogen build-up in the monopile, which could create a hazardous area within the monopile, was not a concern.

To boost the CP current, Delwiche says, the third anode string was connected to the CP system; however, that only made the results worse. The anode current output and cathode CD continued to increase, which raised concerns about the functionality of the CP system. Two months after commissioning the trial CP system's two anode strings, personnel were sent offshore to assess the monitoring equipment and take water samples. The monitoring system was checked and found to be fully functional and the readings were verified to be accurate.

When the airtight platform was opened to take water samples, the findings were surprising. The hydrogen sulfide (H_2S) alarms were set off and a strong rotten egg smell was noted, which confirmed the alarms were, in fact, measuring H_2S. The water had a distinctly blue sheen, Delwiche notes, with whitish deposits seen around the monopile walls that were later thought to be early signs of calcareous deposits. Tavares comments that water samples tested in a laboratory showed very low pH levels – as low as 4.5. Within a 10-week period, the seawater pH inside the monopile had changed from a near neutral pH of 8 to an acidic pH of <5, which was much lower than that for typical seawater.

According to Tavares, the offshore CP retrofit trial had revealed an unexpected phenomenon – the introduction of aluminum anodes inside a sealed wind turbine structure reduces the water's pH level very quickly. A low solution pH reduces the efficiency of the anodes, he explains, making it difficult for them to produce the calcareous deposits required for adequate CP and also increasing the risk of hydrogen production. Water pH levels at the values observed or the production of toxic and flammable gases (namely H_2S) from the operation of a sacrificial CP system when using aluminum alloy anodes had not been previously reported, although trace hydrogen was expected. Aluminum anodes have been used extensively for decades in the offshore oil and gas sector and marine industry – within ballast tanks and platform concrete leg foundations – without any reported concerns relating to changes in water pH, Tavares adds. At the time of the CP trial, issues associated with the use of aluminum anodes in stagnant water conditions were unknown.

The monitoring system collects data from hydrogen sensors, a CD plate, pH probe, dissolved oxygen probe, and current input monitor to confirm the operation of a ventilation system.

The junction box, installed above the lower platform, connects the anodes to the structure.

The reduction of the water's pH is believed to be associated with hydrolysis (the chemical breakdown of a compound due to its reaction with water) of the sacrificial anode's corrosion product. "At the time, we didn't appreciate what the phenomena was. We were putting more aluminum in the water by introducing the third anode string," Delwiche comments. He notes that the additional aluminum alloy anodes increased the amount of corrosion product, and the pH of the water decreased as the aluminum ion concentration increased. Although the CP's electrochemical process produced hydroxyl ions that should have neutralized the acidic conditions created by hydrolysis, the hydroxyl ions also reacted with the buffering salts in the stagnant water to form relatively insoluble calcareous deposits – magnesium hydroxide [$Mg(OH)_2$] and calcium hydroxide [$Ca(OH)_2$]. This reduced the concentration of free hydroxyl ions to a level that was not sufficient to offset the acidic conditions created by hydrolysis of the anode corrosion product.[5]

A number of options were considered to counteract the low pH within the monopile, including the introduction of chemicals into the stagnant water. Several concerns, however, prevented the project team from executing this solution. Conveying chemicals in either large or concentrated doses can pose a health and safety risk on sea vessels and the transition piece. Additionally, it would be challenging to manage a chemical mixture in an offshore environment, Delwiche says.

Ultimately, the solution was to regularly add fresh seawater to the monopile's stagnant seawater environment. This was done by drilling holes in the seals used on the J-tubes at the bottom of the monopile so the seawater inside the pile was continuously flushed with fresh seawater. The holes were carefully designed to allow a 5% change in water per day and drilled so that the tides, especially the spring tides, did not reach the monopile's lower platform. After applying this solution on the trial monopile, the flushing technique was implemented on four additional monopiles with favorable outcomes. The CP design was finalized based on the trial results, and work started on retrofitting the remaining wind turbines in the LID wind farms.

Delwiche notes this solution has proved to be extremely effective, although constant monitoring is required to ensure the fresh seawater flushing continues. Ongoing portable pH checks confirmed that most of the monopiles now have water pH levels above pH 6, which is considered satisfactory, with the majority exhibiting a water pH level of 7. The H_2S, which was subsequently found only in monopiles that had a water pH level <6, abated over time when the pH level returned to normal. The trial was extremely valuable in that it established current output requirements and longevity of the anode strings and confirmed the original CP design premise for the monopile, he says.

This article is based on CORROSION 2017 paper no. 8955, "Retrofit Strategy Using Aluminium Anodes for the Internal Sections of Windturbine Monopiles," by A. Delwiche and I. Travares. It has also been published in the August 2017 issue of Materials Performance. Reprinted with permission.

Photos and images courtesy of Alex Delwiche.

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AC Mitigation – are you affected by "stray"?

(Part 1)

Over the years, Corrosion specialists have increasingly devoted resources to understand, detect and control induced AC Corrosion.

AC interference has become more of a concern today due to the frequency at which pipelines and High Voltage AC power systems are being co-located in shared Servitudes and right-of-way (ROW's), as it is very difficult for operators to secure new ROW's. To overcome these difficulties, more pipeline owners and developers are laying their pipelines adjacent to existing power lines and even though this may appear to be the easiest solution, it too comes with challenges. Co-locating ROW's exposes both humans and materials to danger and influence. Pipeline owners are becoming more conscious of factors that could contribute to AC interference and related safety hazards.

Due to modern techniques and understanding, it is possible to mitigate the interference through carefully engineered and designed AC Mitigation systems, protecting both personnel and assets.

What is AC Mitigation?

Electricity will always look for the path of least resistance. When underground metallic pipelines are near high voltage power transmission lines, Lightening or other power sources, they are subjected to the electric AC or DC interference created by the foreign power source. These power sources are external to our design and need to be considered and corrective measures taken to mitigate interference and dangers.

Figure 1: The need for Solid state de-couplers arises from mitigating induced voltages on pipelines near overhead power lines.

AC Mitigation is designed and installed to decrease the induced voltage on the pipeline. This may be accomplished by installation of different grounding methods such as linear zinc ribbon and/or grounding rods attached to the pipeline with Decouplers for DC isolation.

There are three types of AC coupling;

- Inductive

- Resistive
- Capacitive

Inductive

Inductive coupling occurs because of the electromagnetic field (EMF) that is created around the electric conductors in the HVAC system.

- Each conductor creates an EMF with a direction and magnitude that are related to the direction and magnitude of the alternating current (AC) flow in the conductor.
- If the pipeline is the area of influence for the EMF, the EMF will induce an alternating current on the pipeline.
- Inductive coupling is primarily of concern on electric power lines with voltage ratings of 69 kV or higher, ***however severe phase imbalances on electric lines with lower voltage ratings can result in significant AC interference on a pipeline.***

Resistive

Resistive coupling between the power line and pipeline occurs when the power line transmits an electrical charge directly into the earth at grounded structures.

- This is a short duration occurrence that is not typical of proper system operation, but it may occur during lightning strikes and electrical transmission fault scenarios.
- When this charge is transmitted into the soil near a pipeline, the pipeline can provide a lower resistance path.
- The current pickup and return locations for this charge can result in coating damage and rapid metal loss.

Capacitive

When underground metallic pipelines are in close proximity to HVAC transmission lines, there are three ways in which HVAC can influence pipelines.

Capacitive coupling occurs between two conductors that are separated by a dielectric.

- The power lines are one conductor, the air is the dielectric, and the pipeline is the other conductor.
- The electrical charge from the power line conductors is transferred into the pipeline over time.
- Once a pipeline is buried, the impacts of capacitive coupling to the pipeline are typically negligible.

When the pipeline is isolated above ground during construction, hazardous charges can accumulate on the pipeline.

AC Mitigation design

Theoretical modelling design – computer-based modelling can assist pipeline operators in developing an effective AC Mitigation system. This data-driven, theoretical approach relies on available HVAC system information, measured physical dimensions of the pipeline and HVCA system and soil resistance data. This information is fed into a complex software application that calculates the theoretical ground resistance required to mitigate the predicate AC voltage as well as estimating the residual AC voltage that would be present following installation of an AC Mitigation system.

This approach can result in the design of an effective AC Mitigation system, however, it's relatively expensive and depends on the accuracy of available data.

Field measurement and design – is a multi-layered approach that involves collecting field measurements and HVAC power data, with the goal of installing an AC Mitigation system that protects personnel and pipelines whilst allowing continuous monitoring. This approach is typically the most common AC Mitigation strategy due to its practicality and cost effectiveness.

Designing an AC Mitigation system and protecting your assets

AC Mitigation most often involve some combination of the following:

1. Connecting available natural drains.
2. Providing additional grounding.
3. AC and DC Coupling Devices.
4. Installing coupon test stations to understand the interference.

Natural Drains are existing structures such as steel casings, which operators can utilise to provide AC grounding. This should be identified during field testing.

Additional Grounding options include horizontal linear ground systems or deep vertical-point ground (DVPG) systems. Both

Figure 2: Stray voltage is the occurrence of electrical potential between two objects that ideally should not have any voltage difference between them.

Natural Drains and **Additional Grounding** systems require consideration of existing soil characteristics and ROW availability.

Carefully sized **DC Decoupling Devices** are also key to protecting pipelines from induced AC Corrosion. They establish electrical connections to various components of the AC Mitigation system, allowing continuous passage of AC energy while simultaneously blocking DC current flow, thus maintaining the DC electrical isolation required for effective operation of the CP system.

Coupon test points are another key component of any AC Mitigation system. The coupon is effective for monitoring of both AC potential and AC current density by providing a steel surface exposed to the surrounding soil. The steel surface is representative of coating holidays found on the pipeline under study. Coupons should ideally be placed in areas where geometric alignment changes to co-locate exist, since there will be a peak in AC voltage at the point of intersection (IP).

Solutions to the complexities of combining right of way usage are indeed available and only need to be recognised and incorporated into the pipeline at design stage or incorporated when the spatial infrastructural environment changes introducing the complexities.

Look out for Part Two in the next issue and for more information on AC Mitigation check out our blog at www.cathtect.com or send your questions to info@cathtect.co.za.

Serving the corrosion industry for 75 years

NACE celebrates its diamond anniversary in 2018

By Gretchen Jacobson, MP Managing Editor-in-Chief

As the corrosion control industry has developed and grown, NACE International established itself early on as an organization committed to controlling and preventing corrosion. From its beginnings as a small group of engineers focused on cathodic protection (CP) to address metal pipeline degradation, NACE has evolved into a worldwide organization that is involved in every industry and area of corrosion prevention and control, from oil and gas and water systems to marine, transportation, and infrastructure protection.

Next year the association celebrates its Diamond Anniversary, a milestone made possible by the knowledge, expertise, and continued support of its members from around the globe. As it has in the past, NACE continues to advance education and training, technical discussions, and standards development and advocate corrosion control as part of its mission to equip society to protect people, assets, and the environment from the adverse effects of corrosion.

NACE founded in 1943

At the beginning of the 20th Century, little was known about the science of corrosion control. By the 1930s, however, significant strides in corrosion mitigation had been achieved and CP had come into widespread use to control corrosion on underground pipelines. This generated well-founded concern about possible damage to adjacent structures from stray current. It soon became apparent that a dedicated organization was needed to serve as a clearinghouse for information about underground operations and to establish standard procedures for installing and maintaining CP systems. This led to the formation of the Houston, Texas-based Mid-Continent Cathodic Protection Association in 1938. In 1940, the Petroleum Industry Electrical Association (PIEA) offered to sponsor the work of this group, which then became the PIEA Cathodic Section. Members of this section quickly determined the value of forming a separate association dedicated specifically to corrosion and its control. On October 9, 1943, 11 corrosion engineers agreed to found this endeavor, and the National Association of Corrosion Engineers (N.A.C.E.) was born.

Association growth over the decades

The first officers to lead the fledgling organization were President R.A. Brannon, Vice President F.J. McElhatton, Secretary-Treasurer O.C. Mudd, and Directors G. Gorfield, G.R. Olson, R. Pope, W.F. Rogers, and L.R. Shephard. In 1945, with 268 members, NACE was officially incorporated under Texas law as a not-for-profit technical association. In 1946, the Houston Section was the first section formed and association membership grew to 801. The South Central and Western Regions were established in 1946, followed by the Southeast and North Central Regions in 1947. By the end of the 1940s, NACE had five regions, 17 sections, and more than 1 700 members.

NACE also began broadening its scope during its formative years, expanding beyond a purely CP and pipeline focus to include the oil and gas production, chemical processing, and refining industries, as well as other methods of corrosion control such as protective coatings and linings, chemical treatment, and materials selection and design. This, along with increasing public knowledge and concern about the costly and damaging effects of corrosion, served to fuel impressive membership growth throughout subsequent years. Today, the association (renamed NACE International

THE FOUNDING ENGINEERS

B. Bond, Texas Pipe Line Co.

R.A. Brannon, Humble Pipe Line Co., NACE president, 1943-1946

D. Holsteyn, Shell Oil Co., Inc.

F.J. McElhatton, Panhandle Eastern Pipe Line, NACE president, 1946-1947

M.C. Miller, Ebasco Services, Inc.

O.C. Mudd, Shell Oil Co., Inc., NACE treasurer, 1943-1950

W.P Noser, Humble Pipe Line Co.

G.R. Olson, United Gas Corp., NACE president, 1947-1948

W.F. Rogers, Gulf Oil Corp., NACE president, 1953-1954

J.A. South, The Texas Co.

H.W. Wahlquist, Ebasco Services, Inc.

Attendees at the inaugural NACE annual conference in 1945 enjoy the first of many annual banquets.

in 1993) has four areas and 80 sections in North America, four international areas with 61 sections, and a total of more than 36 000 members from 140 countries. In addition to NACE headquarters in Houston, Texas, there are now staff offices in Al-Khobar, Saudi Arabia; Kuala Lumpur, Malaysia; San Diego, California; Sao Paulo, Brazil; and Shanghai, China.

Technical committees

The need to develop corrosion control technologies and document them for use in industry was the primary force driving NACE's formation. Two technical committees were established in 1944 to make headway in the areas of condensate well corrosion and galvanic anode testing. These committees soon merged into the newly established NACE Technical Practices Committee (TPC) under the leadership of R.B. Mears.

The TPC grew rapidly – by 1949 it comprised 13 subcommittees encompassing all methods of corrosion control and prevention. The number grew to 19 subcommittees before a reorganization in 1954 combined them into several group committees. The evolution of the TPC is documented in L. Perrigo's book, *A History of the NACE Technical Practices Committee and Technical Committees*, which was released in 1993 to coincide with NACE's 50th Anniversary.

> "The fact that NACE entered these and other fields too numerous to cover here while maintaining a high level of integrity has resulted in its good reputation in industry with the outcome of steady growth over the years, which has dramatically increased throughout the world. The thirst for knowledge still exists and NACE member volunteers and staff continue to work hard to fulfill this need."
>
> *W. Brian Holtsbaum, NACE past president and member since 1957*

The TPC generated numerous technical reports in the 1950s and early 1960s. In 1966, the Board of Directors approved the association's next step toward becoming a standards-writing organization to document emerging corrosion control technologies and how they should be used. By 1969, NACE completed and issued two standards: TM0169, "Laboratory Corrosion Testing of Metals for the Process Industries," and RP0169, "Control of External Corrosion on Underground or Submerged Metallic Piping Systems." In 1970, the TPC held its first Technical Committee Week (later renamed Fall Committee Week) in Dallas, Texas, which attracted 260 members in 50 technical groups that held 146 meetings, two TPC training sessions, as well as other gatherings and events.

The TPC underwent a significant reorganization in 2000 that was designed to speed up standards development, reduce the number of administrative meetings, simplify information exchange, and make it easier to develop joint standards across NACE subcommittees and other associations. The TPC was renamed the Technical Coordination Committee (TCC), and technical committees were organized by Specific Technology Groups (STGs), Task Groups (TGs), and Technology Exchange Groups (TEGs).Today there are more than 345 technical committees comprised of 3 400 members.

NACE officers meet at the 1948 annual conference held in St. Louis, Missouri.

Fall Committee Week became Corrosion Technology Week (CTW) in 2003 to include activities other than technical committee meetings and attract attendees who might not be members. Most technical committees also meet each spring at CORROSION, NACE's annual conference.

Since NACE issued its first two standards more than five decades ago, the association has developed more than 200 standards and technical reports, including standard practices, materials requirements, and test methods. Recommended practices were changed to standard practices in 2006, and existing recommended practices are being changed to standard practices as they are revised or reaffirmed.

By 2016, the globalization of NACE was embraced by translating more than 50 standards into Chinese and/or Spanish, launching the Section Technology Advisory Group (STAG) program to obtain more participation internationally, and establishing more effective strategies for engaging with the worldwide ISO standards organization.

Annual Conference

NACE's first annual meeting was held in 1944 at the Rice Hotel in Houston, Texas. There were 260 attendees and the proceedings included 25 papers. As with membership, conference attendance swelled steadily in ensuing years, reaching 2 000 participants in the mid-1950s, 3,000 in the mid-1970s, and 6 000 in the late 1990s and beyond. The annual exhibition has grown from 250 exhibitors in 1994 to 438 exhibitors in 2017, including 87 new exhibiting companies. This annual conference featured 44 technical symposia with 488 paper presentations, six research symposia with 89 presentations, and 196 technical committee meetings. CORROSION 2018 will be held April 15 to 19 in Phoenix, Arizona, featuring special events celebrating NACE's 75th anniversary.

Recipients of NACE's prestigious Association Awards have been honored at annual conferences since 1947, when the first two awards presented were named for and given to W.R. Whitney and F.N. Speller.

Additional awards were established in 1953 (A.B. Campbell Award), 1973 (R.A. Brannon Award), 1987 (T.J. Hull Award), and 1996 (H.H. Uhlig Award). The Distinguished Service Award (established in 1969) and Technical Achievement Award (initiated in 1986) honor outstanding contributions to the association and the field of corrosion control. On the occasion of its 50th Anniversary in 1993, NACE created two new categories of awards: NACE Fellow and Distinguished Organization Award. The *CORROSION* journal Best Paper Award was added in 2010.

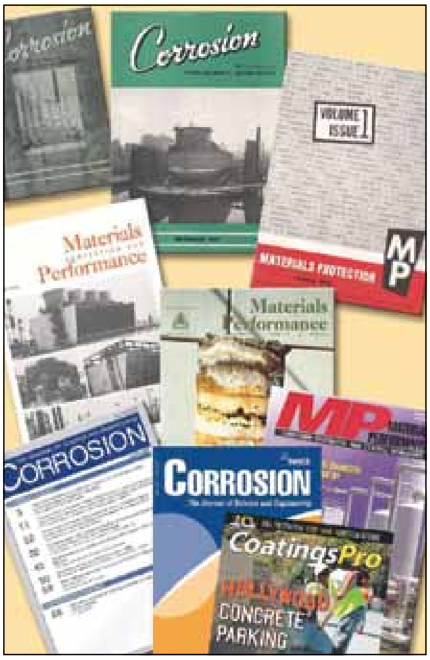
In addition to the CORROSION conferences, NACE conducts a multitude of topical and regional conferences, seminars, and other events around the world.

Publications

In March 1945, *CORROSION* debuted as NACE's official publication to provide a permanent record of the papers prepared for the association at meetings and annual conferences, and from other editorial sources. The journal contained several technical articles, editorials, abstracts from other corrosion papers, information about association activities, and a roster of NACE members. Its frequency grew from quarterly to monthly in 1946, and changed from a 6 by 9-in publication to its current standard magazine format in 1949. In addition to its printed format, *CORROSION* became available via the Internet in 1998, with subsequent improvements and upgrades for robust access to the journal and other resources at www.corrosionjournal.org.

The early 1960s saw a departure of the Corrosion Abstracts department in *CORROSION*. These were published in a quarterly journal entitled *Corrosion Abstracts (COR*AB). COR*AB* was eventually sold to Cambridge Scientific and can be accessed online by subscription.

In 1961, the NACE Board of Directors approved a recommendation by the Publications Committee to separate "theoretical" and "practical" papers, and in 1962, NACE became a two-journal society. *Materials Protection* became the official NACE membership publication and *CORROSION* primarily became a scientific journal. Ivy Parker, who served as editor of *Materials Protection*, stated in a February 1962 editorial, "Today's communications problems demand more strenuous efforts and



"Mars Fontana once said that solving a corrosion problem involved 25% knowledge, 50% experience, and 25% luck. By attendance at NACE national meetings you can increase your knowledge and make a circle of friends and acquaintances, many of whom will share their experience with you when you most need it for a crisis in your own company."

Hugh P. Godard, editor, February 1974 MP

different solutions than those which were satisfactory as recently as five years ago. This magazine is one effort NACE is making to obtain more attention to useful data."

Materials Protection became *Materials Protection and Performance* in 1970 as an interim step toward the ultimate plan of changing the magazine's title to *Materials Performance (MP)*, which occurred in 1974. Then-editor H. Godard wrote, "I am all for the shorter name, but it's what's inside that really counts... papers in *MP* will continue to be practical and will be selected to be useful." In 1999, *MP* underwent a redesign and editorial overhaul in response to reader needs for an even wider selection of shorter articles emphasizing practical, hands-on experiences that can help them in their jobs. Today, *MP* is available in digital format online as well as in print, and is distributed to NACE members and other subscribers each month. The *MP* web site, www.materialsperformance.com, was launched in 2015 and contains exclusive web articles and news in addition to the magazine content.

In 2006, NACE initiated the phased, three-year acquisition of Four Point Publishing, LLC, which published *CoatingsPro Magazine* and *SprayFoam* (NACE later ceased publishing *SprayFoam*). With a current circulation of more than 26 000 readers – primarily coatings contractors but also specifiers and engineers – *CoatingsPro* offers an in-depth look at coatings based on case studies, departments featuring topics such as safety, and product and event news. In 2017, *CoatingsPro* is celebrating its 15th anniversary. As with *MP, CoatingsPro* has its own web site, www.coatingspromag.com, that features the digital edition of the magazine as well as articles and news unique to the site.

NACE continues to add to its suite of print and online topical and area newsletters, as well those supporting students of NACE education and training.

Education and training

The critical need for education and training programs to benefit anyone involved in corrosion prevention and control was recognized early on by NACE leaders. One of the first educational efforts sponsored by NACE was a 1949 short course at the University of Texas at Austin, which was designed for people who dealt with corrosion problems in industry but did not have the background or experience to do so efficiently. NACE developed its first formal education course in the late 1960s – Basic Corrosion – which was initially offered as a correspondence course. The material was then formatted as a four-day course and first offered by the Houston Section in 1971.

Throughout the years, NACE developed many more programs and courses focusing on such areas as CP, protective coatings and linings, materials selection and design, refining, and corrosion fundamentals. Several are now available online and in other languages. The world-renowned Coating Inspector Program (CIP) was developed in the 1980s in response to a request from Group Committee T-6 on Protective Coatings for a certification program to upgrade the coatings industry. By 1985, NACE changed the terminology in its older accreditation programs to certification and began adding certification in specialty fields. All categories have requirements for work experience in the field of corrosion and passing examinations as well as signing a NACE attestation concerning professionalism.

Multiple courses are taught every week throughout the world in NACE facilities – primarily the Elcometer Building in Houston that accommodates more than 3 000 students per year – and company in-house locations. In 2014, NACE opened a 4 000 ft2 (372m^2) training center in Dubai, U.A.E. offering the entire suite of NACE courses. Hundreds of students from the area and surrounding countries are taking advantage of the local center.

In 2012, NACE established the NACE International Institute (NII) to establish an organization focused on certification activities and to further advance the corrosion profession. The institute supports growth and quality of certification for the corrosion control field, improving the business conditions of the industry, and advancing knowledge through certification programs that promote public safety, protect the environment, and reduce the economic impact of corrosion. The NII also leads its certification programs toward compliance with the ISO standard for certification bodies (ISO 17024). Today, it administers 23 certifications plus the CIP endorsements. There are more than 35 000 NACE certification holders worldwide.

Public affairs

Over the years, NACE Public Affairs has been at the heart of efforts to promote the association, educate society about the importance of corrosion control, and incorporate NACE standards into government regulations. The U.S. Federal Government and more than 40 states reference NACE standards and certification programs in their regulations, most commonly in the fields of oil and gas, hazardous waste, and water/waste water.

As NACE has grown, it expanded its government affairs efforts on Capitol Hill and with federal agencies – most notably the U.S. Department of Defense (DoD), the U.S. Department of Transportation (DOT), and the U.S. DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA). Much of the association's success in Washington, DC is directly linked to NACE's initiation of a 2002 investigation by the Federal Highway Administration (FHWA) on the costs of corrosion. This study, "Corrosion Costs and Preventive Strategies in the United States," showed the total annual estimated direct cost of corrosion was $276 billion, about 3.1% of the nation's gross domestic product (GDP). In 2016, NACE released a two-year study, the "International Measures of Prevention, Application, and Economics of Corrosion Technologies" (IMPACT), to examine the current role of corrosion management in industry and government and to establish best practices. This global study – the first of its kind – found that the cost of corrosion is $2.5 trillion, which is equivalent to 3.4% of the world's GDP. It estimates that savings of between 15 and 35% of this cost could be realized if current best practices are employed. More information can be found at impact.nace.org.

NACE has also followed changes in pipeline safety legislation over the years and sponsored several highly successful pipeline integrity management seminars. In 2003, the U.S. Congress passed a law requiring the Secretary of Defense to designate a specific office to oversee corrosion prevention and control, and the DoD Corrosion Policy and Oversight Office was created. Since then, NACE has served as a strategic partner with this office, as it carries out its mission to enhance DoD efforts to improve design and maintenance of DoD vehicles, equipment, and infrastructure. As a strategic partner, NACE has provided training and certification courses to military personnel as well as other initiatives to support the DoD's efforts to fight corrosion.

NACE International Foundation

The NACE International Foundation has been in existence within NACE since 1986. It was originally created as the Endowment Committee to provide members and other industry professionals the opportunity to donate toward scholarships for students and young aspiring scientists with corrosion control interests. In 2002, the Endowment Committee was officially transformed into what is now known as the NACE International Foundation, a nonprofit organization with the mission to promote awareness and create educational opportunities for the future, global corrosion workforce.

As the only organization dedicated to encouraging and promoting the interests of the future generation of engineers and professionals in the field of corrosion, the NACE Foundation has created many innovative and groundbreaking programs that focus on increasing public awareness on corrosion issues. These include the implementation of education programs, academic scholarships, business partnerships, student awards, a workforce development program for returning veterans, and providing funding for the Elcometer Building – the 15 000-ft^2 (1 394-m^2) training center in Houston. To memorialize this endeavor and the continuous efforts of many, the Founders Award was created in 2005 to recognize exceptional contributions and meritorious work by individuals on behalf of the Foundation. More information can be found at www.nace-foundation.org.

Seventy-five years of member-driven success

As the structure of NACE has grown and changed over its 75-year history, one thing remains the same – NACE is driven by its members. The NACE Board of Directors, area and activities committees, TCC committees, and many other active members provide valuable oversight and input to ensure that the association best serves its diverse membership. NACE leadership is continually involved in strategic planning to address the association's direction and define its goals and objectives for years to come.

To commemorate NACE's 70th anniversary in 2013, the NACE Past Presidents Council compiled a complete, illustrated history of the association from the time it was founded by 11 pipeline engineers in 1943. This book is being updated and revised to honor NACE's 75th anniversary and will be released at CORROSION 2018. It highlights the knowledge and expertise of dedicated members and staff, as well as the activities conducted over the years that have led to the thriving, 36 000-member international technical society that NACE is today.

The determination of "salts" in the inspection game

By Mark Terblanche, Prime Inspection (Pty) Ltd

It is well documented that the presence of soluble salts on the substrate's surface or between the layers of applied paint, is a significant cause of concern and has been attributed to many premature failures of coating systems. Delamination of coatings from corroded substrates, hygroscopic blistering and/or intercoat adhesion failure are just some of the results of salt contamination. It is also true that the measurement (determination) of salt content is a point of much conflict and can lead to project delays.

Two of the most commonly referenced standards are:

1. SSPC-Guide 15, Field methods for the retrieval and analysis of soluble salts
2. ISO 8502 (various parts), Preparation of steel substrates before application of paints and related products – Tests for assessment of surface cleanliness

These standards go into significant detail regarding the methodology for the assessment of soluble salts, but it must be noted that specific instructions from the proprietary manufacturers of the testing equipment must also be strictly adhered to, to ensure accuracy of results. However, the standards intentionally omit any details regarding the pass/fail and test parameters of specific salts – more on this later.

Let me begin with a few statements that will define and limit this article:

1. Salts are defined as an *ionic substance containing an anion (typically chlorides, sulphates and nitrates) but not the hydroxide ion (OH^-) or the oxide ion (O^{2-})*[1]. Sodium chloride (NaCl), or table salt, is only one form of a chemical salt. Correctly speaking then, ferrous oxide and/or ferrous hydroxide, which are analysed in certain of the salt tests, are actually ionic species. The commonly accepted reference to these species as salts is technically incorrect.
2. The solubility of common ionic substances (salts) is determined by their ability to dissolve in water. A "soluble" compound dissolves to the extent of 1g or more per 100ml. The solubility of an "insoluble" compound is less than 0.1g per 100ml[2]. It is noted that chlorides, sulphates and nitrates are deemed to be soluble in water while hydroxides (e.g. ferrous hydroxide) is insoluble in water and only soluble in acids and strong bases[3].
3. Iron is the second most abundant metal, after aluminium, and the fourth most abundant element in the earth's crust[4]. The use of iron in the manufacture of steel components, and therefore the corrosion of iron due to exposure to an environment, is the basis for *salt* determinations.
4. Three common internationally accepted field tests will be investigated and discussed. While there are many other tests available I have specifically chosen these three as they are probably used most often by coating inspectors. The tests are:
   I. The Potassium Ferricyanide Paper Test
   II. The Sleeve test with Kitagawa Tube
   III. The Bresle Patch
5. Approximately 71% of the earth's surface is covered by seawater. As such, the most abundantly analysed salt is sodium chloride. The chloride ion is not limited to coastal regions, but due to high-altitude wind currents, sea-air is observed well inland and will therefore have an effect on the corrosion rates of steel surfaces.

Potassium Ferricyanide Paper Test

This is a truly qualitative test – all it gives is a *"Yes/No"* answer to the presence of ferrous (Fe^{2+}) ions. By definition, these chemical species are not salts as no anion is present. However, this test is incorrectly referred to as a test for the presence of iron salts.

The chemical formula below *(Equation 1)* shows the reaction of the Fe^{2+} ions, on the metal surface, reacting with the ferricyanide ions, impregnated into the test paper, to form a dark blue mixed iron(II)/iron(III) compound, commonly known as Prussian blue ($C_{18}Fe_7N_{18}$)[5].

Equation 1

$$Fe^{2+} + [FeIII(CN)_6]^{3-} \longrightarrow Fe^{III}_4[Fe^{II}(CN)_6]_3.xH_2O$$

Yellow Colour — Prussian blue

Coating delamination: automotive process plant – rinse tank.

Coating delamination, blistering and cracking: flooded field joint adjacent to scour valve.

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Potassium ferricyanide is one of two compounds present in ferroxyl indicator solution which turns blue (Prussian blue) in the presence of Fe^{2+} ions, and which can therefore be used to detect metal oxidation that will lead to rust. It is well understood that, in the presence of oxygen and water, iron will oxidise (rust) to give a hydrated iron (III) oxide (approximated by the formula $Fe_2O_3.H_2O$)[6] *(Equations 2 and 3).*

Equation 2

$$Fe^{2+}_{(aq)} + 2OH^-_{(aq)} \longrightarrow Fe(OH)_{2\,(s)}$$

Equation 3

$$4Fe(OH)_{2\,(s)} + O_{2(g)} + xH_2O_{(l)} \longrightarrow Fe_2O_3.(x+4)H_2O_{(s)} + 2H_2O_{(l)}$$

The blue spots on the test paper therefore indicate the presence of ferrous ions which, if left untreated, *will* result in the formation of rust.

Sleeve Test with Kitagawa Tube

This is a quantitative test specific to the measurement of chloride contamination.

In an adaption of the Mohr titration[7], a pre-activated tube containing a known concentration of silver chromate and potassium chromate (as indicator) impregnated onto an inert carrier (silica gel), is reacted with the soluble chloride ions extracted from the substrate. At the end-point, the point where the concentration of the chloride is determined, a colour change will occur in the tube (pink to white interface).

The argentometric reaction is expressed as follows *(Equations 4 and 5)*[8].

Equation 4

$$Ag_2CrO_{4\,(ppt)} + xH_2O \longrightarrow 2Ag^+ + CrO_4^{2-} + xH_2O$$

Equation 5

$$Ag^+ + Cl^- \longrightarrow AgCl_{(ppt)}$$

The silver chloride precipitate (ppt), being white in colour, is then easily read in parts per million (ppm) and converted to

An introduction to the Elcometer 130 SSP (Soluble Salt Profiler)

By John Fletcher, DipIM, CSci, FICorr, Technical Support Manager

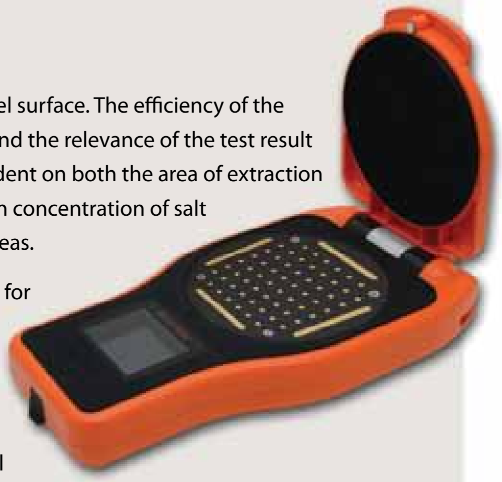
Contamination of blast cleaned steel surfaces prior to application of protective coatings leads to premature coating failure resulting from corrosion caused by the soluble salts left on the surface after the cleaning processes. It has become common practice to include a salt contamination test prior to the application of the first coat to ensure that the required cleanliness has been achieved.

Soluble salt measurements in general require two processes, the first is to extract a test solution with the salts from the surface, and the second is to analyse the solution to determine the concentration of the salt on the surface.

In the case of the saturated filter paper extraction method, specially cleaned filter papers are wetted with a controlled volume of pure water and the paper is then placed on the surface to extract the soluble salts. The paper is left on the surface for 2 minutes and then it is removed from the surface and placed on the electrode of the conductivity meter. The meter then tests the conductivity for this known area of the filter paper and the known volume of test solution. The result is displayed by the gauge as a value in µg/cm².

In line with several modern electronic coating inspection gauges, the latest design of conductivity meter makes use of microprocessor electronics to enable operational features to be added to make the measurement of surface salt concentration and the management of the resulting data quicker and easier. The gauge case is hand-held and fully portable for field use and is designed to be dust and water resistant to IP64 equivalence.

The NACE equivalency test described in SP0508, Methods of Validating Equivalence to ISO 8502-9 on Measurement of the Levels of Soluble Salts, has shown that salt crystals do not form evenly on a steel surface. The efficiency of the extraction method and the relevance of the test result are therefore dependent on both the area of extraction and the differential in concentration of salt between adjacent areas.



A new sensor design for the Elcometer 130 SSP conductivity meter has been developed that has a matrix of individual contact spots rather than the usual concentric rings. By taking the conductivity measurements between the spots using a raster scan of the sensor, it is possible to plot the relative conductivity across the filter paper.

Using the matrix array it is possible to measure the conductivity of selected areas of the filter paper and even produce 2-D and 3-D conductivity maps of the area of the filter paper. Four Bresle Patches can comfortably fit in to the area covered by the filter paper.

Working with the University of Manchester in the UK, an automated, repeatable and reproducible doping method was developed to apply known salt concentrations over large blasted steel panels. The variation in readings between the Elcometer 130 SSP method and the Bresle Test method are significantly within the background contamination level of the Bresle Patches.

The Elcometer 130 soluble salt profiler provides fast and accurate measurement of the level and density of soluble salts – over 4 times faster than other Bresle equivalent methods.

micrograms per square centimetre (µg/cm^2). There is a 1:1 relationship for this conversion.

The reaction is pH sensitive and care must be taken to ensure the extracted solution is within the pH parameters of 6.5 – 9. Acidic environments will lead to inaccurate readings due to preferential reaction of the chromate ion and the hydrogen ion of the acid.

Care must be taken during the application of this test to allow the extraction solution to wick all the way to the top of the Kitagawa tube, usually around 90 seconds. A colour change to amber at the top of the tube indicates the total saturation of the tube and thereby an accurate result is ensured.

Bresle Patch (conductivity measurements)

To measure the conductivity of a solution it is placed in a cell of which the cell constant has been determined by calibration with a solution of accurately known conductivity, e.g. a standard potassium chloride solution. The measuring cell is placed in one arm of a Wheatstone Bridge circuit and the resistance is measured[9]. This electronic principle forms the basis for the use of conductivity meters using Bresle patches to determine the ionic content of a solution extracted from the substrate.

What is true is that all ions will "conduct" an electrical current and these known constants are expressed as the Limiting Ionic Molar Conductivity at 25°C (Λ_o). The table extract below shows the ions that are most commonly encountered in the steel corrosion process[10].

Ion	Λo (S cm^2 mol^{-1})
½Fe^{2+}	54
½Fe^{3+}	68.4
Cl^-	76.3
NO^{3-}	71.5
½SO_3^{2-}	80
½PO_4^{3-}	80

So what does this mean? When we extract the pure-water solution from the Bresle patch on the substrate, we are measuring all the ionic species that are present on that specific substrate. The conductivity meter will present a reading in siemens per meter (S/m) or microsiemens per centimetre (µS/cm) and must be converted to the desired microgram per square centimetre (µg/cm^2) by a conversion table – check the operating instructions for the equipment being used.

As with the Sleeve test, it is vitally important that the volume of the extraction solution and the area under the patch (Bresle or Sleeve) be accurately controlled. The result – the concentration of the salts and ions present – is reliant on the accuracy of these parameters. Using a mathematical equation *(Equation 6)*, conductivity can be converted to concentration[11]. This mathematical equation is of importance as the volume of extraction solution and/or the contact area of the Bresle patch can vary depending on the standard or test method employed. It is important to obtain, read and understand the manufacturers technical information before undertaking the tests.

As an additional point, a chemical blank must be run before the actual extraction is undertaken. The blank is analysed with the extraction solution only and this value is deducted from that of the extraction. By doing this, the final result obtained is a true representative of the salt (ionic) concentration on the substrate.

Equation 6

E = 0.5 * S * (V/A)

Where:

E = Surface Concentration (µg/cm^2)

S = Conductivity (µS/cm)

V = Volume of Extraction Solution (cm^3)

A = Area of Sample Collection (cm^2)

So, what must we "know"?

The current standards do not prescribe the parameters under which salts must be measured. This aspect is left to the specifier to determine and indicate within the specification. Unfortunately, due to a misunderstanding of the chemical terminology, specifications are often not specific enough in the requirements for salt/ionic determination.

What should the specification address?

Regardless of the salt to be tested, a good specification would (at least) need to address the following points regarding soluble salt measurements:

- Specific salts to be tested for. Each of the different test methods described above test for a different *type* of salt.
- The test method to be used. Here specifics must be given as different instruments have a different measuring protocol and variations in results can be achieved. As a default, the testing equipment manufacturers instructions would be the minimum test method to be used.
- Limits (tolerances) of the soluble salts to be considered acceptable for the coatings process to continue.
- Where to take the test. The location of the tests is vital e.g. windward or leeward environmental conditions must be considered as variation in results can be achieved.
- The frequency of the tests. How often, what is the sampling protocol?

An inspector must understand, and address, these potential conflict points.

With over 25-years' experience in the coatings industry Prime Inspection offers a range of consulting services that include: coating and corrosion investigation, specification review, defect analysis and quality management auditing services to the chemical and coatings sectors. Prime can be contacted on:

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Corrosion protection for steel reinforcement in concrete: The case for galvanizing

By Dr Stephen R. Yeomans – University of New South Wales, Canberra, ACT Australia

The recent publication of the Permanent International Association of Navigation Congresses (PIANC) Report No 162 (2016) presents broad-ranging recommendations for the increased durability and service life of new marine concrete infrastructure with a focus on reinforcement corrosion. The report covers a range of important issues in the design and detailing of reinforced concrete, concrete mix design and construction practices.

The report also gives guidance on strategies and protective measures to combat the effects of reinforcement corrosion including stainless steel and non-metallic reinforcement and concrete surface protection. While there is no question concerning the sound technical basis of such measures, it is apparent that another important and widely used protective mechanism for reinforcement has been omitted from this discussion, namely galvanized reinforcement.

In presenting the following review, the purpose is not to criticize the PIANC Report for it is a very useful guide to the design and construction of marine concrete infrastructure. Rather, the purpose is to highlight another widely used, economical and reliable method of reinforcement corrosion protection for marine and coastal concrete structures and other similarly aggressive exposure conditions.

The galvanizing of reinforcement (i.e. coating with zinc) provides additional corrosion protection in the event of a lack of durability of the concrete and also where long maintenance-free life is required. It has been widely used over the last 40 – 50 years in many types of reinforced concrete infrastructure in aggressive exposure conditions.

Where chloride corrosion resistance is required, galvanized reinforcement has been used in coastal and marine structures including wharves, docks, jetties, marinas and sea walls, floating and submerged structures, offshore and subterranean pipelines, seawater aquariums and cooling channels, and in coastal bridges. Other important examples are in bridge decks, road surfaces and crash barriers exposed to de-icing salts. In all of these applications, it is the high chloride tolerance of galvanized reinforcement compared to that of black steel that has been the primary feature of its use.

A brief review is presented here of the characteristics and performance of galvanized coatings for concrete reinforcement. Some examples will be given of laboratory research and field studies of existing galvanized reinforced structures, many more than 35 years old. A detailed review of this topic was published in 2004 (Yeomans 2004).

Galvanizing of steel

While steel can be coated with zinc in a number of ways, for steel products greater than 5 – 6mm thick and including reinforcement, hot dipping is the preferred method. Hot dip galvanizing involves immersing clean and pre-fluxed steel in molten zinc at about 450°C. During immersion, a metallurgical reaction occurs between the steel and the zinc resulting in a coating that has a specified minimum thickness (ISO14657, ASTM A767) of 85 microns, equivalent to a coating mass of about 600 g/m^2. In practice the thickness of galvanized coatings is generally 100 – 120 microns.

The coating is integrally bound to the base steel and comprises a series of iron-zinc alloy layers (gamma, delta and zeta phases) which grow from the steel/zinc interface with a 40 – 50 micron layer of essentially pure zinc (eta phase) at the outer surface. A key feature of a galvanized coating is that the iron-zinc alloy layers are harder than the base steel resulting in a coating that is not only firmly adhered to the steel but is tough and abrasion resistant.

Changi treatment facility, Singapore.

Changi outfall pipes, Singapore.

As is the case with general galvanizing, the zinc coating on reinforcement provides both barrier protection to the underlying steel as well as sacrificial cathodic protection of exposed steel in the event the coating is damaged.

Zinc in concrete

When zinc comes in contact with fresh concrete (or mortar) it is passivated by the formation of an adherent layer of calcium hydroxyzincate (CaHZn) (Andrade and Alonso, 2004). At around pH 12.6 the zinc surface is totally covered with a dense and compact layer of CaHZn crystals though as the pH increases the individual size and distribution of the CaHZn crystals also increases. Typically, most modern concretes have a pH around 13.1 and in these conditions passivation readily occurs.

When bright galvanized coatings react with wet cement, about 10 microns of zinc from the outer layer of the coating is consumed by the passivation reaction. This occurs through the initial set of the concrete (about 1 – 2 hours) though once the concrete starts to harden the reaction at the surface diminishes as the passive film forms and blankets the zinc surface. Once the passive film has formed it will remain intact even if the pH increases to about 13.6.

Carbonation resistance

The carbonation of concrete, due to reaction between the high alkalinity of concrete and weak atmospheric acidic water progressively lowers the pH of the cover concrete. With black steel in concrete, carbonation-induced corrosion commences when the carbonation front at about pH 11.5 reaches the depth of the reinforcement.

With galvanized reinforcement however, due to the increased corrosion resistance of zinc as the pH reduces below pH 11.5, carbonation does not significantly increase the corrosion of galvanized steel embedded in concrete and in some circumstances may actually reduce the rate of corrosion.

Chloride tolerance

Chlorides find their way into concrete by either being mixed into the concrete or by migration in coastal/marine environments or the use of de-icing salts. A threshold concentration of chlorides, which is pH dependent, is required to initiate corrosion. The effect of the chlorides is to disrupt the passive film on steel and prevent it from re-forming. For steel, a chloride content of less than 0.2% by mass of cement is recommended for a low corrosion risk (ACI, 1994) while a chloride threshold of 0.4% by mass of cement is often cited.

For zinc in concrete, while there is some divergence on a precise chloride threshold, a conservative value of 1% chlorides by mass of cement is often used. What is clear from the extensive array of both laboratory and field studies is that a significantly higher chloride threshold is needed to initiate corrosion of galvanized steel compared to black steel. In many aqueous solution studies using simulated pore water, zinc corrodes at a chloride

National Aquarium, Taiwan.

Cape Town seawall, South Africa.

concentration about 5x higher than for black steel. In concrete, what has been observed is a chloride threshold for galvanized bars at least 2 – 2.5x higher than that for black steel, and perhaps even higher (Yeomans, 1998). Recent studies report chloride threshold levels some 3 – 4x that of black steel (Darwin 2007, 2009) and 2.6 – 3x Maldonado (2009).

Life extension

The higher chloride tolerance of galvanized reinforcement translates into an extension of the time to the onset of corrosion. This can be demonstrated by a Fick's law approximation of the time to corrosion of black steel and galvanized steel in similar exposure conditions (Broomfield, 2004). Assuming a marine concrete with 0.35% chloride concentration at the surface, 30 mm cover and $D = 1.4 \times 10^{-12}$ m^2/s, an upper chloride threshold for black steel of 0.4% chloride and a threshold of 1.0% chloride- for galvanized steel, the time to initiation of corrosion of black steel is 15 years, while that for galvanized steel corrosion is 44 years. This indicates a 3x theoretical extension of life over black steel bar in good agreement with both experimental and field observations.

Zinc corrosion products

When the galvanized coating first comes in contact with wet cement, about 10 microns of zinc is dissolved from the outer layer of the coating though the remainder of the coating (generally 100 microns or more) remains in its original condition for extended periods of time. As such, little further metal loss will occur from the coating until active corrosion commences, usually due to the accumulation of threshold levels of chloride at the depth of the reinforcement. Once this occurs, continued dissolution of remaining free zinc occurs in and around in the alloy layers, particularly so the delta phase, which comprises the bulk of a bright galvanized coating (Yeomans, 1998). Though the coating appears to be dissolving, a dense layer of both the gamma and delta phases remain intact at the bar surface and this affords ongoing corrosion protection to the underlying steel. This effect is observed in field studies of galvanized reinforcement in marine and bridge deck exposure where the remaining zinc coating is typically more than the original 85 micron minimum thickness even after extended periods of high-chloride exposure.

Once corrosion of the zinc initiates, a variety of corrosion products (primarily zinc oxide and zinc hydroxide) form. In contrast to the situation with black steel where the bulky ferrous corrosion products precipitate at the bar interface and disrupt the concrete mass, zinc corrosion products, being friable and less voluminous, migrate away from the bar and into the adjacent concrete matrix where they fill voids and micro-cracks (Yeomans, 1998).

The importance of this is that zinc corrosion products cause very little physical disruption to the surrounding matrix, thereby maintaining the integrity of the cover concrete. The filling of the pore space in the interfacial zone also creates a barrier of reduced permeability which not only increases the adhesion of the matrix to the bar but also reduces the transport of chlorides to the coating surface.

Field studies

The corrosion protection afforded by the galvanizing of reinforcement is primarily due to the combination of the higher chloride threshold of zinc and its resistance to the effects of carbonation. The benefit is that the zinc coating not only delays the initiation of the corrosion process but provides barrier protection when the coating is reacting (i.e. dissolving) but remains intact. Supplementary sacrificial protection occurs where the underlying steel is exposed.

Evidence from numerous field applications has demonstrated that galvanizing significantly extends the life of reinforcement in concrete and provides a safe-guard against premature cracking of the concrete. This has been extensively reviewed by ILZRO (1981), Yeomans (2004a) and Presuel-Morento (2009).

A brief summary of a host of world-wide examples of the use of galvanized reinforced concrete infrastructures exposed to high chloride conditions follows.

In Singapore, 1 200t of galvanized reinforcement was used in the top 6m of 3 200 foundation piles for Changi Water Treatment main facility. Located immediately adjacent to the coast, the facility is subject to a tidal salt water table which is highly corrosive. Treated effluent is discharged into the Straits of Singapore some 5km from the shoreline via twin galvanized reinforced concrete pipes laid in a dredged trench on the seabed. A total of 1 300 pipes were manufactured on site using some 10 000t of galvanized bar. The corrosivity of seawater and the need for a 100 year life dictated the use of galvanized reinforcement.

In the construction of the ANDOC North Sea Oil platform, 2 000t of galvanized reinforcement was placed in the roof of the seabed oil storage caissons. The primary concern was the temperature difference between seawater at 5°C and crude oil which is cooled from 75 to 35°C. The temperature difference causes expansion and contraction of the inner and outer surfaces of the caisson which may propagate cracks leading to corrosion of unprotected reinforcement. Galvanizing was used to overcome this risk.

In Australia, floating precast concrete marinas are galvanized reinforced. After more than 20 years operation, the Townsville Marina in tropical Queensland was redesigned in which all floating cells were removed and inspected. Though a number of black steel reinforced elements around the marina needed to be replaced, the galvanized reinforced cells were in such good condition that all were re-located in the new marina layout.

Also in Australia, galvanized reinforcement was used in the linings for three deep water ocean outfall tunnels in Sydney. The tunnels, bored through coastal cliffs and the seabed to a distance of about 3km offshore, were lined with both precast panels and insitu concrete utilising galvanized reinforcement for long-term corrosion protection.

In Taiwan, 4 600t of galvanized reinforcement was used in the construction of the foundations of the National Museum of Marine Biology and Aquarium. A further 3 680t was used in the construction of the sea water tanks and other facilities around the coastal site.

In the UAE, the Al Maktoum Floating Bridge over the tidal Dubai Creek was fabricated with galvanized reinforcement. The bridge, opened in July 2007, is 360m long with three lanes of traffic in both directions. It carries large amounts of traffic each day.

In South Africa, tidal pools at Koegel Baai and Strandfontein used galvanized reinforced hollow precast units subsequently filled with concrete. After many years exposure they show no spalling distress despite some local damage to the elements. Similarly, the diving platform at Seapoint, originally built from black steel rebar and demolished after 10 years, was rebuilt with galvanized reinforcement and is showing no symptoms of spalling in this aggressive coastal location. Another severe exposure example is the reconstructed galvanized reinforced seawall in Cape Town harbor.

In Okinawa where prevailing winds carry salt-laden moisture across most of the island, galvanized reinforcement is used in public works projects and also in residential housing. As one example, 415t of galvanized reinforcement was used in the foundation of the fish breeding water tanks for the Okinawa Marine Research Institute.

In Chile, galvanized reinforcement has been used in the sea water reticulation system for a coal-fired thermal power station at Coronel

Al Maktoum floating bridge, UAE.

Port. Also at Coronel, 28t of galvanized reinforcement was used in the concrete deck of the Artisanal fishing pier expansion project.

In Spain, galvanized reinforcement was used extensively in precast seawall sections in Denia dock, and also in the construction of a new marina at the Port of Torrevieja.

In the USA, the use of galvanized reinforcement for concrete bridge and highway construction exposed to deicing salts or marine exposure has been widely studied. Surveys of many structures at various ages of exposure and high-to-extreme chloride levels (to 10x recommended ACI levels) at the reinforcement, have consistently revealed that galvanized steel outperforms black steel. In one long-term survey from 1974, a number of bridges in Iowa, Florida and Pennsylvania were examined to compare the performance of galvanized and uncoated reinforcement in decks exposed to humid marine conditions or deicing salts (Stejkal, 1992). After 24 years, the galvanized bars had suffered only superficial corrosion in sound, uncracked concrete even when the chloride levels were very high, and the average thickness of zinc remaining on the reinforcement was still well in excess of that required by ASTM A767. A follow-up study in 2002 of concrete bridge decks in Pennsylvania showed an average chloride level more than 2.5x higher than the threshold value for black steel though the galvanized bars retained well in excess of the minimum 85 microns coating thickness (Olson, 2002).

Similar data from Bermuda has also verified the long-term durability of galvanized reinforced concrete in marine environments (Allen, 2004). Commencing shortly after WW2 and continuing to this time, a number of docks, jetties and other infrastructure were constructed using a mix of galvanized and bare steel bars. A 1991 survey showed that the galvanizing was providing continuing corrosion protection to reinforcement at chloride levels well in excess of threshold levels for black steel. Follow-up examination confirmed these findings and revealed that the galvanized bars maintained a residual zinc coating thickness at 42+ years well in excess of the minimum requirement.

Summary

Over a period of some 50 – 60 years, hot dip galvanized reinforcement has been successfully used in a range of concrete construction in many different exposure conditions. While many applications are in building and construction, there is a significant inventory of galvanized reinforced concrete structures in marine, coastal and offshore exposure where the high chloride resistance of galvanized steel, typically at least 2.5 times that of black steel, has been the principal criteria for its use. Periodic surveys of many of these structures, some now 40+ years old, have revealed the ability of galvanizing to provide on-going corrosion protection to reinforcement even in high-to-extreme chloride conditions.

In the context of the PIANC Report No 162, what the above points to is that the omission of galvanizing as an alternate protective means for reinforcement in marine conditions is a significant limitation to the scope of this very useful guide to the construction of new marine concrete infrastructure.

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From the KETTLE

The role specifiers and end-users have in selecting a corrosion control coating, suggests that all aspects of a hot dip galvanized coating be highlighted and if necessarily de-mystified. The intension of this series of surface conditions is to ensure that the customer or specifier has a greater understanding of the coating so that it is not necessarily rejected or accepted for the wrong reasons, resulting in wasted time for all personnel. See F16 - HDG and F16 – ZEP.

Legend

#1 As the life of a zinc coating is proportional to its thickness, a thicker coating will proportionally outlast a thinner one, however, a thicker coating can be more prone to mechanical damage, when handled inappropriately.

#2 All passivation products including sodium di-chromate will be excluded by the galvanizer when he has received written instructions that the hot dip galvanized steel is to be painted.

#3 While double dipping is occasionally seen to be necessary due to a limited bath size, the galvanizer must inform the customer that this practice can increase the propensity for distortion, before he commences with the work.

#4 While the galvanizer can lower the zinc temperature and shorten the immersion time to limit coating pickup, however, due to increased costs to himself, he is not obliged to do this and if necessary will recover the cost from the purchaser. Insufficient vent, fill and drain holes will lengthen immersion times.

Hdg Hot dip galvanizing **A** Accept **R** Reject **N** Negotiate **C** Clean **REP** Repair **SS** Significant surface.

F16 – HOT DIP GALVANIZING

DESCRIPTION:

Hot dip galvanized fasteners used for bolted assemblies of hot dip galvanized structures.

CAUSE:

Irrespective of the type of zinc coating, the service life of the steel component is proportional to the thickness of the zinc coating system. Hot dip galvanized fasteners should be specified to assemble hot dip galvanized structures.

See hot dip galvanized nuts and washers in the photos.

EFFECT / REMEDY:

Specify hot dip galvanized fasteners to SANS 121:2011 (ISO 1461:2009) or ISO 10684:2004 for grade 10.9 high strength bolts. For additional barrier protection in future inaccessible places, overcoat the fastener with an appropriate zinc rich paint, epoxy or other appropriate top coating system to extensively lengthen the normal service life of the hot dip galvanized fastener.

ACCEPTABLE TO SANS 121:

A or overcoat with appropriate material for enhanced durability.

ACCEPTABLE FOR DUPLEX:

A

ACCEPTABLE FOR ARCHITECTURAL FINISH:

?

Hot dip galvanized coating thickness on this flat washer 117μm.

Hot dip galvanized coating thickness on this nut 131μm.

Hot dip galvanized coating thickness on this nut 77μm.

Hot dip galvanized coating thickness on this nut 134μm.

Should ZEP or uncoated bolts be used in a hot dip galvanized structure and cannot be easily replaced, they can be appropriately over coated. Even when HDG fasteners are used in future inaccessible places, they too can be over coated in order to enhance long term corrosion control.

Over coating of the fastener with an appropriate coating system may not look aesthetically pleasing but for inaccessible places where future maintenance is impossible, the procedure is most appropriate.

F16 – ZINC ELECTROPLATED

DESCRIPTION:

Zinc electroplated fasteners used for bolted assemblies of hot dip galvanized structures.

CAUSE:

Irrespective of the type of zinc coating, the service life of the steel component is proportional to the thickness of the zinc coating system. Zinc electroplated fasteners generally have insufficient coating thickness and are

Zinc electroplating coating thickness 26μm.

Zinc electroplating coating thickness 10.8μm.

F16 – ZINC ELECTROPLATED continued...

incorrectly used to assemble hot dip galvanized components.

EFFECT / REMEDY:

Specify hot dip galvanized fasteners to SANS 121:2011 (ISO 1461:2009) or ISO 10684:2004 for grade 10,9 high strength bolts. For additional barrier protection overcoat the fastener with an appropriate zinc rich paint, epoxy or other appropriate top coating system.

ACCEPTABLE TO SANS 121:

R or overcoat with appropriate material for durability.

ACCEPTABLE FOR DUPLEX AND ARCHITECTURAL FINISH:

R

Zinc electroplating coating thickness 11.0μm.

Zinc electroplating coating thickness 15.9μm.

Zinc electroplating coating thickness 9.2μm.

Life of a zinc coating is proportional to its thickness, therefore in mild to aggressive atmospheres, zinc electroplated fasteners will always rust prematurely.

The Mini Corrosion Expo

Comment – Overall Senior Manager-On-Site

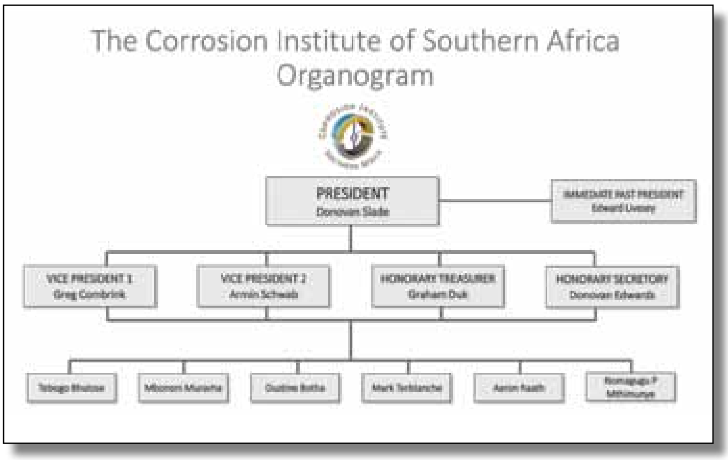
This past year has been a huge challenge, but that is exactly what keeps us pushing ahead. Not many people like change or disrupting the routine of "how things used to be done", although it is necessary for this organisation to grow, progress and succeed.

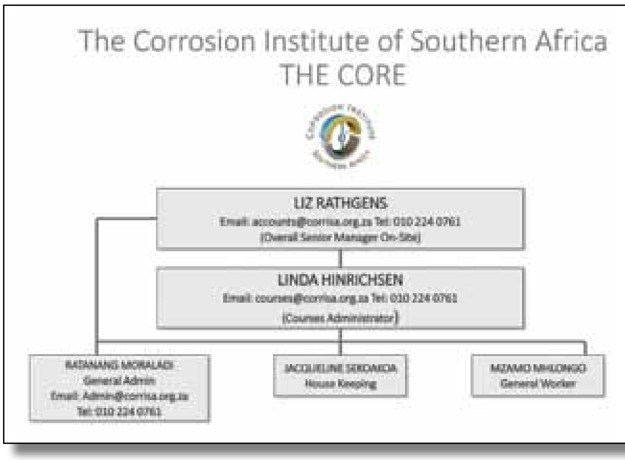
Suffice it to say, that running the Core on only three administrative staff members since 20 July was and still is not an easy task. I am grateful for the extra efforts made by Linda who added Health and Safety to her portfolio and Ratanang, who continued with her sub committees and took on memberships, all social media and administrative duties. We thank all our loyal members, council and staff for their continuous support throughout this year.

The technical evenings have continued to remain successful with good turnouts being experienced every month. As we wind down 2017, we look forward to some well-deserved R & R and to regroup in order to take CorrISA to new heights in 2018. The Core offices will shut down for the December period on 15 December and will re-open on 8 January 2018.

We wish all our members a blessed Christmas and a healthy and prosperous New Year.

Liz Rathgens





Comment – Chairman of KwaZulu Natal

I've always found the 3rd quarter of a business year to be one that seems to never end but also one that is almost lost within the year – it's far from the start of the year so everyone is tired and it's far to go to the end of the year when everyone gets excited for a Christmas break. Thankfully we made it through another "tough" 3rd quarter and by the time this copy of the magazine is out we're all be thinking (almost) only of the Christmas break.

I guess the past two technical presentations can be summed-up as the Ivor Blumenthal show….

For those of you who missed the two presentations, the first on the role and prospects of a Professional Body *(right)* for the Corrosion Industry and the second on how BBBEE status affects the industry – I believe you missed good opportunities. Both aspects will, and have, a significant impact on our business lives – whether we like it or not. *Change*, often when it is legislated, can be daunting but with careful planning and astute management *change* can work to one's advantage.

From Karyn and I, we wish you a blessed Christmas. Please stay safe and enjoy the break.

See you in 2018….

Regards, Mark Terblanche and Karyn Albrecht.

Comment – Chairman of the Western Cape

Its been another very good and successful year for the Corrosion Institute Western Cape. Since the last edition of Corrosion Exclusively we have had two successful events with the Mini Expo in September at Rand Air and the Health & Safety talk which took place at Emplast. The rest of the year has already been reported on but in summary, all the presentations were well received and well attended.

This was the first Mini Corrosion Expo that we have held and we were extremely pleased with the interest that was shown with 22 exhibitors showing what they have to offer and a lots of interest and visitors from the industry. John Houston deserves a special mention for all the time and effort he put into making this the first Mini Corrosion Expo such a success. I would like to congratulate all the finalists in the award for the best stand. They are Bidvest TMS, Blastrite, Corrocoat, Dry Force, Stoncor & Toprope. The winner will be announced at the Annual Gala Dinner at Kelvin Grove and they will be the first recipient of the Mini Expo best stand award.

In October we held a very pertinent and inciteful presentation by Armand Hoffmann from Coetzee Safety Consultants on health and safety in the work place and the responsibility of the employer as well as the employee in ensuring that no incidents take place.

In November we look forward to another successful and fun Annual Gala Dinner. With the world renowned comedian Barry Hilton as our entertainment it will be a not to be missed event. There are still one or two sponsorship opportunities available as well as space for an extra table or two. If you would like to come on your own you would be most welcome as well. Book your spot now by getting hold of Tammy Barendilla!

We also held a very enlightening BBBEE workshop in October which was very insightful about ways and methods of achieving high ratings with the new scorecard. On 21 November, we will hold a Special General Meeting. The SGM is to discuss the proposed Professional Body for Corrosion Practioners. Dr. Ivor Blumenthal (who also presented the BBBEE workshop) will present and subsequently a secret vote by CorrISA members will take place. Please make sure to attend this very important event which will determine the future direction of the Corrosion Institute.

I would like to extend a big thanks to Kelvin Grove, who have been excellent in assisting us in hosting our very well attended functions and making each occasion a special one for our members and guests.

The success of the year is in large part due to the commitment of our very competent and efficient committee, so a big thanks to the ladies and gentleman featuring below. We would also like to extend our thanks to the ladies at the Core in Joburg who support us on the admin side of things and make our lives here in the Western Cape that much easier.

Hopefully see you at Kelvin Grove for one of our functions soon! If you have not attended before, please feel free to join and if you have, bring a friend to the next gathering.

Yours in Corrosion

Graham Duk, on behalf of Tammy Barendilla, Leonie du Rand, Thinus Grobbelaar, John Houston, Sieg le Cock, Indrin Naidoo, Terry Smith, Gilbert Theron, Flippie van Dyk, Pieter van Riet

Gauteng council meeting

CorrISA signs Africa agreement with NACE officials

Above left: The CorriSA executive met with NACE International's Director of Global Operations, Tommy Tam and NACE International's Head of West Asia & Africa area office, Dr Gasem Fallatah on Saturday 14th October 2017 at The Balalaika Hotel, Sandton. Mr Donovan Slade, President of CorriSA signed the Joint Venture agreement regarding the marketing of the Africorr Conference to be held next year in Johannesburg, South Africa. NACE have agreed to assist with the marketing of this event throughout Africa and abroad. We are confident that Africorr will be an even larger event with the addition of the ever so popular mini expo. The theme of Africorr 2018 will be corrosion in mining and industrial sectors which is a prevalent topic in the African context.

Above Centre: NACE International's Director of Global Operations, Tommy Tam seen shaking hands with Mr Donovan Slade, President of CorriSA.

Above Right: NACE International's Head of West Asia & Africa, Dr Gasem Fallatah shaking hands with Vice President of CorriSA, Mr Armin Schwab.

The second contract signed was The Global Partnership NDA between NACE and CorriSA agreeing to work together to fight corrosion. CorriSA is only the third such organisation to potentially sign such an agreement.

Johannesburg Awards Breakfast

Above left: Student award certificate being handed out by Vanessa Sealy Fischer and Kevin Richardson to Heiko Hanson who was not able to attend the function – Vanessa received it on his behalf.

Above centre: Kevin Richardson handing out "Thank you" vouchers on behalf of CorrISA, to Jeanette Roos (The President – Don Slade's company PA), Ratanang Moraladi and Linda Hinrichsen of CorrISA for arranging the Awards Breakfast.

Above right: Mr Braam Bosman receiving HLM award.

CorrISA Gauteng 2017 AGM

CorrISA 2017 Annual Charity Golf Day

spotlight

INTERVIEW WITH DENIS PEART OF AURECON

WHY CONSULTING ENGINEERS SHOULD ATTEND CORRISA TECHNICAL EVENINGS

Denis, what is your background?

I worked for the City of Cape Town for 26 years, with the first 10 years linked to their Mechanical Engineers Workshop in Ndabeni and thereafter I started working for the Bulk Water department, including Pump Stations and Water Treatment Works. Owing to the resignation of one of the senior players, I started getting involved in Waste Water Treatment Plants until 2007 when I was involved with most of the current water treatment plants in Cape Town. The experience I gleaned during these years is directly related to my contribution currently at Aurecon who I joined in 2007. There are at least 60 people on this floor of the building who are involved in water projects.

Give us a background summary of the different engineering divisions within Aurecon

We cover everything from Waste Water Treatment, Sewage, etc. In addition we have Civil (including Roads and Building Services, which in turn includes fire, ventilation, air conditioning, lighting, plug points, etc.), Structural, Mechanical and Electrical Engineering divisions who can handle most engineering requirements. Currently there are about 2000 Engineers and Scientists within Aurecon in South Africa. The bulk of our work is local but we also have projects in Africa, eg. Angola, Tanzania and Mozambique.

You obviously receive email invitations from CorrISA regarding their Technical evenings, what makes you tend to want to attend them?

If the topic is related to something that we are likely to come across in our dealings with new or existing projects. These may include projects that include corrosion of piping, structures and infrastructure. For example we really enjoyed listening to Graeme Stead when he spoke on his practical experiences in corrosion and corrosion protection, in March this year.

Why do you encourage others within your department to attend?

For the same reasons and to build up knowledge of many of the young engineers and technical staff in Aurecon.

One of the values encouraged by CorrISA members is the networking after the evening presentation, do you feel there is merit in this and why?

While networking for the sake of networking is important, what I value is being able to discuss corrosion challenges with a select variety of people from all spheres of corrosion and corrosion control related backgrounds. The other benefit I see is being able to subsequently contact a person who I have met at a technical evening relative to a corrosion or corrosion control related situation that we have subsequently faced on a project.

In your opinion do you think other engineering disciplines within Aurecon would benefit from attending the evenings and do you have any suggestions in approaching these people?

Having such a large organisation with many disciplines, while our department through myself receives the magazine, I am not sure if any others do receive it. Corrosion Exclusively, in my opinion is a fantastic publication in that serves a dual role serving the social aspects and corrosion control right through to the technical issues of corrosion.

Would you say the same applies to other Consulting Engineering practices?

Absolutely, I would say currently, by Aurecon staff attending these evenings we have a distinct advantage over other consulting engineering practices in understanding the requirements of appropriate corrosion control and who to contact when it is necessary.

During the time that you have attended the technical evenings, are there any specific incidences where what you gained from the presentation or subsequent networking at one or other technical evenings, you were able to successfully implement increasing the value provided to your client on the project you were working on?

Yes, I have learnt over the years that if one hears something once, it doesn't mean that you will successfully apply it but if it is repeated with practical implications, it becomes valuable. The concept of sweep blasting I always thought I understood, knowing the requirements of reduced blast pressure, use of microgrit, etc. until the day when the method of so-called sweep blasting removed an excess of the hot dip galvanized coating we were to subsequently paint. We called yourself and on site discussed the reasons for the zinc layer being partially ripped off the steel substrate, to our mutual benefit. Now we are more aware of the requirements of this valuable method of preparation prior to painting of a hot dip galvanized substrate.

Any other comments of how to encourage other engineering disciplines to attend?

It's a long hard slog to get prospective people to understand the benefit of what I have said to you. This is particularly harder when it comes to more experienced engineers.

Maybe send consulting engineers a motivational invitation to attend the technical evening followed up with the latest copy of CE.

As a further suggestion perhaps more practical demonstrations on the range of corrosion control methodologies.

TECHNICAL EVENTS: Cape Town

TECHNICAL EVENTS: Cape Town

NACE CIP 1 TRAINING COURSE: Johannesburg

NACE CIP 2 TRAINING COURSE: Johannesburg

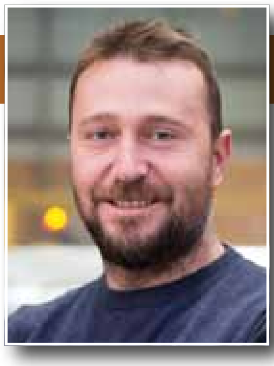
TECHNICAL EVENTS: Gauteng

The planning for our Grill & Chill themed Gala Dinner is almost complete, from top notch entertainment by renowned Comedian, Barry Hilton to a mouth-watering gourmet three course braai-style menu.

Sponsors have been generous, with Defelsko in the USA being our Title Sponsor. The joint Pyro-cote / Blastrite Safely Home sponsor is a first. Guests can book a driver to take them home in their own car, allowing them to indulge in the wonderful wines on offer at Kelvin Grove. We thank BAMR, Simple Active Tactics, Jotun, Kansai Plascon, Progalv, Corrocoat and Dry Force for their sponsorships and welcome any others who would like to sponsor towards the evening.

There are still tables and individual seats available for the Gala Dinner. Join us for an unforgettable evening. Kindly email me at tammy.barendilla@stoncor.com for bookings, sponsorships or general enquiries.

The RUST Spot...



in conversation with Francesco Indiveri

Briefly explain your background and how you came to be involved in Transvaal Galvanisers?

My interest in the family business started at a very young age, going into work with my father on weekends and during school holidays. After matriculating in 2005 I went on to study Financial Accounting and after 2 years I left university as my interest in the family business had far greater importance to me than having a piece of paper to my name. I started working at our manufacturing plant Imab Engineering straight away. Once I had grasped and gained much needed knowledge at Imab, and having experienced galvanizing issues from the customer's perspective, I wanted to really understand galvanizing. Transvaal Galvanisers, being part of our group, was predominantly an in-house galvanizer for our manufacturing plant. I knew it had the potential to expand and assist our group of companies in a much greater way, thus my interest in closing the gap I foresaw in the market.

Briefly what additional services or techniques do you offer that make Transvaal Galvanisers unique to the galvanizing industry?

Transvaal Galvanisers is a one stop shop. We offer the full range of galvanizing services as well as being able to galvanize the smallest to the largest items. We also offer shot blasting and duplex coating facilities. Transvaal Galvanisers' expertise in chemistry allows for the most efficient pre-treatment processes, resulting in a great quality product. This process aids in less materials being rejected, and fewer materials needing to be reworked. We have our own fleet, which allows us to meet transportation needs for dispatch and delivery. We are flexible and our knowledgeable and dedicated compliment of staff does it's very best to accommodate varied requests received from our customers.

How has the current economy, particularly the lack of projects in the mining fraternity in South Africa affected Transvaal Galvanisers and what if anything did you implement at the plant to bolster production?

We have definitely seen a downturn in the mining industry, but we have managed to bolster our production by securing manufacturing and galvanizing contracts for renewable energy projects.

What is your vision for the future of Transvaal Galvanisers?

The vision for Transvaal Galvanisers changes as we grow and diversify. At the moment we are working towards expanding and broadening our footprint in South Africa as well as Africa. We are striving to become the leaders in galvanizing on the African continent.

Would you like to briefly elaborate on the efforts Transvaal Galvanisers has made to comply with the recent environmental regulations that have been imposed on the hot dip galvanizing industry?

All our galvanizing lines are fully equipped with fume enclosures and extractors. Our aim is not only to extract harmful fumes, but to capture these harmful bi-products, neutralize them and correctly dispose of any harmful waste. We have a highly trained and skilled group of people dedicated to ensuring environmental compliance and we are in the process of getting our OHSAS 14000. We have an extensive environmental management plan incorporated into our Business Management System which encompasses all environmental related activities and environmental legislation. We constantly modify our processes to ensure their efficiency, while at the same time, minimizing our carbon footprint.

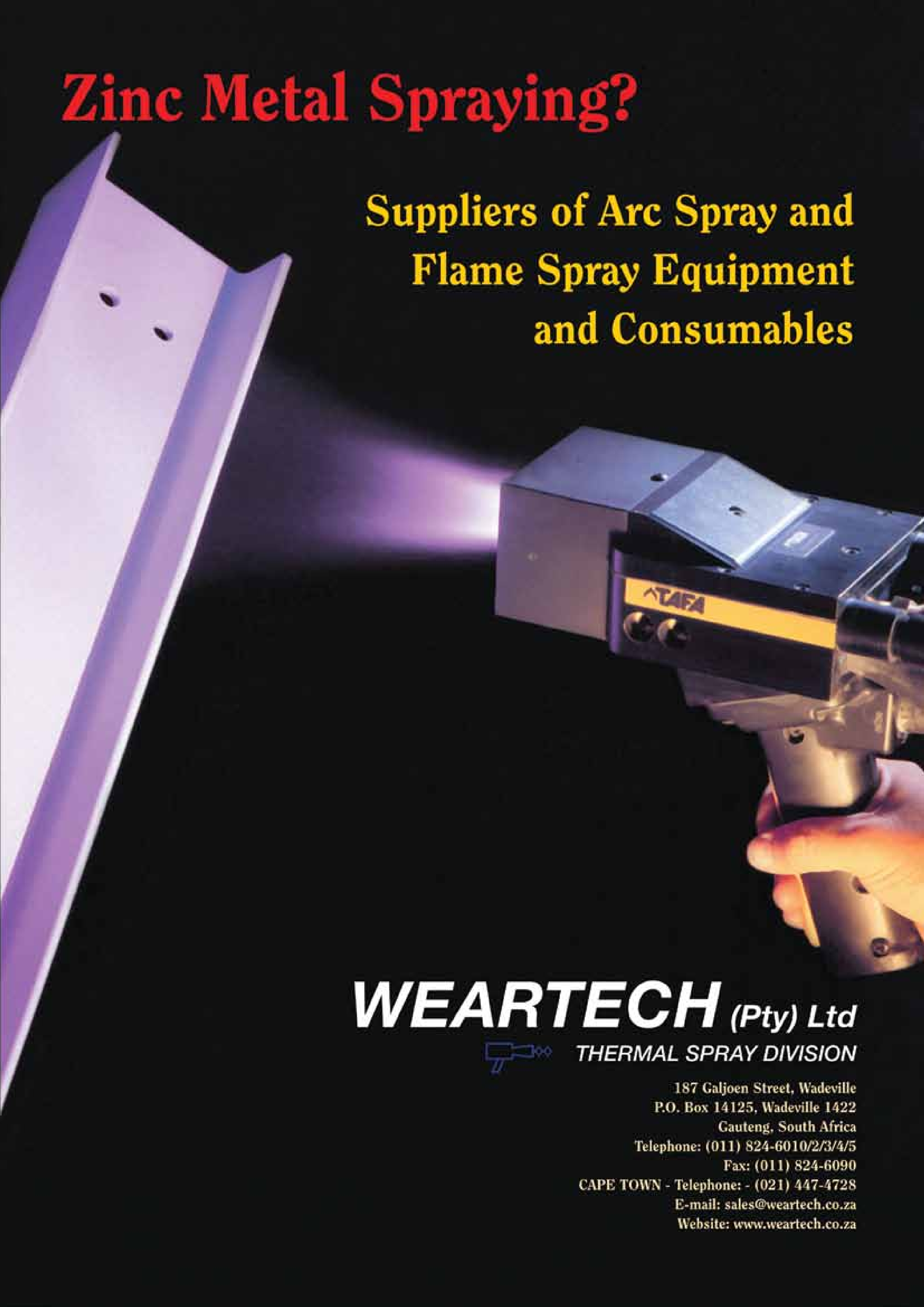
For what purpose and when did you join CorrISA?

To promote the importance of corrosion protection in infrastructure development in all sectors.

What advice do you have for the corrosion industry going forward?

Perhaps putting together a Galvanizing Training program that is recognized by the relevant seta to improve the knowledge and upskill people in the industry, Employees and end user/ customer alike. Implementing courses for people wanting to be employed in the galvanizing industry as this does not exist and galvanizers purely do on the job training and tend to employ unskilled people who take a long time understanding the processes etc.

THE INSTITUTE WOULD LIKE TO ACKNOWLEDGE THE ADVERTISERS AND THANK THEM FOR THEIR SUPPORT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