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CORROSION & MATERIALS

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PROTECTIVE COATINGS FEATURE

Inside this Issue:

CORROSION & PREVENTION 2016

13–16 November
SKYCITY Convention Centre
Auckland, New Zealand

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www.newzealand.com

Technical Topics

Corrosion & Prevention 2016 invites technical papers on all subjects related to corrosion. The conference will bring together leading researchers and industry practitioners who combat corrosion on a daily basis. Diverse technical streams will showcase the latest developments in corrosion, ranging from fundamental corrosion science to hands-on application. Submissions may include research papers, review papers and case studies related to the technical streams and industry sectors listed below.

Technical Streams

- Advances in sensing & monitoring
- Asset and integrity management
- Cathodic protection
- Concrete corrosion and repair
- Corrosion mechanisms, modelling and prediction
- Corrosion prevention implementation
- Education, training and research
- Materials selection and design
- Protective coatings

Industry Sectors

This conference will have material of value to those working within the following industries:

- Buildings and construction
- Cultural and historical materials preservation
- Defence, aviation, maritime
- Education and research
- Food processing
- Government
- Marine, transportation and infrastructure
- Mining and resources
- Oil & Gas
- Power Generation and energy systems
- Water and wastewater

Conference Convenor

Raed El Sarraf

Technical Chair

Raman Singh

Committee

Brian Hickinbottom
Erwin Gamboa

Sponsorship and Exhibition

Sponsorship will enable your company to make a significant contribution towards the success of Corrosion & Prevention 2016. In return, the conference offers strong branding and exposure in a focussed and professional environment. As with every conference, the exhibition will be an integral part of the activities. It provides an opportunity for organisations 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 the Australasian Corrosion Association on +61 3 9890 4833 or email aca@corrosion.com.au

To Register please visit www.acaconference.com.au

Corrosion & Prevention 2016

Early Bird Registration Competition

Register for Corrosion & Prevention 2016 before *Friday 19 August* to go into the draw to win

- **Four nights accommodation in the 4.5 star SkyCity Hotel Auckland**
- **A SkyWalk Experience for 2 people**

Total prize value over $1400

Terms and conditions

For full competition terms and conditions please refer to www.acaconference.com.au

CONTENTS

Corrosion & Materials

Corrosion & Materials is the official publication of The Australasian Corrosion Association Inc (ACA). Published quarterly, *Corrosion & Materials* has a distribution of 2,500 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.

Vision Statement

Reducing the impact of Corrosion.

Front Cover Photo: In-situ field fit flange and rebate internal coating repairs using Chem-tect RB300
Photo by Greg Bladowski/Chemco.

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CONTENTS

Vol 41 No 3, August 2016

Dean Wall
Chairman

Greetings everyone, we are midway through the year and as Chairman of the ACA Board we have seen some challenging times for our Association. The Industry we all work in continues to be affected by one of the biggest down turns in many years if not decades and we have all been challenged to deliver targets. We too have had to tighten our belts and make decisions to cut costs and ensure we are in a good position to move forward.

The ACA Board met again in June and we were joined by two new Board members (non ACA Members); Di Brookman and Chris Badger. They both bring a wealth of experience and a fresh perspective to the ACA. Their contribution to our meeting was invaluable and and I can report the Board made a unanimous decision to elect Di and Chris to the Team. We discussed many current issues affecting the organisation and I can reassure you all, we are making the right decisions for our Association's future growth and longevity.

Our staff led by Executive Officer Wesley Fawaz, are excited by the joining of two new Board members who have already assisted Wesley's team with ideas/direction and are working diligently to deliver our first round of a new suite of training courses. Our energies and investment during such downturns will be the key to our future growth, for example the new 'ACA Hot Dip Galvanizing Inspector course'. This initiative and Peter Dove's push for this diversification has the Board's unanimous support. We need to continue to maximize future opportunities with this and other ACA courses both locally and overseas. Further training diversification, sales and an updated Strategic Plan were important matters for discussion during the recent June Board Meeting. Recommendations to Wesley and the ACA staff to capitalise on the development of other protective coatings applicator courses for marine, protective and concrete applicators, should be high on the list of priorities.

The ACA Board has prioritised investment, development and the importance of offering alternative up to date training from around the globe, to be delivered to our markets.

Our recent Board Meeting in June also preceded a very important strategic planning meeting for the ACA. Here we brought together representatives of our corrosion community (Branch Presidents, Board members and ACA Centre staff) and started the scoping process for our Association's Strategic Plan for 2017-19. The planning meeting's direction was well led by an independent facilitator and I would like to thank all those who attended for their personal and Branch's valued contributions. It is a very important step in leading the Association into the future, delivering and building on our ACA strategic plan. Stay tuned for more updates along the way.

I recently had the pleasure of attending a Technical Event (TE) in Auckland and the Tasmanian Branch's TE and report it was great to see over one hundred corrosionists collectively gather, to learn from some good technical presentations and network with local industry experts. They were both enjoyable events to attend and meet and greet our Association's Members. Well done to the ACA Auckland and Tasmanian Branches who were well supported by ACA Centre staff in arranging successful local events. The events facilitate the delivery of the corrosion message to the communities at large.

As the ACA Board Chairman I wish to acknowledge the fine efforts of ACA Executive officer Wesley Fawaz and his team. In closing, I would like to say thanks firstly to my employer, Jotun Australia, for their ongoing support of my involvement with the ACA. On behalf of the ACA Board, to all the ACA Staff and many volunteers, thanks for your ongoing efforts and I look forward to meeting you at one of the many ACA events coming up this year.

Yours in Corrosion and best wishes to all the Dads for Father's Day.

Dean Wall
Chairman

ACA Board Meeting Friday 24 June

Strategic Planning Session Saturday 25 June

ACA 2016 Events

Part of the role of the ACA is to organise events that bring together industry experts to present on new technologies, updates to standards, and share knowledge and experiences via case studies on a variety of projects. Here are the events planned for the balance of 2016.

September

ACA/APGA Pipeline Corrosion Management Seminar
Tuesday 13 September | Perth

Corrosion in the Water & Wastewater Industries
Thursday 22 September | Sydney

October

Concrete Corrosion Technical Event
Tuesday 25 October | Adelaide

November

Corrosion & Prevention 2016
Sunday 13 – Wednesday 16 November | Auckland

Introduction to Corrosion
Tuesday 15 November | Auckland

Branch Events

Each of the 8 ACA Branches will conduct regular technical events throughout 2016. To enquire, you may 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

Wesley Fawaz
Executive Officer

A New Strategic Direction Ahead

While the ACA is in its 61st year with an illustrious history behind it, it now faces nearly limitless potential ahead with a new strategic direction which will effectively transform the ACA from an inwardly-focused 'learned' society to an outwardly-focused professional association.

ACA's opportunity is not only to keep growing but to harness that growth to deliver ever greater value in membership and to demonstrate value to the wider community in corrosion prevention and management.

I have mentioned in recent years how the ACA was setting a solid foundation through implementing good governance and then diversifying and investing in its revenue streams for its future. Now we have entered the next phase of planning our new strategic direction which began with the recent membership survey (please see summary of results on pages 30–31). In this survey members were asked to determine the value in their membership and what industry challenges they are facing. This feedback was critical in the development of a new strategic plan and I thank all those who took the time to complete this.

Whilst the new plan will include goals that will stretch and transform the Association, I believe the ACA has a very capable team of staff and volunteers committed to strengthening the collective voice of the importance of corrosion mitigation.

The new strategic plan will be announced shortly and members will be able to discuss elements of this with myself and members of the Board during Corrosion & Prevention 2016 in Auckland. The annual conference is the ACA's largest single activity and signature event and is a vital networking and learning opportunity for industry. It was last held in Auckland 16 years ago, so it's a great opportunity to visit this geographically blessed city.

On a final note, one Member's dedication to the ACA that will be missed is Dr Erwin (Erk) Gamboa of the University of Adelaide who is moving to Canada to work for TransCanada Pipelines. On behalf of the ACA Erk, thank you for your support over many years and we wish you and your family a wonderful experience.

Wesley Fawaz
Executive Officer
wesley.fawaz@corrosion.com.au

ACA Training Calendar 2016

ACA/ACRA Corrosion & Protection of Concrete Structures

Member $1115 *Non-member $1395*

Adelaide October 24 – 25

New Zealand November 10 – 11

ACA Coating Inspection Refresher

Member $605 *Non-member $740*

Australia December 5

New Zealand October 29

ACA Coating Selection & Specification

Member $1560 *Non-member $1900*

Sydney September 5 – 7

NACE Cathodic Protection Program CP 1 – CP 4

Member $3335 *Non-member $3670*

CP1 Melbourne October 17 – 22

CP2 Brisbane July 25 – 30

CP2 Melbourne October 24 – 29

To express interest an in CP 3 & CP 4, please email aca@corrosion.com.au

NACE CP Thailand

Member $2600AUD *Non-member $2850AUD*

CP1 - Tester Bangkok November 7–11

CP2 - Technician Bangkok November 14–18

Hot Dip Galvanizing Inspector Program

Member $1560 *Non-member $1900*

Perth August 30 – 31

Sydney September 6 – 7

Corrosion Technology Certificate

(Also offered as Home Study)

Member $2330 *Non-member $2730*

Sydney November 28 – December 2

CTC Home Study

Member $2330 *Non-member $2730*

Start any time

Corrosion & CP of Concrete Structures

Member $1115 *Non-member $1395*

Melbourne October 6 – 7

Metallurgy of Steels Introduction

Member $1560 *Non-member $1900*

Melbourne September 26 – 28

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 Coating Inspection Program CIP 1

Member $3740 *Non-member $4275*

Adelaide August 22 – 27

Brisbane September 12 – 17

Melbourne October 10 – 15

New Zealand October 31 – November 5

Perth November 21 – 26

Sydney December 5 – 10

NACE Coating Inspection Program CIP 2

Member $3740 *Non-member $4275*

Brisbane September 19 – 24

Perth October 17 – 22

New Zealand November 7 – 12

Prerequisites now apply to this course.

NACE Pipeline Corrosion Integrity Management

Member $2950 *Non-member $3250*

Perth October 3 – 7

Brisbane October 10 – 14

Protective Coatings Quality Control

Member $1560 *Non-member $1900*

Brisbane August 29 – 31

SSPC Concrete Coatings Inspection

Level 1 $3000 *Level 2 $3500*

Sydney September 12 – 17

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 3 9890 4833 or aca@corrosion.com.au**

ACA Recruits External Directors

Following the governance review in 2014 and the acceptance of the new Constitution, the ACA has now recruited two external directors to join the ACA Board. After a recruitment campaign was conducted, six applications were shortlisted by the Governance Committee and then reviewed by the ACA Board. Attending the recent June Board meeting were Di Brookman and Chris Badger who had been selected and were officially elected onto the ACA Board.

Di and Chris bring exceptional skills and experience in addition to the current Board members as summarised here:

Chris Badger

Di Brookman

Chris Badger - BEng(AUS), CPIEA(AUS), ADP (LBS UK), LC&OR (SUBS USA), LDP (WUBS UK) & GAICD (AUS)
Chris Badger has over 30 years' experience both in Australia and Internationally in the utilities, energy & infrastructure sectors with senior executive level positions with Loy Yang Power, WestNet Energy, Alinta Asset Management, E.ON Ag and Powergen plc. He is currently a Non-Executive Director (NED) with South Gippsland Water, skill based NED with Gippsland Waste & Resource Recovery, was formerly Independent NED with Murray Irrigation Ltd, Director & Deputy Chair of Trafalgar and District Bendigo Community Bank (2009). Mr Badger is a Superannuation Trustee Director (2012), Associate Director with Maddison Cross (2014) a management consultancy firm, and is a Director of his own consultancy business (2010).

Di Brookman – BSc Hons & GAICD
Di is an Oil & Gas industry professional with over 25 years' experience in energy finance and investment banking. Her technical, debt and equity markets experience enables interpretation of scientific, financial and investment data and provision of innovative business development and funding solutions for clients. She possesses strategic evaluation, governance, communication and risk management skills and has marketed research ideas extensively to international fund managers.
Di grew leading energy equity franchises at Citi, Credit Lyonnais Securities Asia (CLSA) and Barclays de Zoete Wedd and at Westpac originated debt solutions for energy corporates. Within the corporate sector she ran investor communications/ relations at ASX listed Dart Energy and earlier was a petroleum development geologist at Bridge Oil working its Cooper Basin and SE Queensland upstream and midstream gas assets.

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A smarter, safer way to reduce corrosion

Better protection against rust and corrosion is a step closer thanks to a breakthrough by a research team, who have discovered a material and manufacturing process for a smart release coating.

The discovery provides a boost for the steel industry, helping it to retain its focus on high-quality steel meeting the very highest standards of performance and safety. The breakthrough is of particular importance because the industry needs an alternative to the corrosion inhibitor most widely used at present, hexavalent chromate, which will be banned across the EU from 2019.

Release coating outperforms hexavalent chromate

Corrosion inhibitors are commonly used in a wide range of sectors, including coated steel products used to construct industrial, commercial and other buildings; aerospace and aircraft; and the car industry. Led by Professor Geraint Williams, the team, based at the Swansea University's College of Engineering, discovered a material and manufacturing process for a smart release coating which outperforms hexavalent chromate in laboratory tests.

Triggering on demand

The new method involves a stored reservoir of corrosion inhibitor. It works by channelling aggressive electrolyte anions into the coating, triggering the release of the inhibitor 'on demand', thus preventing corrosion. The product has been tested with salt spray, the standard test for corrosion, outperforming hexavalent chromate. Researchers used a scanning Kelvin probe, specially built by the team, which can detect the state of the metal beneath a coating without touching it. This allowed them to test different products much more quickly, with each test taking around 24 hours, rather than 500 hours as was previously the case.

Prize-winning discovery

The discovery could lead to the product taking a significant slice of a multi-million euro market. The market for coiled coated steel is potentially worth EUR3.8 billion per year in Europe alone. Initial discussions with industry have been extremely positive. The work has won the Materials Science Venture Prize of EUR31.720 awarded by The Worshipful Company of Armourers and Brasiers, and presented at the University of Cambridge.

Paint is one of the coatings for metal which the team investigate, to assess its relationship to corrosion. Source: Swansea University

Story: www.european-coatings.com

BP Touts Microsubs' Potential for Spotting Problems

Small, inexpensive autonomous underwater vehicles called microsubs are the next big thing for oil and gas companies, according to BP, which posted a report July 7 about its research on their use to record highly detailed photos and information about the underwater environment.

"We're adapting a microsub to perform environmental surveying that would normally be done at considerable cost using large-scale AUVs or remotely operated vehicles," said Joe Little, technology principal in BP's digital innovation team.

The report says these AUVs are only 50 centimeters long and cost as little as $7,000. BP is working with manufacturer Planet Ocean, the Marine Robotics Innovation Centre at the UK's National Oceanography Centre, and the Scottish Association of Marine Science to optimize the microsub technology before starting the first trial in the North Sea in December. The company will use them to patrol its subsea infrastructure, such as pipelines, to provide an early warning of any potential problem.

"When you have numerous units working intelligently, the speed of work and the volume of data and information you get is very impressive," said Peter Collinson, BP's global environmental response expert and Little's partner in the project. If the trials are successful, BP intends roll out a fleet of microsubs for environmental and operational monitoring and also crisis response planning, as soon as next year.

The report says their miniature size allows them to explore previously inaccessible areas such as shallow water, wrecks, and reefs, and they can be used to pinpoint pipeline corrosion or potential leaks. "There are a lot of different ways we could deploy them: crates on the seabed, platforms, the shoreline, helicopters – we're even looking into dropping them from drones," Little said.

Microsubs have less space for sensors, so the image quality they afford is not as good as with larger machines, but they should more than make up for that in data quantity, the report says. "As microsubs go up and down alongside our pipelines, we won't get high-definition video, but we will get very sensitive hydrocarbon and possible methane readings," Collinson said. "We can tell if there's any hydrocarbon in proximity to our pipeline, consistently and at a phenomenally low cost.

Story: www.ohsonline.com

NACE Pipeline Corrosion Integrity Management

5 day course

CALL FOR LECTURERS

ACA is seeking expressions of interest to become qualified to lecture this course.

Please contact ACA Executive Officer Wesley Fawaz on +61 3 9890 4833 or wesley.fawaz@corrosion.com.au for further details.

Perth 3 – 7 October & **Brisbane** 10 – 14 October 2016

Course Fees:

$2,950 (members)

$3,250 (non members)

Course Summary:

This course serves as the key training track for the PCIM professional who is expected to focus on the implementation and management of an integrity program for a pipeline system. The course provides a comprehensive up-to-date coverage of the various aspects of time-dependent deterioration threats to liquid and gas pipeline systems and will focus on: interpreting integrity related data, performing an overall integrity assessment on a pipeline system, calculating and quantifying risk, and making recommendations to company management on risk management issues.

Learning Objectives:

The goal of this course is to prepare an individual to:

- accurately collect data for use in the evaluation and monitoring of a pipeline corrosion integrity plan.
- recognise pipeline anomalies.
- make recommendations for resolving technical issues 'in the ditch'.
- evaluate a pipeline in-service using External Corrosion Direct Assessment and Internal Corrosion Direct Assessment methods and techniques.
- recognise problems 'in the ditch' and be able to collect the data necessary for further engineering evaluation.

Recommendations:

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.

For further information please contact the ACA on +61 3 9890 4833 or aca@corrosion.com.au or to register please go to www.corrosion.com.au

AUSTRALASIAN CORROSION ASSOCIATION INC.

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'Nano scalpel' allows scientists to manipulate materials with nanometer precision

For German researchers, the new Focused Ion Beam microscope serves as both magnifier and milling machine. The so-called nano scalpel allows researchers to precisely prepare samples for observation.

"The microscope is not only able to examine microscopic defects, cracks or point-like corrosion sites underneath the surfaces of materials, but also to machine the surface of samples with extremely high precision, on a nanometer scale," Maxim Bykov, a researcher from the University of Bayreuth, explained in a news release.

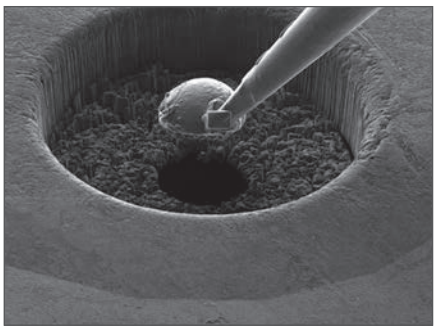
The ion beam is what gives the microscope its scalpel-like abilities. The team of scientists at Deutsches Elektronen-Synchrotron, or DESY, a German research center, say the multipurpose tool has a variety of scientific applications.

"Apart from examining the structure of materials, the ability of the ion beam to remove material also leads to a wide range of different applications," said Natalia Dubrovinskaia, a professor at Bayreuth.

Researchers employed their new device in a separate experiment involving tiny diamond anvils. High-pressure experiments at DESY's Extreme Conditions Beamline require the precise arrangement of diamond anvil cells.

Scientists have also used the FIS microscope to analyze chemical composition signatures by measuring fluorescent radiation.

"Together with the built-in milling machine, we can not only determine the three-dimensional structure, but also the distribution of the elements beneath the surface by alternately removing material and carrying out a chemical analysis, much like in 3D tomography," concluded Thomas Keller, head of microscopy and nano structuring at the DESY NanoLab.



Scientists used their new "nano scalpel" Focused Ion Beam microscope for the precise arrangement of a double-staged diamond anvil cell. Photo by Leonid Dubrovinsky/University of Bayreuth

Story: www.upi.com

ACA attends its first ACRA Exhibition & Seminar

Wednesday 1 June, Swinburne University

ACA Staff Tracey Winn, Wesley Fawaz and Skye Russell.

CCE adds a wealth of experience to its WA operations

Corrosion Control Engineering (CCE) has added another proficient Principal Engineer to its WA team. Dr Grahame Strong has recently joined CCE's Perth office alongside Regional Director, Principal Engineer and ACA Past President, John Grapiglia.

Dr Grahame Strong has 27 years' experience, mainly in corrosion engineering within the petroleum industry. During this time Grahame has applied his expertise and interest in all things related to science, engineering and mathematical modelling to address problems related to corrosion and corrosion control. He holds a PhD and Bachelor of Science degree, and as a qualified chemist specialising in electrochemistry, his role is to support CCE's Cathodic Protection and corrosion engineering activities in the WA region.

New Media Partner for ACA

ACA is delighted to announce a new non-exclusive media partnership with EPC Media Group (EPC). EPC produces three industry leading publications; *Highway Engineering Australia*, *Construction Engineering Australia* and *Waste & Water Management Australia*.

This partnership will provide substantial benefits to members, including unlimited digital access to EPC's publications and additional access to print publications at various ACA events. The three publications reach more than 50,000 readers, exposing members to new markets and providing access to educational resources

Concrete Service Life Extension Conference

Delegates from more than 20 countries including the US descended upon Orlando, Florida over the period 23-25 May 2016 for the NACE International Concrete Service Life Extension Conference. Keynote speakers at the conference were Ivan Lasa (refer Photo) of the Florida Department of Transportation (FDOT) and Warren Green (refer Photo) of Vinsi Partners Sydney. Supporting organisations of the conference were the American Concrete Institute (ACI) and the International Concrete Repair Institute (ICRI).

The title of Ivan Lasa's paper and presentation was 'Corrosion Risk Management for Florida Bridges in Marine Environments'. Warren Green's paper and presentation was titled 'Experiences with the Design of Repair & Protection Measures for Concrete Structures in Australia'.

More than 50 technical presentations were delivered by international and local speakers on topics including:

- Service life estimation and maintenance strategies.
- Effects of concrete cracking on service life estimation.
- Concrete durability performance testing.
- Corrosion evaluation methods.
- Modelling and projection of the onset of corrosion initiation and propagation.
- Corrosion inhibitors for concrete.
- Advanced coating systems for reinforcement steels and concretes.
- Protective penetrant systems for concrete.
- Cement and binder chemistry effects on concrete performance.
- Specialist laboratory based methods for concrete durability assessment.
- New test methods for the NDT of concrete and reinforcement corrosion surveys.
- Bridge inspection and repair.
- Impressed current cathodic protection.
- Galvanic anode systems.
- Hybrid treatment of concrete.
- Cathodic prevention to achieve long-life concrete durability.
- Management of aging infrastructure.
- Structural health monitoring.
- ROV inspection and photogrammetric 3D modelling.
- Heritage structure condition assessment, repair and protection including effects of new materials.

Special thanks are afforded to the Conference Chair, Paul Noyce of Axieom LLC, Conference Co-Chair, Gina Crevello, Echem Consultants LLC and Katie Flynn, NACE Conference Program Senior Specialist for their efforts. Copies of the presentations and papers are available to NACE Members at www.nace.org.

Ivan Lasa, FDOT.

Warren Green, Vinsi Partners Sydney.

ACA Coatings Selection and Specification

Sydney 5–7 September

Member $1560 Non Member $1900

Participants will gain an understanding of the factors that are considered when selecting protective paint coatings for steel and be able to produce a specification that will ensure a quality job.

Largely based on the recently updated AS/NZS 2312.1 Guide to the Protection of Iron and Steel Against Exterior Atmospheric Corrosion – Paint Coatings, the course provides theoretical and practical information on coatings selection for corrosion control.

Inspection is only one part of ensuring a quality coating job, and selecting the correct coating system and writing a good specification are just as important.

Course Objectives:

On completion of this course, participants will be able to use AS/NZS 2312 Part 1 to:

- determine the corrosivity of an atmospheric environment
- identify the design and fabrication features of steel structures which influence coating durability
- describe the methods and Standards of steel surface preparation and the factors that influence selection of the method used
- recognise the different types of paint coatings, their properties and where they are used
- identify the factors which affect selection of a coating system
- choose the optimum paint coating system for structural steel from those described in AS/NZS 2312 Part 1 Table 6.3
- calculate the most economic coating protection system
- evaluate typical coating systems used in specific industries
- plan and prepare a paint coating specification.

For more information go to www.corrosion.com.au

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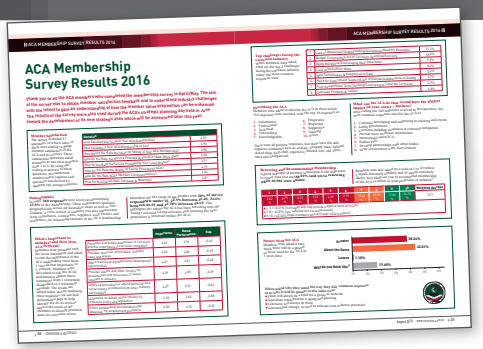
ACA Membership Survey Results 2016

Membership Survey

Thanks to all Members who participated in the May 2016 Membership Survey. There were 3 lucky winners, **Jack Steyn** who received a Full Registration to C&P2016, **Rohan Healy** and **Marianne Seter** who received $100 gift cards of their choice!

See the Membership Survey Results Summary on pages 30–31.

Professor Wei Gao named Officer of the NZ Order of Merit

ACA member Professor Wei Gao from the Department of Chemical and Materials Engineering at the University of Auckland was made an Officer of the New Zealand Order of Merit (ONZOM) in the Queen's Birthday Honours list for his services to science and engineering. The honour was presented to him for making a significant impact in addressing the environmental, industrial and technological challenges faced both here and worldwide.

Professor Gao has had a long and distinguished career in materials science and engineering. His research interests include nanostructured materials, light metals and alloys, electronic properties of materials, and advanced coating and surface technologies. He is a Fellow of the Royal Society of New Zealand and IPENZ, and is on the editorial board of several international journals.

Professor Nic Smith, Dean of the Faculty of Engineering, offered warm congratulations to Professor Gao. "This Honour is doubly pleasing because it not only recognises Professor Gao's stellar contribution to New Zealand but also celebrates the excellent research in engineering being done in this country."

VALE Ray Osborne

The ACA has been recently notified of the passing of Life Member and NZ Branch Historian Ray Osborne.

Ray was a wonderfully tireless worker for the ACA in New Zealand. He was involved in organising four ACA conferences, in 1976, 1984 (as Conference Convenor), 1990 and again in 2000. He spent three periods as Secretary of the New Zealand Branch, from 1973 to 1976 (when he became President for two years), in 1983-4 and 1989-1993.

Ray was Australasian President 1984- 5 and was heavily involved in the production of the ACA's Silver Jubilee film 'The Corrosion Problem'. He was made a Life Member of ACA in 1988 and was awarded the ACA Corrosion Medal in 1990 for his outstanding services to our Association.

Ray graduated from the University of Canterbury with a Bachelor of Science in 1953 and began a long and illustrious career with the Telegraph Department of the NZ Post Office which in 1987 became Telecom. His projects included laying of the first fibre optic telecommunication cable between NZ and Australia, the design and construction of the country's first earth satellite station at Warkworth (commissioned in 1971) and the construction of a telephone exchange in Rotorua (complete with an air filtration system to prevent geothermal gases from corroding the copper contacts in the mechanical dialling system).

He retired in 1989 as Regional Engineer in charge of the Post Office Workshops in Newmarket, Auckland, and then became a communications consultant for the 14th Commonwealth Games that were held in Auckland in 1990.

His other achievements include being made a Fellow of the NZ Institution of Professional Engineers in 1987, and being elected President and Life Member of the Lions Club. In 1995 he became the Executive Officer of the NZ Branch of ACA until 2001. Ray retired from the Auckland Division Committee in 2003 and moved to a retirement village in Havelock North with his wife Lynda. He is survived by his three children and eight grandchildren.

Submitted by Willie Mandeno with assistance from Donald and Susan Osborne and John Duncan.

ACA Welcomes New Members

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Central Highlands Water
www.chw.net.au
Central Highlands Water is a regional water corporation providing high quality drinking water, sewerage, trade waste and recycled water services to customers in Ballarat and surrounding towns. Formerly known as the Central Highlands Region Water Authority, it is one of 19 state-owned water businesses operating under the guidance of the Victorian Water Act. Providing fully integrated catchment-to-tap-to-catchment water services, they collect, store, filter, disinfect and deliver water, and collect and treat wastewater.

Pipe Lining & Coating Pty Ltd
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Integral Engineering Pty Ltd
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VIC Branch

from Research to Reality, the Future of Corrosion Wednesday 11 May

The Victorian Branch's May event '*From Research to Reality: The Future of Corrosion*' had the ambitious aim of presenting on the future of corrosion research and it's industry applications. Three engaging presentations outlined key aspects of this topic to a crowd of nearly 60 attendees. Professor Nick Birbilis (Monash University), presented a fascinating insight into some of the latest corrosion research both at Monash and from around the world. He discussed the mindset change from the traditional model of discovering (perhaps accidentally) new materials and subsequently finding a use for them, to the modern process of developing a material to fit a need or product requirement. Interestingly, this was reflected in Jason Farrugia's (Dulux Protective Coatings) presentation on commercialisation in the corrosion world. Jason spoke on the process of identifying an industry need and undertaking many R&D iterations until the product was just right. The final presentation from Timothy Khoo (Deakin University) offered insight into a way we, as an industry, can harness the existing knowledge base to better our industrial application of corrosion prevention. Tim talked about the ACID (Australian Centre for Infrastructure Durability) and how it has brought together a range of institutions and their capabilities to tackle industries' corrosion related problems. Of course, like all VIC Branch events, there was plenty of opportunity to meet and greet.

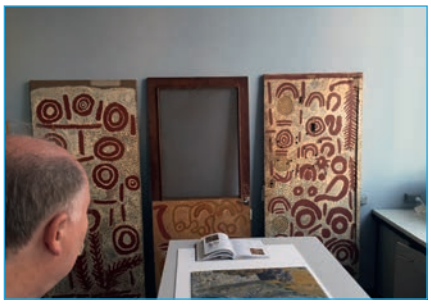
The Branch Committee extends a warm thank you to all presenters and attendees, as well as to Jan Sikora of Independent Maintenance Services, for their support of the event.

SA Branch

Artlab Tour. Thursday 5 May 2016

SA Branch members were invited to a tour of the conservation laboratories of Artlab Australia, to view current work in progress.

Groups were led by Ian Miles, Senior Metals Conservator, and Helen Weidenhofer, Assistant Director at Artlab who explained the treatments being undertaken and discussed the wide range of work undertaken by Artlab conservators. Conservation works viewed by members ranged from items retrieved from salvaged shipwrecks, through to antique statues, textiles and painted artwork.



SA Branch

Technical Meeting
Thursday 9 June, 2016. Cucina Ristorante North Adelaide

The SA Branch secured Julian Wilson, Inspection Sector Manager from NATA, to provide the Branch with an overview of NATA's history, services, progression and importance to many varied industries and sectors. NATA is the National Association of Testing Authorities, Australia's (NATA) role is the delivery of accreditation programs that facilitate a network of competent scientific and technical facilities throughout Australia, to meet national interest and public benefit objectives.

Auckland Division

Meeting Report
Thursday 28 April 2016

An audience from a wide range of backgrounds, including members from Wellington and Whangarei, heard Nick Hodgson, NZ Sales Manager for Hempel NZ, talk about expected forthcoming changes to ISO12944 – an international Standard on corrosion protection of steel structures by protective coating systems which is currently under review. Nick explained that this is important for NZ audiences because while AS/NZS2312 covers pretty much the same subject – and gives pretty similar outcomes - there can be premiums extracted by overseas fabricators for using standards which differ from the ones they are used to. Since ISO12944 is a global standard more overseas fabricators are aware of its requirements. It is also extensively used by international companies as their required standard.

ISO12944 has not been updated fully since 1998, and there have been many paint system improvements since then. The 1998 standard had as its highest durability class 15+ years. Many customers specify 25 to 40 years, and this is proposed be addressed in the revision by creating a class of 25+ years. The revised standard will recognise there are 'extreme' atmospheric corrosion environments. It will also allow for CP use in 'immersion' (water or soil) environments. Contradictions with ISO20340:2009, which covers offshore structures (and which covers effectively the same fields), is proposed to be reconciled by absorbing this subject matter into the revised ISO12944 as a new 'Part 9'.

An area of the revision causing some contention is Part 6 on Laboratory performance and test methods. Some parties in the industry (at least) regard this section in its current form as 'too little, too weak', but agreement on what should be stiffened up seems difficult to reach. More updates to the revision are hoped to be reached at a meeting in Paris in May, after which point there will no doubt be further consultation, to which New Zealand is encouraged to provide its input. It is foreseen that the publication of the revision should be published in mid-2017.

There was an extensive question time, covering topics ranging from UV effects to protection of metal-sprayed substrates and to specifications for intumescent coatings, before ACA NZ Branch President Raed El Sarraf drew the session to a close with a vote of thanks to Nick.

Auckland Division

Meeting Report. 22 June 2016

The ACA Auckland Division annual mid-year dinner meeting was held at The Landing hotel on 22 June on a blustery winter's night. It was good to welcome along Dean Wall, the ACA Board Chairman who was able to attend the meeting. The speaker for the annual dinner meeting was Jacque de Reuck, MD of *Metal Spray Suppliers (NZ) Ltd*, who gave a light-hearted presentation entitled "*From Boating to Coating*".

Jacque outlined his journey sailing from his native Belgium on a yacht named Kiwi in 1974. A one month holiday turned out to be a six-year sailing journey on different sailing boats built from different materials. After sailing in the Mediterranean Sea and on the Atlantic Ocean he eventually sailed to New Zealand through the Panama Canal via Tahiti.

During his sailing career Jacques had the opportunity to witness the corrosive effect of salt water on materials, especially on one 7-metre steel sloop that he sailed. After emigrating to NZ Jacques set up *Metal Spray Suppliers (NZ) Limited (MSS)* in 1983. He realised that the way forward was to learn more about thermal spray technology so Jacques attended international ASM conferences to increase his knowledge of the industry. MSS has also provided support to an Auckland University student carrying out a PhD on HVAF thermal spray coatings. Ferrous and non-ferrous thermal spray coatings are the MSS passion and this provided a good mix with Jacques' other passion of sailing yachts. MSS have been involved in many thermal spray projects in the Pacific region over the past 33 years since the company was established.

Chairman John Duncan thanked Jacques for his very entertaining presentation. A group of the ACA members and partners present then joined Jacques and his wife Catherine for an enjoyable winter solstice dinner in the nautical-themed Landing restaurant.

Newcastle Branch

Inspection & Testing Tools
Wednesday 18 May 2016

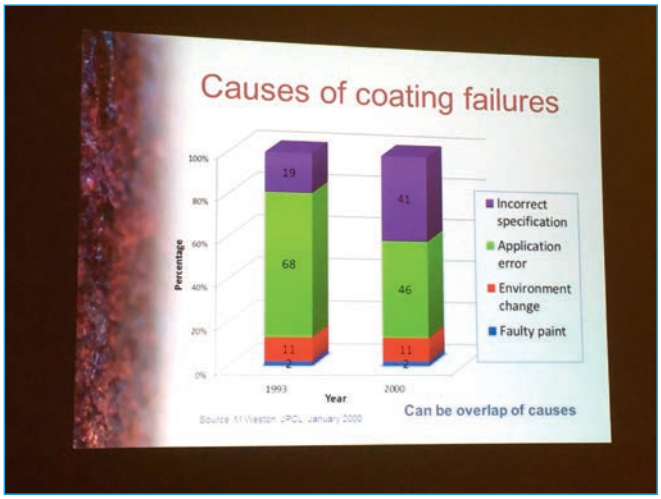
It was with great enthusiasm that 42 members and guests from the Newcastle Branch hosted the team from Russell Fraser Sales (RFS) to speak at their Branch's May Technical Event. Adhering to the Branch's traditional relaxed and inviting atmosphere over a two course meal and some drinks, the Newcastle Branch functions are now held at the Beaches Hotel in Merewether, which provides an outstanding venue with remarkable sea views. Russell Fraser and his team had the rewarding experience of presenting their technology on both the new as well as the tried and tested tools they provide for corrosion detection and measurement.

"We were pleased to be able to bring to the Newcastle Branch of ACA our display of equipment at the May meeting. It was especially good to have Gilberto Fregoso of TesTex with us with his LFET (Low Frequency Eddy Current Technique). The members of the Branch showed a lot of interest and this was beneficial for RFS. Thanks to the Branch committee for the opportunity". Russell Fraser.

Of particular interest was a handheld 3-D laser scanner system and a very low frequency eddy current system that could detect wall loss in pipes through thick coatings and insulation. The RFS 'Toy Shop' was a great opportunity for the attendees to have a 'hands on' experience on what tools are available to detect and measure corrosion.

TAS Branch

Paint Coating Failures: How, why and whose fault? presented by Rob Francis
Wednesday 15 June 2016



SA YCG

Onshore Petroleum Centre of Excellence Site Tour
Thursday 2 June 2016






WA Branch

Corrosion Monitoring Techniques
Wednesday 25 May 2016

This event was held at the ATTAR offices located in Morley, WA.

Initially, delegates had the opportunity to network with their peers.

During the presentation, David Lake covered the various aspects and NDT techniques for detection of localized corrosion (pitting), general corrosion and loss of section.

Malcolm Oakley then covered the advanced NDT techniques used, including Phased Array Ultrasonics and Eddy current demonstration.

Both speakers shared the wealth of their combined experience and this was evident in the informative and well-presented content and their very detailed answers to many questions asked after the presentation.

Once the presentation was completed, delegates were allowed to try using the NDT equipment, under guidance of Malcom Oakley, to give them a basic understanding of how each testing method works and what to look out for.

Overall, this event was well attended with all attendees agreeing it was a good presentation and took away valuable information for different corrosion monitoring techniques.

The WA Branch would also like to offer our appreciation to ATTAR for graciously offering to hold this event at their facility.

Tony Smith
WA Branch Events co-ordinator



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ACA Membership Survey Results 2016

Thank you to all the ACA members who completed the membership survey in April/May. The aim of the survey was to obtain member satisfaction feedback and to understand industry challenges with the intent to gain an understanding of how the member value proposition can be enhanced. The results of the survey were also used during the ACA's strategic planning day held in June toward the development of its new strategic plan which will be announced later this year.

Member Satisfaction

The survey included 37 questions, of which some of these were aiming to gauge member satisfaction of the ACA and its services. These satisfaction questions asked members to rate their response from 1 to 5. By using the scaling of answers to these questions, the numerical number below (against each question) was derived to quantify the average response.

Question	
How Satisfied Are You with Your ACA Membership?	4.07
How Valuable is Your ACA Membership to You?	3.90
How Would You Rate the Value for Money of Your ACA Membership?	3.90
How do You Rate the Service Provided by the ACA Head Office Staff?	4.00
How do You Rate the Service Provided by Your Local Branch?	3.77
How Do You Rate the Quality of Events Provided by ACA?	4.19
How Do You Rate ACA's Member Communications?	4.04
How Do You Overall Rate *Corrosion & Materials*?	4.07

Demographics

In total, **360 responses** were received representing **17.5%** of the membership. These respondents spanned geographically across all Australian states as well as New Zealand. A cross section of industry was also represented from consultants, contractors, suppliers, asset owners and academics. An interesting element of the ACA membership identified was the range of age profiles with **20% of survey respondents under 35, 22.5% between 36-45, 23.6% between 46-55 and 22.8% between 56-65**. This highlights the efforts the ACA has been investing into the Young Corrosion Group activities and ensuring the next generation is involved within the ACA.

What's Important to members and How Does ACA Perform?

Members were provided with the seven statements and asked to rate the importance of the ACA undertaking these from 1 (not all that important) to 5 (critical). Members were also asked to rate the ACA's performance against these statements from 1 (extremely dissatisfied) to 5 (extremely satisfied). The results are tabled below and by analysing these responses, we can find performance gaps to help identify the ACA's services against the needs of the members to identify potential areas for corrective action.

	Importance	Rated Performance	Gap
Promotes and builds awareness of corrosion and the importance of corrosion mitigation	4.45	3.96	-0.49
Provides technical information, industry news and issues	4.33	4.04	-0.29
Offers training and professional development opportunities	4.31	3.91	-0.40
Provides events and other forums for presentation and discussion of issues relevant to industry	4.29	4.00	-0.29
Offers opportunities to attend technical and social events to network with other industry participants	4.25	4.01	-0.24
Advocates on behalf of the industry to influence policy and legislation	4.18	3.60	-0.58
Offers professional accreditation that advances my employment prospects	4.05	3.70	-0.35

Top challenges facing the corrosion industry

When members were asked, what are the top 3 challenges facing the corrosion industry today, the most common responses were:

1	Lack of Awareness/Understanding/Acceptance/Need for Education	21.2%
2	Budget Constraints/Lack of Corrosion Spending/Economy	18.0%
3	Aging Workforce/Encouraging Next Generation	9.0%
4	Lack of Skills/Poor Work	8.2%
5	New Technologies & Keeping up to Date	5.9%
6	Need for Government Support/Lack of Standards/Adherence to Quality	5.7%
7	Poor Design/Short Term Thinking/Convincing to Consider Corrosion	4.9%
8	Overseas Products & Labour	4.8%

Describing the ACA

Members were asked to describe the ACA in three words. 762 responses were received, with the top 10 responses as:

1. Informative
2. Professional
3. Technical
4. Networking
5. Knowledgeable
6. Progressive
7. Respected
8. Supportive
9. Training
10. Active

These were all positive responses, but there were the odd negative comments such as; archaic, arrogant, basic, behind, closed shop, boys club, expensive, limited, lost, old, static, tame and unorganised.

What can the ACA do that would have the biggest impact on your career / business?

After coding the 540 responses received to this question, the most common responses were for the ACA to:

1. Continue developing and improving its training and events
2. Lobby government
3. Continue building awareness of corrosion mitigation
4. Provide more technical information
5. Mentoring/Career/YCG
6. Reduce Fees
7. Develop partnerships with other bodies
8. More involvement with Asset Owners

Renewing and Recommending Membership

A good indicator of member satisfaction is the indication to renew next year and **88% said yes to renewing while 11% were unsure**.

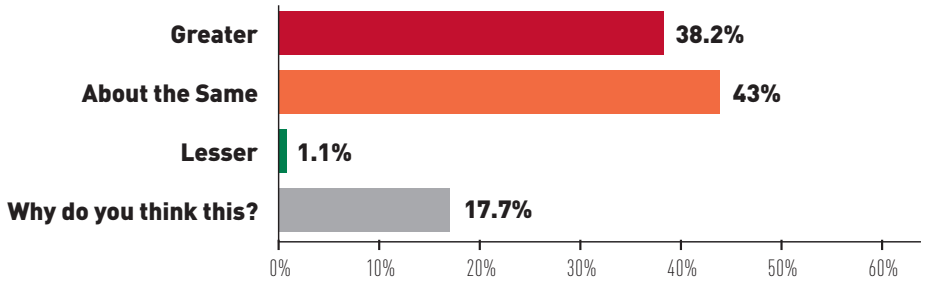
Members were also asked on a scale of 1 to 10 (where 1 equals extremely unlikely and 10 equals extremely likely), how likely are you to recommend membership of the ACA to others in your profession or industry?

1	2	3	4	5	6	7	8	9	10	Weighted Average
2.6 %	0.8 %	0.8 %	2.3 %	4.5 %	3.8 %	13.5 %	29.6 %	17.6 %	24.7 %	7.8%

- 1-6 = 14.6% (not happy and may provide negative word of mouth)
- 7-8 = 43.1% (are satisfied but not enthusiastic)
- 9-10 = 42.3% (loyal members who will refer ACA to others)

Future Need for ACA

Members were asked if they think there will be a greater or lesser need for the ACA in 5 years time.



When asked why they rated the way they did, common responses as to why it will be greater or the same were:

- There will always be a need for a group to network
- Australian Infrastructure is aging and growing
- Corrosion will always be there
- Generational change, so need to educate next industry personnel

ACAF International Travel Scholarship Report

by Mieka Webb

I was one of two ACA members to be awarded an Australasian Corrosion Association Foundation International Conference Scholarship at the ACA Corrosion and Prevention Conference in 2015, enabling me to travel to the NACE Corrosion conference in Vancouver, Canada, from March 6th to 10th 2016.

I graduated from Chemical Engineering at the University of Adelaide in 2011 and began working for the South Australian Government, now the Department of State Development (DSD), in the technical regulation of upstream petroleum pipelines and facilities licenced under the *Petroleum and Geothermal Energy Act* (the PGE Act). The PGE Act is performance based legislation which requires licensees to carry out regulated activities in accordance with industry best practice and with due care for the health and safety of the public, the environment and the need to ensure security of natural gas supply. I am involved in the regulation of surface facilities - from the gathering systems in the Cooper Basin through to the high pressure gas transmission pipelines servicing Adelaide, South Australian regional centres and industrial customers.

Corrosion, specifically of aging assets, is the leading cause of loss of containment incidents occurring on facilities regulated by DSD. The PGE Act and Regulations allow for proactive monitoring of the licensee's management systems, including corrosion management systems. Some of the ways in which DSD monitors the performance of licensee management systems include; desktop assessment of relevant documentation at the design or activity stage, site inspections, attendance in an observational capacity at risk workshops and audits, review of resulting reports and management system documents, and quarterly compliance meetings with operators. Under the PGE Act, licensees are also required to submit incident reports which allows DSD to monitor trends in root cause and failure mechanisms. Understanding relevant forms of corrosion and the application and limitations of inspection and analysis techniques is crucial in effectively assessing the information provided to DSD by our licensees.

I applied for the Australasian Corrosion Association Foundation International Conference Scholarship for the opportunity to attend the NACE Corrosion conference and improve my understanding of industry best practice corrosion management - including assessment of corrosion threats, identification of barriers to prevent and mitigate those threats, and monitoring of the effectiveness of those barriers.

Specific areas of interest for me included management of Microbiologically Influenced Corrosion (MIC) in the oil and gas industry, the utilisation and limitations of direct and indirect assessment methods, and case studies of incidents and challenges faced by operators of aging upstream oil and gas facilities and transmission pipelines. I also hoped to increase my exposure to industry standards and regulatory regimes from other countries.

I applied for the Australasian Corrosion Association Foundation International Conference Scholarship for the opportunity to attend the NACE Corrosion conference and improve my understanding of industry best practice corrosion management - including assessment of corrosion threats, identification of barriers to prevent and mitigate those threats, and monitoring of the effectiveness of those barriers.

The NACE Corrosion conference was easily the largest conference I have attended. Thankfully I had a long flight to browse the 220 page program and plan my schedule. There were up to 14 concurrent technical symposia sessions, in addition to the technical committee meetings, research symposia, forums and plenary lectures, and booths in the Exhibit Hall. There was even an interactive cathodic protection (CP) field testing exhibit, which allowed attendees to undertake tasks such as observing the effects of CP interference and measuring. In 2014 I attended a cathodic protection course through the

ACA, and the field set-up at the NACE conference was a good chance to revise the practical aspects of CP measurement as I have not had the chance to use these skills in my line of work.

I attended a number of sessions on corrosion management which provided an overview of various aspects of corrosion management, some specific to oil and gas pipelines. These included a presentation on *Dead Leg Internal Corrosion Management* by Lynsay Bensman; *Coating Deterioration – A Mechanistic Overview* by Kenneth Tator; and two sessions presented by Joe Pikas - *Remaining Strength of Corroded Pipe Direct Assessment Process* and *Are You Trained, Certified and Qualified to Assess Corrosion and Related Defects*. I found the last paper specifically interesting. The author provided four case studies to highlight importance of experience and appropriate education for engineers and technicians responsible for the assessment of corrosion defects. Inadequate selection of assessment techniques or interpretation of the results may quickly lead to loss of containment incidents, and examples were also presented where the difference between a decision to repair or leave a defect was dependent on knowledge of the corrosion mechanism present, rather than just expertise in use of the NDT technique itself.

Throughout the conference I attended a number of technical sessions on Microbiologically Influenced Corrosion (MIC). A forum on the Management of MIC in the Oil, Gas and Petroleum Industry was held on the first afternoon of the conference, with a focus on the application and limitations of the newly introduced molecular microbiological methods (MMM) in the industry, as compared to more traditional methods, such as cultivation methods. This session was chaired by Dr Torben Lund Skovhus from VIA University College. It was discussed that a very small proportion (i.e. less that 1%) of organisms can be grown in the lab using the cultivation method. Conversely, some organisms are over represented due to bias introduced from the culture media used. MMM is a genetic method independent of cultivation, and can be used to identify the species present, then accurately quantify the represented populations. Only a very small sample is required and live bacteria are not necessary. However it was discussed that results of either method are highly dependent on the sample used – the location at which it is collected, whether it is a sample bulk fluids (targeting planktonic microorganisms) or is a sample of the pig trash (targeting sessile microorganisms). Overall, the most value is obtained from monitoring trends in the organisms recorded from consistent sampling regimes, rather than specific quantities. Information and guidance on the use of these methods is captured in the NACE Standard TM0212-2012 *Detection, Testing, and Evaluation of Microbiologically Influenced Corrosion on Internal Surfaces of Pipelines*.

Presenters also provided case studies of their own experience with MIC. One operator of a large oil and gas field in the Middle East offered his experience of extremely fast corrosion growth rates during the Oil and Gas Production Material Information Exchange (TEG 374X), and demonstrated how, at this particular field, the groups of bacteria present could be identified from the pit morphologies in the corrosion coupons removed from service.

In addition to the many technical presentations I attended, one of the highlights of the conference for me was a forum titled: *Working in the Pipeline Industry - The Real World Need for a Safety Culture, specifically Part 1 - Pipeline Safety*. The session featured regulators Peter Watson, from the Canadian National Energy Board (NEB), and Alan Mayberry, from the United States Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA). Both speakers presented on their respective regulatory regimes, what they perceived as the role of safety culture in improving pipeline environmental and safety performance, and how best to regulate a safety culture.

The National Energy Board are the Canadian federal regulator for power lines, pipelines, energy development and energy trade. The NEB operates under a variety of acts and regulations to deliver a regulator regime which is a hybrid of a prescriptive and performance based approach. In their regime, the company is responsible for meeting set objectives, however unlike the South Australian PGE Act, these objectives are specified by the NEB. The NEB also prescribes key standards (such as Canadian Standards Association CSA Z662 for Oil and Gas Pipeline Systems), minimum technical requirements, minimum required management processes and reporting requirements. They utilise methods such as audits, inspections, compliance meetings and field exercises to monitor compliance. PHMSA operates under a more prescriptive regime – for example they publish specific rules on a range of aspects of pipeline operation and design which the operators must comply with.

To compare regulatory regimes, the South Australian PGE Act and Regulations are primarily performance based – it is the responsibility of the licensee, not the regulator, to ensure compliance with the Act and environmental objectives. These environmental objectives are developed through a process, specified under the PGE Act and Regulations, which involves an appropriate level of

consultation with other government departments and the public as required, depending on the potential impact of the activity. The objectives must include guidance as to how each objective can be met. Under the PGE Act, the definition of environment also includes public safety and security of supply. The only standard prescribed under our Act is *Australian Standard AS 2885 for high pressure gas and liquid petroleum pipelines*, which is required under regulation in each state in Australia.

The performance based approach to regulating requires that the operator has systems in place to ensure that threats are identified, controls are put into place, and that the health of those controls and of the whole system is continuously monitored to ensure that all threats are effectively mitigated. This has similarities to the requirements of an effective corrosion management system. As well as monitoring a company's operations and logging indicators such as incident data, it is important that regulators are able to effectively monitor and challenge the operators' systems and establish leading performance measures, to assess the health of these systems before an incident occurs.

The North American oil and gas regulators have recognised that promoting and encouraging "Safety Culture" is one way to improve safety and environmental performance. The NEB defined safety culture as "the attitudes, values, norms and beliefs which a particular group of people share with respect to risk and safety". Representatives from both NEB and PHMSA, in addition to other North American regulators, met in 2013 to discuss the role that safety culture plays in ensuring effective implementation of safety management systems. This North American Regulators Working Group on Safety Culture (NARWGSC) released a guidance paper in March 2016 on safety culture indicators, to provide indicators which can be used, in conjunction with other compliance monitoring methods, to gauge the state of a company's safety culture. These metrics, which are included in the appendices of the paper, can be used to identify strengths and weaknesses within a company's safety culture.

Through the Energy Pipelines Cooperative Research Centre (EPCRC) Research Program 4 – Public Safety and Security of Supply, the Department of State Development has been involved in similar projects. Work has been completed by the EPCRC on the role that organisational safety and human factors play in major incident events.

Both the NEB and PHMSA also recognised the important role that transparency and the sharing of information play in improving the environmental and safety performance of operators. They discussed how failure and compliance statistics are often made public to help drive compliance performance and prevent recurrence of incidents with the same root cause. The public release of incident investigation reports can also serve to educate the general community on the importance of managing corrosion in vital infrastructure. In addition to public reporting by regulators, platforms such as the NACE conference allow for companies to share learnings through case studies and information exchange – both failures and innovations – leading to growth and improvement in environmental and safety performance

This theme was echoed in the Keynote session, featuring journalist Steve Kroft from the US version of *60 Minutes*. Kroft produced a news segment which aired on 23 November 2014, informing viewers of the corrosion damage effecting large amounts of US infrastructure, such as bridges, ports and water distribution systems. He reported that while the government is aware that action is required to manage the corrosion issues, they have issues justifying the spending as there is not enough political pressure. A solution to this is increasing public awareness – the general population do not realise the potential risks associated with corrosion, and hence there is less motivation for the governments to increase taxes to raise the funds required to repair. Kroft made it clear that he believes that

> *"...the lesson that most resonated with me was the need for a shift in culture – for industry and government to adopt corrosion management as a fundamental part of operations, just as they have with work health and safety. It is not just vital that the engineers and technicians on the front-line are educated and certified in corrosion management, but that the company and government policy makers are also aware of the cost and impact that poor corrosion management can have. Just as it is important that companies have a strong and healthy safety culture, it is also important that the significance of corrosion management systems are recognised at all levels of operation."*

educating the public on the risks to infrastructure from corrosion is vital to influence policy makers to take the issue seriously.

It was not coincidence that Kroft was invited to speak on this topic at the NACE Corrosion Conference. The topic of his session was in harmony with the release of the NACE International Measures of Prevention, Application and Economics of Corrosion Technologies (IMPACT) Study. This study found the current economic impact of corrosion to be US$2.5 trillion. It reports that reducing the cost of corrosion requires "a change in how decisions are made". Section 8 of the report discusses strategies for integration of corrosion management through all levels of an organisation. If you are only going to read one section of the NACE IMPACT study I would recommend you read this section, as this is a space in which ACA and its members can work to reduce the impact of corrosion.

While the technical information that I gained through attending the NACE Corrosion conference will aid me in my assessment of licensee's corrosion management initiatives and enable me to make more informed regulatory decisions, the lesson that most resonated with me was the need for a shift in culture – for industry and government to adopt corrosion management as a fundamental part of operations, just as they have with work health and safety. It is not just vital that the engineers and technicians on the front-line are educated and certified in corrosion management, but that the company and government policy makers are also aware of the cost and impact that poor corrosion management can have. Just as it is important that companies have a strong and healthy safety culture, it is also important that the significance of corrosion management systems are recognised at all levels of operation.

I was not a member of NACE prior to attending the NACE Corrosion Conference. I was aware that NACE developed corrosion prevention and control standards and provided training certification, however I did not realise the number of standards and reference material that are available. The various technical sessions made reference to standards and papers which I have since been able to download (as a member, most of these are free!) and become familiar with. I have also been able to use the reference material, also available on the NACE website, to clarify queries which I have come across in my day-to-day work.

By attending the NACE Corrosion conference I was able to increase my knowledge on MIC and its management, pipeline defect assessment techniques, exposure to different industry standards and gain and insight into regulatory regimes for North America. I also was able to witness debate on some of the key issues facing our industry – such as education of the next generation of corrosion professionals and awareness on the impacts of corrosion. The conference was by far the largest that I have ever attended, with no shortage of technical sessions to choose from, and many exhibitors to visit. I would like to thank the Australasian Corrosion Association Foundation for awarding me with a scholarship to allow me to attend this international conference, and would recommend anyone who has an interest to attend to apply for the ACA Foundation Scholarship program this year.

ACAF International Travel Scholarship Report

by Vahid Afshari

NACE International's Annual Conference and Exhibition, Corrosion 2016, bought together more than 6,000 leaders from industry, government and academic to discuss the latest technologies, issues, and make decisions on the most effective means of corrosion prevention. The conference was officially opened by lighting the Olympic Cauldron in Vancouver on Monday 7 March 2016. It was great to see so many professionals from different disciplines together in one place and opportunities to connect with industry experts and peers focused on the prevention and mitigation of corrosion worldwide. I was pleased with the technical education and knowledge exchange, plus the opportunity to meet people I had heard so much about.

There were over 400 exhibitors who displayed the latest corrosion control products, technologies, and services at the world's largest corrosion expo. I enjoyed meeting and talking to the many exhibitors and familiarizing myself with the new technologies and products. The NACE Bookstore was also available during the conference with more than 400 resources including newly released titles from the NACE Corrosion Authority.

NACE Past President E. Bowman introduced the NACE IMPACT Study in the conference. She said "we must make sure that management truly understands the direct and indirect costs of corrosion". The IMPACT Study was designed to communicate best practices, not just reveal the cost of corrosion. Poor corrosion planning leads to unanticipated costs. Corrosion costs the global economy $2.5trillion yearly according to the IMPACT Study. It affects people's lives and livelihoods. The Report emphasized how to integrate corrosion technology with organizational management systems to optimize corrosion decisions with respect to both cost savings and concern for safety and the environment. IMPACT – the International Measures of Prevention, Application, and Economics of Corrosion Technologies study – is now available to the general public at www.impact.nace.org.

The CORROSION 2016 Plenary Lecture titled 'Materials Science & Technology in the Digital Age'was given by Ken Tator. He discussed the rapidly accelerating rate of technological change, information availability and worldwide communication. Technology, according to Ken, spawns new generations of products by using existing components, a phenomenon he calls 'combinatorial evolution'. Material science and Engineering has rapidly advanced over the past decade or so. These advances, coupled with the advent of rapid communication via e-mail and the ability to store and make available vast sums of knowledge in digital-electronic format over the Internet to virtually anyone, is changing the world. These changes present opportunities and challenges in the near and distant future that will affect all of us from a personal, professional, and global viewpoint. An historical perspective of material and coating advances and human technological evolution, up to the present time, was presented. To take full advantage of new technologies, we need to fundamentally rethink our approaches to learning and education and our ideas of how new technologies can support them. The proliferation of digital technologies has accentuated the need for creative thinking in all aspects of Materials Science and Engineering and has also provided tools that can help us improve and reinvent ourselves. Throughout the world, computing and communications technologies are sparking a new entrepreneurial spirit, the creation of innovative products and services and increased productivity.

She said "we must make sure that management truly understands the direct and indirect costs of corrosion". The IMPACT Study was designed to communicate best practices, not just reveal the cost of corrosion. Poor corrosion planning leads to unanticipated costs. Corrosion costs the global economy $2.5 trillion yearly according to the IMPACT Study. It affects people's lives and livelihoods.

The key note speaker, Steve Kroft said "we are upping our game when it comes

to government relations, not just in the US but around the world. Corrosion really can be prevented if you do the work up front and maintain your assets. US Chamber of Commerce says US needs to invest $8 trillion to modernize US infrastructure". Part of protecting people, assets, and the environment from corrosion includes telling the industry's story and the importance and value of corrosion control. Kroft presented an inside look at how news is reported and the effects it has on today's society.

The Corrosion Management stream at CORROSION 2016 offered forums, symposia and meetings that provided up-to-date information on managing corrosion in many industries specially in Oil and Gas Industry.

A Corrosion Management System (CMS) is defined as the documented set of procedures, strategies and systems designed and intended to maintain asset integrity and protect it against corrosion. Asset integrity means ability of an asset to function efficiently while maintaining personnel safety and protecting environment. The demonstration of asset integrity into the future requires the development and implementation of an effective Corrosion Management System. CMS can continually improve the ability of an organization to manage the threat of corrosion for existing and future assets and keeping it within acceptable or at least predictable limits over the whole lifecycle of the asset.

The two stages of asset corrosion management implementation are at the design and operation phase. The design stage includes proper materials selection and environment control i.e. pH, temperature, velocity and aeration. The operation stage includes inspection, chemical treatment, corrosion monitoring system, organization and communication. For example, one of the most important steps to ensure the integrity of an offshore pipeline and subsea system is materials selection with a properly designed corrosion mitigation strategy. Carbon steel is typically the first option considered for these structures due to its low cost and variable grades meeting mechanical design requirements but when exposed to corrosive substances (e.g. CO_2, H_2S, organic acids) during its lifetime, may have its integrity threatened.

To mitigate such threats, strategies including corrosion allowance, chemical inhibition, and/or using alternative material options (e.g. corrosion resistant alloys, flexible pipes, internal/external coating, etc.) should be considered for corrosion mitigation. Engineering assessments are complex, multidisciplinary reports that require careful planning to ensure that all potential threats to asset integrity have been considered and assessed in accordance with industry standards. A well thought-out methodology is necessary to ensure that the engineering assessment covers all regulatory requirements and addresses all known threats. When properly executed, an engineering assessment will highlight existing threats and hazards in need of mitigation and will also identify unmanaged threats and areas where little information exists, facilitating improvement to integrity management.

Corrosion risk assessment is one of the most significant constituents of CMS. Managing the threat of corrosion requires consideration of both the likelihood and consequence of corrosion events. The probability of failure itself is a function of internal and external threats while the consequence, or impact, of corrosion is considered the potential or actual monetary loss associated with the safety, environment, or asset integrity. This value is typically quantifiable when considering lost revenue, cost of repairs, and clean-up costs, as applicable. Repair and rehabilitation activities are established to restore damaged structures to their original or required service level and correct the deficiencies that might have resulted in corrosion deterioration. These activities are performed at different times throughout the lifetime of a system. Maintenance is considered to be a regular and necessary activity that is characterized by an annual cost. Inspections are scheduled periodic activities and repair is performed on an as-needed basis. Repair can involve the replacement of parts, but not the replacement of the basic structure. Other aspects of corrosion impact include deterioration of an asset to the point where it is no longer fit for its intended purpose (e.g., lost future production). The corrosion risk assessment can be performed either on a line level or on a corrosion-circuit (subsystem-level).

In general, corrosion threats should be mitigated to a point where the expenditure of resources is balanced against the benefits gained. To determine whether a corrosion management investment is appropriate, it can be compared to the potential corrosion consequence through a return on investment (ROI) analysis. ROI is a benefit (or return) of an investment divided by its cost. For corrosion management, the costs may include inspection and other maintenance costs and the benefit of ROI is not always measured in financial gains, but in the avoidance of safety or integrity costs. Some risks are hard to monetize including reputation and societal costs. One outcome of this study is that a financial analysis might conclude that a technically sound corrosion mitigation action is unjustified. The goal of corrosion management is to achieve the desired level of service at the least cost.

Corrosion key performance indicators were also defined as a numerical

summary of the performance of various critical activities, or the magnitude of certain variables/parameters with regard to acceptable limits, ranges or specifications. Management information is typically required on predicted costs of problems, the risks involved, the remaining life of the affected equipment, and what can be done to improve or eradicate these problems. The key performance indicators were developed specifically to measure the effect of corrosion on the technical and financial performance of assets and to address the performance of particular critical corrosion related systems. The key performance indicators are a vital element of any corrosion management strategy. Control of theses parameters within a defined operating envelope will minimize the deterioration of the plant due to corrosion. Key performance indicators are determined and calculated on a percentage basis within a defined time period. In order to calculate such key performance indicators, target values or ranges have to be determined. If the measured value is within the accepted range or target value then that parameter is considered compliant and vice versa.

In order to properly and adequately implement a corrosion management process in a project several prerequisites are necessary. These include human resources, competency, teamwork and managerial support. The human factor is a key issue in corrosion management and reducing corrosion accidents. It was stated that about 75% of all corrosion failures occurred because of insufficient information, communication, interaction, and knowledge. The reasons for human mistakes are the lack of awareness, education, knowledge, and training, incorrect design, insufficient control and supervision, lack of motivation or incentives to reduce corrosion risks, and incorrect operation.

It was suggested to establish legislation about corrosion management at the state and federal levels, improve education of students, experienced engineers, educators, and managers, and knowledge transfer. One thought was proposed to apply penalties on enterprise management to force them to place more attention on corrosion problems and make it a priority issue in technical and economic policy in their enterprises.

Corrosion Management is an essential integrity management tool, and should start during concept development and the proposal stages of a new project. Throughout the project detailed design and construction phases, the corrosion management program should be developed and refined.

There were technical committee meetings during the conference to learn how NACE STANDARDS are prepared and how you can get involved. The one which I was interested in and attended, related to developing a new standard titled 'Cathodic Protection System Retrofit for Offshore Platforms'. The main reasons for developing this new CP standard were stated as structural integrity and regulatory requirements.

Cathodic protection is the primary corrosion control method used on the submerged sections of most offshore platforms. The vast majority of these structures are initially fitted with galvanic anodes designed to provide protection for a given design life. As the structure ages these original systems consume and at some point are unable to continue to provide reliable levels of cathodic protection resulting in the onset of corrosion. Many platform structures may be maintained as offshore pipeline connectors or as metering installations. With the service life of many platforms extended beyond their initial design, it becomes necessary to consider a cathodic protection retrofit. Furthermore, depending on the geographical location of the structure, there may be regulatory requirements to maintain the cathodic protection system in working condition. These may be governmental regulations or rules set by certification authorities or insurance carriers. An in-service structural or corrosion failure on an offshore platform or a connected pipeline would not be acceptable.

"In order to properly and adequately implement a corrosion management process in a project several prerequisites are necessary. These include human resources, competency, teamwork and managerial support. The human factor is a key issue in corrosion management and reducing corrosion accidents. It was stated that about 75% of all corrosion failures occurred because of insufficient information, communication, interaction and knowledge."

The CP stream at CORROSION 2016 offered forums, symposia and meetings that deal with everything from theory and research to application of cathodic protection in pipelines, tanks, and oil and gas production facilities, including offshore installations. The sessions were very informative and provided great networking opportunities.

There were breakout sessions covering technical topics on management of MIC in a variety of systems found in the oil, gas and petroleum industry. Case studies

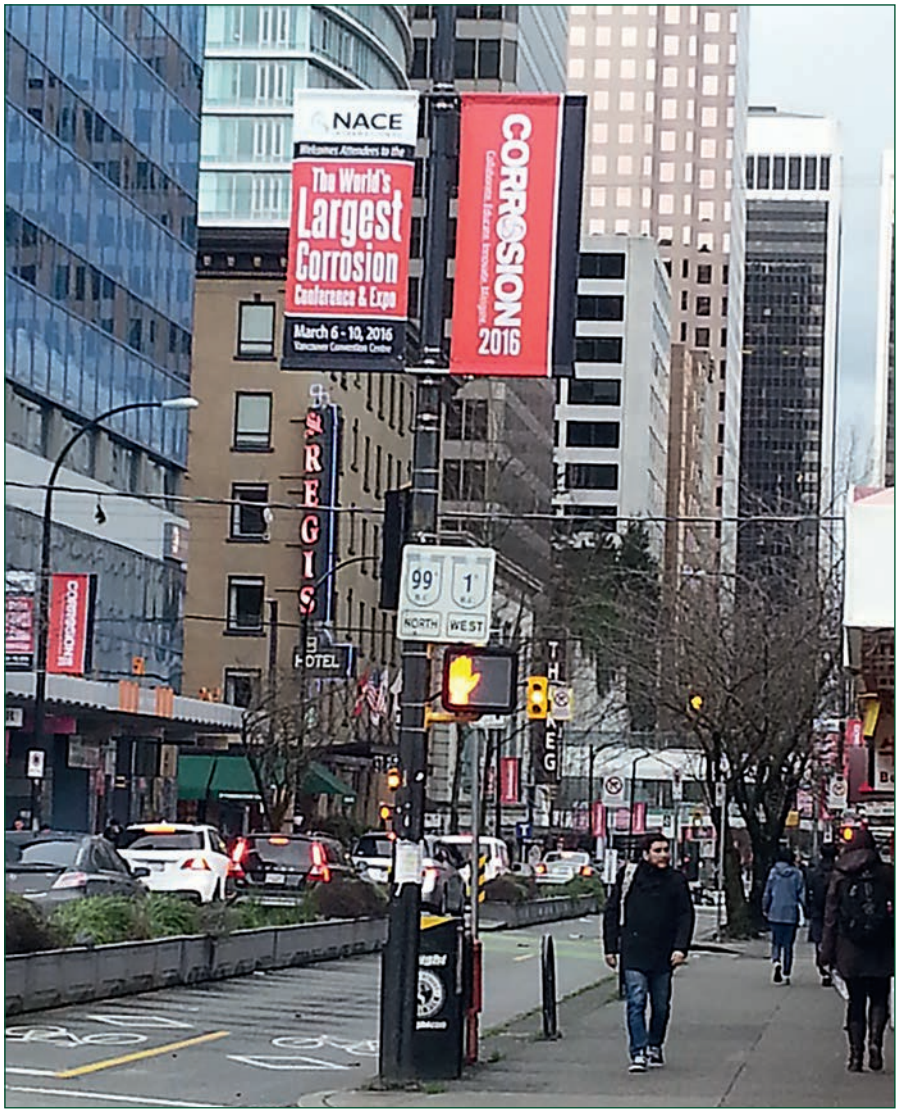
> *Finally, I would like to express my sincere gratitude to the ACA Foundation Committee for selecting me as a recipient of the International Conference Award. It was a very enriching experience for me to attend this conference.*

were demonstrated on how operators are addressing the threat of MIC as part of a corrosion management system. MIC effects stand out through leaking tanks and pipes, sudden pressure drops in an industrial complex, increased treatment costs, reduced efficiencies in the system, and increased secondary environmental impacts. The chronic causes of corrosion are often forgotten while the actual symptoms are more easily recognized and corrected but often at a high cost. The cause of MIC is fundamentally two fold. First the microbes associated with corrosion would need to be present and active. Second the environment should be conducive to the development of the various MIC events that would lead to corrosion. The nature of the MIC at any site may be examined by looking for pits and perforations, encrustation, nodules, tubercles, ochres and various forms of biomass plugging. The MIC sessions were very informative and fulfilled my expectation by providing influential and passionate key note speakers.

Finally, I would like to express my sincere gratitude to the ACA Foundation Committee for selecting me as a recipient of the International Conference Award. It was a very enriching experience for me to attend this conference. Corrosion professionals are encouraged to apply for an ACA scholarship to attend such a conference. The learnings from this conference will have a direct impact on your performance as a corrosion engineer. You will gain hands-on knowledge of new technology, products and services which help you discover how to be more productive.

Sincerely,
Vahid Afshari

Vahid Afshari is working as Senior Materials and Corrosion Engineer in GHD Pty Ltd, Perth office. Vahid is the current President of the Australasian Corrosion Association (ACA) Western Australia Branch and has been a Committee Member since 2011 and an ACA Member since 2004.



Vancouver's Granville Street was decked out with Corrosion 2016 banners.

MEET THE ACA BRANCH PRESIDENTS

WA Branch
Vahid Afshari
GHD Pty Ltd
Senior Materials
& Corrosion Engineer

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

I am a materials and corrosion engineer by education, training and experience. I have worked in consulting engineering firms for more than 18 years with responsibility for providing materials and corrosion engineering consultancy to our internal and external clients. Our diverse workforce has exposed me to many different cultures and practices, both personally and professionally. Knowledge of the various forms of corrosion and the data used to characterise them, are essential for effective design and material selection. It is clear that if the cost of corrosion is to be reduced in the future, materials engineers need to have a better understanding of material properties, the various forms of corrosion and electrochemical phenomena so they can be involved in the design/materials selection processes.

How long have you been volunteering for the ACA?

I have proudly been a Committee Member since 2011.

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

The ACA is like my 'career' family. It's more than a volunteering job. It's a passion. I have lots of colleagues and friends in the ACA and have known them for more than 12 years. I love working with them and I am so proud to be part of the corrosion association, making a real difference in our industry.

What do you hope to achieve in your term as Branch President?

I have appreciated the opportunity to be Branch President and am passionate about being a contributor to our community. Demonstration of a strong commitment to the ACA may inspire others to follow the passion, exemplify the values and generate connections that inspire wider audiences. I want to serve our Members so they gain maximum benefit from their Membership by providing regular high level technical events that support our Members in their different industries. I also want to encourage our young Members to get involved in Branch activities, as well as mentorship of young talent interested in the field of corrosion.

QLD Branch
Nicholas Doblo
APA
Corrosion Engineer

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

My role is to manage the corrosion protection on the APA transmission pipelines in QLD. This is primarily technical support for our field technicians, reporting, design and project management of CAPEX upgrades. I also provide support to the wider integrity team with coating inspection and defect direct assessment.

How long have you been volunteering for the ACA?

Since 2010, my first year after graduating from University.

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

My first employer out of University was a very strong ACA supporter and advocate. Through their encouragement I began attending local Committee meetings and volunteering. This made possible my attendance of the YCG forum and the national conference via a scholarship amongst other benefits and experiences.

While somewhat clichéd, my involvement with the ACA has been invaluable in achieving my goals. I couldn't imagine a more cost and time effective way to achieve the broadening of my knowledge base, gaining access to technical expertise and developing management skills. All while having access to better job opportunities!

What do you hope to achieve in your term as Branch President?

I hope to achieve the development of Webinar and other e-delivery services to allow our Members located outside the major centres (or on roster) a level of access to technical events and meetings similar to that of the metropolitan Members.

MEET THE ACA BRANCH PRESIDENTS

Newcastle Branch
Simon Krismer
Bureau Veritas Asset Integrity
& Reliability Services
Senior Materials Engineer

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

I have been providing failure analysis and materials performance consultancy services for 16 years. I work principally with the mining industry, but also in petrochemical, power generation, manufacturing, buildings and infrastructure. Corrosion is a problem that is experienced in every facet of industry and for this reason I have come across just about every form of corrosion imaginable, ranging from simple rusting of carbon steels; to environmental issues such as stress corrosion cracking, caustic cracking, hydrogen sulphide stress cracking, microbial induced corrosion, crevice corrosion, current leakage and pitting; to application specific problems such as; high temperature failure mechanisms like metal dusting, sulfidation, and oxidation. My clients rely on me to have a detailed understanding of the causes of corrosion and to provide advice regarding what they can do to prevent corrosion related failures.

How long have you been volunteering for the ACA?

I have been a Member of the ACA since 2002, but have been on the Newcastle Committee since 2010. I was the Vice President for 3 years prior to becoming President this year.

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

I find Membership of the ACA to be very rewarding, on both a personal and professional level. The ACA provides a great forum for networking and meeting people from an incredibly diverse range of industries and from all walks of life - I doubt there is any other association that could match the ACA on this. At our local Branch, we hold excellent social technical events which develop good friendships. Professionally, the technical events, training courses and conference provide opportunities for ongoing learning and business networking to develop sales leads.

What do you hope to achieve in your term as Branch President?

In my term as Branch President, I plan on leading a new and progressive Committee to make some changes to how we operate. To date, I have set up a cloud based account to store and share all files that the Committee works on. I have also changed the Committee structure by creating formal roles for an YCG Coordinator and an Event Coordinator. This will help us to focus/improve servicing our YCG Membership and ensure that we continue to deliver great technical and social events for our Membership. I also hope to increase the communication with other ACA Branches to form working relationships so that we can share our thoughts and experiences regarding event management, Branch operations and the opportunities/challenges we face. There is no need for us to reinvent the wheel when another Branch may already have the answer. Collaboration is helpful to all.

SA Branch
Alex Shepherd
Incospec
General Manager

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

A large part of my role at Incospec is in sourcing, winning and managing Corrosion related projects that our company undertakes. Project types include Protective Coatings, Cathodic Protection, Asset Management, Materials and Welding projects.

Regardless of the type of project, we at Incospec must have a clear understanding of what we are trying to protect, design or repair and that all projects, personnel and environmental elements are fully considered in order to meet maximum durability expectations.

How long have you been volunteering for the ACA?

8 years since joining the SA Branch Committee

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

The ACA has and continues to introduce me to a diverse range of Members, whose areas of expertise range across the full spectrum of Corrosion disciplines. These connections in turn, provide me with valuable relationships and knowledge bases.

What do you hope to achieve in your term as Branch President?

My goal as SA Branch President is to provide our SA Members with regular, high quality events which provide both technical depth and networking opportunities, helping Members to grow their own knowledge base (and business) through the connections they make, by being part of the ACA.

I believe that by understanding the needs of our Membership and then planning ahead to deliver what Members need from 'their ACA', we will deliver Branch Membership growth and satisfaction.

VIC Branch
Graham Sussex
Sussex Materials Solutions Pty Ltd,
Principal Consultant & Director

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

About a third of my work is for the Australian Stainless Steel Development Association (ASSDA) providing technical advice to private individuals and industry on which stainless steel to use and how to treat it to avoid corrosion. I also write articles and run webinars for ASSDA. It's a pleasant change to be giving advice before use, compared to the many years of failure investigations and finger pointing which often occurs when something corrodes – for all too obvious reasons. My non stainless work includes lecturing in SE Asia for the Nickel Institute and solving corrosion problems ranging from building water systems, chemical plant, pipework and even the odd stray current issue.

How long have you been volunteering for the ACA?

I joined the ACA in 1981 while I was at UMIST and when I returned to Australia in 1987, I was editor of C&M from 1989 to 1995. I have been a long time Member of the Branch Committee (interrupted for the 5 years I worked for Materials Australia as CEO) and active on the ACA/WTIA Committee on welding and corrosion. This is my second stint as President and in the interim I spent 6 years on the Operations Committee - as it was then known.

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

Of all the organisations I belong to, the ACA is the most enjoyable and rewarding. It is partly the free communication of ideas amongst members that you meet and talk to in notionally commercially neutral environments but also just those corrosion investigations and solutions are challenging – you do not know what will come next. It's been said by many others, but I feel that the ACA has given me a lot more in development and satisfaction than I have been able to put back.

What do you hope to achieve in your term as Branch President?

I see the role of Branch President as co-ordinating and supporting the work of a strong Committee in continuing to deliver an interesting and varied technical program, developing members to advance into positions in the ACA and to re-vitalise the school corrosion education program that the Victorian Branch developed before the ACA membership boost.

NZ Branch
Raed El Sarraf
Opus International Consultants Ltd
Structural Materials
& Corrosion Engineer,

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

I started my career as a structural engineer, before becoming interested in corrosion prevention. I have been working with Willie Mandeno, ex-ACA President and Life Member, since 2012. Together we provide technical guidance and address structural materials and durability related issues, to the over 3000 staff worldwide who work at Opus. These range from new structures, such as bridges and buildings, to existing structures such as hydro dams, hangers, and wharves, including heritage structures.

I also undertake failure analysis of corrosion protection systems, from coatings to stainless steels. This includes preparing remediation solutions, taking into account whole of life costing, with the aim of providing cost effective long term solutions for the asset owners.

Finally, I have co-authored a number of structural steel design, coatings and durability related industry guidance documents over the years that were published in Australasia. I have also published papers in conference proceedings, journals and magazines.

How long have you been volunteering for the ACA?

I have been a Member since 2004, joining the Auckland Division Committee in 2010, becoming Division Chairman in 2015, and President of the NZ Branch this year.

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

The ACA provides a font of knowledge, both through its published conference papers and talking with our Members. Networking through local technical events to the annual conference, provides excellent opportunities to discuss case studies, share learnings and have a great time with like-minded people. Also, participating in ACA events boosted my confidence and improved my presentation skills, all of which are useful, whether talking to an asset owner or the men working on the tools.

What do you hope to achieve in your term as Branch President?

Change is coming to our Association; I am looking forward to working with the ACA Centre, the Board, and our Members in strengthening the ACA; encouraging future young corrosionists and growing our community. Together we can promote the risks of corrosion, educate asset owners, and lobby our respective Governments about the importance of durability design and asset management.

MEET THE ACA BRANCH PRESIDENTS

NSW Branch
Peter Hosford
Retired Corrosion
& Public Lighting Consultant

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

I was for many years involved in public lighting first as project manager and later as a consultant. I was the Energy Networks Association (Australia) representative on the Australian/New Zealand Public Lighting Standards Committee for over 14 years. For 22 years I was the Secretary of the Electricity Supply Professional Officers Association (a state registered union) where I had a lot to do with politicians from both sides of the political spectrum. Perhaps the most rewarding part of my career has been my involvement in the corrosion mitigation industry.

How long have you been volunteering for the ACA?

For over 20 years

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

The ACA gave me a lot during my working life and I'd like to give something back

What do you hope to achieve in your term as Branch President?

To help make the ACA the preeminent corrosion industry organisation.

TAS Branch
Grant Weatherburn
Zinga Pty Ltd
General Manager

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

We distribute Zinga in Australia and New Zealand. Zinga is a zinc-rich protective coating, specifically formulated to provide corrosion protection of steel. It is unique in that it is readily rejuvenable. Corrosion protection is the core of our business.

How long have you been volunteering for the ACA?

I have been actively involved with the ACA Tasmania Branch since 2009, taking office as Secretary in 2011 prior to my current role as President since 2015.

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

Prior to joining the Zinga team I did not have any experience in the protective coatings industry.

Attending ACA events and conferences has been invaluable in providing me with a sound understanding of the challenges of the corrosion professionals. It has also been the foundation of my own technical development. The networking has been great and I look forward to the social aspects of each conference. It is good to know we can tap into expert advice in any corner of our region.

What do you hope to achieve in your term as Branch President?

I am very keen to bring in some new Members to the Branch, particularly from the younger segment. There is a wealth of knowledge within the ACA and I believe that our key role is to provide a conduit to disseminate this information to the broader community, so that those stakeholders responsible for assets can facilitate cost effective management for the future.

Preventing Corrosion in the Maritime Industry

Thursday 28 April 2016 | Melbourne

SPONSORED BY: FREYSSINET, HEMPEL

HOSTED BY: Australasian Corrosion Association Inc., Maritime Industry Australia Limited

Protecting Infrastructure & Assets against Corrosion

PROUDLY PRESENTED BY: Australasian Corrosion Association Inc.

Thursday 19 May | Auckland

SPONSORED BY: galvanizers Association of Australia, GalvanizingNZ Association, International

Corrosion in the Power & Energy Industries

PROUDLY PRESENTED BY: Australasian Corrosion Association Inc.

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9 June 2016 | Brisbane

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Maintaining & Preserving Assets in a Challenged Economy using Protective Coatings

23 June 2016

Melbourne

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NEW PRODUCT SHOWCASE

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

ATG View application

Emerson's new ATG View application allows quicker and easier access to critical asset health information by putting data from Emerson's CSI 6500 ATG machinery protection and prediction monitoring system in the palm of users' hands.

With a mobile device, users can scan a quick response code (QRC) located on the CSI 6500 ATG cabinet and immediately view the status and health of all cards and measurements from the associated rack on their mobile device. This enables quicker maintenance rounds and reduces unnecessary trips to the control room, helping maintenance teams be more productive and responsive to changes in equipment health.

"Having protection and prediction data from the same cards and measurements available on a mobile device is a real time saver," said Bjoern Mueller, product manager sensors & systems, of Emerson's Reliability Solutions business. "The new app was designed to make it easier for users to track equipment and process health to ensure they operate reliably and profitably."

The app is built to be intuitive and easy for users to get started quickly. ATG View is available in both the Apple Store and Google Play. For more information on Emerson's ATG View app or other CSI products, visit www.emersonprocess.com/csi.

For more information, please contact:

Kim Blizzard, Emerson
1 (865) 672-1052, Kim.Blizzard@Emerson.com

OpenVision™ OVCF-NDT

OpenVision™ is a lightweight live video X-ray imaging system. It includes a highly sensitive radiographic imager and battery-operated 70kV X-ray tube, designed for portable field operation. The proprietary intensified video imaging system captures images and displays them on a hand held LCD viewer, head mounted display or portable recorder with LCD display in real-time.

The traditional method of stripping down the insulation and searching for the CUI problem spots is a costly and time consuming process. The OpenVision™ OVCF-NDT X-ray system allows the operator to inspect lengths of pipework, bends and joints in a matter of minutes, pinpointing any defects and areas of interest without removing the insulation. This saves time and money.

For further information or to book a demonstration, please contact:

NDT Equipment Sales
Unit 21, 3 Box Road
Taren Point NSW 2229

T: (61-2) 9524 0558
F: (61-2) 9524 0560
E: ndt@ndt.com.au
W: www.ndt.com.au

Olympus' iPlex NX videoscope and 6 mm probe.

Olympus iPlex NX Industrial Videoscope

Remote Visual Inspection (RVI) of materials, components and structures can give inspectors and technicians—using a videoscope—warnings of many potential catastrophic failures before they cause problems.

With the iPlex NX industrial videoscope, Olympus enters a new era of precision with a unit that has the greatest measurement accuracy on the market allowing the detection of the smallest defects.

"The NX can be used for a broad range of applications and is the new 'gold standard' for videoscopes," said Brendan Slaven, Product Specialist – RVI at Olympus. "This latest unit gives you the best of everything."

The videoscope combines an industry-leading high-pixel CCD chip, an ultra-bright laser diode light system delivered through the tip of the probe, and Olympus' unique PulsarPic™ processor. The iPlex NX also offers a unique multi Spot-Ranging function that enables real-time measurement of the distance from the scope tip to multiple points on the inspection surface. This provides real-time surface shape information with no pause or break in the inspection.

"The NX is also the first high-end scope with a touch screen interface," Slaven added. "You have the choice between the touch screen or Olympus's ergonomically designed manual controls to suit the environment and inspection application."

The NX videoscope can be configured for a variety of inspection tasks using 6.0 mm and 4.0 mm probes. The compact and robust construction complies with stringent US military standards for dust and rain resistance, as well as drop testing.

Post-inspection tasks such as archiving and reporting are simplified as operators can quickly recall and give titles to captured images. Diagnostic information can easily be added to specific images using a couple of button clicks during the inspection.

The iPlex models provide the latest technology in videoscope instrumentation, in line with the Olympus tradition of producing instruments that continue to be at the forefront of non-destructive testing.

For more information, please contact:

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An iPlex NX videoscope can be taken to areas that have restricted access.

The latest videoscope from Olympus features touchscreen controls and buttons allowing one-handed operation.

Hempaline Defend Vinyl Ester Linings

Global coatings company Hempel announced the launch of its new Hempaline Defend Vinyl Ester range of linings. The linings are designed specifically for challenging applications – such as tanks, stacks, ductwork, flue gas desulphurisation units and secondary containment areas – where heavy-duty performance is critical to reducing corrosion and maximising production uptime.

The Hempaline Defend Vinyl Ester range is a comprehensive set of linings for the power generation and oil & gas markets. In the power generation industry, the linings are used to protect the internal surfaces of flue gas desulphurisation units, ductwork and stacks in wet and dry environments. In both the power generation and the oil & gas industries, the Hempaline Defend Vinyl Ester range can be used as tank linings, as well as to protect concrete surfaces, such as secondary containment structures, from aggressive cargoes.

The launch of the Hempaline Defend Vinyl Ester linings range means that Hempel can now offer customers a full range of products for internal and external protection.

The Hempaline Defend Vinyl Ester linings range includes glass and mineral-flake filled coatings and fibreglass-reinforced linings for specific applications.

For more information, please contact:

Sarah McAleny
Hempel Group Marketing Communications Manager - Protective/Decorative
Phone: +44 1254 870052

ACA Standards Update Summary*

Welcome to the third corrosion related standards report for 2016.
The standards reporting for 2016 is scheduled against Technical Groups (TG) as indicated below:

Issue	2016 Standards search for TG interests
Feb	Asset Management
May	Water/Waste water (inter-alia) Material
Aug	Concrete & Cathodic Protection
Nov	Oil & Gas

This Standards report focuses on Concrete & Cathodic Protection in relating to corrosion.

As previously this is in two stages, namely:

1. A global standards and publication focus at **13 July 2016**, searching through SAIGLOBAL Publications at https://infostore.saiglobal.com/store, for all current publications and standards relating to corrosion of materials in the water and waste water industry. This is in 2 searches for 'corrosion and concrete' and 'Cathodic protection'.

These results are shown under Stage 1, Search 1 and Search 2.

2. A SAI Global search, as previously, at http://www.saiglobal.com/online/ 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 5 April 2016 to 13 July 2016, 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 under Stage 2.

Summary

Stage 1

A. Through SAIGLOBAL Publications at https://infostore.saiglobal.com/store, for a search on 'Corrosion and Concrete' on 13 July 2016, there were 166 citations including:

- None from AS or AS/NZS;
- 10 from ASTM;
- 7 from BSI (All BS EN);
- 7 from NACE;
- 4 from ACI;
- 2 from AASHTO;
- 1 from BRANZ; and
- 1 from SPC.

B. Through SAIGLOBAL Publications at https://infostore.saiglobal.com/store, for a search on "Cathodic Protection" on 13 July 2016, there were 420 citations with:

- 24 from NACE;
- 23 from BSI (as BS EN);
- 13 from ISO;
- 8 from AS;
- 2 from ASTM;
- 2 from AWWA;
- 1 from AASHTO and
- 1 from ENA.

Stage 2

Across SAIGLOBAL online Standards Publications there was a total of 55 listings of new Standards, Drafts and Amendments found, 4 April 2016 to 13 July 2016; 1 Standard and 1 Draft from AS AS/NZS being

AS/NZS 1214:2016	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)
DR AS 1897:2016 CP	Fasteners - Electroplated coatings

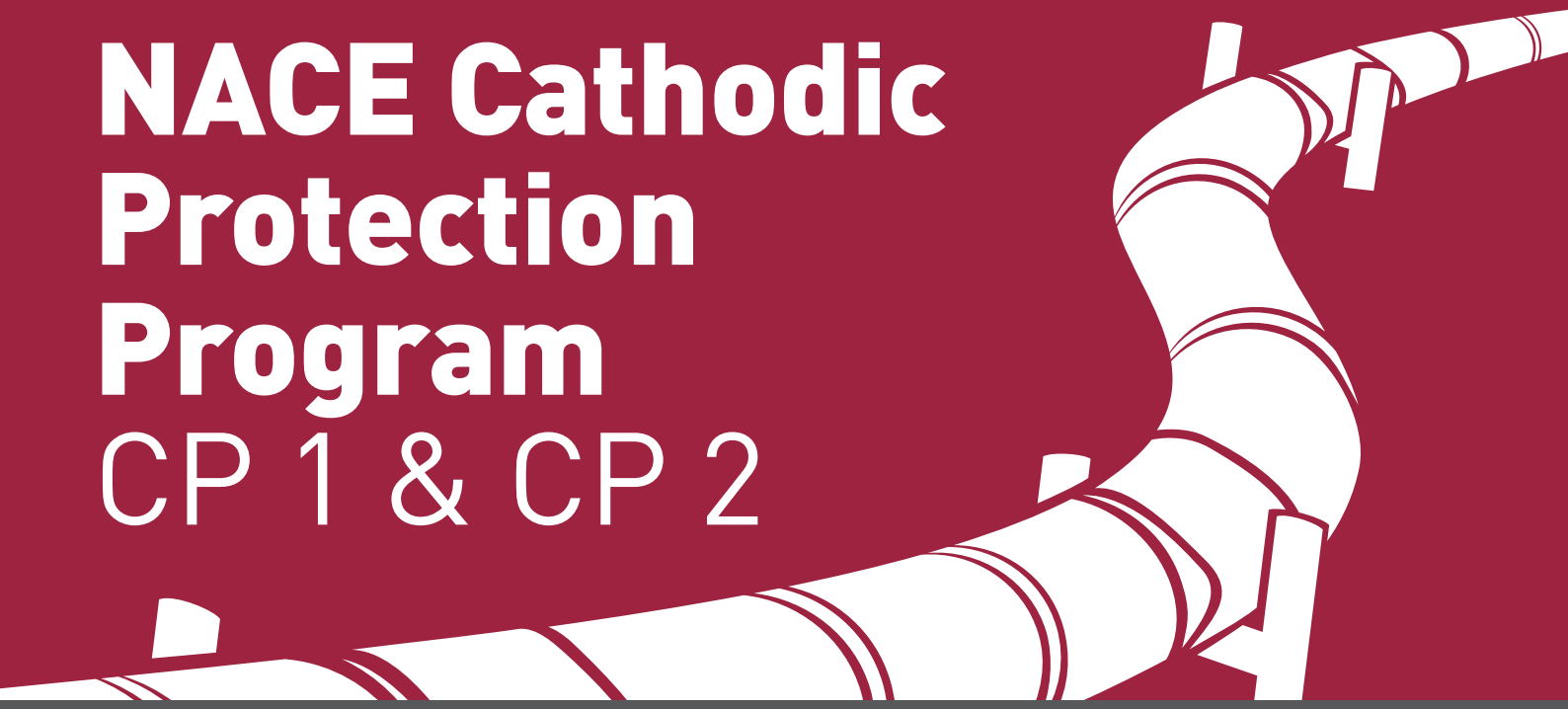
Regards,

Arthur Austin
(Arthur.Austin@alsglobal.com)

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

NACE Cathodic Protection Program

CP 1 & CP 2



The NACE Cathodic Protection (CP) Program is a comprehensive program for professionals in any industry including pipelines and bridges, tanks and well casings, the maritime and offshore industries, coated steel and concrete and water and wastewater systems.

Cost: Member – $3,335 | Non Member – $3,670

CP 1—Cathodic Protection Tester

Provides theoretical knowledge and practical fundamentals for testing on both galvanic and impressed current CP systems. Classroom instruction is comprised of lectures and hands-on training, using equipment and instruments for CP testing.

Assessments

Students will learn and be assessed on (but not limited to):

- Basics of electricity, electrical laws, electrochemistry, corrosion and CP theory
- Polarity related to current flow and metal corrosion activity
- Conduct tests to identify shorts and continuity tests in CP systems
- Use test instruments to perform a variety of field tests such as structure-to-soil potentials, voltage and current measurements, soil resistivity, pipe/cable locating and rectifier readings
- CP components including impressed current systems, galvanic anodes and test stations
- Read shunts and understand their use in rectifiers, bonds, and anodes

CP 2—Cathodic Protection Technician

Provides both theoretical knowledge and practical techniques for testing and evaluating data to determine the effectiveness of both galvanic and impressed current CP systems and to gather design data. Classroom instruction is comprised of lectures and hands-on training, using equipment and instruments for CP testing.

Assessments

Students will learn and be assessed on (but not limited to):

- Performing advanced field tests (including current requirement test, shorted casing test, IR drop test, soil resistivity, and interference tests) and evaluate the results
- Performing tests to verify the presence of stray current interference and recommend method(s) to mitigate the interference
- Understanding AC voltage and its mitigation
- Maintenance of documentation and records, including data plotting and analysis
- Conducting and understand the importance of periodic surveys, including IR- Free readings, polarization decay tests and current measurements
- Testing and troubleshoot rectifier component parts

For questions please contact Skye Russell at the ACA on +61 3 9890 4833 or aca@corrosion.com.au

To register or for more information on the NACE CP Courses to be offered by the ACA go to www.corrosion.com.au or www.NACE.org/cp

AUSTRALASIAN CORROSION ASSOCIATION INC. SEMPER TUENS

NACE® INTERNATIONAL

NACE® INTERNATIONAL INSTITUTE

Chemco Protective Coatings

Q: In what year was your company established?

A: Chemco is a world leader in innovative coating solutions with over 30 years' experience in manufacturing high quality, problem solving, speciality coatings and polymers for the Protective & Marine Coatings Industry. The Australian office consists of a team of management and technicians which have been applying superior protective coatings since the early 1990's.

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

A: Chemco Australia started with 3 very experienced people with similar goals. Being part of a team of like-minded people, the only way is up.

Q: How many do you currently employ?

A: The Chemco group currently employs about 80 people. Our labour force ebbs and flows depending on the work load. We have the ability to increase and decrease labour to suit the market's needs. No job is too big or too small.

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

A: Our office and workshop is based in Wollongong NSW. However, predominately our work is site based, so we travel all over Australia and overseas. Our experienced site team can be anywhere, anytime.

Q: What is your core business?

A: Chemco Specialty Coatings Australia is part of an international organisation that specialises in the manufacture of specialty protective coatings for marine and heavy industrial applications. Our local focus is on providing long term corrosion solutions, coating specification and refurbishment of corroded equipment.

Q: What markets do you cover with your products or services?

A: Due to our wide range and product adaptability, we cover many different industries. Our products are being used extensively in Oil & Gas, Mining & Mineral Processing, Petrochemical, Power Generation, Steel Manufacturing, Water Supply, Tank Linings and Chemical Bunds.

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

A: We have excellent workshop facilities where we conduct a portion of our work. The majority of our work is site based due to the nature of our coating solutions. For this reason, we have geared ourselves up with comprehensive site based equipment and an experienced team of supervisors, technicians and applicators.

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

A: Our focus is directed more at providing long term solutions rather than tonnage turnover. At Chemco, we understand the need to meet deadlines. A large portion of our work is outage based, so we have no option but to complete it by that specific deadline. We always deliver

on time and have gained a reputation in the industry for being reliable and professional under pressure.

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 problem solvers. Everything we do we regard as a specialty service. Generally, when it's outside the range of generic coating applicators, we will have a long term solution. We are renowned for saying 'yes we can'. The depth and variety in our staff give us a strong advantage due to our wide range of skills sets and experience.

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

A: We were recently asked to provide a solution for a process facility, where they were experiencing coating failures within one of their processes involving quenching of hot coking coal. A rail wagon is specifically designed to capture hot coke exiting the ovens at 1000°C. The rail wagon then travels along a rail line to a quenching station. Large volumes of water are dumped over the coke to quench the coke quickly. This puts an extreme strain on any protective coating. This process is repeated hundreds of times a day and due to the regular thermo cycling, most protective coatings were failing within a short period of time, normally between 2-8 weeks. Engineers had tried and tested many different coatings with unsatisfactory results. We applied a Chemco system designed for this environment and implemented a regular inspection plan. The coating has proved it is able to withstand the most extreme conditions and far outperformed previous coatings. This has made a significant difference in the life cycle cost of this asset.

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

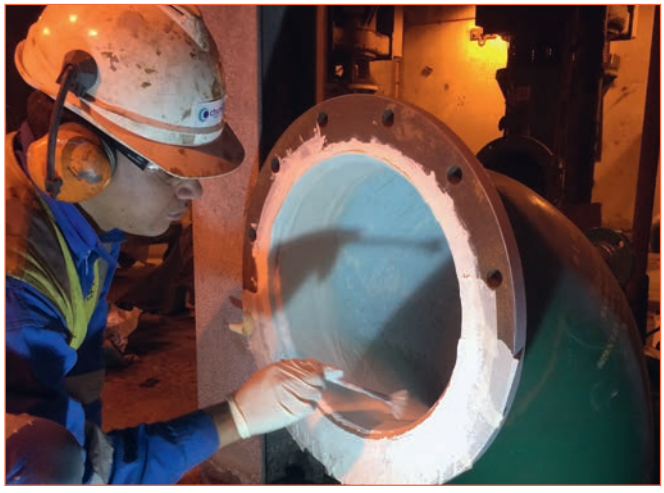
A: Make sure you have a clear understanding of what your client is after. Understand the environment you are working in and be able to back up your recommendations with case studies and previous experience.

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

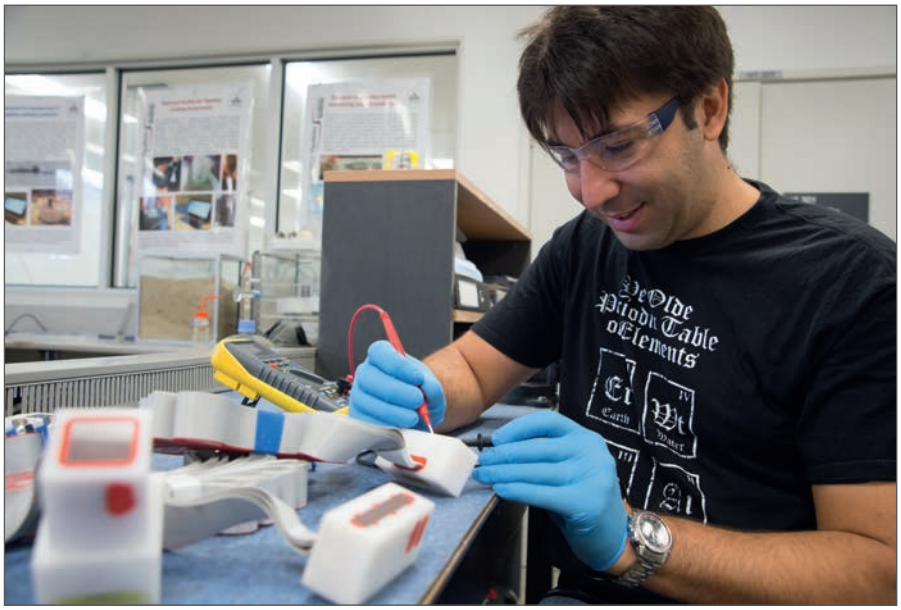
A: We use a combination of both. We believe there is a lot to gain from very experienced technicians with years of practical experience. In addition to our internal training, our experienced technicians have obtained the qualifications of Certificate III in Surface Preparation and Coating Application. Our senior staff members have ACA and NACE accreditation.

Contact
P: 1300 CHEMCO (243 626)
W: www.chemcosc.com.au
E: enquiries@chemcosc.com.au

AUSTRALIA chemco PROTECTIVE COATINGS



Corrosion research at Deakin focuses on major infrastructure



Dr Bob Varela evaluating new sensors for predicting pipeline failure.

Corrosion research at Deakin University focuses on corrosion engineering and infrastructure durability studies. We are developing major research programs with particular emphasis on the reliability, durability and protection of critical industrial infrastructure, such as energy pipelines, desalination, road and transport infrastructure.

The Deakin corrosion research team, led by Professors Maria Forsyth and Mike Yongjun Tan, draws together researchers from a range of disciplines, including chemists, engineers, physicists and microbiologists. The group comprises researchers from both the School of Engineering and the Institute for Frontier Materials, working across two campuses – Geelong Waurn Ponds and Melbourne Burwood. Industry experts, Honorary Professor Bruce Hinton, Adjunct Associate Professor Warren Green and Adjunct Associate Professor Ashley Flitcher provide key technical advice from an industry perspective, on the group's research projects as well as co-supervising students on collaborative research projects.

Australian Centre for Infrastructure Durability
The new Australian Centre for Infrastructure Durability (ACID) is a Deakin initiative which seeks to provide an efficient, one-stop national platform for industry to access the combined research capabilities and testing facilities of a number of leading Australian universities, each with unique strengths in different aspects of durability research. The research partners in ACID include CSIRO, ANSTO, the University of New South Wales, University of Sydney, Swinburne University, University of South Australia, RMIT University, Queensland University of Technology and Curtin University.

ACID's research areas include:
- Smarter structural maintenance technologies and techniques
- New materials for improved durability and corrosion resistance
- Advanced corrosion mitigation technologies
- Access to research and testing capabilities in electrochemical and surface characterisation; durability assessment for carbon-fibre reinforced polymers; and variable environmental test chambers.

In 2015, Professor Frank Collins was appointed as Director of ACID. Prof Collins has extensive research experience in the areas of cement and concrete durability, ageing of built infrastructure; utilisation of wastes as alternative construction materials; and improved construction materials for durable and stronger infrastructure (e.g. carbon nanotube-cement composites). His recent research has involved 3D visualisation of corrosion damage, mechanisms of corrosive transport through concrete, predictive modelling of deterioration and durability of cement-fibre composites.

In 2015, ACID research teams carried out significant research contracts with more than 10 companies.

The range of potential funders of ACID projects covers a broad range of built infrastructure types and functions and construction materials. At present, ACID is targeting future projects from the following sectors: energy (Viva) and EPCRC; product suppliers; defence (DMTC/DSTO); and port authorities.

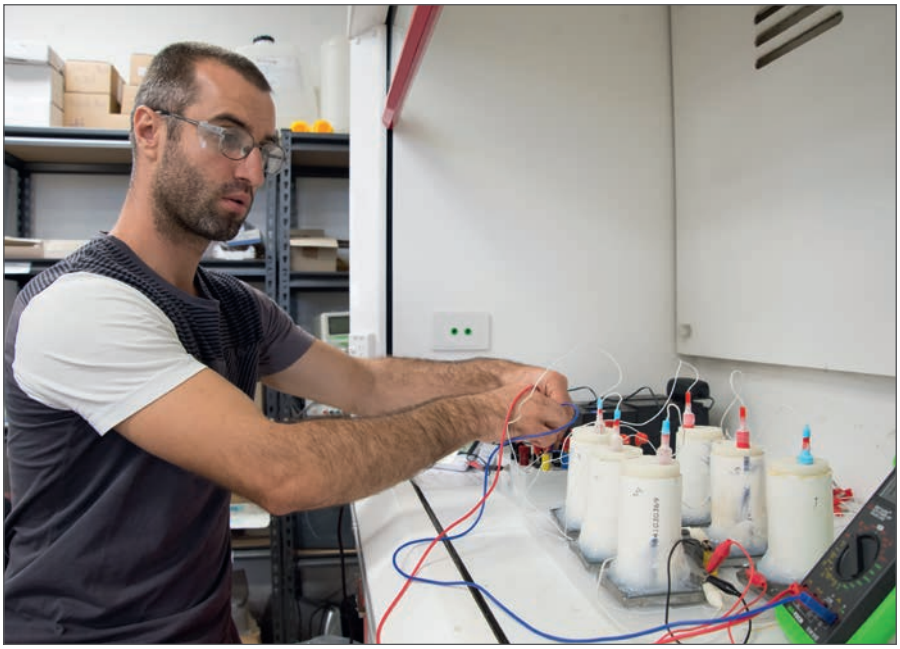
Energy Pipelines CRC research
Deakin leads the Energy Pipelines CRC (EPCRC) Program 2 on coatings and corrosion, which is headed by Prof Tan. The goal of this research is to cost-effectively extend the life of pipeline infrastructure by mitigating corrosion and environmentally assisted pipeline degradation. A major area of research concerns coating selection, application and testing, which is supported by the National Facility for Pipeline Coating Assessment (NFPCA). Other research themes are cathodic protection, stress corrosion cracking and pipeline corrosion measurement and prediction. The NFPCA also provides commercial, independent coating testing services to the wider industry including coating manufacturers, suppliers, applicators and end users. The NFPCA has now gained NATA accreditation and is an independent laboratory.

Current EPCRC projects include:
- Predicting pipeline failure through corrosion modelling
- Cathodic shielding and corrosion under disbonded coatings
- Pipeline condition monitoring sensors
- Methods for assessing coating integrity and CP efficiency under complex pipeline conditions
- Understanding SCC initiation on gas pipelines.

Our corrosion research is supported by advanced electrochemical facilities and state-of-the-art testing and characterisation available within the Institute for Frontier Materials (IFM) and the School of Engineering.

Our work on a remote sensor for monitoring pipeline corrosion has achieved a world first by installing a pipeline health monitoring system on a Victorian high pressure pipeline. The team has received $1 million in funding from the EPCRC over three years to develop the sensor technology, leading to commercialisation. The researchers will also use the funds to undertake extensive modelling of corrosion under disbonded coatings. Prof Mike Tan says the monitoring system should help the industry to extend the lifetime of pipelines by decades. The system uses wireless or satellite technology to alert companies when issues occur.

Student Fariba Mahdavi takes measurements on a defective coated probe to study cathodic disbondment of coatings.



The National Facility for Pipeline Coating Assessment provides an independent, commercial testing service for oil, gas and water pipeline industries.

Bio-corrosion and corrosion inhibitors

Led by Corrosion Medal recipient Prof Forsyth, our research in this area focuses on the development of biomaterials and generating new knowledge about the corrosion of materials in a physiological environment. Projects focus on controlling the corrosion processes of magnesium and titanium alloys and their use as degradable scaffolds, coronary stents and medical implants.

A core competency of the group also includes the development of chromate-free corrosion inhibitors and coatings. A series of organic compounds pioneered by our group offer a viable alternative to the use of chromates as corrosion inhibitors for steel applications due to their benign nature. These inhibitors present for excellent corrosion mitigation for mild steel in aqueous environments. The protection is related to the chemical formation of a nanometer thick interphase occurring on the surface that reduces the electrochemical processes leading to corrosion. Furthermore, filiform corrosion can be suppressed when these compounds are added as a pigment to a polymer coating. More recently, we have added additional functionality to these compounds by chemically combining mixtures of these to pharmaceutically active compounds that display inhibition to antimicrobial activity, providing for protection against MIC.

The group has also developed new coatings based on ionic liquids as corrosion inhibiting films on Mg and Al alloys. Their performance can be influenced by the chemistry, applied potential, temperature and time, and a combination of these have led to the successful development of corrosion inhibiting coatings.

Contact: Prof Mike Yongjun Tan, School of Engineering, Deakin University, Geelong Waurn Ponds Campus, mike.tan@deakin.edu.au; Ph. 03 5227 2443

Prof Frank Collins, Director Australian Centre for Infrastructure Durability, frank.collins@deakin.edu.au

Prof Maria Forsyth, maria.forsyth@deakin.edu.au

Website: acid.org.au
deakin.edu.au/ifm/corrosion-and-protection

DEAKIN UNIVERSITY

University Galvanized to Face the Future

As part of the Arts West Redevelopment project, the University of Melbourne has renovated the Arts faculty building on Medical Road in the main Parkville campus. A stunning visual feature of the new building is the louvered façade on three sides; the steel sections of each louvre have been shaped so that they form part of a series of 3D images that can be viewed from different angles as people walk around the building.

To protect the steel from corrosion and add visual appeal, the project team opted to galvanize the louvres. Industrial Galvanizers (IG), a member of the Galvanizers Association of Australia (GAA), was engaged to take the more than 480 individual steel sections and coat them in zinc prior to delivery to the construction site. The IG factory in suburban Campbellfield, north of the Melbourne CBD, returned each batch of the completed galvanization project to the steel fabricators, Fabmetal Specialists, with an average turnaround of 2-3 working days in plant. According to David Reilly, Sales Manager at IG, galvanization provides a long lasting, tough, durable coating that provides complete corrosion protection both inside and out in addition to enhancing the appearance.

Galvanization has been used for nearly two centuries and is a very effective method of protecting steel structures. Items to be coated are dipped into a bath containing a solution of molten zinc. The process provides three types of protection in the one coating: barrier protection, cathodic protection and a zinc patina providing long-lasting protection.

A GAA datasheet explains that a galvanized coating completely encapsulates all surfaces of a steel structure and acts as a barrier to the surrounding environment. The coating has a natural electrical potential which cathodically protects the steel from coating imperfections caused by accidental abrasion, cutting, drilling, or bending. The last critical component is the zinc patina itself which is relatively insoluble and passive, thus greatly reducing the corrosion rate.

"Galvanizing has a similar initial cost as any other surface protective coating, in many cases it is lower," said Peter Golding, CEO of GAA. "It is a myth that the process increases the cost of a project."

The stability of a galvanized surface means that the time between maintenance inspections is much longer which greatly reduces the life-cycle costs of the structure.

In today's environmentally conscious world, galvanization is a very sustainable process. "Both the metal substrate and the zinc coating can be

Some of the stylised figures embedded in the panels of the redeveloped University of Melbourne Arts faculty building.

A long view of one of the sides of the redeveloped Arts building.

The cramped construction site drop zone that had to be negotiated by the semi-trailers delivering the galvanized sections.

Sections of the galvanized façade being lifted into place by crane.

repeatedly recycled forever," Golding added. Galvanizing is carried out to Australian and New Zealand Standard AS/NZS 4680 ensuring minimum coating thicknesses are applied and making coating life and performance reliable and predictable.

The hot dip baths at IG can accommodate pieces up to 12 metres in length, 1.8 metres wide and 2.7 metres deep. "We can work with larger structures if they have been designed in sections that can be bolted together after galvanizing," Reilly said. "Alternatively, if an object exceeds the dimensions of our zinc bath, it is possible to progressively or 'double' dip larger single pieces."

Safety is always of utmost importance when IG staff are working in proximity to the molten zinc. "We spend the majority of the time checking that the item delivered for galvanizing meets the design and fabrication specifications," said Reilly. "We have to ensure that there are vents and holes in the appropriate places to make sure that excess hot liquids drain fully from the structure."

While the iconic façade on the Arts faculty building was being installed, Reilly had to contend with the constraints of restricted site access for the trucks delivering the oversize galvanized sections. The University of Melbourne is located in a leafy area north of Melbourne's CBD, but most of the buildings are nestled close together with narrow laneways between them making it difficult to manoeuvre large vehicles.

"All the façade sections were numbered as they had to be installed in a very precise sequence," Reilly added. "It was a challenge to get the semi-trailers in and unload the steel because they had to be taken off in such a way that they could be lifted up the building without double handling." The panels were packed with spacers and carpet so that the coating would not be damaged as the client wanted to maintain an "architectural" look and finish. The sequencing was a critical aspect of the project to ensure the shaped sections correctly formed the embedded image.

The durability of the galvanizing process meant stacks of panels could be stored on site with exposure to the elements and a construction environment. The coating has a unique metallurgical structure which gives outstanding resistance to mechanical damage in transport, erection and service.

Different environments are classified on a scale of C1 to C5, with C1 being a very benign location to C5 being extremely severe in terms of temperature extremes, humidity and corrosive components such as salt or chemicals. Average suburban areas—such as where the University of Melbourne is located—are mostly classified as C2.

The standard AS/NZS 4680 calls for minimum zinc deposition thickness of 85 microns for the items galvanized in this project. The estimated life-span and performance of a galvanized structure is calculated using the thickness of the zinc coating and the severity of the operating environment. Combining the results—Parkville being C2 and the zinc thickness meeting the requirements of the standard—gives the new façade an expected life-span of more than 99 years.

A galvanized structure lasts longer and requires less frequent inspections, so in the vast majority of cases is the cheapest process in the longer term. Every part of a galvanized article is protected, even recesses, sharp corners and inaccessible areas. No inorganic coating applied to a structure or fabrication after completion can provide the same protection. Maintenance requirements add to the life-cycle costs of any facility or structure, especially when plant shutdown or disruption to production is involved.

The majority of the steel that IG processes comes in fairly regular shapes, but the company also occasionally galvanizes sculptures and art installations. "The unusual shapes break up the monotony of I-beams and girders that come through," Reilly said. "Some of the stranger pieces get a raised eyebrow from a few of our staff though."

According to Reilly the choice of coating depends on what the client is after. Asset owners need to consider initial cost, life cycle costs, aesthetics and the environment when choosing a coating system. It is important to also remember that galvanization is not appropriate for every situation. "However, if it is made of steel we will do our best to galvanize it," he added. "While the metal was too thin to survive the process, a customer once even asked us to hot dip some standard coil bedsprings as part of an art installation."

The Galvanizers Association of Australia represents many of the leading galvanizing companies throughout Australia, New Zealand and Asia. Established in 1963, the Association works with companies like IG to ensure the highest standards in design and quality of galvanized products. GAA's objectives are to provide technical consulting services on a not for profit basis and to assist consumers achieve the economic benefits inherent in the correct design and application of the galvanization process.

Spotlight on Polyurea in NZ

Introduction

In 1996 when the Earth had had just about enough substance abuse, the New Zealand HSNO Act (Hazardous Substances & New Organisms) outlined the framework for containment around fuel storage tanks. Between 2004 and 2006 while still in draft, warnings and timelines were being handed out with the view of full compliance by 2009. Basically '*Nothing is allowed to Spill Back into the Planet*'.

Shell/STOS Upgrade

Being part of a global network, and industry leaders, Shell NZ and STOS (Shell Todd Oil Services) decided to upgrade all their tank farms located in NZ with a containment system put together by their design engineers, a top local civil engineering team and a specialist applicator, NZ Application Service Ltd (NZAS).

After five years or so Shell NZ had finished their research and due diligence, NZAS received an invitation to discuss and answer all concerns regarding the use of Polyurea as part of a containment liner system. This took a further few months and then the round table discussions began to review design feasibility, and Health & Safety.

NZAS asked Nukote International, the suppliers of *Polyurea ST* to put a General Method Statement together for this work. After the first bund lining was completed and the flood test passed, Shell NZ have now completed the rest of their installations.

Geotextile

When using woven geo-cloth for containment and applying fast-set products on them like Polyurea, you can't just use any type of geotextile. You must be aware of the limitations of both cloth and product, such as shrinkage, etc. A lot of cloth makers cut corners to offer lower cost material, but when you apply a hot product like Polyurea which constricts while curing you need the best you can find so there's no recalls to redo the job. When trying to keep track of the amount of product being sprayed on, there must be a Grid-System in place. Also to monitor thickness NZAS use 'Panels' which is a way to test the thickness on geotextile over compacted fill without destructive testing.

Bund Design

Without going into the full specification, which is massive, all of the Tank Farm Bunds had the existing top layers of fill removed and replaced with a specifically designed volcanic based drainage system and various types of fill plus geo-matting. All of the sites when finished need to facilitate servicing with heavy vehicle access incorporated into the design. Some with very large tanks will need to have 300 tonne cranes drive into the bund to service the roof areas. This bund design needs to keep the membrane intact during servicing. Composite Polyurea was the material choice and has proven its worth. The DFT on the tank surrounds was higher than under the pipe lanes, i.e. typically 3-4 mm compared to 2 mm elsewhere.

The scale of projects like these only work when everyone is fully on the same page. The organizations that played a part in success of these rehabilitations are amongst the best. From consulting engineers, civil contractors, Health & Safety, they must gel together for success.

Equipment

The Spray Rigs are on the road most of the time. All are equipped with everything to be self-sufficient. This one has a 110KVA Gen-Set – Rotary Oil free compressed air with Max-Dryer multiple plural pumps, work bench and preparation equipment plus storage to carry 12 tonne of product.

To be able to run this type of gear, sometimes days on end, needs the expertise of, great staff and good training. This would not be possible without the extensive experience of NZAS Engineering Manager.

NZAS has also completed containment linings for Air-BP Aviation Fuel Depot, many of Fonterra's factory roofs and the Tirohia Landfill (*The largest of its kind in Australasia*).

It was here the award for 'World's First Polyurea Lining System for Containment of Leachate' was granted. Also numerous Transformer Bunds for Vector NZ, and countless Pump Stations, Waste Water Treatment and Water Treatment structures for Watercare Services Ltd. All have different types of ***Polyurea Containment***, both primary and secondary with geotextile, used throughout New Zealand & the Pacific region.

This Project Profile was submitted by ACA member, NZ Application Service Ltd, a plural component mobile application company, specializing in Polyurea.
For further information visit www.nzas.biz

Pickling and Passivation

The chemicals used in pickling and passivation are acidic and must be handled with due OHS and environmental precautions as well as neutralisation and suitable disposal of waste. In addition, hydrofluoric acid n(HF) is a schedule 7 poison. Stainless steel can corrode in service if there is contamination of the surface. Chemical treatments can be used to improve the corrosion performance of the steel, and hence its appearance in service.

Both pickling and passivation are chemical treatments applied to the surface of stainless steel to remove contaminants and assist the formation of a continuous chromium-oxide, passive film. Surfaces must be free of grease and dirt before using these acid treatments.

Stainless steels resist corrosion best if they are clean and smooth. Clean means being free of contaminants on or in the surface that can either react with the steel (like carbon steel or salt) or that create crevices or other initiation points where corrosion can start. Smooth means having a low surface profile at the 'micro' level. Mechanically abrading the surface can roughen the steel's surface and may also embed unwanted particles. After mechanical cleaning, passivation is required for maximum corrosion resistance.

The common feature of chemical treatments is that they all clean the surface of the steel. They may also smooth or roughen the steel surface, or leave it unaffected depending on which process is chosen. But if carried out properly, they all increase the corrosion resistance.

ASTM A380 Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems is a valuable source of information on pickling and passivation treatments. Other sources of information may be obtained by contacting ASSDA.

Stainless Steel Products

During steel making, sulphur in the steel is controlled to very low levels. But even at these levels sulphide particles are left in the steel, and can become points of corrosion attack. They can be removed by chemical surface treatment.

Most bar products are slightly higher in sulphur for easier machining, so chemical treatment to remove inclusions in the surface of these products becomes more important.

Generally mill finishes for flat products (sheet, plate and strip) will be smoother as their thickness decreases.

A No. 1 (HRAP) finish on a thick plate may have dimples or other imperfections and a surface roughness of 5 to 6 micrometres R_a.

A typical 2B cold rolled finish on 1.7mm thick sheet might have a surface roughness of 0.2 micrometres R_a or better.

New surfaces will be created during fabrication processes (eg. cutting, bending, welding and polishing).

The corrosion performance of the new surfaces will generally be lower than the mill supplied product for a number of reasons: the surface is rougher; sulphide inclusions sitting just under the surface have been exposed; or mild steel tooling contamination may have occurred.

Chemical treatments that are correctly performed can clean the surface and ensure the best possible corrosion performance.

Chemical Surface Treatments

These can be grouped into four categories:

Pickling - acids that remove impurities (including high temperature scale from welding or heat treatment) and etch the steel surface. 'Pickling' means some of the stainless steel surface is removed.

Passivation - oxidising acids or chemicals which remove impurities and enhance the chromium level on the surface.

Chelating agents - chemicals that can remove surface contaminants.

Electropolishing - electrochemical treatments that remove impurities and have the added benefit of smoothing and brightening the surfaces.

Electropolishing is also an electrochemical process. It removes gross weld scale and heat tint but is not intended to brighten or smooth the surface.

Both pickling and passivation solutions can employ dangerous acids that can damage both the operator and the environment if not handled correctly. Pickling acids for stainless steel are highly corrosive to carbon steel.

It is essential that all acids are thoroughly removed by rinsing the component after completing the process. Residual hydrofluoric acid will initiate pitting corrosion.

If there are crevices, it may be of benefit to neutralise the acid with an alkali before the final rinsing step.

Pickling

Pickling is the removal of any high temperature scale and any adjacent low chromium layer of metal from the surface of stainless steel by chemical means.

Where the steel has been heated by welding, heat treatment or grinding to the point where a coloured oxide layer can be seen, there is a chromium depleted layer on the surface of the steel underneath the oxide layer.

The lower chromium content causes lower corrosion resistance. To restore the best corrosion resistant performance, the damaged metal layer must be removed, exposing a fully alloyed stainless steel surface.

Pickling time is longer with higher grades, lower temperatures or more severe heat tint, which is usually caused by poor gas purging.

Example of a good post-weld practice.

Mechanical removal alone may leave abrasive or other particles embedded (interfering with corrosion performance) or may be impractical. If mechanical means are used, chemical passivation will be required for maximum corrosion resistance.

Procedures incorporating pickling solutions, such as a mixture of hydrofluoric (HF) and nitric (HNO_3) acids, remove the scale and the underlying chromium depleted layer and restore the corrosion resistance.

Mixtures of HF and HNO_3 are the most common and are generally the most effective. Acids are available as a bath, a gel or a paste.

Commercially available mixtures contain up to about 25% HNO_3 and 8% HF. These chemicals etch the stainless steel which can roughen and dull the surface.

Pickling solutions also remove embedded contaminants such as carbon steel and ferrous and ferric oxide particles. Pickling solutions other than mixtures of HNO_3 and HF acids exist and can be used for specialised applications. They tend to be slower.

Pickling pastes, where the solution is mixed with an inert carrier, are commonly used to treat selected areas such as welds. Pickling involves metal removal and a change or dulling in the visual brightness of the metal.

Procedures involving electropolishing are a useful alternative or additional treatment following pickling. Metal removal is achieved and usually results in a bright, smooth and more highly corrosion resistant finish.

Passivation

Passivation is the treatment of the surface of stainless steels, often with acid solutions (or gels), to remove contaminants and promote the formation of the passive film on a surface that was freshly created, eg. through grinding, machining or mechanical damage.

Passivation works by dissolving any carbon steel contamination from the surface of the stainless steel, and by dissolving out sulphide inclusions breaking the surface. Nitric acid (HNO_3) may also enrich the proportion of chromium at the surface. Some chelants also claim to do this.

Common passivation treatments include HNO_3 solutions or pastes which will clean the steel surface free of iron contaminants.

Formulations contain up to about 30% HNO_3 and may also contain other oxidisers such as sodium dichromate. When used correctly, an HNO_3 treatment should not affect the appearance of the steel.

Passivation does not usually result in a marked change in appearance of the steel surface, although mirror polished surfaces should be tested first.

The corrosion resistance of the stainless steel is affected by the roughness of the surface after polishing, with a marked decrease in the corrosion resistance as the surface roughness increases above a R_a value of about 0.5 micrometres. This roughly corresponds to the surface produced by grinding with 320 grit abrasives as discussed below.

Either passivation or electropolishing can be used to improve the corrosion resistance of polished surfaces.

Chelants

Chelants have chemical 'claws' designed to selectively clean the surface.

The carboxylic acid group -COOH is the basis for many chelants which are used in cleaners, water softening and lubricants. The pH and temperature must be correct for the chelant to do its job. Chemicals containing these COOH 'claws' include citric and oxalic acids and EDTA. Citric based formulators are most used as they are not toxic.

Turbulent rinsing of pipes and vessels afterwards is important.

Cleaning by chelating agents tends to be based on proprietary knowledge and systems, and is less standardised than the other methods described.
The successful use of these systems needs to be established on a case-by-case basis.

Chemical vs Mechanical Treatment

The figure below shows the relative importance of the surface smoothness and chemical treatment on corrosion resistance. Note that a pickled or passivated rough, matt 36 grit finish could have better corrosion resistance than an untreated 220 grit finish. The study reported by G.Coates (Materials Performance, August 1990) showed the effect of mechanical and chemical treatments of furnace generated heat tint on a high molybdenum grade of 316.

Electropolishing

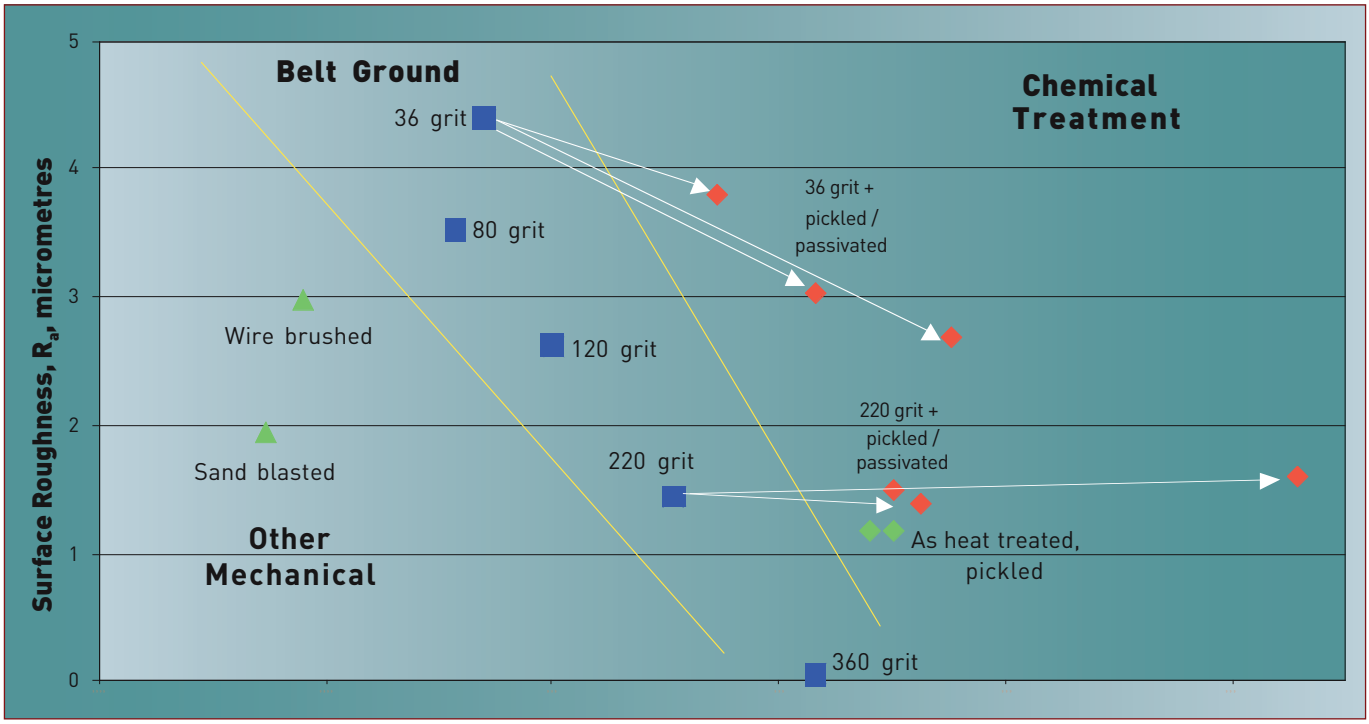
Electropolishing of stainless steel is a method of imparting brilliance to its surface by removal of a thin surface layer, especially the peaks.

Studies have also shown that electropolishing benefits corrosion resistance. The work to be polished is the anode in an electrochemical cell containing a suitable electrolyte.

The process may be considered the opposite of electroplating and is an important production tool in the fabrication of the stainless steels, along with mechanical polishing processes.

Generally speaking, electropolishing supplements the mechanical polishing

Effect of chemical and mechanical treatments on corrosion resistance



Corrosion resistance improves as you go to the right of this graph. The graph shows the relative importance of the smoothness of the surface and chemical treatment of the surface. They can be used togther to get the best corrosion resistance.

The study reported by G.Coates (Materials Performance August 1990) looked at the effect of various methods of treating an artificial welding heat tint on a 2B surface.

Contrasting features of pickling and passivation

Pickling	Passivation
Removes both weld oxide and stainless steel	Does not remove weld oxides not attack stainless steel
Typically hydrofluoric, sulphuric (or in steel mills, hydrochloric) acid	Nitric acid or electropolishing. Chelating formulations can have similar effects to nitric acid
Removes surface breaking sulphides and carbon steel	Removes surface breaking sulphides and, less rapidly, carbon steel smears
Changes appearance as it lowers gloss by etching	Nitric and chelating treatments should not change appearance. Electropolishing will brighten and slightly smooth it
Usually mixed with nitric acid – and with rinsing leaves a passive surface	Will improve the passive film over a simply pickled one.

methods by providing an economical means of brightening many shapes or forms that cannot readily be finished mechanically.

Electrolytic methods should not be specified to remove surface blemishes such as scratches, burrs, pits, scale patterns, forging marks, etc. although they will do so if such defects are very shallow. It is important to realise that defects initially present on surfaces may be greatly accentuated if not treat appropriately.

Surface condition before electropolishing governs the finished appearance. These processes are also applicable to cast stainless steels. However, the resulting surfaces will not be as smooth as those on wrought materials, unless they are mechanically prepared beforehand.

Most commonly, phosphoric and sulphuric acids are used in conjunction with a high current density to clean and smooth (by metal removal) the surface of the steel. The process preferentially attacks peaks and rounds valleys on the surface and raises the proportion of chromium at the surface.

The technique can have a substantial effect on the appearance, increasing lustre and brightness while only reducing the measured roughness by about 30%.

Standards

The four categories of chemical treatment are detailed in a number of standards, but the most commonly used are:

ASTM A380 Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.

ASTM A967 Standard Practice for Chemical Passivation Treatments for Stainless Steel Parts.

ASTM B912 Standard Practice for Passivation of Stainless Steels using Electropolishing.

These very useful documents give detailed recommendations on many aspects of selection, application and evaluation of these treatments and are highly recommended.

Precautions

Pickling and passivation use strong acids, and normal precautions for safety should be followed. Consult the Materials Safety Data Sheets and product packaging for detailed advice.

Note that hydrofluoric acid is a schedule 7 poison and in concentrations greater than 1% requires a specific licence for use.

For chemical processes that etch the stainless steel, reaction times will increase with increasing grade.

More care is required with 'free machining' grades and these will usually require substantially less aggressive chemicals. The sulphur addition in these steels means they are readily attacked by chemical treatments. Care is also required when treating martensitic or low chromium ferritic stainless steels.

Detailed recommendations for each grade of stainless steel are given in the ASTM Standards.

Bath composition (acid strength and iron concentration) must be checked as extended pickling times or old solutions tend not to give as good a result.

Dirt and grease will mask the surface from treatments outlined above. Therefore, the steel surfaces must be free of these agents before applying chemical treatments.

Many of the chemical treatments described contain strong acids and both handling and PPE requirements must be followed. Before disposal they will require neutralisation. Check with your local authority concerning the requirements for trade waste, neutralisation and disposal.

Many of the chemicals described above will be classified as hazardous substances under State OHS legislation, with implications for purchasing, transport, storage and handling.

Chemical treatments are useful tools in cost effectively achieving peak performance with stainless steels. With appropriate training, hazards associated with their use can be managed.

More details on chemical handling and disposal are given in suppliers' datasheets and Trade Waste and/or Environmental legislation and/or regulations.

Extract from the Pickling and Passivation section of the Australian Stainless Reference Manual (2012) published by Australian Stainless Steel Development Association (ASSDA)

Surface Preparation for Inorganic Zinc Silicate Coatings

By Rob Francis

The single-coat inorganic zinc silicate (IZS) coating provides one of the most durable and cost-effective coating systems available. Properly applied, it will provide many years durability in even the most severe environments, such as off-shore platforms and other marine applications. It is also widely used in many other industries where colour is not required, such as power stations, refineries, bridges and other engineering structures and water and wastewater treatment facilities. In fact, as long as the environment is not too acidic or alkaline, it can be used in just about any atmospheric application. There are water-borne inorganic zincs, ideal where there are VOC limitations, and solvent-borne coatings, which are easier to use but require humidity to cure. Both types provide similar long-term protection.

Inorganic zinc has a number of unique properties compared to other protective coatings. It can be used in high temperature applications up to a dry heat temperature of 400ºC. It can be used with friction grip joints, and its toughness makes it especially effective in bolted applications that would damage other coatings. It is resistant to most solvents and was widely used for tank linings for oils and other hydrocarbons. However, new epoxy and epoxy-phenolic linings have largely taken over as they are easier to apply and clean and more resistant to acidity or alkalinity. As with other zinc coatings, it should not be used outside a pH range of about 6 to 12. Nor should IZS be used for applications where it will be continually wet, such as water tanks or underground.

As a single-coat thin-film system, it can provide great cost and time savings as blasting and coating can often be done in a day. But with a single coat, you do not have the luxury of second or third coats covering any misses, so thorough visual inspection of every surface is essential. As long as weather conditions are correct, it will rapidly dry and cure, so can be transported or put into service quicker than many conventional coating systems.

Surface preparation

As with any coating system it must be applied to surfaces with the correct standard of surface preparation. However, these requirements are not too onerous, and getting this stage of their application correct should not prove too difficult for the specifier, contractor and inspector.

Treatment of fabrication defects such as rough welds, weld spatter and sharp edges should always be the first stage of any surface preparation and IZS systems are no different. However, because of the fact that they provide galvanic protection and have very little shrinkage on drying, edge treatment can be minimised for these coating systems, cutting costs and time requirements considerably. Corbett investigated the corner build characteristics of common bridge shop primers to determine the required extent of corner preparation and concluded:

"…no treatment of corners is required if an inorganic zinc-rich coating material is specified, provided the coating materials are applied using proper spray technique to ensure full thickness and adequate coverage of the coating."

Removal of sharp edges and defects that could cause injury or prevent proper alignment of joints should always be carried out, but treatment of defects to draft AS/NZS 5131 Section 9.8.4 (ISO 8501-3) Treatment Grade P2 would normally be sufficient.

Morgan-Whyalla pipeline.

NZ Bridge over the Kaitung River coated with IZS in 2012.

Morgan-Whyalla pipeline.

Morgan-Whyalla pipeline.

Morgan-Whyalla pipeline.

As with any coating system, the next stage will be to ensure the surface is free from oil and grease. The water borne product is especially intolerant of any oil, but it is good practice to remove any oil and grease using a method described in standards such as AS 1627.1.

Inorganic zinc must be applied to an abrasive blast cleaned surface, with a high standard of cleanliness. The zinc dust needs to electrically connect with the steel surface to provide cathodic protection and the coating chemically reacts with the steel. Very thorough blast cleaning (Sa 2½ to AS 1627.4) is normally required for atmospheric exposure, although some suppliers allow a slightly lower standard. This would be false economy and a clean "near white" surface should be mandatory.

However, other surface preparation requirements are less critical. A surface profile typically in the range of 40 to 75 microns is often specified, but this is not crucial. The original coating applied to the iconic Morgan-Whyalla pipeline in South Australia, still in good condition 70 years on, was applied to a pickled surface so steel roughness is clearly not essential. The blast profile should be rough as obtained from angular abrasive but the actual profile is not critical.

The final requirement of surface preparation, freedom from salts, is also less critical with inorganic zincs than for other coatings. As a porous coating chemically adhered to the steel substrate, osmotic blistering is unknown. Moreover, any salt in the air after application can actually assist in the continued curing and hardening of the coating as it assists in polymerisation of the silicate. A surface with heavy salt contamination will rapidly re-rust so you will lose the blast, but if the surface keeps its near white metal cleanliness, it should be acceptable for coating with inorganic zinc.

In summary, other than the essential requirement for a surface free from oil and grease with a near white blast finish, surface preparation requirements for a single-coat inorganic zinc silicate coating system are not too onerous. The inspector's main requirement would be for a thorough visual inspection to ensure all surfaces have been blast cleaned to the required standard. However, application, drying and curing of these coatings is much more problematic as discussed in the paper, '*Inorganic Zinc Silicate Coatings: Fallacies and Facts*' published in the August 2014 issue of *Corrosion & Materials*.

The use of Cementitious Coatings to Repair Low Nominal Cover on Reinforced Concrete Structures

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Summary:
Reinforced concrete is used extensively in modern construction of numerous assets including bridges, jetties, public and industrial infrastructure. Structural design lives of >50 years means durability is a critical consideration. The durability of reinforced concrete depends on a variety of factors including the surrounding environment, concrete mix design and construction practices. A nominal design cover, the thickness of concrete over steel reinforcement bars to provide corrosion protection, will typically be specified based on the environment and the type of concrete used. In practice whether on site or in the pre-cast yard the specified concrete cover thickness is not always achieved. This will reduce the time to first maintenance and can lead to expensive repair costs particularly in severe coastal or industrial environments where high levels of chlorides and or acidic gases are present. When this occurs it can lead to project delays, scrapping of pre-cast units, potentially re-casting concrete on site or the use of protective coatings to reinstate the cover. Advanced cementitious coatings offer an innovative solution to this problem due to their ability to be applied to new, green, concrete and act as a barrier to moisture, chlorides and acidic gases increasing the level of protection.

1. Causes of low cover

There are lots of causes of low cover and, although mistakes can happen on the project site, problems can sometimes be traced back to the design process. With the wish to make modern concrete structures more complex and aesthetically pleasing, the design becomes more complicated, and insufficient attention may be given to the practicality of turning the concept from the designer's drawings into reality. In some cases, designers do not picture the construction sequence or envisage the difficulties on a project site, and so the requirements for steel reinforcement are based upon structural needs rather than the ease of assembly as subsequent encasement in concrete. This is seen as a common problem in highway and marine structures, where the sheer density of reinforcement provides big challenges for the contractor. In these instances, insufficient consideration is sometimes given to the mix design of the concrete to enable it to be poured into confined spaces.

Another cause of low cover can be poor workmanship, with the wrong or inadequate spacers being used or inadequate fixing of the formwork. Furthermore, great care must be taken when concrete is being poured and compacted to avoid displacement of the reinforcement. It must be remembered that, if the concrete fails to meet its specified characteristic strength, the cover quality will be inadequate to maintain the required durability requirements. Poor compaction and honeycombing will again reduce effectiveness of the concrete cover and will require remedial action. Therefore, it is vital to maintain tight quality control at all times to avoid such potentially costly mistakes.

2. Consequences of low cover

The concrete cover must have a minimum thickness for three main reasons:

- To protect the steel reinforcement bars (rebar's) from environmental effects to prevent their corrosion.
- To provide thermal insulation, this protects the reinforcement bars from fire.
- To give reinforcing bars sufficient embedment to enable them to be stressed without slipping.

The depth and quality of the concrete is vital as the relatively thin layer of concrete has to be able to maintain a passivating alkaline layer, formed by the release of calcium hydroxide as cement hydrates, while still forming a barrier to ingress of chloride ions or carbonation. Typical levels of cover are given in Table 1.

Country	Concrete Code	Range of Concrete Cover (mm)
UK	BS:8110	25-50
EU	EN 1992 (EC2)	Diameter +10-55
USA	ACI:318	40-50
AUSTRALIA	AS:3600	20-65
NZ	NZS:3101	20-65

Table 1. Typical National Requirements for Concrete Cover

This is especially important where concrete structures are exposed to industrial or marine environments. The premature failure of corroded steel reinforcement and the expansion of the iron corrosion products around the rebar are one of the main causes of the concrete degradation. The minimum concrete cover will depend on the environmental conditions encountered and must be thicker when the concrete is also exposed to moisture and chloride. A high quality concrete made with a low water-to-cement (w/c) ratio will have a lower porosity and will be less permeable to water and to the ingress of corrosive species (dissolved oxygen, chloride). A thicker cover or a more compact concrete will also reduce the diffusion of CO_2 in the concrete, protecting it better from carbonation and maintaining a higher pH for a longer time period, so increasing the rebar's service life.

2.1 Remedial actions

2.1.1 Demolition

Demolition is a drastic measure and the last resort, however once a client finds a major defect within a new structure the first suggestion is often to demolish those sections that do not meet the specification, or in the case of precast concrete elements reject the item. This is not always practicable, as it may be sometime before the problem is found or the costs in terms of delay to the project may be unacceptable.

2.1.2 Recasting

An alternative to demolition maybe partial recasting, which involves removing defective concrete back to behind the level of the reinforcement using high pressure water jetting to avoid damage to the adjacent structure. The formwork is then repositioned to achieve the desired cover and the concrete is recast. However, depending when the problem is discovered, there may be problems with accessing the area to carry out the work.

2.1.3 Rendering
It may be practicable to increase the cover by building out the face of the concrete with a polymer-modified render, although it is important to ensure an adequate key by removing the surface laitance and achieving a rough surface using wet grit blasting. Depending upon the protective properties of the render, it may be possible to reduce the thickness of the cover while still providing the same degree of protection.

2.1.4 Protective Coatings
By far the easiest and most cost effective way of enhancing cover is to use protective coatings. These will not only compensate for the low cover but also provides additional aesthetic and protective properties. But when selecting a coating system care must be taken to assess the film thickness required providing the necessary protection. In addition, the coating must be compatible with the substrate and its surroundings, and the product's expected lifespan should be considered in-conjunction with regular maintenance so ensure the coating performs for its anticipated lifecycle.

The system must also be backed up by relevant independent test data and approvals.

3. Common Causes
3.1 Chloride Induced Corrosion
To use a well-known analogy, if a chloride ion were the same size as a tennis ball, then a capillary pore within even good-quality concrete would be the size of a railway tunnel (the radius of a chloride ion is 1.8×10^{-10} m. The critical radius of the smaller capillary pores in concrete is 2.0×10^{-8} m. The diameter of a tennis ball is 67mm therefore multiply this by the difference in size (100) and you get 6.7m, which is certainly the size of a railway tunnel). Therefore, when concrete structures are exposed to salt spray in marine environments, chloride ions easily penetrate the concrete, eventually reaching the steel, breaking down the passivating layer and causing corrosion, even under highly alkaline conditions. Corrosion most rapidly occurs in the splash zone where the wet/dry conditions exacerbate chloride penetration and there is enough oxygen to facilitate the corrosion process.

Figure 1. Result of chloride attack on a wharf structure,

3.2 Carbonation Induced Corrosion
The carbon steel of rebar is protected from oxidation by atmospheric oxygen by the high pH of concrete interstitial water. The rebar surface is passivated as long as the pH value is higher than 10.5. Fresh cement water has a pH of about 13.5 while evolved cement water pH ~ 12.5 is controlled by the dissolution of calcium hydroxide. Carbon dioxide present in the air slowly diffuses through the concrete and progressively reacts with the alkaline hydroxides (KOH, NaOH) and with calcium hydroxide leading to the carbonation of the hydrated cement paste. As a result, the pH of the cement drops and when its value is below 10.5, the steel surface i.e. the rebar, is no longer passivated and starts to corrode.

Figure 2. Carbonation induced spalling.

4. Cementitious Coatings – Solutions for low cover
To achieve these barrier properties required to protect the rebar encased in concrete, the technology of cementitious coatings uses a number of different mechanisms to minimise both the porosity and permeability of what is essentially an ultra-thin but highly modified section of concrete. Low water:cement ratio and the use of pozzolanic materials such as fly ash, which react with the lime from the cement hydration to form further hydrates, reducing pore size, while micro-glass fibres dramatically reduce permeability. However the most influential raw material is silica fume, which is a byproduct of ferro-silicon steel production and is commonly referred to as a super-pozzolan due to its high reactivity with lime. It is 100 times finer than cement and contains material in the nano-particle range, which is capable of blocking the finest pores in the cement matrix. Many investigations have documented the dramatic reduction in the rate of chloride diffusion that can be achieved by incorporating silica fume into concrete [1,2], which is largely attributed to the refinement of the pore structure. This modification in the pore structure also affects other properties resulting in a 2mm film resisting water under 10 bar hydrostatic pressure (100m head of water). Gas diffusion resistance is also enhanced so that 2mm of silica fumed concrete will provide the same resistance to carbon dioxide as 100mm of good quality concrete.

Polymer coatings such as epoxy can also provide a suitable solution for low cover, however cementitious coatings have the application advantages of bonding to damp and green concrete thus shortening application and return to service intervals.

Silane technology has limited performance in tidal applications as water pressure will push the impregnant through the pore structure, effectively removing the barrier.

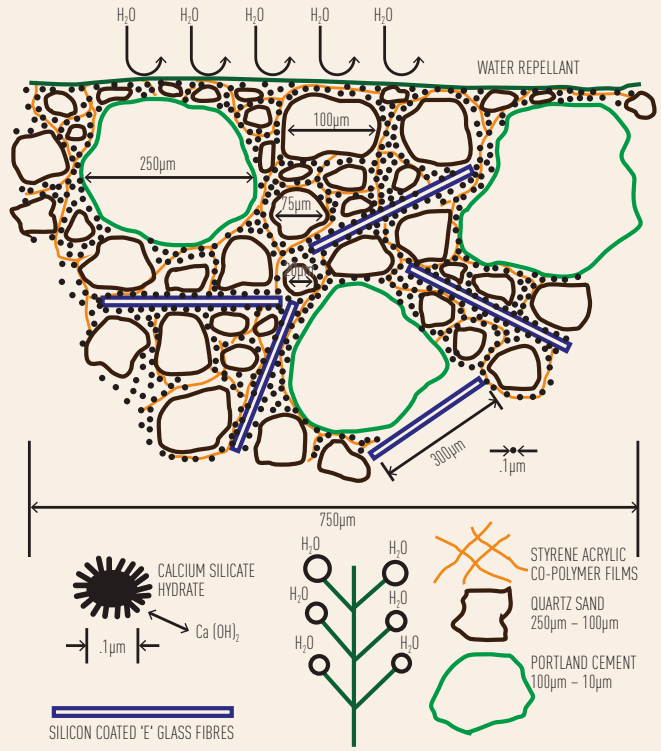


Figure 3. Schematic of Composition of Cementitious Coating.

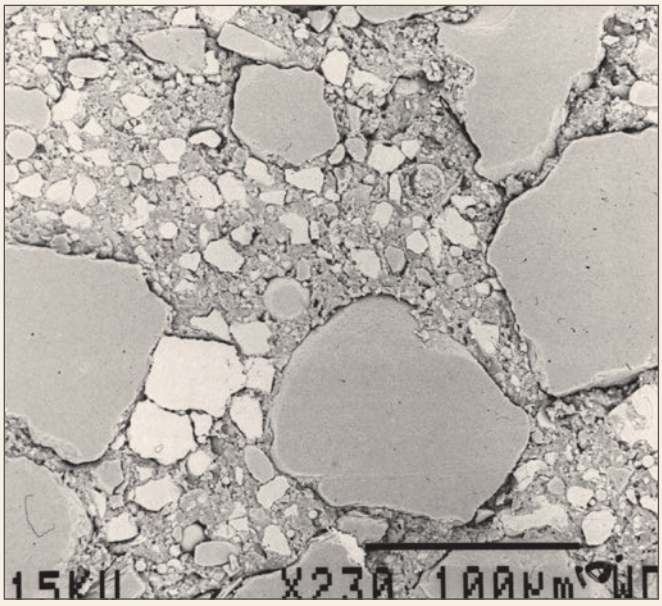


Figure 4. Microscopic View of Cementitious Coating.

5. Performance of Cementitious coatings

As previously mentioned the two main modes of failure are carbonation and chloride attack of the rebar over prolonged exposure periods. This is obviously exacerbated with low cover issues resulting in the requirement that cementitious coatings must be shown to protect against these corrosive mechanisms. There are two relevant tests that can show this and can be used as a type of prequalification.

5.1 Chloride Diffusion Test

One such test for chloride diffusion began in 1988 initiated by Taywood Engineering (then Taylor Woodrow International and now VINCI Technology Centre).

5.1.1 Test procedure

Two coats of the cementitious coating, each approximately 1mm thick were applied to one surface of a concrete slice using a palette knife. After this layer had cured for about 2 hours at 23°C and 60±5% relative humidity the second coat was applied at right angles. The coated specimen was then left to cure for 28 days under the same conditions prior to testing.

The coated specimen and an uncoated control had their top and bottom faces masked with plastic and tape respectively. They were then placed in individual moulds and the edges sealed with a cold curing epoxy resin. After allowing the resin to cure overnight, the specimens were immersed in a saturated calcium hydroxide solution for 4 days. This was carried out to avoid anomalous effects due to chloride ingress by sorption rather than diffusion. Each specimen was the mounted in a diffusion cell as shown in Figure 7.

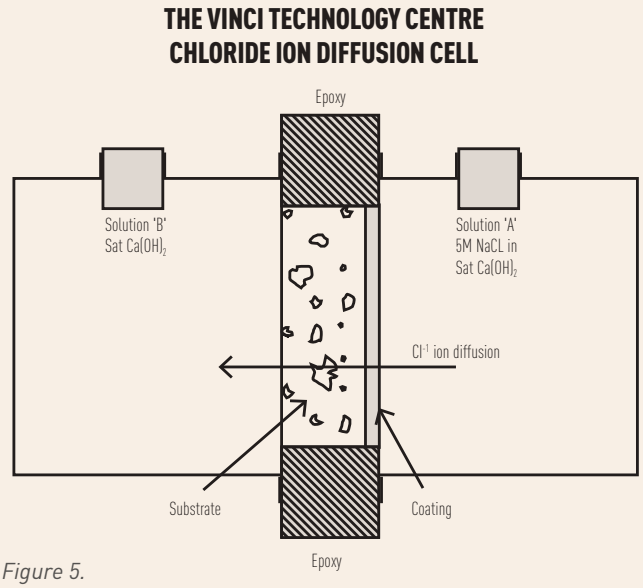


Figure 5.

The cells were maintained at 23±2°C and the chloride diffusing though the specimens was determined at suitable intervals. An aliquot of each sample was accurately pipetted into a clean oven dried glass container. Nitric acid (approximately 50-70cm^3) was added to the sample, which was then left to stand with occasional stirring. Automatic potentiometric titration with continuous stirring was used to analyse the samples. The titrator used was a Metohm 798 MPT Tritrino and the course of the titration was monitored using a Metrohm electrode system. The accuracy of the method was checked using control samples of known chloride content (0.10±0.01%, by weight of sample). The above titration was carried out in general accordance with UKAS approved in house Test Procedure TP1303/90/4670, Issue 11.

5.1.2 Test Results

The following graphs Figure 8 & Figure 9 show the results from the titrations described above.

Figure 6. Chloride Ion Diffusion.

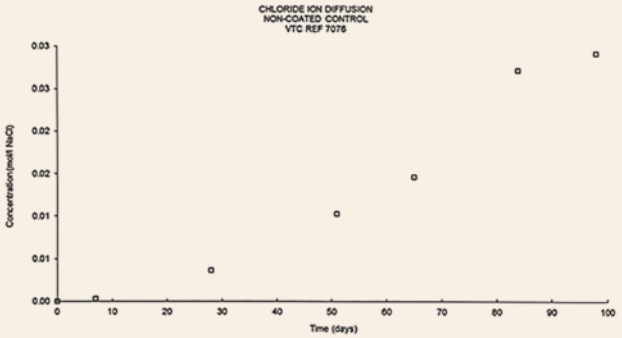


Figure 7. Chloride Ion Diffusion non coated control.

The cementitious coating has been on test for a period of 9484 days and counting (approximately 26 years). To allow the calculation of Chloride Ion Diffusion Coefficient, CIDC, to be calculated, the chloride concentration must attain a steady state which is deemed when reaching >0.1 M. After 9484 days of the test, the chloride concentration was only 0.0039 M, so no CIDC could be calculated. Results can be seen in Table 2 below.

Sample Ref	Cementitious Coating	Un-coated control
Substrate thickness (cm)	1.414	1.465
Coating thickness (µm)	2100	n/a
Test area (cm^2)	78.54	78.54
Chloride ion diffusion coefficient (cm^2s^{-1})	n/a	1.03×10^{-8}

Table 2. Chloride Ion Diffusion Coefficient results (After 26 years on test).

Although no CIDC could be calculated it can be stated that the cementitious coating on test proved a very good barrier to the ingress of chloride ions. The non – coated sample had reached a steady state after 98 days and the CIDC has been calculated.

5.2 Carbon Dioxide Diffusion Coefficient
One such test for carbon dioxide diffusion was carried out in 2007 initiated by Taylor Woodrow Technology.

5.2.1 Test procedure
Taylor Woodrow Technology supplied four standard unglazed ceramic tiles 100x800mm for coating with the cementitious coating. Two coats of the cementitious coating, each approximately 1mm thick were applied to the test specimens using a palette knife. After this layer had cured for about 2 hours at 21°C and 60±5% relative humidity the second coat was applied at right angles. The coated specimen was then left to cure for 21 days under the same conditions prior to testing.

The coated samples were allowed to condition at 23°C and ambient relative humidity at the test house prior to testing.

One coated tile was sealed in a circular steel rig such that the coated and uncoated faces were exposed. Due to the cementitious nature of the coating, oxygen at a known pressure and flow rate was passed over the coated face of the plate and helium gas was passed over the uncoated face at the same pressure and flow rate. The helium gas stream was continuously monitored by gas chromatography to analyse for oxygen. Equilibrium conditions were achieved after approximately 24 hours and the steady state flux was then calculated from the percentage of oxygen in the helium stream and the flow rate of gas.

The diffusion coefficient for oxygen (DO_2) is calculated using Fick's Law of Diffusion and Crank's equation.

Due to the cementitious nature of the coating, the testing was undertaken using oxygen and results converted for use with carbon dioxide using the following criteria;

*$DCO_2 = 0.316\ DO_2$

*This equation has been derived from measurements of oxygen and carbon dioxide diffusion coefficients conducted with non-cementitious coating systems [3].

It is assumed that the relationship is valid for polymer modified cementitious materials such as that tested. This assumption is made as a direct relationship of DO_2 and DCO_2 is not available for polymer modified materials – direct measurement of DCO_2 cannot be carried out on such materials due to interference from the carbonation reaction.

5.2.2 Test Results
The results of the testing are tabulated below.

$DCO_2(cm^2s^{-1})$	8.02×10^{-6}
µ-value	1.86×10^{-4}
R (m)	39
S_c (cm)	10
Mean Dry Film Thickness (DFT) (µm)	2121

Table 3. Carbon Dioxide Diffusion Coeffficient.

Notes:
The equivalent air layer thickness (R-value) is calculated for the measured thickness of the specimen as follows;

µ-value = $0.149/ DCO_2$ R-value = µ x specimen thickness (m)

DCO_2 and the diffusion resistance coefficient (µ-value) are calculated using the mean DFT measured on a spare unused specimen.

DCO_2 for an uncoated plate was 1.0×10^{-3} cm^2s^{-1}.

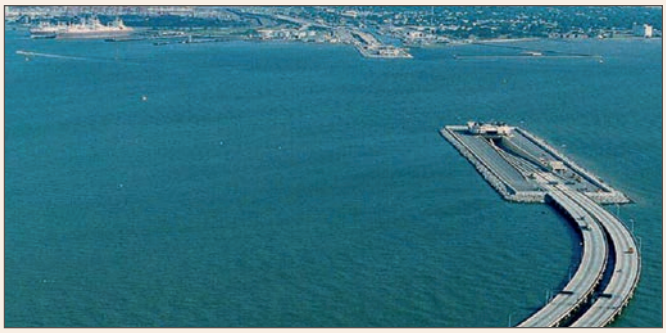
The equivalent thickness of concrete (S_c-value) is calculated for the measured thickness of the specimen as follows:

µ-mortar x specimen thickness (cm) = µ-concrete x Sc where the µ-value for an average grade of concrete is taken to be 400 (µ-concrete)

Klopfer criterion for effective anti-carbonation coating is R greater than 50 metres.

EN 1062-6 Classification C1 for Carbon Dioxide Permeability requires SD value greater than 50 metres.

6. Example projects
6.1 Øresund Tunnel, (links Denmark & Sweden)



Figures 8 & 9. Øresund Tunnel Completed.

Low cover undermined the integrity of the precast segments, with additional concerns regarding potential of chloride induced corrosion. Segments weighed 55 tonnes, with the segments towed out and sunk into position. Cementitious coatings were chosen to increase the effective cover due to the coatings ability to resist up to 10 bar head of hydrostatic head of water pressure (positive and negative) and resistance to chlorides and carbonation, with the cementitious coatings applied in the casting yard.

6.2 Gorgon LNG Caissons, Australia

Figures 10 & 11. Gorgon LNG Concrete Caissons.

Cementitious coatings were chosen to reinstate the effective concrete cover on new caissons for the LNG jetty and ensure the design life of the structure is maintained. The poured in-situ segments had insufficient cover over the reinforcement and there was a concern over long term durability with the segments exposed to seawater ingress. Silane technology was not considered as the coating needed to be submerged and resistance to hydrostatic head of pressure was required.

7. Conclusions
Correctly formulated and tested cementitious coatings can present an ideal solution to non-conformance of concrete cover within specifications. Not only do they reinstate cover, they also provide structures with additional protection against carbonation, de-icing salts, water and chloride ion penetration. This allows the life span of the structure to be achieved or extended.

8. Acknowledgements
Graham James and Christopher Lloyd, Flexcrete Technologies, Leyland UK.

9. References
[1] Richard J. Kessler, Rodney G. Powers (retired) and Mario A. Paredes, Florida Dept of Transport – Corrosion Research Laboratory "Performance of Corrosion Prevention Methods – 18 year study" NACE Corrosion Conference & Expo 2009 Paper No 09219

[2] Fabio Bolzoni, Marco Ormellese and Andrea Brenna, Politecnico di Milan, Dept.CMIC "Efficiency of Concrete Coatings on Chloride-induced Corrosion of Reinforced Concrete Structures" NACE Corrosion Conference & Expo 2011 Paper No 11001

[3] H.L. Robinson "Evaluation of Coatings as Carbonation Barriers". Construction Repair, February 1987 pp 12-17.

INTERESTING CORROSION PHOTOS

Photos taken by Ian MacLeod of a corroded sign at Cook on his way across the Nullarbor via train.

Almost without fail a coating system has some form of carrier in the form of a solvent or a plasticiser or a catalyst to bring about the necessary transformation from oligomer to polymer. When the lead-based paint was applied to this ***Evacuation Point*** sign at the Cook railway station (population 4) the sign was smooth and professional but periodic rain, high day-time temperatures and freezing nights caused the steel substrate to expand and contract day after day until microscopic cracks began to appear on the surface. As water penetrated the surface the ubiquitous red dust was attracted to moisture laden fronts of decay and this provided micronutrients for hungry bacteria, yeasts, moulds and fungi. The uneven molecular weight distribution of the components of the paint began to react differently with the sunlight and moisture and acidity from the microflora. Gradually the patina of decay emerged until it was captured with a camera. Some fraudulent antique dealers use accelerated ageing techniques to obtain similar surfaces which add age and apparent authenticity to their items. Caveat Emptor! No coating system will last forever but with good maintenance and appropriate protection from a UV absorbing topcoat much of this damage can be avoided.

So we give thanks for all members in the coatings profession and we use this image of a reminder of the bad old days before the ACA team came on board - IMAC

Barge gets a new life

After 20 + years at sea, this Mooring Barge, North Island, New Zealand, needed a birthday. The owner stripped all that he could, made some repairs, then asked for his barge to get a new lease of life.

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CORROSION & MATERIALS

NOVEMBER (CONCRETE & C&P2016 FEATURE)	FEBRUARY 2017 (OIL & GAS FEATURE)
Booking Deadline 23 September	Booking Deadline 15 December 2016
Material Deadline 30 September	Material Deadline 19 January 2017
Publication Date 28 October	Publication Date 16 February 2017

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