

# Corrosion

## Exclusively



### INSIDE:

- Corrosion management of lattice structures
- Microbial induced corrosion
- Building the Icelandic geothermal power plant
- Proactive asset management of concrete infrastructure
- Creating a professional body for the corrosion sector





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## President's Comment

In this, my last Presidents message, I want to address one of the most exciting projects which the Corrosion Institute has embarked on during my term of office as your President. The project which will be handed over to Donovan Slade, our new incoming President to continue with and to see through to implementation.

This is the project intended to Professionalise our sector of Corrosion in South Africa and to finally provide our members with the opportunity to be recognised as competent and accountable Professionals. We intend to achieve this by offering Designations

or categories of Professional classifications to practitioners in all Industries within the Sector of Corrosion, from entry level "Professional Technicians", to the mainstay of our membership who practice as "Professional Operators" and culminating in the recognition of the most experienced, qualified and accountable practitioners as "Professional Practitioners". We also intend to confer higher-level professional status on Master Practitioners who will be recognised not only for the length of their service and expertise to the sector but also for the variety of applications which they have mastered in the process.

What excites me the most with this project is the notion that in professionally designating deserving recipients, the system which we are designing and implementing will be one which recognises a variety of routes to true competency. While the one will be those applicants who possess traditional professional qualifications and registration with ECSA as an Engineer / Technologist and who can evidence considerable and appropriate experience in the daily practice of Corrosion applications, the other route will be for those who have qualified through NACE over time, and at the highest levels. Those people who are certified and have been quality assured by NACE and hence who present to the "Professional Body for Corrosion" (our South African vehicle for the management of such professional recognition), the certainty of both their proven Competency and Ethical accountability in the process. As a third option, we will be creating the route of Recognition of Prior Learning (RPL). This is the mechanism whereby an applicant may have been in the sector for many years, applying Corrosion practices on a daily basis, yet not have a qualification obtained either locally or Internationally. This is after all true transformation. This is the opportunity for those individuals who may not have had the funds or the access to formal training or qualifications, to be recognised, acknowledged and respected for their expertise developed on the job, for their true contribution to our sector.

These "Professional Designations" are intended to be developed from within our sector, by individual and corporate stakeholders, in our sector and for our sector, not only for recognition and use in South Africa but also on a continental basis in Africa, and which are intended to correspond to Certifications available through our International Partner NACE, on a global level.

A balancing component of this project intended to professionalise the sector of corrosion in South Africa, is our intention as CorrISA to introduce a Grading System amongst our Corporate Members. This system is designed to reflect the compliance criteria related to BBBEE, particularly those of Skills Development, Enterprise Development and Social Development. In so doing, Corporate Members of CorrISA will be recognised as "Excellent" where they evidence, with respect to the Professional Body for Corrosion, an ongoing and sustainable commitment to the development and professional recognition of their employee's, their managers and their sales and consulting agents.

This basket of initiatives will hopefully be the way that CorrISA is able to loudly proclaim to South Africans and the Global Community of Corrosion that as a Sectoral Authority, we, CorrISA, remain accountable for the quality of our members as Professional Practitioners, and as Corporates, by conferring Designations on those individuals and for holding them accountable for their competence and ethical behaviour, as well as their commitment and participation, in Lifelong Learning of best practices and of ever-changing norms in the marketplace, and in the process by recognizing the commitment of our Corporate Members to do likewise.

Edward Livesey, President

### 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."



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Cover: A collage of corroding components, including a street sign in Gauteng.

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## Editorial Comment

Having run the Comrades Marathon starting in the early seventies and now only casually running the extensive trail paths we are fortunate to have in Cape Town or at best the occasional half marathon, both my wife and I these days find enough entertainment on Comrades day by watching the race on TV. This year it was especially great to see South Africans dominating the first 10 gold medal winners in both the men's and woman's categories.



This year's event co-incided with a relevant political tweet of the day associated with the current events in our country which I thought was entertaining and wish to share with you – "The Comrades Marathon is officially the only thing in South Africa the Guptas don't run."

Seriously though, we are proud to present our seventh edition of Corrosion Exclusively and wish to thank all the contributors and advertisers, the latter of which in spite of the current economic environment are quite amazingly with thanks, still standing behind the publication.

While we encourage local participation, we accept from an interest perspective that contributions from experienced overseas corrosion related organisations and individuals, are necessary and will in time add value to a reader's experience simultaneously enhancing the publication's credibility.

The following articles have been selected for inclusion in this seventh edition:

- The third part of "Corrosion management of elevated lattice galvanized structures" by Mark Dromgool of KTA Tator in Australia. The shortened version of the article originally appeared in the Journal of Protective Coatings and Linings (JPCL).
- *Did you know that bugs can eat your equipment?* by Simon Norton of Chemical Investigation Services.
- *Thermal metal spraying – new technologies*, by Adam Wintle of Weartech.
- *What is Geothermal Energy?*
- *Building the Icelandic geothermal power plant – material of choice*, contributed by NACE.
- *Proactive asset management of concrete infrastructure*, by ACA.
- *Innovative painting of the ABSA Towers – Pretoria*, by Kaare Mason of Custom Linings SA and Donovan Slade of NUI.
- *21st Century water supply solution using hot dip galvanized pipes*, by the Hot Dip Galvanizers Association of Southern Africa.
- *How long has hot dip galvanized steel been used in concrete*, by Stephen Yeomans, Professor at Canberra University, NSW, Australia.
- *From the KETTLE*, a regular contribution.
- *Creating a professional body for the corrosion sector*, by Dr Ivor Blumenthal.

Lynette van Zyl the Manager at the Coré as well as Graham Duk and Mark Terblanche the Western Cape and KZN Chairmen respectively give account of their activities.

Other activities of the Institute include feedback on a number of NACE and BAMR Elcometer presentation / training evenings, plus a number of interesting technical evenings held both in Johannesburg and Cape Town.

Simon Norton of Chemical Investigation Services, gives us an account of his professional life in corrosion in "The RUST Spot".

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 advise me?

Terry Smith

# Corrosion management of elevated lattice galvanized structures (Part 3)

By Mark B Dromgool,  
MD of KTA Tator Australia Pty Ltd

Republished in Corrosion Exclusively from the Journal of Protective Coatings & Linings (JPCL) with the permission of Technology Publishing Company, 2016.

## Treating new sections or assemblies

If new steelwork members or assemblies are to be fitted to a structure on a like-for-like basis it makes good sense to maximise their potential durability. The default procedure would be to fabricate and hot dip galvanize these in the same manner as they were made originally. However, there are some initiatives that can be adopted that can significantly increase the life expectation of these members.

Our advice is to adopt the following steps for all new steel items:

- After fabrication countersink all drilled or punched holes (just to break the edge), remove all weld spatter, deburr all guillotined or cut edges and corners to provide a radius of around 2mm minimum. Achieving a P2 grade of surface finishing as per ISO 8501.3 is a good achievement.
- Abrasive blast to at least Sa 2½ (AS 1627.4) or SSPC-SP 10 to produce a sharp angular surface profile.
- Hot dip galvanize to a locally-recognised standard, e.g., AS 4680 ; preferably quench in fresh water, i.e., with no chromic acid or similar white rust suppressing agents in the quench water, or air cool.
- Lightly whip abrasive blast the galvanized steel using a non-metallic abrasive to produce a fine angular surface profile.
- Apply a high performance tower paint

vinyl coating system to minimum DFT of around 180 microns.

Suitably preparing the steel after fabrication as described can make quite a difference to durability of a duplex (galvanizing plus paint) system. Whilst forming a radius on edges and countersinking holes is not technically required for hot dip galvanizing per se, if an organic paint system is to follow the galvanizing, then these preparatory steps will avoid the thinning of paint build on sharp edges and corners, which is where the breakdown ultimately will commence.

The second step – that of abrasive blasting prior to galvanizing – is equally important. This is the simplest method of increasing the collective coating thickness, and thus the life span, of hot dip galvanizing. By increasing the effective surface area of the steel versus the planar area, the reactivity of the steel substrate with the molten zinc can be enhanced, which allows the formation of greater coating thickness of the zinc-iron alloy layers, specifically the delta and zeta layers, during the standard hot dip operation. We have conducted tests showing that blasting the steel to a near white condition results in galvanizing coating thickness of around 200 – 230 microns versus about 120 – 140 microns for unblasted steel galvanized on the same dipping jig at the same time. An increase in galvanizing coating thickness equates to a longer life potential, not always in a lineal manner, but significantly so.

After galvanizing the steel is again abrasive blasted, this time at a reduced blasting pressure and using a sharp angular non-metallic abrasive (to avoid embedment and the chance of bi-metallic corrosion) so as to roughen the outer surface for paint adhesion. The aim is not to remove any zinc thickness, but simply to profile the eta layer. An angular profile with an amplitude of around 25 microns is more than adequate, but as always, it is the shape of the profile that counts more than the height.

Our preference for a long life, low maintenance, high durability coating system for over whip blasted galvanizing is based on solvent-based solution vinyl. Whilst vinyls are decades-old products, their performance, reliability and durability is legendary. Tower paint vinyls were mostly developed for field application to erected structures but they are equally useable as shop-applied materials. Well formulated vinyls have a MVT (moisture vapour transmission) rate way below almost every other protective

coating available, which means a much lower film build is required to provide a very low rate of permeability of oxygen and moisture through to the reactive substrate (being the outer surface of the galvanizing, not the carbon steel beneath). Typically, three coats to a collective film build of about 180 microns is adequate. Being single pack and with a drying mechanism that is purely by solvent evaporation means maximum recoat windows are measured in decades not hours. Whilst multicoat epoxy layers with a polyurethane topcoat have been used on towers as well, the best long term performance in our experience has been delivered by vinyl products. Epoxies tend to ultimately crack along the section edges of angle steel members as they age and embrittle, which does not tend to occur with vinyls with their lower film build, better long term flexibility and their higher tensile strength. Modern tower paint vinyls have volume solids around 50% and often have some MIO pigment incorporated which aids slip resistance when painters are working aloft but also likely further lowers permeability. The vinyl primer usually needs to be formulated differently from the subsequent coating layers so it will tolerate the zinc and bare steel substrate; some acid modification is one way of ensuring high levels of adhesion and compatibility.

Performing this blast/ galvanize /blast/paint treatment to all replacement steel is a sound way of ensuring that a life for new steel members is well beyond what would have been delivered if the same treatment was employed as was used when the towers were originally built. Performing the correct site touch-up of the shop-applied paint system after erection will be a vital step in ensuring compromises due to shipping, handling and erection damage do not occur.

### Treatment for site-painted steelwork

The procedures and practices that have been developed over a number of decades to field-paint aged towers are well proven. These apply whether entire structures are to be cleaned and painted, or just selected pieces and items. Whilst high pressure fresh water jetwashing was once the preferred treatment method, with some added mineral abrasive to aid the removal of corrosion, staining and zinc corrosion products, many contractors now employ wet abrasive blasting. This treatment has the flexibility to dilute or remove soluble materials and other corrosives with the flexibility of adding abrasive to enhance physical removal of all types of corrosion products and to profile the

surface for paint application and adhesion. Catching the members that are to be field prepared and painted in situ before the onset of steel corrosion can significantly reduce the intensity of surface preparation, and thus the cost and assist with the logistics.

Usually, if the structure has a previous coating system or if it is in an urban area or proximate to sensitive receptors, erecting a



*This is a medium strain tower after just over 50 years of exposure. Note the commencement of ginging on the main legs members just above the lower limit of the ladder and around the waist near the lower cross arms. Legs, other primary members and sections in compression should be protected from any advanced corrosion or section loss. It is best to clean, prepare and coat these with a high performance coating system before they lose most of the galvanizing protection.*



*These bolts are more corroded but are actually also still functional, as is the angle brace. Within the next three to four years it would be opportune to replace both the member affected by corrosion and the accompanying bolts.*



*For a galvanized lattice tower located in an urban environment after about 50 years of exposure, this condition would be considered quite typical. However, all members and bolts are still functional, even with some ginging commencing. If the next action is to prepare and paint, then work should be planned to occur relatively soon; however, if replacement like-for-like is adopted, some further life is readily achievable.*



*These are good examples of corroding bolts. However, these are nowhere near in need of replacement as their functionality is not yet in doubt. These have been painted in the past but it is not recommended that any effort should be expended on cleaning and painting these as it would be a poor reward for the effort expended.*

containment system around the members to be prepared and coated will be required. Many of the older red and white civil aviation obstruction marking paints were lead- or chromium-based or had these pigments as colourants. The cost, poor productivity and logistics of erecting containments around elevated structures is one reason why minimising the amount of field surface preparation by replacing those members that can be extracted should be maximised.

Those asset owners who have been maintaining aged elevated structures by field painting for many years have mostly gravitated to user-friendly high performance paint systems that have demonstrated their capability on a long list of structures in many exposure conditions over decades. The best of these, in our experience, has been the solution vinyls, for reasons that have been outlined earlier. Single pack coating materials are preferred by many field painting contractors, especially for the intermediate and topcoats. The most popular and with the longest and best history are the tower paint vinyls and some

of the moisture-cured polyurethanes. Both single pack and catalysed zinc-rich coatings are used as primers; our experience clearly favours epoxy zinc-rich.

We do not endorse the use of single pack zinc-rich organics as multi-coat, single product systems. Several vendors of single pack cold galv-type coatings have tried to convince asset owners that multiple layers of a zinc-rich is the way to rejuvenate aged and weathered galvanizing and/or zones of bare steel after surface preparation. There has been some inventions of science promulgated about how the galvanic capability of an organic zinc-rich product can protect these substrates for any length of time. Some facility owners have since learned that these (often expensive) systems do not give the service life promoted. A good zinc-rich is certainly the best primer that can be applied to aged atmospherically-exposed steel after an appropriate surface preparation, but the best durability and performance comes from then overcoating the zinc-rich with a low permeability, well adhered polymeric topcoat system. In our

lengthy experience, a good zinc-rich epoxy over the correctly prepared galvanizing or areas of spot bare steel followed by solution vinyl topcoats trumps all other contending systems for cost, logistics, performance, durability, recoatability and risk management.

When the nominated tower members items are being site cleaned, prepared and painted, the question arises of where to terminate the treatment on affixed members. Ideally, splitting all connections would minimise unsealed joints, e.g., diagonal braces bolt-fixed to leg members potentially allowing all surfaces on the nominated items to be treated. This is not really practical. Our experience is that a very good result can still be obtained without opening up these connections and running the repaint treatment for a distance of about 150 – 200mm out from the boundary of the nominated member along the affixed item. Careful attention to painting around the joint is needed, which may involve some selected spot gap filing with a compatible and paintable sealant. Moisture-cured

  
**NOTICE TO ALL MEMBERS**  
**43<sup>rd</sup> CorriSA Annual General Meeting**  
**Gauteng Region**  
 You are invited to attend the 43<sup>rd</sup> Annual General Meeting of  
 The Corrosion Institute Southern Africa to be held at "the CORE",  
 38 Allan Road, Glen Austin, Midrand on 14 September 2017 @ 18:00  
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You are cordially invited to  
**The Corrosion Institute Western Cape Region**  
**Annual General Meeting**  

 The Annual General Meeting of  
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polyurethane sealants have been found to be about the best in this situation, although a full paint treatment into and around the joint must be applied before sealant is introduced (because there is no corrosion protection in sealants) and then the cured sealant should be stripe-coated over with topcoat.

### Looking after the new-born

We also have clients and owners who build new lattice towers and similar structures. For example, Australia's largest telco owns or looks after some 27 000 elevated structures including towers, masts poles and others. Some of the new-build structures are where services are being extended; others are where the existing structure has become unserviceable due to corrosion, fatigue or damage due to location, environment or extreme weather events. On one of the islands in the Torres Strait, (between Australia and Papua New Guinea) a hot dip galvanized mast that was erected new about twelve years ago had suffered severe section loss due to corrosion in the severe tropical marine environment and a cyclone to an extent that it required replacement. Replacing the structure was the only feasible action, however, with such a short life span from galvanizing in this environment, a better solution for the severe corrosion was deemed worthwhile of some dedicated design effort and attention.

The solution adopted was to design a structure that potentially would allow each and every member to be extracted and replaced – including the main mast leg and primary compression members – if and when required. This required changing the method of fixings at member-to-member connections so that an engineered splint strongback could be affixed to a main leg member, even whilst the tensile loads from guys are maintained, so that a safe extraction and reinstallation can be conducted. As well as these and related steps, the durability potential of the hot dip galvanized steel was enhanced. This involved almost exactly the same steps as are detailed above for the replacement members on old structures: careful metal finishing after fabrication; abrasive blasting; hot dip galvanizing; whip blasting; and a high performance three-coat tower paint vinyl system.

Interestingly, the design team insisted that, if a high performance coating system was to be applied to the piece-small sections a way would have to be found to ensure full electrical continuity, i.e., minimal electrical resistance must exist across every member-

to-member bolted joint. The solution adopted was to use circular self-adhesive stickers that were applied to every fixing hole in every member right across the structure. The diameter of the stickers was slightly larger than the OD of the flat washer to be used with the galvanized tower bolt so that both the bolt head and the nut/washer would be in full electrical contact across the joint after torquing. Stickers were applied after whip blasting and prior to priming with the tower paint vinyl primer. Very careful attention was paid to proper packing and stacking of painted steel sections to minimise or avoid damage in transit, shipping, handling and erection. The extra effort in designing, planning and execution of this project is confident of achieving a life span of between 200 and 250% of the original structure.

Other initiatives being explored for highly corrosive sites are to look way more carefully at tower/mast design to use steel sections that are much more amenable to corrosion protection and durability, have fewer pockets and unsealed joints, include engineered connections allowing easier member extraction/replacement and so on. Adopting tubular or solid round bar sections for the main tower legs will avoid the multiple sharp edges associated with angle members; creating bespoke knuckle joints that connect in-line and multiple angled connectors will

ease extraction and minimise clamped, ponding and unsealed joints. There is even a suggestion to make towers or masts with six legs (thus as a hexagon in cross section) as opposed to three or four legs on the basis that individual leg and other members could be more easily extracted; the cross bracing of a hexagon would be more effective; lighter individual sections could be used due to load sharing; and torsional resistance of the structure with eccentric antenna loads in high winds would be much improved.

Collectively, these initiatives could make future elevated structures way more durable and much longer lasting, as well as easing maintenance practices in the decades ahead.

- <sup>i</sup> ISO 8501.3, *Preparation Grades of Welds, Edges and Other Areas with Surface Imperfections*; International Organization for Standardization; 2006.
- <sup>ii</sup> AS 1627.4, *Abrasive blast cleaning of steel*; Standards Australia; Melbourne, 2005.
- <sup>iii</sup> SSPC-SP 10, *Near-White Metal Blast Cleaning*; SSPC; Pittsburgh, PA; 2007.
- <sup>iv</sup> AS 4680, *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*; Standards Australia; Melbourne, 2006.

We wish to thank Mark Dromgool for Part 3 of this interesting article.

### Mark B. Dromgool, Managing Director, KTA Tator Australia Pty Ltd

Mark Dromgool is the managing director of KTA Tator Australia Pty Ltd, based in Melbourne. He has been continuously active in the protective coatings industry for 39 years. Mr Dromgool's experience includes about ten years as a coating application contractor and about seven working for two of the largest protective coating suppliers in Australia and New Zealand. In 1994, he formed KTA Tator Australia as a protective coating engineering, inspection and consulting company.



Mr Dromgool is a long-standing member of SSPC and NACE, and is former president of the Blast Cleaning and Coating Association (BCCA) of NSW. He has written and published many papers on coatings and linings and has lectured widely at local and international conferences. In 1996 and again in 2007, Mr Dromgool was the recipient of the JPCL Editor's Award for papers entitled "*Maximizing the Life of Tank Linings*" and "*Epoxy Linings – Solvent-Free But Not Problem-Free*", respectively. In 2006, Mark Dromgool was awarded the John Hartley Award for Excellence by the BCCA of NSW.

Mr Dromgool has qualifications as a mechanical engineer; is an ACA Certified Coatings Inspector; a NACE-accredited Protective Coating Specialist; an SSPC-accredited Protective Coating Specialist and a NACE-Certified Coatings Inspector – Level 3.

# Did you know that bugs can eat your equipment?

## The basics of microbiologically induced corrosion

By Simon Norton

### Background

While the field of microbiologically induced corrosion (MIC) is quite new and only came into focus in the 1990's the discovery that microbes could be assisting in the corrosion of steels goes some way back to 1910 when an engineer called Gaines hypothesized that bacteria may have caused sulphur enrichment of corrosion product he had analysed. But it was in 1934 that von Wolzogen Kuhr and van der Vlugt discovered that sulphate reducing bacterial (SRB) were the prime cause of iron pipe failures in the sulphate rich soils of northern Holland. The research work that they did resulted in a hypothesis on the mechanism of MIC, that for nearly 40 years lead various researchers down the wrong road. Only in 1974 did Costello convincingly demonstrate a new mechanism for sulphate reducing bacteria and their role in assisting corrosion. Until recently the mechanism and way that sulphate reducing bacteria influenced the corrosion of steel was unknown. As recently as 2004 it was thought that bacteria assisted in steel corrosion by an indirect sulphate reduction via iron sulphides, in 2004 a novel corrosion mechanism was discerned that demonstrated that certain bacteria consume iron derived electrons directly and that consequently microorganisms can accept electrons directly from steel, resulting in corrosion.

### How do biofilms play a role?

When a metal structure, whether it is coated or uncoated, is immersed in an aggressive aqueous medium e.g. seawater, simultaneously a biological process starts from the water medium inwards towards the metal surface and a series of inorganic chemical changes take place at the metal surface. There is an interaction between the inorganic corrosion chemical processes occurring at the metal surface and the

biofilm formation. For example, when sulphate reducing bacteria (SRB) induced corrosion of carbon steel starts in seawater, a series of complex interactions takes place. The carbon steel at first forms a film of the mineral mackinawite that changes after several chemical and electrochemical pathways to stable iron sulphides. These iron sulphides then cause an increase in the rate of corrosion at the steel surface. When a biofilm forms it forms a gel which consists of 95% water and a mixture of exopolysaccharide substances and a mix of microbial cells and inorganic debris. So, what is the role of a biofilm in enhancing corrosion at a biologically conditioned metal-solution interface:

- a. The biofilm forms a barrier preventing chemical species in the water from easily being transported to the metal surface. So, a well-formed biofilm may prevent oxygen getting to cathodic sites on the metal and stop chlorides moving to the anodic sites
- b. Biofilms can easily facilitate the removal of protective films from metal alloys such as copper-nickel alloys
- c. A biofilm can induce differential aeration on a metal surface by its patchy spread and thus under a biofilm there may be depletion of oxygen caused by respiring microbes but a plentiful supply where there no biofilm – then corrosion currents commence
- d. The presence of a biofilm can change the oxidation-reduction conditions at the interface between a metal and an aqueous solution – it has been demonstrated that the dissolved oxygen level can decrease to zero just 180 microns from a metal surface. Thus, anaerobic sulphate reducing bacterial can proliferate under a biofilm but not



Figure 1: Damage caused to a material surface by microbiologically influenced corrosion.

- in the bulk solution
- e. Biofilms can alter the structure of inorganic passive films on certain metal alloys and cause their dissolution from the metal surface.

### What are these microbes that support corrosion?

Included in the family of microorganisms that can result in microbiologically induced corrosion (MIC) are algae, fungi and bacteria. Algae are found in most aquatic environments from freshwater to seawater and produce oxygen in the presence of light and consume oxygen in the dark. The presence of oxygen is a major factor in the onset of corrosion in salt water systems. Algae flourish over a wide temperature range and in the pH range of 5.5 – 9.0. Fungi consist of mycelium structures which grow from a single cell or spore, they are immobile and can grow to very large sizes. Fungi are often found in soils and some



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Species	pH	Temperature °C	Oxygen Needs	Metals Affected
Desulphovibrio	4 - 8	10 - 40	Anaerobic	Iron, steel, stainless steel, Al, Zn, Cu alloys
Desulfotomaculum	6 - 8	10 - 40	Anaerobic	Iron, steel, stainless steels
Desulfomonas	-	10 - 40	Anaerobic	Iron & steel
Acidithiobacillus Thio oxidans	0.5 - 8	10 - 40	Aerobic	Iron, steel, Cu alloys, concrete
Acidithiobacillus Ferrioxidans	1 - 7	10 - 40	Aerobic	Iron and steel
Gallionella	7 - 10	21 - 40	Aerobic	Iron, steel, stainless steels
Siderocapsa	-	-	-	Iron and steel
Leptothrix	6.5 - 9	10 - 35	Aerobic	Iron and steel
Sphaerotilus	7 - 10	21 - 40	Aerobic	Iron, steel, stainless steel
Sphaerotilus natans	-	-	-	Al alloys
Pseudomonas	4 - 9	21 - 40	Aerobic	Iron, steel, stainless steels
Pseudomonas Aeruginosa	4 - 8	21 - 40	Aerobic	Al alloys
Cladosporium resinae	3 - 7	10 - 45 Best at 29 - 35	-	Al alloys

Table 1.

species can live in water and they produce organic acids which are corrosive.

Bacteria are classified based on their affinity for oxygen as AEROBIC bacteria while those that do not metabolize oxygen are termed ANAEROBIC bacteria. Some bacterial can operate under both regimes and are termed FACULTATIVE. All these bacteria can co-exist in the same environment and become activated based on the oxygen content of the system. Bacteria can be further classified by their shape as Spherical (bacillus), rods (coccus), comma (vibrio) and filamentous (myces).

Microbes that float freely in the aqueous environment are in the PLANKTONIC state and can resist harsh chemicals, disinfectants



Figure 2: An electron microscope image of Desulphovibrio species, a prime agent for MIC.

and more and can last hundreds of years before germinating under favourable conditions. Microbes in the SESSILE state attach themselves to a surface and develop a protective membrane collectively termed a BIOFILM.

### Which microbes accelerate corrosion?

Once microorganisms form a biofilm on a material surface the micro-environment created under the biofilm is dramatically different to the bulk aqueous environment in which the material sits. There are changes close to the material surface in pH, dissolved oxygen, organic species and inorganic species which lead to electrochemical reactions that can increase the rate of corrosion of the material. Microorganisms metabolic reactions which influence corrosion can involve sulphide production, acid production, ammonia production, metal deposits as well as metal oxidation and reduction.

Table 1 shows some of the microorganisms that are commonly found where Microbiologically Induced Corrosion has taken place.

### Let's talk about some metals that suffer MIC?

Since microbiologically induced corrosion is a process that accelerates corrosion it is to be expected to occur in metals more

susceptible to the various forms of corrosion. Whereas carbon steels exhibit everything from uniform corrosion to environmentally assisted cracking, the remaining metal alloys usually exhibit only localised corrosion such as pitting and crevice corrosion. However, MIC shows itself in most metals which are susceptible to MIC such as carbon steels, copper alloys, stainless steels, aluminium alloys and nickel alloys. In contrast titanium alloys are virtually immune to MIC under ambient conditions.

Carbon steels have been widely documented with MIC problems particularly in piping systems, storage tanks, cooling towers, and structures located in water. Coatings such as hot dip galvanized zinc on steel and various organic coatings have been applied to steels, however biofilms that form on the surface produce acids to digest zinc, while on coated steels the biofilm forms over coating flaws. Biofilms are often known for disbonding organic coatings from steels followed by coating delamination as the electrolyte attacks and corrodes the underlying unprotected steel surface. The use of untreated waste water and poor quality water in piping and tank storage systems can lead to MIC and so can the accumulation of sediment and debris as well as stagnant water.

Stainless steels also suffer MIC but in their case the failure is more rapid than carbon steels in that they corrode through localised corrosion i.e. pitting and crevice corrosion.

With stainless steels the corrosion due to MIC is firstly due to rapid localised corrosion occurring in low lying areas, stagnant water, joints and crevices. Particularly in stainless steel piping and vessels where hydrotesting has taken place using unclean water or groundwater, the MIC attack occurs during the period before the pipe or tank comes into service. The second MIC related corrosion failure with stainless steels occurs adjacent to welds as microorganisms are known to attack the inhomogeneous material located either side of a weld.

Aluminium alloys suffer MIC failures largely in fuel storage tanks and aircraft storage tanks. The main culprits here are Cladosporium resinae a fungus and Pseudomonas Aeruginosa. These can attack fuel tank coatings and then attack the underlying metal surface.

Copper alloys such as 90/10 CuNi and 70/30 CuNi are used in seawater piping systems and heat exchangers and these alloys are susceptible to MIC attack. By-products of the microbe's metabolism such as ammonia, hydrogen sulphide, carbon dioxide, organic acids, inorganic acids and other sulphides are harmful to these copper alloys. It appears that the higher alloyed 70/30 CuNi alloy while showing excellent erosion-corrosion resistance is more susceptible to MIC than the 90/10 CuNi alloy.

**So what can you do to detect and prevent MIC attack in your systems?**

Detection is not easy and thus design and maintenance to prevent MIC damage is vital for important marine systems, power station and industrial systems.

**The following detection methods are used:**

- Sampling and testing water systems for pH, conductivity, temperature and dissolved solids and Total Viable Count – the last should be monitored to see if there is an increasing growth trend
- Bacterial counts to see microorganisms are proliferating
- Visual examination of surfaces using bright light and boroscopes
- Applying fluorescent dyes with a UV lamp deployed to show up the biofilms
- Metal test coupons are also useful for detection and are easily removed for examination
- Electrochemical sensor probes and fluorogenic bioreporters are now being used to detect changes brought about by MIC in systems
- An electrochemical sensor for monitoring biofilms has recently been developed and is a powerful tool to optimise biocide dosing

**Methods to prevent MIC of metal alloys in critical systems include:**

- Try to prevent the growth of biofilms if at all possible
- Once a biofilm forms it becomes resilient to biocides
- Monitoring and detection of microorganisms
- Monitor the presence of water in fuel and lubricant storage tanks and pipes
- Remove water from such systems once a certain level is reached

- Avoid ingress of silt, sediment, organic matter and settling of deposits as these provide firstly a source of food for microorganisms and secondly conditions under sediment which leads to the rapid proliferation of anaerobic bacterial such as SRB
- Introduce an optimal level of biocide to a system and in some cases a biocide containing coating may be very useful
- Design systems to avoid low flow rate zones, dead zones and stagnant areas and minimize crevices and welds
- Try to utilise smooth metal alloy surface with minimal defects
- Research into alternative coatings has demonstrated that polydimethylsiloxane coatings on steel, reduced MIC over an extended period of nearly 2 years

While it may seem a complex and difficult task to prevent and control MIC in your key piping, tank and other equipment, a knowledge of how and where MIC occurs as well as prevention and control methods will

ensure that most of the major problems are prevented. Once biofilms have established themselves they are difficult to get rid of from your systems and biocides might not help. The field of MIC identification, mitigation and control is complex and the technology for testing and assessment is complicated. Engineering managers and consulting engineers are strongly advised to seek advice and testing/mitigation guidance from an MIC subject specialist.

*Simon Norton is a graduate industrial chemist and expert in corrosion investigation and control and specialises in the assessment of microbiologically induced corrosion in fuel systems, water systems, cooling towers and diverse industrial applications.*

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*We wish to thank Simon Norton for this contribution.*

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# Testing materials for corrosion in an Icelandic geothermal environment

By Kathy Riggs Larsen, MP Editor, NACE International

Geothermal power stations, which use heat energy from the Earth's core, are similar to other power stations that use heat from a fuel source to create steam that turns turbines to generate electricity. Because these power plants use steam from a renewable energy source – hot water located below the Earth's surface – they are considered to be environmentally friendly.

In Iceland, geothermal power is the country's single largest source of energy.<sup>1</sup> Geothermal steam, however, contains noncondensable gases (gases that are not easily condensed by cooling), such as carbon dioxide (CO<sub>2</sub>), hydrogen sulfide (H<sub>2</sub>S), hydrogen (H<sub>2</sub>), nitrogen (N<sub>2</sub>), methane (CH<sub>4</sub>),

and argon (Ar), that are considered to be either greenhouse, corrosive, or toxic gases. A recent Icelandic regulation with a stricter guideline on atmospheric concentration of H<sub>2</sub>S, which took effect in 2014, has compelled the country's geothermal industry to take actions that will reduce H<sub>2</sub>S emissions into the air.<sup>2</sup>

Through a collaboration of universities and Icelandic power companies, an injection abatement project, CarbFix-SulFix, is being implemented at the Hellisheiði geothermal power plant operated by ON Power (Reykjavik, Iceland), a subsidiary of Reykjavik Energy. The Hellisheiði geothermal plant is one of the largest geothermal power plants

in the world with a production capacity of 303MW of electricity and 133MW of thermal energy. It is located in one of Iceland's biggest geothermal zones, the Hengill area, which is linked to three volcanic systems.<sup>1</sup>

The project captures CO<sub>2</sub> and H<sub>2</sub>S emissions from the Hellisheiði power plant in a gas abatement plant that separates them from the noncondensable gas stream using a simple scrubbing process, and then reinjects them in water into reactive basaltic rock at a depth of around 800 m or greater. If these gases were not captured and reinjected, the Hellisheiði power plant would emit ~40,000 tons of CO<sub>2</sub> and ~12,000 tons of H<sub>2</sub>S.<sup>3</sup>

Steam ejector vacuum systems are used to extract the noncondensable gases from the geothermal turbine's exhaust steam. The noncondensable gas stream is sent to the gas abatement plant, which includes a gas separation station that isolates the H<sub>2</sub>S and CO<sub>2</sub> from the other noncondensable gases such as H<sub>2</sub>, N<sub>2</sub> and CH<sub>4</sub>. The H<sub>2</sub>S and CO<sub>2</sub> are separated by dissolving them in condensed water, says NACE International member Sigrún Nanna Karlsdóttir, associate professor in the Industrial Engineering, Mechanical Engineering, and Computer Science Department at the University of Iceland (Reykjavik, Iceland).

The process pumps the compressed noncondensable geothermal gases (CO<sub>2</sub>, H<sub>2</sub>S, H<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, and Ar), which are contaminated with a small concentration of oxygen gas (O<sub>2</sub>), into the bottom of a ~20-ft (6-m) tall absorption tower, explains Karlsdóttir. Cold condensed water (68°F [20 °C]) from the power plant is simultaneously pumped to the top of the absorption tower. As the gases flow upward, the water trickles downward through the separation equipment, which facilitates the dissolution of the gases into the water that is reinjected into the basaltic bedrock. The colder the water, she notes, the more soluble the H<sub>2</sub>S.

When H<sub>2</sub>S and CO<sub>2</sub> gases are dissolved in geothermal fluid, the corrosive nature of the

## What is geothermal energy?

Geothermal energy is heat energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. The geothermal energy of the Earth's crust originates from the original formation of the planet and from radioactive decay of materials (in currently uncertain but possibly roughly equal proportions). The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface. The adjective geothermal originates from the Greek roots γη (ge), meaning earth, and θερμός (thermos), meaning hot.

Earth's internal heat is thermal energy generated from radioactive decay and continual heat loss from Earth's formation. Temperatures at the core-mantle boundary may reach over 4 000°C (7 200°F). The high temperature and pressure in Earth's interior cause some rock to melt and solid mantle to behave plastically, resulting in portions of the mantle convecting upward since it is lighter than the surrounding rock. Rock and water is heated in the crust, sometimes up to 370°C (700°F).

Geothermal power is cost-effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels.

The Earth's geothermal resources are theoretically more than adequate to supply humanity's energy needs, but only a very small fraction may be profitably exploited. Drilling and exploration for deep resources is very expensive. Forecasts for the future of geothermal power depend on assumptions about technology, energy prices, subsidies, plate boundary movement and interest rates.

*Acknowledgement: Wikipedia, the free encyclopedia.*



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The Hellisheiði geothermal power plant in southwest Iceland. Photo by Arni Saeberg, courtesy of Orkuveita Reykjavíkur (Reykjavík Energy).

gases and other process factors, such as the pressure, flow rate, and pH level of the liquid containing the dissolved gases, can cause corrosion in geothermal equipment and wells that may lead to failure. In addition to general and localized corrosion,  $H_2S$  also can cause hydrogen-induced cracking (HIC), stress corrosion cracking (SCC), and sulfide stress corrosion cracking (SSCC). Karlsdóttir comments that the gas separation station in the initial pilot plant had considerable uniform and pitting corrosion problems that stemmed from the construction material used – carbon steel (CS). Because the gas separation station is a crucial component of the abatement process, it was extremely important that the gas separation station in the larger-scale plant would perform without major corrosion issues. This meant that a more suitable material needed to be selected for the plant's construction.

### Materials selection

The material chosen for the construction of the absorption tower and piping in the larger-scale gas separator was austenitic stainless steel (SS) UNS S31603. Karlsdóttir comments that austenitic SS is the most widely used class among SS. Austenitic steels contain Cr and Ni, which render a compact, passive surface film that resists corrosion in corrosive environments. UNS S31603 also contains 2 to 3% Mo, which makes it more resistant to pitting corrosion. It also contains a lower amount of C (< 0.03%) to decrease the risk of intergranular attack in the as-welded condition or in short periods of high-temperature exposure (from 788 to 1 490°F [427 to 816°C]).

Austenitic SS is commonly used in the oil and gas industry where  $H_2S$  is present, Karlsdóttir says. She notes that some research has been done on SCC and SSCC of UNS S31603 in environments that contain  $H_2S$ ,  $CO_2$ , and chlorides, and both  $H_2S$  and chlorides were found to promote and accelerate general corrosion and SCC. UNS S31603 in geothermal environments was also studied, and pitting corrosion was observed in laboratory experiments in geothermal brine at 140°F (60°C) with a pH of 4.7, and SCC was also reported at 140°F. The temperature in the abatement system's larger-scale gas separation station, however, is considerably lower at ~20°C, and chloride ions are not expected to be in the environment. However, oxygen is present, which can accelerate corrosion in a geothermal environment.

### Corrosion study

To evaluate the corrosion resistance of the absorption tower, which is in contact with high concentrations of  $H_2S$ , Karlsdóttir and her colleagues at the University of Iceland and the Innovation Center Iceland conducted a study<sup>4</sup> on the corrosion behavior of UNS S31603 while being exposed to the  $H_2S$  cleaning process in the absorption tower. Karlsdóttir was the chief investigator of the corrosion testing in the tower. The project investigated the steel's resistance to uniform and pitting corrosion as well as its susceptibility to SCC. Other materials – CS (S235JR), austenitic SS (UNS S30403), and duplex SS (UNS S31803) – were also investigated for comparison.



The gas separation system with the absorption tower. Photo courtesy of Sigrún Nanna Karlsdóttir.

The round corrosion coupons used for testing, 45mm in diameter with an 11mm hole in the center, were cut from 3-mm thick plates of S235JR, UNS S30403, UNS S31603, and UNS S31803. Before testing, the specimens were cleaned and weighed. Three coupons for each material tested were threaded onto a specimen holder, with a 15-mm space between them and separated with a plastic material (polyoxymethylene). To study the likelihood of UNS S31603 cracking in the high  $H_2S$  concentration, the ASTM G30-97(2016)<sup>5</sup> U-bend test method was used. Test specimens, 90mm wide by 15mm long by 3mm thick, were cut from UNS S31603 plate, with the longitudinal direction parallel to the rolling direction of the steel plate. All specimens were bent around a predetermined radius of 15mm with a custom made U-bend machine capable of providing single-stage stressing.



An image of the surface of the S235JR CS specimen after four weeks of testing, taken with an optical microscope equipped with a digital camera. Large cracks and blisters are clearly visible. Photo courtesy of Sigrún Nanna Karlsdóttir.

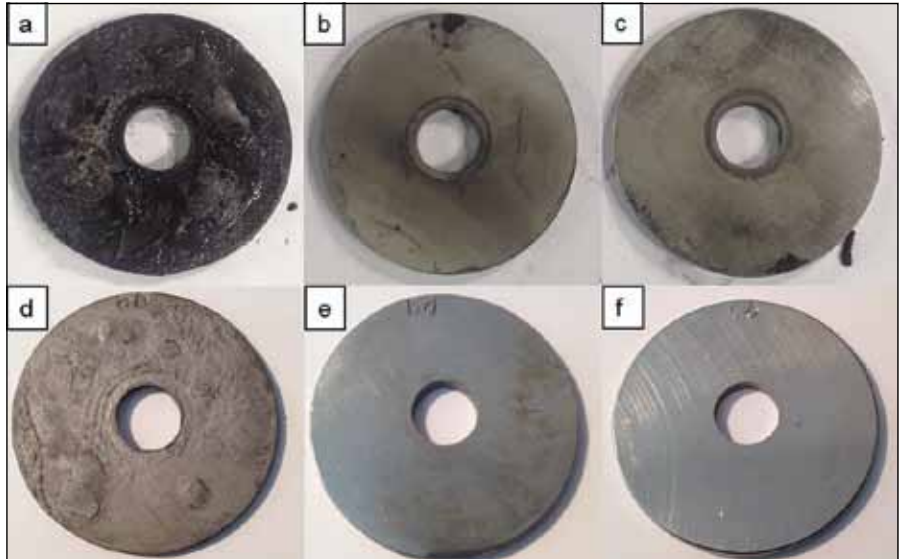


The specimen holder was inserted in a valve located near the middle of the tower, where the  $H_2S$  concentration is midway between the lowest and highest concentrations, to get test results that represented an average for the tower, says Karlsdóttir. After four and 12 weeks of testing, the specimens were removed, cleaned, weighed, and evaluated for corrosion. For each material, the microstructural and chemical composition of a specimen's surface and cross-section were analyzed with scanning electron microscopy (SEM) and x-ray energy dispersive spectroscopy (EDS). The corrosion rates were calculated per ASTM G1-03(2011).<sup>6</sup>



The UNS S31603 and S31803 SS samples held up quite well in this experiment. "They performed as expected," Karlsdóttir comments. The corrosion rates were negligible and no corrosion damage was detected in the microstructural analysis of the cross-section of either the UNS S31603 or the S31803 SS samples after four and 12 weeks of testing. The UNS S31603 U-bend specimens did not experience SCC, and cracking or pitting was not detected in the



The specimen holder with three disk coupons and one U-bend coupon for each material.  
Photo courtesy of Sigrún Nanna Karlsdóttir.



Photographs of the disk specimens after testing for four weeks before cleaning (top row) and after cleaning (bottom row): (a, d) CS, (b, e) UNS S31603, and (c, f) UNS S31803.  
Photos courtesy of Sigrún Nanna Karlsdóttir.


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tested specimens. The results of this test indicate that S31603 is a sufficient material choice for the absorption tower. "Because of the low temperature, UNS S31603 is a pretty safe selection for this system," Karlsdóttir says, adding that a longer testing time is advised to support that conclusion. She notes that SCC would be more likely to occur with UNS S31603 if the temperature was higher.

In the UNS S30403 SS samples, stress corrosion cracks were starting to form. Since this SS grade does not contain Mo, Karlsdóttir explains, it is more susceptible to localized corrosion such as SCC and pitting when exposed to H<sub>2</sub>S.

The S235JR CS samples exhibited poor performance during the test, with a significant amount of corrosion damage and a high corrosion rate – 4.2mm/y and 3.0mm/y for four and 12 weeks respectively, which is considerably higher than the acceptable limit of 0.1mm/y.

Although Karlsdóttir expected the CS to corrode, she was surprised at the degree of blistering and HIC that was observed – particularly for the four-week test, a relatively short testing time in the absorption tower. The researchers acknowledge that wet environments containing H<sub>2</sub>S and/or CO<sub>2</sub> along with oxygen contamination can be very aggressive to carbon and low-alloyed steels. Internal blistering, HIC, and stress oriented hydrogen-induced cracking (SOHIC) of CS in the presence of very high H<sub>2</sub>S concentrations have been associated with wet H<sub>2</sub>S environments.

The study confirmed that the selection of UNS S31603 for the absorption tower was a good material pick, Karlsdóttir comments. "It verified that it was the right decision not to go with a lower-grade material like UNS S30403 because cracking was detected, indicating its susceptibility to SCC in the system," she says. The research also shed light on what happened to the CS components in the first pilot plant: the availability and aggressiveness of the H<sub>2</sub>S along with the presence of oxygen caused the corrosion damage. "The environment really requires the use of UNS S31603," Karlsdóttir concludes. "It is not expensive compared to higher grades of corrosion-resistant steels. It was a good choice."

More information on the study can be found in the NACE International CORROSION 2016 paper, "Corrosion Testing in H<sub>2</sub>S Abatement System at Hellisheidi Geothermal Power Plant in Iceland," by S.N. Karlsdóttir, S.M. Hjaltason, and K.R. Ragnarsdottir; which is available at [www.nace.org/store](http://www.nace.org/store).

*We wish to thank NACE and particularly Kathy Larsen for this contribution.*

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**Kathy Riggs Larsen, MP Editor, NACE International**

Kathy Riggs Larsen has been a NACE International staff member for 13 years and with Materials Performance (MP) magazine for the past 10 years. She started with the magazine as the staff writer and is currently serving as editor, a position she has held for two years. Before working on MP, Larsen was a member of NACE's web group and acted as assistant webmaster. Being in a communications role for NACE has enabled her to learn much about corrosion and the effects it has on so many aspects of modern life. "It's easy to take the world's infrastructure for granted and not give much thought to how it can disintegrate or how it is being maintained to keep corrosion at bay," she says. "What I love most about writing on corrosion is bringing corrosion threats – and solutions – to the front of the line in terms of awareness. People all over the globe are faced with different types of corrosion problems and they are finding ways to solve them. For me, it is very empowering to find these stories and share them with others in corrosion control."



Larsen holds a B.S. degree in journalism from the University of Maryland and a M.S. degree in administrative science from Johns Hopkins University. She currently resides in Houston, Texas, USA.

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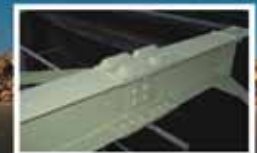
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# Proactive asset management of concrete infrastructure

Monitoring the impact of corrosion on concrete infrastructure such as storage sheds, wharves and bridges is a critical aspect of ensuring structural integrity and durability performance. A key way of minimising corrosion is to design for durability and employ the most appropriate technologies and prevention techniques.

Corrosion continues to impose a massive cost on asset owners and industry. This has been estimated, in a report issued by NACE (USA), to be more than three per cent – or many billions of dollars – of global GDP each year. Owners of high-value infrastructure assets must understand the cost implications of ignoring the effects of corrosion.

Concrete reinforcing steel corrosion is a worldwide problem that causes a range of economic, aesthetic and utilisation issues. Asset owners and managers operating and maintaining concrete infrastructure face different corrosion challenges depending on the industry sector in which they operate. The concrete degradation in the football pitch-sized storage sheds operated by Queensland Sugar differs from that of the bridges maintained by VicRoads.

Harsh environments – especially coastal, tropical or desert ones with high salt levels or extreme temperatures – can accelerate the rate of corrosion of steel in concrete.

Usually, the most exposed elements deteriorate first but it may take 5 to 15 years for the effects of reinforcing steel corrosion to become visibly noticeable.

The Australasian Corrosion Association Incorporated (ACA) is a membership association that works with industry and academia to research and disseminate information on corrosion and its prevention through the provision of training courses, seminars, conferences, publications and other activities.

The two commonest causes of concrete corrosion are carbonation and chloride or 'salt attack'. The alkaline (high pH) conditions in concrete forms a passive film on the surface of the steel reinforcing bars, thus preventing or minimising corrosion. Reduction of the pH caused by "carbonation" or ingress of chloride (salt) causes the passive film to degrade, allowing the reinforcement to corrode in the presence of oxygen and moisture. As reinforcing bars rust, the volume of the rust products can increase up to six times that of the original steel, thus increasing pressure on the surrounding material which slowly cracks the concrete. Over the course of many years, the cracks eventually appear on the surface and concrete starts to flake off or spall.

Fred Andrews-Phaedonos, Principal Engineer – Concrete Technology at

VicRoads, said the government road authority has a range of assets throughout the State that face degradation from a range of sources. "The iconic Westgate Bridge carries massive loads in addition to being subject to high winds and salt spray," he said.

Inspection of the many concrete culverts and low road bridges along the hundreds of kilometres of country highway has shown that their effective operational life is being reduced as the size of interstate road trucks increases. Many structures were designed for vehicles half the size and weight of modern trucks. "Current estimates suggest that a proportion of Australia's bridges are structurally or functionally deficient and require major rehabilitation, strengthening, improvement or replacement to bring them to current design standards," Andrews-Phaedonos said.

Queensland Sugar Limited (QSL) operates and maintains a range of assets, the major ones being its storage sheds and wharves from where raw sugar is loaded onto ships. According to David Edelman, Project Engineer at QSL, the company's massive storage sheds – some of which are 45 metres wide and 400 metres long – also face a slow acting but pervasive threat.

"Sugar makes a mildly acidic solution that can slowly eat away at the concrete floors and walls of the sheds," Edelman said. "This damage leads to a pot-holed, uneven surface and breaking of the concrete at joints, which adds to the difficulty of washing the floors in addition to presenting hazards to workers. The sugar forms a sticky, unsafe coating that builds up over time and makes work inside the sheds difficult meaning the floors have to be washed periodically."

To minimise the damage caused by the sugar-attack, the walls and floors of the company's storage sheds are coated with a sealer. Deeper holes and cracks are filled with epoxy, and joints are kept maintained to prevent sugar attacking deeper into the slabs. In addition to this chemical attack, the continual operation of large, front-end



Raw sugar being poured into a QSL sugar bulk storage shed.



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Offshore loading conveyor at Lucinda Bulk Sugar Terminal.



Mooring dolphin at Cairns Bulk Sugar Terminal scaffolded for concrete repair works.

loaders moving hundreds of thousands of tonnes of raw sugar through the sheds and onto conveyor belts and ship loaders damages the concrete surfaces.

Similarly to VicRoads' coastal concrete structures, QSL's port assets degrade in the aggressive maritime environment. For QSL this is exacerbated by them being located in the Tropics as well. The wharves and associated infrastructure at Lucinda, Bundaberg and Cairns are under threat of chloride attack, in addition to damage from tropical storms and cyclones.

"Correct interpretation of observations and testing is essential to a correct diagnosis and prognosis of the problem, and thus enable appropriate corrective measures to be taken," Andrews-Phaedonos said.

The traditional method of concrete repair is to remove the cracked, delaminated

and spalling concrete to a depth of 20 – 30mm behind the reinforcing bars to fully expose the rusted material and remove the contaminated concrete from the steel. All the corrosion affected material is then removed and the steel treated or replaced, after which specialist repair concrete mortars are applied and the surface made good. A modern development is for the repair mortars to be polymer modified to improve adhesion and resist further ingress of contaminants. Coatings are commonly used in combination with patch repairs to reduce further entry of carbonation or chlorides.

Edelman said that when the QSL jetty at Lucinda was built there was an issue with alkali silica reaction (ASR) causing cracking of the concrete. Chlorides have penetrated the concrete and caused premature corrosion of the reinforcing steel on parts of the structure. In some highly exposed parts of the structure this corrosion has caused

extensive damage where elements have had to be repaired or replaced. However, in large sections of the jetty structure, the chlorides in the concrete have not yet reached a concentration where corrosion has initiated.

"The chloride concentrations have been monitored over many years and they are slowly increasing," Edelman said. To counter this, QSL has started a program to apply an impregnating silane coating to the underside of the 5.7 kilometre length of the jetty to prevent further ingress of chlorides. "By putting this relatively inexpensive protection in place now, we can extend the life of the structure," stated Edelman. "If we wait another 10 or 15 years the chlorides levels will have increased, corrosion will have started and it will be too late." "The square-metre cost of a simple protective coating like silane is as little as 1/100th the cost of a concrete patch repair, but it is only effective before corrosion starts".

## How long have galvanized steels been used in concrete?

The first reports on the use of zinc coated steel in concrete date to about 1908. Its first regular use as a reinforcing material was in the 1930s in the USA. One early example was in the construction of concrete water tanks where galvanized wire was used to pre-stress the tank wall. In the post-WWII period the use of galvanized rebar became more common and by the 1960s and early 1970s a considerable tonnage of steel reinforcement was being galvanized especially for use in bridge and highway construction across the snow-belt states of the USA and Canada. Its use diminished somewhat from the late-1970s when the FHWA temporarily classified galvanizing as an experimental system. This ruling was rescinded in 1983 thereby allowing the various States more flexibility in the selection of corrosion protection systems,

again including galvanizing. Since this time, and especially over about the last 25 – 30 years, there has been a steady world-wide use of galvanized reinforcement in a wide variety of types of concrete construction and exposure conditions. Acceptance of the use of galvanized reinforcement is also reflected in the number of national and international standards for the use of zinc coated (i.e. galvanized) reinforcement published in recent years, and the existence of many Codes and Specifications relating to galvanized reinforcement published by Federal and State bodies, especially in North America.

*We wish to thank Prof. Stephen Yeomans, author of a number of books on the subject, for this contribution.*

Monitoring chloride levels, through core sample testing, allows a proactive approach. All asset managers should get to know the chloride and carbonation profile of their concrete better, particularly if that concrete is aging and located in coastal environments. "Without a proactive approach, the first sign of a problem with a structure is typically when a piece of concrete falls off due to corrosion," said Edelman. "At that point it may be too late for a coating to protect the remainder of the structure, and you may be up for some very large repair bills."

A number of QSL's assets have experienced significant corrosion and spalling of concrete over the years due to chloride ingress. Traditional patch repair, in many cases with replacement of corroded reinforcement, has been used, but with inconsistent results. "We have some patch repairs that are pushing 30 years old and remain in great condition," Edelman said, "but others are beginning to crack and fail after less than 10 years." However, one of

the limitations of patch repairs is that it is often necessary to remove large quantities of sound concrete to solve the problem, causing extensive disruption and costing approximately \$3 000 per square metre.

One of the alternative methods of protection used on concrete, especially in marine environments, is Cathodic Protection. One type, Impressed Current Cathodic Protection (ICCP), is a technique whereby a small, permanent current is passed through the concrete to the reinforcement in order to virtually stop the corrosion of the steel.

Cathodic protection is relatively simple in theory. Anodes are inserted into the concrete at set spacing attached to the positive terminal of a DC power supply and connect the negative terminal to the reinforcing steel. Large amounts of cabling and permanent power supplies are required, making the technology really only suitable for commercial infrastructure. The initial CP current totally passivates the steel reinforcement, migrating chloride away from

the bars and restoring an alkaline (high pH) environment in the concrete around the steel reinforcement.

Well designed and installed CP systems can achieve a 30 year or longer operational life.

One of the QSL conveyor tunnels has already had an ICCP system installed and the company is preparing to add the technology to a particular section of the Lucinda Jetty that is subject to near-constant wetting from waves. "In this section, chlorides have reached a level where corrosion has begun and some spalling has occurred. Cathodic protection is a more cost-effective option compared to allowing the corrosion to continue and having to carry out constant repairs," Edelman stated. "There will be long term cost savings, which helps a lot – with the total annual spend for concrete repair and protection of around \$1 million across the six terminals."

During the past 30 years, there has been a lot of research into replacing some of the

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Portland Cement used in concrete with alternative components such as 'fly ash', 'blastfurnace slag', 'silica fume', polymers, recycled car tyres and fibres. Some of this research has been published through the ACA. 'Fly ash' is a by-product from burning coal at a power station and incorporating fibres into a mix is similar to the old practice of adding horse hair to wet plaster. One particular area of research is in the field of geopolymer concrete, utilising alkali-activated binding agents.

According to Andrews-Phaedonos, the enhanced characteristics of fibre reinforced polymer (FRP) concrete include increased flexural and shear capacity of beams and slabs. FRP concrete is now regularly specified by VicRoads for repair and strengthening works. "The material is thinner, lighter, non-corrosive and easier and quicker to install," he said. "It also has increased axial load, bending, shear and confinement capacities."

As a result of the research into concrete additives, construction companies and

engineering consultancies have access to all the latest technologies that yield a suite of proactive and reactive processes and procedures to maximise the effectiveness of reinforced and pre-stressed concrete. "If you have all the appropriate specialists involved at the design stage it is very possible to have a design life of 100 years or more," said Warren Green, a Director and Corrosion Engineer at engineering consultancy, Vinsi Partners.

By incorporating the by-products of other processes into the concrete mix, it has been possible to get "green star" ratings for different types of concrete. There is the challenge of 'thinking outside the box' as to what might be incorporated into concrete in order to enhance sustainability and durability.

In addition to new materials being incorporated into the concrete mix, other additives have created 'self-compacting' and 'self-levelling' concrete which can save both time and money. Off-site construction of

pre-stressed concrete panels, under factory conditions, permits a far greater degree of quality control. "Advances in admixtures means that we can build almost anything out of concrete these days," Green said.

"The Australian Standards for concrete work gives basic guidance for normal situations, but in aggressive environments such as tropical, coastal, acid-sulphate soils, etc., a structure will not necessarily achieve its design life if simply designed and constructed to comply with the Standards," said Green. To complement the Standards and support designing for maximum durability in specific situations, the Concrete Institute of Australia is developing a range of 'recommended practice' guidelines. "VicRoads was the first State Road Authority in Australia to publish standard specifications for concrete maintenance work and has made a significant contribution to the preparation of Standards such as AS 5100 Part 8," added Andrews-Phaedonos.

As concrete infrastructure ages, corrosion prevention has to be as cost effective as practical. Owners and operators are being challenged to find better ways to maintain the integrity of their assets. Some of the factors that need to be considered include how long the asset has to remain in operation and would a shorter life extension be acceptable if maintenance has to be repeated more frequently.

*The ACA is a not-for-profit, membership Association which disseminates information on corrosion and its prevention by providing training, seminars, conferences, publications and other activities. The vision of the ACA is that corrosion is managed sustainably and cost effectively to ensure the health and safety of the community and protection of the environment.*

*As part of its charter, the ACA presents a continual program of technical seminars and training courses each year. On July 26 – 27, the ACA will be presenting the Brian Cherry International Concrete Symposium at the Marriott Hotel in Melbourne featuring 11 high-profile international speakers. For more information go to the Events tab at [www.corrosion.com.au](http://www.corrosion.com.au).*

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# Innovative painting of ABSA Towers, Pretoria

The construction of the ABSA Towers building located in the Pretoria CBD was completed in 1976. This building comprised of a concrete superstructure and the exterior decorated using 40mm x 20mm glazed tiles adhered and grouted in position with a cement mortar.

Over the past 37 years the cementitious adhesive and grout had debonded off the concrete superstructure in certain areas due to various factors as well as freeze thaw cycles that had loosened the glazed tiles from the concrete substrate.

Over time some of these tiles had fallen off in patches down to the pavement below putting pedestrians and the general public at risk. The total height of the building is 132m.

National Urethane Industries in conjunction with Murray & Roberts South Africa were asked to design a system to prevent these miniature tiles from debonding off the concrete substrate during the installation of an entirely new façade system.

The National Urethane Industries team formulated an aliphatic moisture cure primer that bonded to the surface of the glazed tile and penetrated the remaining grout. The surface was pre-cleaned according to NACE 5 SSPC SP12, WJ2, and NV3 using Low Pressure Water Cleaning (LPWC) at 250psi.

The substrate was allowed to dry to a surface dryness of <4% according to ASTM F 2170-2. NUI formulated an aliphatic primer that was roller/brush applied to achieve a DFT of 20 microns.

The specially formulated primer was left overnight to cure and over-coated within 24 hours.

The overcoating times were monitored by NUI comparing the RH% versus temperature using an EXTECH, RHT10 humidity temperature datalogger.

The preferred applicator chosen was Custom Linings South Africa. This contractor was chosen due to the many years of Polyurea application experience.



Pretoria Towers now ABSA Towers PTA.



Scaffolding erected against ABSA Towers. Glazed tiles ready to receive NUI formulated glaze tile primer.



Workers in correct safety equipment preparing substrate for primer.



NUI Ultraspray 401 Polyurea being sprayed with a Graco Reactor EXP 2 and a Graco Fusion gun.



Newly applied Ultraspray 401 Polyurea.

The overcoating data was supplied to Custom Linings with every batch of primer to ensure the correct window period for overcoating was achieved.

National Urethane Industries Polyurea system, Ultraspray® 401-455 medium sea grey, was sprayed onto the primer at >1.5mm however <2mm DFT. This system was chosen due to its exceptional elongation, tensile and cut-tear resistance.

The Polyurea system applied exhibited 90% of its physicals within 20 minutes which is exceptional for a monolithic coating.

Direct pull-off tests were conducted according to ASTM D 7234 with a minimum acceptable result of >1,5 Mpa. NUI and Custom Linings achieved between 3 Mpa and 10 Mpa, which is remarkable. These tests were conducted by NUI's NACE CIP 2 & 3 Inspectors.

The new façade system was then erected over the Polyurea coating for aesthetic purposes.

*We wish to thank Kaare Mason of Custom Linings SA and Donovan Slade of NUI for this article.*



*Window sills after application of Ultraspray 401 Polyurea.*



*Graco Reactor EXP 2 Polyurea spray machine mounted on trolley for ease of transportation.*

## 21st Century hot dip galvanized water supply solutions

Hot dip galvanized pipes, couplings and tanks have been used for water reticulation, storage and delivery of potable water to consumers for well over a hundred years. These systems and components remain cost effective both from an initial capital expenditure and life cycle value perspective.

Hot dip galvanized piping is suitable in both above and below surface applications. The availability of high strength options make it suitable for use across a broad spectrum of challenging environments. Using the appropriate jointing systems allows for quick and reliable installation.

Recently, a hot dip galvanized water supply solution was selected to serve the Mokopane community in the Limpopo province. The town council in conjunction with Anglo Platinum initiated a water optimization project to improve the water availability, which was in short supply, to the community.

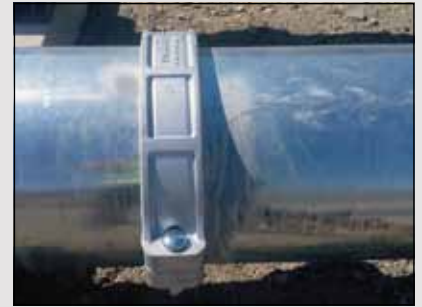
Macsteel Tube and Pipe were awarded the Mogalakwena Dewatering Project in 2015. Water collected from six disused pits, at Mogalakwena Mine, fed by natural rain run-off and other mining operations is recycled and used for general daily mining water requirements. This relieved the demand on council water supply to the benefit of the local community.

An innovative pipe joining system was used, in preference to the conventional flanged and grooved method. The use of the galvanized SHURJOINT coupling was a first in South Africa. This option allowed for high speed fabrication of the pipes; as well as for the fast and straightforward installation of the scheme.

More than 32 000 meters of 450mm bore hot dip galvanized pipe and 2700 SHURJOINT galvanized couplings were supplied and installed. Local labour was trained to install the pipes and couplings and the project was completed within the scheduled time frame. This cost competitive and optimally corrosion controlled system was handed over for service in April 2016.

By utilizing a hot dip galvanized piping system and components, a proven and compelling solution for future water reticulation and supply projects throughout the Southern African region was completed. The hot dip galvanized system provided not only a cost and labour effective solution, justifiable to the times we live in, but furthermore met the need for an environmentally friendly and low maintenance long term solution.

*We wish to thank the Hot Dip Galvanizers Association Southern Africa for this contribution.*



# From the KETTLE

Because corrosion control of steel by hot dip galvanizing plays such an extremely important role for specifiers and end-users in their specification choice, it was proposed that we highlight and demystify a number of surface conditions over a series of editions that bear very little influence of the coatings durability seen both during the initial inspection and also after years of being exposed to a particular environment. See surface condition F8 and F12.

**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 (not practical in terms of the first photographic example) 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.

**F8**

**DESCRIPTION:**

Rough thick coatings caused by the chemical composition of the steel, "tree bark effect".

**CAUSE:**

This can include coatings that have a generally rough striated characteristic with raised parallel ridges or groove type surface configurations, called a "tree bark effect". This is caused by variations in steel surface chemistry.

**EFFECT / REMEDY:**

The thicker coating produced will provide greater corrosion protection except when the coating tends to flake off or delaminate. See F6 and F7.

**ACCEPTABLE TO SANS 121:**

A  
Depending on customers use.

**ACCEPTABLE FOR DUPLEX AND ARCHITECTURAL FINISH:**

R  
Customer to refer to steel supplier.  
See the Association's Architectural Check List #1 and #4.

Two identical tubes one with a coating thickness of 127µm (normal steel). Less reactive. Both pipes were galvanized together for the same time.



Two identical tubes the other with reactive levels of phosphorous with a resulting coating thickness of 262µm. Reactive. Both pipes were galvanized together for the same time.



Coating thickness 523µm.



Coating thickness 387µm.



Two commercial grade square tubes welded together after galvanizing. Coating thickness on this section is slightly higher than standard at 89µm and is considered normal.



The adjacent square tube has a rough coating with coating thickness of 327µm.



**F12**

**DESCRIPTION:**

Rolling and fabrication defects in steel.


These defects may be broadly classified as surface discontinuities in the steel that have been elongated during rolling or severely removed during fabrication leaving surface imperfections.

Steel sliver lifting after hot dip galvanizing. Sliver should be removed and coating repaired.



Steel sliver lifting after hot dip galvanizing. Sliver should be removed and coating repaired.



<p><b>F12 continued...</b></p>	<p>Rolling imperfections at the fillet of an H-column are highlighted after hot dip galvanizing. While considered rough and will affect the aesthetic appeal it is not detrimental to corrosion control.</p> 	<p>Steel sliver removed after hot dip galvanizing. Coating should be repaired.</p> 
<p><b>CAUSE:</b> Steel may occasionally include laminations, laps, folds and non-metallic impurities, which result in slivers rolled into the metal surface. Defects of this type are sometimes detected before or after pickling but may only become apparent after hot dip galvanizing.</p> <p><b>EFFECT / REMEDY:</b> Surface flaws in the base material may be removed by local grinding before or after hot dip galvanizing followed by repair (if necessary) of the affected surface. Minor surface defects will not adversely influence service life of the coating.</p> <p><b>ACCEPTABLE TO SANS 121:</b> A AND REP Refer to customer</p> <p><b>ACCEPTABLE FOR DUPLEX AND ARCHITECTURAL FINISH:</b> R prior to hot dip galvanizing and refer to customer.</p>	<p>Rolling imperfections or rolled in millscale at the fillet of an H-column can sometimes be seen before hot dip galvanizing. These can, if not specifically removed before galvanizing, influence the success of the hot dip galvanized coating.</p> 	<p>Rolling imperfections may have been severely removed by grinding but the result will be highlighted after hot dip galvanizing and may or may not be acceptable.</p> 



## CORRISA (GAUTENG) INVITES YOU TO OUR 10<sup>TH</sup> ANNUAL FISHING DAY 1<sup>ST</sup> JULY 2017

Join us for our 10th Annual Fishing Day at the Brookwood Trout Farm, bring your family, friends and even your mother-in-law along to this fun filled event.

The competition is fierce, and great prizes are up for grabs. Kiddies compete in the Annual Crab catching competition and Fisherman / Ladies compete for a number of titles. Don't miss this awesome day, come along and share in what has become one of our most anticipated annual events.

Get there Early!!! We will be there from 08h00 until around 14h00. For the early birds the gates open at 6am, we are told the fish bite better at sunrise....

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For directions please follow the link below: <http://www.brookwoodtroutfarm.co.za/contact-us>



## Manager's Message

Winter has arrived and the cold is here to stay for a while, but here at the Corrosion Institute there is no time for us to hibernate.

Our Corrosion Awareness was a great day and I would like to thank our exhibitors for participating and for contributing to the success of the day (more about the day in this issue) In addition we hosted our first of what will become an annual Debate. This was hosted by CorriSA and CorriSO (Student Organisation) the calibre of speakers in the two teams that participate was exceptional and well done to team TUT for winning.

This year has been challenging to say the least, course attendance has been low and as a result we have been left with no choice but to postpone numerous scheduled courses. I am hopeful that 2017 / 2018 will be a busier year for us.

The Training Schedule for the remainder of the year is available in this issue and Linda is always accessible for assistance and guidance. Linda can be contacted on 0861 267 772.

A list of our upcoming events can be seen on our website and on our Facebook page, we invite you to contact us should you wish to be involved. One of which is our Annual Fishing Day scheduled for the 1st of July. Should you wish to participate or sponsor please call us at +27 10 224 0761.

Our Awards Dinner is scheduled for 29 September 2017. For more information please contact myself.

The 2017 Financial year is drawing to an end and if you are a member, your membership for 2018 will be due in June, for more information please email [members@corrisa.org.za](mailto:members@corrisa.org.za)

Our Technical Evenings are scheduled well in advance, however should you wish to present and sponsor our evenings either in Gauteng or in KZN or WC. Please contact Thobi for assistance.

That's all from me.

Until next time.

*Regards, Lynne*



## Comment – Chairman of the Western Cape

The Western Cape region continues to thrive and we have had some great turnouts at our recent Technical presentations. Two of the 3 have been in conjunction with OCCA and we value the mutual synergies that we have with OCCA and we hope that similar synergies can be achieved with other like minded associations and institutes.

Graeme Stead, an ex OCCA president regaled some very interesting stories from his time in the industry and the 50 odd people who attended thoroughly enjoyed listening to one of the stalwarts in the industry. In April we again linked up with OCCA and Danny Grady (IMCD SA) and Kirsten Scott from WACKER Chemie who sponsored the evening treated us to a presentation entitled "Silicates, a touch of eternity". Again it was very well attended with 50 odd people.

In May, Craig Woolhouse from Elcometer trained and presented "Non destructive measuring of coatings on concrete" in a number of centres around South Africa and Namibia which proved to be interesting and informative about latest developments in the industry. Thanks to Elcometer and BAMR for sponsoring the evening.

We are looking forward to our next presentation by Darelle van Rensburg – "Corrosion Rates around the country". This was presented at Africorr and was very

well received. Darelle has taken the early studies by Bryan Callaghan and the CSIR to a more advanced stage.

The July presentation will be a first in that 3 companies – Pyrocote, Jotun and Stoncor will be joining us for a round table discussion on Intumescent Coatings. It promises to be a very interesting evening.

Our Mini Expo in September is taking place at Rand Air and we encourage exhibitors and interested parties to get hold of us. Space is filling up fast.

We have some exciting news regarding our end of year Gala Dinner. The world renowned comedian Barry Hilton will be our entertainment for the evening. Book your spot now!

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, Flippie van Dyk, Indrin Naidoo, John Houston, Terry Smith, Thinus Grobbelaar, Pieter van Riet*



## Comment – Chairman of KwaZulu Natal

Way back in April, before Easter and all those crazy long-weekends and short workweeks, we hosted Mrs. Jillian Brett, the late Michael Brett’s wife, to a special “technical evening” dedicated to the work Michael had undertaken within the coatings and corrosion industry.

As part of the evening’s presentation a short synopsis of the CEP program (Corrosion Education Productions) was shown. These original videos have been reformatted onto DVD by Michael’s stepson, Nicholas Fitzell, and were made available to us. It was interesting to see how, in the greater scheme of things, much has changed within the corrosion industry, but also nothing has changed.... The instruments we use, the dress and hair styles of the inspectors have all changed, but corrosion prevention is still based on a sound substrate being ensured and then a good coating system being applied – FOLLOW the SPECIFICATION.

As part of the evening, Neil Webb who was also instrumental in the CEP program, presented Jillian with a copy of the 2016 CorriSA Annual Award (right), awarded to (amongst others) Michael Brett and Partners, for the work undertaken on the Beira-Feruka Pipeline. A nice touch – Thanks Neil.

As quarter 3 of 2017 looms ahead, the KZN section will once again start the planning for the annual golf-

day in support of Highway Hospice. This event has a long history and we would like to again run a special day and raise funds for this worthy cause. Please drop me a line if you have ideas or are willing to support/help.

Keep an eye on the CorriSA newsletter, website and/or Facebook page for info regarding our technical evenings. I’m trying to mix things around and get presentations from different sectors, e.g. Toyota SA, Epol Foods, Buckman Laboratories etc.

Please feel free to contact either myself on mark.terblanche@primeinspection.co.za or Karyn Albrecht on karyn@avaxprojects.co.za if you have any suggestions or comments – These are always welcome.

*Regards, Mark Terblanche and Karyn Albrecht.*



# Nominate your chosen recipient for 2017 Annual Awards.

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Innovation.

**BEST-PROJECT**  
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**GOLD MEDAL**

**SILVER MEDAL**

**BRONZE MEDAL**

**IVAN OGILVIE**  
Research Project

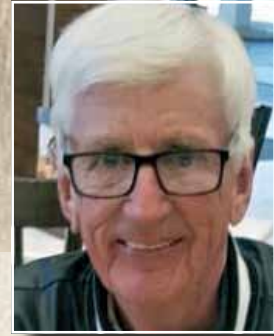
**WALTER BARNETT**  
Scholarship

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**Submission Deadline: 4<sup>th</sup> August 2017**  
**Email: [admin@ccorisa.org.za](mailto:admin@ccorisa.org.za) or call Lynette 0861 267772**

# In Loving Memory of ANDREW ARMOUR YOUNG

1947 - 2017

By Dr Colin Alvey



*The Corrosion Institute regrets to advise that Andy Young passed away recently after a long illness. Andy was one of the original 'old school' coating inspectors from the 1970s working with Michael A Brett & Partners and later Corrosion Advisory Technical Services. He was well respected in the coatings inspection fraternity because of his wealth of both technical and practical knowledge covering all aspects of protective coatings including heavy duty paint coatings, metallic coatings, powder coatings, external pipeline coating and wrapping systems and internal linings. His contribution will be sorely missed.*

*The Corrosion Institute of Southern Africa would like to extend its condolences to family and friends.*

## A TRIBUTE TO ANDY

Andrew Armour Young was born in Glasgow in Scotland in 1947. Having completed his primary and secondary schooling he studied building trades at the Glasgow College of Building.

In 1972 Andy, and his wife Ellen, arrived in South Africa. Andy joined Walter Barnett at Rietfontain General Galvanisers where he spent 5 years as a Quality Control inspector, a Works Production Planner and a Dispatch Superintendent.

Whether it was the fumes of the acid pickling bath or the heat of the galvanizing kettle that made Andy make a change is not known but fortunately for the inspection industry he decided, in 1977, to join the then expanding team of coatings inspectors at Michael A Brett & Partners (MAB&P).

During his time at MAB&P he was involved in numerous mining, power generation and miscellaneous projects which greatly broadened his practical expertise in protective coatings. Andy remained with MAB&P until it was closed by the TUV Rheinland Group in 1993 when he joined the newly formed Corrosion Advisory Technical Services (CATS) and was re-united with Michael Brett, Charlie Brett and Colin Alvey. In 1996 Andy formed his own proprietorship, Andy Young Corrosion Inspection Services (AYCIS), and continued working with CATS as a sub-contractor until his retirement in December 2016.

Andy was a rarity in the coating inspection fraternity in that he took no pleasure in the issuing of reject certificates for substandard work. He always approached his work with the client's best interests and project costs uppermost in his mind. Reject certificates invariably lead to increases in costs due to the requirements of re-inspection and reams of Quality Assurance documentation in the form of Non-Conformance reports. When Andy found work that did not meet the specification requirements he pointed it out to the contractor and offered his advice on how to repair it, giving practical demonstrations (and training) where required. He would then instruct the contractor to repair the work to be re-inspected during his next visit. If he then found that the necessary requested repairs had not been satisfactorily attended to, a rejection certificate was issued and all hell broke loose.

This modus operandi was clearly illustrated during a project where CATS had been appointed to carry out Quality Assurance and pipe mill inspections on coating and lining activities for a major municipality. Some 3 months into the project the client contacted CATS to find out if the coating and lining activities were proceeding satisfactorily. The client expressed his concern in that he had yet to receive a rejection certificate from CATS whereas his previously appointed inspection authority had issued weekly rejection certificates. It was pointed out to the client that Andy Young and CATS had a different philosophy where reject certificates were only used as a last resort. The client was more than satisfied with the explanation and remained a client for the next 20 odd years.

Being a Glaswegian it goes without saying that Andy was a very staunch Glasgow Rangers football supporter. He had a mascot in his car which was a miniature blue Glasgow Rangers football jersey. Being a Manchester City supporter myself, I jokingly asked him one day if this was a Manchester City mascot. His response can unfortunately not be repeated here.

Apart from football, Andy's other sporting passion was bowls. He and Ellen started bowling with the Benoni Municipal Bowling club where Andy was a committee member for many years as well as serving a term as chairman. After the closure of the club they moved on to the ERPM Bowling Club. This club was unfortunately also closed and they had to move on to the Boksburg Bowling Club.

Andy will always be remembered as one of the original 'old school' inspectors in the South African coatings industry. With the introduction of formal inspector qualifications through the South African Qualification and Certification Committee (Corrosion) in the mid-1990s, Andy was the first 'old school' inspector to become qualified through this scheme.

I consider myself privileged to have had Andy as a friend and colleague for some 40 years. Andy's contributions to the coatings inspection industry will be sorely missed as will Andy as a friend and colleague to many.



## CorrISO hosts First Corrosion Debate



Debate winner 2017, Tshwane University of Technology.



Debate runners-up 2017, University of Johannesburg.



Best Speaker, Mahlangu Khulekani.

The CorrISA\_Student organisation (CorrISO) had a privilege to host the First Corrosion Debate which happened at The Core on the 21st of April 2017 together with the Corrosion Awareness Day. The debate is aimed at creating corrosion awareness among students from different universities. The students got a chance to learn about corrosion from each other, from the corrosion companies which were exhibiting and the corrosion institute while having fun. The debate was a team effort where CorrISO worked close together with the main body CorrISA especially Lynette, Thobi and Karen.

Two debate topics were proposed by CorrISO which were: *Is imposing a carbon tax a good and effective way to encourage corrosion awareness?* and *Should corrosion technicians, engineers, and specialists start entrepreneurship at least 10 years after graduation from an institution of higher education?*. Two teams participated where one team was proposing and the other opposing. The first team was the University of Johannesburg which consisted of three students Prince Sibanyoni, Simphiwe Thabede and Cindy Sithole. The Tshwane University of Technology team consisted of Masindo Joy, Masemola Khumo and Mahlangu Khulekani.

I would like to take this opportunity to congratulate Tshwane University of Technology for winning the First Corrosion Debate for 2017 and Mahlangu Khulekani also from Tshwane University of Technology who was crowned a best speaker.

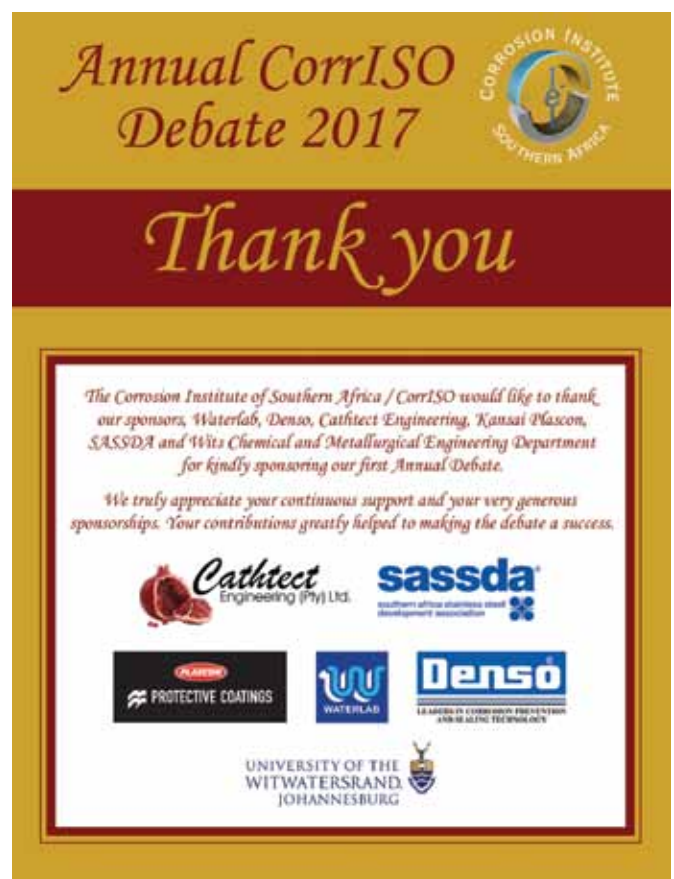
It was a successful, fun and informative debate. We are looking forward to making this an annual event when we host the second debate in 2018 and we are hoping that other universities will also partake as Tshwane University of Technology will be defending their title.

Thanks to the judges Armin Schwab from PPT, Aaron Raath from Cathtect Engineering and Dayanda Masia from Mintek. A special mention goes to the sponsors Waterlab, Kansai Plascon, Cathtect Engineering, WITS Engineering and Metallurgy Department, SASSDA and Denso.

Dayanda Masia, CorrISO Chairperson



Debate judges, Armin Schwab, Nomsombuluko (Dayanda) Masia and Aaron Raath.



# Corrosion Awareness Day 2017

The annual Corrosion Awareness Day Exhibition was held at the CORE on 21 April 2017. Attendees included companies within the corrosion industry, University engineering students and local high school students. Students participated in a show and tell of experiments depicting corrosion and the effects thereof.

Companies within the corrosion industry set up stands to showcase their products and provide more information on corrosion to our visitors.

A big thank you to all our exhibitors for taking the time to share the Corrosion Awareness Day with us. Your presence contributed greatly towards the day being a success.

The exhibitors included:

Kansai Plascon, Cathtect Engineering, Kare Industrial Suppliers, Waterlab, Mintek, The University of Johannesburg, The University of The Witwatersrand and Weartech.

Feedback received about the exhibition was extremely positive and we are very glad that the weather decided to play along unlike previous years, where we experienced rain.

We would like to thank all our visitors for taking time out of their busy day to visit us. We look forward to seeing you all again next year!!



**CorriSA invites you to join us at our Annual Charity Golf Day**  
taking place on the 27th October 2017 at Jackal Creek Golf Estate

**ALL MEMBERS ARE WELCOME**

Contact: Donovan Edward 082 900 2020 / don@denso.co.za

PLEASE BOOK AND PAY IN ADVANCE TO AVOID DISAPPOINTMENT...

# Professionalising the sector of corrosion is a task which CorrISA is set on tackling

By Dr Ivor Blumenthal, CEO : ArkKonsult – Consultant to CorrISA

*Should the Corrosion Sector be regarded as a viable and valid group of industries operating in South Africa? If not, then is the anti-Corrosion focus simply a component of every other conceivable Industry which is susceptible to the inevitable reality and ravages of Corrosion?*

CorrISA believes that Corrosion is not only an Industry, but a Sector of dedicated, independent and critical Industries, which need to step out of the shadows, raise their hands and insist on being recognised as a collective Profession, upon which others rely and are absolutely dependent for their success.

Beginning with the Industry of **Asset Owners**, there can be no doubt that State Owned Enterprises, and private sector property and asset owners need to focus a percentage of their activities and employee's on the task of anti-corrosion practices. The individuals employed to deal with such issues can be regarded as Internal Corrosion Consulting Practitioners, who are required to procure, apply and project manage the services, products and equipment required to combat the scourges of corrosion which left unattended can destroy those assets. It is the Asset Owners who first and foremost need to be conscious that they are procuring services from Professionals who are both Competent in matters of Corrosion, and Accountable for their ethical and acceptable behavior at all times. It is these Assets Owners who need to be insistent that such Professional Practitioners are quality controlled, that their performance is standardised and importantly measurable.

CorrISA is very concerned that at the moment, there are very few professional standards available to distinguish the Professional Practitioners from those who act independently and are simply not accountable for their advice, interventions or judgement. There appears to be a history of no barriers to entry in-terms of Professional Recognition, Lifelong Learning or any meaningful Accountability for people who work as Corrosion Professionals in the marketplace.

Perhaps the most focused Industry which applies to Corrosion, is that of the **Corrosion Consulting Industry**, which would include Engineers registered with ECSA, who have

specialised in Corrosion Practices, but are not, beyond their accountability to ECSA, accountable in any concrete manner for the nature and content of their specialisation in corrosion. ECSA do not have an Engineering Stream identified as "Corrosion" and their members who work in this arena do so in an unregulated and non-accountable fashion. In-addition, there is an entire spectrum of practitioners who operate within the banner of Consulting Practices, who are not ECSA Registered Engineers, and therefore remain on the fringes of being responsible and accountable for anything that they do, except possibly to their clients. But the question is to-whom their clients have recourse should either the Competency, or the Ethical Behavior of the Consultant ever be called into question?

The Industry of **Quality Assurance**, relates not only to products and equipment, but importantly to the nature and the quality of all work done, from detection and diagnosis, through to the quality assurance of interventions applied by contractors, and the issuing of finalised "Certificates of Completion". The question in this regards needs to be asked: Which organisation is finally accountable for the quality assurance of these "Certificates of Completion"? Additionally who, which level of recognised and registered Professional Practitioner is responsible for issuing and signing off those "Certificates of Completion" and therefore can be held accountable for their quality?

Other Industries identified as part of the Corrosion Sector equation are those of **Science, Technology & Academia, Product and Equipment Manufacturing, Importers and Suppliers and Distributors**, and very importantly **Corrosion Contracting**.

In-short CorrISA has a plan. It is one which is both bold and necessary. It's a timeous plan which involves recognising its responsibility at the head of the Corrosion Sector in South Africa. It is one which is dependent on the participation, cooperation and contribution from companies in all of the affected Industries, and from individuals who see the benefit in the professionalisation of what they do as advantageous to the sector of Corrosion as a whole.

In the year ahead, CorrISA will have established a "**Professional Body for Corrosion**", which will develop a series of **Professional Designations** applicable to the full range of Professional Practitioners working at various levels and in the variety of Industries constituting the Corrosion Sector in South Africa. Alongside awarding these Professional Designations to deserving recipients, CorrISA will work hard in establishing a calendar of **Continuous Professional Development (CPD)** for every one of those Designations so that the public at large can have peace-of-mind that irrespective of how long a person has been in the sector, their competence, knowledge and their behavior is up-to-date, and reflects best International practice.

With regard to Companies, CorrISA will have, within the next year established a meaningful and impactful **Grading System** for corporate members, which amongst other criteria will attest to the fact that recipient companies are **Excellent Companies** when it comes to the training, development, professional recognition and commitment to lifelong learning of all affected staff members.

CorrISA appeals to both individuals and companies within the Sector of Corrosion, to be watchful for Information Sessions and invitations to attend and participate in a range of activities designed to further our objectives as set out above. We will attempt to establish forums nationally, beginning in Gauteng, KZN, the Western Cape and the Eastern Cape to ensure that we attempt to reach companies and individuals working in the sector of Corrosion, wherever you are.

Whether you work in the Private or the Public Sector, we want the public to be aware that we encourage them to only deal in the future, with individuals who are Professionally Designated by the Professional Body for Corrosion, and companies which are Graded as Excellent, by CorrISA, the Trade Association for the Corrosion Sector. In that way the Individual and Companies are properly accountable, and the public properly protected and assured that the services they receive are ones underlined by our two principles, namely **COMPETENCY** and **ETHICAL ACCOUNTABILITY**.

**TECHNICAL EVENT: Kelvin Grove, Cape Town**



**BAMR ELCOMETER PRESENTATION: Kelvin Grove, Cape Town**



**BAMR ELCOMETER TRAINING: Kelvin Grove, Cape Town**



**BAMR ELCOMETER PRESENTATION: Namibia**



**NACE CIP 1 TRAINING COURSE: The Core, Midrand: 3 - 8 April 2017**



**BAMR ELCOMETER PRESENTATION: Gauteng**



**BAMR ELCOMETER TRAINING: Gauteng**



**BAMR ELCOMETER PRESENTATION: KZN**





**THE CORROSION INSTITUTE OF SOUTHERN AFRICA**  
**COURSE SCHEDULE 2017**

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<b>Introduction to Corrosion Engineering Course</b>	
2nd – 6th October 2017	Johannesburg, GP

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<b>Economics of Corrosion</b>	
2nd – 3rd August 2017	Johannesburg, GP

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<b>Not Just Rust</b>	
12th June 2017	Cape Town, WC
9th October 2017	Durban, KZN
1st November 2017	Johannesburg, GP

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<b>ECDA – External Corrosion Direct Assessment</b>	
17th – 18th July 2017	Johannesburg, GP

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<b>CITWI – Corrosion in the water Industry</b>	
16th – 19th October 2017	Johannesburg, GP

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<b>NACE CIP 1 – Coating Inspector Program</b>	
3rd – 8th July 2017	Johannesburg, GP
14th – 19th August 2017	Cape Town, WC
4th – 9th September 2017	Johannesburg, GP
13th – 18th November 2017	Johannesburg, GP

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<b>NACE CIP 2 – Coating Inspector Program</b>	
18th – 23rd September 2017	Johannesburg, GP

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<b>NACE CP 3 – Cathodic Protection Technologist</b>	
27th – 1st December 2017	Johannesburg, GP

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<b>NACE P-CAFT – Pipeline Corrosion Assessment Field Techniques</b>	
19th – 23rd June 2017	Johannesburg, GP

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<b>NACE NPP – Nuclear Power Plant for Coating Inspectors</b>	
24th – 28th July 2017	Cape Town, WC

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<b>NACE PCIM – Pipeline Corrosion Integrity Management</b>	
21st – 25th August 2017	Johannesburg, GP

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<b>NACE O-CAT – Offshore Corrosion Assessment Training</b>	
23rd – 27th October 2017	Cape Town, WC

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**REGISTRATION LINK:**  
<https://docs.google.com/forms/d/1e9ZGdsM01Sd8aXuCvys2bstXr5SrpVBxuqEQPK9fHJM/viewform?c=0&w=1>

# The RUST Spot...



in conversation with **Simon Norton**

## Briefly explain your background and how you came to be involved in the Corrosion Institute. Why and what year did you join?

I first became fascinated by corrosion while at school when I used to cycle to Cape Town Harbour to view ships during the school holidays. One June school holiday in the 1970's while cycling along the Duncan Dock wharf side I saw a man in white coat opening a manhole in the wharf and when I enquired as to what he was doing, he replied that he was checking the anti-corrosion protection on the fuel pipelines running under the wharf. He explained the work he did so well that I became interested in science and chemistry. I realised later that he was measuring the cathodic protection on the pipelines.

Years later while working for Shell South Africa in the lubricants technical team, we started work on the corrosion testing of hydraulic oils, high water based mine pit prop fluids and bearing greases and I became hooked on corrosion science. I asked to attend a corrosion school in 1991 and my boss allowed me to go. The school was held at the University of Witwatersrand and all the doyens of the corrosion industry in South Africa presented papers. This corrosion school I never forgot and in 2008 I returned to my roots and started my own independent consultancy in corrosion engineering and science.

I later joined the Corrosion Institute of SA in the hope that I may meet experts in corrosion science and at the same time share my expertise in corrosion science with colleagues in industry. I have presented several lectures to the Institute technical meetings and given lectures on the Corrosion Engineering course.

## What did you hope you would achieve by being a member of the institute?

I joined the Corrosion Institute of SA in the hope that I may learn and acquire new expertise in corrosion engineering, to leverage new work for my independent corrosion investigation practice and to lecture and present in applied corrosion science to industry and students.

## Talk about the successes you have had over the time you have been in practice and what role (if any?) did the institute play in this success?

I am relatively young in corrosion science and engineering but my hope to become an expert in corrosion investigation and testing is being fulfilled. My work over the past 10 years in corrosion has exposed me to some of the most complex and puzzling corrosion failure cases, and I have now used a wide range of test and evaluation methods that begins to set me apart as a true corrosion specialist. I love exploring new and front-line test methods and have recently used Ion Chromatography, Fourier Transform Infrared Spectroscopy and tailor-made Cyclic Accelerated Test methods to solve customer problems. I suppose the success is measured by the fact that my clients come back to me repeatedly to sort out their corrosion problems. The Corrosion Institute of SA has helped in that whenever I attend a technical meeting I see and hear that the industry is alive and I get new ideas going through my mind while listening to the many diverse talks and presentations.

## What have you enjoyed during your time with the institute and what role do you play now?

Being a member of the Institute has challenged me to challenge the painting fraternity at the Institute who dominate the meetings and events. While I understand that painting ships and structures is vital, many of the complex corrosion investigations that I undertake have no connection to paint, blasting grit, DFT or paint ingredients. I see my role now at the Institute as being the pioneer to bring corrosion science and engineering alive for university students, new entrants to the industry and for consulting

engineers. I also want to challenge the Institute to move from its emphasis (dare I say obsession) with paint and coatings to real world corrosion engineering.

## If you could change things at the Institute what would they be and what would you suggest for the future?

I would love the Institute to create for itself such prestige that it does not need to seek SACQA accreditation for its courses or other such listings, but is seen by industry and engineering as the place to go for corrosion know how and that Institute membership implies exceptional skill and expertise. The Institute must move away from being a Johannesburg branch and become a truly national institute that is too attractive to miss!

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

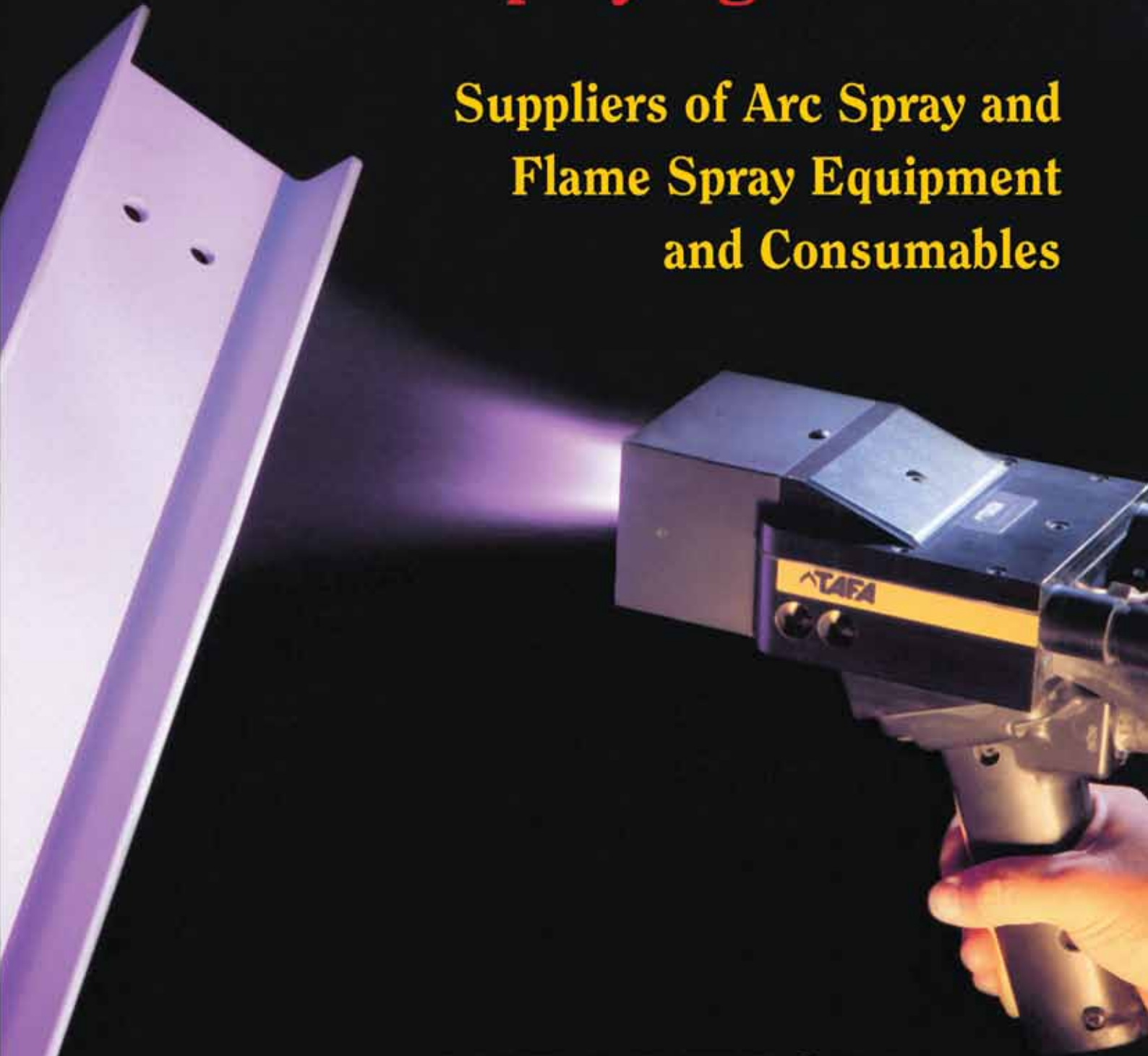
Well of course if South Africa sinks any lower under current poor government policy and leadership it will be a real pity since as a country of 60 million people we can be a tremendous technological power house for the Southern Hemisphere never mind for Africa. South Africa has a long history of excellence in engineering and technology and if the right leadership can arise then the sky is the limit. We must be far more exacting in what we do and demand more exacting standards from university students and industry players, else we will not be able to compete in the world arena and that means excellent education and advanced studies. It's not the amount of funding that matters but how the funding is used. Here the Corrosion Institute can challenge all industrial members to fund the founding of a school of corrosion science and engineering even if only small in size.

## Something about yourself: your family, sports, hobbies, pets, travel, passions...

I walk a lot in the mountains of the Cape and love cycling and my passion is 20th century military history and I often give lectures on military historical topics to diverse audiences. I am a film buff and have an extensive library of documentary and historical films but at the same time enjoy spy thrillers and good drama films.

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