CORROSION

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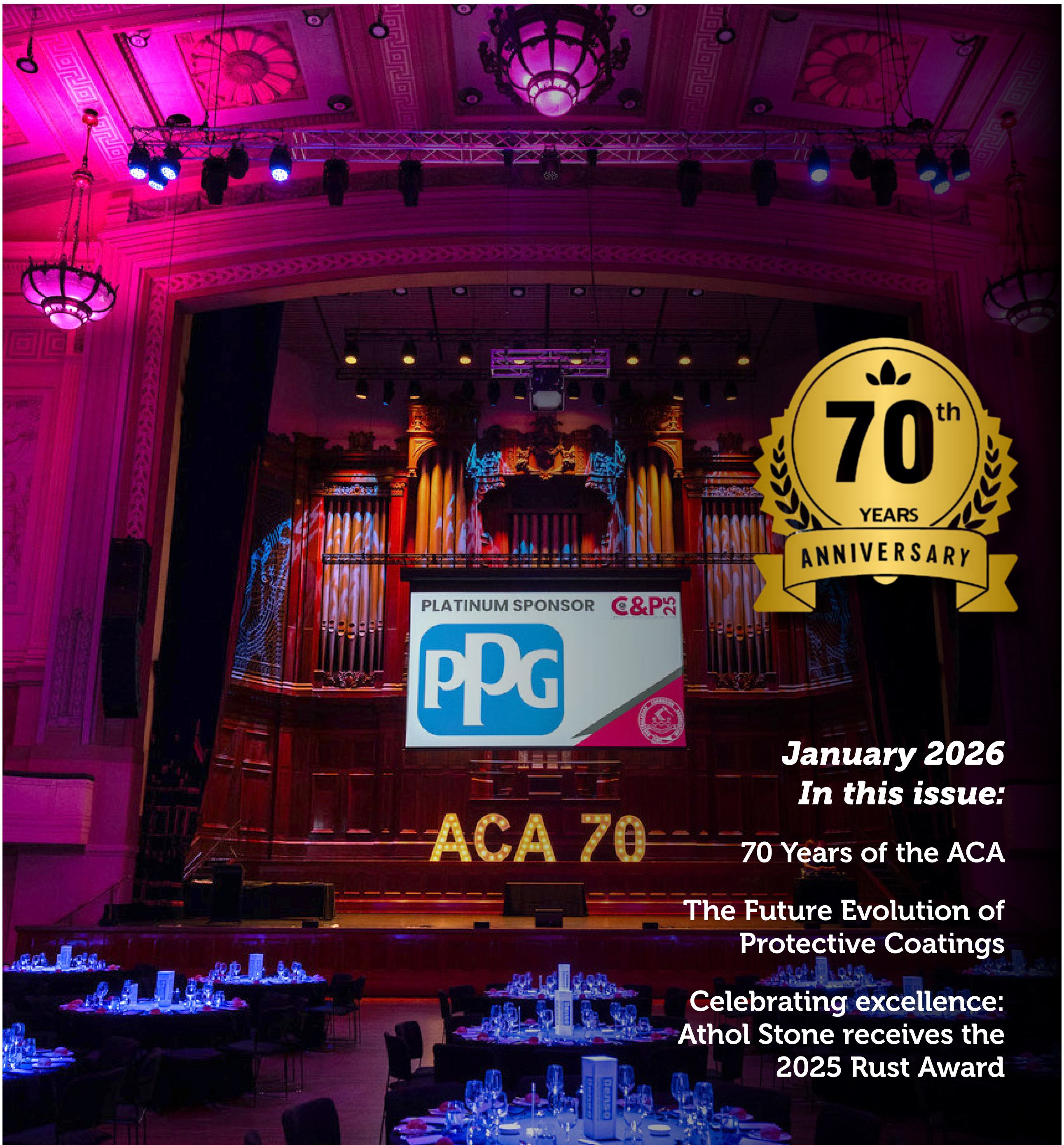
& Materials



MATERIALS PROTECTION FOR THE FUTURE

AUSTRALASIAN CORROSION ASSOCIATION LTD

Official Publication of The Australasian Corrosion Association Ltd

Dear ACA Members,

It was a pleasure to see so many of you at Marvel Stadium in Melbourne for the C&P Conference in November.

On Sunday 9 November, we held the ACA Board and Council Meetings, along with a Special General Meeting of members. I was pleased to see strong support for our new ACA Ltd Constitution. We now begin establishing the new Company Limited by Guarantee, with the major change occurring in June 2026 when all ACA members will be invited to vote for ACA Board Directors. The new Constitution and Bylaws are available on our website.

Thank you to our Conference Technical Co-Chairs, Oscar Dyvestyn and Austin Bennett. The technical program was exceptional, with more than 90 papers submitted.

I also acknowledge our outgoing President, Raed El Sarraf, for his leadership throughout the year—particularly in strengthening collaboration between the ACA Board and Council. We welcome incoming Council President, Ramon Salazar Romero, and look forward to continuing this positive momentum.

My thanks to the ACA Board for their outstanding voluntary contribution in 2025. This has been the most productive year I have seen in my eight years on the Board. Congratulations to Dr Patricia Shaw, newly elected Vice Chair, and welcome to Mike Tan, appointed as a new Director in November.

I am honoured to have been elected Chair of the ACA Board until my term concludes in June 2026. I encourage members to consider nominating for the four Board Director roles that will become available at that time.

Finally, sincere thanks to our outgoing CEO, Maree Tetlow, for her leadership over the past three years. The ACA is in a significantly stronger position today than in 2022. We look forward to welcoming our new CEO, David Roche, who joined us in mid-December.

David brings extensive experience across commercial, government and not-for-profit sectors, with senior leadership roles at the Gastroenterological Society of Australia, Dairy Australia, and the Victorian Department of Infrastructure. His consulting background includes work with Boston Consulting Group, Partners in Performance, and Arthur Andersen. With qualifications in science, business and finance, David offers strong strategic and operational expertise—from major infrastructure projects to on-site performance improvement in mining and manufacturing. He is committed to supporting members, fostering collaboration, and advancing corrosion science and asset protection.

Wishing all members a happy and healthy summer holiday season.

Kingsley Brown

ACA Board Chair

Feature: Materials Protection for the Future

Reports

Industry News

Training News

Feature: Materials Protection for the Future

Feature

Member Benefits

Plenary Papers

Greetings Fellow Corrosionists,

As I reflect on the past year, I would like to close my term by saying how rewarding it has been to serve our Association during a period of strong engagement and change.

Our Melbourne conference was a genuine highlight of the year for me, a great opportunity to reconnect with colleagues, share ideas, and be reminded of the strength and depth of expertise within our community. The quality of discussion, technical content, and collegial spirit reinforced the value of coming together in person.

I am also pleased that, after considerable effort and collaboration, we were able to progress to formally finalise and ratify our Association's updated Constitution. This was an important milestone and one that positions the ACA well for the future.

As I hand over the role, I would like to wish the incoming President, Ramon Salazar Romero, every success. I am confident he will lead the Association with energy, commitment, and a clear vision for what lies ahead.

I would also like to acknowledge Maree Tetlow, who has recently concluded her role as CEO. Her guidance, professionalism, and steady hand have been instrumental in supporting the Board, Council, and broader membership, and I thank her sincerely for her service to the ACA.

At the same time, I warmly welcome David Roche as the new CEO of the ACA. I look forward to seeing the Association continue to grow and evolve under his leadership.

My thanks also go to Kingsley Brown, Board Chair, for his leadership, support, and sound counsel throughout my term.

Finally, thank you to the Board, Council, the ACA Centre team, and you, the members, for the support, trust, and camaraderie over this period. It has been a privilege to serve the Association.

With appreciation, and farewell.

Raed El Sarraf

ACA 2025 President.

Incoming CEO Message – David Roche

As I step into the role of CEO of the Australasian Corrosion Association, I want to recognise the strong foundation built by Maree Tetlow, our volunteers across the Board, Branches and committees, and the ACA team. The direction set in recent years, and the structures now in place, provide a sound platform for the next phase of the Association's work.

Before formally commencing, I attended the recent Conference, AGM and Special Meeting. I was struck by the depth of technical knowledge on display, the practical focus on improvement, and the professionalism of the event. It was also encouraging to meet asset owners attending for the first time, including from overseas, who spoke positively about the capability and expertise within our region and their intent to engage more deeply.

Looking ahead, my focus is straightforward: to work closely with the Board, Council, Branches, members and partners so ACA continues to both grow and strengthen its value to members and its contribution to safer, more reliable assets. That means supporting a strong technical programme, making it easier for members to connect and share good practice, and continuing to lift awareness of corrosion as a material risk that can be managed well.

I look forward to meeting more of you over the coming months and learning directly from your experience across the industry. Feel free to reach out to me at David.roche@corrosion.com.au

Thank you again to Maree for her contribution in building and leading the Association and its team.

David Roche

Chief Executive Officer
Australasian Corrosion Association

Dear ACA Members

Thank you to all ACA members who contributed to a successful Corrosion & Prevention Conference at Marvel Stadium in November 2025.

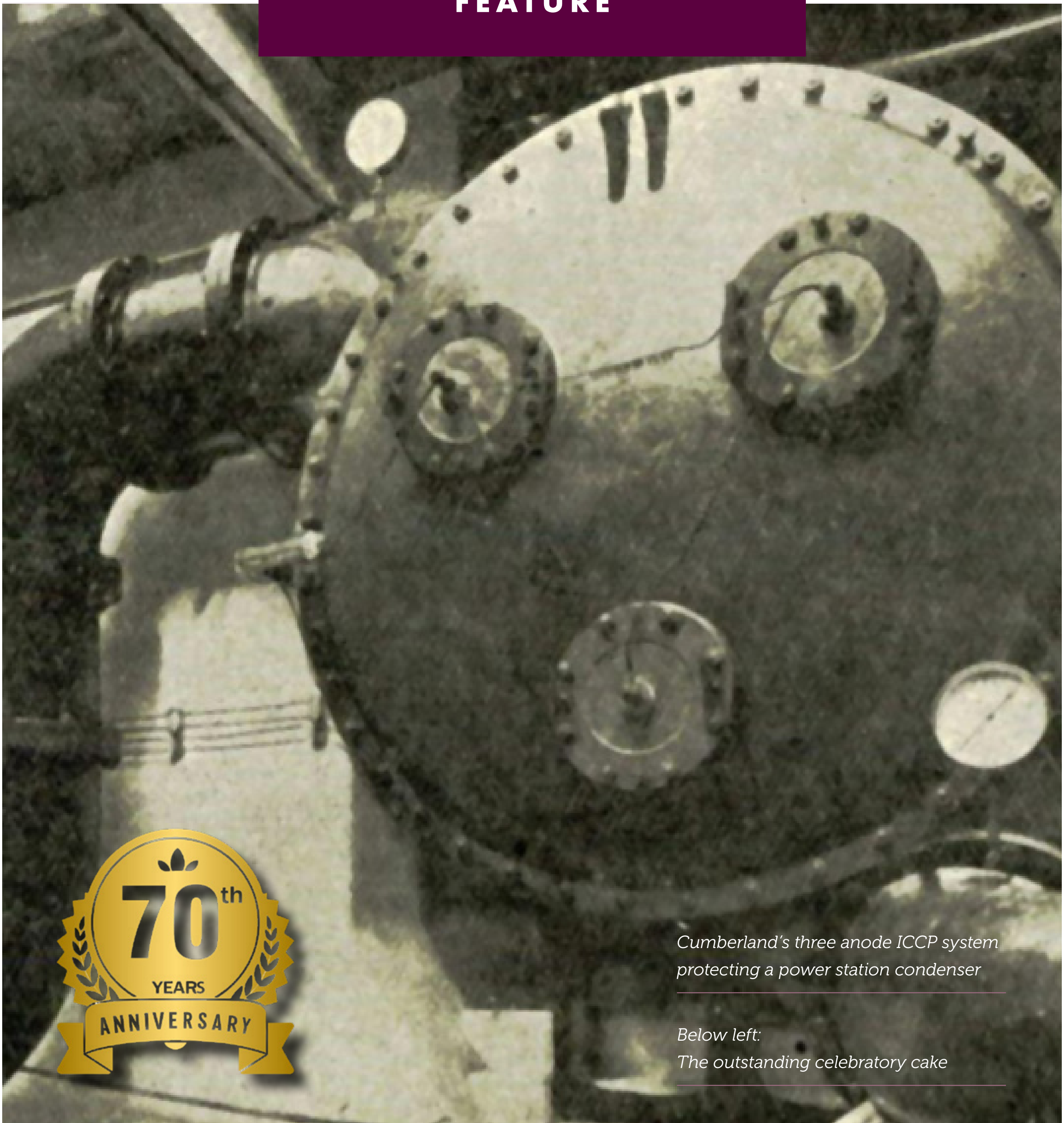
We welcomed more than 20 asset owners to the Asset Owners Program on Monday, 10 November, and hosted primary and high school students on Tuesday, 11 November. Their enthusiasm for the science projects and demonstrations brought great energy to the exhibit hall—and perhaps revealed some future corrosionists.

This year's conference was particularly meaningful for me as my final major event before stepping down in mid-December. I'm pleased to welcome David Roche as my successor; he will be an excellent leader for the ACA's next chapter.

Thank you for your support over the past three years as CEO. I look forward to staying in touch in some way.

Maree Tetlow

ACA CEO



Cumberland's three anode ICCP system protecting a power station condenser

Below left:
The outstanding celebratory cake

70 years of the ACA

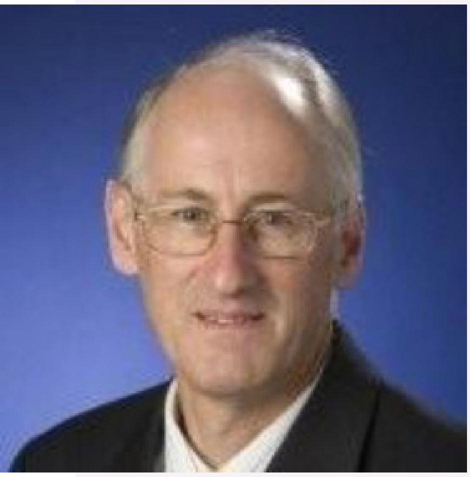
In 2025, the Australasian Corrosion Association Inc (ACA) celebrated 70 years of history.

The seeds of the Association were sown in Australia in late 1954 when the Victorian State Electrolysis Committee decided that problems connected with cathodic protection could be solved by widening discussion to include the advice and cooperation of representatives from greatly differing disciplines.

A meeting was held and the motion passed that an Association be formed to deal with corrosion and that a committee within the structure of such an Association be set up to co-operate with the Electrolysis Committee in the matter of stray current electrolysis" This action led to a series of events which decided the whole future of the Association.

In 1955 the number of people interested in an Association was 50 - today we have nearly 1300 people as members of the ACA. A brief early history is noted below:

1955	(March) Formation of the Melbourne Branch of the Australian Association for Corrosion Prevention (Mr A. F. Dunbar).
1956	Formation of the Sydney Branch of the AACP (Cdr. J. F. Bell) (NOVEMBER)
1957	"Australian Corrosion Engineering" became the Official Journal of the Association.
1958	Formation of the Brisbane Branch of the AACP (Mr M.A. Simmonds) (SEPTEMBER)
1959	Melbourne Branch acted as Interim Federal Body to amalgamate the three branches.
1960	(November) The First ANNUAL CONFERENCE held in Melbourne.
	Amalgamation of branches in Australia and Corrosion Prevention Association in New Zealand (represented by the late Mr A.S. Partridge) discussed at Council Meeting resulting in the combination of four branches Victoria, N.S.W., Queensland and N.Z. to form the AUSTRALASIAN CORROSION ASSOCIATION (Mr C. G. Robilliard)
1961	(June) Formation of the South Australian Branch (Dr W. T. Denholm) (October) Formation of Division in West Australia by Victorian Branch
1962	Formation of the West Australian Branch (Mr P. J. Hill) (APRIL)
	Australasian Corrosion Association NZ Branch Incorporated was registered as an Incorporated Society in New Zealand.
	(May) Formation of Division at Illwarra by N.S.W. Branch.
1963	(April) Formation of Division and Branch in Newcastle by N.S.W. Branch
1971	Formation of Division of Tasmania by Victorian Branch
1972	Formation of the Tasmanian Branch.



With four decades of expertise in atmospheric corrosion and protective coatings, Dr Rob Francis is a leading authority in corrosion mitigation.

Presentation: Local Corrosion Legends

Presented by Dr Rob Francis

Australia has made a number of important contributions to corrosion and its control. Following are five legends from Melbourne who have left their mark on the corrosion industry locally and globally.

One of the earliest breakthroughs came from *Elliott Cumberland* (1872–1933), based initially in St Kilda. In 1908, he developed the first commercial Impressed Current Cathodic Protection (ICCP) system, using iron anodes powered by a low voltage power supply to protect submerged boiler and condenser components. Initially applied to local steamships and later to power stations in Sydney, Elliott even proposed its use for internal water pipe corrosion in Kalgoorlie—though this idea wasn't adopted. He moved to the UK, founding the *Cumberland Engineering Company*, which continues to operate today. His system was embraced by both naval and civilian fleets across the UK and Europe, and he became wealthy enough to own property on a Surrey golf course—where a tournament still bears his name.

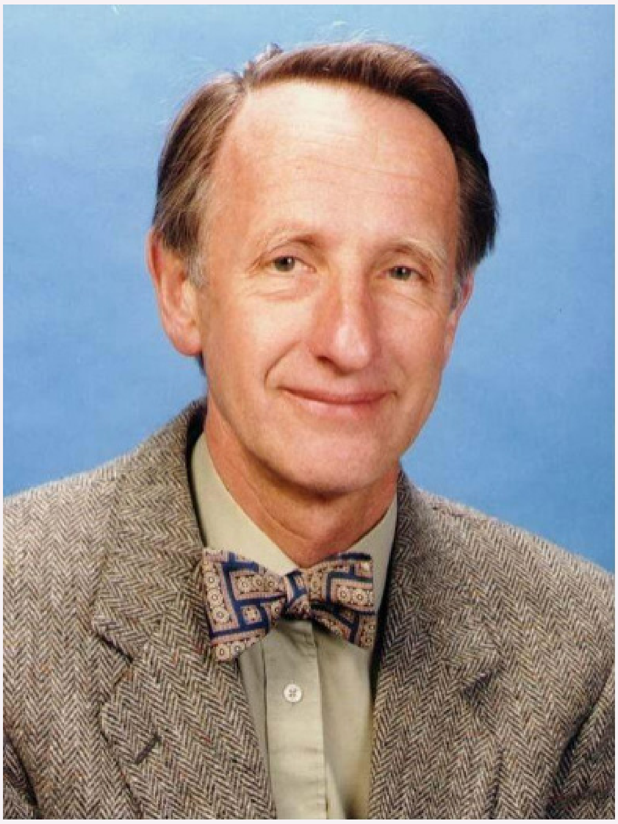
Another legend, *Victor Nightingall* (1881–1947), worked from his home in Heidelberg, where he experimented with zinc dust and sodium silicate in an effort to create "artificial rock." This led to the invention of inorganic zinc silicate coatings. In 1939, he established the Dimet company, and his product "Galvanite" was used extensively on the Morgan–Whyalla pipeline, constructed in the early 1940s to provide water for the steel plant at Whyalla. The Engineering and Water Supply Department tested numerous coatings at the time and famously declared, "Nothing can hold a candle to Galvanite." Today, his innovation protects millions of square metres of steel, either as single coat or part of a coating system. The ACA "Victor Nightingall Award" is in recognition of distinguished achievement in the protective coatings industry.

The Morgan-Whyalla pipeline was the first major structure coated with inorganic zinc silicate.

P F Thompson carrying out a demonstration in the 1920s.

Percival Faraday Thompson (1884–1951) made his mark by demonstrating the existence of a passive film on stainless steel in 1925 using electrochemical methods. His career spanned the Metallurgy Department at Melbourne University (1918–1941) and later CSIR, RAAF, and CSIRO at Fisherman's Bend (1941–1951). During World War II, he discovered that an inhibitor used in aluminium aircraft cooling tubes actually accelerated corrosion. Known for his emphasis on practical demonstrations, P F Thompson was one of Australia's first corrosion experts. His middle name, "Faraday," was inspired by his father's passion for electrical instruments and science, and there is a collection of his electrical instruments at the Melbourne Museum. Each year, the PF Thompson lecture is given by a person who has made a significant contribution to corrosion science and engineering in Australia.

In more recent history, *Brian Cherry* (1935–2018) quantified the economic impact of corrosion in Australia, estimating it at around 1.5% of the Gross National Product. His findings highlighted the immense savings possible through corrosion control. Joining Monash University's Engineering faculty in 1970, Brian mentored generations of corrosion scientists and engineers and gained international recognition for his work, particularly in the field of reinforcement corrosion in concrete. He received numerous awards and served as editor of Corrosion & Materials. The Brian Cherry Awards Forum is conducted annually for final year undergraduate and postgraduate students who are studying any aspect of corrosion.



Brian Cherry

Finally, *David Whitby* (1946–2000) played a pivotal role in promoting the Australasian Corrosion Association (ACA) as a professional society. In 1974, he founded AMAC Corrosion in Bayswater, producing CP anodes. In 1997, AMAC supplied 73,000 anodes for Libya's Man Made River project, the world's largest irrigation initiative. David Whitby championed young researchers through the AMAC award and leveraged Cherry's report to secure Victorian government funding for a Corrosion Centre. His efforts fostered ties with NACE, enabled ACA to hire full-time staff, and culminated in an international conference in Melbourne in 1996. The David Whitby Best Review Paper is awarded annually at the ACA conference.

David Whitby presenting the AMAC award to Xiaoyi Xu in 1994.

The Future Evolution of Protective Coatings

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ABSTRACT

The protective coatings industry is undergoing significant transformation driven by three key evolutionary trends: efficiency optimization, sustainability imperatives, and future-proofing requirements. This paper examines contemporary challenges and upcoming future trends in protective coating technologies, focusing on coatings and coating systems that enable material protection and enhanced performance. The analysis reveals critical developments in digital printing applications eliminating masking requirements, room temperature curing systems reducing energy consumption, transition from two-component to one-component systems for simplified application, and plant-based raw materials achieving significant bio-content while maintaining high performance. Sustainability initiatives include mass balance approaches enabling drop-in replacements, waste and emission reduction strategies, and energy use optimization. Future-proofing trends encompass haptic coating technologies engaging tactile senses, new adhesion solutions for composite substrates and zirconium-based pretreatments, and service life enhancements through engineered longevity solutions. Case studies demonstrate practical applications including infrastructure projects achieving 25-30 year service life extensions and high-performance coating systems enabling faster return-to-service times while reducing labor costs that constitute over 60% of contractor basis costs.

INTRODUCTION

The future evolution of protective coatings encompasses primarily coatings and coating systems that enable material protection and/or enhanced performance. This analysis focuses specifically on technologies and chemistries, rather than enabling or adjacent technologies, to provide a comprehensive examination of the core developments shaping the industry.

Contemporary challenges and upcoming future trends are examined through the lens of three key buckets of trends that define the trajectory of protective coatings development: efficiencies, sustainability, and future-proofing. These interconnected themes represent the fundamental drivers that coating manufacturers, formulators, and end-users must navigate to remain competitive and compliant in an evolving market environment.

The protective coatings industry operates within the context of several broad megatrends affecting all market spaces, including increased urbanization, climate change, demographic change, and population growth. These overarching trends create specific pressures and opportunities that manifest in the three key areas of focus for this analysis.

Efficiency considerations encompass both performance optimization and cost reduction strategies, recognizing that modern protective coating systems must deliver superior protection while addressing economic realities. Sustainability has emerged as a critical innovation driver, encompassing raw material sourcing, manufacturing processes, application methods, and end-of-life considerations. Future-proofing addresses the need for coating systems that can adapt to changing substrate materials, evolving performance requirements, emerging surface preparation methods, and application methods.

DISCUSSION

Efficiency Trends in Protective Coatings

The efficiency bucket is shaped by several critical drivers that reflect both economic pressures and operational requirements in the modern coatings industry. Onshoring and reshoring initiatives, combined with a lack of skilled labor, have created significant pressure to reduce labor costs, which constitute over 60% of contractor basis costs. Additionally, the imperative to maximize durability and longevity focuses on optimizing total cost effectiveness measured in dollars per square metre per year.

Digital Printing Applications

Digital printing technology represents a significant advancement in coating application efficiency by eliminating masking requirements and reducing waste. A ubiquitous area of use would be in high end custom flexible packaging and signage. Current applications in automotive and aerospace sectors for applying graphics demonstrate the technology's viability, with future potential for painting full parts or infrastructure components. This method employs an "inkjet on steroids" equipment type which sprays minute droplets of coating on to the surface. The outcome is substantial labor reduction from both masking and painting processes, addressing the critical need to minimize the dominant labor cost component in coating applications.

Room Temperature Curing Systems

The transition from oven-cured to room temperature curing systems addresses multiple efficiency challenges simultaneously. Current bake ovens employed to cure high-performance coatings require additional assets, extra production steps, and extended processing time. Reactive coating systems can be tuned to meet future efficiency requirements of new production lines, eliminating ovens or infrared curing equipment entirely.

Future production lines designed around room temperature curing systems would achieve higher nameplate capacities i.e. higher throughput than the original facility or line design rating . The outcome includes shorter cycle times, smaller production footprints, and reduced material handling requirements, collectively contributing to significant operational efficiency gains.

One-Component versus Two-Component Systems

The ongoing transition from two-component (2K) to one-component (1K) systems addresses complexity and waste reduction while maintaining high performance characteristics. While 2K systems deliver superior performance, they require extensive personnel training both from the standpoint of health and safety as well as learning the math and procedure for mixing the two components at the correct mix ratio. Additionally, 2K systems have a limited pot life, creating operational challenges and material waste.

The industry's desire for 2K properties in 1K coating systems has driven emerging developments in acrylic, polyurethane, and silane-terminated prepolymer technologies. These advances move toward simplified application for under-skilled workforces which would reduce possible mixing and off-ratio errors while reducing waste and increasing service life, with future developments potentially enabling even more automated application processes.

Fast-Curing High-Build Coatings

Polyaspartic coatings represent a significant advancement in efficiency through faster curing and higher film build capabilities. Current applications in building and construction on metal and concrete substrates demonstrate excellent substrate protection with fast return-to-service times. Continued refinements and optimization are expected due to favorable speed, film build, durability, and color/gloss advantages.

The adaptability of polyaspartic systems to future substrates, including composites, positions this technology for expanded applications. The outcome includes faster cure and return-to-service times, higher film build per coat, and the ability to reduce the number of coats and associated labor requirements.

Case Study:
U.S. Bank Stadium Structural Steel Project

The Minneapolis stadium project demonstrates practical efficiency gains through advanced coating systems. The roof trusses covering a 38-acre footprint required coating to meet engineering specifications originally calling for a two-coat system. By utilizing a single coat of fast-curing 2K direct-to-metal polyaspartic coating for shop application and similar field joinery treatment, the project achieved significant labour savings eliminating extra coating layers and fast cure characteristics (Figure 1).

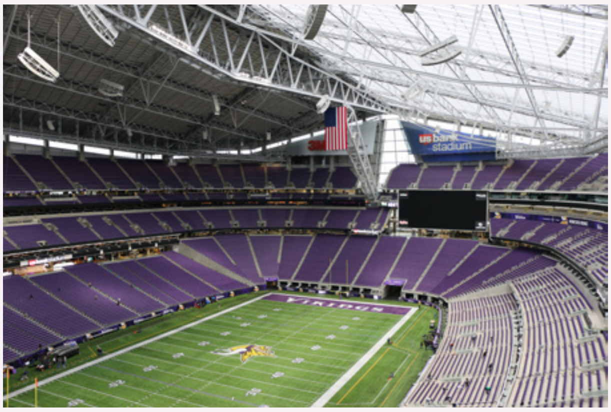

Figure 1. Vikings Stadium, Minneapolis

Case Study:
Commercial Flooring Application

The Springhouse Market and Bakery project in Eighty Four, PA, illustrates efficiency gains in commercial flooring applications. The existing sheet vinyl floor with peeling seams required replacement with a seamless, easy-to-clean surface within a 2.5-day service window. Surface preparation to ICRI CSP3 standards was followed by application of pigmented 2K polyaspartic basecoat, colour chips, and clear 2K polyaspartic topcoat achieved necessary film build in two coats, reducing project time and enabling return to service in 2 days (Figure 2).

Figure 2. Finished polyaspartic floor

Sustainability Initiatives and Implementation

The sustainability bucket encompasses multiple drivers reflecting both regulatory requirements and market preferences. New requirements and preferences, both regulatory and perception-based, create pressure for environmental performance improvements. Economic and environmental drivers for reducing energy costs align with desires toward a circular economy focused on Scope 3 emission reductions. Additionally, reducing volatile organic compounds (VOCs) and materials of concern addresses both regulatory compliance and environmental stewardship objectives.

Plant-Based and Mass Balance Raw Materials

Innovation in plant-based resins has evolved significantly, moving beyond the historical trade-off between high bio-content and high performance properties. Continued developments now enable both significant bio-content and high-performance solutions simultaneously. The mass balance approach allows for drop-in replacement of conventional materials while maintaining traceable content through the production process.

Plant-based resins utilize unique building blocks from nature to deliver high-performance products, typically achieving bio-content levels ranging from 25-70%. Plant-based materials including tree bark, castor beans, and corn are converted into renewable building blocks, leading to various high-performance partially plant-based polymers. The outcome includes reduced dependence on fossil-based resins and associated energy savings.

Mass Balance and Segregation Approaches

Two distinct production routes enable biomass integration: mass balance and segregation methods. Mass balance involves joint processing of alternative and conventional raw materials, making it possible to verifiably attribute the share of alternative raw materials used to specific products. Segregation maintains separate processing of alternative and conventional raw materials through batch processes with verifiable bio-content.

Certification of verifiable mass-balanced raw materials according to the ISCC PLUS (International Sustainability and Carbon Certification) system provides internationally recognized sustainability certification. This framework enables customers to meet sustainability commitments while maintaining confidence in product performance and traceability.

Waste and Emission Reduction

Protective coatings contribute to waste reduction through multiple mechanisms. Aging infrastructure lifespan extension through protective coatings diverts waste streams from landfills, while future infrastructure designed with low VOC and lower Scope 3 production emission coatings reduces overall environmental impact. High-performance coatings with enhanced durability reduce emissions by eliminating multiple recoat cycles, and advances in waterborne technologies further reduce VOC and solvent emissions.

Energy Use Reduction

Protective coatings enable energy reduction through several pathways. Cool or reflective pigments and fillers incorporated into protective coatings reduce cooling loads during summer months. Reactive systems in fabrication shops allow users to eliminate drying ovens or infrared lamps, while 2K polyurea systems enable application at ambient temperatures below 32°F (0°C) for low-temperature cure, extending application seasons without supplemental heating.

Case Study:
Fort Carson Army Post Roofing

The Colorado military installation project demonstrates sustainability benefits through roof restoration rather than replacement. The concrete, foam, and metal roof system experienced extreme weather, sun exposure, and thermal movements. Rather than complete tear-off and associated waste generation, the aged roof was repaired and recoated with a two-coat high-build flexible polyurethane coating system designed for 15+ year service life. High initial and long-term solar reflectance reduced energy load for cooling in the high-elevation environment (Figure 3).

Figure 3. Recoated roof at Fort Carson

Case Study:
Louisiana School Roofing System

The Fountainbleu High School project in St. Tammany Parish, LA, addressed 115,000 square feet (10, 684 m2) of existing standing seam metal roofing in an environment experiencing high heat, torrential rains, and hurricane-force winds. Low-pressure water cleaning with biodegradable cleaner properly prepared the metal substrate for application of a three-coat system: 1K waterborne epoxy primer, 1K moisture-cure polyurethane basecoat, and 1K moisture-cure aliphatic polyurethane topcoat, demonstrating sustainable application methods and material selection (Figure 4).

Figure 4. View of recoated roofing at Fountainbleu High School

Future-Proofing Strategies and Technologies

The future-proofing bucket addresses evolving requirements and emerging challenges in protective coatings applications. Key drivers include elevated expectations in user experience, demand for more resilient infrastructure, and increased use of composites and new pretreatments in infrastructure and transportation applications.

Haptic Coating Technologies

Haptic coatings engage the sense of touch, responding to increasingly sophisticated user expectations for additional sensory experiences. One may be most familiar with the use of haptic coatings in low end or single use applications such as business cards or luxury food item packaging. Current examples exist for higher performance applications in automotive interiors and electronics applications, with future potential for application in other protective coating market spaces such as architectural applications where textural attributes may enhance user experience. The outcome anticipates increased use of tactile coatings across multiple market segments.

New Adhesion Challenges and Solutions

Modern substrate materials and pretreatment methods create new adhesion challenges requiring optimized coating solutions. Pretreatment changes such as the transition from iron or zinc phosphate to zirconium-based systems enable phosphate and heavy metal-free processing while requiring optimized primers and coatings for proper adhesion.

Increased use of composite substrates in wind energy, transportation, and infrastructure applications demands more forgiving coating systems that adhere to surfaces with different properties than traditional metal substrates. The outcome includes optimized coating systems specifically designed to address new adhesion opportunities and substrate requirements.

Service Life Enhancement Solutions

Infrastructure resilience requirements drive development of engineered solutions for significant longevity gains. Recognition that "weather will be weather" and that demands on infrastructure will remain high with increased population and usage creates pressure for enhanced durability. Projects are increasingly designed with longevity considerations from the initial planning stages, with resilience becoming a larger component of fiduciary responsibility to asset owners.

Protective coatings are being engineered specifically to extend total service life of assets, with outcomes including increases in asset design-life values achieved in part through enhanced protective coating systems.

Case Study: Beau Catcher Tunnel Infrastructure

The Asheville, NC tunnel project demonstrates long-term infrastructure protection through advanced coating systems. The aged, leaking concrete tunnel required a flexible coating system with aesthetic considerations. Surface preparation through high-pressure water jetting and crack repair preceded application of an epoxy primer, 50 mils (1,250 μm) aromatic polyurethane thick film waterproofing coating, and 16 mils (400 μm) aliphatic polyaspartic flexible topcoat. The system has extended the tunnel life by nearly 30 years, demonstrating the potential for protective coatings to significantly enhance infrastructure longevity (Figure 5).

Figure 5. Relined Asheville Tunnel

Case Study:
San Mateo Bridge Longevity Design

The San Francisco Bay bridge project illustrates future-proofing through intentional longevity design. Engineers needed to extend the 100 year design life by an additional 25 years for the 7.5 kilometer flat trestle structure. Girders, piles, and caps were coated off-site, with pile/pile cap interfaces and pile caps between girders coated on-site. The system included epoxy primer, 50 mils (1,250μm) aromatic polyurethane thick film waterproofing coating, and 12 mils (300μm) aliphatic flexible topcoat, demonstrating how protective coatings can be engineered into infrastructure design for enhanced service life from project inception (Figure 6).

Figure 6. Coated pile caps on San Mateo Bridge

CONCLUSIONS

The future evolution of protective coatings is characterized by the convergence of efficiency, sustainability, and future-proofing requirements that collectively reshape industry practices and product development priorities. The analysis reveals that successful coating systems must simultaneously deliver enhanced performance, reduced environmental impact, and improved application efficiency while addressing evolving substrate and user experience requirements.

Efficiency trends demonstrate significant potential for cost reduction and performance improvement through digital printing applications, room temperature curing systems, simplified one-component formulations, and fast-curing high-build technologies. These developments directly address the critical challenge of labor costs exceeding 60% of contractor basis costs while maintaining or improving protective performance.

Sustainability initiatives show substantial progress in plant-based raw material integration, mass balance certification systems, waste and emission reduction strategies, and energy use optimization. The ability to achieve significant bio-content while maintaining high performance properties, combined with verifiable sustainability certification, positions the industry to meet evolving environmental requirements and customer expectations.

Future-proofing strategies address emerging challenges through haptic coating technologies, optimized adhesion solutions for new substrates and pretreatments, and engineered service life enhancement approaches. Case studies demonstrate practical achievement of 25-30 year service life extensions and successful adaptation to challenging environmental conditions and substrate requirements.

These future coatings will likely speciate from contemporary coating technologies as needs change and evolve, driven by the intersection of efficiency, sustainability, and future-proofing requirements. The industry's capacity to address multiple performance criteria simultaneously while meeting economic and environmental constraints positions protective coatings as critical enablers of infrastructure resilience and sustainability objectives.

ACKNOWLEDGMENTS

I would like to thank my employer of nearly 37 years for the opportunity to experience many of these dramatic shifts and changes in the protective coatings industry firsthand by being in the trenches with many capable contractors, engineers, architects, and other professionals. I would also like to thank the Australasian Corrosion Association for providing the platform to share these industry insights.

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5. The GreenHouse Gas Protocol at https://www.carbontrust.com/

AUTHOR DETAILS

S. Reinstadtler is the author of this paper. He is the Business Development Manager at Covestro LLC., a position he has held nearly 37 years. He is responsible for the Construction Coatings business. Steven works closely with architects, engineers, specifiers, contractors, and organizations that build with durability, sustainability, and circularity in mind by promoting high performance options for flooring, architectural, corrosion, roofing, and waterproofing applications.

FEATURE

Cumberland, Corrosion and Cathodic Protection

By Robert A Francis; Retired Consultant

Introduction

The golden era of steamships in the first part of last century still captures the imagination of many. The tragedies of the sinking of the Titanic and Lusitania, the arms race following the introduction of the Dreadnought battleships and the glamour and excitement of the Blue Riband competition between the Atlantic liners are all stories to stir the soul. But the inevitable exposure of iron and steel to salt water and steam created severe problems that caused headaches in both the civilian and naval shipping industry. Brass and bronze fittings and pipes made the problem worse. Rust and corrosion were constant and costly companions to steamship operators and much effort and money were spent on its control. One important and successful method, impressed current cathodic protection, was developed by an inventor from the Melbourne bayside suburb of St Kilda, with the grand name of Peregrine Elliott Gloucester Cumberland.

Early Days

Peregrine Elliott Gloucester Cumberland (Figure 1) was born on July 13, 1872 in the Melbourne suburb of Toorak, second child of Peregrine Bertie Cumberland (1834 – 1893) and Harriett Lillie Penrose Mackellar (1846 – 1900). His father came from a long military family, but had left service to become a Customs Officer in Melbourne

Figure 1: Elliott Cumberland [5]

after marriage. His youngest brother Harold was a champion Australian Rules footballer [1] – Melbourne royalty! Another brother, Cecil, was a mining engineer who patented a method for mineral separation in 1934. Elliott married Mabel Josephine Hicksh (1868 - 1951) in Melbourne on 17 September 1907. (Mabel's first husband, a Joseph Gill, and Mabel's mother, Ella Hicksch were imprisoned in 1896 for allegedly burning down the Stieglitz Coffee Palace in the small mining town of Stieglitz. Mabel, who had lost her only child a year before, successfully petitioned for their release [2]). Elliott and Mabel lived at 85 Barkly Street in the Melbourne suburb of St Kilda, where it appears he carried out his investigations. We have limited details of his education or working life. In 1908, he claimed "he has been a student of electro-chemistry for the past 12 years" [3] which suggests an interest in the field from an early age and later referred to himself as an "engineer and inventor". The only qualification he referred to was his membership of the (UK) Institute of Metals. He did his original work with an unknown co-inventor, but his collaborator had little faith in the invention and willingly sold his interest to Cumberland for a few pounds. There was no obligation to do so, but after Cumberland's success in England, and the money began to pour in, he sent a substantial portion of it as a gift to his co-inventor. [4] He and Mabel moved to the UK in 1912. Before looking at his inventions, it is worth getting some background on corrosion and its control by cathodic protection, specifically in ships.

Corrosion in Shipping

The availability of cheap iron and steel in the latter half of the nineteenth century led to a massive increase in the application of this incredibly useful engineering material, not least in shipping. But shipping especially showed the Achilles heel of the metal, its propensity to corrode or rust. Iron in contact with salt water rapidly deteriorates as both uniform and localised (pitting and crevice) corrosion. And the use of copper alloys such as brass and bronze to mitigate the problem (and providing heat transfer), compounded the problem. Galvanic (or bimetallic) corrosion arises when dissimilar metals are electrically connected in a common electrolyte, a conducting solution such as sea water. Steel will rapidly corrode when connected to a copper alloy in the presence of an electrolyte. The more active (or anodic or electronegative) metal will corrode or oxidise. Electrons from the oxidation reaction travel to the more noble (or cathodic or electropositive) metal. Electrons are taken up by a reduction reaction, usually oxygen and water reacting at the cathode. The basic parts of the galvanic cell are shown schematically in Figure 2. Galvanic corrosion points to an important solution to this dilemma.

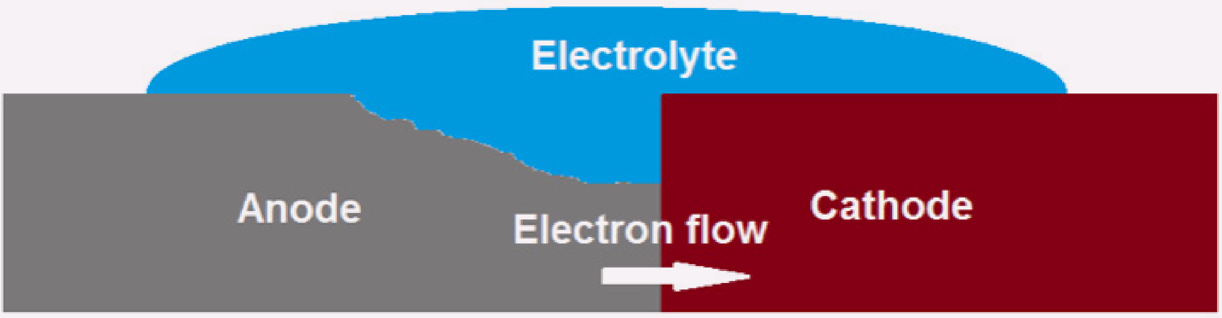

Figure 2: Basic principle of galvanic corrosion.

Development of Cathodic Protection

Joining a noble metal to steel will cause galvanic corrosion, but joining an active or electropositive metal will protect the steel. This is called cathodic protection (CP). CP can be defined as a technique for reducing the corrosion of a metal surface by turning that surface into the cathode of an electrochemical cell. CP was first established in 1824, when Sir Humphrey Davy made a presentation to the Royal Society of London based on his experimental findings of protecting copper (which was used on ships' bottoms to stop marine fouling) against corrosion from seawater through the use of cast iron anodes. An important development in understanding the science of corrosion and CP came in 1834, when Michael Faraday discovered a relationship between corrosion and electrical current.

Zinc is the best known and most useful metal to provide cathodic protection to iron and steel, and zinc blocks or anodes, known then as protectors, were increasingly used to protect submerged steel throughout the Victorian era. In theory, it can protect iron in boilers and condensers, but the process was very inefficient because the high water temperature caused the zinc to be rapidly depleted. Furthermore, the inevitable build-up of scale on the zinc blocks was believed to cause a reversal in polarity in hot water environments.

From studies of cathodic protection, it became apparent that an external source of current could be applied to the surface of a corroding anode to overcome the natural corrosion potential and provide electrolytic protection in the same manner as zinc. In this case, an inert anode insulated from the structure to be protected is connected to the positive of a power supply while the negative is connected to the structure. The water is an electrolyte which completes the electrical circuit. Thomas Alva Edison tried to achieve this so-called impressed current cathodic protection (ICCP) of ships hulls using a trailing anode in 1890; however, the sources of current and anodic materials available to him were inadequate. By the turn of the century, more reliable sources of power had become available and the process was revisited. In 1902, K. Cohen achieved practical cathodic protection of metallic structures using an impressed

Country	Application date	Patented	Patent Number	Example items illustrated in patent
AU	27.07.1906	04.06.1907	6532	Marine boiler, stern tube, tail shaft, rudder post and stern frame of a steam ship.
NZ	04.08.1906	11.07.1907	21592	Marine boiler, stern tube, tail shaft, rudder post and stern frame of a steam ship
GB	10.06.1907	04.06.1908	13417	Marine boiler of a steam ship
US	13.06.1907	11.05.1909	921641	Stern tube, tail shaft, rudder post and stern frame of a steam ship
GB	15.04.1908	04.02.1909	8422	Marine boiler of a steam ship
US	22.12.1908	08.02.1910	948968	Marine boiler of a steam ship (more details of power supply)
NZ	22.12.1908	13.01.1910	26999	Marine boiler of a steam ship (more details of power supply)
GB	03.04.1909	13.05.1909	8068	System using both a dynamo and storage cells
US	27.04.1911	19.03.1912	1020480	Surface condensers in contact with injection water
GB	04.09.1911	13.06.1912	4251	Steam Boilers and other Liquid containing Structures
GB	04.09.1911	27.06.1912	19637	Surface condenser
US	12.03.1927	26.01.1932	1842541	Water main, marine steam condenser and turbine plant subject to stray currents
GB	19.04.1927	19.07.1928	293909	Steam condenser protected from stray currents

Table 1: Patents taken out by Elliott Cumberland in English-speaking countries

current system. Herbert Geppert, the manager of public works in Karlsruhe, Germany, constructed the first cathodic protection installation using a direct current generator for pipelines in 1906, although the process never took off. [6]. The more widely known use of impressed current cathodic protection for the buried water, gas or petroleum pipelines took place in the 1920s in the USA.

Stray current corrosion (sometimes termed "electrolysis") is a special type of corrosion problem that occurs when a direct current leaves a metallic structure and returns to the current source through another structure. This results in localised corrosion which can be quite severe where the conventional (positive) current leaves the second structure. Stray current corrosion can be a problem with poorly-designed ICCP systems and differs from electrochemical corrosion in that the damage is caused by an electric current from external sources.

The Cumberland Process

Elliott Cumberland apparently commenced work on his electrolytic system in the early 1900s, but we have no details of early experiments or applications. He submitted patent applications in Australia and New Zealand in mid-1906 (see Table 1) so the process was largely finalised by then. From the content of the almost-identical initial patents in Australia and New Zealand, we can see that the work concentrated on stopping galvanic and other corrosion in submerged regions in steam ships. At its most basic level, the process involved connecting the iron or steel to be protected to the negative of a DC power supply, and the positive to an iron anode, insulated from the structure.

The early patents described the use of the system in boilers and on external rudder fittings. Such fittings included stern tubes (a hollow tube that holds the propeller shaft), tail shaft (portion of the drive train which connects directly to the propeller), rudder post and the stern frame of a steam ship. These items are manufactured from iron or steel, and will have various copper and copper alloy fixtures, exposing them to considerable corrosive conditions. Figure 3 shows a diagram of the process, advertised as the "Cumberland Electrolytic System", applied to the rudder post and stern frame of a steam ship from these early patents. Zinc galvanic anodes were commonly used (and still used today) in this region of a ship and the electrolytic system, although theoretically sound, has not become widely used for such an application. The anode design is complex and may not protect all regions. While zinc anodes will deplete fairly rapidly, regular maintenance of ships means they can be easily and economically replaced.

However, its use in boilers was more successful. The hot water in a boiler and steam condenser are extremely corrosive to zinc, and again with the presence of copper and copper alloy tubes and other fittings, zinc anodes would not be economic. The Cumberland system was used in marine boilers from the early days, with Figure 4 showing application in a marine firetube Scotch boiler, widely used in steamships in the early part of the century. Iron anodes, completely insulated from the boiler shell, are placed within the boiler water nested between the tubes. These are connected to the positive of the power supply, with the negative terminal connected to the boiler shell. The current was provided by low voltage dynamos generating a 6 to 10 V direct current and pass currents of about 2 to 4 amperes (according to the area of the heating surface). The current polarises (makes the surface cathodic) the whole inner wetted surface of a boiler, so that after a time comparatively weak currents could be used. Hydrogen, liberated from the surface of the metal in bubble form, tends to take any scale or other matter that may lie clinging to it from the surface. The process was later applied to water tube boilers, such as a Yarrow [7] and Babcock & Wilcox [8] boilers, where anodes were placed in the steam drums below the water level.

The process was submitted to Dr. Thomas Lyle, Professor of Physics, Melbourne University, an expert in power engineering who, after numerous tests, reported as follows [9]: -

"The University of Melbourne, October 2, 1906.

I have put the method proposed by Mr. Cumberland for the purpose of protecting metals, immersed in sea water and other liquids from corrosion due to galvanic action to a series of laboratory tests, and I find that it succeeds in doing what he claims for it. My tests have been made not only with metals immersed singly and in connected pairs, in cold and hot salt water, but also with the same immersed in weak dilute acids, and in all cases I have found that by Mr. Cumberland's process the hurtful galvanic action on the metal intended to be protected can be suspended by a small expenditure of electrical power".

(Signed) Thomas R. Lyle."

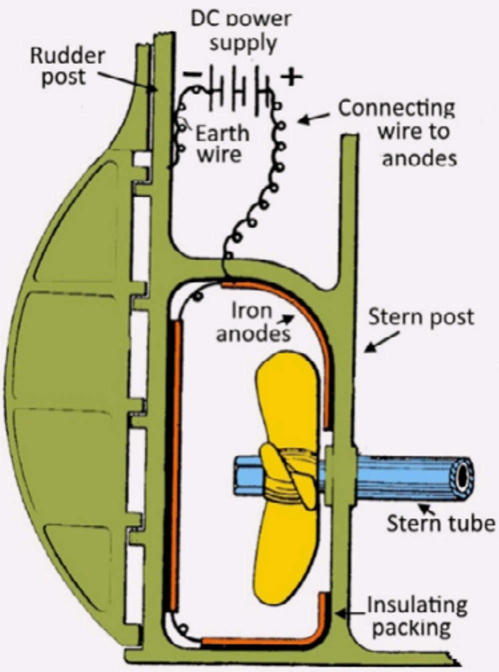

Figure 3: Cumberland system applied to rudder post and stern frame of a steam ship

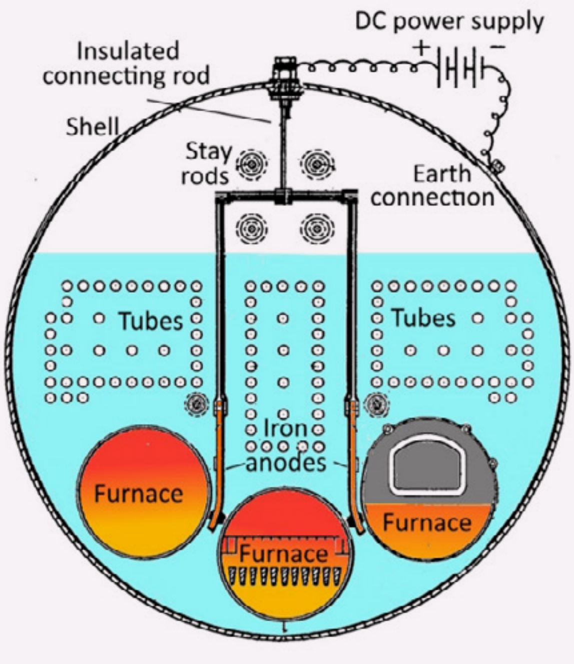

Figure 4: Cumberland system applied to a firetube marine boiler

The first public announcement of the invention was in the (Melbourne) Argus of 17 August 1907 [10]:

A NEW INVENTION

A new method of preventing corrosion has been recently introduced by Mr. Elliott Cumberland, of St. Kilda. This is an application of electricity to the boilers, stern, frames, propellers, tail-shafts or other metal portions sought to be protected. It was first submitted to and thoroughly tested by Professor T. R. Lyle, of Melbourne University, who found the process in all cases completely effective. Some months ago, it was installed in one of the boilers of the S.S. Perth, and has worked without a hitch, and to the complete satisfaction of the engineers and the Marine Board inspectors. The method of application is comparatively simple, and the expenditure of electricity is so slight as to be hardly worth calculating. As many broken tail-shafts have been due to corrosion, and reduced speeds and heavy expense are due to the same cause, operating in marine boilers, this new method should prove a boon to shipowners. In many mines too, boiler trouble is a serious one especially where water from the mine is used, for the more acid and impure the water the more rapid is the corrosion.

The *SS Perth* belonged to the Melbourne Steamship Company and ran regular services between the eastern and western states. The company was a major coastal shipping concern and had a number of other steamers running regular cargo and passenger services between Australian ports. It is likely that the system was installed on these. A year later, Elliot reported that the largest shipping company in the southern hemisphere at the time, New Zealand's Union Steamship Company, and a major Australian shipping company, Howard Smith, both had adopted his process to prevent corrosion in their numerous steamboats [9]. It was also adopted on the steamer *S S Bingera*, operating between Brisbane and Townsville [11].

Cumberland developed the method to prevent corrosion of a surface (shell and tube) steam condenser. In Figure 6, from patents taken out in 1911, there are four small iron anodes fitted in, but insulated from, the removable end-plates. The anodes have a "tell-tale" hole drilled partially through the centre from the outside which will cause water

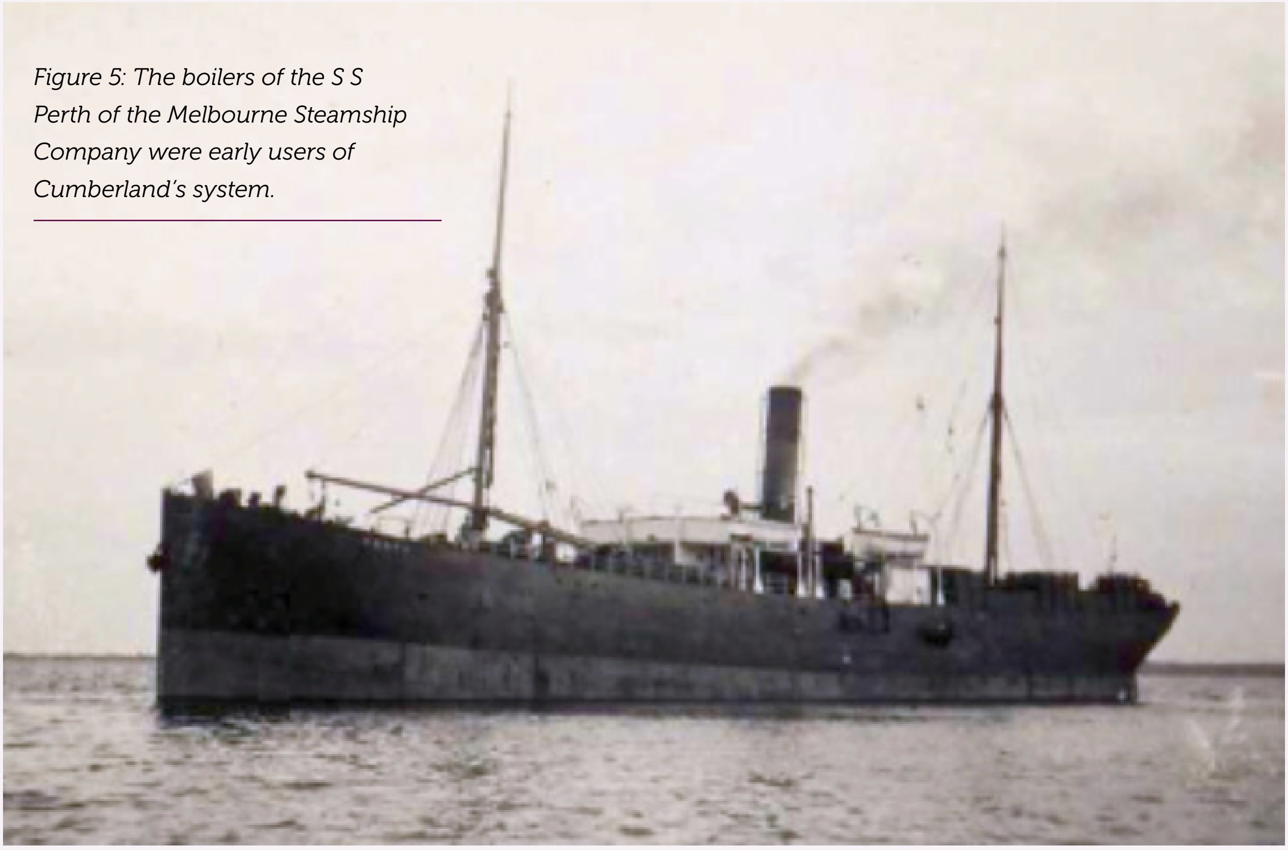

Figure 5: The boilers of the S S Perth of the Melbourne Steamship Company were early users of Cumberland's system.

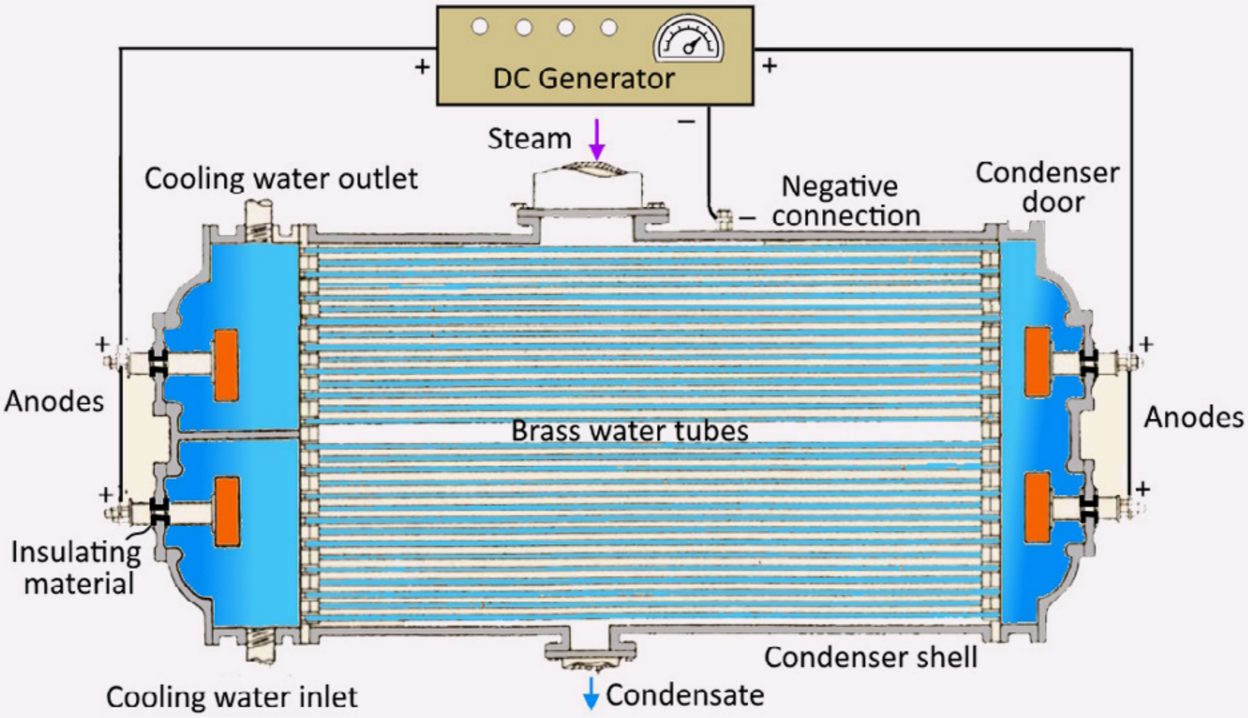

Figure 6: Cumberland system used on a surface condenser

leakage when the anode is spent and that a new anode must be installed. The anodes are connected to a 110-220 volt dynamo which provides the power, with connections being made through a switchboard provided with an ammeter and lamps which act as visible indicators of the current supply to the anodes. Under ordinary conditions, even with a large condenser, one ampere per anode was found to give adequate protection. An early use was in electric light stations in Sydney where pitting had occurred in the condenser tubes. A 7 inch (175mm) iron plate was fitted on each condenser door as an anode and, although corrosion had not been absolutely stopped, it was greatly diminished. There was also further advantage that the condensers were kept perfectly clean by the treatment [12].

However, not all proposals were successful. In 1909, Elliott recommended his process to prevent further corrosion of the pipeline carrying water from Mundaring Dam outside Perth to the goldfield towns of Kalgoorlie and Coolgardie [9]. The pipes had been suffering severe corrosion in the form of internal tuberculation leading to perforation. He made presentations to government and Goldfield's water scheme representatives including carrying out a demonstration of the process. However, the experts were not convinced that it would be economic for such a long structure and went instead for a system of de-aeration and lime dosing, which appeared to reduce the corrosion problem. Even today, it would be difficult to engineer an ICCP system to protect internal surfaces of potable water pipes.

Cumberland System Hardware

For protection of simple structures such as a rudder, the anodes were simply pieces of iron placed in similar positions to where zinc blocks would normally be placed. In the boiler, they are arranged in "convenient" positions. Anodes fitted to boilers usually consist of bars of iron or mild steel approximately 75 x 15 mm cross section and are fitted with sufficient area to last about two years. Flat, circular cast iron

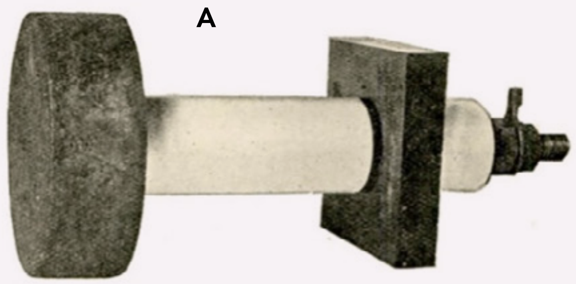

Figure 7: Cast iron condenser anode (a) as new, (b) after 12 months operation.

anodes 180 mm diameter by 50 mm thick were found most convenient for condenser protection, shown as new and when spent in Figure 7. They must, of course, be insulated from the condenser shell. Their life in practice was found to be about 12 months.

Cumberland originally noted that anodes are made from ordinary bar iron mild steel or cast iron, although later documents noted the process used soft iron for the anodes. Soft iron, a special low carbon alloy for electrical applications, is still used in heat exchangers today and has the advantage that the ferrous iron produced provides dosing for the protection of the inner surfaces of the copper alloy tubes.

For the power source, the early patents required simply the anodes be connected to the positive pole of a source of electric energy while the negative pole of this source of electric energy is connected to iron or steelwork being protected, such as the shell of the boiler. In practice the source of electrical energy could consist of a dynamo or batteries which maintain a potential equal to or higher E.M.F. than that caused by the differences of potential between the metals comprising the structure. A typical source was a 110-220 volt dynamo; connections being made through a switchboard provided with an ammeter and lamps which act as visible indicators of the current supply to the anodes (Figure 8). Suitable safeguards must be provided against passing the current in the wrong direction. Similarly, any outside current may reverse the process, and start corrosion on the structure being protected. This might easily happen if stray currents from outside electric equipment create a potential difference in the wrong direction. However, Philo [13] points out that the Cumberland system typically prevents attack from outside stray currents, a common source of trouble in ships and central power stations. He does note, however, that the installation of an electrolytic protective system does not, as a rule, prevent the effects of poor design or careless operation.

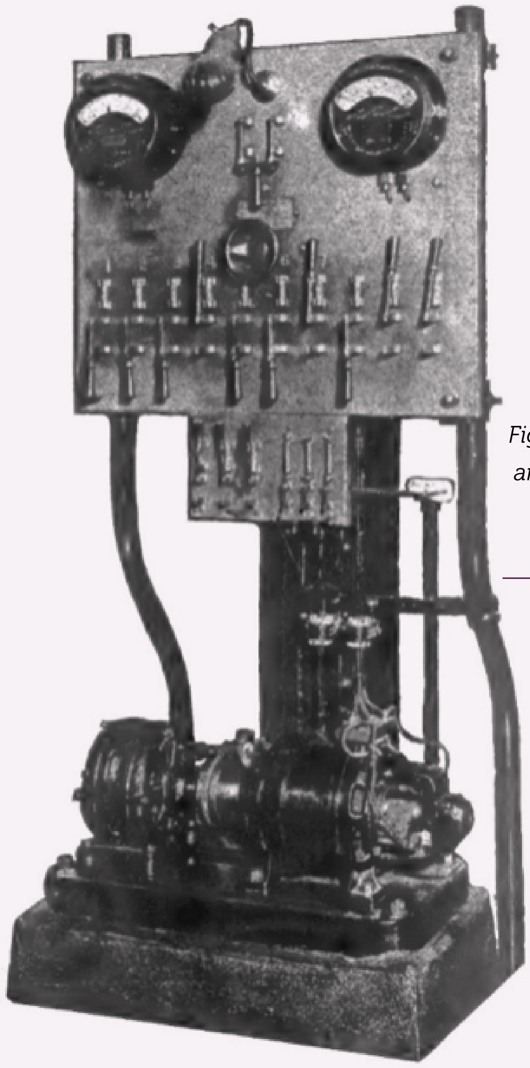

Figure 8: Generator and switchgear for the Cumberland process in 1916.

In regard to the amount of current required to protect surface condensers, this varies slightly, but in extreme cases one ampere per 500 square feet (50 square metres) was found in practice to afford complete protection. In the case of boilers where removal of scale was taken into account, the amount of current found necessary is rather more and of the order of one ampere to 300 square feet (30 square metres).

The Cumberland Engineering Company in the UK

Elliott moved to the UK in 1912 and set up the Cumberland Engineering Company to provide corrosion and scale control in industrial boilers, with its headquarters in Lloyd's Avenue, London (Figure 9). In the UK, the White Star Line (of Titanic infamy) were the first to adopt the Cumberland system, and a number of their ships fitted the system to the boilers and condensers. Cunard and other big lines of steamships quickly adopted it, where it proved effective against pitting and galvanic corrosion, with the additional advantage of loosening scale. It was also used by the British, French, American, Italian and Argentinian navies and adopted in the power industry. The Llanelly Electric Light and Traction Company in Wales put this system into use in 1915, and others soon followed. Following are two reports of its successful use at the time.

"In 1916, a steamer belonging to White Star Line has recently returned to port after being away as auxiliary cruiser for some thirteen

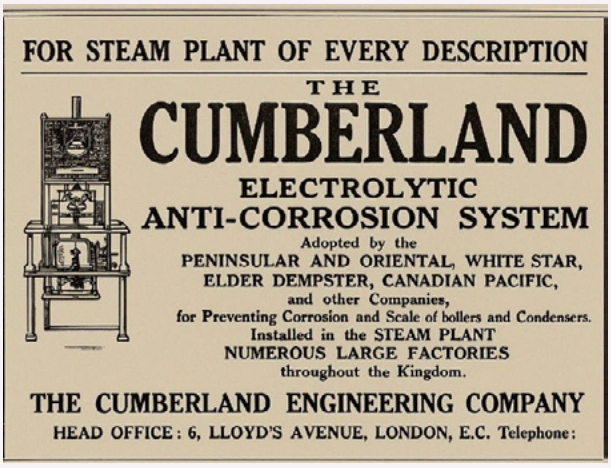
FOR STEAM PLANT OF EVERY DESCRIPTION
THE
CUMBERLAND
ELECTROLYTIC
ANTI-CORROSION SYSTEM
Adopted by the
PENINSULAR AND ORIENTAL, WHITE STAR, ELDER DEMPSTER, CANADIAN PACIFIC,
and other Companies,
for Preventing Corrosion and Scale of boilers and Condensers.
Installed in the STEAM PLANT
NUMEROUS LARGE FACTORIES
throughout the Kingdom.
THE CUMBERLAND ENGINEERING COMPANY
HEAD OFFICE: 6, LLOYD'S AVENUE, LONDON, E.C. Telephone:

Figure 9: Advertisement for the Cumberland system from an English newspaper.

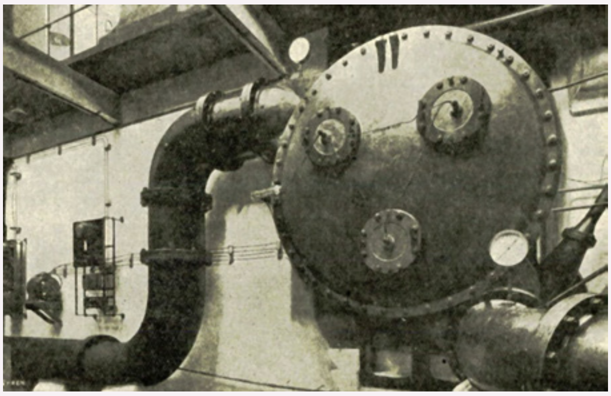

Figure 10: The Cumberland system applied to the condenser door at Brighton power station. The generator and switch gear can be seen on the far left.

months. Her boilers were found to be in excellent condition, being free from corrosion and scale; and her condensers, which previously gave much trouble from corroded tubes, are perfect, and not a single tube failed during this period. The results are considered to be so satisfactory, that this company is not only installing the process in the boilers and condensers, but also in fresh and salt water tanks. The main condensers of E.M.S. Britannic are protected by the Cumberland system." [14]

"In 1916, Mr John Christie of Brighton report that very serious trouble had been experienced from corrosion in the electric power supply station at Brighton, which was under his charge. In this plant the condensers used sea-water for circulating purposes, and latterly it had been found that the tubes failed after twelve to eighteen month's service, the cost of replacement being about £1000, less the value of the scrap metal. He had tried zinc, and found that it arrested corrosion to a certain degree, but it was only partially successful. Zinc cost a great deal, and unless it was constantly renewed and kept clean the results were negative. The trouble became so acute that he consulted several of the leading authorities in the country, amongst them Mr. Arnold Philip, and as a result of their investigation he had adopted the process [and] ... although the process had only been in use at his works for some six months, it had already proved most satisfactory. It appeared to have arrested the corrosion, and

from a practical point of view it seemed to be a correct solution of the trouble." [14]

The Cumberland system installed on a condenser door at Brighton is shown in Figure 10.

Technical Presentations

In 1910, Harker and McNamara of the Colonial Sugar Refining Company of Sydney reported in detail on laboratory experiments carried out using Cumberland's system [12]. Using numerous different anodic and cathodic materials in a range of electrolytes, they concluded "... although the electrolytic process does not actually prevent [the cathodic] metal from entering the solution ... the tendency for the metal to pass into solution is much diminished."

Elliott Cumberland presented a paper on his invention to a meeting of, the Institute of Metals, London, published in the Faraday Society Proceedings [14] in 1915, and a similar one to the Institute of Locomotive Engineers [15] in 1916. In it, he described numerous examples of corrosion in the marine industry, the theory of galvanic corrosion and how his process provided protection in condensers and boilers. He also a provided a practical demonstration of the process. A year later, a Mr John Peter of The Cumberland Engineering Company presented a similar paper to the Institute of Marine Engineers in London [16]. This covered much the same material as the earlier paper.

Elliott and company representatives would often give demonstrations of the system as part of their presentations. One experiment showed how zinc was only effective when clean and new, and if not frequently renewed, its action would not retard, but accelerate corrosion [16].

In the late 1920s, Elliott took out patents for protection from corrosion by stray currents. Apparently, there had been cases where the system had not provided the expected protection. He carried out experiments and found the cause to be due to stray current, or what he referred to as "electro-disturbances" resulting from the operation of electric or other machinery. His solution was to ensure that all sources of corrosion-producing electric currents would be electrically connected to the articles to be protected, a process known today as "bonding" or "drainage". He provided examples of a water main in the vicinity of an electrical generating station and in a marine turbine and condenser plant. Stray currents had been known to cause serious corrosion problems when electric trams were introduced in the late 1800s, and methods such as insulation, additional return rails and drainage had been used to mitigate its effects from the early 1900s. So, Elliott's "invention" here was not original but probably provided useful information for users of his impressed current system suffering this affliction.

The market for the process diminished somewhat as diesel took over from steam for transport applications in the inter-war years, although its use in stationary applications such as in power stations continued. The side effects of the process led to a change in direction for the company. Elliott had reported in 1916 [14] that in a sea water condenser the process removed shellfish and barnacles. He incorrectly attributed this to formation of hydrogen and sodium ions on the protected condenser tubes. We know now that the process generates chlorine gas at the anodes in sea water which is toxic to marine growth, and this is more important. This aspect took over and the company designed and manufactured of electro-chlorination equipment from 1970 and Cumberland is now one of the world's leading electro-chlorination plant manufacturers serving a range of industries. Cumberland Cathodic Protection continues as a separate company, mainly in the Middle East, and is probably the world's oldest CP company.

Later Years [4,17]

The *Cumberland Electrolytic Anti-Corrosion Device* was marketed by Elliott on a mileage royalty basis and brought him great wealth. In 1918, he took over the Coombe Hill Golf Course at Kingston-upon-Thames, Surrey and lived in its impressive club house (Figure 11). He made the golf course one of the most beautiful in the country, and spent thousands of pounds adding a floral garden, once described as 'the most colourful sight in Surrey'. A keen golfer and all-round sportsman, as the owner of the course, he exercised autocratic control. He persuaded war hero, Earl Haig, to become captain of the club and chairman of the committee. Shortly after his appointment, the Earl received a letter of protest from members against Mr. Cumberland's iron autocracy. "I think you will have to pay some attention to this, Mr. Cumberland," said the Earl. "It is signed by two hundred members of the club." The owner glanced over the letter and the signatures and replied. "Wrong; not two hundred members — two hundred ex-members, you mean." Very shortly they were.

There was another side to this apparently autocratic behaviour. A fellow Australian, a Major Woosley, said that Cumberland hated all forms of conceit, and when a couple of members saw fit to stand at the bar and talk with a frightful lot of 'haw-haw' importance, Cumberland very impolitely, and in his very best Australian language, 'ticked them off.' Then followed the petition from the captain of the club, Earl Haig. However, in instituting the club on his golf course, Cumberland had reserved a provision which entitled him to 'sack' anyone he chose, and he at once exercised that right, but he did it gallantly. He directed the secretary to forward to the 200 petitioners a cheque each for 35 guineas — refund of 20 guineas entrance fee and current year's subscription — and then called a meeting of his club's committee for the purpose of announcing what he had done.

A great lover of dogs, Mr. Cumberland specialised in golden retrievers, Labradors and Cairn and Irish terriers, and was the possessor of many handsome trophies won by them at Crufts. This fondness for dogs led him to come into contact with the Prince of Wales (later Edward VIII), who often played golf at Coombe Hill. He also won a number of trophies in connection with motorboat racing on Windemere, at Southampton and at Poole. He suffered for many years from cancer of the throat and died at the Coombe Hill Club House in December 1933, aged 61. In accordance with his instructions, his remains were cremated and the ashes scattered at his favourite spot among the silver birch trees between the seventh and ninth greens. A trophy, the keenly-contested Elliott Cumberland Memorial Challenge Cup, was instigated at Coombe Hill in 1984 (Figure 12) to honour the man who had devoted his energies, and a lot of his own cash, to Coombe Hill.

Figure 11: Coombe Hill Club house in 1915, where Elliott resided from 1918.

Legacy

Elliott Cumberland did not "invent" impressed current cathodic protection, as there had been a number of small-scale installations leading up to his work. It appears he was very aware of the potential problems of galvanic and pitting corrosion that had arisen with the rise of large iron and steel ships. He concentrated his efforts on solving these problems in the rapidly growing marine industry. He was fortunate that his process had appeared at a point in history where his process could solve these problems relatively simply. Earlier attempts at electrolytic corrosion prevention had been thwarted by the lack of reliable power sources that become available to Elliott. Perhaps most importantly, he knew the importance of marketing a new invention and spent a great deal of effort travelling to potential customers, giving presentations and providing demonstrations. He also set up a company early on so could reliably provide products and services to his customers, both big and small. Elliott Cumberland's success was a perfect example of being in the right place at the right time with a sound product that solved a real problem.

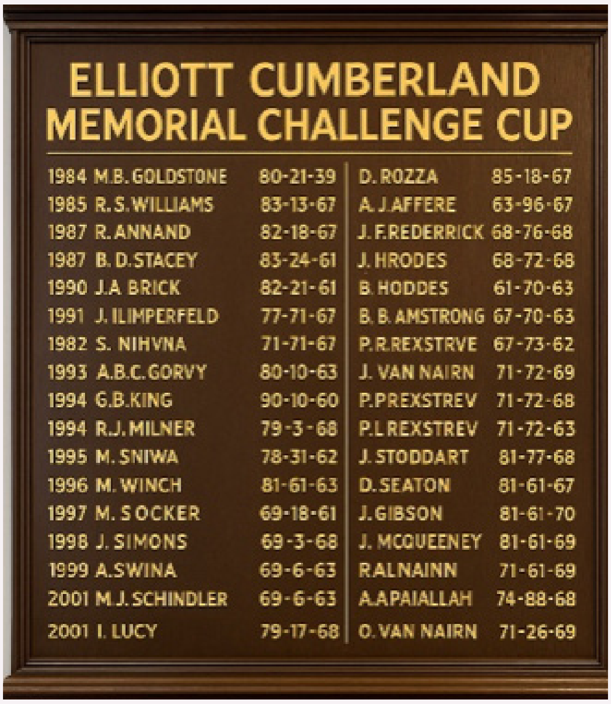

Figure 12: Cumberland Memorial Cup winners.

Acknowledgement

Thanks to Colin Chapman of the Coombe Hill Golf Club for information on Cumberland's time there.

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17. Donald Zec, "Coombe Hill Golf Club: A Remarkable History" Bookcraft UK, (2002)

Celebrating excellence: Athol Stone receives the 2025 Rust Award

The Australasian Corrosion Association proudly announces Athol Stone as the recipient of the 2025 Rust Award, recognising his outstanding contribution to the protective coatings industry over more than five decades. The prestigious 2025 Rust Award, proudly sponsored by Remedy Asset Protection, highlights excellence and innovation in corrosion prevention and protective coatings.

Athol's career began at just 15 years old as a painter. By 17, he was self-employed, working on renovations and new homes before moving into industrial coatings at the age of 20. His first major role was at Barry Beach Marine Terminal, where he worked on offshore oil rig components for Esso. Reflecting on this turning point, Athol said:

"This was the first time I'd witnessed abrasive blasting done and protective coatings applied to the prepared steel and I appreciated that preparation was a key factor in long lasting of coatings."

Over the next decade, Athol applied coatings on some of Victoria's most significant projects, including the MCG light towers, Melbourne Tennis Centre and a number of Melbourne Water storage tanks. He became more proficient in the best practices of coating application, all while adhering to strict specifications and inspection standards. His ability to adapt to new products and techniques as the industry evolved set him apart as a leader in craftsmanship and innovation.

At 30 years old, Athol transitioned into supervisory roles, managing complex projects such as the ANZAC Frigates at Williamstown Shipyard. He later became an operations manager before stepping into coating inspection in 1993. Under the mentorship of Sandy McPherson, Athol earned ACA and NACE (now AMPP) certifications and acquired Macspec Pty Ltd, continuing its respected legacy for the next 30 years. His inspection work spanned Australia and overseas, contributing to the durability of critical infrastructure such as the Westgate Bridge refurbishment, AAMI Stadium, and Monash Freeway gantries.

One of Athol's most notable achievements was his role in the Wonthaggi desalination plant project. Sent to Thailand to assist a contractor struggling with coating valves, Athol recalls:

"They were lacking the knowledge in the type of spray equipment to apply the specified coatings, so my practical experience kicked in and helped them set up the conventional spray correctly."

His hands-on guidance in blasting standards, spray techniques, and QA documentation transformed the contractor's capabilities and ensured compliance with specifications.

Athol has always believed that practical experience is the foundation of success. He encourages newcomers to start with hands-on roles such as blasting or painting before moving into inspection. This background, combined with formal training and certifications, builds confidence and credibility in the field.

Photo: On going instruction of surface preparation and application techniques in Thailand © Athol Stone

"I have learnt a lot of valuable information, been to places where I probably wouldn't have gone and met some amazing people and given me a lifestyle that I enjoyed. So yes, join the corrosion industry and make a difference."

The ACA congratulates Athol Stone on this well-deserved recognition.

Acknowledgment

The 2025 Rust Award is proudly sponsored by RemedyAP, supporting excellence and innovation in the protective coatings industry.

Corrosion & Prevention 2025 Conference *wrap-up!*

What a week it was for the corrosion industry at Corrosion & Prevention 2025! Held at Marvel Stadium in Melbourne from 9–13 November, the conference brought our community together for five days of industry-leading insights, innovation, and collaboration.

Seeing so many corrosion professionals connect, exchange knowledge, and support one another highlighted the strength and dedication of our industry. Thank you to everyone who attended, your participation is what made this event such a standout success.

Last year's program featured 6 plenary speakers, 4 concurrent streams, 7 technical forums, 75 technical papers, 75 exhibitors, and 20 sponsors, a true testament to the scale and depth of expertise within our field.

A special thank you to our 2025 major sponsors:
Platinum Sponsor: PPG Industries
Gold Sponsor: MCU-Coatings
Silver Sponsors: Dulux, Anti-Corrosion Technology, Jotun, and Scape Consulting

C&P25 MATERIALS PROTECTION FOR THE FUTURE

2025 PLENARY SPEAKERS

Our plenary program brings together leading voices from across the corrosion industry to share insights, challenge thinking, and highlight emerging trends shaping our future.

Theme: Materials Protection for The Future

EVENT HIGHLIGHTS - PLENARY PRESENTATIONS

- **Michael O'Malley** presented *History of Coatings and Emerging Markets*, exploring how coating technologies have evolved over time and the emerging global markets shaping the future of materials protection.
- **Peter Dove** delivered *History of the ACA as Seen Through the Eyes of Peter Dove*, offering a unique and personal perspective on the ACA's legacy, milestones and growth across decades.
- **Kod Pojtanabuntoeng** delivered the PF Thompson Lecture titled *Advancing Decarbonisation Through Corrosion Science and Technology*, highlighting the vital role corrosion research plays in supporting global decarbonisation efforts.
- **Michelle Lau** presented *Let's Get Talking: Bridging the Gap in CP Interference Management*, focusing on improved communication, collaboration and technical practices to reduce CP interference issues across the industry.
- **Steven Reinstadtler** delivered *The Future Evolution of Protective Coatings*, providing insights into emerging technologies, next-generation systems and the direction the coatings sector is heading.
- **Roman Dankiw** presented *State of the Corrosion and Coating Industry Australia*, offering a data-driven overview of current trends, challenges and opportunities shaping the national industry landscape.

MICHAEL O'MALLEY

Business Manager Protective and Marine Coatings - ANZ

PPG Industries

PETER DOVE

Technical Director - Materials Technology

GHD

KOD POJTANABUNTOENG

Chevron-Woodside Chair in Materials & Corrosion Engineering

Curtin University

MICHELLE LAU

Managing Director

Mach3 Engineering Sdn Bhd

STEVEN REINSTADTLER

Business Development Manager

Covestro LLC

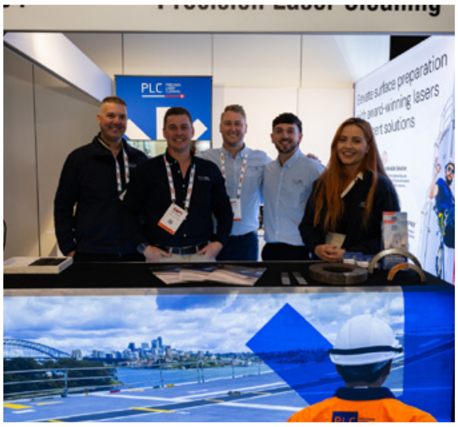
ROMAN DANKIW

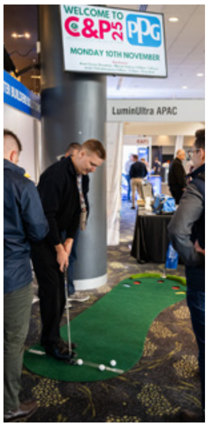
Principal Inspection Consultant

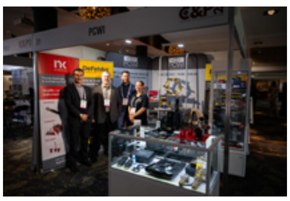
Asset Inspection Consultants

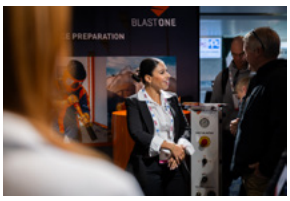
EXPLORE THE EXPO HALL

C&P25 MATERIALS PROTECTION FOR THE FUTURE









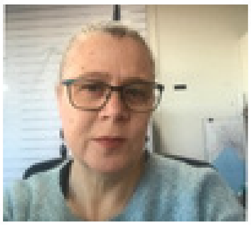

C&P25
MATERIALS PROTECTION FOR THE FUTURE
WELCOME
RECEPTION

Women In Corrosion Breakfast

highlight

ELAINE CHIU
CHAIR

MICHELLE LAU



NARELLE HUNTER

HODA ADELKHAH

KATE DUNSTAN

ALEXANDRA NORTHEY

The Women in Corrosion Breakfast kicked off with five powerhouse panelists who delivered bold insights on career journeys, mentorship, tech and leadership. Their stories sparked conversation, inspiration and a whole lot of motivation. A brilliant morning celebrating women driving the future of corrosion.

ACA ANNUAL AWARDS DINNER

The Corrosion & Prevention 2025 Annual Awards Dinner, held at the historic Melbourne Town Hall, was an inspiring celebration of excellence across the corrosion industry. The evening brought together respected leaders, rising professionals, and innovators to acknowledge outstanding achievements in research, technical advancement, and industry service. The ACA's Chair, Kingsley Brown, shared reflections on the strength and collaboration of our community, highlighting the impact of shared knowledge and collective progress. A special moment of the night saw all Life Members invited to join Raed on stage to decorate the commemorative cake celebrating 70 years of the ACA. Attendees then enjoyed a beautifully curated dinner and participated in a spirited charity auction in support of the ACA Foundation.

TOP HONOURS FOR INDUSTRY PAPERS

The prestigious paper awards, recognising outstanding research and practical contributions.

Marshall Fordham Award:
Oscar Duyvestyn & Henry Morrow | Effects of Varying the Time Between Surface Preparation and Coating Application on the Performance of Epoxy Marine Coating Systems Applied to Aluminium *(pictured)*

David Whitby Award:
Dr Rob Francis | Protection of Steel at Edges and Scratches by Zinc Coatings *(pictured)*

Les Boulton Award:
Judy Turnball & Roger Metcalf | Failure of Steam Expansion Bellows *(absent)*

The Chair of the Applicator Technical Group, Tim Billing, invited Donna Rutherford, Mike's wife, to once again join him to award the **Michael Rutherford Golden Trowel Award** to this year's recipient, **Tom Wenzel.**

Tim then invited Justin Rigby to the stage to present the **Rust Award**, which was awarded to **Athol Stone.**

HONOURING INDUSTRY ICONS

The Life Membership Award, one of the ACA's greatest honours, recognises outstanding and continuous service to the Association and was presented to two remarkable individuals.

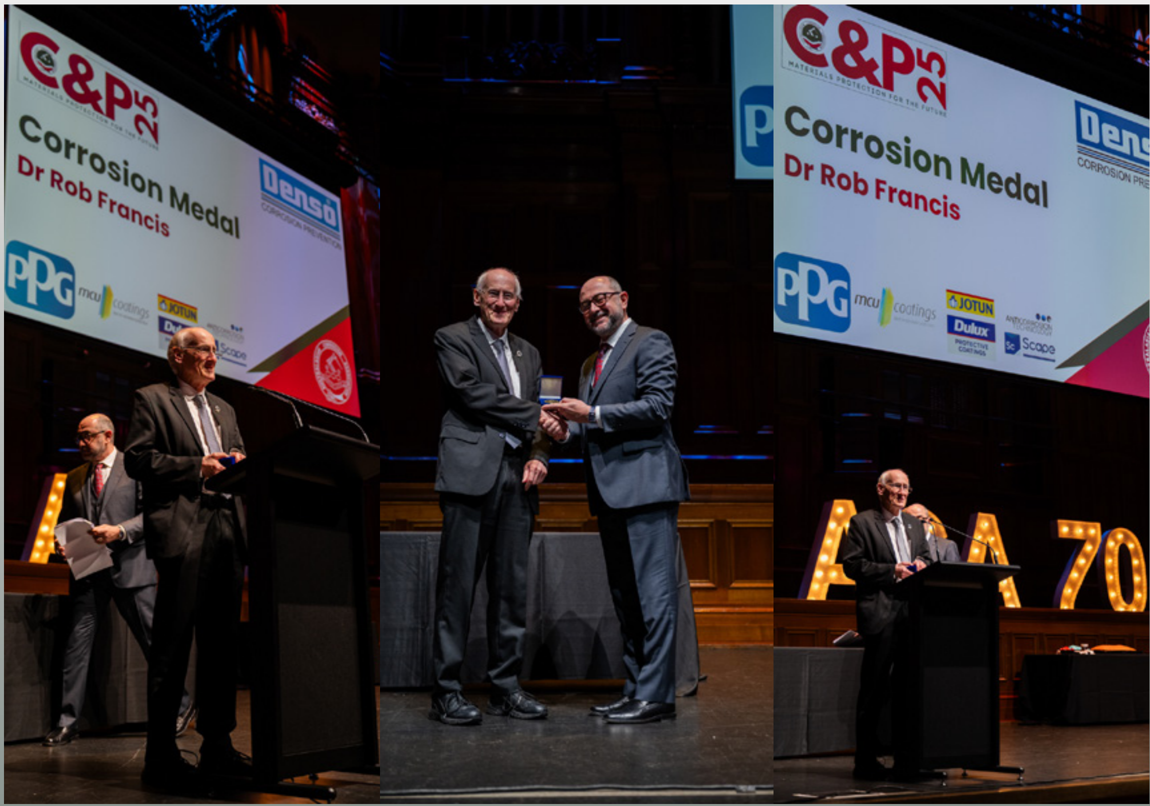
David Anderson has shown exceptional dedication to corrosion protection and coatings, contributing significantly through his technical expertise, leadership, and commitment to mentoring emerging professionals. His influence across the Victorian Branch and the wider industry has strengthened best practice in coatings and tape wrap applications, supporting high standards across major infrastructure sectors. It is with great pleasure that we recognise his outstanding service with Life Membership of the Australasian Corrosion Association.

Warren Green has made outstanding contributions to the corrosion and durability sector, applying his expertise across marine, industrial, and civil infrastructure projects to ensure long-term asset protection. His leadership in coatings, cathodic protection, and durability practices, combined with his commitment to training and mentoring emerging professionals, has strengthened both industry capability and the wider ACA community. It is with great pleasure that we recognise his exceptional service with Life Membership of the Australasian Corrosion Association.

The YCG Award, This award honours a young professional who demonstrates exceptional commitment to advancing corrosion practice and actively contributes to the growth and strength of the ACA community.

Austin Bennett exemplifies the spirit of the YCG Award through his exceptional commitment to the field of corrosion and his active contribution to the ACA community. His leadership, technical skill, and innovative approach have strengthened industry practice and inspired his peers as an emerging professional. It is a pleasure to recognise his achievements tonight with the National YCG Award.

THE ACA'S HIGHEST DISTINCTION



Corrosion Medal Award

Dr Rob Francis

The Corrosion Medal is the Australasian Corrosion Association's highest honour, awarded to individuals whose lifetime work has advanced corrosion science and strengthened our industry.

This year's recipient, Dr Rob Francis, embodies leadership, innovation, mentorship and an unwavering commitment to corrosion prevention. With more than four decades of contributions across research, practice, education and industry guidance, he continues to elevate standards and inspire the next generation of professionals.

We proudly recognise Dr Francis for his distinguished service and lasting impact on our community, congratulations.

AWARDS FOR INDUSTRY EXCELLENCE

The Recognition of Service Awards recognise the significant contributions of our volunteers to assist the ACA's operational efforts. This year we honoured:

RECOGNITION OF SERVICE AWARD

Vincent Stafrace - ProDigitek

The first Certificate of Recognition was awarded to Vincent Stafrace, who has continuously exhibited with the ACA for an incredible 39 years. Vincent first joined us as an exhibitor in 1986 and has not missed a single conference since.

RECOGNITION OF SERVICE AWARD

Arthur Kokolekos - LuminUltra

The second Certificate of Recognition was presented to Arthur Kokolekos in acknowledgement of his dedicated volunteer service to the Oil, Gas & Energy Technical Group throughout the year. Arthur's commitment, support, and willingness to contribute his time have been invaluable to the group's activities and success.

AUDE SAPERE AWARD

EPTEC

The Aude Sapere Award recognised an ACA member organisation's ongoing commitment to staff training and professional development through consistent participation in ACA-delivered courses each year. The recipient was determined by the ACA Training Department based on the previous year's training attendance data. This year, the Aude Sapere Award was presented to Eptec.

ACA FOUNDATION SCHOLARSHIPS

The Australasian Corrosion Association (ACA), with the ACA Foundation, offers annual scholarships to help members attend key events, including training courses and the Annual Corrosion & Prevention Conference. Supported by our corporate partners, these scholarships promote professional growth and create new opportunities across all sectors and age groups in the corrosion industry.

CARBOLINE NZ AWARD
Matthew Meylan

CRL AWARD
Nathanael Erwin

UCC TRAINING AWARD
Michael Kururangi

CPT AWARD
Ylli Leka

FREYSSINET AWARD
Dr Michaela Wawryk

METSPRAY AWARD
Anthony Jujnovich

INFRACORR AWARD
Ata Aminfar

MCM PROFESSIONAL AWARD
Vincent Wong

DENSO STUDENT AWARD
Benjamin Bickerton

MIKE RUTHERFORD MEMORIAL AWARD
Fiona Collins

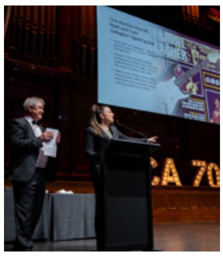
RAY OSBORNE MEMORIAL YCG AWARD
Grace Bryant

CLOSING HIGHLIGHTS: FUN, LAUGHTER, AND 70 YEARS OF ACA

Ian MacLeod provided the evening's entertainment, delivering a hilarious and insightful 20-minute speech reflecting on the ACA's 70-year history. His quirky, humorous storytelling offered both a witty perspective and meaningful insight into the association's milestones, leaving everyone thoroughly entertained.

The conference also celebrated the ACA's 70th anniversary in style. All Life Members in attendance came forward to decorate the specially arranged 70th cake, each adding their own creative spin. This fun, interactive, and lighthearted activity perfectly highlighted the milestone and the community spirit of the ACA, making it a memorable part of the evening.

The awards concluded with a lively auction of donated items conducted by Ian Godson and Rachelle Rigby, creating a fun and engaging atmosphere for attendees.



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Applicators Technical Group

Coatings Technical Group

APPLICATOR DAY AT C&P25

BlastOne had an excellent week in Melbourne – the location at Marvel was ideal, the setup worked seamlessly and the event delivered real value and opportunities for us to connect with the right people across the industry.

We had strong engagement during the Exhibitor Hall and especially at the Applicator Day on Thursday. The level of attendees, including government, asset owners, and key industry players made it an incredibly worthwhile week for our team.

Thank you again for all the effort that goes into bringing this together. Your passion really shows and we appreciate the work behind the scenes that makes this such a valuable event for our industry.

Looking forward to next year already and how BlastOne can continue to grow our conference support and give back to the industry.

Kate Dunstan

Marketing Manager APAC
BlastOne International

THANK YOU, OUR 2025 SPONSORS!

PLATINUM SPONSOR
PPG INDUSTRIES

GOLD SPONSOR
MCU-COATINGS

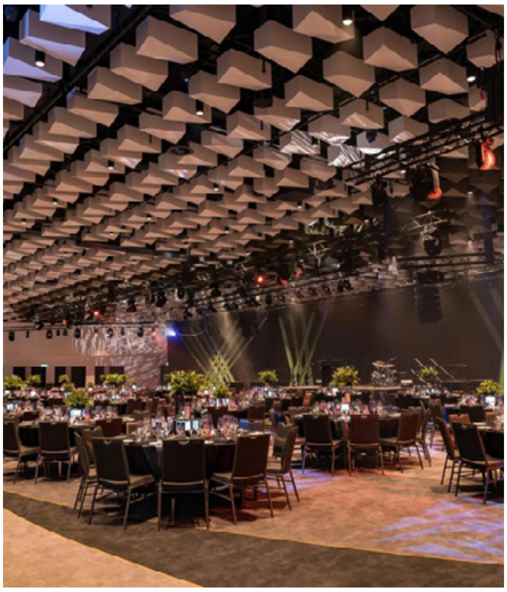
SILVER SPONSORS
SCAPE CONSULTING, JOTUN, ANTICORROSION TECHNOLOGY, DULUX

SUPPORTING SPONSORS

The Australasian Corrosion Association is excited to announce that Corrosion & Prevention 2026 will be held in Christchurch, New Zealand, at the stunning Te Pae Convention Centre from 6-9 October 2026.

Support for the conference is already exceptionally strong, with sponsorships and exhibition booths filling quickly, early signs suggest another sell-out event.

More details will be available under the Conference tab on the ACA website early this year, so keep an eye out for updates. If you have any questions or wish to secure a booth or sponsorship opportunity, please contact our Conference Manager at conference@corrosion.com.au or visit corrosion.com.au



Submit your abstract

Call for Abstracts – C&P26, Christchurch
Abstract submissions are now open for C&P26, the Corrosion & Prevention Conference & Exhibition, heading to Christchurch in 2026. This is your opportunity to showcase innovative research, real-world case studies, and practical solutions shaping the future of corrosion prevention and asset integrity.

Join industry leaders, engineers, researchers and decision-makers from across Australasia and beyond, and be part of a world-class technical program that drives knowledge, collaboration and impact.

Submit your abstract here and take your place on the C&P26 stage, where ideas meet industry.

CORROSION & PREVENTION 2026

On Thursday the 4th of December 2025, the Newcastle ACA Branch wished old and new members a Merry Christmas via a technical project showcase presentation from the University of Newcastle's Critical Infrastructure Performance and Reliability (CIPAR) research group team members. Hosting attendees from Vector Corrosion Technologies, Titan Quality, Freyssinet Australia Pty Ltd, ArmorGalv, Bureau Veritas, TAFE NSW, Australian Industrial Plastics, Parlin Pty Ltd, BG&E Pty Ltd, and of course The University of Newcastle.

Proudly sponsored by Think Brick Australia, a long-established network focused on research and development of masonry construction related products and technologies, CIPAR showcased how corrosion science is helping the masonry construction sector by developing a non-destructive method for detecting which brick walls are prone to collapse. Led by AProf Igor Chaves, through a lovely dinner and desert combo, the audience enjoyed hearing details about various Think Brick Aus. sponsored projects, detailed real-world inspection of older masonry walls, detailed corrosion of wall stability anchor investigators in partnership with the Galvanizers Association of Australia (GAA), details related to the non-destructive vibration-based wall health monitoring technology, and finally how the CIPAR lead project is important for State Building Regulatory offices and asset owners.

The sold-out event reinforced the NCL branch's reputation of putting on a great technical + social event.

On behalf of the NCL Branch, we would like to thank our Head Office Events team for their support in making this event happen, and A Merry Christmas to all those reading this article.

Best of wishes,

Igor Chaves
(On behalf of the NCL Branch)

The SA Branch would like to thank all SA members for their continued support of the ACA and their passion for all things corrosion.

A dreary, wet evening in Adelaide on Friday kept many of the attendees home, but those who made it out to the Adelaide Bowls club enjoyed a great night with many spirited discussions and reflections on the year that was. 2025 was an exciting year for the SA branch starting with a fantastic Stainless Steel event, co-hosted by Weld Australia and Materials Australia, followed by many exciting events planned by the hardworking volunteers in the committee. Looking ahead, next year is gearing up to be another fantastic year with more collaboration being arranged between technical societies and, both technical and social events on the calendar.
If you have enjoyed being part of the SA corrosion community, reach out the committee and think about joining the SA committee in next year's AGM to give back to this great community.

We hope you have a well-deserved break and look forward to seeing you in the new year.

Kind Regards,

SA Branch Committee

Technical Event Summary

Automated Radiography Testing (ART) for Enhanced CUI Screening

The ACA WA Branch recently hosted a well-attended technical event in Perth, delivered by Vertech in collaboration with MISTRAS. Craig Davies, Group Business Manager at Vertech, presented an insightful session on how Automated Radiography Testing (ART) is advancing the detection and management of Corrosion Under Insulation (CUI) across industry.

The presentation explored how this next-generation inspection technology enables rapid and reliable screening of potential CUI locations, providing owner–operators with a powerful tool to prioritise maintenance, reduce uncertainty, and optimise inspection resources. Attendees were particularly interested in the improved accuracy, reduced access requirements, and minimal operational disruption that ART can offer compared with traditional methods.

The event drew an excellent turnout, with strong engagement and discussion from members across the Oil & Gas, mining, and infrastructure sectors. Vertech expressed its ongoing commitment to supporting the Australasian Corrosion Association and contributing to the technical development of the corrosion management community.

The WA Branch extends its thanks to Vertech, MISTRAS, and all attendees for contributing to an informative and forward-looking session on the future of inspection technologies.

What a year it's been!

ACA Queensland Branch kicked off 2025 with energy and purpose, delivering a mix of technical events, social gatherings, and collaborative initiatives that strengthened our community and advanced industry knowledge. From insightful discussions to hands-on networking, this year truly showcased the value of coming together.

Special thanks to our 2025 Branch Partners: Denso, Scape Consulting, and International Paint, to our wider branch membership and Branch Committee for your ongoing support.

This year we successfully trialed multi-topic technical events and joint association collaborations, both of which were well-received and will shape our future programs.

Looking Ahead

As we wrap up an exciting year, we're already planning for 2026 with even more opportunities to learn, connect, and innovate. Thank you for being part of ACA Queensland's journey—your involvement makes all the difference. Here's to another year of growth and collaboration!

2025 HIGHLIGHTS

MARCH

- AGM and Social Gathering at BrewDog

APRIL

- YPF/YCG Joint Event: Kindred Association Bowls
- University Outreach: QUT Materials & Chemistry Career Round Table, supported by Joe Davies (YCG Rep), Ben Biddle (Branch President), and Matthew Brown (Branch Member)

JULY

Cairns Technical Event featuring multi-topic sessions:

- Passive Fire Protection
- Composites as Alternatives to Cold Rolled Steel in Corrosive Environments
- Overview of AS/NZS 2312 Guide for Structural Steel Protection
- Thermal Metal Spray Coatings

AUGUST

YCG Branch Technical Event at South Bank TAFE covering:

- Electrical Shorting of Isolation Joints on Cathodically Protected Pipelines
- Maximising Value with Stainless Steel: Durable, Resilient, Sustainable Structures

NOVEMBER

Technical Event at Easts Football Club with topics:

- Unconventional Methods for Extending Asset Lifespan
- Drinking Down Under: correct use of Polyurea for Water Assets

DECEMBER

- End-of-Year Social Dinner at Easts Rugby League Club

Wishing all a happy end to 2025 and a safe and prosperous 2026

Ben Biddle
Branch President Queensland

THANK YOU TO OUR 2025 BRANCH PARTNERS!

QUEENSLAND

Scape Consulting – Corrosion Solutions

Denso Corrosion Prevention

International

NEW SOUTH WALES

Dulux Protective Coatings

Remedy Asset Protection

VICTORIA

M. Brodribb Pty. Ltd.

SOUTH AUSTRALIA

Denso Corrosion Prevention

2026 BRANCH PARTNERSHIPS – NOW OPEN!

Partnering with an ACA Branch in 2026 is a unique opportunity to support the industry while gaining targeted exposure for your business.

Enjoy a year-long partnership that puts your brand front and centre. You'll be the spotlight sponsor for one key event and stay visible all year through live events, webinars, and digital channels. For more information, click here.

Submit Interest

Year in Review

Throughout the year, the Young Corrosion Group (YCG) across Australasia delivered a strong and diverse program of events and activities, reinforcing its commitment to engaging, supporting, and developing the next generation of corrosion professionals.

Across multiple branches, YCG committees successfully hosted a mix of social, technical, and professional development initiatives. These included social networking events such as the VIC YCG Lawn Bowls, which provided an informal and engaging setting for members to connect, as well as several national YCG webinars, including *An Insight into the ACA's Young Corrosion Group + Experts and the Young Corrosion Group (YCG) Career Panel*, offering valuable industry insight and career guidance.

In NSW, YCG members participated in a Corrosion Industry Networking Night, fostering meaningful connections across the sector, and a field visit to Cockatoo Island, where attendees observed remedial works involving blasting, painting, and lead coatings management. NSW also delivered a technical event on Innovations in Welding and Corrosion Control, highlighting advancements and practical applications within the industry.

YCG Field Visit to Cockatoo Island

In South Australia, the YCG SA Node collaborated with the Future Industries Institute at UniSA, further strengthening links between industry and academia and supporting knowledge sharing and innovation within the corrosion space.

Across all regions, YCG volunteers worked tirelessly throughout the year to engage members, build capability, and strengthen the corrosion industry across Australasia. These efforts reflected the passion, professionalism, and dedication of YCG committees nationwide.

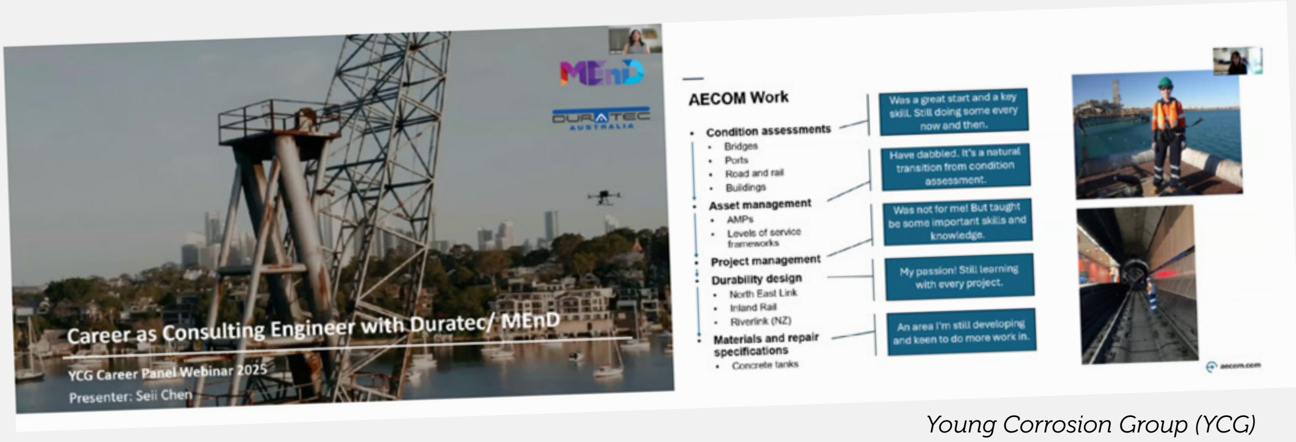
A sincere thank you is extended to all YCG Chairs and Committee members for their hard work, commitment, and ongoing contribution. Their efforts were instrumental in delivering a successful year of YCG activities.

With strong momentum behind the group, the YCG looks forward to building on these achievements and continuing to grow, connect, and inspire the corrosion community in 2026.

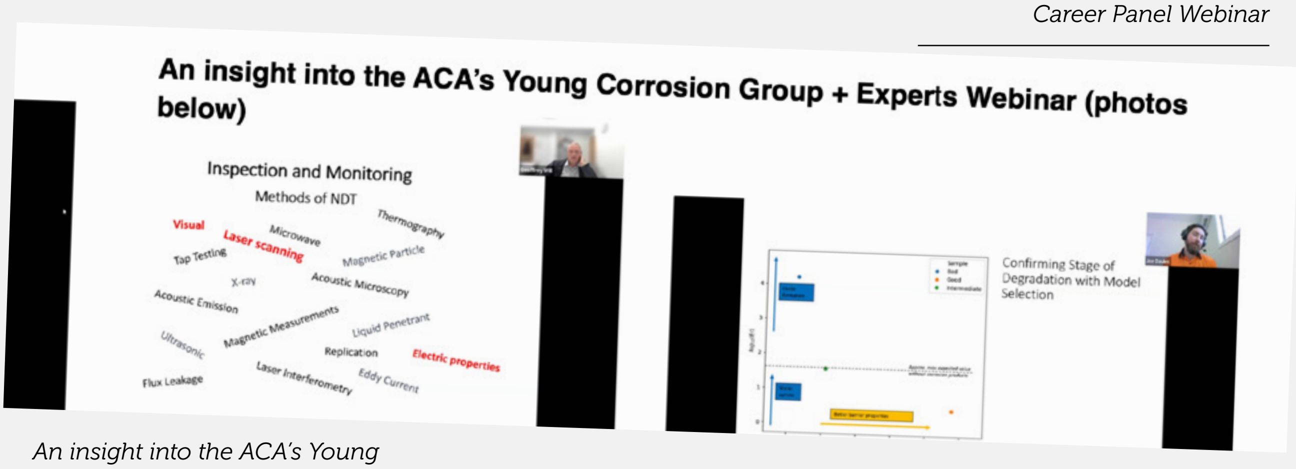
Acknowledgement

We would also like to take this opportunity to once again congratulate Austin Bennett (Universal Corrosion Coatings) on being awarded the National YCG Award at the C&P26 Conference this year. This recognition was thoroughly well deserved and reflected Austin's outstanding commitment to the Young Corrosion Group.

Austin has consistently gone above and beyond in his efforts to strengthen and grow the YCG, actively engaging not only with the VIC Branch but also through his role as the YCG National Lead for the Steering Committee. His leadership, energy, and dedication have played a significant role in boosting



Young Corrosion Group (YCG) Career Panel Webinar



An insight into the ACA's Young Corrosion Group + Experts Webinar

engagement and supporting YCG initiatives nationally.

We sincerely thank Austin for his continued contribution and commitment, and we greatly appreciate the time, passion, and effort he brings to the YCG and the wider corrosion community.

New Zealand

2025 has been a year of strategic foundational work for the New Zealand YCG. Navigating a small membership pool and wide geographic spread, we focused our energy on virtual engagement, with member attendance at joint YCG and ACA webinars. A major priority has been working with the ACANZ committee to address the constitutional changes, ensuring the NZ branch remains robust and relevant. We have also reinforced the need for outreach, initiating promising connections within the contractor, engineering, and tertiary spaces that we intend to expand in 2026.

From an engineering perspective, the graduate market in New Zealand remains highly competitive. My hope is that as the industry seeks new talent, we can highlight corrosion expertise as a vital differentiator. Graduates are leaving university with a strong desire for sustainable design, and by teaching them that corrosion control is essential to the 'whole-of-life' cost of infrastructure, we can weave a greater appreciation for our field into the fabric of New Zealand's future engineering landscape.

Declan Cruickshank

Oil, Gas & Energy Technical Group 2025

2025 delivered another great year for the Oil, Gas & Energy Technical Group.

The membership numbers of the Technical Group continued to climb from the previous year and throughout 2025.

We meet up every 2 months via Teams as our members come from all over Australia and New Zealand.

All members volunteer their time in their hectic schedules to bring passion and engagement to the industries that we work in aligned with the Technical Group.

These meetings include communications, knowledge sharing, industry projects and trends discussions, presentations & events planning by members.

Of particular presentation highlight this year was Nestor Sequera's from SN Integrity; Corrosion Monitoring at Santos Moomba Gas Plant.

Again this year there were a number of noteworthy successful activity highlights. In September we ran our annual webinar; Young Corrosion Professionals: From Lab to Field.

Another successful webinar that was highly attended and showcased young professionals in our industry covering a diverse range of topics, commended by all in attendance,

Notable individual stand out highlights by members of the Oil, Gas & Energy Technical Group include Prof. Mike Tan from Deakin University, the recipient of the MP Corrosion Innovation of the Year Award at the AMPP Annual Conference + Expo Nashville 2025 and Rodrigo Moraes Kunrath for his achievements as well deserving recipient of the Brian Cherry Award Winner 2025.

Final highlight to conclude another successful year was the Oil, Gas & Energy Technical Forum at C&P25 in Melbourne.

This year we presented two panel discussion sessions, one on our legacy Oil & Gas sector and one on the emerging Energy and renewables.

The Forum as always was well attended with an engaging audience participating in the panel discussions along with esteemed panellists from local and abroad.

This year concludes my 2 year tenure as Chairman of the Oil, Gas and Energy Technical Group. A big thank you to Margarita Vargas who has supported both myself and the Technical Group over this time and the same goes to all the members of the Oil, Gas and Energy Technical Group for all their support.

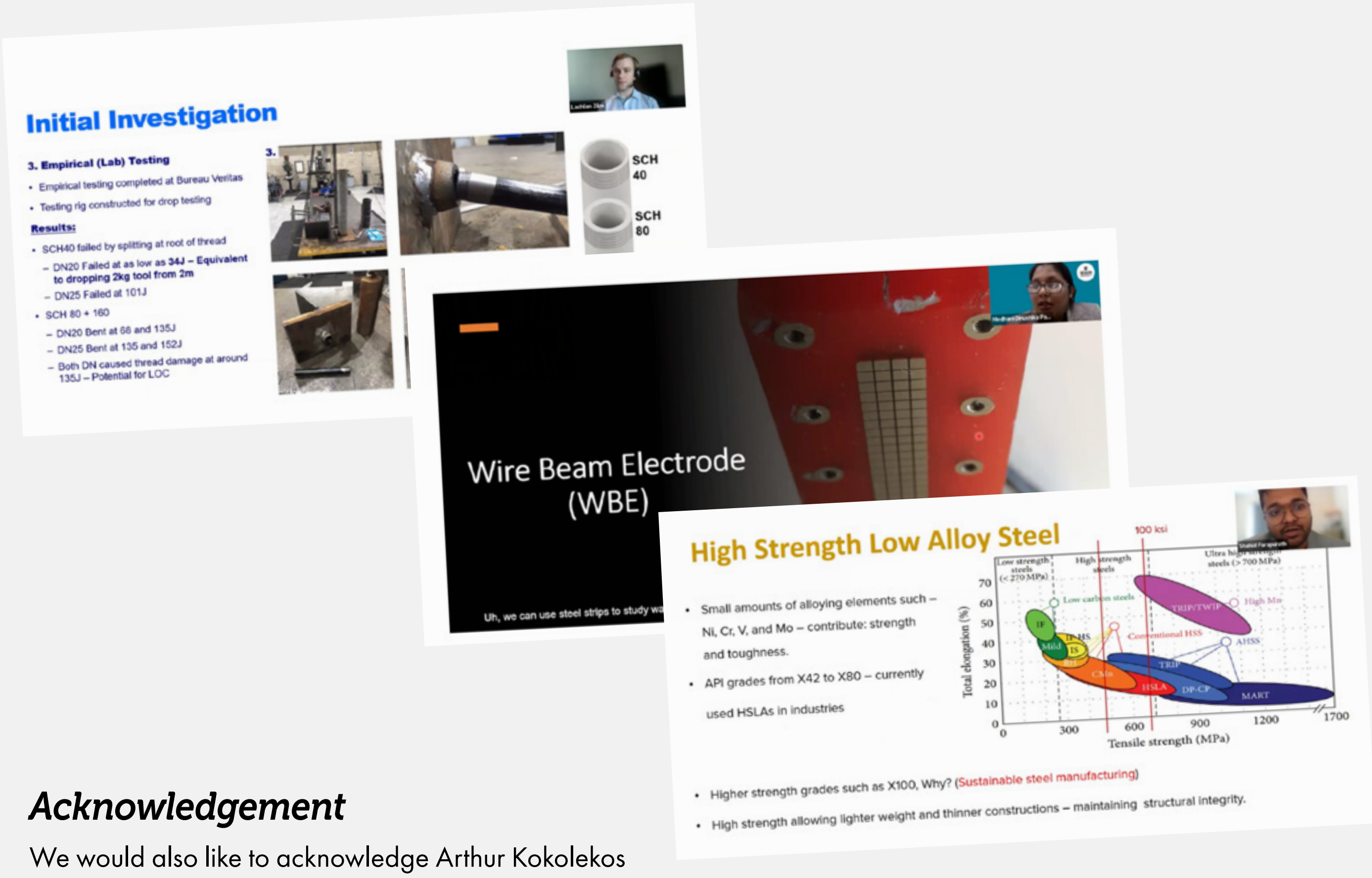
At our Technical Group Forum this year the baton has been passed over to Duncan Nicholas; new incoming Chairman and Rodrigo Moraes Kunrath; new incoming Secretary.

We wish them well with the same full support of the Technical Group as they continue the journey and upward trajectory of the Oil, Gas & Energy Technical Group as the shing star of the ACA for 2026 and beyond.

Arthur Kokolekos
Chairman
Oil, Gas & Energy Technical Group
Australasian Corrosion Association.

Oil, Gas & Energy Young Corrosion Professionals

From the Lab to field



Acknowledgement

We would also like to acknowledge Arthur Kokolekos (LuminUltra), Chair of the Oil, Gas & Energy Technical Group in 2025, who was awarded a Certificate of Recognition at the C&P26 Conference in recognition of his loyal and dedicated service.

Arthur played an integral role in the success of the Technical Group, providing strong leadership and making a pivotal contribution to the organisation and delivery of activities and webinars across the Oil, Gas and Energy sector on behalf of the ACA. His commitment, professionalism, and willingness to go above and beyond were instrumental in supporting member engagement and advancing technical knowledge within the industry.

We sincerely thank Arthur for his vital contribution, dedication, and continued support, and we greatly appreciate the impact of his work throughout the year.

News from the ACA Foundation Chairman

Wayne Burns, Chair – ACA Foundation Limited

It was a pleasure to present eleven ACA Foundation scholarship awards at the recent 2025 Annual Conference in Melbourne in November. The award decisions rested with the ACAF Education and Scholarship committee. Without the remarkable support of ten corporate and individual donors we would not have been able to achieve this record ouput.

ACA Foundation Scholarships 2025

Carboline NZ Award	Matthew Meylan (NZ)
CPT Award	Ylli Leka (QLD)
CRL Aust. Award	Nathanael Erwin (VIC)
Denso Student Award	Benjamin Bickerton (VIC)
Freyssinet Award	Dr Michaela Wawryk (QLD)
Infracorr YCG Award	Ata Aminfar (NSW)
MCM Award	Vincent Wong (NSW)
Metspray Award	Anthony Jujnovich (NZ)
Mike Rutherford Memorial Award	Ms Fiona Collins (QLD)
UCC Ray Osborne Memorial YCG Award	Miss Grace Bryant (NZ)
UCC Training Award	Michael Kururangi (QLD)

ACAF Corporate Donors / Sponsors

The ACAF has been very fortunate in gaining the support of corporate organizations who provide long term commitments to support ACAF Scholarship Programs. In 2025, through the hard work of our Sponsorship committee we are pleased to confirm the sponsors have provided the important funding that will allow scholarships to continue to be delivered.

For our 2026 Scholarship Program our Sponsorship team already have 18 potential corporate scholarship sponsors. We are anticipating the number to grow before the end of February. Should your company be considering a scholarship sponsorship please contact us via email – ACAFoundation@corrosion.com.au

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Scholarship History

Since its introduction of Scholarships in 2000, ACAF has now delivered more than 150 scholarships to ACA Members and related community members with a passion for decay.

- training scholarships
- post graduate scholarships
- Conference attendance assistance
- International education and travel scholarships
- Future Leaders Forum Program

ACAF Centurion Program

- The ACAF initiated the Centurion program in 2010 for individuals, corporations or community-based organisations to become donors for local and international scholarships, so young people can expand their knowledge and their careers in Corrosion Engineering, Corrosion Management or Specialist Corrosion Integrity and Prevention Programs.
- ACAF Centurion Donors can contribute as little as $100/ annum in support of future scholarships. Individuals can also make larger contributions on a regular basis. These charitable donations are all tax deductible.

Updating your Centurion & Donors Support

The ACA Foundation is proud of our members Centurion donor program. that has enabled delivery of the Scholarship programs for members & the wider community.

If you have been a Centurion supporter, please take this opportunity to continue your 2025/2026 membership by opening this link.

If you are a company or corporation, you can provide a scholarship program over a 5 year term. Open this link to make contact with one of our ACAF Directors to discuss the opportunity further. Be part of the future development of our young people's careers.

International exchange programs are coming. The opportunity for our young community to travel and foster future international participants in our Australasian business's rests with you.

The financial support provided from Centurions, Industry & the Business Community will help grow the expertise of our future generations and to ensure continued viability of the ACA community.

Acknowledgements from Scholarship Nominees

It is exciting when we receive responses from past scholarship recipients of how the scholarship program has contributed to their individual developments. We encourage you to visit our web site to see some of these acknowledgements.

We deeply appreciate you taking the time to read to our message. We look forward to your continued support as either a Centurion Donor or as a Corporate Scholarship donor for the longer-term.

Effects of Varying the Time Between Surface Preparation and Coating Application, on the Performance of Epoxy Marine Coating Systems Applied to Aluminium

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Keywords:

aluminium, aluminium corrosion, surface preparation, marine coatings

ABSTRACT

Specifications for application of marine coatings to aluminium substrates often nominate a maximum time limit of 4 hours between surface preparation and coating application. For larger vessels, this is usually not a practical proposition and not practicably enforceable for quality control inspectors or the shipyard's QA/QC staff. The origin of the four-hour time limit is not known with certainty and there is no literature in the public domain that supports or refutes that this time is critical to coating performance. This paper covers a recent study that explores the effects of varying the time between surface preparation and coating application on the performance of an epoxy marine coating system applied to aluminium. For the study, aluminium panels were abrasive blast cleaned at different intervals before application of the coating system, ranging from less than one hour to two weeks. After coating cure, scribes where cut through the coating and the samples exposed in a neutral salt spray cabinet for up to 1,000 hours. Performance of the coatings was reviewed by evaluation of corrosion and delamination at the scribe and testing of coating adhesion. The study revealed that there was no discernible difference in coating performance, regardless of the time left between surface preparation and coating application.

INTRODUCTION

This paper is based on a literature review, laboratory testing and practical experiments that were carried out for the preparation of a civil engineering thesis in 2022.[6] The topic of the thesis was chosen in a collaborative effort between Central Queensland University (CQU) and local marine industry practitioners when both parties discussed opportunities for research that would benefit the local industry and the community at large. The topic was derived from the practical issues experienced during maintenance

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painting of large aluminium vessels where the specification calls for a maximum time of four hours between surface preparation and coating application. This limit is difficult to comply with and adds significant cost to maintenance painting due to repeated re-blasting and dust removal, and the vessel being painted in sections rather than in large parts or in its entirety. The four-hour time limit does not seem to be based on known risks or established standards and it was therefore considered useful if it could be determined if extended exposure of prepared aluminium substrates before coating application would present risks to coating performance. Since the information gathered for the preparation of the thesis is of interest to the corrosion prevention industry and of practical value to corrosion protection practitioners, this paper summarises the key findings.

METHODOLOGY

The literature review and laboratory testing that was carried out serve to provide insights into the corrosion behaviour of aluminium, specifically in the early stages of the formation of the oxide film after surface preparation, and to put perspective on the time it takes for the film to form and the typical thickness of the oxide film.

For the practical experiment, aluminium sample panels were cut from a cropped section of the hull of a government department owned patrol boat. The cropped section was stored at the shipyard and all coatings had been removed by ultra-high pressure water jetting before the plate was cut out of the underwater hull of the vessel. At intervals between 15 minutes and two weeks before coating application, the panels were abrasive blast cleaned with garnet. For the period between abrasive blast cleaning and coating application, the prepared panels were stored inside the enclosure where this vessel type is normally prepared and coated. After testing for surface profile and the presence of residual contaminants, all prepared panels were coated at the same time with the anti-corrosive system that is normally applied to the same class of patrol boat.

After full cure of the coating system, the panels were exposed in a neutral salt spray cabinet for up to 1,000 hours and coating system performance evaluated to determine whether coating performance shows significant differences if the time between surface preparation and coating application is varied at regular intervals from 15 minutes and two weeks.

TYPICAL SURFACE PREPARATION REQUIREMENTS FOR ALUMINIUM

In the absence of an Australian Standard for corrosion protection of non-ferrous metals with the use of wet applied protective coatings, it is usually left up to the asset owner or the coating manufacturer to nominate the maximum permissible exposure time of the prepared surface before the first coat is applied. Contrary to popular belief, AS 2312.1 (for corrosion protection of structural steel) does not mention a time limit of 4 hours and it is unclear where this often-used limit originates from. It stands to reason that the most pragmatic approach to an acceptable exposure time should be determined by the condition of the prepared substrate at the time of application of the first coat, not the time of exposure. Provided that the specified cleanliness grade and acceptance criteria for residual contaminants complies with the specified requirements, the prepared substrate should be in a suitable condition to apply the coating. However, cleanliness grades that are typically specified for steel (e.g. Sa 2½) are not available for (other than SSPC-SP16, Brush-Off Blast Cleaning of) Non-Ferrous Metals and visual cleanliness requirements are normally specified by describing the required appearance of the prepared substrate. To specify acceptance criteria for surface profile and residual contaminants, the same parameters and test methods normally used for steel substrates are typically used.

LITERATURE REVIEW

Aluminium Oxide Layer

Aluminium spontaneously forms an oxide layer when exposed to clean air. Although the formation of the oxide layer is a form of corrosion, the layer is extremely thin (3-6nm depending on the grade of aluminium and other variables [1]), tightly adherent, and provides corrosion protection to the underlying material. Formation of the oxide layer occurs so rapidly that current experiments to study the mechanics of this reaction must be analysed in a vacuum chamber of a scanning electron microscope (SEM).

When reacting with oxygen, aluminium forms an amorphous aluminium oxide, known as alumina (Al203), which has been theorised to flow like a fluid across the surface of the aluminium as a thin layer [2]. SEM data presented by Cai, et al. in 2022 [4], suggested that the electrochemical reaction between aluminium and air in a vacuum produces a 1.74nm thick oxide layer in 51 seconds (see Figure).

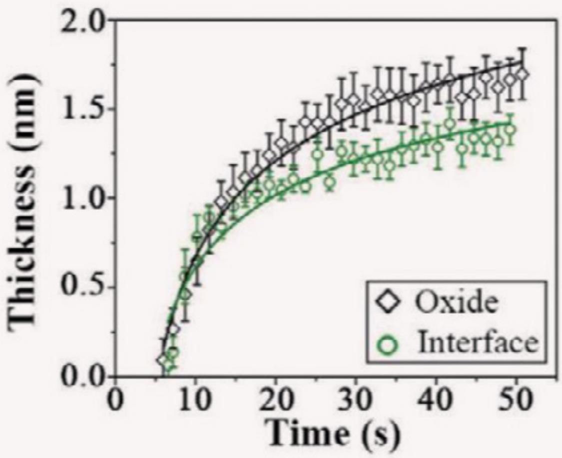

Figure 1 - Passive oxide film thickness over time from p.2 (Cai, et al., 2022)

The oxide layer grows in the atmosphere via the aluminium leaving the substrate and moving through the amorphous/para-crystalline layer of oxide, where it builds up on the interface between the air and the oxide layer. The growth rate and thicknesses achieved appears to vary. The rate of oxidation when comparing oxide thickness versus time is found to be logarithmic and follows the Cabrera-Mott equation [3] and shows that as the oxide thickness increases, the rate of oxidation decreases logarithmically as shown in the equation below.

$$x = k_e \log(at + l)$$

The graph in Figure 1 shows a logarithmic curve association, but in Cai's research it is mentioned that the Cabrera-Mott model doesn't quite fit the findings while using transmission electron microscopy (TEM). The findings deviate because at an atomic level the layering of oxide is not consistent, which the Cabrera-Mott model assumes. The growth of the oxide starts as small para-crystalline regions from intralayer disordering of the metal lattice and then transforms into an amorphous oxide with increased oxygen intake. The high-quality images in Figure 2 from the TEM analysis also demonstrates that the oxide growth on aluminium to a thickness of 1.74nm occurs over 51 seconds.

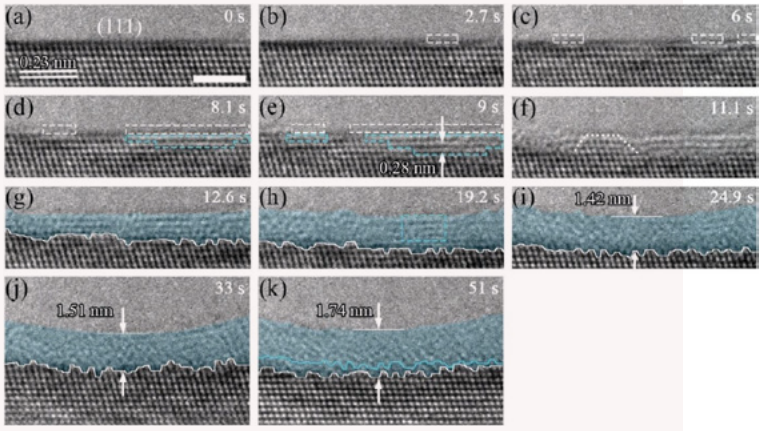

Figure 2 – TEM images for the growth of aluminium oxide (cai, et al., 2022)

The results from Figure 2, showing each atom at a high resolution, were not achievable before 1997. It wasn't until Ondrej Krivanek and his team developed the aberration corrector for the scanning transmission electron microscope (STEM). This invention enabled increased accuracy at the atomic scale. The FEI Titan 80-300 TEM used in the experiments by Cai, shown in Figure 3 is an extremely powerful piece of equipment and in 2008 was the most powerful electron microscope. The Titan 80-300 has high accuracy for analysis of atomic structures and the results shown in Figure 2 are some of the most accurate recordings of aluminium oxide build-up in illustrative form.

Due to the instantaneous build-up of oxide initially the experiments used to measure and analyse oxidation on aluminium have all required vacuums

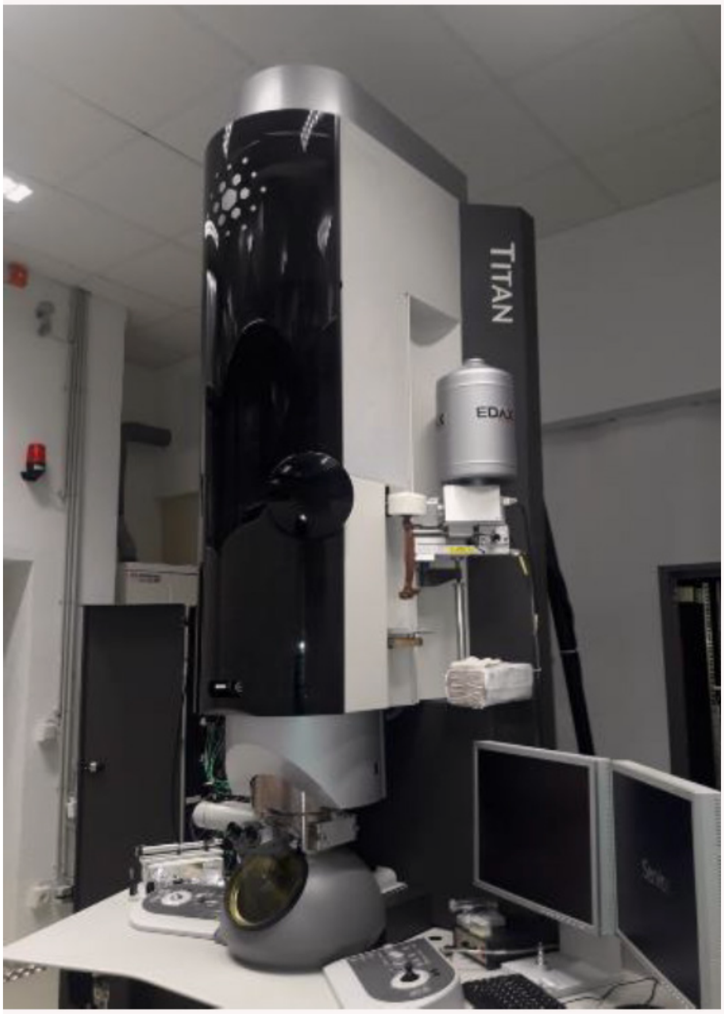

Figure 3 - Fei titan 80-300 tem used by cai et al.

and extremely controlled environments. The development of equipment for atomic analysis has improved over the past few decades and research has become easier and cheaper to find the thickness, growth rate and composition of oxidising metals.

Evertsson, J; et al., 2015, used X-ray reflectivity (XRR), X-ray photoelectron spectroscopy (XPS) and electrochemical impedance spectroscopy (EIS) methods to measure the thickness of oxide. The XRR and XPS results produced a good correlation of oxide thickness while the EIS showed significantly less thickness[1]. These varying results provide a good insight into the challenges of measuring thickness of aluminium oxide. Evertssons and the team's experiments were based on various alloys and demonstrated that EIS didn't measure the thickness accurately enough.

LABORATORY ANALYSIS

The literature review has brought forth results that demonstrate a rapid forming aluminium oxide on aluminium. Various spectroscopy and microscope tests were considered to determine the effect of exposure on aluminium oxide thickness. The tests considered include EDS, WDS and SEM. Consulting the Centre for Microscopy and Microanalysis (CMM) at the University of Queensland, it became evident that SEM wouldn't provide enough data to find thickness and EDS wasn't as accurate for oxides as XPS. UQ's Kratos Axis Ultra XPS system was ultimately selected to analyse the aluminium samples.

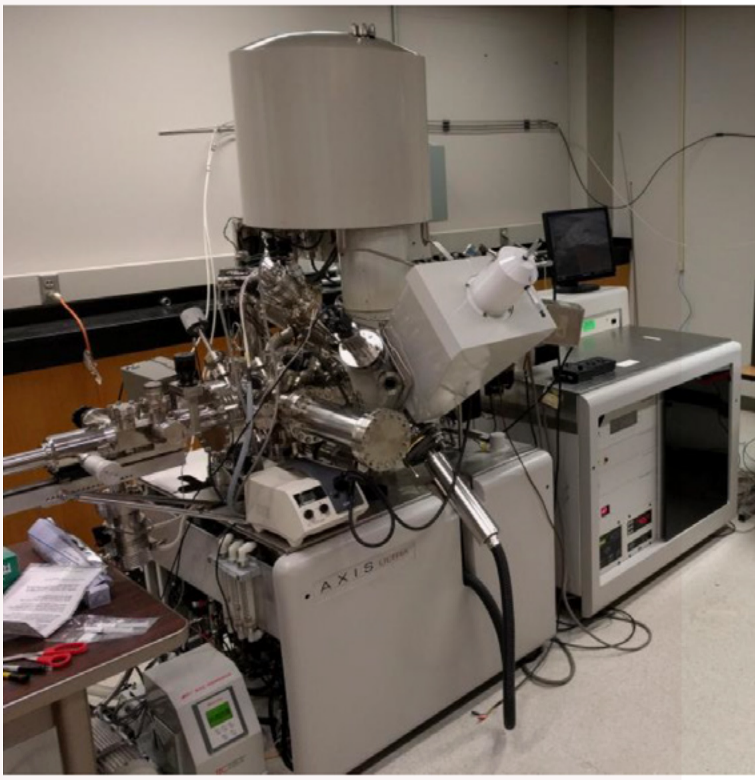

Figure 4- Kratos axis ultra x-ray photoelectron spectroscopy (xps) system (example)

The following process was used to obtain the XPS results.

- Three 10x10mm x 3mm thick pieces were cut out of shipyard's aluminium panel and sent to lab.
- The aim was to have samples analysed after an exposure time of 2 weeks, 1 day and as close as possible to 0 hours. However, maintenance issues at the laboratory resulted in a 3 week

exposure of the sample rather than the intended 2 weeks. The 3-week sample was not cleaned prior to placing it into the XPS machine.

- The laboratory cleaned the aluminium oxide off the 1 day and 0 hour sample before putting into XPS machine where an operator obtained the results.
- The results were then used to determine aluminium oxide thickness by using a calculation developed by B.R. Strohmeier & T.A. Carlson [5] as shown in the equation below.

$$d = \lambda_{ox} Sin\Theta \ln\left[\left(\frac{(N_m \lambda_m I_{ox})}{(N_{ox} \lambda_{ox} I_m)}\right) + 1\right]$$

- d = aluminium oxide thickness
- θ = photoelectron take-off angle
- Im = percentage areas of the metal peaks fitted from the high-resolution spectrum.
- Iox = percentage area of the oxide peaks fitted from the high-resolution spectrum.
- λm = inelastic mean free paths of the photoelectron for the metal.
- λox = inelastic mean free paths of the photoelectron for the oxide.
- Nm = volume densities of the metal atoms in the metal.
- Nox = volume densities of the metal atoms in the oxide.

The XPS generated results shown in the graphs in Figure 5 of high-resolution output data of the aluminium and aluminium oxide count. This data shows two peaks that demonstrate the quantity of the elements. In this case, the first peak is the aluminium oxide count and the second peak is the aluminium count. Upon first inspection it is clearly shown that the aluminium oxide increases between the 0 hours, 24 hours and 3 weeks exposure while the aluminium decreases. Cai, et al., 2022, used a different testing technique to find oxide thickness and demonstrated that the aluminium oxide growth is rapid. To confirm rapid intial growth, the oxide thickness results were calculated using the Strohmeier Equation and put into a graph presented in Figure . The values

Table 1 – Calculation results of oxide thickness using strohmeier equation (graphed in figure)

Exposure	Formula	Iox	Im	IMFPo λox	IMFPm λm	Nox	Nm	Sintheta (rad)	d(nm)
0 hour	Al /Alox	43.87	37.42	27.95	26.81	1.0000	1.5000	1.0	2.76
24 hours	Al /Alox	59.79	26.81	27.95	26.81	1.0000	1.5000	1.0	4.02
3 weeks	Al /Alox	73.76	17.5	27.95	26.81	1.0000	1.5000	1.0	5.46

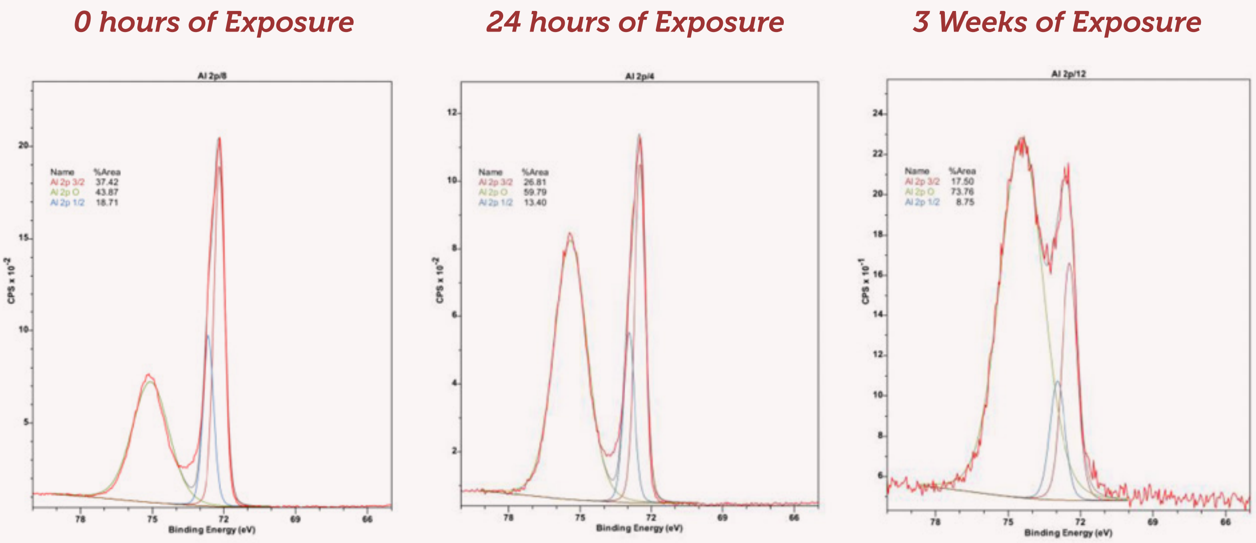

Figure 5 - XPS data: aluminium oxide results for varied exposure

presented in Table were obtained in various ways, including the percentage areas values, Im & Iox, from Figure which is the "Al 2p 0" percentage areas. Known values of aluminium and aluminium oxide were used for λox, λm, Nox & Nm. The photoelectron take-off angle is 90 degrees (sin $\pi/180$=1.0rad) and is standard for XPS test.

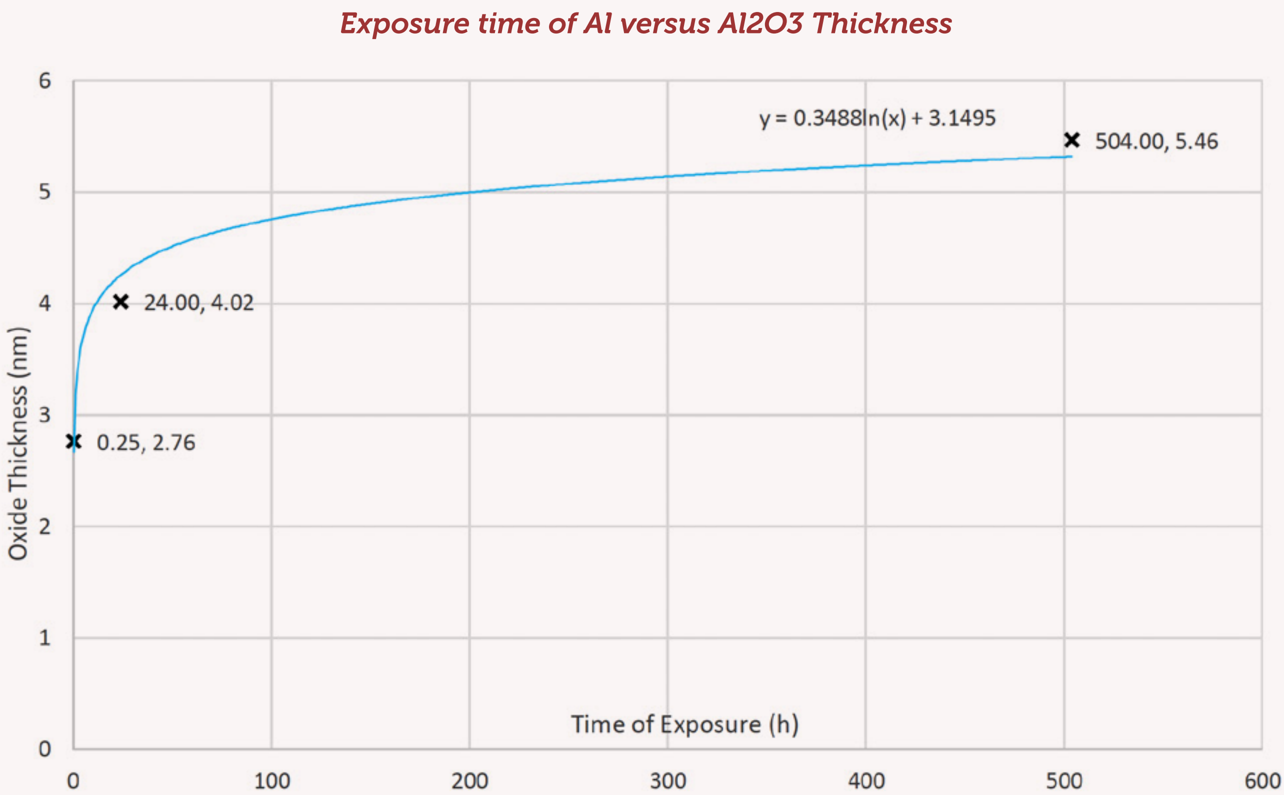

Figure 6 – Exposure time of aluminium versus aluminium oxide thickness – using strohmeier's equation

PRACTICAL EXPERIMENT

Sample Panels

For the practical experiment, a total of 21 aluminium test panels of A5 size (148 x 210 mm) were cut from a cropped section of the aluminium hull of a patrol boat. The grade of aluminium was not disclosed as it is to remain outside the public domain.

Selection of the number of exposure intervals dependant on the size of the SH-90 Salt Spray Chamber as it could only hold 18 samples. This limit meant that triplicate samples for five exposure times provided a good balance between repeatability and exposure time data points.

Based on the information gathered during the literature review, coating specifications and industry practice, exposure times of 14 days, 5 days, 24 hours, 4 hours and 0 hours (as close to zero as possible) were selected. Exposure of the coated panels in the salts spray chamber was dictated by the time limitation of the university term.

The panels were marked for easy identification at all stages of the experiment as shown in Table 2. Each sample ID was engraved on the surface and written on with a permanent maker. The ID numbers for samples are based on the time of exposure and if the sample is one of a triplicate. The identification system is as follows:

Table 2 – Sample identification

Test	14 Days	5 Days	1 Day	4 Hours	0 Hours	Sample Size mm	Coating	Evaluation
Salt Spray Chamber Samples	14D-#1 (*)	5D-#1 (*)	1D-#1	4H-#1 (*)	0H-#1 (*) 1	48 x 210	2 layers	Visual, Adhesion
	14D-#2	5D-#2	1D-#2 (*)	4H-#2	0H-#2	148 x 210	2 layers	Visual, Adhesion
	14D-#3	5D-#3	1D-#3	4H-#3	0H-#3	148 x 210	2 layers	Visual, Adhesion
Adhesion Test control	14D	5D	1D	4H	0H	148 x 210	2 layers	Adhesion
External lab	14D-XPS			4H-XPS	0H-XPS	10 x 10 x 3	None	XPS

Panels marked with (*) were exposed for 1000 hours, the remainder of the panels were exposed for 672 hours

- [Time of exposure] - [Numerical increase for one of triplicate sample]
  - E.g. Sample 2 of 3 for the 14 day exposure batch.
    - o 14D-#2
- Control samples can be identified only the time of exposure as they were not done in triplicate.
  - E.g. 5 days of exposure as a control sample
    - o 5D

Surface Preparation and Coating Application

At each selected interval, the batch of samples were abrasive blast cleaned with new fine grade garnet in a well-protected enclosure. All samples were blast cleaned to a visually clean and uniformly profiled surface free from staining or discoloration, similar to an 'Sa 3' cleanliness grade produced on steel. After removal of surface dust, the samples were placed horizontally, blasted side facing downwards on scaffolding within the blasting and painting enclosure, out of reach, and with 10-50mm gaps between samples.

Surface preparation and coating application was conducted at the same facility that is commonly used to drydock, prepare and repaint the aluminium patrol boats.

After 14 days when all samples had been abrasive blast cleaned and left exposed for the nominated intervals, dust was removed with clean compressed air and the first coat was immediately applied to the four 0 hour samples to keep the time between abrasive blast cleaning and coating application as short as possible. This resulted in a 15-20 minute exposure time of the 0 hour sample before the coating was applied by conventional spray.

Surface profile was tested on all remaining samples with a digital needle type micrometer, and the measurements produced a calculated average of 107 μm. According to the shipyard's painting foreman, this measurement is consistent with what is normally produced during the vessel refits.

A visual evaluation of the panels showed that the 14 day exposure panel had slightly discoloured to a darker grey than the other panels. Some of the panels showed visible fingerprints with 20 mm from the edges.

Residual soluble salts were tested on one each of the 14D and 5D samples using Bresle patches, both returning values below the maximum permissible 5μg/cm^2. Curiously, the 14D sample returned a somewhat lower residual salt level than the 5D sample (3.8 vs 4.8 μg/cm^2 respectively).

Climatic conditions were measured at RH 62.5%, Ta 25.5°C, Ts 25.6°C, Td 17.8°C, ΔT 7.8°C.

The remainder of the panels were coated but wet film thickness gauging indicated that the dry film thickness (DFT) was going to be somewhat higher than normally specified, but still within the limits recommended by the coating manufacturer. The second coat was applied a day after the first coat.

The coating material used is a solvent borne pure epoxy formulation without aluminium pigmentation that is normally used for the first two layers (2 x 150 µm DFT) above and below the waterline.

After a 7 day cure of the second coat, the dry film thickness on each panel was measured with an electronic non-ferrous DFT gauge. The location of the measurements on each panel is shown in Figure 7 and the test results are show in Table 4.

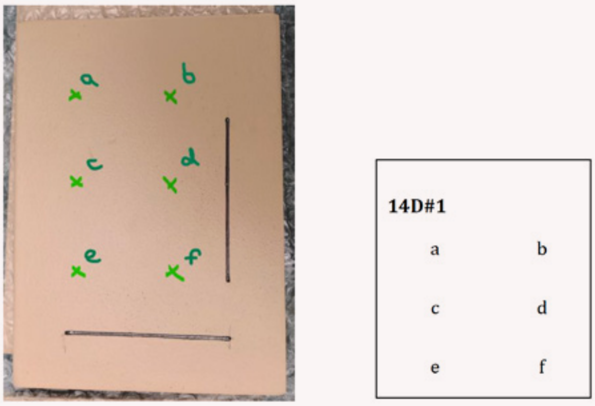

Figure 7 – DFT measurement positions

Table 4 DFT test results

14D#1	
522	530
518	502
548	584
Ave = 534µm	

14D#2	
478	474
460	462
466	482
Ave =	470µm

14D#3	
390	428
435	422
438	458
Ave =	429µm

5D#1	
524	480
564	504
558	476
Ave = 518µm	

5D#2	
430	422
498	512
388	374
Ave =	437µm

5D#3	
380	430
430	460
412	496
Ave =	435µm

/*1D#1	
456	416
470	376
476	406
Ave =433µm	

1D#2	
424	498
448	446
500	458
Ave =	462µm

1D#3	
410	372
402	388
480	418
Ave =	412µm

4H#1	
376	394
384	370
430	364
Ave =386µm	

4H#2	
364	372
402	446
406	466
Ave =	409µm

4H#3	
392	410
434	456
394	466
Ave =	425µm

0H#1	
386	386
384	374
424	422
Ave =396µm	

0H#2	
412	392
402	372
390	384
Ave =	392µm

0H#3	
426	496
432	468
388	442
	442µm

The test cabinet shall be operated in accordance with the following conditions using the test solution specified in Clause 5:

(a) Test cabinet temperature....................35 +2°C.

(b) pH of collected test solution....................6.5 to 7.2.

(c) Average collection rate of sprayed test solution over a minimum period of 24h for a horizontal collecting area of 80cm' .... 1 mL/h to 2 mL/h.

(d) Concentration of NaCl in collected test solution....................50 $10 g/L.

Figure 8 - Cabinet operating conditions (AS 2331.3.1:2001, Cl. 7.1)

Salt Spray Chamber

For accelerated testing of coating performance, the neutral salt spray test (NSST) to AS 2331.3.1:2001 was used for this experiment. The NSST has a consistent salt spray mist and keeps the temperature and pressure constant throughout the test.

Initially, the time allocated for NSST was 1000 hours whoever 10 of the 15 samples were taken out after 672 hours due to time constraints for university assessment timelines. To compare changes, photographs were taken of every sample prior to placement in the SSC, to compare with results after salt spray testing.

The salt spray chamber was monitored in order to top up the salt water and empty the spray rate tubes. Operating conditions of the cabinet adhere to AS 2331.3.1:2001, shown in Figure 8.

Panel Evaluation

After exposure in the salt spray chamber, the panels were visually assessed for the presence of coating defects and the extend of corrosion creep from the scribe. Results are shown in Table 6.

- Column 1 - AS 1580.481.3:2002 – Degree of overall corrosion of coating
- Column 2 - AS 1580.481.1.8:1998– Cracking of the coating
- Column 3 - AS 1580.481.1.9:1998 – Blistering of the coating
- Column 4 - AS 1580.481.1.10:1998 – Flaking and peeling of the coating
- Column 5 - AS 1580.481.3:2002 - Undercutting corrosion, around the scribe

The zero results for all panels show that there is no obvious performance difference between the varied exposure times. One of the more interesting observations was that there was no appreciable corrosion creep at the scribe as shown in Figure 9. These results are somewhat inconclusive as to the mechanisms or variables that prevent corrosion creep but it appears that the coating's adhesion to the substrate outweighs the variables associated with differences between exposures.

Adhesion testing

Coating adhesion tests were performed on samples that were in the salt spray chamber (SSC) for 672 hours and the control samples. Using the method described in AS 1580.408.5:2006, roughened 20mm diameter aluminium dollies were glued to the prepared coated surface of the panels and the adhesive left to cure for 24 hours. A PosiTest AT-M Manual adhesion tester was used to get the results shown in Table 1 and depicted in Figure 10. The same process was repeated for the extra samples that were left in the SCC for 1000 hours, and the results are shown in Table 2. This extra time was used to determine if more variations in the test results would occur.

The results in this Table 1 show that the coating adhesion values consistently stay around 10MPa where glue failure didn't occur. The control samples showed slightly less coating cohesion than the salt spray chamber. Perhaps the higher temperature and

PANEL EVALUATION AFTER SCC EXPOSURE					
Test	14 Days	5 Days	1 Day	4 Hours	0 Hours
14D#1	0	0	0	0	0
14D#2	0	0	0	0	0
14D#3	0	0	0	0	0
5D#1	0	0	0	0	0
5D#2	0	0	0	0	0
5D#3	0	0	0	0	0
1D#1	0	0	0	0	0
1D#2	0	0	0	0	0
1D#3	0	0	0	0	0
4H#1	0	0	0	0	0
4H#2	0	0	0	0	0
4H#3	0	0	0	0	0
0H#1	0	0	0	0	0
0H#2	0	0	0	0	0
0H#3	0	0	0	0	0

Figure 9 - Photo of scribe of 14D#3 after 672 hours in SSC

humidity in the salt spray chamber have somewhat improved the cure of the epoxy coatings.

Results from Table 2 offered quite different values compared to the samples from the 672 hours SSC exposure. The biggest difference is the pull-off strength is a lot lower for 5d, 4h and 0h batches, but the results are distorted by the relatively high number of glue failures. If the values for glue failures are removed, the remaining values still indicate that the adhesion between the substrate and the epoxy coating are quite similar.

The failures/fractures shown in Figure 10 never occurred at the substrate to coating interface, which indicates that the adhesion of the epoxy coating to the aluminium substrate is stronger than the cohesion of the epoxy coating or the adhesive. Failures below 9.8MPa all showed predominant glue failures. Since there is no failure at the substrate, this implies that the varied exposure doesn't affect coating performance even after 1000 hours of SCC exposure. The data from adhesion testing suggests that there is a correlation with the corrosion creep results in Table 6. where the substrate wasn't compromised at all by undercutting corrosion from the scribe.

ADHESION TEST: 672 HOURS SSC VS CONTROL									
14 days	Adhesion (MPa)	5 days	Adhesion (MPa)	1 day	Adhesion (MPa)	4 hours	Adhesion (MPa)	0 hours	Adhesion (MPa)
14D-#2	12.19	5D-#2	7.77	1D-#1	10.62	10.62	10.88	0H-#2	10.76
14D-#3	10.49	5D-#3	10.51	1D-#3	10.98	4H-#3	9.33	0H-#3	9.87
Average	11.34		9.14		10.80		10.10		10.32
14D-CTRL	10.66	5D-CTRL	10.46	1D-CTRL	4.55	4H-CTRL	8.26	0H-CTRL	9.13

Table 1 – Adhesion results for samples in salt spray chamber for 672 hours and control samples

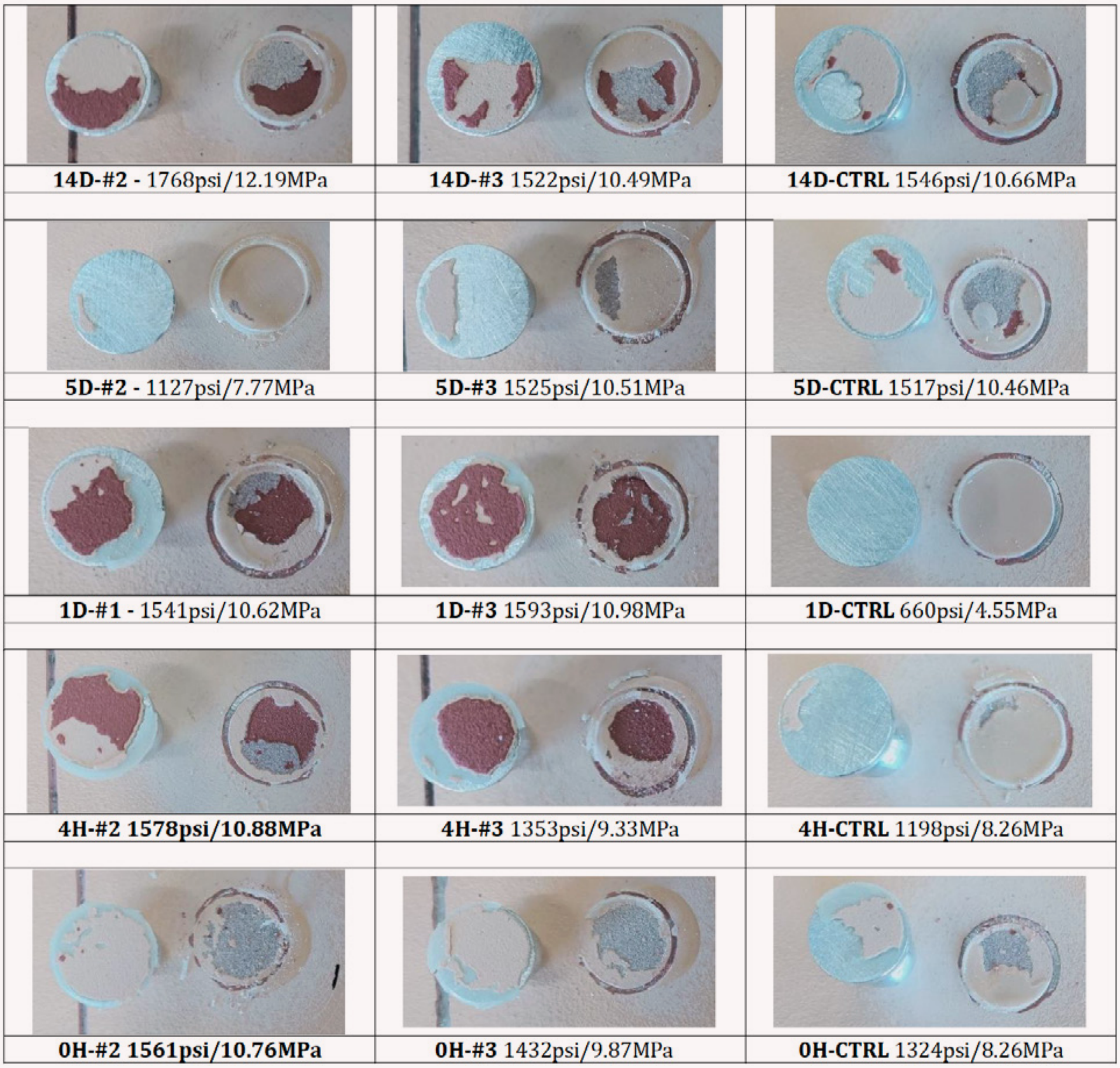

Figure 10 - Photos of coated surface (RHS) and dollies (LHS) after adhesion testing upon 672 hours exposure in SSC

ADHESION TEST: 1000 HOURS SSC VS CONTROL									
14 days	Adhesion (MPa)	5 days	Adhesion (MPa)	1 day	Adhesion (MPa)	4 hours	Adhesion (MPa)	0 hours	Adhesion (MPa)
14D-1 top	10.62	5D-#1 top	6.23	1D-#2 top	7.05	4H-#1 top	6.01	0H-#1 top	5.92
14D-#1 bot	7.97	5D-#1 top	7.56	1D-#2 bot	9.40	4H-#1 bot	6.07	0H-#1 bot	6.81
Average	9.29		6.90		8.23		6.04		6.36
14D-CTRL	10.66	5D-CTRL	10.46	1D-CTRL	4.55	4H-CTRL	8.26	0H-CTRL	9.13

Table 2 - Adhesion results for samples in salt spray chamber for 1000 hours

DISCUSSION

The experiments have been basic in nature and more testing may give further insights into possible coating performance risks that have not become obvious in the experiments covered in this paper. Literature review and lab testing provided a better understanding of the development of the aluminium oxide layer and provides an insight to the risk they may pose to coating performance. Perhaps further testing of the coatings at various intervals may reveal more useful information about likely coating performance in the long term and it would be interesting what for example EIS might show on panels that are prepared and coated in a similar way to the practical experiment.

CONCLUSIONS

The practical experiments indicate that the performance of the coating is not compromised by leaving prepared aluminium exposed for prolonged periods before application of a coating. The authors do not advocate that prepared aluminium surfaces are left exposed for days or weeks and acknowledge that all surfaces still need to comply with surface profile requirements and be clean (acceptable levels of residual salt and dust) before any coating is applied. The overall findings outlined in this paper do however indicate that imposing a time limit between surface preparation and coating application in an attempt to prevent oxidation is futile. If further testing confirms that longer exposure times do not pose a risk to coating performance, surface preparation and coating application to aluminium substrates can be made more cost effective and sustainable if the maximum exposure time is relaxed by specifiers.

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AUTHOR DETAILS

Henry Morrow is a mature aged Graduate Civil Engineer with five years of solid industry experience. With degrees in Civil Engineering, Mechanical Engineering, and Small Business, Henry has a unique blend of technical expertise. Until Henry started the research that is covered in this paper, he had no prior exposure to the corrosion protection industry but was offered an opportunity to get involved in this field by the ACA Coating technical group's mentoring initiative to connect academia and industry and attract new people to the industry.

Oscar Duyvestyn has a life-long career in corrosion prevention and specializes in protective coatings and linings. In over 30 years, he has worked in a variety of industries in different capacities in Australia, Europe, The Middle East, South-East Asia and PNG and has prepared more than 500 technical specifications for the protection of complex steel and concrete structures. Oscar is a Certified Materials Professional, a AMPP Senior certified coatings inspector, as well as a AMPP CIP and CCI course instructor.

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Let's Get Talking: Bridging the Gap in CP Interference Management

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ABSTRACT

One of the most underestimated threats to pipeline integrity on a shared right of way (ROW) is interference, affecting cathodic protection (CP) systems. With urbanisation and development occurring rapidly, the energy corridors naturally become more congested with new installations of pipelines, high voltage alternating current (HVAC) powerlines, railway systems, and most recently renewable energy installations. All these developments increases the possibility of both steady state and dynamic interference, which can compromise CP performance, jeopardise pipeline integrity and induce personnel safety hazards.

This paper identifies the three gaps that hinder effective interference management in CP, namely technical, organisational, and skills and awareness gap. It addressed the importance of proactive collaboration between stakeholders, accurate data acquisition and interpretation, at the same time prioritising continuous monitoring of installed mitigation systems. Through these three case studies, it highlights the consequences of inadequate proactive mitigation plan, systems that are lagging behind new developments, and the influence of HVAC powerlines influencing typical inspections methodologies.

By bridging the gaps and adopting a holistic approach towards interference mitigation and management, the industry can move beyond reactive responses. It is not only a technical necessity, but also an integral part of ensuring asset integrity and can minimise the environmental, social and governance (ESG) reputational risk by potentially avoiding any leak or failure from occurring.

INTRODUCTION

Pipelines are considered a crucial form of energy transportation; in fact, they can be treated as the backbone of energy transportation. Typically, any buried metallic installation, for example steel pipeline installation will require external corrosion mitigation method. The first barrier of protection applied on the pipeline will be involving a coating system, which is impermeable and has to coat the entire surface area, protecting the pipeline from the aggressive environment. The second barrier of protection will be using an electrochemical method: cathodic protection (CP). CP is implemented either using an impressed current system or sacrificial anodes to polarise the structure, protecting it against metal ion loss in an electrolyte. With this technique operating continuously, the buried steel lasts indefinitely, as metal loss from the steel pipeline is avoided.

However, with the ever-growing demand for energy, utility corridors and shared easements become increasingly congested with co-located infrastructures. These infrastructures include pipelines owned by other operators, high-voltage AC (HVAC) powerlines, water lines, telecommunication cables, electrified railways, and lately with increasing traction in the energy field, renewable energy installations. All these infrastructures could potentially cause CP interference instigated by stray current, which is a very real and proven threat that compromises the asset integrity and even increase the risk of personnel safety working on existing installations guarded by CP systems. Additional external factors that could potentially compromise pipeline integrity are aging coating systems, third party activities such as excavation that cause mechanical damage to the pipeline itself or its coating, and any vandalism or right of way (ROW) encroaching activities.

Interference is commonly grouped into two categories, namely static which is steady-state and dynamic which is time dependent. Static interference, such as that from adjacent CP systems or even new underground metallic installations, causes a relatively constant shift in pipe-to-soil potentials and can often be detected and mitigated with conventional drainage bonds and grounding improvements. On the other hand, dynamic interference, results from time dependent sources such as fluctuating AC loads of powerlines, DC transit systems, large rotating machinery, naturally occurring telluric current, and even power system fault events. These transients are often hard to detect as it does not occur all the time and can be misinterpreted by an untrained eye. Most importantly, it can potentially lead to cyclic polarization and depolarization of the pipeline, increasing the risk of coating degradation and AC-induced corrosion.

Despite the various methods proven to be successful in mitigating interference, there are still significant gaps remaining in the way pipeline and utility operators and various stakeholders collaborate to address the risk. Data sharing between operators is often limited, or in fact non-existent; dynamic interference occurrences are often missed by conventional survey techniques or untrained data interpreter, so simulation and modelling approaches are not matched with actual site happenings, thus not providing the actual results. Furthermore, the rapid expansion of renewable energy sources in these recent years, especially in photovoltaic and wind farms which are highly dependent on the weather conditions introduces new possibilities of interference due to rapid DC power generation fluctuations, in which the influence on pipeline interference is still ambiguous.

This paper delves into the gaps in terms of technical, organizational, and knowledge that hinders effective interference management and stewardship on shared ROWs by different owners. Interference in CP protected cross country pipelines is not a sci-fi fiction and shall be acknowledged and actioned by the respective stakeholders. Sessions to get together talking such as electrolysis meetings, coordination with various Stakeholders and Owners along this shared easement or ROW, its appropriate CP engineering, and other interference causing assets must not only be taken into consideration, but to be actioned accordingly. By "let's get talking" across utility boundaries, asset owners can better protect critical infrastructure, minimize corrosion risk, and improve public and environmental safety.

TYPICAL INTERFERENCE CLASSIFICATIONS

The definition of the term interference in the field of cathodic protection, refers to only electrical interference. Thus, it can be defined as any measurable or detectable electrical disturbance on a structure caused by current travelling through an unintended path, which is fondly known as stray current. Due to the nature that earth is a conducting medium for electrical systems, any such system in contact with earth is considered grounded and will be a potential source of stray current. [1]

As mentioned earlier in the introduction section, generally there are two types of interference namely steady state and dynamic. These two types of interference can be further broken down into individual categories which will be discussed in the following sub-sections.

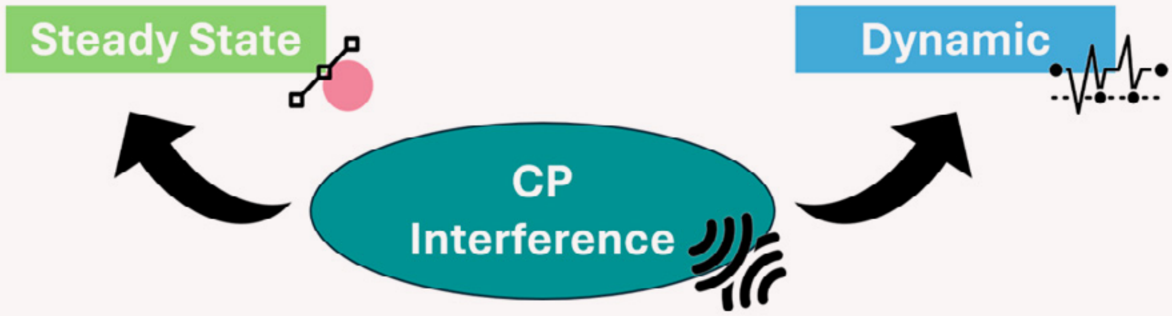

Figure 1: Two types of CP interference

Steady State Interference

Steady state interferences are generally caused by a relatively constant disturbance of similar magnitude and direction over an extended period of time. One fine example of steady state interference is nearby CP systems, especially impressed current CP (ICCP) systems as an existing buried metallic structure can be an attractive current path for stray current. The stray current picked up by the metallic structure is usually caused by the anodic voltage gradient of the nearby ground bed of the other pipeline protected with CP. If there are no electrical bonds or direct electrical path between the two structures, stray current will discharge from the location remote from the current pick-up area of the metallic structure.

When two pipelines cross one another, there is also a high chance that interference due to stray current will occur. This is due to the lowered structure resistance because both pipelines are now considered to be in close proximity. The pick-up and discharge locations are unique to the site conditions and vary from one area to another.

On top of that, bad construction practices combined the lack of isolating flanges or monolithic isolation joints might cause electrical shorting between new and old pipelines running on different CP system can also cause steady state interference.

The negative effects of steady state inference can be mitigated. However, prior to any mitigation work being performed, all related and relevant interference tests involving all stakeholders should be conducted. This is best handled via an electrolysis committee, where all parties share the data of each other's asset for a mutually accepted mitigation methodology. The prescribed mitigation methodology that is unique to the location and severity of that particular interference, and it should also take into consideration the financial impact and CP operational preferences of all stakeholders. Some of the simpler and more direct potential mitigation methodology for static interference caused by CP system stray currents, could be just to reduce the output current or totally remove the interference source or to install an electrical bonding between interfering and interfered-with structures.

Dynamic Interference

Dynamic interference is time dependent and vary in magnitude and/or direction. There are many known causes of dynamic interference that have been observed in the field. Some of the known dynamic interference sources are:

i) HVAC Powerlines:

HVAC powerlines could transfer electrical energy to a pipeline by potentially cause interference via three different mechanisms. These three mechanisms are namely capacitive or electrostatic coupling (which only occur at aboveground appurtenances), conductive coupling which occurs during fault condition, and electromagnetic or inductive coupling. All three mechanisms have different behaviour and are deleterious to the protected structure due to the potential of AC induced corrosion.

One very important fact about AC interference is that it could possibly cause a safety hazard to personnel working on the pipeline or even the general public, especially when the conductive coupling effect result in high pipeline voltages. This elevated pipeline voltage can cause electrical shock or even ventricular fibrillation or heart failure in severe cases when the unfortunate individual comes into contact with the induced pipeline via its monitoring cables at test points or any exposed pipeline appurtenances, or even by just simply standing within the vicinity of an energised structure in contact with earth.

It is important to mitigate the effects of interference caused by HVAC powerlines to reduce risk of AC corrosion, but most importantly to prevent and eliminate the electric shock hazard. Modelling and simulation of AC interference is crucial in provide iterations of mitigation designs which can allow the evaluation of various design options and predict the severity of AC interference and effectiveness of mitigation. AC interference mitigation has the main goal to prevent electrical shock hazard by ensuring the touch and step voltage are well below dangerous levels and protecting pipelines from AC corrosion to ensure asset integrity. Common AC interference mitigation measures include ensuring a safe separation distance is adhered to prevent arcing during fault conditions, the prescription of polarisation cells, solid state decouplers, equipotential mat, deployment of 'dead front' test stations on site, etc. Prescription of AC mitigation methodology is unique to individual cases. Remote monitoring units (RMU) and/or remote datalogging units (RDU) for test points paired with stationary reference electrodes that have AC monitoring capabilities at areas with known AC interference can provide valuable data and pattern monitoring, providing pipeline owners a chance to monitor any AC mitigation installations or take action before the issue worsens. This recommendation is also in line with the recommendations as per field investigation done with Sabkha Soil with regards to AC corrosion [2].

ii) Traction systems:

Traction or railway systems such as electrified rail lines, trams, light rails, metro or subway lines can affect nearby CP systems. Despite the relatively low resistance path in railway systems, current leakage from the rails can be up to 5-10% of the load current [1], causing stray current. On top of that, electromagnetic fields (EMF) of their onboard motor and power transmission systems can also cause electrical disturbance.

The location of stray current pick up will change as the rail carriage move along the rail, and the magnitude of the stray current can vary whenever the velocity of the rail carriage increase or decrease. However, the discharge point(s) will generally remain localised and are usually close to the substation ground, electrically discontinued joints or even crossings remote or far away from the substation ground.

Interference caused by traction or railway systems can be mitigated by various means such as installing electrical isolation or decouplers for the rails and substations, force drainage bond, reverse current switches, etc. However, as always, the prescription of mitigation methodology differs from one site condition to another [1].

iii) Large rotating devices:

Large rotating devices such as pumps and motors are prone to causing interference in piping systems within plants as the EMF given out by such devices are picked up. Despite being observed on site, insufficient studies have been conducted to provide further explanation and suitable mitigation method.

iv) Telluric current:

Telluric currents are geomagnetical natural electric current that flows on and beneath the surface of the earth [3]. It also affects metallic structures such as pipelines and powerlines. Telluric current is a result of the interaction of the Earth's magnetic field and charged solar particles entering the atmosphere. Generally, telluric current follows a direction parallel to the Earth's surface and this current can manifest into current and potential fluctuations on buried metallic structures.

Telltale signs of telluric interference is that induced voltage peaks are prominent at pipeline installed on a east-west direction, near a seacoast, close to the Earth's magnetic poles (but not directly at the poles), or near areas with abrupt changes in seismic properties or mineral compositions. Other factors that can contribute to geomagnetically induced voltage peaks are the presence of isolating joints, changes in pipeline direction, long pipeline lengths, high pipeline coating resistance value and high soil resistivity.

The mitigation of telluric current interference is similar to the mitigation of AC interference as both involve induced current.

v) Emerging renewable energy sources:

Emerging renewable energy sources such as large scale photovoltaic or solar farms, wind turbine farms, wave energy farm, etc. generate large amounts of DC and are highly dependent on weather fluctuations. This large surge of power generation can potentially cause electrical disturbance to metallic structures within the vicinity. Due to the recent development and rapid expansion within the last five years, there are still insufficient studies that have been conducted to provide further explanation and suitable mitigation method.

Why is it important to mitigate interference?

The section above provided the various mechanisms of interference, thus a holistic view of why it is crucial to mitigate interference can be discussed. A diverging radial chart below shows the importance of interference mitigation, approached holistically and considering all internal and external factors.

The main goal of any interference mitigation is to safeguard asset integrity as interference is known to cause disruptions in the CP system and in extreme scenarios cause localised corrosion at a current discharge point which results in metal loss. Tackling interference enables optimum CP levels to be sustained to effectively ensure the protection criteria is maintained along the protected structure.

There are good reasons why industrial standards are available to be referred to as these standards are developed and peer reviewed to ensure relevance to the industry. For example, the ISO15589:2015 discusses the various potential causes of interference

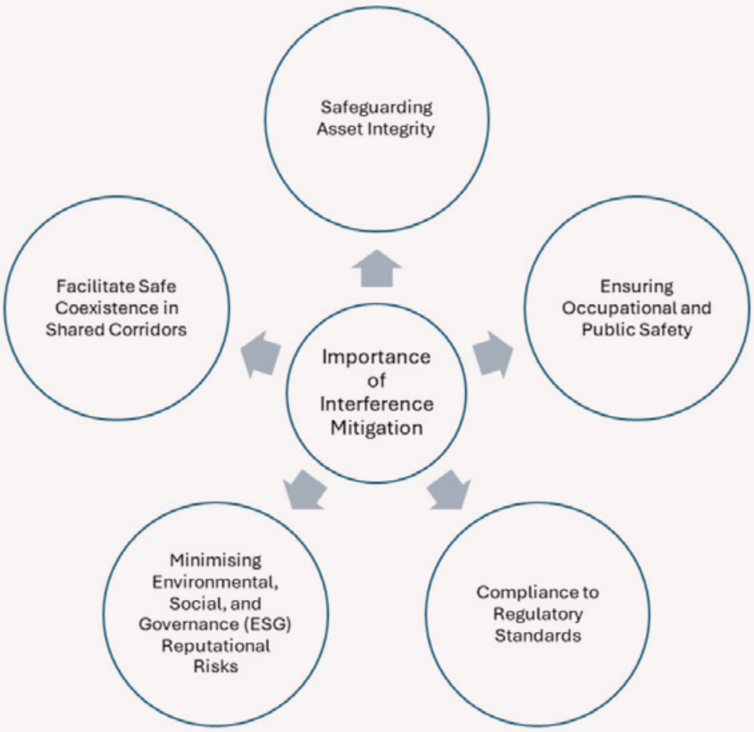

Figure 2: Importance of Interference Mitigation

for both DC and AC sources, typical tests to determine interference, and possible mitigation methods [4]. Whereas, NACE SP0169-2024 has a whole section titled 'Control of Stray Currents' which discusses the mechanism and causes of stray current interferences, typical test methods and methods for mitigation [5]. Two standards which focus more AC interference are NACE SP0177 and SP21424. NACE SP0177 specifically discussed on the mitigation of AC and lightning effects on metallic structures and corrosion control system, which also covers the effects of AC power faults and lightning on human safety [6]. Whereas, SP21424 is focused at providing guidelines and procedures specifically for underground, cathodically protected steel pipelines to be used during risk assessment, mitigation and monitoring of corrosion caused by AC powerlines located within proximity to the pipeline [7].

Interference, especially AC interference can cause shock hazard to personnel working on the structure and public in some cases. Dangerous touch or step potential can happen at test points or exposed pipeline appurtenances during faults. To ensure occupational and public safety, appropriate mitigation measures must be performed to minimise risk of shock hazard.

Any leak or failure in pipelines will result not only in a catastrophic disaster if it is related to a hydrocarbon pipeline, but also major inconvenience to the general public if it is a water pipeline. Hence, interference mitigation can minimise the environmental, social and governance (ESG) reputational risk by potentially avoiding any leak or failure from occurring.

Last but not least, interference mitigation facilitates safe coexistence in shared corridors as it provides owners of different pipelines on a shared ROW the opportunity to sit down and talk together, sharing the issues and challenges they each face and come out with a mutually agreed solution.

GAPS IN CP INTERFERENCE MANAGEMENT

As of any unresolved technical issue, there definitely is a gap involved which hinders the understanding of the issue, hence preventing a solution to be made. Based on our observations and site encounters, CP interference management does not only involve technical gaps, but also involving gaps which are non-technical based, namely organisational gap and skills and awareness gaps. Sub-sections below discuss on the gaps and their root causes.

Technical Gaps

Technical gaps are caused by the deficiency in technical solutions, result taking methodology and uncertainties in standard methods. As interference is a complex issue, the mitigation of it naturally comes with many challenges. The prescription of resistive / coupling bonds and decouplers is complex and involves much understanding and available data for an optimised solution.

On top of it, due to the nature of interference, it can be missed easily during periodic surveys, and this issue is further exacerbated by the lack of remote monitoring / logging units with stationary reference electrodes having built in AC and DC monitoring coupons for high importance areas of interference which provides continuous data acquisition and transmitted back via online networks, allowing the issue to be identified, understood and appropriate mitigation can be designed and implemented.

The uncertainties arise from emerging renewable energy sources coupled with the lack of understanding and research for interference caused by renewable energy is also a technical gap and it is an area that should be looked into.

Organisational Gaps

Organisational gaps are targeted mostly at management factors. Based on experiential feedback, one of the biggest gaps identified is the presence of Management who prefers a 'one size fits all' solution towards mitigation, which generally would not work for interference as each case is unique. This 'one size fits all' outlook is also adopted by those who are inapt to perform the work, however, it could be just lumped under their scope as the generalist consulting engineer.

Reactive management style that focuses on overreaction and assigning blame, instead of providing support to solving an issue, discourages site personnel from reporting abnormalities, thus leading to a culture of concealment and the lack of transparency, which could lead to a hazardous situation

Skills and Awareness Gaps

Skills and awareness gaps are more towards knowledge and skills factor. CP personnel with sound knowledge of interference testing methodology troubleshooting combined with advance data analysis are truly hard to come by as the site exposure, theoretical knowledge, training and experience required is tremendous. The usage of correct tools and equipment by CP personnel is also crucial in performing the interference test correctly.

Awareness on the severity caused by interference may not be seen as important by many as the issue does not cause an immediate physical reaction, but if a physical reaction does occur, it has already severely affected the integrity of the structure.

APPROACH TO BRIDGE GAPS FOR BETTER INTERFERENCE MANAGEMENT

The failure to address the gaps as discussed in the section earlier will potentially expose the pipelines to accelerated corrosion issues, unsatisfactory CP protection levels and potential safety incidents. A proactive and holistic approach is a must in managing interference and acquiring and gathering of different stakeholders to work together.

Establishing a structured stakeholder collaboration framework that includes data-sharing protocols and joint electrolysis or interference committees amongst asset owners and managers sharing a right-of-way (ROW) will enhance coordinated action and transparency. Such collaboration enables joint ROW assessments and mitigation studies to be conducted more effectively and even cost efficiency. Furthermore, developing and agreeing upon standard operating procedures (SOPs) for interference response and mitigation will strengthen consistency, accountability, and technical alignment across all parties. This would then build towards a self-regulation framework.

The adoption of latest technology in CP monitoring and computer aided engineering (CAE) must take place without any delays. Enhanced CP monitoring using remote monitoring units stationary reference electrodes having built in AC and DC monitoring coupons can provide continuous monitoring capable by logging both AC and DC transients. The waveform obtained from the remote monitoring units can be utilised for data analysis, correlating with occurrences and installations within the proximity of the pipeline. CAE software to perform modelling and simulation of AC interference should be leveraged on to predict the severity of AC interference and to allow the evaluation of effectiveness of mitigation under steady-state as well as under fault conditions.

Last but not least, the appropriate technical knowledge and training should be provided to all involved, from site personnel to management level to ensure that all levels are well aware of the intricacies in managing interference.

Technical sharing sessions and industry forums to share best practices, case studies and lessons learned can be beneficial to the industry.

CASE STUDIES AND DISCUSSIONS OF INTERFERENCE

The following sub-sections presents the case studies and discussions of interference issues previously encountered.

CASE STUDY 1: Perfectly Circular Leak Points with Smooth Edges — How Is It Even Possible?

This case study examines a water transmission pipeline in Southeast Asia, located along a right-of-way (ROW) that shares with another utility pipeline and multiple high-voltage AC (HVAC) powerline crossings and parallels. Despite early design recommendations for AC interference and mitigation, the proposal was dismissed as unnecessary, as no national regulatory requirements existed at the time.

From the outset, the pipeline's external coating condition was less than in good condition. Inspection surveys, including DCVG assessments, revealed numerous coating defects — from isolated pinholes to clustered anomalies. Over time, several leaks occurred, prompting investigations following public complaints and service disruptions.

During one investigation, a high consequence area of the pipeline was excavated to install an additional test point with remote monitoring capabilities. The exposure pipe then revealed striking evidence at the liquid-applied coating, multiple coating defects could be spotted via the naked eye, consistent with prior survey results. More notably, one particular defect exhibited perfectly circular, smooth-edged perforations with visible arcing burn marks. This textbook manifestation of AC corrosion is also presented in Wakelin and Sheldon's paper [8]. In the same adjacent area, hard, crusted soil adhered tightly to the pipe surface, indicating localized effects of 'heating' and electrolysis.

Subsequent data analysis confirmed that a combination of factors including soil resistivity, coating defect size, HVAC proximity, and operating conditions has contributed to elevated AC current densities, accelerating localized corrosion and metal loss.

This case points out a critical point to the Owners, who are now aware of the consequences. It was unfortunate that reactive responses were due to public inconvenience, whereas proactive mitigation could have prevented costly failures.

Figure 3: Evidence of AC corrosion on pipeline with visible arcing burn marks, metal loss of approx. 5mm, found on site.

CASE STUDY 2: Nothing Lasts Forever — The Need to Review and Upgrade Mitigation Systems

This second case study looks into an oil & gas pipeline commissioned in the late 1990s. This pipeline was considered one of the very well-engineered pipelines during that time as it was designed with an AC mitigation system that was considered progressive for its time, as the industry's understanding of AC interference and its associated corrosion mechanisms was still at its infancy period at that time.

The AC mitigation system was designed with a combination of zinc ribbon mitigation conductors and decouplers which were strategically positioned along identified high consequence areas, in the vicinity of overhead powerline crossings. Baseline AC voltage measurements recorded during commissioning were typically well within the safe touch-voltage, and pipeline potentials within criterion range.

Over time, due to development of new housing areas and increase of power demand to the industrial township, the areas surrounding the ROW has undergone significant development. Multiple new utilities including other pipelines and HVAC transmission lines were introduced, increasing the number of parallelism and multiple crossing points. These developments had altered the electrical environment along the right-of-way (ROW) substantially, with compounded electromagnetic coupling, close proximity with other foreign pipelines, and possibly a change in soil resistivity characteristics due to construction and land-use changes.

In the recent years, field investigations to obtain AC voltage profiling and current density assessments has found the AC voltage of the pipeline has increased at numerous points, which is of concern. On top of that, the computed current density values surpass 100A/m2, exhibiting very high tendency for AC corrosion to occur. These findings have proven than the original AC mitigation system is no longer capable of performing as per designed and to keep up with the development and expanding utilities within the vicinity. On top of that, several of the original mitigation components, including ground conductors, were found to have deteriorated, further diminishing their effectiveness. Correlation of field data with operational changes and powerline configurations confirmed that the original system design parameters were based on conditions that no longer represent the present-day environment due to infrastructure development.

As the surrounding electrical and physical environments evolve, so must the mitigation strategy. This case highlights the essential principle that AC mitigation systems are not a system to be installed then forgotten, but it should always be seen as a dynamic installation which can be considered as a living component of a pipeline's integrity management framework. Periodic surveys, reassessment, system rejuvenation and even complete redesign whenever necessary to suit existing requirements are crucial to ensuring continued protection. Even the most well-intentioned and forward-thinking mitigation measures of the past cannot be assumed to perform indefinitely.

CASE STUDY 3: CP Survey vs. Pigging — Who Wins?

Close Interval Potential Survey (CIPS) was conducted on a cross-country pipeline that traversed multiple HVAC powerlines crossings in year 2019. Data analysis revealed a section within a one-kilometre corridor exhibiting under protection, with pipe-to-soil potentials consistently below the acceptable CP criteria and at some points even exhibiting corrosion potential. These findings were presented to the pipeline owner, who then confirmed this same segment had experienced repeated metal loss incidents in previous years which resulted in several repairs being performed.

Three years later, a follow-up close interval survey was performed and the same location again exhibited pronounced under protection. This time, it was observed that there are even more prominent discharge and pickup points, along with fluctuating readings, suggesting that the underlaying issue has gotten worse.

To investigate further, a Direct Current Voltage Gradient (DCVG) survey to determine if there were any coating defects was commissioned. To avoid biasness, the asset owner had previously conducted an In-Line Inspection (ILI) run without the knowledge of the survey team when this verification defect locations survey was requested. The aim was to assess data consistency between external and internal assessment methods. The DCVG survey produced clear and repeatable signals of coating defects, whereas the ILI run or commonly known as pigging, detected minimal defects at different locations. A partial External Corrosion Direct Assessment (ECDA) was then performed to physically validate both DCVG and pigging results.

During the direct assessment, obvious AC corrosion points with the distinctive smooth, circular metal loss feature were found. One of the many metal loss points found, had experienced more than 80% wall loss, which gave the asset owner a great shock. Interestingly, the ILI data did not register that anomalies in that same region, despite the physical evidence to the contrary. This discovery prompted a big question mark. Could AC induction from nearby HVAC powerlines be introducing noise that interferes with the accuracy of magnetic-flux-based ILI tools? Definitely more research on this topic must be performed as this finding has unlocked a crucial line of inquiry into the reliability of internal inspection technologies operating under strong AC coupling environments.

The key takeaway from this case is the importance of cross-validation and collaboration between survey methodologies and stakeholders. Correlating all data obtained then supported by direct field verification ensures that all limitations are being looked into.

Conclusion

Interference is a complex issue that is often overlooked as it is not seen by the naked eye and there is a lack of awareness in this topic. The three case studies presented in this paper have pointed out that interference management is a multidimensional challenge that involves various stakeholders, evolves with time, technology, and infrastructure development. In the first case, the absence of proactive mitigation and regulatory guidance resulted in premature failures and public disruption. The second highlighted that even well-designed systems will get outdated and no longer serve its purpose when not re-evaluated in accordance with changing site conditions. The third revealed that the lack of data integration and interfering noises on inspection equipment can obscure true asset conditions, thus raising the need for verification of various methodologies used.

These lessons converge on one simple take away which is that effective interference management is not just a basic operational task, but a critical pillar of asset integrity and public safety. It requires commitment from stakeholders, informed coordination, and shared accountability, all the way from design and construction through to operation, maintenance, and regulation.

For the industry to advance, existing gaps arising from limited technical maturity and awareness must be address and narrowed by stakeholders and policy makers alike. While self-regulation remains a valuable model of professional accountability within this industry, it must not be treated as a means to just perform the bare minimum in order to comply with audits and practice shortsighted, whack a mole solution. The cost of complacency is serious, and asset performance is not its only concern, but human safety, environmental sustainability, and public confidence is also a huge factor.

Ultimately, sustainable interference management requires sound technical knowledge and understanding, transparency in management and collaborations, and farsightedness in decision-making and being open to changes. The industry must adapt, move beyond reactive responses and convenience-based practices to embrace continuous learning, acceptance of new technology, and integrity-driven innovation as these principles are essential to achieving long-term safety, reliability, and resilience in modern infrastructure.

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AUTHOR DETAILS

Michelle is a certified AMPP/NACE Cathodic Protection Specialist and the founder of Mach3 Engineering. With extensive expertise in corrosion management across the Oil & Gas, Power, and Water sectors in Asia Pacific, she is amongst Malaysia's handful of CP specialists. Her leadership, technical strength, and active involvement in engineering associations positions her as a key advocate for industry advancement and the development of future corrosion professionals.

PY is a certified AMPP/NACE Cathodic Protection Technologist with six years of industry experience. As the Technical Manager at Mach3 Engineering, she oversees CP surveys, troubleshooting, and commissioning works. Her expertise includes supervision of installations, CP and interference mitigation system design, and field data acquisition for analysis and optimization of CP performance. A strong advocate for STEM education and industry development, she actively volunteers to give back to the corrosion and engineering community.

State of the Corrosion and Coating Industry Australia

R. Dankiw

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Keywords:

Skills, Shortfall, Demand, TAFE, Universities, Australian Qualifications Framework (AQF), Infrastructure, Occupation Standard Classification for Australia (OSCA), Aging Population.

ABSTRACT

This study looks at the state of the corrosion and coating industry in terms of current strategies and shortfalls, current stock of practitioners, academics and consultants, future demand and challenges facing the industry, and strategies to address shortfalls.

INTRODUCTION

Australia has been and is currently experiencing a skills shortage which is having an impact on major infrastructure projects, and maintenance of current assets in the Civil, Defence, Oil, Gas, Mining and Transport sectors. The skills shortages in key sectors of the Australian economy are contributing to delayed projects, wage inflation, training pressures, hiring challenges and missed opportunities (turning down new contracts).

The estimated cost of skill shortages in Australia is over $3 billion annually, [4] adversely impacting productivity and competitiveness. Up to 50% of roles in the Technicians and Trades Workers Category is reported in the shortage category [4].

For Professional engineers, over 20% of Australia's qualified engineers are not in the workforce and currently only 8.5% of university graduates receive engineering qualifications, well below OECD averages [1] . It is expected that approximately 25,000 engineers will be retiring over the next five years.[1]

A particular focus in this paper are the engineering (Corrosion and Materials) and trades sectors relating to the blasting and painting industries.

The corrosion, blasting and painting industries broadly encompass a range of occupations and professions covering materials engineers (steel, concrete, composites), project engineers, specialist consultants, contractors, technicians, inspectors, blasters and painters.

CURRENT SITUATION

General

In broad terms there has been a lot of publicity both in government and the private sectors relating to the skills shortage and the impact on the Australian economy, even before COVID-19. This topic has recently received attention from the federal government due to an increase in demand and shortages in the workforce.

The skills shortage is across the board, with specific sectors under-resourced namely, healthcare, construction, technology and education [1].

Engineering accounts for approximately 6 per cent of domestic undergraduate degree enrolments at present [1]. This shortfall is generally made up of overseas graduates from the skilled migration program and is well documented.

There is still a shortfall for engineers and professionals driven by demand from infrastructure projects, construction projects and aging population. Figure 1 below provides an overview of the trending data, that also includes the Australian general population. It clearly shows overall demand is strong.

Organisations like Engineers Australia, Australian Bureau of Statistics (ABS), Jobs and Skills Australia, Infrastructure Australia and Industry Partners Australia (NGO'S), are involved in providing essential data, developing strategies and policies to support government and industry. In particular, Universities Australia and TAFE provide training in both higher education and Vocational Education and Training (VET) sectors. Over previous years there has been changes in funding levels between both state and federal governments that adversely affected the ability of Universities and TAFE institutions to deliver training in general.

Immigration has returned to more normal levels since COVID-19 restrictions were lifted in 2021, but notably the permanent skilled migration levels have lagged since 2023 compared to family immigration (figure 2). This had a significant impact on the filling of vacancies. The current situation is that temporary resident, skilled employment visas have stabilised due to the Australian Government making resources available to deal with the backlog of permanent skilled migrant applications.

The temporary skilled employment visas now replace the previous 457 visas and are primarily employer sponsored.

THE CORROSION INDUSTRY IN AUSTRALIA

In the corrosion industry the Australasian Corrosion Association (ACA) and the Association for Materials Protection and Performance (AMPP) organisations deliver corrosion training courses for the industry, both nationally and internationally. The 2024 annual report from the ACA, showed that the ACA had delivered training courses to 714 participants covering approximately 90% of AMPP branded

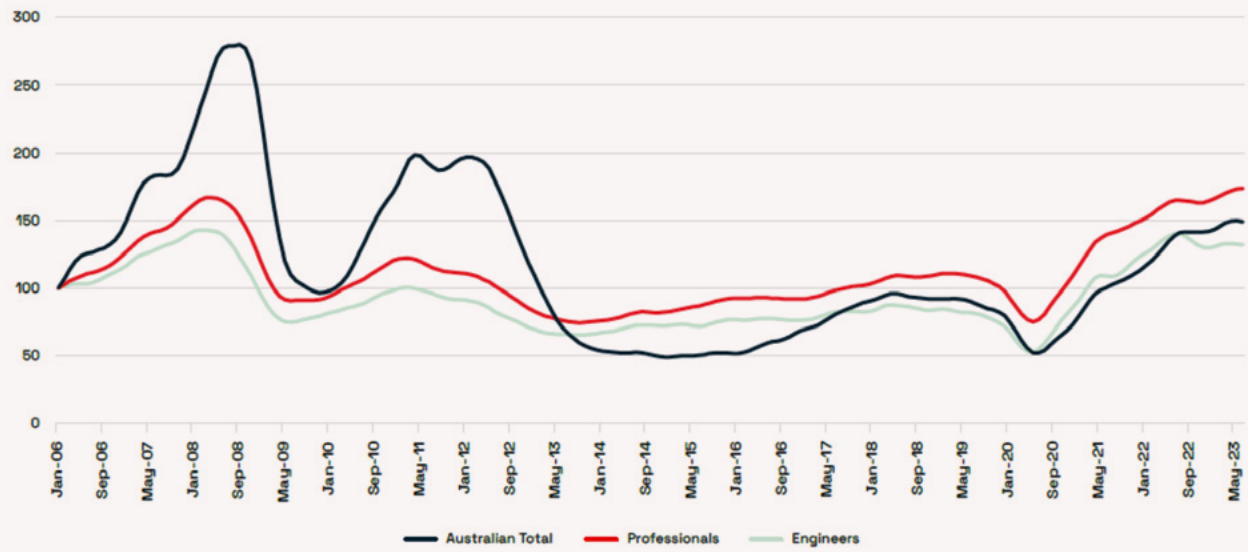

Figure 1- Australian Vacancy Trends, January 2008- June 2023 (indexed). Source: Engineers Australia Statistical overview 15th Edition-November 2023

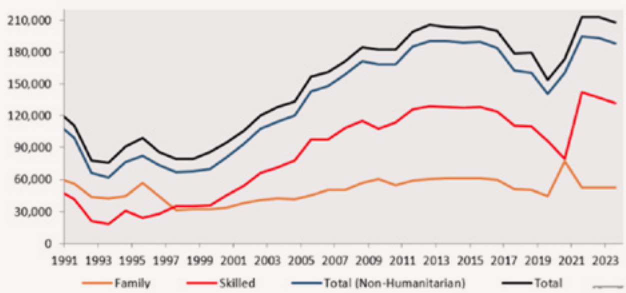

Figure 2- Permanent migrant intake. Source: Department of Immigration

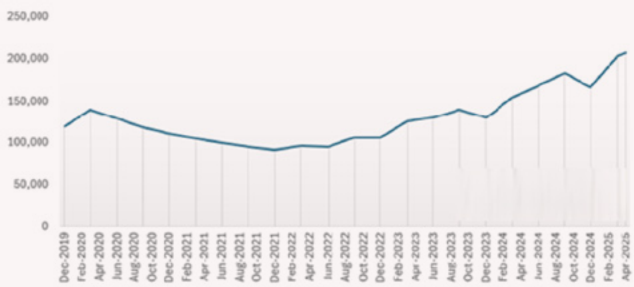

Figure 3- Temporary resident skilled employment migrant intake. Source: Department of Immigration

courses. The AMPP Coating Inspector Program accounted for 15 out of the 37 AMPP courses held in Australia.

Blasting & Painting Training

The ACA has recently introduced the AMPP Craftworker training, which provides hands-on education and practical training in surface preparation and coating application in the industrial coatings sector. This is an example of the non-TAFE based training being offered in the industry. The AMPP Craftworker certification finds its origin in the US Navy's demand for skilled workers.

The Craftworker Certification requirement is now being adopted by specification writers in Australia, primarily for work in the marine sector.

The Industrial Painter category in the OSCA/ ANZSCO classification system is listed on the Jobs and Skill Australia website as an occupation category in Shortage (S) across all states in Australia [3]. The data is supplied by the Australian Bureau of Statistics to measure shortages and demand. See figure 4.

The ASCO/ANZSCO classification systems were developed to provide a clearer and more relevant framework for classifying occupations. OSCA (Occupational Standard Classification for Australia) had replaced the ANZSCO (Australia and New Zealand Standard Classification of Occupations) in December 2024. It has 5 hierarchical levels: major groups, sub-major groups, minor groups, unit groups and occupations, with distinct skill levels ranging from Skill level 1 (bachelor's degree or higher) to Skill level 5 (secondary education or certificate 1).

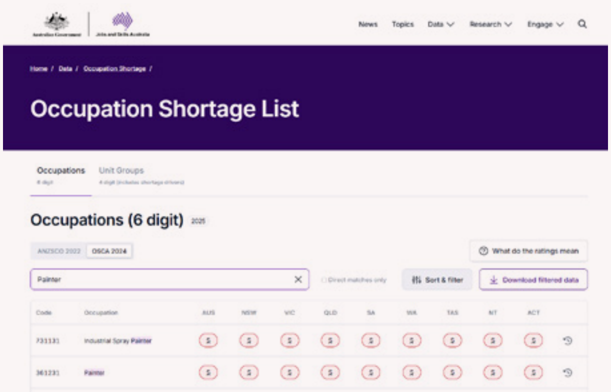

Figure 4- Jobs and Skills Australia website OSCA occupation rating for Industrial Spray Painters (S- in shortage)

Each occupation is assigned a unique code number including sub-groups, see figure 4.

Formalised training for blasters and painters in the industrial sector in Australia is provided by Recognised Training Organisations (RTO's) that deliver the Certificate III MSM30216- Surface Preparation and Coating Application (Traineeship), with a duration of up to 3 years. See figure 3 for a list of RTOs delivering this course in Australia.

This certificate III course is equivalent to MSA30309, which is regulated under the Australian Qualifications Framework (AQF) at level 3. The

Code	Legal name	RTO status	Extent	Scope start date	Scope end date	Delivery notification
3120	South West Institute of TAFE	Current	Deliver and assess	19/Jun/2019	20/Jun/2029	VIC SA
41245	HCR HOMES PTY LTD	Current	Deliver and assess	25/Jan/2023	16/Jun/2029	NATIONAL
40438	National Skills Pty Ltd	Current	Deliver and assess	27/Jun/2023	02/Mar/2028	NATIONAL
45936	Aimpoint RPL Pty Ltd	Current	Deliver and assess	11/Nov/2024	10/Nov/2031	NATIONAL
52787	South Metropolitan TAFE	Current	Deliver and assess	03/Aug/2016		WA
7131	Cape Australia Holdings Pty Limited	Current	Deliver and assess	01/Oct/2021	31/Aug/2026	NATIONAL
90003	Technical and Further Education Commission	Current	Deliver and assess	16/Jun/2016	31/Aug/2032	NATIONAL

Figure 5- Approved RTOs to deliver and/or assess Certificate III MSM30216 -source Australian Government National Training Register

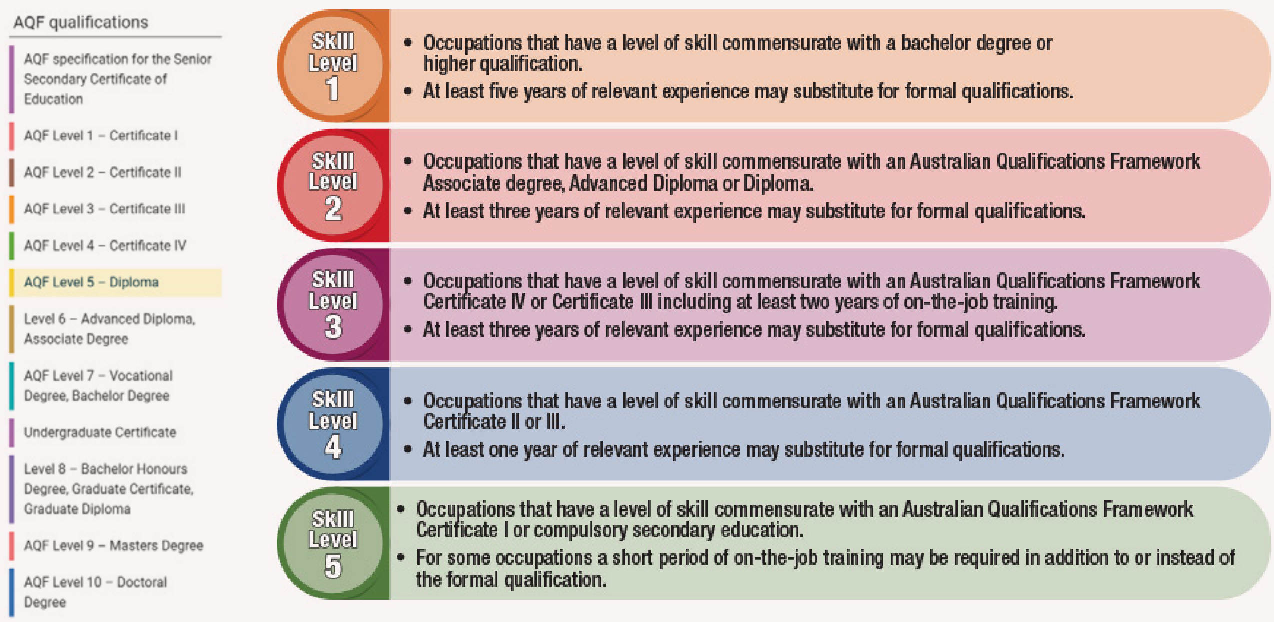

Figure 6- Comparison of AQF qualification levels and OSCA skill levels

AQF is the national policy guide for regulated qualifications in Australia, which defines the required training and learning outcomes for each level of qualification [5].

These qualification levels also relate to skill levels in various occupation groups as used by OSCA/ ANZSCO [3] to categorise all occupations for the purpose of statistical analysis by the ABS for government policy setting and programs.

For instance, industrial blasters and painters have a skill level rating of 3-4 according to OSCA/ ANZSCO, with an AQF level of 3.

The ACA has been active in petitioning both state and federal governments for recognition of industrial painters as a trade and the MSM30216 Certificate III needs to be offered with more qualified trainers to meet demand.

Importantly there is no specific data obtainable from the VET (Vocational Education and Training) specifically related to the MSM30216 Certificate III enrolments and completion, which also needs to be addressed.

Coating Inspector Training

Currently the primary coating inspector training in Australia is provided by the ACA though a licensing agreement with AMPP (formerly NACE and SSPC). The AMPP certification of coating inspectors are provided at 3 levels from Basic to Senior Coating Inspector level.

The certification does not fall under the Australian Quality Framework for training and qualification and is not listed in the OSCA occupation codes.

However, the coating inspector qualification requirements are listed in most construction and maintenance specifications where coating systems are applied to steelwork or concrete.

The estimated value of the global protective coatings market in 2023 was USD $14.94bn by Fortune business insights.

Australia's coating market is estimated at $1.53bn, according to Spherical Insights.

Corrosion Engineers

Corrosion engineers are featured as a subset of material engineering in the OSCA classification as skill level 1, see figure 5.

According to Jobs and skills Australia there are 680 materials engineers who are currently employed, 18% part-time, with 22% females. It is important to note that corrosion engineering is considered a sub-category under materials engineering and that the data does not make a distinction between materials engineers and corrosion engineers.

From a general industry perspective engineers broadly in Australia receive little training about the practical intricacies associated with protective coatings, particularly the application of Australian Standard AS/NZS 2312 [6] in major design projects and routine maintenance.

There is no clear data on corrosion engineer occupational demand statistics via the Australian Bureau of Statistics or Engineers Australia, however materials engineers are in demand in Victoria, Queensland and Tasmania as listed in figure 7.

Specialised corrosion engineering programs (Research, Masters, PhD) are provided by the following main Australian Universities, but is not exhaustive:

Charles Darwin University

Curtin University

Monash University

University of Queensland

Queensland University of Technology

Consultants & Contractors

The ACA Corrosion Control Directory web-site page lists those consultants or companies advertising their services and so does the Yellow Pages. The listings are not reliable in establishing reliable statistical data for the purposes of this paper.

HOW DID WE GET HERE

Whilst the skills shortage is not a new issue, it has been at the forefront of government policy changes since COVID-19, particularly in funding boosts to the training sectors in Australia.

Border closures significantly affected the inflow of skilled migrants, and many older workers exited the labour market early, particularly the baby boomers. There were other groups that reevaluated their careers entirely and changed occupations for greater flexibility and less occupational fatigue [2].

Australia has an ageing workforce, particularly in

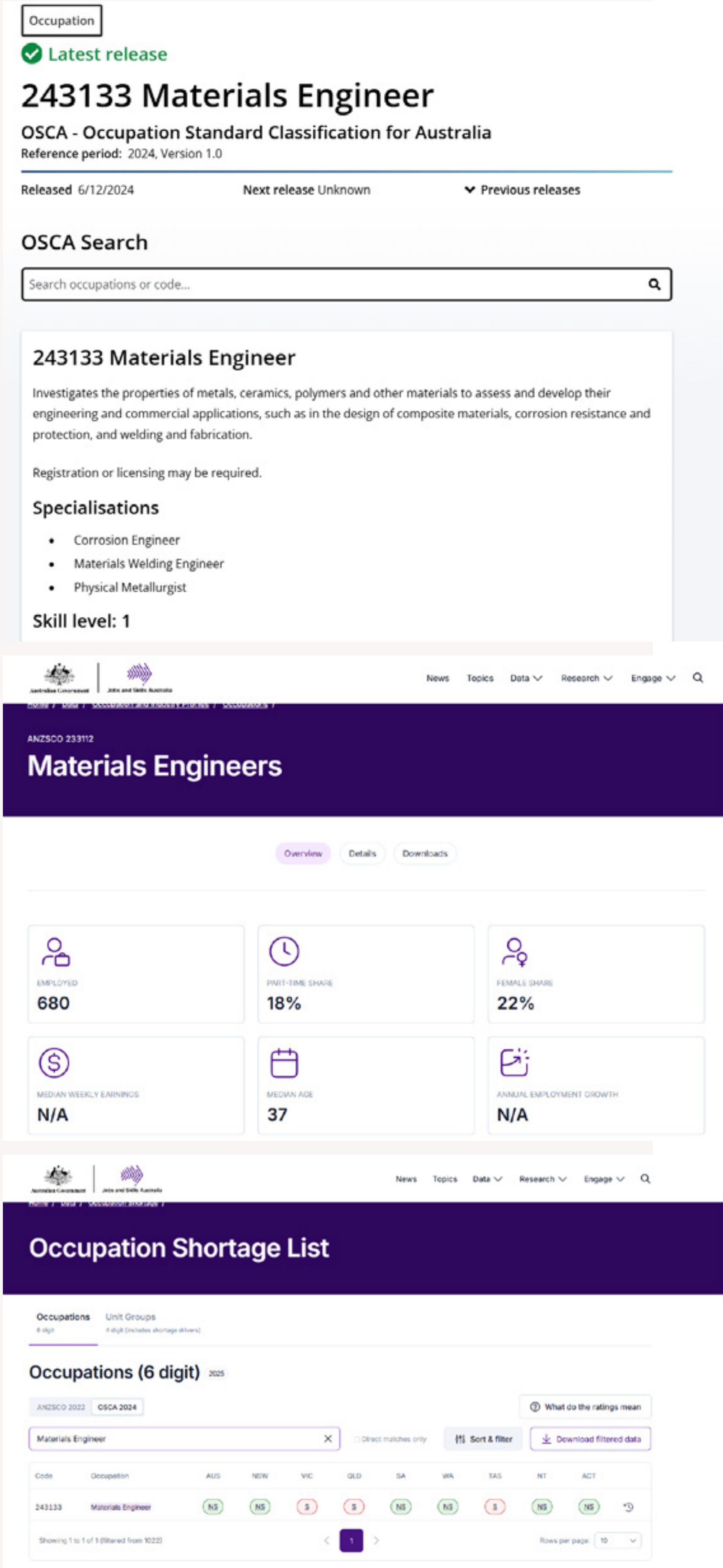

Figure 7-OSCA Occupation Shortage List- Materials Engineers- Source Jobs and Skills Australia

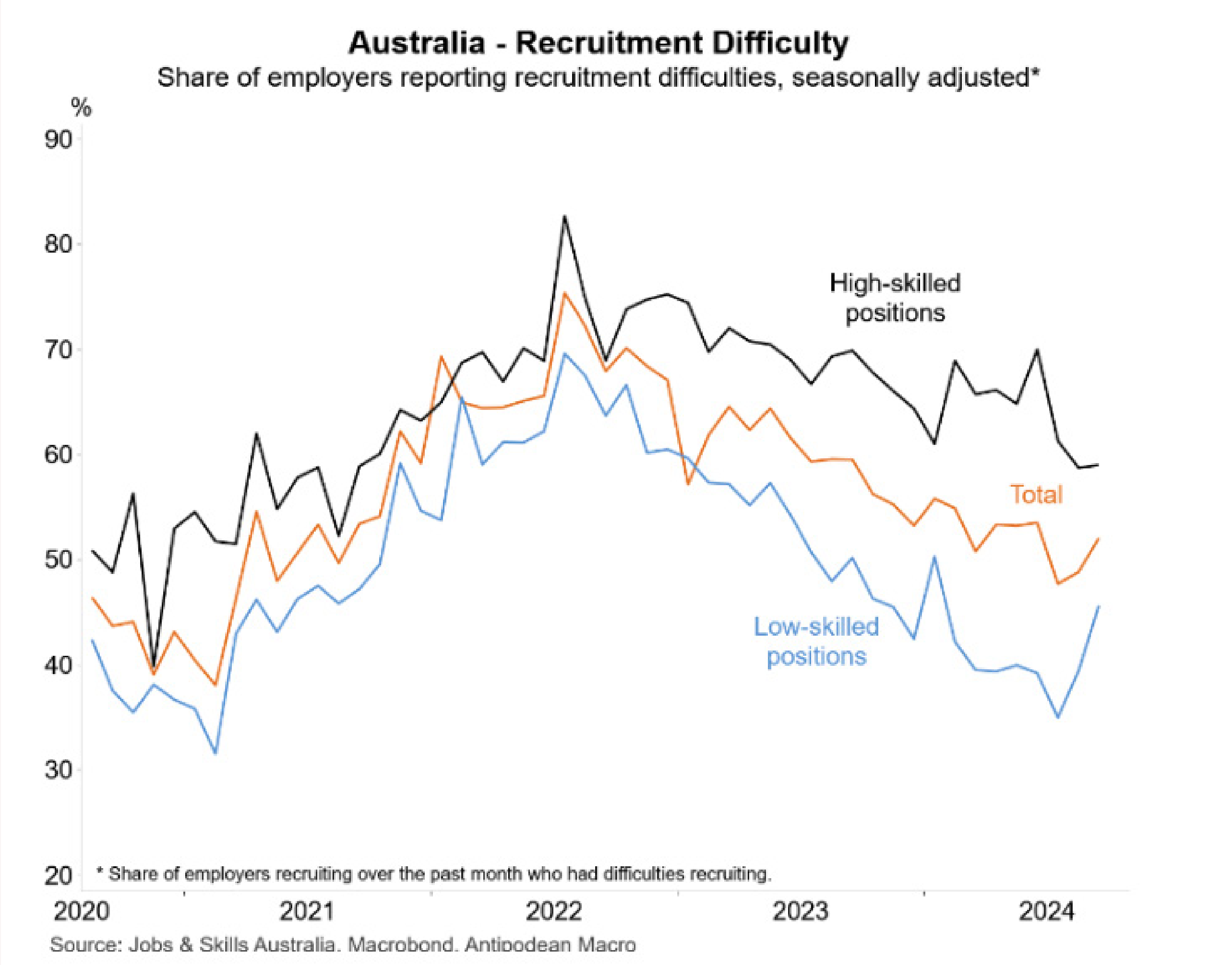

Figure 9- Australian general recruitment demand- source- Jobs and Skills Australia

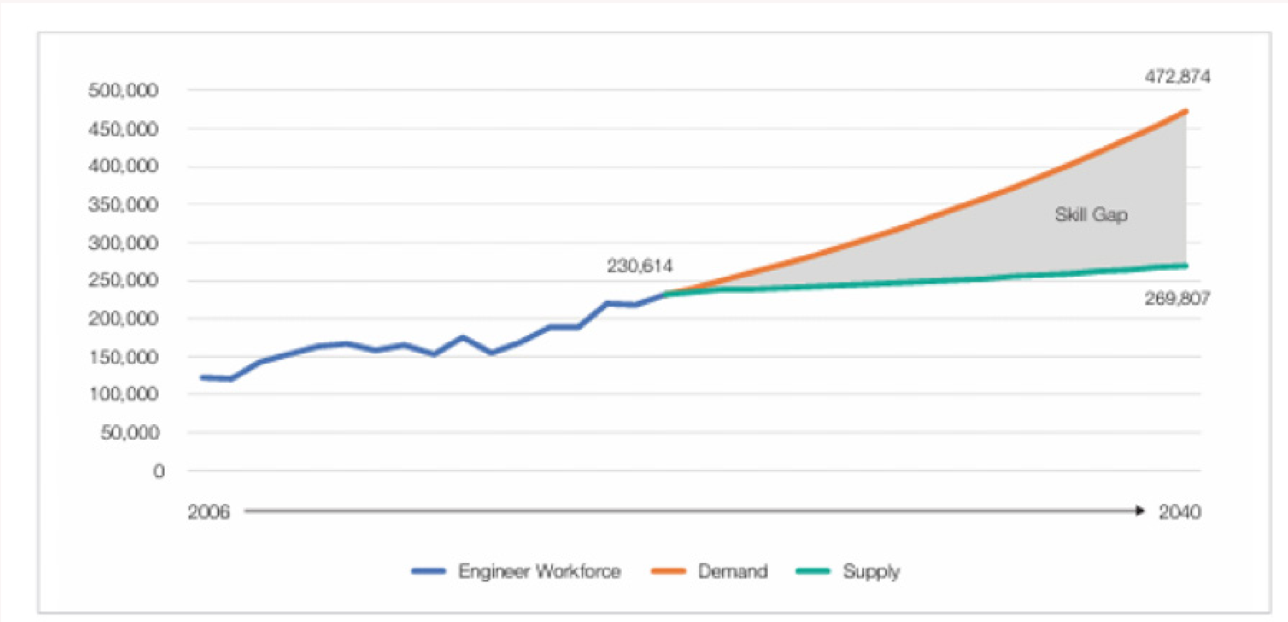

Figure 10- Predicted skill gap from demand and supply from 2022(230,614) to 2040. Source: Engineers Australia

the trades and technical sectors. Where experienced workers retire, there are insufficient trained and experienced professionals or trades in the pipeline to replace them.

There are identified training gaps in the system as many industries also need skilled workers to meet significant demands in the infrastructure and construction boom since COVID-19. See figure 9 showing recruitment difficulties and figure 10 showing the predicted gap of engineers by 2040. The experienced and skilled trainers themselves have opted for retirement, resulting in a shortage in supplying suitable trainers of VET and non-VET courses.

Whilst migration levels have resumed, the skilled talent pool has not recovered as quickly, as the demand is outstripping supply. The processing of skilled visas post COVID-19 was very slow. This was a significant issue for employers in the sectors experiencing high demand.

Currently there has been some recovery in this area due to extra funding and additional resourcing by the Australian Government. For the corrosion industry, this is an important action to fill gaps whilst the industry trains a new generation of practitioners, technicians and professionals.

ADDRESSING THE SITUATION

1. Investment in Upskilling and Reskilling

This strategy can fill gaps in organisations and promote flexibility of existing employees including some that require a new direction. This helps to retain current employees and boost internal culture.

Organisations should consider the following:

- The use of short courses and mentorships
- Partner with TAFE and RTO's
- Encourage employees to pursue further learning with support and incentives.

2. Under-utilised Skills and Talent areas

This strategy is to consider other sources of skill uptake and should include:

- Mature workers returning to the workforce with incentives.
- Encouragement of women in trades and professional fields, noting current Australian Government support in this area for flexible working arrangements and family support arrangements.
- Incentives for skilled workers moving to regional and remote areas experiencing significant skill shortages.

3. Enhance the skilled Migration Program

Whilst this is an area identified by the Australian Government, more emphasis on filling the skill shortage gaps with skilled migration is essential to stabilise the current trends.

4. Strengthen Industry Participation

Fostering collaboration between industry groups through:

- Attending networking events, forums and industry groups.
- Partnering with peers on shared training initiatives, e.g. Cadetships.
- Stronger advocacy with united objectives with industry partners to influence government policy.

5. Explore New Workforce Models

- More flexibility and working hours, especially for mature aged highly skilled personnel.
- More job-sharing arrangements, especially for women in the workforce.
- Explore freelance contract models for highly skilled personnel.

6. Government Policy

The Australian Government still needs to maintain and increase resourcing to address the skill shortages at outlined in Engineers Australia reporting [1]., and that the following measures should be considered:

- Reduced fees in both TAFE and University sectors for 'in demand' trade, technicians and professionals.
- Federal and State Governments need to improve

their funding models to ensure reliable funding for current and future demand for training places.

- Alignment of the National Skills Agreement to suit labour market needs
- Expanded skilled migration lists.
- Support for apprenticeships with better pay structures from government incentives.

7. ACA Involvement for the Corrosion Industry

The Australasian Corrosion Association (ACA) is the leading body in Australia and New Zealand for the handling and mitigation of corrosion and its impacts. The ACA has an opportunity to provide leadership in assisting with the skill shortages in the corrosion industry, including.

- ACA to lobby Government organisations such a Jobs and Skills Australia to include specific occupation categories in corrosion engineering, corrosion technician and coating inspection.
- ACA to advocate for specific data to be recorded and made available for the MSM30216 Certificate III enrolments and completion.
- In its annual reporting, include some data sets on the current stock of corrosion engineers, corrosion technicians and coating inspectors. Such data would be useful to direct future industry training development and partnerships to maintain and improve skills in the corrosion industry.
- Consider partnering with RTOs to improve the uptake of MSM30216 Certificate III for the long term.

Acknowledgments

I would like to thank and acknowledge Andrew (AJ) Russell who provided support and some information sources I was able to use in this paper. AJ is currently employed by BLASTONE as the Technical Services and Training Manager.

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Author Details

The author has had over 40 years' inspection experience in the construction and maintenance of; ships, submarines, oil and gas facilities, pipelines and civil structures.

Roman is the Principal Inspection Consultant of his company Asset Inspection Consultants, who provides inspection services to industry.

Roman holds inspection certifications in coatings (NACE level 3), welding (WTIA, IIW), pressure equipment (AICIP) and Fireproofing & Insulation (Icorr level 2).

Roman also holds Certificate IV Training & Assessment

Roman is an ACA Past-President (2010).

Alex Szokolik (1938 – 2025)

Alex Szokolik, one of the real characters of the local protective coatings industry, passed away on December 3rd at the age of 87 after a short illness. He entered the field of protective coatings in 1963, working for coatings manufacturers as a technical advisor on the correct application and utilization of heavy-duty pipeline coatings. He is best known for his research and promotion of inorganic zinc coatings which started in 1971 when he joined IMP Coatings, subsequently taken over by Dimet, who successfully marketed their inorganic zinc silicate coating technology worldwide.

In 1975, Alex joined Esso Australia, where he used his expertise in both zinc coatings and pipeline coatings. His activities expanded to include maintaining the Esso Protective Coatings Specification, reviewing coatings products and systems and providing technical support to offshore maintenance and new construction projects. After retirement from Esso in 1991, he formed his own consulting company and continued to remain active within the protective coatings industry. He was a consultant to the oil and gas pipeline industry as well as to major resource industries using his experience in coatings evaluation and failure analysis. Alex was also passionate about training applicators and others in the industry. He developed his own training course and took it on the road in Australia and overseas.

Alex joined the Australasian Corrosion Association in 1963 and made many presentations at conferences, branch meetings and seminars. He also wrote numerous articles for the Journal of Protective Coatings and Linings (JPCL). He was bestowed a JPCL Coating Specialist in 1995 and was presented with the ACA Victor Nightingall Award for distinguished achievement in the advancement of the protective coatings industry in 2005.

After retirement in 2012, he moved from Sale to Newcastle where he became active in the local Men's Shed. He and wife Amy, who pre-deceased him by a few months, loved travelling. Being able to return to his homeland Hungary after the wall came down in 1989, which he left after the uprising in 1956, was a highlight. In 2022 Alex attended the ACA Conference in Newcastle and enjoyed catching up with old colleagues and acquaintances from the past. Alex is survived by four children: Jane, Monique, Paul and Marc. As a reflection of Alex's attitude to life, he kept the numerous misspellings of his surname on letters he received on a noticeboard behind his desk at his Esso office.

Alex's interest in inorganic zinc as a single-coat protective coating never waned. In 2023, he sent me pictures of the Morgan Whyalla pipeline taken while on a trip across the Nullarbor!

Alex was a mentor to many in the protective coating industry, he was great company, entertaining and will be missed.

Rob Francis and Ian Glover

VALE BAZZA

We are sad to record the passing of Barry (Bazza) Eldridge on 10th November after a long battle with lung cancer and leukemia.

He was a friend to many CTG members and a fount of knowledge on the use of protective coatings that he shared willingly to all who sought his advice, which was based on a lifetime in the coatings industry. He was largely responsible for the introduction of moisture cured urethane technology into Australia and New Zealand, and co-authored a paper on its success and lessons learned that was presented to the 2003 ACA Conference.

His wife Nola died in 2024 and he is survived by his daughter Mel and two grandchildren. He will be missed by many.

Post-Tensioned Floor Slab Corrosion Failure

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Keywords:

post-tensioning strands, waterproofing, efflorescence, cathodic protection

ABSTRACT

An apartment building in Melbourne was constructed in 1995, with post-tensioned floors and beams, and with in-situ reinforced columns to form the two parking basement levels and 13 above ground storeys. The ground floor slab inside the building was used as the base slab for a swimming pool, with the pool walls constructed in reinforced concrete connected to the post-tensioned floor slab.

Leaking of chlorinated pool water over many years was not detected due to the hidden cavity adjacent to the pool, with the resultant corrosion to all floor slab tendons and some beam tendons over an approximately 15m x 20m area of the ground floor slab. Structural assessment could not determine why the slab did not collapse into the basement levels.

The paper describes the extensive investigation of the extent of strand corrosion and concrete damage to the slab and beam. The repair design is also described, which includes temporary propping of the slab, strand removal and concrete repair, impressed current cathodic protection to post-tensioned beams and pool walls, structural steel support to the slab and waterproofing of the pool and surrounds.

INTRODUCTION

This paper presents an investigation of corrosion of reinforcing steel (both conventional reinforcement and post-tensioning strands) caused by a leaking swimming pool, the approach taken to remediate the damage, and a discussion of the design factors which may have exacerbated the damage.

DESCRIPTION OF BUILDING AND POOL

The reinforced concrete apartment building was constructed in 1995. There are two basement levels, and 13 above-ground storeys. The columns are conventionally-reinforced concrete, while the floor slabs and supporting band beams have both post-tensioning and a small amount of conventional reinforcement. The post-tensioning strands were originally grouted into galvanized steel ducts. The post-tensioning strands are draped – which means that they are located close to the top of the slab or beam

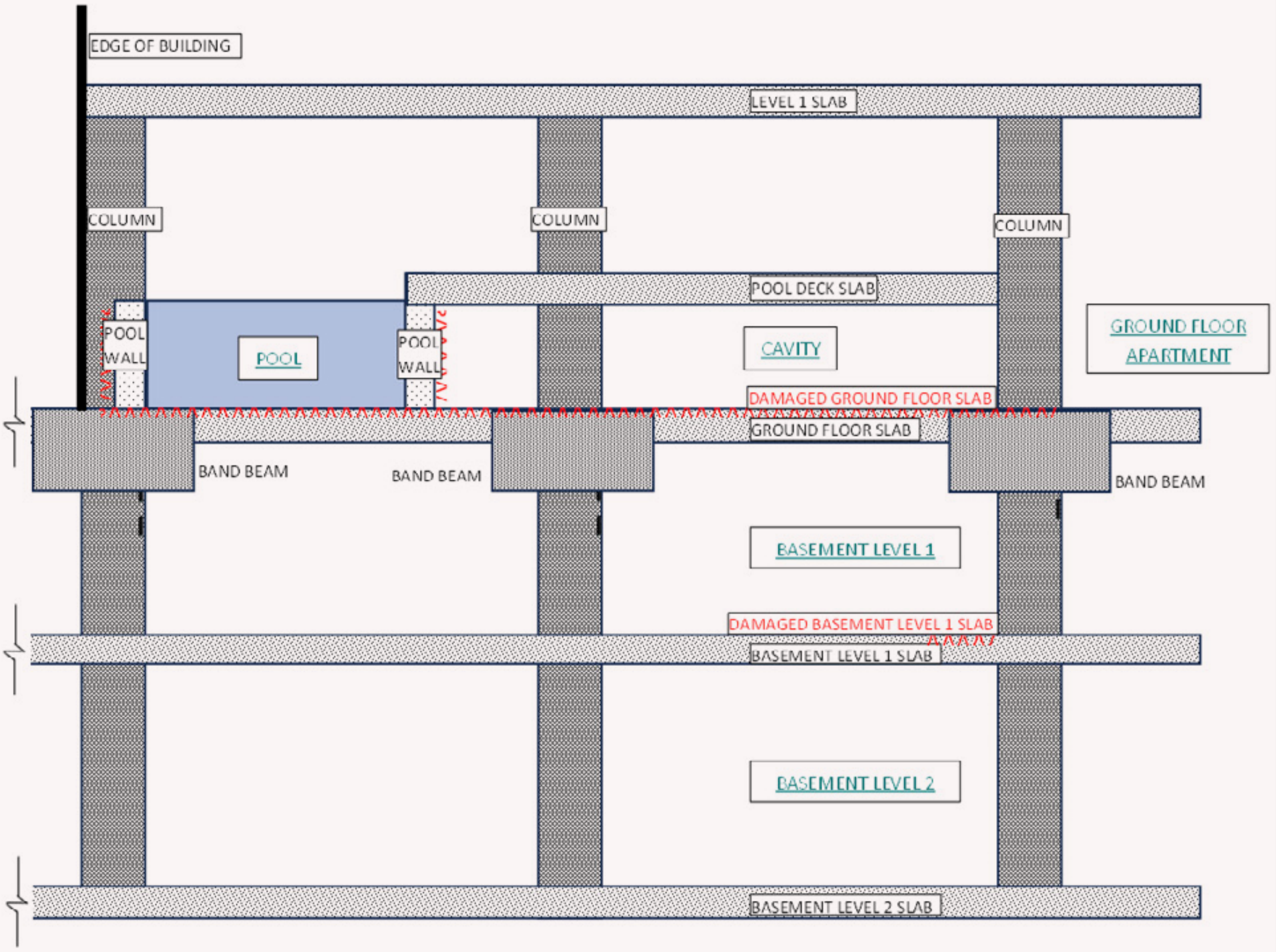

Figure 1. Cross-section of building showing slabs, columns and band beams. The pool sits on a post-tensioned slab, between two band beams. Typical slab thickness 200 mm and band-beam thickness of 450 mm.

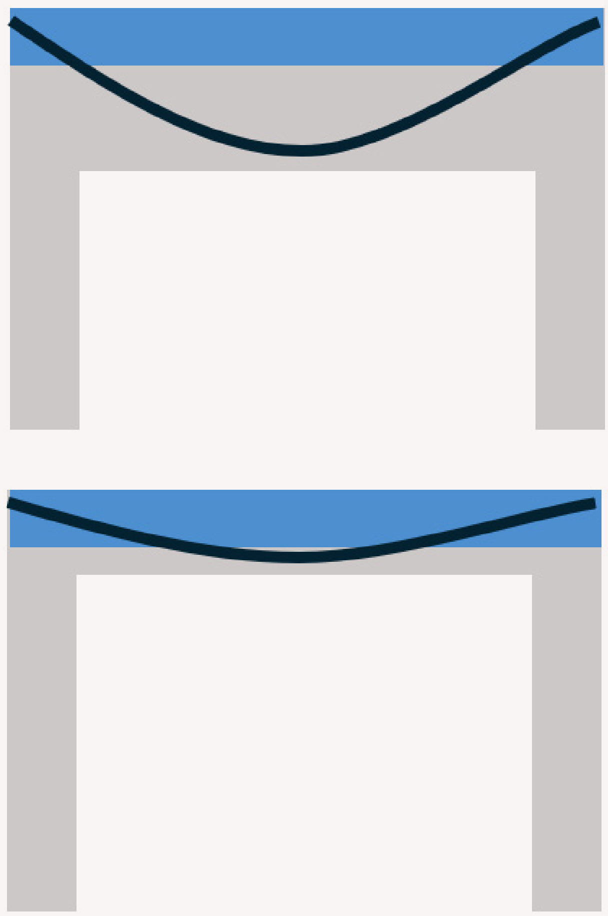

Figure 2. Schematic of band-beam strand drape (middle right) and slab strand drape (right). The blue shading represents the chloride ingress into the top of the slab. The lack of drape within the thin slabs meant that most of the slab strands have been exposed to the high chloride ingress from the pool water; in contrast, only the strands nearest the columns in the band beams have been exposed.

where the slab or beam is supported, and are close to the bottom of the slab or beam in the middle of the span (Figure 2). Accordingly, the concrete cover to the ducts and strands varies throughout the beams and the floor slabs.

The pool was located within the building envelope, with the post-tensioned ground-floor slab of the building also being the base slab of the pool. The pool walls were constructed from reinforced concrete, connected to the post-tensioned floor slab. An elevated reinforced-concrete slab formed the pool deck, underneath which was a services cavity (refer to the schematic in Figure 1).

INVESTIGATION

The Body corporate management were concerned about increasing water loss from the pool and on brief inspection, they were concerned to see spalling and delaminating concrete on the floor slab adjacent to the pool (Figure 3b), with exposed, crumbling post-tensioning strands (Figure 3a) also evident. Extensive efflorescence and spalling was also noted on the pool wall (Figure 3b).

Infracorr were then engaged as consultants to perform a detailed investigation focusing on the slab and band beam post tensioning to evaluate the extent of damage to the pool, its immediate surroundings and to advise on repairs.

Slab Post Tensioning

Upon inspection, Infracorr found extensive deterioration had occurred to the slab strands. In response, we advised the immediate draining of the pool to reduce dead load and to install emergency props, prior to conducting further investigations.

The damage to the strands, along with the presence of salt deposits (Figure 3d), indicated that the pool had been leaking for a considerable time. The lack of cover to some of the post-tensioning strands within the services cavity (Figure 3c), as low as 10mm, had resulted in the duct being completely corroded away in many locations. In other locations, the concrete

Figure 3. Deterioration observed within the services cavity. (a) Heavily corroded post-tensioning strand from the floor slab, (b) Efflorescence on pool walls and delaminated slab concrete due to strand corrosion (c) Low concrete cover (~10 mm) to corroded post-tensioning strands in slab in services cavity. Note that the duct has corroded away completely. (d) "Stalagmite" formed from salt and calcite deposits with delaminated concrete over low cover post-tensioning duct in the foreground.

Figure 4. Water damage to strands and ducts. (a) Breakout of duct and strand within band beam, performed from above the beam in the area adjacent to the pool, (b) Breakout of duct and strand within band beam, performed from below the beam, showing strands in relatively good condition.

surface had delaminated above the ducts due to their significant corrosion. Some severely corroded strands could be removed by hand with corrosion products being all that was left of the high tensile cables.

Deterioration of the slab strands indicated that chloride from the pool water had successfully migrated from the service cavity through the low cover concrete to the slab ducts and strands. Once the duct had corroded through, the strands themselves were exposed. There is some evidence that water from the pool had entered some ducts and had travelled down some of the draped strands through the poorly-grouted ducts. This likely increased the extent of strand deterioration.

Band Beam Post Tensioning

As the slab strands were significantly compromised, the investigation then focussed on evaluating the condition of the band beams, as they now were critical to the ongoing support of the floor slabs of the structure. The locations of the band beams near the columns were of primary concern, where the draped strands had the least cover from the chlorides from the leaking pool. As with the slab strands, there was considerable concern that water may have entered the band beam stressing ducts, likely at their highest points near columns, and, aided by their draped arrangement, may have migrated along their length. It was therefore necessary to conduct extensive testing to these components including exploratory concrete breakouts to inspect the internal and external condition of ducts, strands and conventional shear reinforcement.

An example of a breakout is seen in Figure 4a. This breakout sequentially removed tile, screed, waterproofing membrane, concrete and then revealed the duct. Interestingly, the concrete beneath the waterproofing membrane was dry, indicating that the membrane is functioning as intended at this location. Despite this, the breakout revealed a heavily corroded duct, implying that pool water had been able to reach the duct despite the functioning waterproofing membrane at the immediate location. Minor corrosion of the strands, which were well-encapsulated in the grout, was also seen. A second example of a breakout is shown in Figure 4b. In this case, the duct had some zinc corrosion product on the internal surface, and the strands had some surface corrosion, implying that water had migrated through the duct. There was limited grout between the strands and the duct, suggesting poor encapsulation of the strands during construction. The outside of the zinc plated/galvanised duct appeared in sound condition.

The breakout locations were guided by a broadly spaced half-cell potential survey of the ducts (and, where the ducts had corroded, the strands), part of which is shown in Figure 5. The half-cell potential maps indicated that there was some corrosion risk to the two band beams closest to the pool, mainly near the columns where the strand top cover was most limited.

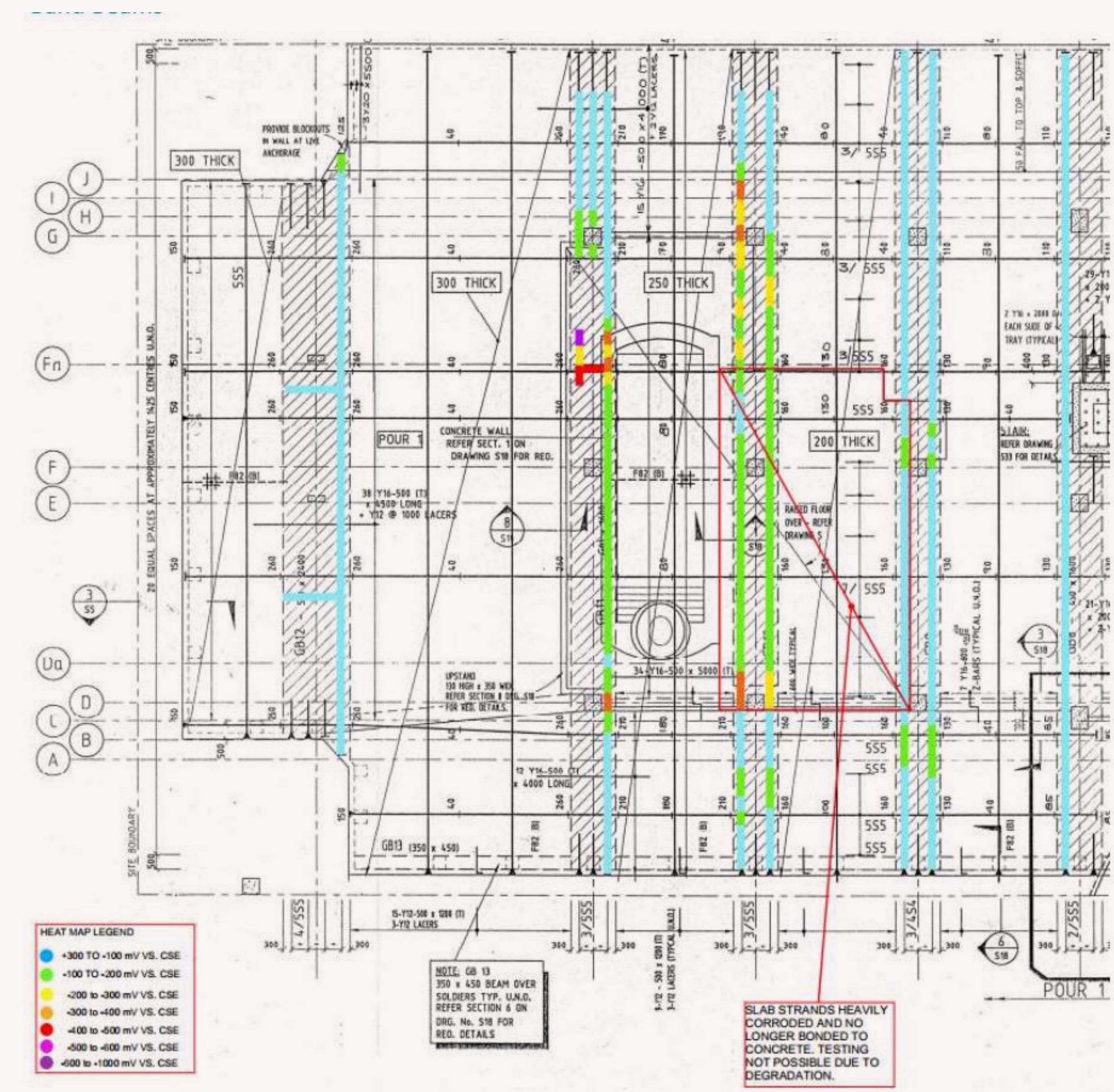

Figure 5. Half-cell potential survey, showing some risk of corrosion activity in the two band beams nearest the pool.

REMEDIATION CONSIDERATIONS

With the extensive corrosion and failure of the floor slab post-tensioning strands, it was determined that structural support for the floor slabs approximately 8m either side of the pool was required. Fortunately, the condition of the post-tensioning in the band beams was much better, where only localised areas were likely chloride affected and corrosion of the strands was limited to local areas near the columns where these strands were close to the top surface.

Impressed current CP was determined to be the best method of ensuring that no further corrosion occurred in the band beams. The floor slabs were to be structurally supported by steel beam sections attached to and spanning between the band beams.

The conventionally reinforced walls of the pool were also to be repaired and protected from ongoing corrosion by impressed current CP. The pool itself was to be totally renovated to address any ongoing leak issues. All pool tiles were to be removed and the interior of the concrete pool and adjacent slab areas waterproofed.

DESIGN OUTCOME

Impressed Current Cathodic Protection to Post-Tensioned Beams

An impressed current cathodic protection (ICCP) system was designed to protect the post-tensioned ducts and strands in the band beams. A conservative design was implemented with close spacing of anodes to allow the system to be operated at low applied voltages to avoid any risk of hydrogen embrittlement [1].

The ICCP system, designed to AS2832.5-2008 [2] with a minimum current density of 20mA/m2 of reinforcement, uses ribbon anodes in the parts of the beams away from the columns, where the strands are at the base of the beams. Discrete anodes installed in drilled holes were designed in the areas nearer the columns, where the strands drape towards the top of the beam. The design used a maximum spacing of 200mm between anodes, as indicated in the section views in Figure 7. A typical band beam anode arrangement is shown in figure 8, as viewed from below the beam.

The anodes are all designed to be installed to the bottom of the band beams, keeping the sides of the band beams, where the steel structural beams are to be attached, free from anodes.

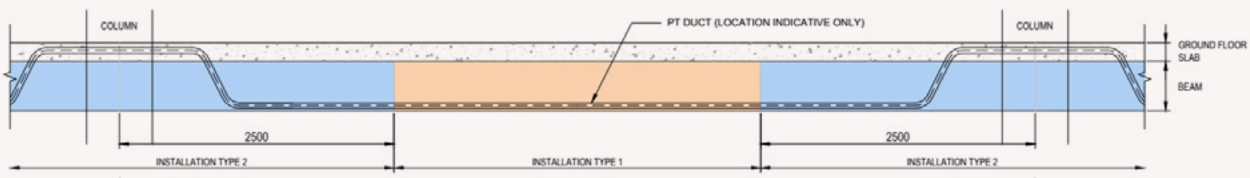

Figure 6. Sketch of typical band beam. Orange area to receive ribbon anode ICCP, blue areas near the columns to receive discrete anode ICCP.

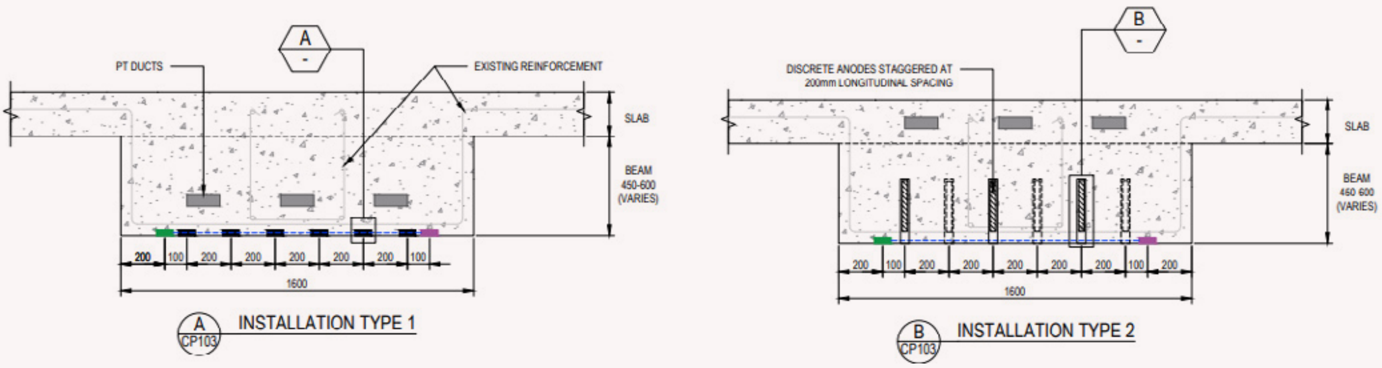

Figure 7. Section views of anode arrangements for band beams: ribbon anodes for centre of the band beam (left), and discrete anodes for nearer columns (right).

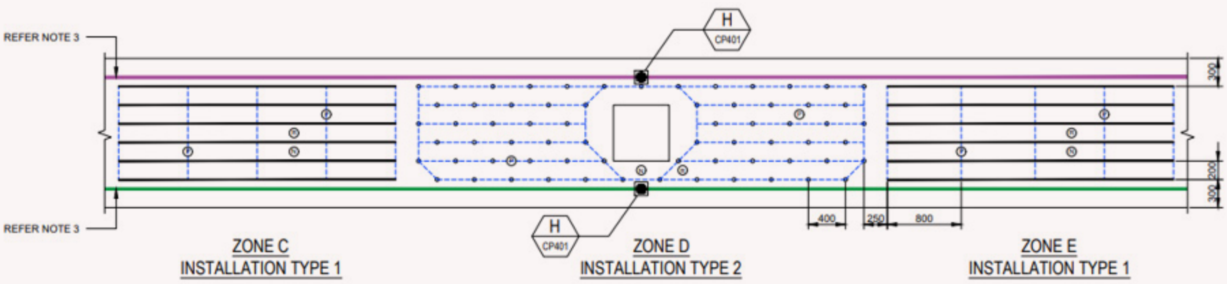

Figure 8. Detailed anode arrangement within a band beam, as viewed from below the beam.

Impressed Current Cathodic Protection to the Pool Walls

The pool walls are to receive impressed current cathodic protection with separate upper and lower zones. Discrete anodes were chosen to ensure adequate cover to the anodes and thus minimise the risk of acid production at the anodes. Wherever possible, anodes are to be installed from within the pool (rather than from within the cavity) to minimise confined space works.

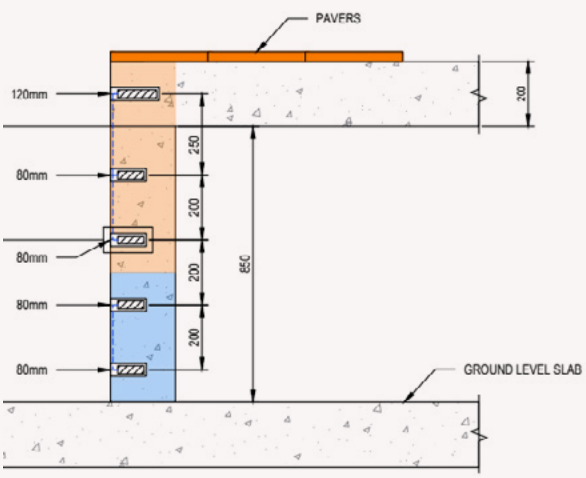

Figure 9. Sketch of typical pool wall cross-section. Orange and blue areas are separate CP zones. Short, discrete anodes are to be installed from within the pool.

Waterproofing and Reinstatement of the Pool and Surrounds

The compromised waterproofing of the pool and the resultant slow leaks of chlorinated pool water onto the slabs and beams were responsible for the large scale corrosion and failure of the post-tensioning strands. To avoid further leak issues, following the installation of the cathodic protection to the pool walls, the entire surface of the pool base, walls and surrounding slabs are to be relined and waterproofed with a polymer-modified waterproofing screed prior to re-tiling. Designs have been completed to ensure high-quality waterproofing details at lights, pipe penetrations and construction joints.

Structural Strengthening to Post-Tensioned Floor Slabs and Beams

The totally failed post-tensioning strands in the floor slabs cannot be repaired and required the structural support of the floors by external means. With design assistance from structural engineers, a steel-beam system was selected as the best option for the strengthening requirements, favoured over a carbon-fibre strengthening system due to the ability to resist the shear forces from the effectively unreinforced slabs.

Galvanized steel beam sections are to be bolted in place to span between the post-tensioned band beams as illustrated in Figure 10, below. Typically, the steel beams were 300 UB 30 spaced at a maximum of 1.4m. A total floor area of approximately 700m2 is to be structurally supported by the beams. Figure 11 shows the bolted structural detail of fixing the beams to the sides of the band beams.

All steel structural elements are detailed to be made electrically continuous to the reinforcement to ensure any current received from the concrete CP system will not accelerate the steel corrosion.

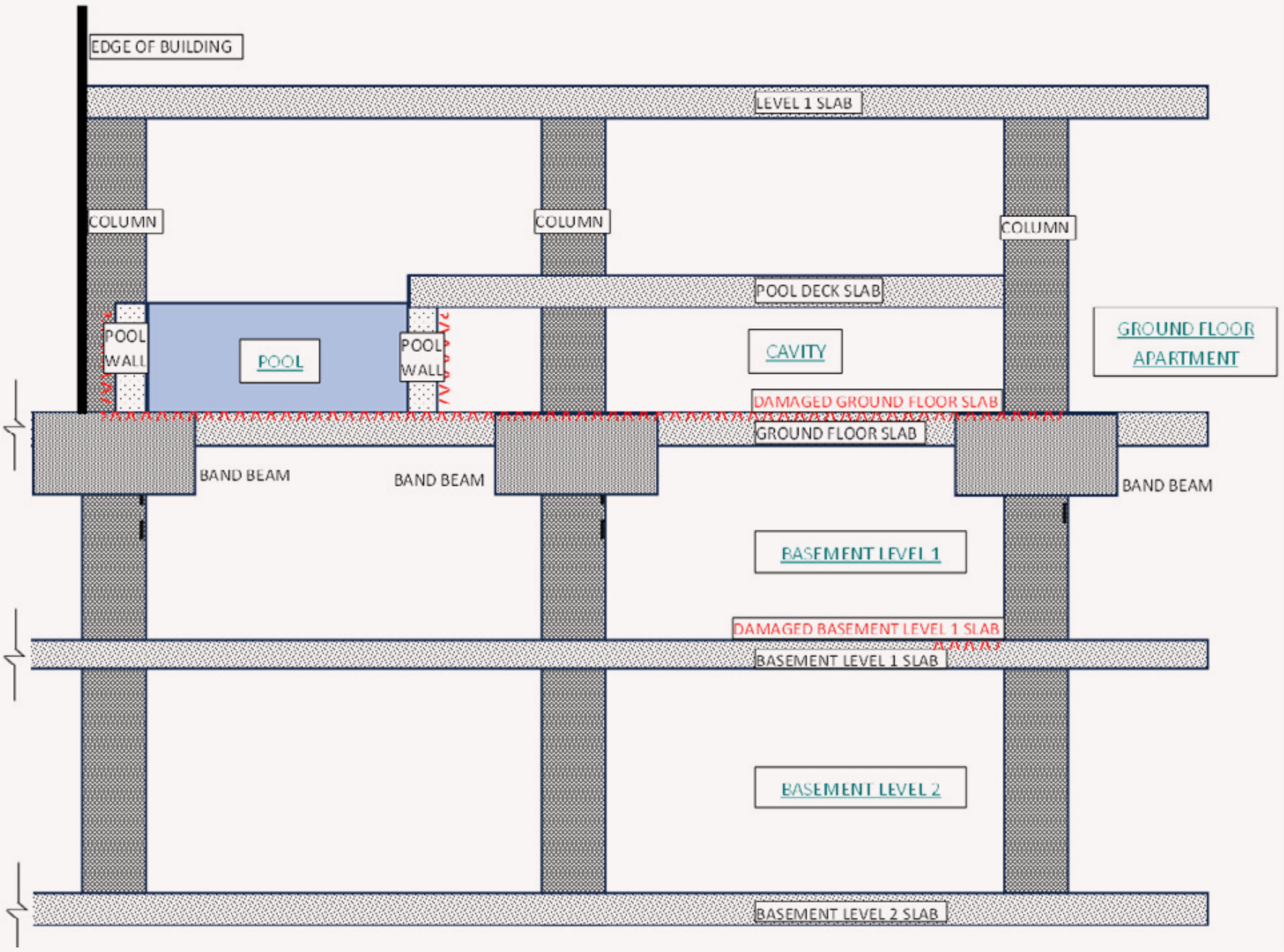

Figure 10. Galvanized steel beams (shown in orange) support the slab at ~1.4m centres, bolted into and supported by the band beams.

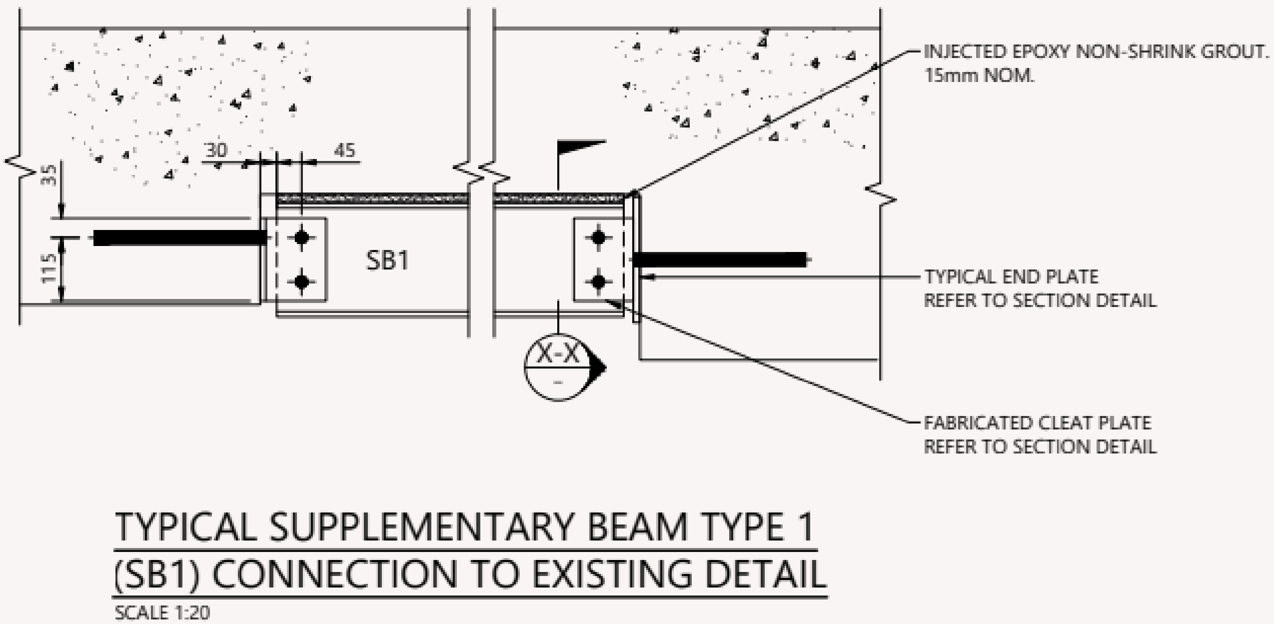

Figure 11. Typical connection detail of the beams spanning between the band beams.

SUMMARY

Leaks from the chlorine treated pool of approximate dimensions of 8m x 4m had compromised the post-tensioning strands supporting the floor slabs, effectively leaving the slabs unreinforced. With the strands unable to be repaired, supplementary strengthening of approximately 700m2 of the slabs is required to be completed with structural steel beams.

Repairs to the pool wall and band beams have been designed using impressed current cathodic protection, conservatively designed to limit the potential and risk of hydrogen embrittlement at the strands. High quality waterproofing has been designed to eliminate further leaks from the pool.

The investigation of the pool and surrounds was completed in 2023 with the repair and strengthening designs completed in 2024. The repair project has been tendered to specialist repair contractors with the repair works scheduled to be commenced in late 2025 and extending into 2026.

This paper illustrates the susceptibility of post-tensioned concrete to corrosion in highly corrosive locations. In most situations including this case, the strands can't be repaired once corrosion has taken hold, unlike conventionally reinforced slabs. This fact has meant the remediation has required some substantial application of additional structural support which is very expensive. Fortunately, the corrosion issue was discovered in time, before the potential collapse of the slab into the basement levels.

The authors strongly suggest that post-tensioning is not utilised in the future design of structures in corrosive conditions and certainly not in the construction of swimming pools that have the potential to leak in the long term. Existing post-tensioned structures in harsh corrosion conditions should be evaluated throughout their life for deterioration with appropriate preventative actions implemented.

ACKNOWLEDGMENTS

The authors acknowledge assistance of Infracorr Consulting staff including Julia Zhang and Razana Razak with investigation fieldwork, Brendon Grey with CP design, and Kate Nairn with writing this manuscript. Further we acknowledge the assistance of Ken MacLeod and Reza Osanloy of Miglic MacLeod structural engineers, whose wealth of experience and structural design expertise has been greatly appreciated.

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2. AS2832.5-2008 Cathodic Protection of Metals- Steel in Concrete

AUTHOR DETAILS

Ian Godson is the corresponding author of this paper. He is a Director and Principal engineer of Infracorr Consulting, a position he has held since founding the company in 2004.

He was the technical lead for this project, responsible to guide the investigation and advise and technically review the remedial designs and CP systems of the repairs.

Nathan Way is a Materials Technologist at Infracorr Consulting, a position he has held since 2017. He is a project manager and key team member, who has undertaken a range of durability projects across Australia and the Pacific.

He was responsible for delivery of this project, leading the investigation team and coordinating the remedial designs discussed.

Case Study: Protection of Sewage Treatment Plant Inlet Pipes

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Keywords:

Sewage treatment, polyisobutene coating, field assessment

ABSTRACT

Sewage Treatment Plants are among the most aggressive environments for steel infrastructure due to significant microbiological activity, high chloride and sulphide concentrations, and highly acidic conditions. This case study reviews the corrosion protection of inlet pipes at an Urban Utilities Sewage Plant operating in a coastal environment. It discusses the asset owner's decision-making process to extend the life of critically important steel inlet pipes suffering from severe corrosion, despite frequent coating maintenance and repair.

This paper presents how transitioning from traditional coating systems to alternative corrosion protection using pure polyisobutene (PIB)visco elastic (VE) coating technology not only halted corrosion but also extended the life of the asset with minimal maintenance. The inlet pipes were revisited ten years after remediation, revealing an outstanding condition under aggressive conditions with only the need to replace a PVC outer wrapping used for UV protection due to minor discolouration and mechanical damage during capital works at the inlet structure. This paper highlights the field assessment findings and what asset owners can expect from using pure PIB VE coating technology for long-term corrosion protection.

INTRODUCTION

Opened in 1923, Luggage Point sewage treatment plant is a world class facility known today as Luggage Point Resource Recovery Centre (RRC). As one of the largest RRC in Australia, this Urban Utilities plant treats sewage from over 800,000 people across Brisbane City. It treats the sewage to produce extra resources and provide biosolids for farmers, recycled water to local industry and energy from the capture of biogas. The sewage comes in from three large rising mains from one of the largest sewage pump stations at Eagle Farm with flows ranging from 1000 L/s to more than 4000 L/s daily.

A key asset in the delivery chain is the Luggage Point RRC inlet works and the three steel riser pipes that transition the sewage flow into the inlet works, presented in Figure 1.

Figure 1 (above): Location of Luggage Point inlet works

Figure 2 (below): Failure of traditional painted coating system on the steel pipe risers

Located at the mouth of the Brisbane River and adjacent Moreton Bay, Luggage Point RRC inlet works is in a highly corrosive location (C3 or higher 1) for steel infrastructure. In addition, the very aggressive nature of sewage in a rising main due to high levels of sulphide concentrations and microbiological activity accelerates the breakdown of the inlet's protective coatings and the deterioration of the steel and concrete infrastructure.

THE PROBLEM

The inlet pipe risers are very critical assets for sewage treatment. In 2011, Urban Utilities focused its maintenance campaign on restoring the riser's corrosion protective coatings to ensure optimal performance and reaching of intended design life, while maintaining other important material properties such as mechanical and heat transfer properties.

With many of the large-scale water and wastewater utilities infrastructure coming to the end of their service life, one of the main focuses of coating maintenance at Urban Utilities was to protect existing assets, but to do it in a sustainable way to minimise application time and production of waste, while maintaining high quality and reliable results.

Consideration for Urban Utilities was the ongoing burden with the widespread occurrence of corrosion and coating materials failures at the inlet works, especially at the rising steel mains. The following items were challenges and considerations for Urban Utilities:

- Reduction of ongoing operational expenditure (OPEX). Operational outcomes are usually prioritised over maintenance and coating campaigns, potentially leading to inadequate coating maintenance, operational outcomes prioritised over maintenance / coating campaigns.
- Reduced availability of resources - which limit frequency and extent of inspection, and accurate condition assessments and repairs. This potentially may lead to an underestimation of corrosion rates, particularly in severely corrosive environments. As a result, the need for urgent repairs when material reaches its critical metal loss thickness, significantly increasing coating maintenance and operation costs.
- Incorrect material and coating selection or specifications leading to early and extensive coating damage and metal loss. Thus, requiring cyclic coating repair/ replacement and reallocation of resources for repair. Repeating coating failures within a few years (every 3-5years) of application was becoming a costly problem.
- Training and qualifications of applicators. it only takes ONE deviation from correct application for the early onset of coating failures and corrosion. Application errors are often compounded by limited safe access to site (e.g., the use of scaffolding, rope access, suspended platform) and contractual pressures.
- Accurate determination of the corrosion mechanisms affecting site. These include atmospheric corrosion damage, sulphide attack, microbiologically influenced corrosion (MIC).

These concerns exemplify some of the burdens faced by water utilities around coating maintenance, with different degrees of criticality. Meaningful opportunities to improve coating maintenance delivery must start with decision making based on smart, cost effective, factual, and sustainable solutions offered by corrosion, materials, and asset integrity specialists [2].

THE ADOPTED SOLUTIONS

Urban Utilities received very competitive submissions from both traditional blast and painting companies and from alternative protection system bids for the remediation of the inlet steel pipe risers and flanges. Urban Utilities selection process included a weighted average costing model addressing the challenges and considerations on site. Based on this, remediation of the riser pipes by application of a self-healing pure polyisobutene (PIB) visco-elastic (VE) coatings technology system was selected over traditional painting systems.

The decision was made based on:

- Ease of Application - Pure PIB VE coatings are flexible, with a non-crystalline non-curing nature that does not require blasting and surface profile for application.
- Molecular adhesion instead of mechanical interlocking, therefore surface preparation is not as critical for bonding. Cold flowing and self-healing.
- Proven track record - with extensive service life, resulting on cost efficiencies on initial application and service lifecycle
- UV protection – VE coating system is complemented by PVC outerwrap layer providing UV protection for 10 years

The works were completed in August 2011, adhering to the PIB VE coating manufacturer specification, following the below scope of work (Figures 3-5):

1. Install lock out procedure on each spool as required.
2. Individually remove the inlet from the ground located flange.
3. Laydown the entire sections and dismantle flange joints to individual spools.
4. Transport the spools to the laydown area, located in the southern area of the Luggage Point facility.
5. Complete initial blast cleaning to Sa 2.5 class to all sections, no surface profile was required
6. PIB VE system application - Apply PIB wrappingband to the areas that would not be affected by crane sling during lifting followed by application of PVC outerwrap, allowing for tie in areas to be completed insitu after installation.
7. Relocate spools adjacent to the work front, re-assemble spools.
8. Re-instate the individual spools back in original position and secure.
9. Complete bolting arrangements to all flanges. Remove lock out as required and return the risers back to service.
10. Complete insitu works with the STOPAQ corrosion prevention system.

Figure 3: Application of the first layer of the PIB Wrappingband

Figure 4: Application of the PVC outerwrap for UV protection of PIB system

Figure 5: Completion of the PIB Coating system at the three main steel risers in 2011

THE DELIVERY EFFICIENCY OF THIS SOLUTION

The project was successfully undertaken over approximately 10 days including set up of system isolation, bypass pumping and recommissioning of the individual risers.

This delivery window was able to be achieved due to the many application efficiencies and cost-effective benefits to the Asset Owner and Contractor when it comes to applying this pure PIB coating technology such as:

1. No sandblasting required
2. No priming required
3. No preheating
4. No post heating
5. No waiting time (for curing between coats)
6. No wasted material
7. No environmental harm or risk
8. Minimal mess and clear up
9. No special machinery, tools, or safety gear
10. No carcinogenic materials/safety risks to the applicators
11. No material expiry date i.e. unlimited shelf life

This coating technology enabled the client and contractor to complete the works in a very small operational window and have no operational impact to the treatment plant or environment harm.

INSPECTION AFTER 10 YEARS

After 10 years of service with no metal loss/ zero corrosion, a condition inspection of the PIB VE coating system and an update of the PVC outerwrap was undertaken. Compared to previous painting systems formerly being employed, no maintenance was required for 10 years.

Anti Corrosion Technology (ACT) along with Veolia Network Services (VNS) undertook these works for Urban Utilities, following the original scope of works which included system isolation, bypass pumping and recommissioning of the individual risers. Following the system isolation works, the riser pipes were individually removed from service and the asset was inspected.

Inspections were undertaken across the pipe work for signs of deterioration and corrosion. To check the condition of the steel pipes underneath the PIB VE system, a few inspection windows were open, as presented in Figure 6.

From these inspection windows no underlying corrosion of the steel was identified, and the coating system showed great performance in preventing corrosion for over 10 years, with zero maintenance.

During this maintenance works, ACT and VNS undertook an upgrade of the coating system installed on the flanges to a new improved method of providing longevity and cost savings in coating material, particularly by reducing the amount of PIB paste previously used. The new coating methodology moved away from the traditional

Figure 6: Inspection windows during condition assessment of steel pipe and self -healing example.

foam roll inserts to engineered pre-cut foam wedges, which provided a better product finish with cost savings to the client. This innovation has been adopted across the board for large flanges/ bolt faces. Figure 7 presents the traditional system previously implemented. Figures 8 and 9 present the application of the engineered foam pre-cuts and the completed system on the flanges.

Figure 7: Previous foam roll insert backing system used in combination with PIB paste, no corrosion of steel

BENEFITS 10 YEARS ON

After 10 years of service in one of the harshest environments for coating system to operate the adopted pure PIB coating technology has performed extremely well and prevented steel corrosion over the last 10 years plus. The benefits of this coating technology are highlighted in the following:

Figure 8: Upgrade of flange coating system with engineered foam wedges and re-application of PIB coating system.

- Minimal maintenance in the last 10 years, new PVC outerwrap required only.
- No visible corrosion of the substrate 10 years on.
- Simple and quick repairs to mechanically damaged areas.
- Access not too difficult, without the need for heavy grit blasting or spray equipment.
- Environmentally friendly and portable water approved.
- No shelf life on the PIB VE products when stored correctly.
- Flanges reinstated with specified system as part of the maintenance campaign.
- Foam blocks used in conjunction to reduce excessive product amounts.

The reasons why pure PIB VE coating technology have outperformed conventional coatings applied in the past are:

1. Being a pure polyisobutene (PIB) homo-polyolefin that is a fully inert, amorphous, monolithic, water displacing corrosion protective coating.
2. Pure PIB coating technology relies purely on molecular adhesion to both metallic and non-metallic substrates with minimal surface preparation conforming to St2 or St3 standards. A clean, dry, intact substrate with no mechanical profile is sufficient to achieve full adhesion without the aid of any adhesive promoters (primers) to provide full corrosion protection, unlike conventional coatings and greasy tape wraps.
3. Pure PIB coating technology's visco-elastic functionality and anti-aging properties will ensure that the material will keep cold flowing providing a constant environmental barrier (impermeable to moisture and gases) to the substrate without ever tearing, shearing or peeling off at any temperature ranging from -45°C to +120°C for the life of the asset.
4. Pure PIB coating technology is 100% environmentally friendly and easy to apply making it far safer, quicker, and cheaper to install with no interruptions to the Asset Owner's daily operational workflow.
5. Pure PIB coating technology cold flow technology and self-healing properties guarantee long-term corrosion protection performance.
6. Pure PIB coating technology is more cost effective to apply and maintain throughout the service life expectancy of the asset. An estimated cost and savings comparison between traditional paintable system versus pure PIB VE coating technology was conducted and provided to Urban Utilities. The following table provides the estimated maintenance cost saving to the client of adopting the pure PIB coating technology application versus the blasting and painting programme over the last 10 years plus.

CONCLUSIONS

This paper has highlighted that transitioning from traditional coating systems of blasting and painting to alternative corrosion protection using pure polyisobutene coating technology not only can halt corrosion, but also extend the life of the asset with minimal maintenance and save the client significant

Projected 30-year program for cost comparison only

Coating of Risers			
Coating campaign	1	Cost	$75,000
Coating campaign	2	Cost	$75,000
Coating campaign	3	Cost	$75,000
Coating campaign	4	Cost	$75,000
		Total	**$300,000**

**With metal loss still evident in susceptible areas such as crevices corrosion.*

Stopaq application of Risers			
Stopaq campaign	1	Cost	$100,000
Stopaq Maintenance	2	Cost	$20,000
Stopaq Maintenance	3	Cost	$20,000
		Total	**$140,000**

** With no metal loss and with an extended life span free from external corrosion.*

maintenance budget to be allocated to other pressing needs.

Ten years later, the inlet pipes are in good working order, revealing an outstanding condition under aggressive conditions. This paper has highlighted via real life application and the field assessment findings what asset owners can expect from using pure polyisobutene coating technology for long-term corrosion protection.

ACKNOWLEDGMENTS

Special thanks to Urban Utilities and Veolia Network Services for performing the work and sharing the benefits of this technology. Many thanks to the team at Anti Corrosion Technology and FITT Resources for their continuous support, and generosity in sharing their knowledge and experience.

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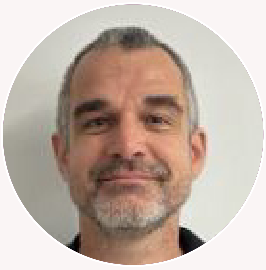
AUTHOR DETAILS



Daniel Faccio is a Civil Engineer professional with 26 years in asset management, maintenance planning and delivery, and asset owner experience within the water utilities, and councils. Daniel was responsible for overseeing and planning the maintenance delivery for tier 1 contractors, water utilities and local councils across Queensland. Daniel has extensive experience in the field of maintenance inspection program and rehabilitation, along with his adoption of STOPAQ® technology on several water utilities asset classes since 2010.

Dr Margarita Vargas is the Engineering Services Manager at Anti Corrosion Technology, a position she has held since 2021. She has over 20 years research, industry, and consulting experience in the areas of corrosion, materials performance, integrity management and failure analysis. She is an SME in the topic of microbiologically influenced corrosion (MIC). As part of her current role, she leads the implementation of corrosion specifications in assets around Australia and is the main consultant in forensic and legal failure reports.

2026 Training Calendar

AMPP Coating Inspector Program Level 1	
NSW - Sydney	12-17 Jan 2026
WA - Perth	09-14 Feb 2026
QLD - Brisbane	23-28 Feb 2026
SA - Adelaide	13-18 Apr 2026
WA - Perth	04-09 May 2026
VIC - Melbourne	04-09 May 2026
NSW - Sydney	06-11 Jul 2026
WA - Perth	03-08 Aug 2026
SA - Adelaide	17-22 Aug 2026
VIC - Melbourne	31 Aug - 05 Sep 2026
QLD - Brisbane	12-17 Oct 2026
WA - Perth	12-17 Oct 2026
NZ - Auckland	19-24 Oct 2026
NZ - Christchurch	02-07 Nov 2026
SA - Adelaide	23-28 Nov 2026
WA - Perth	23-28 Nov 2026
VIC - Melbourne	30 Nov - 05 Dec 2026

AMPP Coating Inspector Program Level 2	
WA - Perth	16-20 Feb 2026
QLD - Brisbane	02-06 Mar 2026
SA - Adelaide	20-24 Apr 2026
WA - Perth	11-15 May 2026
VIC - Melbourne	11-15 May 2026
NSW - Sydney	13-17 Jul 2026
WA - Perth	10-14 Aug 2026
SA - Adelaide	24-24 Aug 2026
VIC - Melbourne	07-11 Sep 2026
QLD - Brisbane	19-23 Oct 2026
NZ - Auckland	26-30 Oct 2026
SA - Adelaide	30 Nov - 04 Dec 2026
WA - Perth	30 Nov - 04 Dec 2026

AMPP Cathodic Protection Level 1 Tester	
VIC - Melbourne	13-17 Apr 2026
SA - Adelaide	03-07 Aug 2026

AMPP Cathodic Protection Level 2 Technician	
VIC - Melbourne	20-24 Apr 2026

AMPP Cathodic Protection Level 3 Technologist	
Online/AEST	15-19 Jun 2026

AMPP Cathodic Protection Level 4 Specialist	
Online/AEST	22-26 Jun 2026

ACA GAA Hot Dip Galvanizing Inspector Program	
VIC - Melbourne	17-18 Feb 2026
NSW - Sydney	17-18 Mar 2026
QLD - Brisbane	14-15 Apr 2026
WA - Perth	21-22 Jul 2026
NSW - Sydney	15-16 Sep 2026

ACA ACRA Concrete Structures & Buildings	
Online/AEST	30-31 Jul 2026
Online/AEST	14-15 Sep 2026

ACA Coating Selection & Specification	
NSW - Sydney	27-29 Jul 2026
Online/AEST	19-21 Oct 2026

ACA Corrosion Technology Course	
VIC - Melbourne	01-05 Jun 2026
SA - Adelaide	07-11 Dec 2026

AMPP Craftworker Series	
SA - Adelaide	14-19 Sep 2026

AMPP Corrosion Under Insulation	
Online/AWST	07-10 Sep 2026

AMPP Concrete Coating Inspector	
VIC - Melbourne	07-11 Dec 2026

Course Spotlight:
AMPP Coating Inspector Program Level 1 (CIP1)

More information & Registration

Overview:

The AMPP Coatings Inspector Program (CIP) is the world's most recognised and specified coating inspection certification program. It is an intensive presentation of the fundamental technology of coating application and inspection. It provides both the technical and practical fundamentals for coating inspection work on structural steel projects. This is the world's most recognised and specified coating inspection certification program.

Who should attend

Although specifically designed for Coating Inspector Trainees, this program benefits anyone interested in gaining a better understanding of coatings and inspection including Project Managers, Engineers, Maintenance and Quality Assurance/Control Personnel, Contractors and Specification Writers, and Coating Applicators.

Course highlights:

- Coatings Introduction
- Curing Mechanisms
- Role of the Inspector
- Environmental Test Instruments
- Inspection Procedures
- Non-destructive Test Instruments
- Coating Specifications
- Application Procedures
- Surface Preparation and Standards
- Coating Failures
- Field Lab
- MSDS and Product Data Sheet Review
- Logbook Documentation
- Non-destructive Testing and Inspection

Joining the Australasian Corrosion Association offers a whole host of benefits for indviduals seeking to advance their careers and expand their networks.

Membership provides access to a wealth of resources including cutting-edge industry research, professional development opportunities through workshops and seminars, and exclusive updates on trends and regulatory changes.

Networking events and conferences enable members to connect with peers, mentors, and industry leaders, fostering valuable relationships and collaborations.

By joining the ACA, you gain a competitive edge, stay informed, and enhance your professional growth and opportunities.

Become a Member

KNOWLEDGE BUILDING

The ACA's trainings and development pathways cater to a variety of skillsets , from entry-level corrosion novices to those seeking advanced specialist training. Training arrangements have flexible capacities and are both locally and internationally recognised for their quality, accreditation, and applicability. The Annual Corrosion & Prevention Conference offers an array of technical initiatives, including industry and research programs, social functions and awards ceremonies to highlight innovation in the corrosion industry. Our Branches offer a year-round calendar of events, including seminars, on-site visits, technical presentations, networking events, Young Corrosion Group events, and more.

RESOURCES

Joining ACA gives you access to our library of resources, papers, and material expertise to assist your business and further your career. The ACA sends out weekly newsletters, social media updates, and one-off packages about news and events to keep members informed. Members also have the option to promote their own people and initiatives through our updates. The ACA has accrued over 2,000 case studies, research papers, technical articles, presentations and more covering a range of subjects written by some of the most respected industry experts. Members can also access papers, publications and seminars from the European Federation of Corrosion.

COMMUNITY

ACA is committed to building an active, engaged, and passionate membership. Networking is both online and in-person; meet people online through seminars, discuss the future of corrosion with your peers at a convention, and join the AGM and other Branch events. Join one of the ACA Committees to become more involved, learn new skills, and access career opportunities with some of the most ambitious and connected in the industry. The ACA acts as your voice and representation; we engage with governmental organisations, other non-for-profits, big business, and others to get the best outcomes for our industry and our Membership. Members can use our Corrosion Control Directory to contact the best industry person to meet your needs or ask your questions.

RECOGNITION

Get involved in the ACA's scholarship program and picking up new skills through the Association's direct financial and administrative support. Obtain certification as either a Corrosion Technician or Corrosion Technologist to receive extended public recognition for your qualifications. Use ACA's logo to demonstrate your qualification. Sign into ACA's website, build your personal profile, and connect with likeminded peers within the corrosion industry.

MEMBER BENEFITS

Membership Benefit	Diamond	Platinum	Gold	Silver	Bronze	Individual
Number of Corporate Delegates accessing benefits (Delegates receive the same benefits as individual members)	30	12	8	5	3	1
Additional Young Corrosion Group (YCG) Delegates YCG Delegates receive the same benefits as individual members. YCG should be students or in early stage of their corrosion career (under 35 years)	Unlimited	10	5	3	2	✗
Join our Technical Groups Applicators Technical Group, Cathodic Protection Technical Group, Coatings Technical Group, Concrete Structures & Buildings Technical Group, Oil & Gas Technical Group, Young Corrosion Group, Water Industry Group.	✓	✓	✓	✓	✓	✓
Discounted prices for Training, Events and Conference attendance for Delegates Upskill with member prices on ACA and AMPP Training Courses, ACA events and our Annual Corrosion and Prevention Conference	✓	✓	✓	✓	✓	✓
Access to our online Corrosion & Materials Journal (Quarterly) Receive four (4) online issues of the Corrosion & Materials Journal for all members, featuring technical articles, latest news, new products, and industry events.	✓	✓	✓	✓	✓	✓
Access to Exclusive ACA Member resources Over 4,500 Technical Papers, Webinar Recordings, 2,000 past ACA conference papers, recorded presentations from ACA events, past issues of Corrosion & Materials, technical articles, case studies and more.	✓	✓	✓	✓	✓	✓
Access to past Conference papers from the European Federation of Corrosion (EFC) congress & access to be appointed on Membership of EFC Working Groups	✓	✓	✓	✓	✓	✓
Access to local, Australia wide & New Zealand networking Branch & Technical Group events	✓	✓	✓	✓	✓	✓
NEW **Exclusive Membership Portal** Renew and pay your membership dues, download invoices, access ACA events and training, update your details, review past training or events, access the technical library, read C&M Journal, and, for corporate members, manage corporate membership. *NEW*	✓	✓	✓	✓	✓	✓
Entitlement to use the ACA Corporate Partner Logo on company's promotional material By submitting a Membership Application Form, you acknowledge that you have read and understood the ACA Terms & Conditions and agree with and consent to the practices described.	✓	✓	✓	✗	✗	✗
Free listing in the Corrosion Control Directory on the ACA website	✓	✓	✓	✗	✗	✗
Priority for annual Branch and Technical Group Sponsorship Opportunities	1st	2nd	2nd	3rd	3rd	✗
Acknowledgement at the Conference + Awards Dinner	1st	2nd	2nd	3rd	3rd	✗
Preferential Lead Service	1st	2nd	2nd	3rd	3rd	✗
Discounts on Advertising	✓	✓	✗	✗	✗	✗
Company Name, Logo and Website listed on Corporate Members Page Linked to your website.	✓	✓	✗	✗	✗	✗
Company Logo used on the homepage of the ACA website	✓	✗	✗	✗	✗	✗
One free advertorial on ACA website & feature in global mail out on sign-up	✓	✗	✗	✗	✗	✗
One annual special feature in Corrosion & Materials Journal	✓	✗	✗	✗	✗	✗