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CORROSION & MATERIALS

Vol 43 No 2, May 2018
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WATER & WASTEWATER FEATURE

Inside this Issue:

Tech Note: *Recent Corrosion Problems in SWRO Desalination Plants*

Tech Note: *Stray Traction Effects – where's the problem?*

Tech Note: *Anodes, Chemical Composition and Your Boat*

Project Profile: *Patterson Lakes Retaining Wall: Corrosion Protection by Hybrid Anode Installation*

Case Study: *Corrosion of Stainless Steel in Aggressive Water Environments*

MAJOR SPONSOR:

JOTUN

CORROSION & PREVENTION 2018

AUSTRALASIAN CORROSION ASSOCIATION INC.

11–14 NOVEMBER 2018 | ADELAIDE CONVENTION CENTRE, SOUTH AUSTRALIA

Registrations now open! Go to conference.corrosion.com.au

See the preliminary program included in this issue for more information on the accepted list of abstracts, plenary speakers & partner program etc.

SPONSORSHIP AND EXHIBITION

Sponsorship will enable your organisation to make a significant contribution towards the success of Corrosion & Prevention 2018. In return, the conference offers strong branding and exposure in a focused and professional environment. As with every Conference the exhibition will form an integral part of the activities. It provides companies with an opportunity to come face to face with the delegates, providing a marketplace to increase your organisation's visibility and to showcase and demonstrate your products and services.

For further information, please contact Lucy Krelle, Event Manager at the Australasian Corrosion Association +61 3 9890 4833 or email lkrelle@corrosion.com.au who will assist you with your enquiry.

The final program for C&P2018 will be available on the Conference website in September 2018.

conference.corrosion.com.au

Register for Corrosion & Prevention 2018 before Tuesday 14 August 2018 to go into the draw to win: Adelaide Oval Roof Climb and Dinner for two people.

Full Terms and Conditions available on the Conference website: www.conference.corrosion.com.au

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Corrosion & Materials

Corrosion & Materials is the official publication of The Australasian Corrosion Association Inc (ACA). Published quarterly, *Corrosion & Materials* has a distribution of 2,000 to ACA members and other interested parties. Each issue features a range of news, information, articles, profiles and peer reviewed technical papers. *Corrosion & Materials* publishes original, previously unpublished papers under the categories 'Research' and 'Professional Practice'. All papers are peer reviewed by at least two anonymous referees prior to publication and qualify for inclusion in the list which an author and his or her institution can submit for the ARC 'Excellence in Research Australia' list of recognised research publications. Please refer to the Author Guidelines at www.corrosion.com.au before you submit a paper to Tracey Winn at twinn@corrosion.com.au

ACA also welcomes short articles (technical notes, practical pieces, project profiles, etc.) between 500 – 1,500 words with high resolution photos for editorial review. Please refer to the Article Guidelines at www.corrosion.com.au before you submit a short article to Tracey Winn at twinn@corrosion.com.au

The Australasian Corrosion Association Inc

The ACA is a not-for-profit, membership Association which disseminates information on corrosion and its prevention or control by providing training, seminars, conferences, publications and other activities.

Front & Back Cover Photo: *Concrete tank refurbishment at Moculta, South Australia.*

Photo: Paul Vince.

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Huw Dent
President

My fellow corrosionists, it is an honour to serve as President of the ACA in 2018. I look forward to seeing many of you at the Corrosion & Prevention Conference this November in Adelaide.

It is with regret that we see the outgoing Executive Officer Wes Fawaz depart the ACA. I thank him for his service over the past 10 years. He has made a tremendous contribution in shaping the ACA and I wish him all the best for the future.

On behalf of all ACA members, I would like to warmly welcome Richard Reilly into the role of Chief Executive Officer of the ACA. It is great to see someone of his talent and experience join the ACA. I expect he will wield his considerable talents to help steward a positive future for the corrosion prevention industry.

I took last year's conference as an opportunity to reflect on the current state of our industry. Some of the papers presented opened my eyes to how quickly the industry is changing, in particular:

- recent advances in materials technology by 3D printing,
- possible applications of artificial intelligence,
- improvements in protective coating products, and
- the development of new corrosion inhibitors.

Added to these research openings are the observations and lessons being learnt from existing structures, which leads me to believe that our industry is set to influence a better, more efficient and resilient society for all. New techniques and materials will be discovered within our lifetimes that will totally change how we design, maintain and extend the life of infrastructure. There has not been a more exciting time to be involved in the corrosion prevention industry. There has not been a more critical time to stay involved and up-to-date with your peers.

The recent work of Marie Jackson and her colleagues at the University of California has highlighted the embarrassing truth that the ancient Romans had the knowledge and ability to make concrete with better durability than modern humans do. I don't know whether this method became too expensive, took too long, or for some other reason failed to withstand the test of time. However, it is unfortunate that knowledge of their techniques should be lost to the collective societal mind for millennia. This example should be taken as a humbling reminder that none of us know as much as we think we do and that there exist better ways of doing things. Some of these ways humanity may have already discovered and forgotten.

At this point in time, we are each fortunate to be a unique and conscious collection of molecules and compounds. These molecules have combined very briefly after a long succession of our ancestors to make us. Nature will ensure that this collection of molecules will degrade and change over time. We must not squander our brief consciousness, or that of our forebears. We must learn from those around us and those who have come before us. We must each take the time to discuss, learn and pass on the lessons of the past so that our society doesn't collectively forget some other beneficial knowledge. Knowledge that might help us to control the degradation of other atomic substances.

The ACA offers opportunities to network with people who have a wealth of knowledge and experience. The ACA offers training courses and publications that can help us to learn. I encourage you to make use of these resources at your disposal to learn more about corrosion and avoid repeating the mistakes of the past. There is always more to learn about corrosion and the ACA is here to help us.

I extend my thanks to all of those who volunteer within the ACA. The ACA relies on your generosity and passion. Our industry is benefited greatly by your efforts and I encourage you to continue your endeavours.

If you are not involved as a volunteer, I would encourage you to do so. The ACA gets the best value from its constrained resources when there is active involvement from all sectors. By helping others and doing your bit you will help develop yourself and learn from those with whom you engage.

Huw Dent
President

ACA 2018 Events

Part of the role of the ACA is to organise events that bring together industry experts to present new technologies, updates to standards, and share knowledge and experiences via case studies on a variety of projects. Here are the events planned for 2018.

May

Australian Electrolysis Meeting
Thursday 24 May | Brisbane

Concrete Technical Group
Friday 25 May | Brisbane

June

CUI Prevention and Mitigation
Tuesday 19 & Wednesday 20 June | Perth
Monday 25 & Tuesday 26 June | Sydney
Thursday 28 & Friday 29 June | New Plymouth

July

Designing for Durability in the Built Environment
Thursday 5 July | Auckland

APGA Joint Pipeline Seminar
Thursday 26 July | Brisbane

August

Coatings Technical Group
Thursday 9 August | Newcastle

Water Technical Group
Tuesday 21 - Wednesday 22 August | Melbourne

September

Roads and Infrastructure - AustRoads TBC
September | Sydney

Oil & Gas Technical Group TBC

October

Corrosion Management for Industrial Assets
Thursday 18 October | New Plymouth

November

NACE Joint Event – Marine Corrosion
Tuesday 20 November | Cairns

Branch Events

Each of the 8 ACA Branches will conduct regular technical events throughout 2018. To enquire, please contact your local Branch at the following email addresses:

New South Wales: nsw@corrosion.com.au
New Zealand: nz@corrosion.com.au
Newcastle: ncl@corrosion.com.au
Queensland: qld@corrosion.com.au
South Australia: sa@corrosion.com.au
Tasmania: tas@corrosion.com.au
Victoria: vic@corrosion.com.au
Western Australia: wa@corrosion.com.au

YCG Events

Targeting individuals under 35, new to the corrosion industry and/or interested in the corrosion industry, the ACA Young Corrosion Professionals conduct regular events. For further details email ycg@corrosion.com.au or go to www.corrosion.com.au

ACA YCG
THE AUSTRALASIAN CORROSION ASSOCIATION INC
YOUNG CORROSION GROUP

CHAIRMAN'S MESSAGE

Dean Wall
Chairman

Greetings everyone, Easter Holidays have come and gone, and this year is already quarter down and as Chairman of the ACA Board team I recently announced to the corrosion community that we appointed a new leader to our association. Richard Reilly started on April 3 as CEO. We welcome Richard who brings executive experience to the newly created position of ACA CEO, having been the chief executive of the Federation of Automotive Products Manufacturers for over six years. He also spent nine years at professional services firm Deloitte in the Global Investment and Innovation Incentive group, delivering tax services to clients.

Richard is very experienced at working with stakeholders in a membership based organisation, providing advocacy and liaising with key industry and government bodies.

His professional background and experience are an excellent fit for the ACA. Richard will be responsible for delivering key outcomes contained in the ACA's strategic plan and I am sure you will enjoy working with him to further the interests of companies and individuals in the Australasian corrosion mitigation sector and related industries.

Richard will meet as many of you as he can in the future and will be charged with delivering the ACA strategic plan and key projects along with overseeing the everyday operations of the ACA.

The Industry we all work in continues to show good signs of improvement and recently at our February meeting the ACA Board reviewed our final numbers for 2017. These will be presented to Association Members at the ACA's AGM Thursday 24 May in Adelaide.

I can proudly say with training performing stronger in the latter half of 2017, delivering a better than expected budget result, and so far this year with training numbers way up on the same time last year, this is a great result. The ACA team will continue to be challenged to deliver and achieve targets.

As I mentioned previously, the ACA Board met in February this year and I am pleased to report that the ACA Board functions well as a team and is focused on delivering our Strategic Plan for the ACA's future growth and better servicing of the membership.

The Board's individual committees, Audit, Finance and Risk chaired by Board member Chris Badger, and Governance chaired by Graham Carlisle, have also met regularly to oversee the finances and governance of the ACA.

Chris Badger will be leaving the Board at the beginning of June and we thank him for his contribution in leading and guiding the AF&R committee and his service to the Board over nearly two years. The Governance committee will announce a new chairperson after recruitment is complete.

As Chairman, I had the pleasure of representing the ACA at the NACE Corrosion 2018 Conference in Phoenix Arizona in April. The ACA was an Industry Association exhibitor and I was joined by our new CEO Richard Reilly, fellow Board Member Brad Dockrill, and ACA Foundation Chairman Warren Green. We met with fellow Associations, NACE, SSPC and Eurocorr along with others from around the globe. I can report after successful meetings we are pleased to announce that the ACA will be providing ACA training courses overseas as well as expanded course offerings in South East Asia, during the year with other courses soon to be announced. It was very pleasing to see over 30 Australians, presenting, networking and attending the NACE Conference, and to have their help promoting our Corrosion & Prevention Conference in Adelaide later this year. Thank you for your continued support.

During the conference we also met with outgoing NACE President Samir Deegan and incoming President Jeff Didas. We discussed our Associations' ongoing commitment to raising the impact of and cost of corrosion with our respective governments and communities.

The ACA Board will meet in late May in Adelaide and will discuss with ACA Foundation (ACAF) Chair, Warren Green, the ACAF's Business plan and the ACA's ongoing support and importance of what the ACAF provides for the greater good of the corrosion community.

Look out for our 2017 Annual Report on the newly refreshed website in late May at www.corrosion.com.au. In closing, and on behalf of my Board, thank you for your ongoing support of the ACA and I wish you every success for the remainder of 2018.

Dean Wall
Chairman

ACA Training Calendar 2018

All registrations are subject to ACA's published terms, conditions and policies

ACA/ACRA Corrosion & Protection of Concrete Structures

Member $1170 Non-member $1465

Sydney June 4-5

Brisbane September 6-7

ACA Coating Selection & Specification

Member $1640 Non-member $1995

Perth June 13-15

Sydney September 3-5

Corrosion Technology Certificate

Member $2450 Non-member $2870

Melbourne October 15-19

Corrosion Technology Home Study

Member $2450 Non-member $2870

At Home Start anytime

Hot Dip Galvanizing Inspector Program

Member $1640 Non-member $1995

Brisbane July 12-13

Sydney November 29-30

All Australian course fees listed are GST inclusive. All NZ and Thailand course fees are exempt from GST.

To calculate the fee pre-GST, divide the fee by 1.1

NACE Cathodic Protection CP 1 – Tester

Member $3500 Non-member $3855

Brisbane September 10-14

NACE Cathodic Protection CP 2 – Technician

Member $3500 Non-member $3855

Brisbane September 17-21

NACE Cathodic Protection CP 3 – Technologist

Member $3500 Non-member $3855

Brisbane September 24-29

IN-HOUSE TRAINING

Did you know that you can have ACA's suite of courses come to you?

The ACA can present any of its courses exclusively for an organisation; we can also tailor any course to your organisation's specific needs. Please contact the ACA's training department on +61 03 9890 483 or aca@corrosion.com.au

NACE Coating Inspection Program Level 1

Australia Member $3950 Non-member $4490
Thailand Member $3105 Non-member $3348

Melbourne June 4-9

Perth July 9-14

Brisbane August 20-25

Sydney September 24-29

Adelaide October 29-November 3

Pattaya November 19-24

Perth December 3-8

NACE Coating Inspection Program Level 2

Australia Member $3950 Non-member $4490
Thailand Member $3105 Non-member $3348

Perth July 16-21

Brisbane August 27-September 1

Adelaide November 5-10

Pattaya November 26-December 1

Prerequisites now apply to this course.

NACE Pipeline Corrosion Integrity Management

Member $2950 Non-member $3250

Brisbane July 30-August 3

SSPC Concrete Coating Inspection Program

Level 1 $3150 Level 1 and 2 $3675

Melbourne August 27-September 1

THE AUSTRALASIAN CORROSION ASSOCIATION INC.

Meet new ACA CEO Richard Reilly

Welcome to Richard Reilly, newly appointed ACA CEO, who joined the ACA team on Tuesday 3 April, based in the Melbourne HQ.

Richard brings executive experience to the newly created position of ACA CEO, having been the chief executive of the Federation of Automotive Products Manufacturers for over six years. He also spent nine years at professional services firm Deloitte in the Global Investment and Innovation Incentive group, delivering tax services to clients.

Richard is very experienced working with stakeholders in a membership based organisation, providing advocacy and liaising with key industry and government bodies. His professional background and experience are an excellent fit for the ACA. Richard will be responsible for delivering key outcomes contained in the ACA's strategic plan.

Richard is passionate about delivering value to members and is well qualified to lead the ACA, with Bachelor Degrees in Arts and Commerce (University of Melbourne) and a Master's Degree in Business Administration (Melbourne Business School) He is also a graduate of the Company Directors' course from the Australian Institute of Company Directors.

UPDATED

Corrosion of Concrete Structures Training

ACA/ACRA Corrosion & Protection of Concrete Structures & Buildings

TWO DAY COURSE

Sydney: June 4-5 | Brisbane: September 6-7

Background

This course has been updated and provides an understanding of the mechanisms of the corrosion, protection and repair of reinforced concrete structures and buildings. It has been particularly designed for those who have the task of resolving the problems of corrosion of steel reinforced, prestressed and post tensioned concrete elements.

Course Contents

The course is delivered as a series of 11 lectures as follows:

- The Characteristics of Cement and Concrete
- Concrete Deterioration Mechanisms (A)
- Concrete Deterioration Mechanisms (B)
- Corrosion of Reinforcement in Concrete (A)
- Corrosion of Reinforcement in Concrete (B)
- Survey and Diagnosis of Concrete (A) – On-site Measurements
- Survey and Diagnosis of Concrete (B) – Laboratory Measuremnets
- Repair and Protection of Reinforced Concrete (A) – Mechanical Methods
- Repair and Protection of Reinforced Concrete (B) – Cathodic Protection
- Repair and Protection of Reinforced Concrete (C) – Further Electrochemical Methods and Permanent Corrosion Monitoring
- Preventative Measures for New Concrete

To obtain an (optional) ACA certificate in this course, the candidate must pass an exam, based on case studies provided.

Cost:

- Members $1,170
- Non Members $1,465

All course fees listed are GST inclusive.

acra

Register now at www.corrosion.com.au

AUSTRALASIAN CORROSION ASSOCIATION INC.

Denso Australia opens new premises

Leaders in corrosion prevention and sealing technology, Denso Australia, is this year celebrating its 50th year of operation in Australia. To mark the occasion, Denso recently moved its Australian Corporate Headquarters to its brand new, purpose-built premises in Melbourne's northern suburb of Campbellfield.

According to Denso Australia's Managing Director, Paul Fortune, the move will consolidate all Denso's commercial, warehousing and manufacturing activities under one roof whilst creating opportunities for increased production and a wider range of locally manufactured corrosion prevention products ideally suited to the Australian climate.

Denso, which has grown into a household name in the Australian corrosion prevention industry, has seen their products used across a wide variety of applications, providing solutions to the most corrosive conditions the Australian environment can produce.

Denso's comprehensive range of corrosion prevention and sealing products include a variety of specialised pipe and structural coatings, marine protection systems, and concrete and tank linings. With globally recognised brands such as Denso™, Seashield™, Protal™, Archco Rigidin™, PCS™, Denso strip™ and Premier Coatings™.

With a focus on the realities of on-site application Denso provides full applicator training to ensure the installation is completed correctly and in a minimum time frame. Additionally, Denso's systems are tailor-made for individual anti-corrosion and sealing problems, suitable for use in a wide range of highly corrosive environments with operating temperatures ranging from sub-zero to 250 degrees Celsius.

Recent pipeline corrosion protection projects that Denso has been involved in include the APA Group's Victorian Northern Interconnect Expansion Stage 3 in which Denso was engaged to supply Protal 7200 high build epoxy for field joint coating (FJC) materials and mainline repairs, APA's Eastern Goldfields Pipeline Project and Jemena's Queensland Gas Pipeline Looping project using Protal 7200 for FJC.

On the marine side, Denso have supplied SeaShield systems on the Bluescope Loading Wharf (VIC), North Wharf (VIC), Webb Dock (VIC), Groote Eylandt Manganese loading facility (NT), Dalrymple Bay Coal Jetty (QLD) and Queensland Sugar Limited Jetty (QLD).

WSP raises the water level with the acquisition of Opus

With ageing assets, increased population growth and climate variability putting pressure on water and wastewater infrastructure, WSP has expanded its service offering to the water sector through the recent acquisition of Opus.

According to Dean Toomey, WSP's Director of Water, "The addition of Opus significantly strengthens our competitive position globally and specifically in the Australia and New Zealand (ANZ) region with our workforce now reaching 4,610 people.

"As a result of this acquisition, our ANZ water business has doubled in size. We have greater depth to help our clients in asset management and water and wastewater treatment, including access to global water experts in Canada and the UK."

In Australia, our team is delivering two of the largest wastewater treatment programs in the industry – Logan Water Infrastructure Alliance and Lower South Creek Treatment Program in Sydney. In New Zealand, we are the leading asset management firm, having delivered many industry firsts including being recognised for advanced infrastructure asset management on the Dundedin 3 Waters project.

Mr Toomey adds, "In a market impacted by a skills shortage, our water team is well-resourced and perfectly positioned to continue delivering a broad range of services to governments, asset owners and operators. By challenging the status quo, we develop innovative and creative solutions that optimise water and wastewater assets across the entire lifecycle. And, by bringing our global expertise to local situations, we help to nurture the thriving local communities – in which we work, live and play."

Dean Toomey

Paul Vince flies the flag on International Corrosion Board

Paul Vince, WSP's Associate Materials Engineer – Water (and ex ACA Chairman), is the first Australian professional appointed to the NACE International Institute Board, a globally-recognised accreditation body for corrosion management.

With corrosion increasingly impacting infrastructure asset owners and managers around the world with economic, aesthetic and utilisation issues, the need for knowledge has never been greater. The NACE International Institute supports its 36,000 members with training activities, certification and education programs that promote public safety, protect the environment and reduce the economic impact of corrosion.

Mr Vince says, "I am passionate about minimising the impact of corrosion and maximising the life of our clients' assets for the wellbeing of future generations. In doing this, there are significant environmental and economic benefits for the communities in which we operate and live. This role allows me to have a hand in shaping the adoption of international best practice in corrosion management while challenging the status quo."

With specialist expertise in concrete corrosion and durability, Mr Vince is also a former Australasian Chairman and long standing member of the Australasian Corrosion Association. Through this new appointment at the Institute, he will actively participate in a study that is developing methods for measuring corporate effectiveness of corrosion mitigation practices, including training of staff, promotion of corrosion skills and funding for long term investments.

Matthew Stahl, WSP's Executive for Asset Management and Planning says, "This is a great opportunity for Mr Vince to contribute to establishing global standards for corrosion management and share valuable knowledge with our clients to optimise their assets – both in the present and in the future. In turn, this will enable them to provide greater value to their end customers while at the same time nurturing sustainable communities by ensuring safe and reliable potable water and wastewater services."

Infracorr Staff Appointments

Infracorr Consulting has recently announced the appointment of Dean Ferguson as the company's General Manager and Houssam Ben Mansour as their Manager – NSW.

Dean Ferguson, currently the ACA Victorian Branch President and also past YCG Steering Committee Chairperson, has been with Infracorr for 4 years. Houssam Ben Mansour, also currently an ACA NSW Branch Committee Member, joined Infracorr in Melbourne in 2012 and in 2015 moved north to establish their Sydney office.

Infracorr is continuing a period of strong growth with its Sydney office recently expanding to three people amid continued support from its head office in Melbourne.

Mr Ferguson said: "The growth in our business over recent years has been driven by strong relationships with clients who see Infracorr as a trusted and independent advisor. As consultants, our ongoing search for world leading technologies and techniques that we can utilise for our customers' benefit continues to set us apart from the industry. It is exciting to work with a team that continues to push boundaries in delivering the best technical solutions, and our continued growth will ensure we have more capacity than ever to deliver these outcomes for our clients across Australasia."

Dean Ferguson

Houssam Ben Mansour

CCE & Cosasco Team Up

Cosasco, the world leader in corrosion and erosion monitoring technology, has signed an exclusive partnership with Corrosion Control Engineering (CCE). Cosasco manufactures and supplies leading-edge high resolution corrosion and erosion monitoring technologies for the oil and gas, chemical, power and water treatment industries.

The agreement provides wider geographical support for Cosasco's products and services throughout Australia and New Zealand. The combination of CCE's strong presence, with eight offices in the region, and their corrosion industry expertise made this a natural choice for Cosasco. It will ensure the highest level of customer service, sales, and technical support are offered to their customers.

The partnership includes a local team of technical experts including Andy Allen, Cosasco's Perth based Australasian Business Manager and Ben Dahl, CCE's Melbourne based Cosasco Product Specialist.

Pictured from left to right at the recent NACE Conference in Phoenix, Arizona are: Rafael Pelli (CCE Product Specialist), Roland Anderson (Cosasco Executive Vice President) & Jason Paterson (CCE Group General Manager).

Kingfield Galvanizing focuses on the future of sustainable corrosion protection

Underlying Kingfield's win at the 2017 Premier's Sustainability Awards (VIC) is their commitment to deliver a commercially viable benchmark for the future of galvanizing. The award acknowledged the company's commitment to developing a sustainable hot dip galvanizing (HDG) plant to meet the increasing infrastructure and construction needs of our growing population.

Kingfield's focus on sustainable HDG is aligned with Australia's infrastructure development over the coming years, with many major projects such as the Melbourne Metro Tunnel, the Northern Connector and Sunshine Coast Solar Farm registered as ISCA rated projects.

Considering that over 80% of Australians live within 50km of the coastline, we have an increasing need for infrastructure projects to withstand the corrosive nature of coastal environments. Hot dip galvanizing offers high performance corrosion resistance with significant benefits in time to first maintenance and total life cycle costs.

Following 30 years of operating a traditional HDG plant, Kingfield looked to the future when major refurbishments were required to modernise equipment and improve throughput for a growing customer base (see photo below). As a family-owned business, the major shareholders were keen to invest in the long-term future of galvanizing in Australia. Kingfield's plant transformation process explored global best practice and sustainable galvanizing options, which were recently recognised at the Premier's Sustainability Awards.

Kingfield Galvanizing's Chair, Steve Lelli commented "We are still basking in the delight of winning the Premiers Sustainability Award 2017. The acknowledgement of our investment and support for our belief that industry can be environmentally responsible and commercially viable is fantastic. We have a long way to go but, we are committed to further investment that supports our sustainability focus."

In March 2018 Kingfield also won the Australian Construction Awards Process Innovation of the Year Award for their technological advances in the HDG industry.

The ACA attends NACE Corrosion 2018

ACA's Chairman Dean Wall and CEO Richard Reilly, along with a dedicated band of ACA rust busters, recently attended NACE Corrosion 2018 conference in Phoenix Arizona, USA from 15–19 April.

Street Pole Promotion.

Dean Wall, Bob Chalker, Kim Chalker and Richard Reilly.

Dean Wall and Warren Green at the ACA Booth.

NACE Awards Dinner.

Justin Rigby presenting a session.

Jim Feather, Bob Chalker, Dean Wall and Terry Greenfield.

Jeff Didas (incoming NACE President), Dean Wall and Samir Degan (outgoing NACE President).

7-11 October

fib 2018

Melbourne, Australia

BETTER | SMARTER | STRONGER

CONCRETE INSTITUTE of AUSTRALIA | fib CEB-FIP

Congress Dates
7-11 October 2018

Registration Now Open

The 5th International Federation of Structural Concrete *(fib)* Congress is coming to Australia in 2018.

The Congress, focusing on the theme **"Better - Smarter - Stronger",** is dedicated to bringing together leaders and practitioners in the concrete industry from all over the world.

The multidisciplinary theme of the Congress provides an excellent forum to share knowledge, and to learn about advances in the concrete world. With over 580 abstracts submitted from over 50 countries and across 25 themes, there is something for everybody!

Features include:

- 4 day technical program with over 350 presentations
- 5 excellent key note speakers from around the globe
- Exhibitors of concrete products & services from all over the world
- *fib* Awards for Outstanding Concrete Structures Gala Dinner
- Opportunities to connect with world leading concrete practitioners

A Conference of this type is a once in a life time opportunity for the Australian concrete industry to show the world what we can do in our own backyard. Head to our website to secure your registration and find out more.

Professor Stephen Foster
Congress Chair

www.fibcongress2018.com

Ogdensburg bridge is safe for now, but lack of money for repairs is a growing concern

OGDENSBURG (Upper New York State) — While recent numbers provided by the Ogdensburg Bridge and Port Authority show growing revenues at its local airport, the agency still hasn't found a way to come up with the $130 million needed to maintain its 60-year-old Ogdensburg-Prescott International Bridge, the link that brings tens of thousands of Canadian travelers across the international border seeking cheap flights annually.

In August, OBPA officials will undertake a new biennial inspection of the span, built in 1958-59 and opened to traffic in 1960. The upcoming engineering inspection is part of a cycle that occurs every two years and is a state and federal requirement to ensure that the structure is safe.

The last report, issued in 2016, determined that the bridge was in "overall satisfactory condition," and as a result, cross-border traffic, and the commerce that comes with it, continues to flow.

But the safety report two years ago did not offer a clean bill of health.

In carrying out their 2016 inspection, engineers pinned the bridge with multiple Yellow Structural Flags. The warnings, a level below a red flag that could close the span, point out areas where age and fatigue have taken their toll.

In an inspection summary issued to the OBPA in January 2017, the engineering firm of Modjeski and Masters told officials that the rate of deterioration is rising.

"During the 2016 inspection, a total of 86 floor joists in the approaches were observed to have severe corrosion, corrosion holes and/or corrosion induced cracking, with 16 locations warranting a Yellow Structural Flag due to the severe deterioration of the joists located within the high shear zone and at the bearing areas above the girders," wrote Modjeski and Masters Senior Associate Michael S. Januszkiewicz. "The number of deteriorating joists continues to rise at an ever increasing rate, and the gap between the number of deteriorated joists found and the number of joists repaired during each inspection cycle also continues to grow at an accelerated rate."

Is it Safe?

With a fresh round of engineering inspections looming for this summer, the questions again become "just how safe is the Ogdensburg-Prescott International Bridge, and where will the OBPA find the money for maintenance and repairs?"

In a recent interview with the Times editorial board in Watertown, OBPA Executive Director Wade A. Davis, along with Director of Authority Operations Steven J. Lawrence, assured the public that the Ogdensburg-Prescott International Bridge is safe. They were joined by OBPA counsel Mark Wladis, of the Wladis Law Firm.

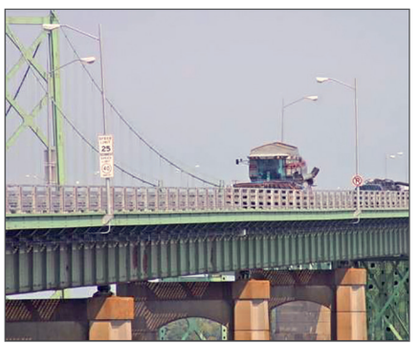
Although the men gave assurances that the bridge is no danger of collapse, they could not say how the OBPA will come up with the money to stay ahead of the bridge's spiking maintenance curve. Repair needs range from $100 million for removing lead paint and repainting the structure to more than $30 million to repair corrosion and issues related to the bridge's steel and concrete support systems.

"Keep in mind that this structure was built in 1958 and 1959," Mr. Davis said. "There are some huge maintenance needs on this thing."

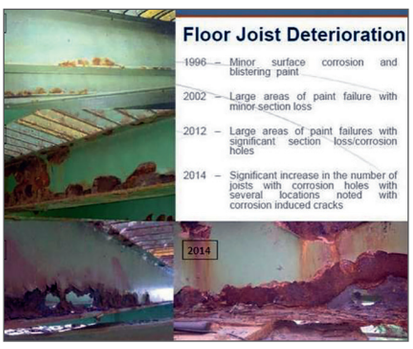
Mr. Davis provided the newspaper with executive summaries from the last three biennial inspections of the bridge, pointing out that independent engineers compiling each of the reports certified that the bridge is safe for travel. However, in doing so, the documents also highlighted a range of discovered problems, from fatigue cracks along metal joints to pitted metal and corrosive holes.

The problems not only highlight the fact that the bridge is showing its age, but they also illustrate the authority's burgeoning need for cash to make repairs.

A view of the Ogdensburg-Prescott International Bridge. Christopher Lenney / Watertown Daily Times.



A combine headed for Lisbon closed traffic in September 2012 on the Ogdensburg-Prescott International Bridge. Christopher Lenney / Watertown Daily Times.



Illustrations of how damage to the underside of the Ogdensburg-Prescott International Bridge has progressed in recent years. Ogdensburg Bridge and Port Authority.

To put the money into perspective, Mr. Davis said, in 2006 the cost of needed maintenance on the span was estimated at approximately $75 million. The most recent tab for a bridge overhaul is approximately $131 million.

"We have a biennial inspection that is done on that bridge every two years, and a copy of that bridge report executive summary has been provided to you folks," Mr. Davis said. "The importance of that is that it has an engineer's stamp at the bottom of it that says it's safe, and that it outlines what the maintenance needs are on it, both short-, medium- and long-term."

But whether short-term or long-term, the financial lift needed for the OBPA to stem the bridge's deterioration is immense.

In March, OBPA officials were notified that they will receive $2 million from the U.S. Department of Transportation's Transportation Investment Generating Economic Recovery Grant Program. The authority had sought money for bridge repairs through the federal grant program multiple times over the years, with the most recent application submitted in 2015.

The $2 million will go toward a $4 million project to remove a portion of lead paint, and repaint sections of the U.S. approach ramp at the bridge. The grant is welcome news, according to the OBPA, but represents just a tiny fraction — 0.015 percent — of the money needed to complete all necessary repairs.

The grant's announcement, in March, is also indicative of just how much time it takes to secure funding for even a portion of the bridge's maintenance needs. And time, as it relates directly to the Ogdensburg-Prescott International Bridge, is money. With each passing year, more corrosion, and other potential safety issues are discovered.

Mr. Davis agreed that the process involved in seeking money for the bridge is one of the issues.

"We submitted seven rounds of TIGER applications, each one better than the last, and we'd get feedback from the various federal officials and offices and actually U.S. DOT themselves," Mr. Davis said. "Scale it back, shrink it down, tune it up, so on and so forth. So this last one, what we did was, we acknowledged, 'Hey, we've got a paint issue.' We scaled it back to the point to take advantage of the scoring as much as we could to get the maximum point score."

The painting project will cost $4 million overall, according to Mr. Davis, with the OBPA required to come up with a $2 million match. The grant is also reimbursable, meaning the bridge and port authority will have to pay for the project first before being paid back by the federal government.

Documented Decay

The deterioration of the Ogdensburg-Prescott International Bridge — its need for paint and its continuing metal corrosion — is not new and has been well-documented over the years. Since it opened in 1960, the structure has never been completely repainted, although spot painting and millions of dollars in structural work has taken place.

In engineering and safety reports conducted in 2012, 2014 and 2016, it was noted that corrosion holes were noticeable and that the bridge's painted surface was in poor condition and worsening. In all three inspections, the bridge was still listed as safe and being in "satisfactory to good condition," although Yellow Structural Flags were nonetheless handed out in each of those years.

The 2016 report, in particular, suggested that it will likely become more difficult over time to maintain the pace of repairs being noted, because as one set of flagged deficiencies are found and rectified, more problem areas are located. "It is strongly recommended that the OBPA issue a steel repair contract to repair the deteriorated joists in the near future to bridge the gap between the number of deteriorated joists found and the number of joists repaired by the OBPA's maintenance crew," the report said.

But there is little money in OBPA coffers to address bridge issues, and Mr. Davis says it has been a challenge to find funding for short-term repairs while simultaneously seeking a larger pool of money to make major renovations.

"We're a $6-million-a-year business and yet we are managing $112 million of assets," Mr. Davis said. "And that is a tough road."

To help stay ahead of repairs and to pinpoint the best places to spend money, the OBPA recently purchased a drone that will be used for the first time this year to make aerial observations of the structure. The authority has also partnered with Clarkson University as part of a program where engineering students have helped develop a computer model of the bridge to more accurately pinpoint areas of stress and to prioritise future upgrades.

However, Mr. Davis and his staff told the Watertown Daily Times editorial board that it's still not enough.

What's needed is a large pool of money, perhaps through a major bonding initiative spearheaded in Albany, that could be earmarked not only for the Ogdensburg bridge but for other infrastructure needs deemed critical around the state.

In the meantime, Mr. Davis said the OBPA is going through the lengthy process of raising bridge tolls as a way to generate more money to keep the bridge repaired and safe. However, raising the bridge fee is expected to take two more years before being approved by state and Canadian officials.

"At the end of the day, that will add about $380,000 to the pot," Mr. Davis said. "That will help, but is a proverbial drop in the bucket."

Mr. Davis said the authority has also adopted a strategy of trying to bolster traffic across the bridge by drawing more people to the Ogdensburg International Airport. He said as many as 90 percent of the airport's users are Canadian.

"We've approached it from the point of view of trying to increase the traffic on the bridge, because if you get enough traffic on the bridge then you can self-fund repairs," Mr. Davis said. "That's where things like developing the airport have helped us; expanding the port is also going to help us because we are working on something that the engineers have already approved."

Although the port project also holds the promise of increasing revenues at the OBPA, Mr. Davis said the roughly $20 million plan to dredge the harbor and expand the port may have to be put on hold because of rising costs.

"We may end up having to push that project off a little bit if we don't get some assistance," Mr. Davis said.

The OBPA's share of the project is expected to be between $5 million and $8 million, according to officials.

By Larry Robinson, Watertown Daily Times
Sunday, April 22, 2018

Newcastle Branch AGM

The Newcastle ACA Branch had a site tour of Amorgalv as its first event for 2018, with 20 members attending. Wayne Sharman, the General Manager of ArmorGalv, gave us an understanding of the ArmorGalv process and the differences to hot dip galvanising, and the different applications that Armorgalv may be used for. We then had a tour of the plant to see how it works and some of the treated components.

We then had our AGM dinner at Hexham Bowling club (which has the iconic 'Ozzie the Mozzie' sign) and were treated to a wonderful meal. The new committee was formed, with Igor Chavez announced as the new Branch President.

Simon Krismer

ACA Queensland Branch AGM and event

The ACA Queensland AGM took place at the Norman Hotel Restaurant, dubbed as 'Brisbane's worst vegetarian restaurant.' It was a fine venue for the many attendees to get to know one another. Many familiar and many new members were present to contribute to the AGM and to listen to our guest speaker Paul Larkin, the ACA Foundation QLD scholarship recipient for 2017. Paul is a civil engineer for SMEC, and is increasingly involved in corrosion and material matters with the SMEC team. The event included a sumptuous dinner and drinks.

The Chair of the meeting and current Branch President, Nick Doblo, started off the evening with introductions of each and every attendee. Nick and Matt Hollywood gave a short summary on activities undertaken in 2017 and the plans for 2018. It was evident that the enthusiasm and energy from the 2017 committee is expected to flow over to 2018. It was a great way for those present to 'break the ice'.

The AGM was run efficiently and nominations and appointments were swiftly made. The committee for 2018 comprises of:

President, Nick Doblo; Vice President, Jason Paterson; Honorary Treasurer, Matt Hollywood; Honorary Secretary, Murry McCormick and YCG Convener, Paul Larkin. There is no fear of these positions being left to bear the load as the balance of last year's committee, and some new faces, vowed to be committed again in 2018.

The Queensland Branch are excited to bring its members a full program of technical and social events in 2018.

Wayne Thomson

PRACTICAL CONSIDERATIONS & SOLUTIONS FOR THE MANAGEMENT OF REINFORCED CONCRETE STRUCTURES

SPONSOR:
AkzoNobel

PROUDLY PRESENTED BY:
AUSTRALASIAN CORROSION ASSOCIATION INC.

SAVE THE DATE

FRIDAY 25 MAY | 8.30AM – 5.00PM | STAMFORD PLAZA BRISBANE

OVERVIEW OF EVENT

The Concrete Structures & Buildings Technical Group of the ACA has produced a technical program that focuses on discussing pragmatic considerations and outlining practical and optimised solutions for reinforced concrete structures. This event continues to build on the success from previous concrete themed events. This event will draw from the presenters' and audience's experience, the lessons they have learnt through real life case studies, and openly explore both successes and failures.

This one day event will bring together all stakeholders to discuss various corrosion issues across the concrete structures and buildings fields.

REGISTRATION

ACA Members – AU$300 (includes GST),
Non-Members – AU$340 (includes GST).

Registration includes, arrival tea & coffee, morning/afternoon tea and lunch.

For further information about this seminar please contact Annalee Gielb on +61 3 9890 4833 or via email at annalee.gielb@corrosion.com.au

PROGRAM COMING SOON

Check the website for details.

CONTINUING PROFESSIONAL DEVELOPMENT

This seminar could be eligible for CPD points (upon assessment by the relevant industry accreditation body).

Register online via the ACA website Events tab at www.corrosion.com.au

ACA Queensland Branch Committee hosts Ross Boucher

The Queensland Branch committee of the ACA invited Ross Boucher from the the ACA HQ to attend the first meeting of the year at the Queensland Maritime Museum. The committee welcomed Ross as part of normal proceedings and dedicated a large proportion of the meeting to understand what plans the ACA has in terms of membership growth, training, finances and Branch support. A number of actions came out of the meeting including: developing events in regional areas and leveraging events off international speakers and experts visiting Australia. The committee felt the effort was worthwhile and that a closer operating relationship with the ACA HQ will result.

Wayne Thomson

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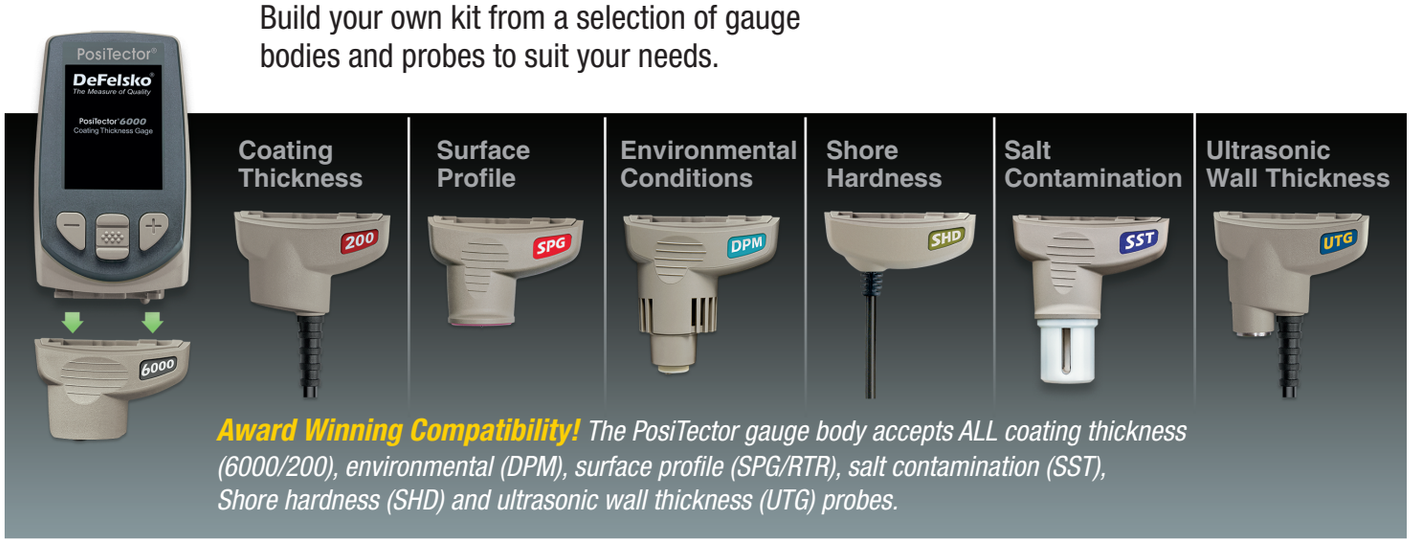

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CORROSION UNDER INSULATION

PREVENTION AND MITIGATION

PROUDLY PRESENTED BY: Australasian Corrosion Association Inc.

SPONSORED BY: AkzoNobel, SN Integrity

3 Workshops

Perth – 19 & 20 June
Novotel Perth , 221 Adelaide Terrace, Perth WA

Sydney – 25 & 26 June
Sydney Masonic Conference and Function Centre,
66 Goulburn Street, Sydney NSW

New Plymouth – 28 & 29 June
Quality Hotel Plymouth International, Cnr Courtenay
& Leach Streets, New Plymouth, New Zealand

PETER BOCK

Overview of Event

This workshop series in Perth, Sydney and New Plymouth will be taught by international Corrosion Under Insulation (CUI) specialist and consultant Peter Bock from Houston, USA. Peter has over thirty years' experience in elevated temperature coatings and CUI, has published numerous articles on CUI issues, and has spoken at NACE, SSPC, ICC and other national and worldwide conferences regarding CUI problems and solutions. The workshop is dedicated to design, specification and inspection of corrosion control systems to prevent CUI in new or aged equipment covering causes of CUI, current state-of-the-art CUI coating systems, inspecting and evaluating aged CUI in the field, suitable CUI repair coating systems, and more.

Register online via the ACA website Events tab at **www.corrosion.com.au**

CORROSION UNDER INSULATION
PREVENTION AND MITIGATION

Continuing Professional Development

This seminar could be eligible for CPD points (upon assessment by the relevant industry accreditation body).

Program as at February 2018 (subject to change by the ACA)

Day 1 History and Basics, Corrosion, CUI, CUI Coatings

Introductions, Meet and Greet, Paperwork	8:15–8:45
Purposes, Schedule, Photo Tour	8:45–9:15
Safety	9:15–9:30
Introduction to Corrosion and CUI	9:30–10:20
Break	10:20–10:30
The CUI Cycle	10:30–11:20
Historical Perspective on CUI	11:20–12:00
Lunch	12:00–1:15
Short History of Elevated Temp. Coatings	1:15–1:45
NACE, API, CINI and ESC Standards	1:45–2:25
Hands-on Demonstrations	2:25–2:45
Break	2:45–3:00
Familiar CUI Liquid Applied Coatings	3:05–3:45
New Technology Liquid Applied CUI Coatings	3:45–4:15
Non Liquid CUI Coatings: Tape, Foil and TSA	4:15–4:40
Questions and Discussion	4:40–5:00

Day 2 Fireproofing, Insulation, Jacketing, Inspection

Recap of Day 1 Presentations	8:15–8:30
Basics of Fireproofing	8:30–9:05
Insulation	9:05–9:45
Spray-on Insulations	9:45–10:05
Break	10:05–10:15
Jacketting (Cladding)	11:15–12:00
Lunch	12:00–1:15
Questions and Discussion	1:15–1:30
Hands-on Demonstrations	1:30–2:10
New Technology in Jacketing	2:10–2:20
Laboratory Testing of CUI Coating Systems	2:20–3:00
Break	3:00–3:15
Close out Hands-on Demonstrations	3:15–3:30
Inspecting and Repairing CUI	3:30–4:10
Risk Based Inspection for CUI	4:10–4:40
Course Recap, Questions and Discussion	4:40–5:00

Registration: ACA Members – $800 (Incl. GST). Non-Members – $950 (Incl. GST).
Please register online via the ACA website Events tab at www.corrosion.com.au
Registration includes, arrival tea & coffee, morning/afternoon tea and lunch.
Handouts from the Seminar will be available in a hard copy booklet.

For further information about this seminar please contact Annalee Gielb on +61 3 9890 4833 or via email annalee.gielb@corrosion.com.au

ACA Auckland Meeting Report and ACA Auckland AGM

February 2018

ACA Auckland Division held the February meeting at the Surrey Hotel, Grey Lynn, Auckland, on the 28th February 2018. The invited speaker was Mr Campbell Batts, MD Spiraweld Stainless Ltd, who addressed the subject of 'Surface treatments for fabricated stainless steel items to improve corrosion resistance.' The attendees gathered for refreshments in the lounge before the meeting and it was great to welcome a number of new ACA members and to meet visitors at the first meeting of the year.

Campbell outlined the development of the Spiraweld business over the years and noted that the management policy was to deliver customers with high quality products that exemplified the best industry practice for surface finishing of fabricated stainless steel (SS) components. To this end Spiraweld had carried out research on electro-polishing in association with the Callaghan Institute and recently they had approached AUT about assistance with further research. Spiraweld also manufacture spiral-welded SS pipe of various diameters in a number of grades including austenitic grades 304, 316 and duplex grade 2205 SS

Campbell's presentation outlined many aspects of the industry processes for surface finishing and cleaning of new and used SS fabricated items:

- Mechanical polishing including No.8 mirror finish
- Bead blasting with various media
- Pickling and passivation with mineral acids
- Electro-polishing in acid baths
- Cleaning of used SS items

Campbell described the pros and cons of each technique, but he favours the electro-polishing (EP) technique because of the pleasing lustrous corrosion-resistant SS surface finish that EP produces on SS fabrications. He then outlined how a modern surface finishing plant carries out the EP process on various geometry SS components and he passed around SS samples to illustrate the excellent results from EP. He described several recent projects carried out by Spiraweld to illustrate how they electro-polish larger SS fabrications.

Spiraweld put a strong emphasis on safety practices in their plant for staff, as required by government inspectors. He also mentioned the daily issues they face with waste disposal of spent chemicals that are used in SS surface finishing. An extensive Question & Answer session followed the presentation and Campbell ably demonstrated his sound knowledge of the SS surface finishing industry. The speaker was thanked for his most informative presentation by the meeting Chairman Les Boulton.

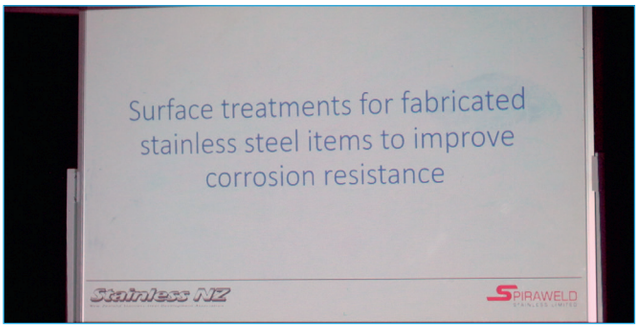
The technical meeting was preceded by the 2018 Annual General Meeting of ACA Auckland Division. At the 2018 AGM the following ACA members were elected to the Auckland Division Committee:

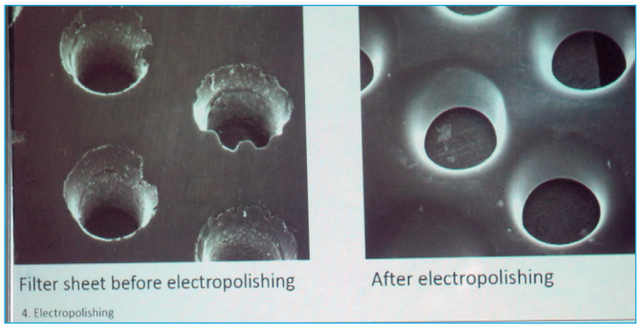
Raed El Sarraf (WSP Opus), Les Boulton (LBA), Hanieh Ghominejad (WSP Opus), Matt Vercoe (MSS), Ash Arya (CSP Coatings), Michael Williams (Target Painters), Andrew Allan (Dulux), Damian Wilson (CCE), Reuben Reeves (Sika).

The Chairman thanked former Auckland Committee member Grant Chamberlain for his valuable contributions to the ACA Committee over the years, as Grant has now moved to Christchurch with his work for Corrosion Control Engineering (CCE).

Les Boulton

Spiraweld Stainless MD, Campbell Batts, gives his presentation at the ACA Auckland meeting.





ACA NZ Branch AGM 2018

The ACA NZ Branch AGM 2018 was held at the Surrey Hotel, Auckland, on 22nd March.

At the well-attended AGM the following members were elected to the NZ Branch Committee for 2018-2019:

President:
Patricia Shaw, Callaghan Institute

Vice President:
Matthew Vercoe, MSS

Secretary:
Mark Sigley, First Gas

Treasurer:
Willie Mandeno, WSP-Opus

Education:
Willie Mandeno

Membership:
Hanieh Ghominejad, WSP-Opus

Technical:
Raed El Sarraf, WSP-Opus

Electrolysis:
Mark Sigley

Branch Editor:
Les Boulton LBA

ACA Council Representatives:
Patricia Shaw & Willie Mandeno

At the closure of the AGM, the incoming NZ Branch President, Patricia Shaw, thanked Raed El Sarraf for his service as Branch President over the past two years.

Les Boulton

The NZ Branch Committee members who attended the Branch Committee meeting held before the AGM.

The audience present at the Branch AGM.

WA Branch Event

The WA Branch recently had the pleasure of hosting Dr. Mariano Iannuzzi from Curtin University for a presentation on hydrogen stress cracking of age-hardened nickel alloys. Mariano recently joined Curtin University as the Chevron and Woodside Chair in Corrosion and Professor of Materials and Corrosion Science. His presentation drew extensively on prior industry and academic experience and challenged the audience to consider their preconceptions of precipitation hardened nickel alloys. Often perceived as the Rolls Royce of metals thanks to their high strength, highly corrosion resistance and high cost, nickel alloys find use in applications like aerospace engine parts and are extensively used in the subsea oil and gas industry alongside high alloy super duplex, stainless and low alloy steels.

With a focus on three alloy grades (716, 718 and 725), the audience learned about what makes nickel alloys so different from iron based steels, their different alloy compositions, the key ingredients for precipitation hardening, deleterious phases and fundamental metallurgy and the different heat treatments used to bring about different grades of specified minimum yield strength.

While Mariano's research specialities now include the hydrogen stress cracking and localised corrosion aspects of corrosion resistant alloys he reminded the audience that at one point in his career he might have said (if asked) that age-hardened nickel alloys were not susceptible to hydrogen cracking or stress corrosion cracking. Indeed he pointed out that one international standard suggests that, treated correctly, these alloys tolerate a wide range of severe service conditions. His examination of four published industry failure case studies under relatively benign conditions clearly showed this was not always the case. In a sneak peek of an upcoming paper he outlined results suggesting that subtle variations in alloy processing could have markedly disproportionate effects on their hydrogen cracking resistance between vendors and even between batches from the same vendor. Mariano also shared his insights into the limitations of optical microscopy-based quality control measures used in industry standards and the work being done to improve their accuracy.

A fruitful question & answer session followed the presentation, including queries from the end users of age-hardened nickel alloys and metallurgy experts in the audience, demonstrating Mariano's sound knowledge of fundamentals and his extensive experience. Mariano plans to continue setting up research collaborations into this broad and international subject and we look forward to hearing more about his insights.

Benjamin Ho

Marianno Iannuzzi.

Thanking Mariano for his presentation.

Some of the attendees at WA Branch event,.

DESIGNING FOR DURABILITY IN THE BUILT ENVIRONMENT

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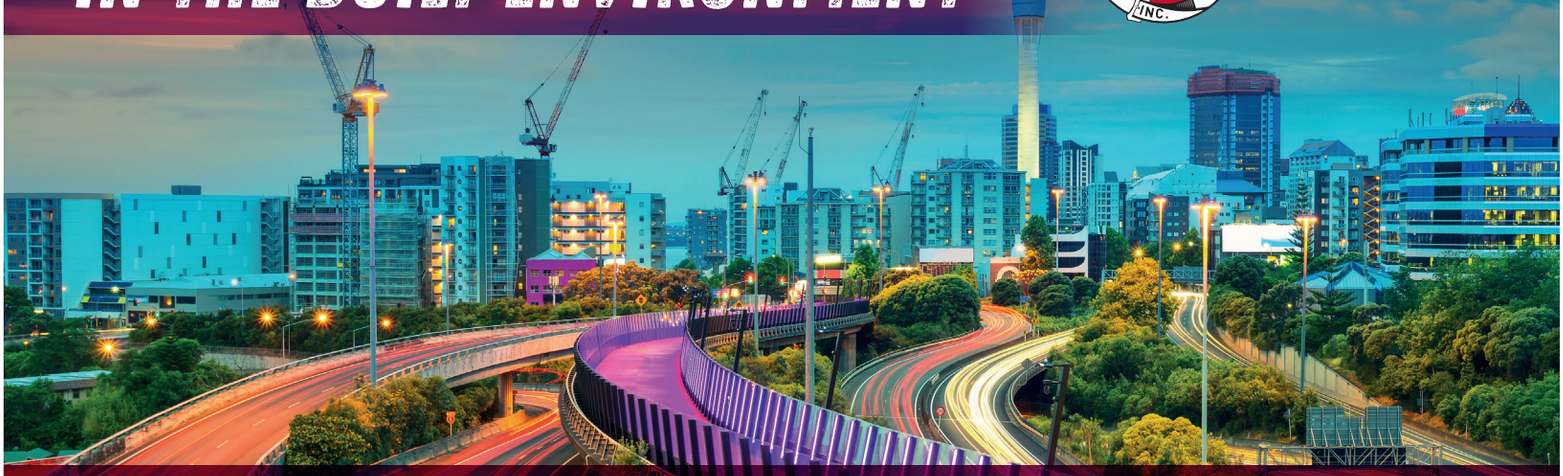

THURSDAY 5 JULY | 8.30AM – 5.00PM | QUALITY HOTEL PARNELL, AUCKLAND

OVERVIEW OF EVENT

The New Zealand Building Code (NZBC) sets the performance standards that all structures are required to comply with. Its main purpose is to ensure they are safe, healthy and durable for everyone who may use them. The guidance given in the B1 Structures clause is clear on how engineers, and users, can work toward its compliance (which includes a rigorous peer review process). Unfortunately it appears that there are limitations with the B2 Durability clause of the NZBC, which has led to misunderstandings on achieving compliance, especially in regards to Acceptable Solution's or using the Verification Methods for some construction materials.

This is especially an issue when Councils are requesting Producer Statements that are signed covering B2, but how can Engineers and Architects sign them if the means of achieving compliance is not clear?

This seminar will commence by highlighting the issues and challenges being experienced by Design Engineers and Architects, in meeting the expectations or requirements of City Councils. This will then be followed by industry organisations (structural steel, stainless steel, concrete and timber) and product suppliers discussing how compliance and achieving the required service life can be demonstrated. It will include case studies highlighting examples of durability problems due to poor design, specification, installation and application.

The seminar will conclude with an open forum, where discussion on a way forward will be had; as well as other topics raised by the audience during the day.

Exhibition Opportunities Available
For further information please contact Lucy Krelle +61 3 9890 4833 or email lkrelle@corrosion.com.au

REGISTRATION

ACA Members – AU$220 (No GST Applies).
Non-Members – AU$275 (No GST Applies).

For further information about this seminar please contact Annalee Gielb on +61 3 9890 4833 or via email at annalee.gielb@corrosion.com.au

PROGRAM

TIME	PRESENTATION TITLE	PRESENTER
8.30 - 8.45	Registration & Exhibition	
8.45 - 9.00	Welcome & Seminar Opening	Stuart Hobbs, ProConsult (Chair)
9.00 - 9.30	NZ Building Code B2 (Durability) - Issues, Solutions and Where to From Here	Raed El Sarraf, WSP Opus
9.30 - 10.00	Challenges Facing Architects When Designing For Durability	Tony Bouwmeester, WSP Opus
10.00 - 10.30	Steel can be Durable, This is how you Design for It!	Kevin Cowie, SCNZ
10.30 - 11.00	Morning Tea	
11.00 - 11.30	Concrete Durability in New Zealand: Design Guidelines, Specifications and Practice	James Mackechnie, Concrete NZ
11.30 - 12.00	Fastener Durability in Timber Structures	Nick Marsten, BRANZ
12.00-12.30	The Role of Stainless Steels in Architecture, Building and Construction	Les Boulton, Nickel Institute
12.30 - 13.30	Lunch	
13.30 - 14.00	Using Metal as a Cladding Material	Rod Newbold, BlueScope
14.00 - 14.30	Sponsor - TBC	Sponsor - TBC
14.30 - 15.00	Durability for Stakeholders - An Observation of Expectations in the NZ Construction Market	Reuben Reeves, SIKA
15.00 - 15.30	Afternoon Tea	
15.30 - 16.00	Views fom Both Sides of the Fence – Stories of When Things Go Wrong	Michael Williams, Target Painters
16.00 - 16.50	Open Speakers Forum	Stuart Hobbs, ProConsult
16.50 - 17.00	Seminar Close	

Register online via the aca website Events tab at www.corrosion.com.au

NEW PRODUCT SHOWCASE

The ACA does not officially endorse any of the products advertised in *Corrosion & Materials.*

MCM-2 Moisture Meter For Corrosion Under Insulation (CUI)

Designed as a screening tool to rapidly locate areas of trapped moisture, the MCM-2 works well in conjunction with corrosion detection equipment to quickly detect areas where corrosion under insulation (CUI) is highly probable.

Features:

- Fast and easy to use; allows thousands of feet of insulated pipe to be tested in a day.
- Designed for maximum accessibility in hard-to-reach areas.
- Telescopic pole allows for testing from a distancof more than 3 metres.
- Microprocessor based. Direct readout in engineering units. All tests can be stored and identified as to pipe or vessel and location. Using the RS-232C serial interface, the data can be quickly uploaded onto a computer or printer.
- "Quick Test Mode" for automatic readings and comparisons with a dry standard. User entered tolerance levels for very fast moisture detection.
- Up to 24K storage capacity for moisture readings and other key data.

Applications:

- Evaluate insulated tanks and vessels quickly for potential corrosion problems.
- Investigate insulated pipe for high concentration of moisture to identify areas for corrosion inspection.
- Quickly detects levels in containment vessels.

Simplicity of Operation:
This state-of-the-art instrument offers two easy-to-use operating modes. The manual mode allows individual tests to be taken at the push of a button, and then recorded in memory. The Quick Test mode takes continuous readings, one every second.

Licensing and Training:
Instrotek offers the necessary radiation safety and application training to ensure proper use of this device on a continuous basis.

Rugged and Reliable:
The MCM-2 detector assembly is enclosed in strong light-weight aluminium housing. The LCD readout is sealed in a dust-proof and water resistant enclosure. The padded shoulder bag offers additional protection and convenience.

Data Logging:
Data logging capabilities allow storage of thousands of readings. The operator can format the memory to identify location, date and time or direction of measurements using a 5-digit ID number. Data can be transferred to a computer or printer and is compatible with most spreadsheet programs.

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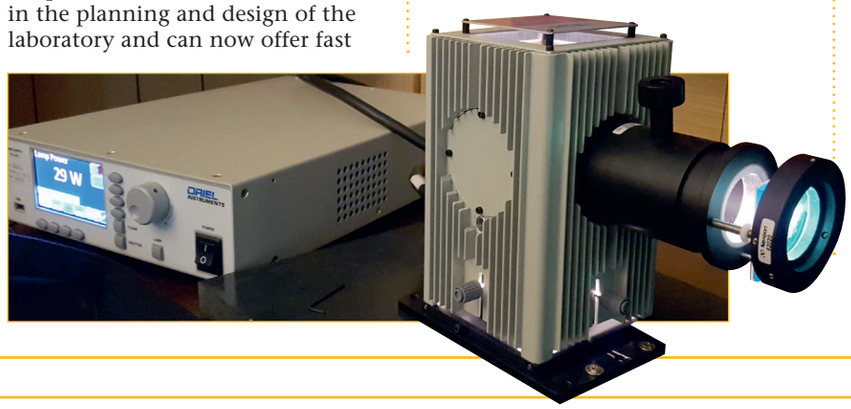
W: www.ndt.com.au

RFS sets up Australian NDT calibrations lab for UV lights

Did you know that Russell Fraser Sales (RFS) has a dedicated, in-house radiography laboratory for the calibration of the Ultraviolet (UV) sensors and lamps they sell? RFS partnered with Spectronics Corporation in the United States in the planning and design of the laboratory and can now offer fast and NIST traceable calibrations in Australia.

The lab was custom designed for the calibration of Spectroline equipment, including Accumax, AccuPRO, 555 Luminance sensors, and all Spectroline UV lamps. RFS' qualified lab technician Paul has a background in science (Bachelor of Science in Nanotechnology (Hons)) and now all calibrations of Spectroline light meters can be performed in-house, rather than waiting for them to be sent overseas, saving you valuable time and money.



If you have a product which requires repair, calibration or service, contact RFS for assistance:

T: +612 9545 4433
E: rfs@rfsales.com.au
Web: www.rfsales.com.au

New videoscope from Mitcorp

Russell Fraser Sales (RFS) has created a new YouTube video to add to their growing catalogue of in-house "unboxing" product review videos for the NDT industry. In this latest unboxing video resident borescope expert Warren walks us through the new F1000 videoscope from Mitcorp.

In this highly informative 5 minute YouTube video, Warren covers everything from what's included in the box to all the important features of the F1000, including its very clear and detailed screen images to the largest range of probes available, including flexible, semi-rigid, articulating and dual-camera types. Warren demonstrates the image quality, build-quality and range of probe options and explains the benefits for a wide range of applications, including NDT, engine cylinders, mechanical works, pipe inspection and a host of other inspection jobs.

Check out the new F1000 unboxing video (along with all of RFS' other videos) on the "Russell Fraser Sales Pty Ltd" YouTube channel or on the RFS blog.

The link to the video mentioned in the article is as follows: https://youtu.be/WrpR-E24iIk

Be sure to subscribe to Russell Fraser Sales' YouTube channel and other social media accounts to stay up to date.

For more information contact Russell Fraser Sales today:
T: +612 9545 4433
E: rfs@rfsales.com.au
Web: www.rfsales.com.au

New Swarm® Non-Intrusive Real-time Wall Thickness Monitor


Swarm® Wall Thickness Monitor

Swarm® is a high resolution ultrasonic corrosion and erosion monitoring system which provides rapid response to wall thickness changes in pipelines, topsides and vessels. It is non-intrusive, installed and operated without interfering with asset production. There is no requirement to remove coatings, no gluing, no welding and no hot work permits required.

The system is available through Corrosion Control Engineering's affiliation with Cosasco, who has signed an exclusive partnership with Sensorlink.

Swarm® is a fixed point, online, non-intrusive ultrasonic monitoring solution that provides precise, reliable and repeatable pipe wall thickness measurements, in real-time. The sensor offers unrivalled speed and accuracy for detecting corrosion and/or erosion.

For more information email the Corrosion Control Engineering (CCE) team at: contact@cceng.com.au

MEET THE YCG COMMITTEE

ACA YCG

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Hannah Watchman – YCG Chairperson South Australia

Please provide your Name, Company, Job Title

Hannah Watchman, Department of Planning, Transport and Infrastructure, Project Officer Overhead Wiring

Tell us about your day to day employment and how it relates to corrosion prevention?

I work with the overhead wiring engineering team in the day to day management of maintenance operations. The Department of Planning, Transport and Infrastructure (DPTI) is responsible for the maintenance of the Adelaide Metropolitan Passenger Rail Network (AMPRN). The rail network includes a diverse range of assets including track, signals, communications, stations, rolling stock, traction systems, overhead wire and civil structures. Corrosion awareness is a big part of optimising asset management particularly on our electrified network where stray current corrosion can be a big issue.

How do you think the YCG can benefit young/new members of the corrosion industry?

The YCG provides a platform on which young and new members can build knowledge and relationships. By networking and bridging the knowledge gap between those new to the industry and the veterans we can avoid mistakes of the past and ensure the ACA continues for years to come.

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

I'm passionate about connecting people. Great things happen when people connect. Building relationships through trust and active communication will let people know what kind of opportunities to look for.

What do you hope to achieve in your time on the YCG committee?

I first became a member to learn and connect with people. I didn't know a lot when I first started but through a valuable network of experts I've built a good foundation of knowledge. Now I am the chair of the National YCG Steering Committee and a Vice President of the South Australian Branch Committee as a way to give back and help the next generation of corrosion enthusiasts succeed.

Huw Dent – South Australia

Please provide your Name, Company, Job Title

Huw Dent, GPA Engineering, Senior Mechanical Engineer

Tell us about your day to day employment and how it relates to corrosion prevention?

My work is divided between engineering design and pressure vessel inspection as a consulting engineer. I consult across all heavy industrial sectors with a particular focus on the energy sector (power generation and oil & gas). I have a passion for learning about steam systems and corrosion monitoring/prevention.

How do you think the YCG can benefit young/new members of the corrosion industry?

Australasia needs an intelligent and informed group of influential corrosion professionals to maintain the growing amount of infrastructure. This is important to ensure that we have a productive nation and a safe community. The YCG supports young/new members of the ACA to integrate with the corrosion industry. The YCG aims to provide the support and knowledge that is usually taken for granted by more experienced people in the field.

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

My involvement with the ACA as a volunteer has yielded personal development opportunities that I value much more than what I have been required to give. I didn't expect this and have been pleasantly surprised. I expect that others who I have got to know have also benefitted more than they have put in. The ACA Foundation has been very generous and given out many scholarships for conference attendance for young corrosionists. In addition to receiving one of these scholarships, it has been great to get to know my industry peers, many of whom I now consider friends.

What do you hope to achieve in your time on the YCG committee?

I am keen to share my early experience in the YCG with other young corrosionists and start preparing the YCG for a strong future before I am considered too old to participate. I expect that the people who join the YCG are likely to be the future captains of industry. They will be the most informed people in their organisations and the quiet achievers that will support a productive Australasian community. It would please me to feel as though I had helped someone succeed in their career and the strengthening of the ACA in the future.

MEET THE YCG COMMITTEE

Candice Blackney – Victoria

Please provide your Name, Company, Job Title

Candice Blackney, Select Solutions, Corrosion Protection Engineer.

Tell us about your day to day employment and how it relates to corrosion prevention?

I work in the corrosion protection department of Select Solutions on a 5-year-long Melbourne Water maintenance and capital contract. I am responsible for the project management and engineering involved in this contract. This means I do CP system design, installation, commissioning, refurbishment and maintenance, pipeline potential surveys, test point installations, DCVG surveys, flange integrity testing, interference investigations and all that technical corrosion engineering type work. Additionally I do budget management, client liaising, materials procurement, works organisation, safety management and a lot of other work associated with delivering a contract. All of this is with the aim to protect Melbourne Water's pipelines from leaking and needing replacement. Ultimately this is good for the community, tax payers and the environment, like all corrosion protection!

How do you think the YCG can benefit young/new members of the corrosion industry?

The YCG and ACA in general, is a truly fantastic organisation. The YCG hosts many events throughout the year which will (1) help you connect with and make similar aged friends in the corrosion industry (2) introduce you to other members and industry contacts in the ACA (3) Technical and career learnings and (4) give you a great night/day out… often with free food and drinks!

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

My involvement with the ACA YCG has helped me also get involved in the wider ACA where I have attended an ACA council meeting and a board planning day. Through the ACA YCG I have some great industry contacts so I never feel like I would be without someone to go to as a mentor, for technical help or even employment. The YCG also offers many scholarships and programs, like the all-expenses-paid two-day personal development course the ACA YCG ran a few years ago.

What do you hope to achieve in your time on the YCG committee?

I have served 5 years on the YCG committee and this is my second year as Victorian Branch Chairperson. This year we have a very strong focus on forming a community amongst the Victoria YCGers, with a lot of fun and social events. I would like to engage young corrosionists not just in the industry but with each other so that they see the world of corrosion protection as contributing to their overall life satisfaction. After all, isn't happiness the goal of life? I want to be a part of making that happen!

William Ward – New South Wales

Please provide your Name, Company, Job Title

William Ward, Papworth Construction Testing Equipment, NSW manager.

Tell us about your day to day employment and how it relates to corrosion prevention?

As the NSW manager for PCTE I am responsible for sales, training and support on a range of non-destructive and laboratory testing equipment. Corrosion location and evaluation, along with the measurement of properties that relate to concrete durability are key outputs of this test equipment. Without real information about the current condition of assets exposed to the environment it is difficult to make informed decisions about asset management and the scop or remedial works.

How do you think the YCG can benefit young/new members of the corrosion industry?

The YCG offer a chance to reach out to the people who are considering their first steps into the corrosion industry, and for those who are beyond that, as a place to learn from their peers. It ensures that there is real outreach from the ACA with a focus on the future.

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

Through my involvement with the YCG I have had the opportunity to work closely with a team from all areas of the industry, consultants, installers, inspectors and more. Working together gives me perspective on my place in the industry as a representative with a supplier and also the chance to practice skills I would not normally do so in my day to day job, such as event planning and design.

What do you hope to achieve in your time on the YCG committee?

I hope that NSW can continue to create new opportunities for university students and those new to the corrosion industry to learn, and to continue to work with the rest of the NSW committee in their events and plans for the future of the ACA.

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MEET THE YCG COMMITTEE

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Paul Larkin – Queensland

Please provide your Name, Company, Job Title

Paul Larkin, SMEC Australia Pty Ltd, Engineer – Materials Technology.

Tell us about your day to day employment and how it relates to corrosion prevention?

Day to day, I undertake condition assessment of transport, water and wastewater infrastructure. The main aim of virtually all the condition assessments work I undertake, is to determine the presence/future likelihood of corrosion, either in steel reinforcement, or in steel components. Based on the findings of condition assessment inspections, I will assist my team in developing appropriate management strategies and remedial recommendations to mitigate the impacts of/prevent corrosion.

How do you think the YCG can benefit young/new members of the corrosion industry?

I see the YCG as providing young/new corrosion engineers with the opportunity to interact with colleagues and more senior engineers. This should introduce newcomers to the industry (like myself!) to some of the many different career paths they can take. I also see the they YCG as a forum to learn how individuals have gained their qualifications, and find out what sorts of training courses and opportunities are out there.

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

Involvement in the YCG has helped me expand my professional network, allowing me to meet a sizeable portion of Queensland's corrosion engineers! Involvement in the group also helps me maintain my interest and passion for corrosion engineering outside of my typical work environment.

What do you hope to achieve in your time on the YCG committee?

In my time with the YCG I hope to raise the profile of corrosion engineering, to show young engineers how many viable career paths are open to engineers within the corrosion industry. I hope that I can use my involvement in the committee to further my career by being in the loop regarding training and learning opportunities.

Willamina Warner – Newcastle

Please provide your Name, Company, Job Title

Willamina Warner, Bureau Veritas, Junior Structural Engineer

Tell us about your day to day employment and how it relates to corrosion prevention?

I am currently studying Civil Engineering full time and working as a Junior Engineer at Bureau Veritas. I work in the Structural Integrity Department this involves conducting structural integrity inspections and dealing with corrosion on a daily basis. We identify and categorise levels of corrosion present and present how it should be treated, whether monitor, remove and apply a protective coating or if the corrosion is presenting a structural hazard and needs to be replaced.

How do you think the YCG can benefit young/new members of the corrosion industry?

I have just become a member of the YCG this month. It is a great opportunity to network and meet like-minded individuals. It offers a platform to connect with other industry professionals.

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

I joined ACA YCG after being inspired by a lecturer and fellow Newcastle ACA member. The ACA provides opportunities to increase my knowledge about corrosion, as I am studying Civil Engineering it is likely my career will involve corrosion mitigation and being part of the YCG gives me an edge as my understanding of corrosion is growing.

What do you hope to achieve in your time on the YCG committee?

I hope to be an active member and inspire others to learn about corrosion.

MEET THE YCG COMMITTEE

Sean Ryder – New Zealand

Please provide your Name, Company, Job Title

Sean Ryder, Phoenix Solutions, Company Director

Tell us about your day to day employment and how it relates to corrosion prevention?

Phoenix Solutions is a multidisciplinary consulting company. Corrosion Prevention is one of our primary business streams providing a range of solutions to meet unique client requirements. Every day is different, we regularly work on CP systems for NZ's largest Water authorities including pipes and any reinforced concrete structure. As well as condition assessment and remediation advice to Government Asset owners for wharves, marinas, large bridges, carparks, buildings, wastewater treatment plants and reservoirs. Durability is a key consideration of our advice, aiming to give clients the best whole of life value from new investment and safely extend the life of existing assets through protection, repairs and/or maintenance.

I particularly enjoy the travel all around New Zealand, Australia and the US that comes with my work. I also enjoy utilising technology (such as drones) to gain efficiencies and different perspectives for our clients.

How do you think the YCG can benefit young/new members of the corrosion industry?

It is a great opportunity for new members to mingle with others at the same level as well as seasoned experts, asset owners and potential employers. It exposes them to different aspects of the job and can help them discover or firm up their career path and specialisation.

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

Many of the challenges we face are the same, so being able to bounce ideas off each other is of great value. Being around others in the industry provides a great sounding board from both a business and technical perspective.

What do you hope to achieve in your time on the YCG committee?

I look forward to helping others get started in the industry and to connect them with companies and people that benefit from their skill set. Learning is a two way street and I am excited to hear fresh ideas and thinking from newer members. This is a rewarding industry and would like to get more people involved.

Giles Harrison – Western Australia

Please provide your Name, Company, Job Title

Giles Harrison, Extrin, Project Manager

Tell us about your day to day employment and how it relates to corrosion prevention?

I work as a consultant so my day to day employment varies quite vastly depending on what projects I am working on. One day I may be designing a cathodic protection system, the next I will find myself on a mine site undertaking some project management work. The consultancy aspect of the corrosion industry interested me for this reason. It allowed me to work on the whole range of corrosion issues whether it is based in our offices in Perth, outback or overseas.

How do you think the YCG can benefit young/new members of the corrosion industry?

A lot of time has gone into coming up with an agenda for the YCG that will be of maximum benefit to the new comers to the corrosion industry. Hopefully the organisation of quality events with an even mixture of technical knowledge and networking/socialising will assist the member's personal, professional or business development.

How does your involvement with the ACA YCG help you achieve your own personal and professional goals?

The ACA YCG is a great platform for meeting other likeminded individuals in the corrosion industry as well as providing support for people new to the industry. By being a part of the ACA YCG one can get a taste of what the ACA has to offer, as well as building networking relationships that can help you achieve your own personal and professional goals as well as helping others achieve theirs.

What do you hope to achieve in your time on the YCG committee?

I joined the YCG at a time when the committee was re-establishing itself and coming back 'online'. Since that time I have been the YCG representative and the YCG national chairman. As the ongoing WA YCG representative I hope to assist others, that were perhaps in the same situation as myself and benefit from the support that the group provides.

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EVER THOUGHT ABOUT JOINING THE YOUNG CORROSION GROUP?

The Young Corrosion Group (YCG) is the Australasian Corrosion Association's Youth Networking Platform.

The YCG organises events of value for professional and personal development, to those new to the corrosion industry, under 35 or those in the industry for less than 10 years. It provides a platform of access to information and networks which are of benefit to personal, professional or business development.

The YCG is now recruiting!

We are looking for fresh faces to join us; to continue the growth and collaboration between the Young Professionals of the various industries we serve.

If you would like the opportunity to share information and develop skills in Leadership, Event Management, Networking to name a few apply to join the committee now! There are positions available at both Branch and National Steering Committee level.

If you need any further information please email ycg@corrosion.com.au or contact the National Committee Chair Hannah Watchman at Hannah.Watchman@sa.gov.au.

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YOUNG CORROSION GROUP

2018 CORROSION TRADE SHOWS

TASMANIA

Wednesday 30 May, Hotel Grand Chancellor - Hobart

1 Davey St, Hobart

Exhibitors so far: Industrial Galvanizers, Hychem International, Phillro Industries, Dulux Protective Coatings, Sherwin Williams

Exhibition Times: 4:00-7:00pm

Registration Free but essential

Drinks and fingerfood provided

Tables $330

VICTORIA

Wednesday 11 July, Oaks on Market

60 Market St, Melbourne

Times: 4:00 - 7:00pm

Registration Free but essential

Drinks and fingerfood provided

Tables $250

For more information and to register visit the Events tab at www.corrosion.com.au

ACA Standards Update

Welcome to the corrosion related standards report for May 2018.
The standards reporting for 2017 is scheduled against specific interests and as indicated below:

Issue 2018	Standards search for Specific Interests
February	Oil & Gas
May	**Water & Wastewater**
August	Concrete & CP
November	Asset Management / Coatings

This Standards report focuses on Water and Wastewater in relation to corrosion.

As previously this is in two stages, namely:

1. A global standards and publication focus at **16 April 2018**, searching through SAIGLOBAL Publications at https://infostore.saiglobal.com/store, for all current publications and standards relating to corrosion and its prevention for the topic of 'Water' and 'Wastewater'.

These results are shown in Table 1.

2. A SAI Global search, as previously, at https://infostore.saiglobal.com/store/default.aspx?SearchType=power for **new** standards, amendments or drafts for AS, AS/NZS, EN, ANSI, ASTM, BSI, DIN, ETSI, JSA, NSAI and standards and amendments for ISO & IEC published from **16 January - 16 April 2018**, using the key words and key word groups:

- 'durability'.
- 'corrosion' or 'corrosivity' or 'corrosive'; but not 'anodizing' or 'anodize(d)'.
- 'paint' or 'coating'; but not 'anodizing' or 'anodize(d)'.
- 'galvanize' or 'galvanized' or galvanizing'.
- 'electrochemical' or 'electrolysis' or 'electroplated'.
- 'cathode' or 'cathodic'.
- 'anode' or 'anodic'.
- 'corrosion' and 'concrete' or 'concrete' and 'coatings'.

These results are shown in Table 2.

Summary

1. Through SAIGLOBAL Publications at https://infostore.saiglobal.com/store for a search of current publications, from all publishers over the title (see Stage 1 Report Table);

   i. There were 56 citations on 'Water' and 'Corrosion' without 'Wastewater'; there were 0 from AS, AS/NZS & SNZ; 27 DIN; 14 BSI; 8 ASTM; 8 NACE; 6 ISO and 1 SAE. See Table 1a for these titles.

B. on 'Corrosion' and 'Wastewater' without 'Water' there were 2 citations;

   i. NACE 08113:2013 Corrosion Problems And Renewal Technologies In Municipal Wastewater Systems; and

   ii. DWA-M 168:2010 Corrosion Of Wastewater Systems - Wastewater Discharge.

2. Across SAIGLOBAL online Standards Publications there was a total of 44 listings of new standards, Drafts and Amendments found that were issued from 16 January - 16 April 2018; 2 from AS, AS/NZS & SNZ;

   a. SNZ TS 3404:2018 Durability requirements for steel structures and components.

   b. AS 1559:2018 Hot-dip galvanized steel bolts and associated nuts and washers for tower construction.

All results are shown in Table 2 in the full report for Members via Resources/**www.corrosion.com.au**.

Regards

Arthur Austin
(Arthur.Austin@alsglobal.com)

***For the full Standards Report, please visit www.corrosion.com.au**

NEWS FROM THE ACA FOUNDATION

EXECUTIVE OFFICER COLUMN

Fundraising is a key challenge for the ACA Foundation. The Foundation relies on the financial support of its donors, sponsors, and the ACA, to continue its work as a not-for-profit organisation.

The Foundation is best known for its extensive Scholarship Program. Centurion donations allow the Foundation to plan and operate its Scholarship Program, providing the best mix and number of Scholarships. In previous years, the Foundation has also offered 60 places in its Future Leaders Forums [FLF's]. Many Scholarship recipients, and FLF participants, have made lasting contributions to the ACA, serving on its Boards and Committees, as well as building the reputation of the ACA through presentations to Australian and international Conferences. The positive experiences of Scholarship recipients are recorded in their written testimonials. A selection of these is available on the Foundation website and in previous issues of this journal.

Annual contributions through the Centurion Program are tax deductible and are easy to make on the Foundation's website through a secure online payment system.

Many not-for-profit organisations divide their time between delivering programs and raising sufficient funds to enable these programs to continue and grow. This is why reliable and ongoing annual contributions from the Centurions are central to the financial wellbeing of the Foundation. Funds raised enable the Foundation to confidently plan ahead and to achieve its targets.

The Foundation also works with ACA Branches to enthuse the younger generation about careers in corrosion science, through the development of "hands-on" learning resources. This was a focal point of the Foundation's work in 2017, and continues this year, with new initiatives in the pipeline for 2018. The Foundation was fortunate in 2017 and 2018 to receive seed funding from ACA Branches to develop learning resources. We are now seeking sponsorships from corporate donors, in order to promote and distribute these resources to Science teachers and students throughout Australia and New Zealand.

Promoting corrosion learning activities, within the secondary school curriculum, is an investment in the future corrosion prevention and mitigation workforce. The Foundation currently has a significant sponsorship opportunity available to promote a quality corrosion science learning activity. More than 60 teacher evaluations of the activity 'All at Sea' have been conducted. The results are very favourable with comments such as, "great way to highlight the importance of a valid scientific method" and "relevant to processes occurring in the real world."

The activity was also run with several groups of secondary school students to test interest levels and learning outcomes. Again the results were very favourable. Please watch a short video on the ACA website of teachers and students enjoying the activity 'All at Sea' at Sydenham College, Victoria.

The curriculum is aligned with the Australian Science Curriculum to ensure relevance and ease of use for teachers. Please contact me for more information at foundation@corrosion.com.au. Your Company will gain exposure to Science teachers and students throughout Australasia by sponsoring this popular learning activity. I look forward to discussing this wonderful opportunity with you.

Linda Lawrie, Executive Officer, ACA Foundation
foundation@corrosion.com.au.

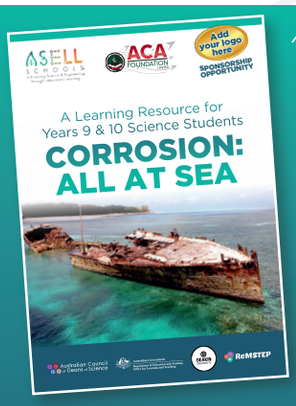
ALL AT SEA

Sponsorship Opportunity
Demonstrate your Company's commitment to corrosion science education

All at Sea, an exciting new corrosion science curriculum resource for years 9 & 10 secondary school students, was developed by the ACA Foundation, working with a national program called ASELL*.

ASELL extends the successful model used for the development of laboratory activities in undergraduate science courses, to the development of laboratory learning activities (LLAs) for **years 7–10** *in schools. At the same time, it provides professional development for teachers.*

The classroom activity, *All At Sea*, is ready for distribution within Australasia to Science Teacher Associations and Secondary Schools.



All at Sea was trialled at 3 Workshops, with a total of 61 teachers in attendance, representing 31 different Schools. The feedback was excellent.

The Foundation is now seeking a SPONSOR for *All at Sea* to promote and distribute this quality curriculum product and to encourage young students to continue with their STEM studies in their senior years of schooling.

Your Company will gain exposure to Science teachers and students throughout Australasia by sponsoring this activity. Please email the Foundation Executive Officer for more information and a Sponsorship Prospectus at foundation@corrosion.com.au

*Advancing Science and Engineering through Laboratory Learning

How can we harness the power of energy to transform the lives of 10 million people by 2025?

An interview with Christine Crawshaw, ACA Foundation Board member

Christine Crawshaw is a Senior Business Advisor with the Operational Excellence Team, Transurban. Christine has been working in the Asset Management industry for 10 years in various roles including project management, consulting, leadership and coaching. She joined the Operational Excellence team at Transurban in April 2015, working across the Transurban portfolio to achieve best practice in asset management through the implementation of the Transurban Asset Management System (TAMS). Prior to this, Christine spent 2 years at the Port of Melbourne Corporation leading the Asset Strategy team, and 5 years at AECOM consulting in the field of materials durability, corrosion, cathodic protection and strategic asset management to infrastructure asset owners. Outside of work, Christine is currently completing her MBA studies at Melbourne Business School.

As part of the annual Hult Prize (sponsored by the Hult International Business School), Christine recently competed, as a member of a 3 person team of postgraduate students, selected from over 100,000 entrants, to develop a social enterprise solution addressing the challenge "How can we harness the power of energy to transform the lives of 10 million people by 2025?" (See team members below). We recently spoke with Christine to find out more.

What is the Hult Prize?

The Hult Prize is considered the world's biggest engine for the launch of for-good, for-profit start-ups emerging from university. The winning team from each region moves into a summer Hult Prize Accelerator at the Ashridge Castle – a world class centre for innovation and entrepreneurship – where they'll be able to take the concept to the next level, refine it and move towards developing a prototype. The finalists from that round will head to New York to present to a panel of judges including Bill Clinton. The winner will receive $1m seed funding to kick start their idea!

How did you get involved?

I heard about the opportunity to get involved in the Hult prize through Melbourne Business School, where I'm currently doing my MBA. I'd previously formed a team with some of the other students to compete in the Aspen Institute's case competition in April last year, where we finished as one of the top 25 teams globally. We got the team back together and, after submitting our idea, we were shortlisted as one of 15 regional finalists pitching in Singapore for one spot at the Hult Prize Accelerator in London.

What was your team's idea?

Our idea was to develop a multi-sided platform, informed by community needs, to drive alignment between energy supply and demand. But more importantly, the platform would accelerate connections within the community to have the most impact possible.

Instead of us trying to develop something new in isolation, we focused on co-creation and collaboration with trusted partners and developing a platform that can be sustainable, scalable and accepted.

The regional final was an opportunity to pitch the concept to investors and judges. It was a great experience, and a chance to meet the other teams from across the world who have a similar passion to drive social impact. Unfortunately we were not successful in making it through to the next round but were really grateful for the opportunity to present to the judges and for making it to the regional finals.

Raj Gopiraj, Christine Crawshaw and Prathab Gopiraj.

Mattioli

Q: In what year was your company established?

A: 1968.

Q: How many employees did you employ when you first started the business?

A: The business was started by the 2 founding brothers and 1 employee.

Q: How many do you currently employ?

A: Around 100 staff working across our commercial and industrial divisions

Q: Do you operate from a number of locations in Australia?

A: We operate out of Melbourne, VIC but are currently exploring office locations in both NSW and QLD.

Q: What is your core business?

A: There is a broad range of speciality application and coating works that we undertake. Corrosion control is a typical challenge our customers face so pre-treatment and coating systems must be resistant to a wide variety of exposures. In many cases aesthetic appeal is not as important as the coating's performance and protective properties.

Q: What markets do you cover with your products or services? eg: oil & gas, marine, chemical process, general fabrication, tank lining, offshore etc.

A: The Water and Infrastructure sector is core to our industrial protective coatings division these include;

- Chemical resistant coating applications
- Concrete remediation works
- Protective Liner/membrane applications

Q: Is the business yard based, site based or both?

A: We can work remotely across Australia but our head office is in Melbourne.

Q: What is your monthly capacity or tonnage that you can blast and prime?

A: This is purely dependant on size and scope, Mattioli are recognised as one of the largest industrial protective coating applicators in Australia.

Q: Do you offer any specialty services outside your core business? (eg. primary yard based but will do site touch up etc.)

A: We are a bit different from the average contractors, we work with our customers focusing on endorsing the correct products and supporting them in getting the best specification possible to the challenges they face. We ensure our customers get the most out of their infrastructure through smart applications and the correct maintenance.

Installing reinforced geofabric liners.

Protective coatings application at WWTP.

Coating film thickness inspections.

Lead paint removal.

Chemical resistant relining.

Coating adhesion testing.

Q: What is the most satisfying project that you have completed in the past two years and why?

A: A small but very satisfying project was for Parks Victoria. We were asked to develop an environmentally sensitive solution to refurbishing a Heritage listed Suspension Bridge. As well as applying a new protective coating to localised areas of corrosion, capturing every piece of lead paint waste was critical. The bridge is one of only two remaining heritage suspension bridges along the Yarra. The particular paint type was crucial, as an above water structure required a low toxicity product to ensure minimal risk to the surrounding environment.

All surface preparation was done by hand using a backup paint capture system to ensure not one flake of lead-based paint ended up in the Yarra.

https://www.youtube.com/watch?v=-v0erUaRh0g

Q: What positive advice can you pass on to the Coatings Group from that satisfying project or job?

A: Customers should see their contractors as friends. By working with the customer taking time out to develop the best possible solution is fundamental to a 'set and forget' application and will ensure the long-standing relationship continues.

Q: Do you have an internal training scheme or do you outsource training for your employees?

A: No, outsource some aspects, confined spaces etc.

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High Temperature Corrosion Research at UNSW

The High Temperature Group in the School of Materials Science and Engineering, UNSW, is one of the world-leading research groups in the field of high temperature corrosion. High temperature research has been conducted at UNSW for many decades. The group has graduated over 60 PhD and Masters students. The research covers a broad area of alloy behaviours in mixed gases, including oxidation, carburisation, nitridation, sulphidation and chlorination. Most of the research is focused on fundamental aspects of thermodynamics, kinetics and corrosion mechanism understanding, but is nevertheless well connected to industries. The group has enjoyed successful collaborations with international research institutes, universities and industries, e.g. Oak Ridge National Lab, USA; CIRIMAT-ENSIACET, France; Forschungszentrum, Juelich, Germany; Max-Planck-Institute for Iron Research, Germany; High Temperature Materials Research Group, Karl-Winnacker-Institute DECHEMA, Germany; State Key Lab for Corrosion and Protection, Institute of Metal Research (IMR), Chinese Academy of Sciences, China.

The High Temperature Group has excellent facilities, and is widely recognised for its capabilities, particularly in the field of corrosion by mixed gases. These facilities include arc-melting apparatus, thermogravimetric analysers, and high temperature flow reactors with mixed gas control systems. These facilities are used for alloy making, processing and reacting with controlled gas mixtures. This environment is further enhanced by the close collaboration with the Mark Wainwright Analytical Centre at UNSW. The characterisation of the reaction products is performed by X-ray diffraction, scanning electron microscopy, electron probe micro-analysis, focused ion beam and transmission electron microscopy in the Centre. By understanding corrosion mechanisms, the way to resist corrosion is proposed by controlling gas and/or alloy compositions.

The main research projects carried out in the Group are listed as follows:

Metal dusting and its prevention
Metal dusting is a corrosion phenomenon which degrades iron, low and high alloy steels and Ni- or Co-based alloys by disintegration of bulk metals and alloys into metal particles dispersed in a coke mass (see Figure 1). It occurs in strongly carburising gas atmospheres (carbon activity $a_c > 1$), at elevated temperatures (400 - 800°C). Metal dusting is detrimental in metallurgical, chemical and petrochemical industries. Understanding of metal dusting mechanisms leading to an ability to control the process is essential to improve efficiency of key industrial processes. The Group has carried out this research for more than 20 years and made significant progresses in understanding the mechanisms of both iron- and nickel- base alloy dusting. Metal dusting prevention has been proposed and testified by either forming a surface barrier via coating or changing alloy chemistry by e.g. copper alloying in nickel-base alloys. Effects of Al, Cr, Si on carburisation and metal dusting of iron and nickel alloys have also been investigated as a function of temperature, gas composition and alloy content. This work has helped alloy coating formulation for dusting resistance, and is influencing commercial alloy developments.

CO_2 corrosion on chromia-forming iron- and nickel- base alloys
This research addresses an important phenomenon in the handling of hot CO_2-rich gas corrosion in coal combustion for power generation. A growing challenge for Australia is the reduction in CO_2 emissions whilst maintaining the economic

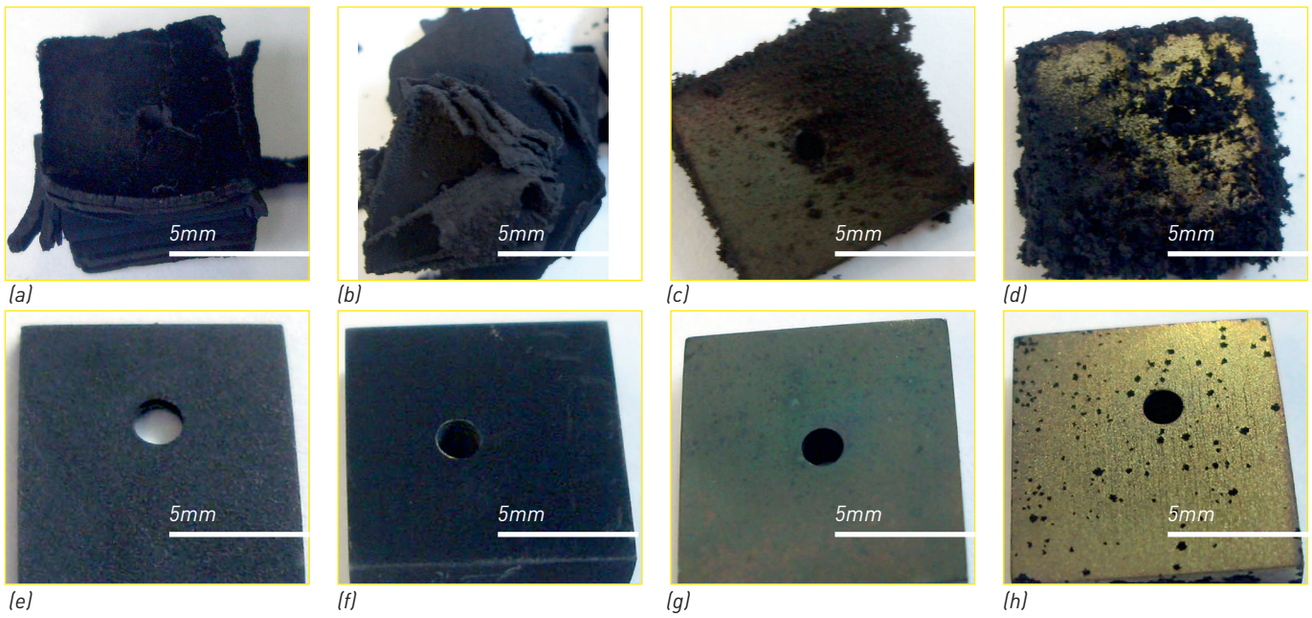

Figure. 1. The morphologies of the samples after metal dusting reaction in CO-H_2 gas (a-d) and after coke removal (e-h): (a, e) AC66 after 50 cycles of reaction; and (b, f) Haynes 25, (c, g) EN105 and (d, h) alloy 230 after 1000 cycles of reaction. [1]

advantages of coal fired power stations. Technologies for limiting CO_2 emission have been developed, one of which is the oxyfuel process. In this process, coal is burnt in O_2 rather than air, so the flue gas does not contain N_2, but CO_2 and H_2O, which makes CO_2 capture feasible. Unfortunately, this gas mixture is very corrosive to steels used for the boiler construction, producing not only oxidation but also carburisation. When exposed to CO_2, many chromia-forming alloys undergo a transition from slow, "protective" scaling to rapid, "breakaway" corrosion as oxide nodules of alloy base metal, usually iron or nickel, develop and spread to form a continuous, nonprotective scale. This change in oxide scale morphology is accompanied by internal carburisation of the alloy. The latter process precipitates chromium as carbide, rendering the metal unavailable for oxide scale formation, and repassivation becomes impossible (see Figure 2).

Breakaway corrosion in CO_2 was first observed in gas-cooled nuclear reactors, and is now becoming one of hot topics because of its relevance to oxyfuel combustion and the use of supercritical CO_2 as a heat transfer medium and turbine working fluid.

This work focuses on chromia-forming alloys and considers the morphological development of corrosion products developed in CO_2-rich gases, the thermodynamic stability of the resulting phase assemblages, the mechanisms whereby carbon penetrates oxide scales and the effects of other gas and alloy components on these processes.

Chlorine-induced corrosion in waste to energy processes

Global warming is a looming catastrophe and many progressive communities around the world are employing waste to energy (WTE) technology to get a more environment-friendly source of energy. In WTE efforts, incinerators are used to burn biomass or agriculture waste, and all other industrial, commercial, and municipal wastes to produce energy. However, high-temperature corrosion is a major problem in WTE efforts. Burning municipal waste produces much more aggressive environments than fossil fuel combustion, as the waste typically contains significant amounts of PVC plastic and many different metals in varying amounts. During combustion of waste in an incinerator, high levels of HCl, NaCl, and KCl are released. Both chlorides and sulphates containing melts may form on superheater tubes due to their lower melting point. This study mainly focuses on the behaviour of chromia-forming alloys relevant to Cl-induced environments at elevated temperatures (450-650°C), particularly the kinetics and mechanisms of corrosion processes.

Effect of dust on super-alloy hot corrosion

Hot corrosion due to molten salt deposits is often observed in gas turbine engine which leads to a severe materials degradation. In dust-containing environment, dust particle ingestion could cause more severe corrosion attack and result in significant performance losses. The dust-induced degradation could also affect other high-temperature processes, e.g., in coal combustion boilers and waste-to-energy processes where a significant amount of fly-ash is present together with salts. However, it is not clear what the effect of these particulate matters is on hot corrosion, and if they do affect the corrosion, what the mechanism is of this effect. The research in this topic is unfortunately very limited and the mechanism understanding is lacking. In this work, the dust effect on hot corrosion of the eutectic Na_2SO_4 and $MgSO_4$ is investigated at 700°C on corrosion of a superalloy.

Contact Details

For more information on research opportunities, collaboration, and consulting with the High Temperature Group in the School of Materials Science and Engineering, UNSW, please contact A/Prof Jianqiang Zhang on j.q.zhang@unsw.edu.au.

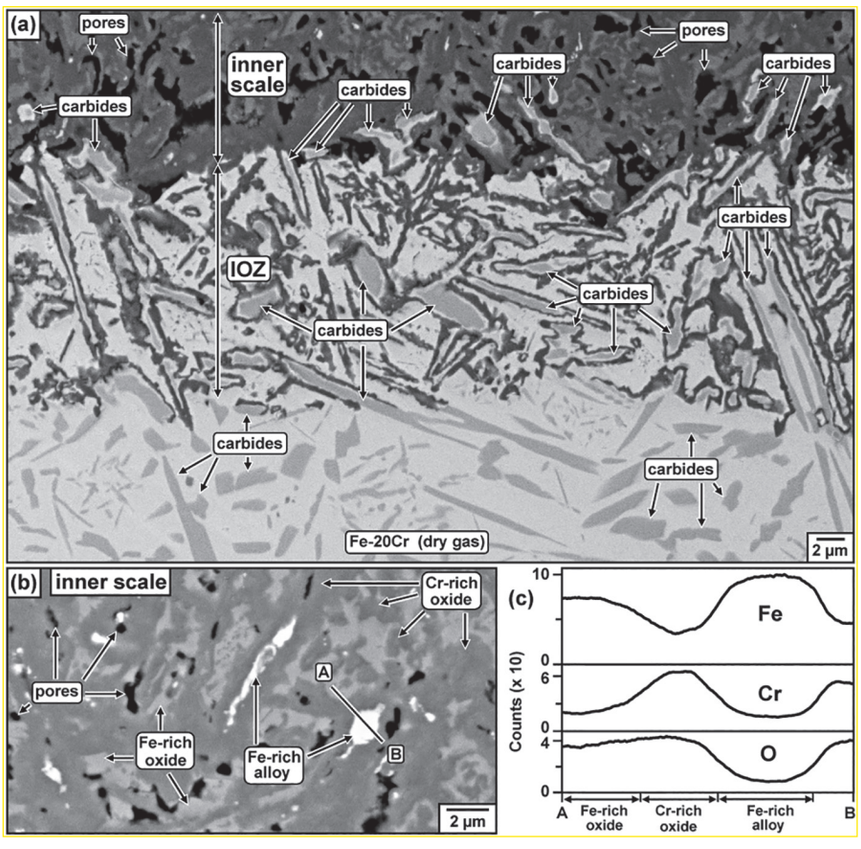

Figure. 2. Fe-20Cr (unetched) after reaction for 1000 h in Ar-20CO_2: BSE-SEM high magnification image of the IOZ (internal oxidation zone) showing chromium carbide formation. [2]

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[1] Q. Wu, J. Zhang, D.J. Young, "Metal dusting behaviour of several nickel- and cobalt-base alloys in CO-H_2-H_2O atmosphere", Materials and Corrosion, 62 (2011) 521-530.

[2] T.D. Nguyen, J. Zhang, D.J. Young, Effects of cerium and manganese on corrosion of Fe-Cr and Fe-Cr-Ni alloys in Ar-20CO_2 and Ar-20CO_2-20H_2O gases at 650°C, Corrosion Science, 100 (2015) 448-465

Recent Corrosion Problems in SWRO Desalination Plants

Sea Water Reverse Osmosis (SWRO) desalination plants are increasingly being used in regions where freshwater is scarce, such as the Middle East, Australia, southern USA and holiday islands. The advantage of SWRO is that it can be turned on and off relatively simply and it can come in a wide range of sizes, from a small skid for a hotel, to a large multi-train system to supply a city. SWRO plants tend to be constructed mostly of stainless steels and Glass Reinforced Plastic (GRP). Despite the fact that corrosion problems with such materials are well understood, failures still occur.

The Process

An SWRO plant can be split into two halves, the low pressure (up to 10 bar) and the high pressure (65 to 100 bar) sections (Figure 1). In the first, seawater is taken in and is subjected to finer and finer filtration processes, to remove solids and organic material. The seawater may be chlorinated to prevent fouling. After this, chemicals are added to prevent scaling and remove any chlorine, plus a non-chlorine biocide may be injected, just prior to the high pressure pumps. In the high pressure section the membranes allow water to pass while rejecting most of the chloride. After two passes the water is usually at a low enough chloride content for drinking water. The energy is recovered from the reject brine prior to disposal, and the permeate is usually chlorinated and may have salts added prior to distribution.

In the low pressure section it is essentially seawater, and seawater grade materials must be selected. GRP is often used for the larger pipe diameters and long straight runs, while high alloy stainless steel is used for smaller diameter piping and more complex configurations, as well as pumps and valves. The stainless steel grades that are satisfactory are the superduplex grades (UNS S32760 and S32750) and the 6%Mo austenitic grades[1]. The former are preferred because of their lower cost. The nominal compositions of the stainless steels discussed here are shown in Table 1.

In the high pressure section, the filtered seawater is not as corrosive as natural seawater, owing to removal of much of the organic material in the filtration processes, and the typical potential of stainless steel is +200mV SCE compared to the +300 to +600mV SCE in natural or chlorinated seawater[2]. This is still corrosive, and Figure 2 shows that at +200mV SCE alloys 2205 and 904L are only satisfactory up to around 22°C, while superduplex and 6%Mo alloys are needed at higher temperatures[2]. Most SWRO plants operate in the range 20° to 35°C, where the higher alloy stainless steels are required. Potentials lower than +200mV SCE can be achieved but they require the injection of large quantities of reducing chemicals, such as sodium metabisulphite, to lower the redox potential.

TABLE 1 Nominal composition of the stainless steels discussed in the text.

TYPE	GENERIC NAME	UNS No.	NOMINAL COMPOSITION (wt.%)						
			Fe	Cr	Ni	Mo	N	Cu	W
Aust.	316L	S31603	Bal	17	10	2	-	-	-
	904L	N08904	Bal	20	25	4	-	1.5	-
	6%Mo	S31254	Bal	20	18	6	0.2	0.7	-
	6%Mo	N08367	Bal	20	25	6	0.2	-	-
Duplex	2205	S32205	Bal	22	5	3	0.16	-	-
Super Duplex	Z100	S32760	Bal	25	7	3.5	0.25	0.7	0.7
	2507	S32750	Bal	25	7	3.6	0.26	-	-
Cast Duplex	Grade 5A	J93404	Bal	25	7.5	4	0.25	-	-
	Grade 6A	J93380	Bal	25	8	3.6	0.25	0.7	0.7

Bal = Balance

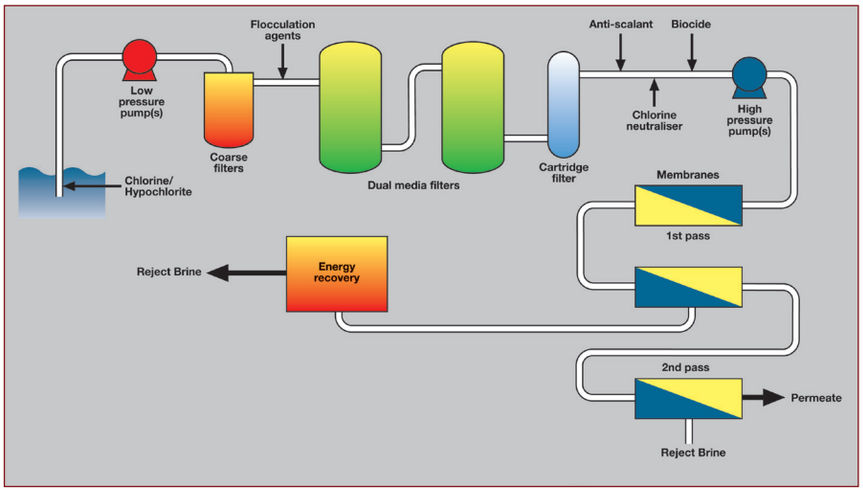

Figure 1. Schematic diagram of a typical SWRO plant.

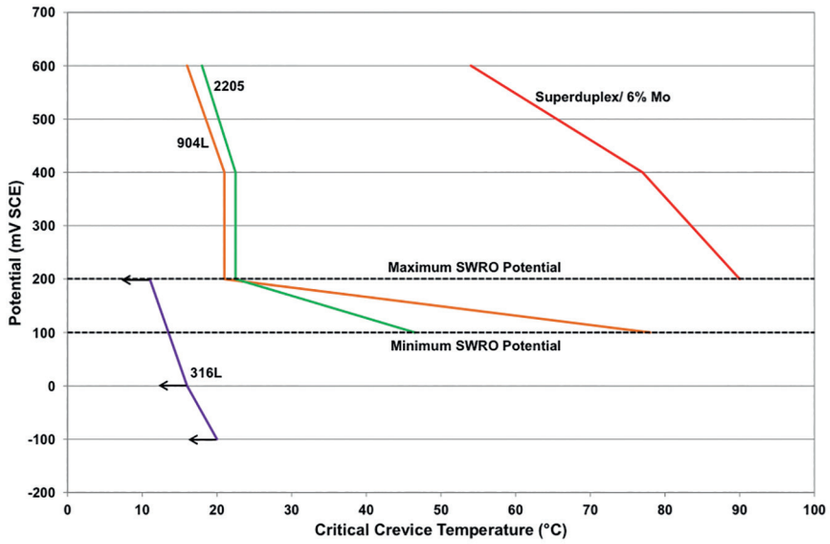

Figure 2. Critical crevice temperatures of some stainless steels in seawater as a function of potential[2].

Case Study 1

The dual media filter vessels (Figure 1) are usually carbon steel with a good quality neoprene rubber lining. This lasts about 10 to 15 years, before the lining must be replaced. A large SWRO plant in the Middle East had a 25-year design life and to avoid relining they selected stainless steel for the numerous filter vessels, in grade 2205. After 6 weeks in service at ~33°C there were numerous leaks at the welds (Figure 3) and also crevice corrosion occurred at the flanged joints.

This corrosion was hardly surprising, as 2205 is not a seawater grade alloy[3], but the solution to it was somewhat tricky. One option was to line the tanks with neoprene and accept that replacement would be necessary. Another was to weld overlay the internal welds and crevices with a more corrosion resistant alloy, such as nickel alloy C-22 (UNS N06022), as superduplex would not be satisfactory in the crevices in the as-welded condition at the service temperature (30 to 36°C). The other option was to replace the vessels with new ones in superduplex stainless steel.

Case Study 2

This case study involved an SWRO plant in Australia that selected 2205 duplex stainless steel for the high-pressure piping. The alloy suffered severe crevice corrosion under the rubber boots in the high-pressure couplings. As the seawater temperature was mostly in excess of 22°C, these failures are not surprising as suggested by the data in Figure 2. The solution was to replace the pipes and fittings in superduplex stainless steel which was a costly exercise.

Case Study 3

Some low-pressure feed pumps were supplied to a SWRO plant and they showed severe corrosion after a few months (Figure 4). The pumps were in ASTM A995 grade 5A with a wrought superduplex shaft. The following problems were found:

- Parts of the pump did not meet the Pitting Resistance Equivalent Number (PREN) > 40, where PREN = %Cr + 3.3(%Mo + 0.5x%W) +16x%N. This is a standard requirement in NORSOK for seawater corrosion resistance[3].
- There were sigma and chi phases in some locations where corrosion occurred. These third phases are well known to reduce corrosion resistance.
- The structure was very ferritic, which tends to lead to uneven partitioning of the elements between the two phases, and this reduces corrosion resistance.
- There was a major weld repair that had no post welding heat treatment (PWHT). This would have had reduced corrosion resistance and contravened ASTM A995 requirements for PWHT after a major weld repair.
- The shaft also contained sigma phase and had clearly been incorrectly heat treated.

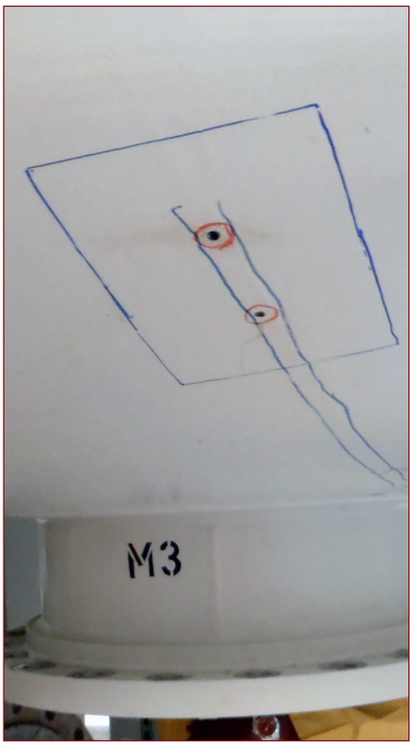

Figure 3. Leaking seam welds in a 2205 dual media filter vessel.

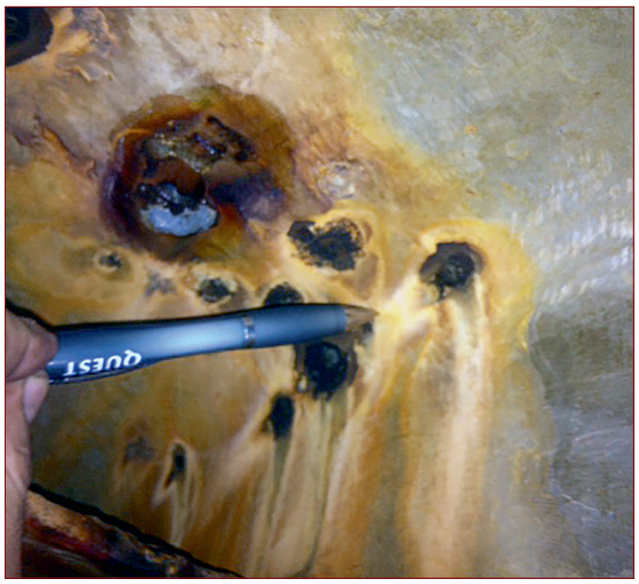

Figure 4. Deep pits in the case of a grade 5A superduplex low pressure pump.

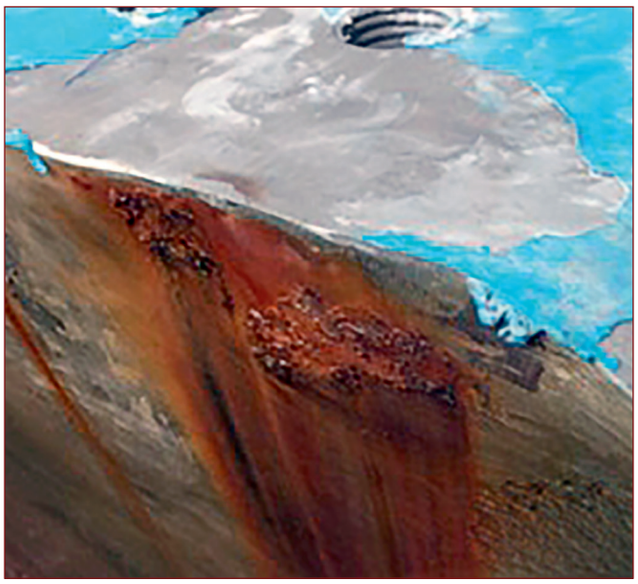

Figure 5. Crevice corrosion at a flanged joint in a grade 6A superduplex casting.

The castings were bought to a bare ASTM specification with no additional test requirements. There had been no QA/QC checks during manufacture or on receipt of the wrought and cast products. The heat treatments of both castings and wrought product had been totally inadequate and there had been no proper control over weld repair. The only solution was to procure new castings and bar to a proper specification (such as in reference 4) and carry out quality checks during manufacture, repair and on delivery[4]. It was also suggested that the alloy be changed to grade 6A as this is easier to cast in thicker sections.

Case Study 4

A number of grade 6A superduplex stainless steel pumps were suppled to a SWRO plant in the Middle East. There were corrosion problems, mostly with the low-pressure pumps before the plant was fully commissioned. The corrosion problems were largely:

- Crevice corrosion at joints and flanges (Figure 5).
- Clear evidence of poor quality weld repair.
- Pitting associated with sigma/chi phases.

Although the heat treatment of some components was not of the best, most of the crevice corrosion problems were associated with sound metal. This was puzzling as the seawater temperature was 25° to 35°C, where superduplex should perform satisfactorily. However, the LP pumps had spent 6 to 9 months full of seawater while the rest of the plant was installed and commissioned. From time to time the pumps would be run for a short interval while another part of the plant was commissioned. It has been shown that if superduplex stainless steel is left in stagnant seawater for 30 days with active Sulfate Reducing Bacteria (SRB) and nutrients, crevice corrosion can initiate at 30°C when the plant is started and receives continuous fresh seawater[5]

The water at the SWRO plant was biologically active, but was only treated with chlorine at infrequent intervals. Hence, it seems likely that it was the SRB activity during stagnation that produced films that were not very protective on start-up and led to crevice corrosion.

The solution to this problem was weld repair, where the corrosion was not severe and replacement of some castings that were severely attacked. In addition it was essential that the pumps be fully drained if left stagnant, or they should be run for several hours every day or two with fresh, chlorinated seawater.

Conclusions

These are just four examples of many more that could have been presented. The main problems seem to be specifying unsuitable low alloy stainless steels instead of superduplex or 6%Mo austenitic alloys, and procuring material without a proper specification or the application of suitable QA/QC procedures. All of the problems presented here are well understood and could have been prevented. It is clear that there is still a role for experienced corrosion engineers in the desalination industry, not just in investigating failures, but also in the writing of suitable procurement specifications and helping ensure that they are followed throughout the manufacturing process.

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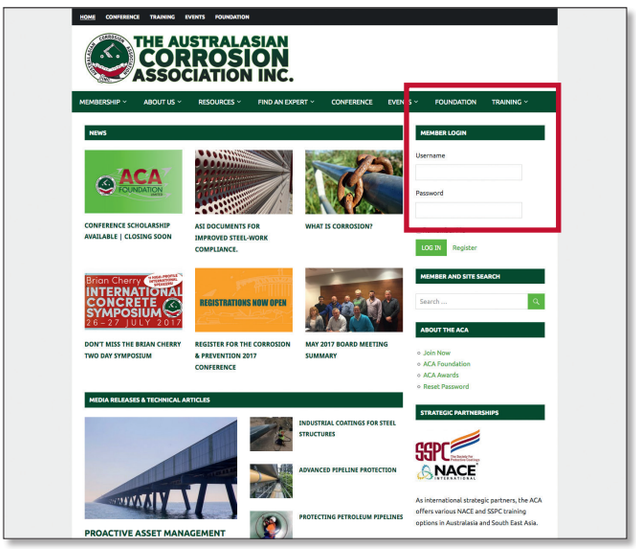

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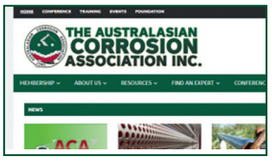

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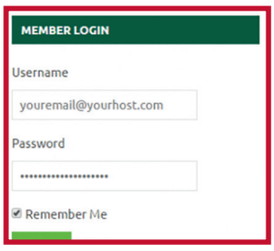

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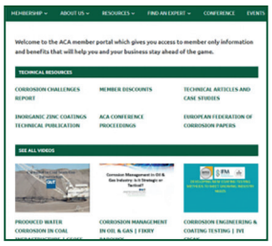

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Stray Traction Effects – where's the problem?

During baseline corrosion interference testing associated with a new light rail project in Sydney NSW, significant stray traction current effects from existing traction systems were measured on the Energy Authority's sub-transmission assets in Sydney CBD. This case study describes the actions taken to identify the corrosion risks and the events that led to resolving the electrolysis interference caused by defective rail safety devices located 20km away from the affected site.

Background

The electrical current needed for DC traction systems is supplied by traction substations which are normally fed from the local electrical network. In overhead networks, current is supplied to the train or tram traction motors through an overhead catenary contact wire and in a catenary free arrangement, via a third rail or underground cables. The running rails are commonly used as the primary current return path back to the source traction substation to complete the circuit. In scenarios where regenerative braking is used, the current will still return via the running rails, but conduct back to the source regenerative motor associated with the train that is undergoing regenerative braking. The running rails are intended to be insulated from earth however; since their associated insulation medium is not perfect and is in contact with the general mass of earth (rail pads, ballast, embedded insulation etc.) a parallel path through the earth is formed with the running rails. Any current that leaks from the rails and conducts through any path, other than the dedicated return path, is known as stray traction current. Where stray traction current flows through a conductive structure such as pipelines, cable screens, building reinforcement, etc. are referred to as foreign structures and are at risk of accelerated corrosion (See Figure 1).

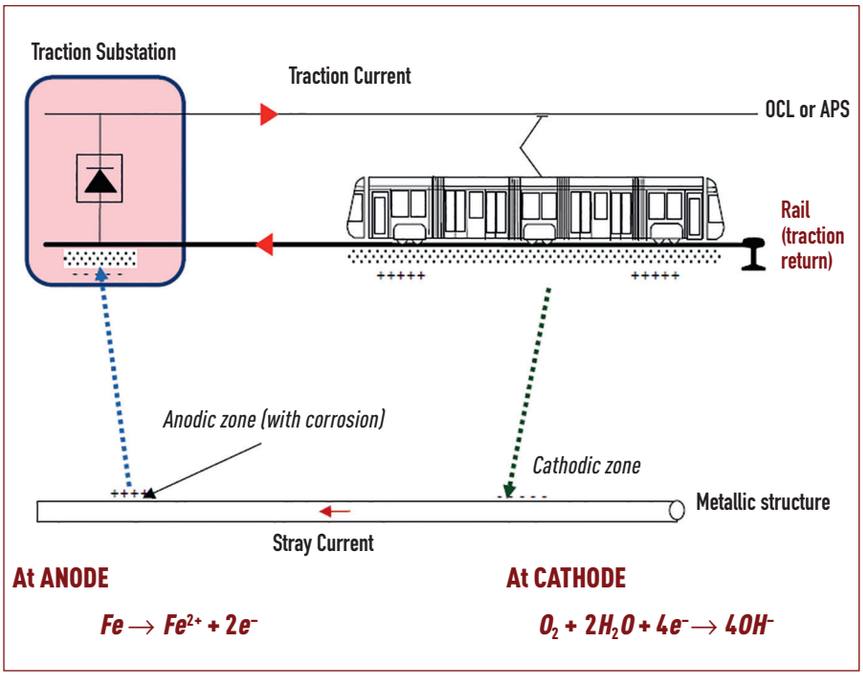

Figure 1 – Stray traction current path.

Transport for NSW have released a project to design and construct a new 12km long light rail (LR) from Circular Quay along George Street to Central Station, with branches to Kensington and Kingsford.

Ausgrid is the energy utility that provides the electricity network for Sydney and has numerous assets that are located alongside and beneath the proposed route of the LR. These assets include underground cables ranging from low voltage distributors to high voltage sub-transmission feeders (See Figure 2), substations both above and below ground and associated buildings and ancillary equipment. Various other assets such as telecommunication networks and pipelines share the same environment with the electrical network. All of these assets are vulnerable to accelerated corrosion when exposed to stray current.

Figure 2 – cable pit under George St., Sydney.

Baseline Corrosion Interference Testing

Interference criteria

There are no formally recognised interference criteria for copper structures that are not protected by cathodic protection systems, so the following standards were used to derive criteria for assessment purposes only.

Derived interference criteria

BS EN 50162 (1). Acceptable maximum positive potential shift (including IR drop) is 300mV for copper bonded steel electrodes.

Various sites were targeted along the route of the LR, for baseline corrosion interference testing. Baseline testing provides a snap shot in time of any existing stray current effects detected on targeted assets. The sites were selected on the likelihood of being affected by stray current once the LR is commissioned, so that a comparison can be made before and after energisation, to determine if any corrosion interference is introduced from the new LR.

Figure 3 – 132kV Feeder cable earth link box.

One particular asset where elevated levels of existing stray traction current effects were measured, was an earthing link box associated with a 132kV sub-transmission feeder running under George St near Circular Quay (See Figure 3). This link box forms part of the cable screen circuit. Structure voltage measurements were taken with reference to a copper/copper sulphate reference cell and it was determined that the link box earth has a quiescent potential of approximately -273mV. The stray traction current effects were causing voltage variations up to 290mV as shown in Figure 4.

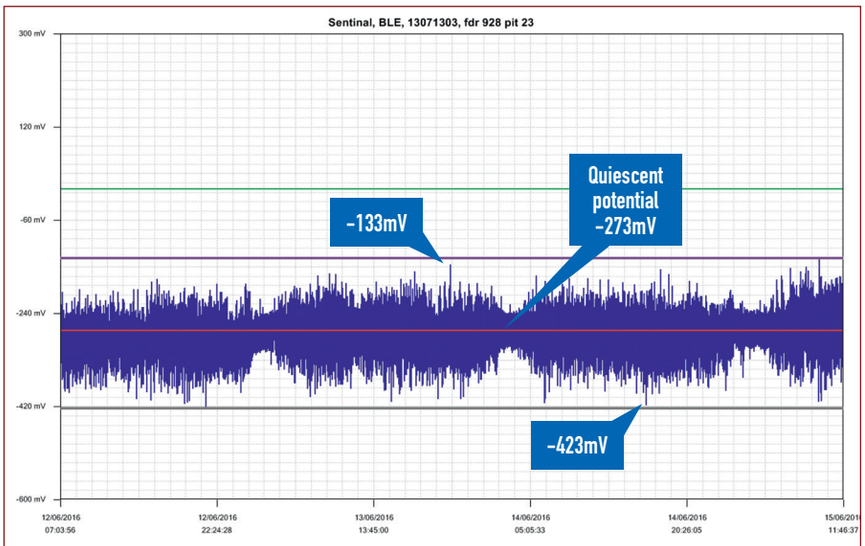

Figure 4 – George St link box earth potential during rail fault conditions – Ref to Cu/CuSO$_4$.

These results warrant further investigation. The measured wave forms were typical of stray traction current effects, so Sydney Trains participated in the investigations to determine if the heavy rail was contributing to the issue.

Corrosion Interference Investigation

Experience has shown that where stray current enters or exits a structure through the earth, larger earth potential rise (EPR) zones, caused by increased current density through the earth, are created that cause high structure potential variation, also referred to as electrolysis or stray current effects. So the first step in resolving this issue was to locate the maximum electrolysis effects along the 132kV feeder route.

The largest magnitude of interference was located on an earthing link box at Wollstonecraft shown in Figure 5, some 3.5km NE of the George St site where the original problem was observed.

Recorded waveform traces indicate that the link box earth has a quiescent potential of approximately -290mV. Stray traction current effects are causing voltage variations up to 2,401mV comprising of 1,166mV anodic and 1,235mV cathodic events.

✘ The maximum positive potential shift from the quiescent potential is +1166mV which far exceeds the limit of +300mV as derived from BS EN 50162.

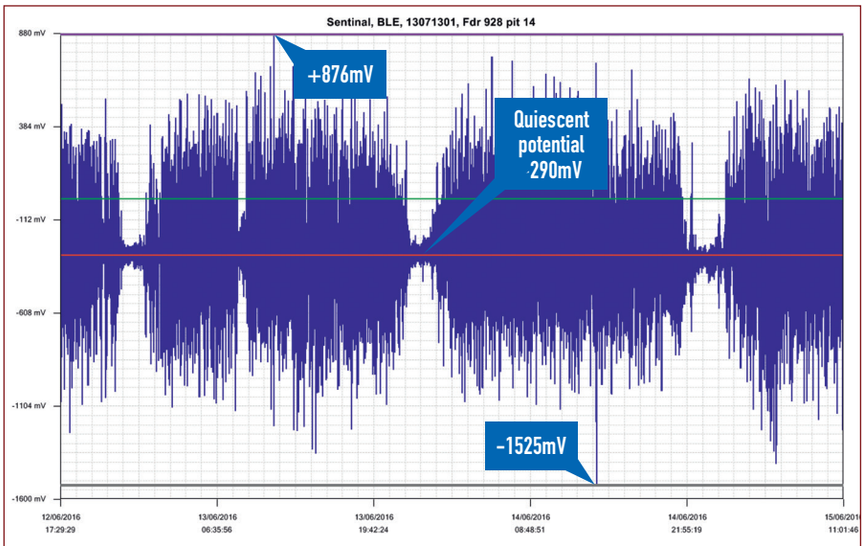

Figure 5 – Wollstonecraft link box earth potential during rail fault conditions – Ref to Cu/CuSO4.

✘ The calculated average anodic potential is -104mV which results in an average anodic shift from the quiescent potential of +186mV.

When applying the derived criteria BS EN 50162, these assets are considered at risk of accelerated corrosion. In addition to Ausgrid's concern for the elevated corrosion risk to critical assets, added pressure was applied from the LR project designers to find a timely resolution so there would be some interference head room available by the time the LR was to be commissioned.

Since the heavy rail network is located in the same vicinity as the link box, an investigation was conducted by Sydney Trains to locate and repair any rail insulation defects. Results from the extensive investigation by Sydney Trains spaning from the North Sydney area through Sydney CBD to Central Station failed to reveal any underlying issues.

Concurrently with the Sydney Trains investigation, Ausgrid's electrolysis team conducted DC current and loop resistance measurements at various substations connected to this particular 132kV feeder cable and a number of interconnected substations that supply the Sydney Trains Traction Substations. DC current was detected in all cable screens tested and in some cases recorded 6A variations in DC current flow. These test results with visual inspections confirmed that Ausgrid's sub-transmission earthing network is directly bonded to Sydney Trains Traction Substation earthing systems, which explains the likelihood of stray current flowing through the cable link boxes. This is a concern since the traction substations are generally located within the rail corridor and exposed to a greater risk of stray current pickup and discharge which can then be transferred through Ausgrid's electrical network.

Sydney CBD earthing network utilises a common multiple earthed neutral system (CMEN) whereby the sub-transmission earthing network is common bonded to the high voltage zone and distribution earthing systems via interconnected cable screens and overhead earth wires, which in turn are bonded to the local MEN system via interconnected LV neutrals.

In summary, the electrical network provides a conductive path throughout Sydney that reticulates into the rail corridor at numerous locations and is an attractive path for stray traction current.

At this stage, we suspected that the source of the stray current may be much further afield than first thought which added to the complexity of actually finding the problem and resolving it in time for the new LR energisation.

Corrosion Risk

The concern with stray current being conducted through foreign structures, is the unidentified zones where the stray current discharges from the foreign structure to earth. These zones are where the earth resistance is low enough

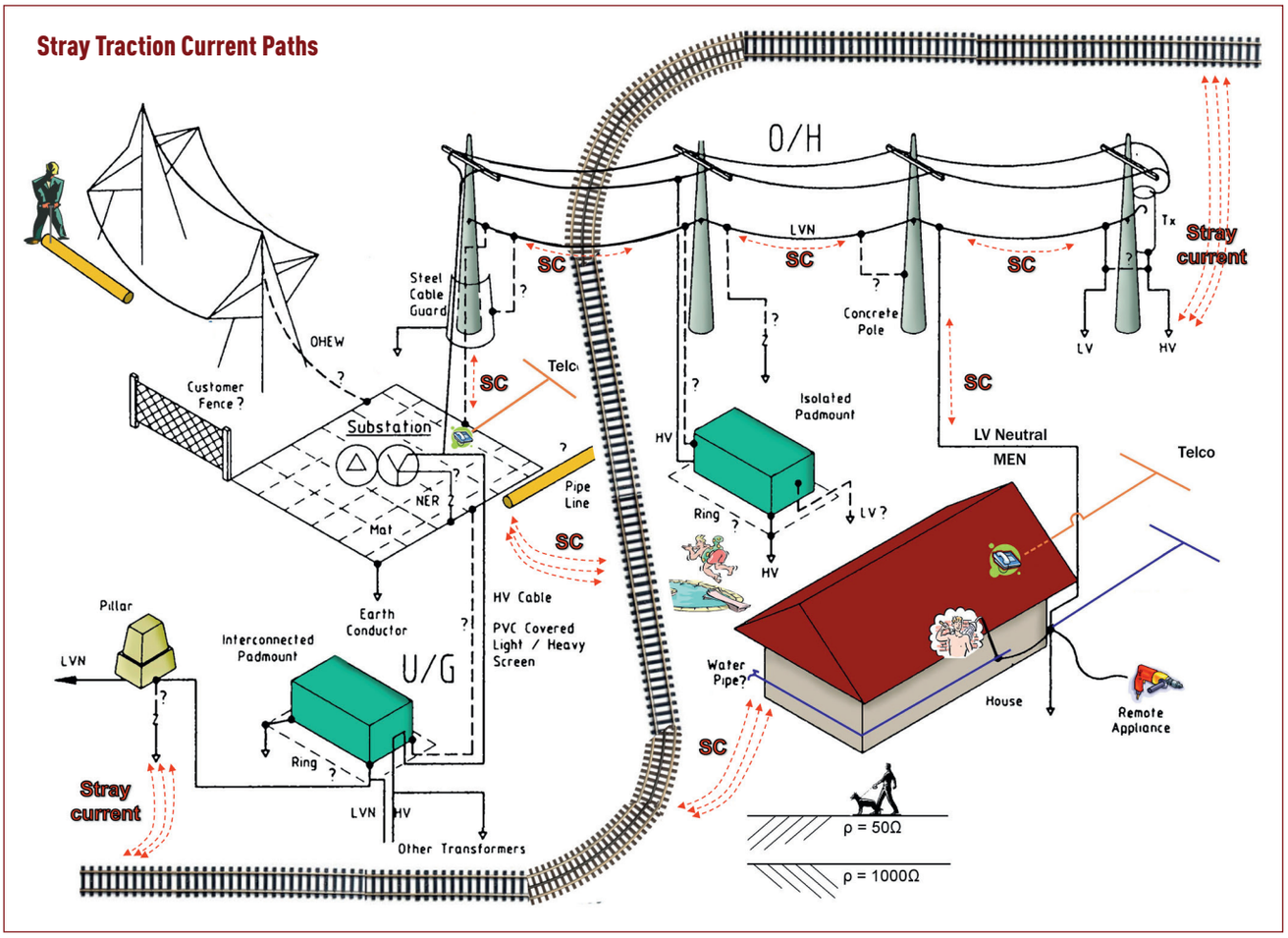

Figure 6 – Interconnected earthing systems provide a low resistance metallic path for stray current.

to allow current to exit the foreign structure and flow through the earth to the traction return circuit (See Figure 6). Typically the corrosion risk is greater at locations where foreign structures are electrically discontinuous and are not necessarily close to the rail corridor.

The breakthrough

Some months later, we experienced a fortunate breakthrough. During routine interference testing of a cathodic protection system for Telstra cables located in Wahroonga, high magnitudes of stray traction effects were measured on numerous assets affecting Telstra, Ausgrid and Sydney Water. The cause for the stray traction current was found to be 7 defective safety devices (spark gaps) in the vicinity of Wahroonga Rail Station. The safety devices had failed by short circuiting that effectively provided a low resistance path from the rail to earth via the rail structure earthing system, which resulted in large magnitudes of stray current flowing through any conductive earth path.

If the local water pipes, telecommunication cable network and electrical earthing network including traction substation earthing systems, can collectively provide a continuous metallic path from outer North Sydney to Sydney CBD and beyond then it is possible for stray current to be transferred significant distances to return to the source traction substation. Armed with this notion, it was worthwhile assessing the electrolysis effects at Wahroonga once the spark gaps were rectified.

Recorded waveform traces indicate that the link box earth has a quiescent potential of approximately -355mV, the stray traction current effects are causing voltage variations up to 599mV comprising of 316mV anodic and 283mV cathodic events as shown in Figure 7.

When comparing these results with the structure potentials prior to replacing the safety devices, the stray traction current effects at Wollstonecraft have greatly improved. Although these levels indicate further issues to be resolved, it addresses the immediate threat to both Ausgrid assets and progression of the LR project. It is expected that similar reduction of electrolysis effects will be achieved on assets in Sydney CBD which will be confirmed at a later date. This result proves that stray current effects can be detected many kilometres from the defect site and is not restricted to within the rail corridor; it simply comes down to Ohm's Law that determines the paths of lower resistance that the stray current will take to complete the circuit.

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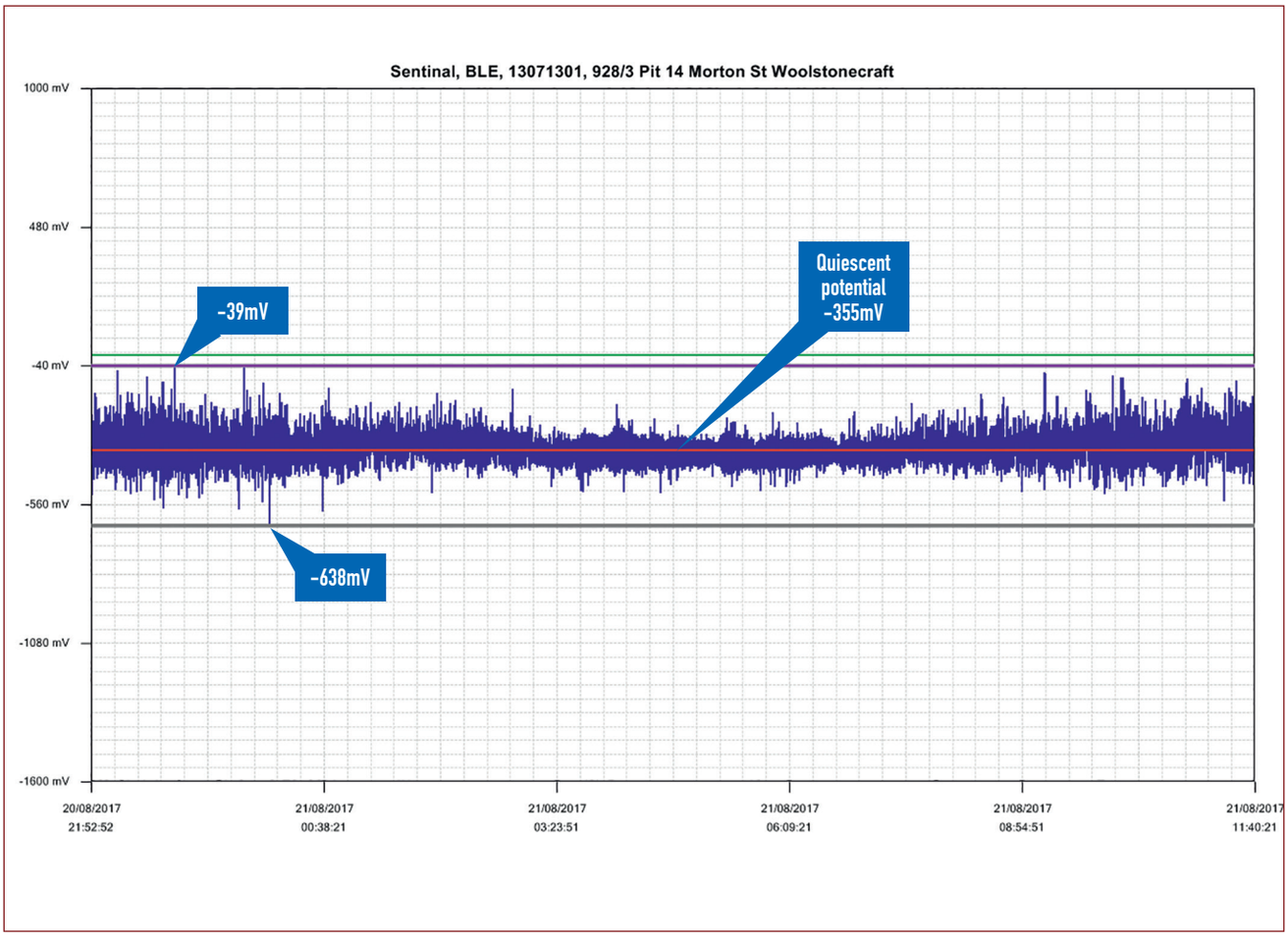

Figure 7 – Wollstonecraft link box earth potential after spark gap replacement – Ref to Cu/CuSO4.

The Measure of Success

It is unlikely that a corrosion engineer will be chosen as a crew member for the first human mission to Mars. But why not? A corrosion engineer could be an extraordinarily valuable member of the first Martian society. They could assess the environment and evaluate the performance of all sorts of materials on Mars. I can visualise crowded racks of coupons being studiously inspected by a corrosion engineer shuffling along in a space suit making salient notes on a clipboard. Red will be the new black and all the paint suppliers will have their own webcam so we can watch paint dry on another planet!

I was fortunate to hear Buzz Aldrin speak at the NACE Corrosion conference in New Orleans in 2008. He talked about his impressive life and achievements, including the Apollo 11 mission to the moon, but noted that he never dreamed of such things as a child. There was no such thing as an astronaut when Buzz was in his youth. In 2013, the US Department of Labor reported that 65 per cent of today's school children will eventually be employed in professions that do not currently exist. Dell Technologies recently postulated that 85 per cent of jobs that will exist in 2030, have not been invented yet. Why not add Martian corrosion scientist to the list of future professions?

But, for the time being, the exotic sprinkling of corrosion engineers that exist on this planet are fully occupied saving everything that has already been built. Our ageing infrastructure is a dormant nightmare that threatens to undermine the forward movement of humanity. Our roads, our bridges, our electricity, our water, our digital communications all depend on physical assets. All of these assets require a minimum condition to function as intended. A plan is required for every asset to ensure it can be maintained and renewed to achieve its purpose. Enter stage right: durability professional.

The role of a durability professional is intrinsically linked to the success of our planet. But how do we define that success? And, is humanity actually moving forward? One would hope that we are on an upwardly trending learning curve, extracting poignant lessons from our failures and applying new knowledge to future projects. But is this the case?

At the 2017 ACA Annual Conference we were blessed to hear a keynote presentation from Dr. Brian Skerry, Global Director – Corrosion Programs for Sherwin Williams. His presentation showed that coating technology is clearly advancing and we are developing sophisticated techniques for proving their performance. Given that one of the primary functions of coatings is to protect assets, these advancements are a good thing. Dr. Skerry was also a co-author of a 1983 study of 'Corrosion in Australia.' That study found that the cost of corrosion in Australia was equivalent to 1.0 per cent of Australia's GDP. It noted that improved technology transfer and implementation could potentially recover a large portion of the corrosion costs.

At the completion of Dr. Skerry's keynote presentation, Professor Derek Northwood, from the University of Windsor in Canada, asked a pertinent question that set a number of hares racing in my mind, pinballing against the inside of my skull and foreshadowing significant anguish. He asked about our progress as a corrosion community. He acknowledged we had gained a great deal of knowledge since the Cherry Skerry Report of 1983, but asked whether we have been successful in changing our industries and reducing the cost of corrosion? Good question.

Professor Northwood was no doubt cognizant of a series of studies into the cost of corrosion. Most of these focus on the financial cost which is estimated in specific countries to be about 3 per cent of GDP. While there are only a small number of studies, there is little evidence to show that the cost of corrosion is decreasing. In 2016 the IMPACT Study conducted by NACE International concluded that the annual global cost of corrosion was US$2.5 trillion, equivalent to 3.4 per cent of the global GDP. The study found that 15-35 per cent of the costs were avoidable using currently available corrosion control practices. That's a remarkable sum at US$375-$875 billion.

The BIG question rattling around inside my head was 'WHY?' Have we failed as corrosion engineers in our crusade against asset decay? Why is the cost of avoidable corrosion so high? Not to mention the indirect costs such as loss of production and, in extreme cases, loss of lives. The Mina Al-Ahmadi Refinery fire in Kuwait in June 2000 resulted in six deaths and caused US$4 billion in damage. It was found to have been caused by vapor cloud explosion due to a corrosion leak in a 10-inch condensate pipe. There is no doubt that corrosion engineers around the world are working tirelessly to prevent such events.

The answer to the rising cost of corrosion was found in a theme running through these studies that stretches back to 1983 and even back to studies in West Germany and the United Kingdom in 1969 and 1970.

Corrosion control technology and techniques exist to reduce the amount of corrosion. A small population has detailed knowledge of those technologies and techniques but dissemination of that knowledge has been like honey through filter paper – a slow trickle. Some knowledge has filtered out to a larger diameter of engineers and scientists and some proactive outsiders have sourced rich veins of knowledge directly from the honeypot. But a large portion of society demonstrates a low level of corrosion literacy, including managers, asset owners, business owners and consumers. In many quarters, there is an agnostic lack of awareness, but some behaviour can only be described as deliberate apathy.

The ACA's own study into the 'Corrosion Challenges in the Australian Urban Water Industry' in 2010 found that the annual cost of corrosion was AU$982 million. The report identified several opportunities to reduce the cost of corrosion. Some of the most significant recommendations relate directly to the employees within the water industry. The first relates to corrosion training. It was found that there was a significant amount of training available to workers but that this training included minimal corrosion content and no competency units that specifically related to corrosion. It was identified that corrosion training at all levels of employment would enhance the

performance of the water industry. Corrosion knowledge would improve design, improve data capture, improve asset knowledge and improve decision making. The report goes on to make two further recommendations. The first is that it should be mandatory for designers and auditors in the water industry to demonstrate a minimum level of competency in corrosion understanding before being accredited. The second is to introduce specific regulatory or legislative requirements for the design and operation of critical infrastructure – that is, where failure of that infrastructure will be catastrophic to public health and safety or to the environment. Such measures would be advantageous for many other industries also.

Clearly there is an opportunity for a proactive bunch of evangelists willing to share the good gospel of corrosion prevention. There is a need for corrosion awareness to infiltrate all levels of political and corporate thinking from government to the stock market to the production line. The most common measure of corporate success is the annual profit statement. Increasingly, there is recognition that financial success is not always the best outcome for the advancement of humanity. The corrosion engineer is interested in the life cycle of an asset, not just the capital cost. There is an opportunity to partner with asset owners and operators to attain a higher level of corrosion knowledge and consider longer reporting cycles. Then, I am sure wiser investment decisions can be made.

One day, when I am inspecting my coupons on Mars in my mithril space suit, designed by the random alloy generator from Monash University, I will have the opportunity to look back at Earth through my telescope. I hope I will see a vibrant, active and beautiful planet where communities are thriving. Because then I will know that someone, somewhere listened to a corrosion engineer. That will be the ultimate measure of success.

Paul Vince,
Associate Materials Engineer, Water, WSP

Anodes, Chemical Composition and Your Boat

Let us start by saying that there is nothing mystical about anodes. They sacrifice themselves to protect your hull and other immersed or buried metallic fittings against corrosion.

Metals and alloys that are higher on the Galvanic Table protect those alloys below them on the table (refer to Figure 1).

Decades of research and field testing has been undertaken by engineers and scientists from universities, defence organisations and private companies from around the world. Their combined research has identified the best combinations of elements to create the most effective anodes for various environmental conditions.

Their research and testing has been performed in fully equipped and accredited laboratories and in controlled long term field testing facilities. Research papers are peer reviewed by industry bodies such as the ACA (Australasian Corrosion Association) in Australia/New Zealand and NACE (National Association of Corrosion Engineers) in the US, as well as many similar organisations around the world. After rigorous testing and review, if alloys are proven to be more effective than the alloys before them, eventually they become part of national and international standards. This is the process that has been undertaken to determine the current accepted AS/NZS and ISO standards for anode alloys.

THE GALVANIC SERIES IN SEA WATER	
	Metal or Alloy
ANODIC actively corrode	Magnesium anode alloy – high potential
	Magnesium anode alloy – low potential
	Aluminium anode alloys
	Zinc anode alloys
	Aluminium alloys
	Cast iron
	Carbon steel (mild steel)
	Copper alloys (brass/bronze)
	Cupronickels
	Copper
	Nickel
	316 stainless steel (active)
	Silver
	Titanium
	304 stainless steel (active)
	Silver
	Titanium
	304 stainless steel (passive)
CATHODIC noble passive	316 stainless steel (passive)
	Platinum
	Gold
	Graphite

Figure 1: The Galvanic Table

The current internationally accepted alloys have been in production for many years; they are cast by anode manufacturing foundries all around the world and they protect billions of dollars' worth of vessels and other infrastructure such as oil rigs, sheet pile walls, wharves and pipelines. Their strong scientific backing, along with long term data on their in-field performance is what makes them the universally accepted alloys.

Like any industry, anode manufacturing has some inexperienced and unethical suppliers. From the backyarder to the shonky salesman trying to baffle boat owners.

The Inexperienced Manufacturer: Some manufacturers cast their anodes using just aluminium or zinc ingot without adding the activating elements required to promote the corrosion process. These anodes can offer limited protection but usually end up becoming passive and non-protective.

Also, we have recently seen imported aluminium anodes cast onto zinc galvanized straps. This combination does not comply with recognised Standards because aluminium has a melting point of around 660 deg C and zinc has a melting point of around 420 deg C. When the much hotter aluminium is cast onto the zinc galvanized strap, it melts the zinc, which can create voids in the anode adjacent to the strap and also increase the amount of zinc in the body of the anode, which can in turn reduce their effectiveness.

The Backyarder: Some manufacturers use scrap aluminium or zinc as the base metal which is often contaminated with other elements such as iron or lead. They melt the scrap and cast it into moulds then visit slipways and chandleries offering cheap anodes that may look great, but do not offer any protection against corrosion.

Impurities in the scrap material can adversely affect the efficiency of the anode. For example a single rusty nail dropped into a furnace of molten aluminium or zinc will prevent all of

Figure 2: Optical Emission Spectrometer.

Figure 3: Dodgy Anode Manufacturer gets run out of town.

the anodes from working. They will become passive and offer no protection to your vessel.

If the surface of your anodes are black, this can indicate that the anode has a high lead content, which usually leads to the anode becoming passive. Also, if your anodes are bubbling away like a Berocca tablet and disappearing very quickly, this indicates high levels of other impurities which shortens the anodes service life, leaving your vessel vulnerable.

Some years ago a Queensland foundry started selling cheap anodes to the commercial fishing industry. Subsequent investigations revealed that they were mixing high purity zinc ingot with scrap zinc previously used for printer type setting. This scrap material was cheap and readily available, the only problem was that it contained high levels of lead and iron. No surprises, the anodes never worked. Unfortunately the vessels owners were not aware of the problem until their vessels came up on the slip 12 to 18 months later. The corrosion damage to hulls and metallic fittings was extensive. Legal action followed.

The Decorative Anode: There are many different aluminium grades, they are selected for a whole range of characteristics from strength to durability, architectural properties or finished appearance. aluminium anode alloys are different, their primary objective is to protect against corrosion. Appearance and other characteristics are of secondary importance.

A distributor of ours had a customer who removed an anode from the back of their boat. It had been installed for over 2 years and only showed minimal signs of corrosion. The very low corrosion rate caused some concern as it indicated that the anode was not doing its job.

To find out the chemical composition, we analysed it on our Optical Emission Spectrometer (Figure 2), which is set up to identify the chemical make-up of aluminium, magnesium and zinc based products. This so called anode turned out to be an aluminium based alloy with no resemblance to any recognised anode alloys. In fact it had a very high percentages of iron, which limits the effectiveness of the anode and explains why it had become passive. The anode was offering very limited corrosion protection, more likely it was offering no protection at all.

The aluminium grade of this so called anode may have been chosen because it extrudes well and the finished product looks great, adding to the illusion that it is a superior anode. Keep in mind that anode alloys are designed to protect against corrosion. Appearance is irrelevant in anodes.

To make matters worse, this suppliers' website claims that their anode meets the highly respected internationally recognised anode manufacturing standard DNV-RP-B401. Our spectrometer analysis tells a very different story.

Conclusion

Keep in mind that there is no magic or mystery associated with anodes, just a lot of research and testing by a lot of engineers and scientists over a very long period of time to identify the alloys that really work.

Do not let a supplier tell you that their anodes are made of some mysterious Wiz Bang alloy that has amazing properties that regular anodes cannot achieve!

Some National and International alloys that are universally recognised include:

Aluminium

Australian Standard AS 2239
- A1, A2 and A6
- Det Norske Veritas DNV RP-B401 – Aluminium
- National Association of Corrosion Engineers NACE TM0190 and NACE SP0607
- NORSOK M-503
- US Military Specification MIL-DTL -24779A(SH)

Zinc

- ASTM International ASTM B418
- Australian Standard AS 2239 - Z1
- Det Norske Veritas DNV RP-B401 – Zinc
- National Association of Corrosion Engineers NACE SP0607
- US Mil Spec MIL-DTL-18001L

If the anodes on your vessel do not appear to be working, you can analyse their chemical composition and find out what they are made of (Figure 4).

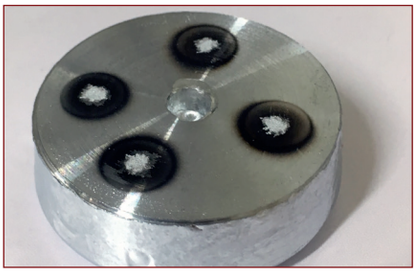

Figure 4. the chemical composition of anodes cast by CAA are analysed and approved prior to casting.

Oil and Gas, Government, Defence and Mining are industries that have strict protocols when it comes to specifying the chemical composition of the anodes that they require, and rightly so. Their assets are valuable and must be suitably protected against corrosion, just like your vessel.

Brent Linde, Cathodic Anodes Australia

Patterson Lakes Retaining Wall: Corrosion Protection by Hybrid Anode Installation

Melbourne Water has recently completed the installation of anodes for the protection of 7km of retaining wall which surrounds the lakes and canals forming Patterson Lakes, Victoria. Patterson Lakes consists of a development of residential properties bordering a man-made group of lakes and tidal canals which connect to the Patterson River via a system of tidal gates. It was constructed in the 1970's as a means of reclaiming the site which originally formed part of the Carum Carum swamp. Soil excavated to form the water features was able to be used to elevate the surrounding residential development. Lakes and canals form an integral component of the area's drainage system and are therefore managed by Melbourne Water as the floodplain management and drainage authority in the Greater Melbourne area.

The retaining wall located between the water and the higher ground levels on the side of the properties was constructed between 1979 and 1986. It is made of three sections; a buried cut off reinforced concrete wall, a reinforced concrete foundation, and the exposed 1.2-2m tall vertical upper retaining wall section made of concrete blocks fitted with grout-filled vertical and horizontal steel reinforcement. A 3m land easement exists from the wall to allow for access and prevents concentration of heavy loads against the wall.

Melbourne Water's inspection program in 2010 identified poor condition in sections of the wall. Further investigations revealed a risk of chloride induced corrosion of the steel rebar likely to initiate within the next decade and that gradual replacement of the walls would be necessary. A later assessment in 2012 confirmed a low depth of carbonation, but high chloride penetration at the reinforcement depth (Figure 1). Corrosion had just initiated, as shown by visual inspection, and it was predicted that retaining wall failure would occur in approximately 10 years. This was a disappointing performance for an asset meant to be in place for far longer than its then age of 30 years. The area of the structure mostly at risk was

Figure 1. Electrolysis Test Point placed adjacent to wall and flush to ground level.

Figure 2. Cathodic Protection Junction Box.

Figure 3. Temporary fence installed during installation.

predictably found to be the tidal zone of the exposed vertical wall with the ever-changing moisture conditions, while the buried/submerged sections were determined as less vulnerable.

Different options were assessed including gradual replacement with sheet piling, gabions, or similar reinforced blocks, however the option that provided the least cost was shown to be cathodic protection. A series of trials using a traditional galvanic soil cathodic protection system, a main component of which focused on reinforcement connectivity, proved the feasibility of this solution which was then selected for implementation. During the tender process, a variation of the more traditional galvanic or impressed current cathodic protection (ICCP) was proposed, in the form of the 'hybrid' anode system. This system would consist of embedded zinc anodes within the retaining wall connected by titanium wire to the reinforcement. The system would initially be energised via an external DC energy source in a temporary impressed current phase, followed by a permanent galvanic phase.

Despite its lack of previous experience with such a system, Melbourne Water was attracted to this solution as it offered a number of benefits. Embedding the anodes within the wall meant that there would be minimal disturbance to properties easement and therefore residents, as all work could be carried out from the water side of the wall. Fittings such as junction boxes and test points are placed closely to the wall to minimize future risk of disturbance to the system (Figure 2). The innovative technique of incorporating an initial impressed current phase to the anodes, as well as the possibility of re-energisation if required without the need to replace the anodes, provided greater advantage in terms of capability to provide adequate corrosion protection when compared to a traditional galvanic system, and without the permanent cabling requirements of an impressed current system. The vastly reduced size and quantities of metal (zinc) and also played a role in reducing manual handling risks. Unfortunately the patented nature of the hybrid anodes (*DuoGuard*™) meant that this reduction was not reflected equivalently in the project cost.

Disadvantages of the hybrid anode solution from Melbourne Water's perspective was its lack of experience with this approach compared to the use of conventional ICCP and galvanic systems, and the lack of longer term published results in this area. This created uncertainty and debate around the selection of the appropriate cathodic protection criteria to apply in order to ensure that the system would perform as intended and meet the requested 50-year design life. Aspects such as correct interpretation of depolarisation response, reference electrode placement and the influence of the highly variable moisture content within the marine environment, added to the complexity of the overall problem.

Before proceeding with the system installation, trials took place to prove the feasibility of the concept and to provide data on which the system design could be based. Natural potentials of the steel were obtained which showed a high likelihood of corrosion as per ASTM C876-91, without however accounting for the effect of chloride concentration or other factors. The charge able to be passed easily achieved the required design criterion of 50kC/m^2 of reinforcement. Depolarisation testing was carried out and corrosion rates calculated using potential shift and current density in accordance to the Butler-Volmer equation (Note 9, Clause 8.6 of BS EN ISO 12696:2012). System design was based on long term protective currents of 2-4mA/m^2 (of reinforcement surface) as validated through the trial, to meet the ambitious design life of 50 years.

This system installation was recently completed in December 2017 by Melbourne Water framework contractors John Holland and KBR with Infracorr as CP system designer. The installation process was able to follow an effective sequence of anode installation (Figure 3), connectivity testing and anode energization before moving to the next section of wall. Next steps will be to monitor the performance of the system in the long term, through a number of reference electrodes and test points installed for this purpose. A research project will also examine the performance of this hybrid system in comparison to an adjacent control section where no treatment has been applied. This will be a useful measure of real benefits provided by this installation and also add to the body of literature available for this type of hybrid anode system, which to date mainly covers its application in the protection of bridges.

Theodora Hogan Karastergiou & Agus Effendy, Melbourne Water

This Paper was originally presented at Corrosion & Prevention 2016

Corrosion of Stainless Steel in Aggressive Water Environments

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1. Introduction

Stainless steels have found increased applications in marine environments in many countries around the world over recent decades. Successful service provided by stainless steels, such as in desalination plants, has led to increased confidence in the suitability of the alloys for applications in aggressive aqueous environments such as seawater. This success has been accompanied by the increased knowledge of how design, fabrication and operational practices can achieve the best performance when using appropriate stainless steel grades for marine applications.

Designers and engineering specifiers ideally require a good knowledge of the stainless steel grades available and the service capabilities of the chosen alloys in order to ensure the successful application of stainless steels. Knowledge of stainless steel fabrication practices and post-fabrication cleaning procedures for stainless steel are most important to avoid premature failure. Good industry practice for the successful use of stainless steels during service in aggressive waters, including seawater, is now more prevalent in the design of marine structures (1).

However, situations are encountered, from time to time, where a grade of stainless steel has been incorrectly specified for water service conditions when the stainless steel is continually exposed to a corrosive salt water environment. Problems have also been experienced where poor design or use of an out of specification alloy has contributed to premature failure of stainless steel components in marine service. A case study of premature failure of the so-called 'marine grade' AISI Grade 316 stainless steel is discussed to illustrate how corrosion problems occurred using this grade of austenitic stainless steel.

2. Crevice Corrosion and Factors Influencing Crevice Corrosion

2.1 Crevice corrosion mechanism

Crevice corrosion is a form of localised corrosion usually associated with a stagnant solution on the micro-environmental level (2, 3, 4). Such stagnant micro-environments tend to occur in crevices (fissures or shielded areas) such as those formed under gaskets, washers, insulation material, fastener heads, surface deposits, disbonded coatings, threads, lap joints and clamps. Crevice corrosion is initiated by changes in local chemistry within the fissure:

a) Depletion of a corrosion inhibitor in a crevice

b) Depletion of oxygen in a crevice

c) An increase in the acid conditions within a crevice

d) Build-up of aggressive ionic species in a crevice, e.g. chlorides

e) Development of differing potentials between active and passive stainless steel surfaces.

As oxygen diffusion into the crevice is restricted, a differential aeration cell tends to be set up between crevice (microenvironment) and the external surface (bulk environment). The cathodic oxygen reduction reaction cannot be sustained in the crevice area, giving it an anodic character in the concentration cell. This imbalance can lead to the creation of highly corrosive micro-environmental conditions in the crevice, conducive to further metal dissolution. This results in the formation of an acidic micro-environment from metal ion hydrolysis reactions, together with, in salt water, a high chloride ion concentration.

All forms of differential and concentration cell corrosion on stainless steel can be very aggressive, and all result from environmental differences at the surface of the metal. Even the most benign atmospheric or immersed environments can become extremely aggressive.

2.2 Crevice Shape

The geometry of the Stainless Steel (SS) crevice will influence its susceptibility to attack and the speed of progress (4). The narrower and deeper (relative to its width) a SS crevice, the worse corrosion attack will be. Metal to flexible plastic crevices tend to be narrower than rigid metal to metal gaps, so metal to plastic joints provide more aggressive crevices.

2.3 Environment

The more aggressive the fluid outside the SS crevice, the more likely it is that the SS in the crevice will be attacked. If the electrical potential of the cathodic SS area outside the crevice is higher than the anodic SS area inside the crevice, then the anodic SS area in the fissure is more vulnerable to accelerated localised corrosion, because of a larger potential difference created on the SS surfaces. This is why crevice corrosion may be a more serious problem on SS fittings installed in a chlorinated salt water swimming pool, but crevice corrosion is not as serious on SS fittings in a chlorinated fresh water swimming pool.

2.4 Temperature

Once the Critical Crevice Temperature (CCT) is exceeded, then as with exceeding the Critical Pitting Temperature (CPT), higher temperatures mean corrosion on SS is more rapid. Based on the Arrhenius equation it can be expected that a 10° C rise in temperature can double the corrosion rate. At higher temperatures not only are SS crevices more likely to start corroding but, once corrosion initiates, the component will corrode faster.

2.5 Alloy corrosion resistance

Using a more corrosion resistant SS produces less crevice corrosion attack (4, 5). For example, in seawater at ambient temperature, crevices will form on austenitic Grade 304 SS if there is less than a 0.9 mm gap, on Grade 316 SS if there is less than a 0.4 mm gap, and on Grade 904L SS (similar corrosion resistance to duplex grade 2205 SS) if there is less than a 0.15 mm gap.

2.6 Minimising the risk of crevice corrosion

Good design, good fabrication and controlled operating practices will anticipate and help to minimise crevice corrosion on most of the SS grades.

2.7 Design to minimise corrosion

It is good practice to design to minimise the presence of crevices in SS components and fittings for water immersion. If a crevice is a necessary part of a design, it is best practice to make the fissure as wide as possible to allow oxygen ingress into the fissure. Full penetration butt welds are best for joints in SS to minimise crevices. It is also good practice to seal lap joints in SS and to avoid gaps between SS pipes and SS fittings.

2.8 Pitting Resistance
A factor that needs to be considered when choosing a SS grade for structures submerged in seawater is the Pitting Resistance Equivalent Number (PREN). The theoretical PREN-value for austenitic SS is calculated using the following formula:

PREN = % Cr + 3.3 x % Mo + 16 x% N (w/w)

In general, the higher the PREN-value the more corrosion resistant the SS grade. Grades of SS with PREN-values above 40 are considered to be corrosion resistant when submerged in seawater. The PREN-value for Grade 316 SS is in a range from 23-29, depending upon the Mo content in the 316 SS alloy. There is a likelihood that a structure fabricated from Grade 316 SS immersed in seawater during service may be subject to localised corrosion attack. The PREN value is only a guide. There are cases where Grade 316 SS has performed well when submerged in seawater If crevices are present in an immersed Grade 316 SS structure the likelihood of crevice corrosion occurring is higher. Due to the likelihood of localised corrosion occurring it is advisable not to employ grade 316 SS for seawater immersion. In the tidal zone or above, seawater grade it can give reasonable performance. However, using the generic name "marine grade" for Grade 316 SS is misleading since designers can inadvertently assume it is sufficient for the task in hand which can result in unexpected failures of the alloy due to localised corrosion if it is subjected to seawater immersion.

3. Case Study: Corrosion in a Swimming Pool
3.1 Observations
Premature corrosion occurred on Grade 316 stainless steel fittings in a private swimming pool. The initial cause of concern was the stainless steel pool steps where corrosion was noticed on welds and cap nuts holding the step treads (Figures 1 and 2). Corrosion was also observed on the inlet suction port fitting, the water outlet fitting (Figure 3) and in the skimmer box. An underwater light fitting showed evidence of minor corrosion, however when the cover was removed rust staining was evident on both the cover plate and on the plastic light casing (Figure 4). At one end of the swimming pool a spa pool was installed. Stainless steel fittings in the spa pool, including lights and vents, all showed rust staining (Figure 5). The stainless steel fittings that exhibited the most corrosion were the aerator jet covers (Figure 6). The pool was heated by a solar unit on the roof of the house and the treated pool water at times reached 40° C. Originally, the water pipes feeding and leaving the solar heater were stainless steel but the pipes had corroded and had been replaced with plastic pipes. A lamp cover-plate, cap nuts from the pool steps and screws from the pool lamp were removed for analysis and further investigation.

3.2 Laboratory Examination of Components
3.2.1 Microscopic examination
A stainless steel (SS) screw, removed from a pool light was examined under an optical microscope. The examination of the SS screw shank revealed that extensive localised corrosion had occurred. The hole on the cover-plate where the fastener passed through to hold the plate in place also showed signs of localised corrosion. The corrosion observed where the fastener entered the pool light cover plate and the face of the nut was consistent with crevice corrosion occurring on the components.

3.2.2 Material analysis
The metal fittings in the lap pool and spa pool were specified as being Grade 316 SS. The lamp cover-plate, a cover-plate screw and a ladder cup nut were analysed for elemental composition in a laboratory using optical emission spectroscopy (OES). Table 1 gives the OES analysis results (element weight %) and the specification for the composition of AISI Grade 316 SS. As with all measurement there is some degree of uncertainty. The OES calculates its uncertainty from the standard deviation of a number of readings, the uncertainty of precision of the machine and calibration uncertainty resulting in a combined expanded uncertainty (95% confidence interval). A typical combined expanded uncertainty for Grade 316 SS is included with the results shown in Table 1


Figure 1: Stainless steel pool steps showing rust under cup nuts.


Figure 2: Corrosion on inner weld of stainless steel step.


Figure 3: Corrosion on inner edge of pool water outlet vent.


Figure 4: Severe rust staining on stainless steel housing of pool light.


Figure 5: Corrosion on stainless steel fittings in spa pool


Figure 6: Corrosion on stainless steel spa pool aerator jet cover

Analysis of Pool Fittings				
Component	Ni %	Cr %	Mo %	Comment
Specification 316 SS	10.0 – 14.0	16.0 – 18.0	2.00 – 3.00	
Cover plate	10.14	16.75	1.96	Mo slightly out of specification
Cup Nut	10.49	17.13	2.04	
Cover plate Screw	11.71	17.76	1.92	Mo slightly out of specification
Combined Expanded Uncertainty	0.050	0.0664	0.0321	

Table 1.

The SS fittings analysed had close to the minimum, or below the minimum specification for the molybdenum (Mo) content of 316 SS. The correct Mo content is critical to provide the corrosion resistance expected of Grade 316 SS. Over recent years the composition of austenitic Grade 316 SS has tended toward the absolute minimum specification for Mo content and this is in part related to the high cost of molybdenum metal. The Mo content was at the bottom of the acceptable range.

3.2.3 Chemicals added to the Pool Water
Chloramine, NH_2Cl, forms by ammonia reacting with chlorine. Chloramine is very soluble in water and it can be used as a disinfectant in public swimming pools and water supplies. However, chloramine is known to increase the risk of corrosion occurring on stainless steels (2). The lap pool water was treated with a number of chemicals to maintain the correct water pH and chlorine level. The chlorine is added as a bacterial and viral disinfectant and as an algicide. It should be noted that a report by the Urban Water Research Association of Australia, (6) suggests chloramines at levels in drinking water have no effect on stainless steel. Higher chloride levels may however make the chloramines more aggressive, similar to chlorine and increasing chloride levels.

In order to ascertain if any of the chemicals used in the pool maintenance contained ammonia-based species an audit was undertaken of the chemical products added to treat the pool water. A list of pool additions and their active ingredients is given in Table 2. Another source of ammonia based compounds, mostly in public swimming pools, is human perspiration and urine. It was assumed that the lap pool had insufficient use to consider this factor as a source of ammonia.

Table 2.

Active components of pool water treatment

Pool Additive	Active components
Pool Salt	Sea salt (sodium chloride)
Pool Acid	Hydrochloric acid
Balance Pak 100	Sodium hydrogen carbonate
Balance Pak 300	Calcium chloride
Salt Pool Sparkle	Sodium dichloroisocyanurate Sodium tetraborate pentahydrate

None of the pool water treatment chemicals contained ammonia-based compounds so it was unlikely that chloroamines had been formed to exacerbate corrosion on the Grade 316 SS fittings. However, the addition of sea salt (chlorides, Cl^- ions) was of interest because chlorides can assist localised corrosion on Grade 316 SS if the SS fittings and other SS components are permanently immersed in salty pool water. In a salt water pool sodium chloride (NaCl) is added to facilitate electrolytically generate chlorine in the swimming pool and in the spa pool. Salt water pools typically have 3,000 to 5,000 mg/L chlorides added.

3.3 Discussion
It was apparent that the premature corrosion on the swimming pool and spa pool Grade 316 SS fittings was due to crevice corrosion. Grade 316 SS is often called the 'marine grade' of stainless steel, but it is susceptible to crevice corrosion when immersed in salty water, particularly at temperatures greater than about 22° C. The Grade 316 SS used for the pool fittings contained very close to the minimum of the molybdenum composition which can diminish the corrosion resistance of the immersed fittings. Furthermore, the design of the pool steps with built-in crevices contributed to the initiation of crevice corrosion on the Grade 316 SS components.

3.4 Remediation
A solution to the premature corrosion of the Grade 316 SS fittings was to extricate the pool fittings that could be unfastened and have the components electro-polished. The Grade 316 SS components that could not be removed from the pool needed to be thoroughly cleaned and well-polished in-situ with a water-resistant metal polishing agent to minimise future contact of the Grade 316 SS components with the pool and spa water. All crevices should then be sealed to prevent corrosion reoccurring unless they can be increased to be wider than the critical width (>0.4mm).

In addition, the Grade 316 SS fittings in the pool need to be inspected regularly to ensure that crevice corrosion does not recur. Regular maintenance of the Grade 316 SS fittings is necessary to clean the 316 SS components and to remove any build-up of aggressive chemicals that might deposit in SS crevices.

4. Conclusions
Although there have been successful applications of Grade 316 stainless steel in salty water and marine environments, the so-called "marine grade" 316 stainless steel has its limitations in aggressive service environments. It is preferred that austenitic Grade 316 stainless steel is not employed in full seawater immersion conditions due to the risk of localised corrosion occurring at joints and connections on marine structures where crevices exist.

In applications where a marine structure is likely to experience full or intermittent immersion in salty water it is best to choose a higher grade of stainless steel such as a super-austenitic grade or a super-duplex grade. The selection of the stainless steel grade is very dependent upon the expected service environment. If unusually aggressive water environments are anticipated during service due to the location of a marine structure it is advisable not to select 'marine grade' Grade 316 stainless steel.

5. References

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[3.] A. J. Sedriks, Corrosion of Stainless Steels, 2nd Ed., Ch. 5, John Wiley & Sons, New York, USA, 1996.

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[5.] R. W. Ross & A. H. Tuthill, Practical Guide to Using Marine Fasteners, Nickel Institute, Technical Series No 10045, 1990.

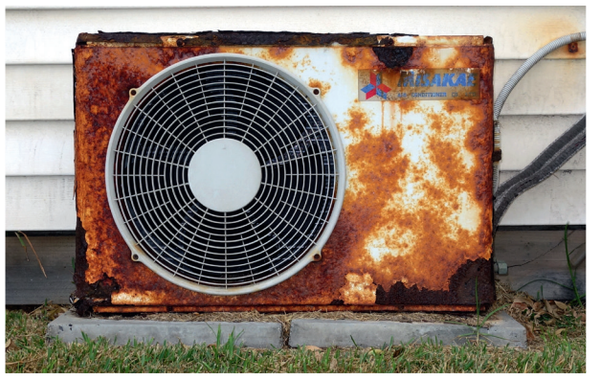
[6.] Effects of Chloramination of Potable Water on the Performance of Materials,(1998), Report UWRAA 141, Urban Water Research Association of Australia,

INTERESTING CORROSION PHOTOS

Reo exposed on sea wall (VIC).
Courtesy Robert Slater, ACA HQ IT guru.

Brass plated Fe hinge on St Georges Cathedral (WA). April 2018.
Courtesy I. MacLeod.

Above the waterline pier corrosion (VIC).
Courtesy Robert Slater.



AC unit corroding 30 metres from the sea (VIC).
Courtesy Robert Slater.

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It is recommended that students who wish to register for this course have either 8 years pipeline work experience OR 4 years pipeline work experience AND a degree in physical science or engineering.

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