A journal of the Institute of Corrosion

Corrosion Management

Issue 175 Sept/Oct 2023

A Comprehensive Integrity Management Approach to Addressing Process CUI Risks

Page 25

INSTITUTE OF CORROSION

Institute News:
Annual Corporate Sponsorship Dinner.
Page 11

Industry News:
Lake Chemicals and Minerals Celebrates 20 years of Growth.
Page 20



Contents

INSTITUTE OF CORROSION

Issue 175 September/October 2023

Published on behalf of the Institute of Corrosion
Square One Advertising and Design Limited
Neepsend Triangle Business Centre, Unit 8,
1 Burton Street, Sheffield, S3 8BW.
Publisher and Managing Editor
Debbie Hardwick
Tel: 0114 273 0132
Email: debbie@squareone.co.uk
Consulting Editor
Shagufta Khan
Email: editor@icorr.org
Design
Square One Advertising & Design
www.squareone.co.uk
Advertising Manager
Jonathan Phillips
Tel: 0114 273 0132
Fax: 0114 272 1713
Email: jonathan@squareone.co.uk

Editorial content for November/December Issue is:
15th November 2023
Subscriptions

UK	£70.00
Europe	£80.00
Outside Europe	£90.00 airmail £80.00 surface mail

Enquiries and subscriptions to the Institute of Corrosion at the address below:
The Institute of Corrosion
President
Stephen Tate
Past President
Bill Hedges
Hon. Secretary
Dr. Jane Lomas

Institute of Corrosion, Corrosion House,
5 St Peters Gardens, Marefair,
Northampton, NN1 1SX

Tel: 01604 438222
Email: admin@icorr.org
Website: www.icorr.org

ISSN: 13 55 52 43

This publication is Recyclable.

MIX
Paper | Supporting responsible forestry
FSC® C019447

The President Writes

Dear Members,

Our last three months have been very eventful, with so many activities ongoing nationally and locally in our branches.

EuroCorr 23 was a major milestone for ICorr with the announcement of our successful joint bid with IOM3 for the Dublin 2026 conference, following on from planned events in Paris in 2024, and in Stavanger in 2025. The Institute owes a huge debt to Gareth Hinds, our past president from 2018–2020, for achieving this success. We must also congratulate Steve Paterson for his recent Honorary Fellowship award at the EFC Conference.

Also in August, the Aberdeen Branch hosted an extremely well-attended Corrosion Awareness Day (CAD) event with very generous sponsorship from Rysco Corrosion UK.

In September, our Corrosion Science Division (CSD) held a very successful Corrosion Science Symposium (CSS) in conjunction with Electrochem 2023 at Bristol University, with this year's U.R. Evans Award going to Professor Nick Birbilis of Deakin University, Melbourne.

Our Young ICorr (YEP 2024 Programme) also launched this month in London City. Please contact James McGladdery James.McGladdery@uknnl.com if you wish to join in for next year.

The Institute's AGM and Autumn Mini-Conference at the Birmingham Science Museum organised by our Midlands Branch featured five magnificent Technical Papers along with a well-deserved presentation to Trevor Osborne of the H.G Cole Award.

During early October and following our very successful NE Branch Sustainability Conference, we also exhibited at Floating OffshoreWind (FOW). https://www.scottishrenewables.com/events/198-floatingoffshore-wind-2023

Do please join us for our new technical session now starting within our many regional branches with regular monthly meetings and networking opportunities.

Finally, please look out for details of the 34th Christmas Luncheon of the London Branch to be held at the Royal Over-Seas League (ROSL), St. James's, on December 7th.

For anyone who has not yet renewed their membership, please do liaise with the Institute of Corrosion HQ at admin@icorr.org who will be happy to help you, especially if your contact details have recently changed. As an institute, we value every membership and will work hard to assist you wherever we can.

With my very best wishes.

Stephen Tate, President Institute of Corrosion

From the Editor

Welcome to the September/October issue of the magazine. Many thanks to readers for their positive feedback on the previous issue.

This issue is dedicated to "corrosion under insulation". Firstly, a technical article by Philip Enegela, "A Comprehensive Integrity Management Approach to Addressing Process CUI Risks," reviews the state of the art in corrosion under insulation (CUI) management, highlights the need for proactive management of cold-duty insulation, and discusses results from the validation of a novel CUI monitoring technology from an end-user's perspective.

Secondly Chris Fyfe and Dave Wickham have contributed their expanded technical article based on their earlier Aberdeen Branch presentation "Asset Operating Integrity and Repair of Damaged or Aged PFP".

Epoxy PFP can be regarded as relatively maintenance-free when installed correctly; therefore, in the context of this paper, maintenance and repair (M&R) focuses on anomalies in dense concrete and lightweight cementitious and provides an overview of an ongoing work programme to develop solutions that aim to focus M&R scheduling on only those locations that are critical to the operational safety of the facility.

"Ask the Expert" answers a very important question: Under what conditions can MIC occur and what are the effective methods to prevent MIC? The answer to this question was compiled by Dr. Tony Rizk, ICorr MIC training course lead.

A new section, "Corrosion Around Us", is included this time. The idea behind this new feature is to publish pictures of preventable corrosion of various assets like bridges, ships, buildings, industrial equipment etc along with details of the contributor. All ICorr members are invited to submit high-quality images (1MB+) of active corrosion sites that need addressing in their own locality. Please provide supporting text explaining the causes and impacts of ongoing corrosion/erosion issues.

We invite industry news, technical articles, and articles for fellow's corner from you in whichever part of the world you are based. Your suggestions and feedback are very important for ensuring that we deliver magazine content that will engage you our valued members. Please send all your content for consideration to, **editor@icorr.org**

Dr Shagufta Khan, FICorr
Consulting Editor

Local Branch News

Aberdeen Branch

On Tuesday 22nd August 2023 the Aberdeen Branch held its annual fund-raising Corrosion Awareness Day (CAD) and welcomed eight corrosion industry speakers along with multiple equipment demonstrations from Rysco, who were ICorr's host for this one special event. CAD is designed to assist the development of those unfamiliar with Corrosion and it's prevention and provides an understanding of the corrosion processes and causes which are specific to a range of common industries.

Delegates learned the basics of the role of the corrosion engineer, including materials selection, corrosion mitigation; failure investigation; testing and design issues.

Delegates – Group photo with Aberdeen Branch Chair, Siji Anjorin centred kneeling.

The welcome was provided by the Aberdeen Branch Chair, Siji Anjorin, supported by Dean Smith, Bridge of Don Operations Manager for Rysco U.K. for the Safety Moment.

Rysco is headquartered in Calgary and is a global provider of corrosion management solutions. They are both ICorr Gold Sustaining Member and Aberdeen Local Branch Sponsor.

A comprehensive series of talks and demonstrations followed the introductions, designed to cover all they key corrosion Topics.

1. Principle and Cost of Corrosion

Steve Paterson, Ph.D., C.Eng., Arbeadie Consultants provided the opening presentation running through the fundamentals of corrosion and electrochemistry with emphasis on what drives corrosion and the corrosion process of metals. He then outlined the different types of corrosion and common corrosion mechanisms and how these relate to the Oil and Gas industry. Internal Corrosion mechanisms discussed were: Acid gas corrosion (CO_2/H_2S) consisting of: CO_2 (sweet) corrosion, Preferential weld corrosion, H_2S (sour corrosion, Mixed sweet and sour corrosion), Sulphide stress cracking (SSC), Hydrogen induced corrosion (HIC), Hydrogen embrittlement, Chloride pitting/ crevice corrosion, Oxygen corrosion, Microbial induced corrosion (MIC) and Sand erosion.

Several methods of corrosion control and management were outlined, including:

- Materials selection: The most effective solution that can remove the corrosion threat completely (e.g., CRA/non-metallic material).
- Water removal by dehydration.
- Chemical treatments (e.g., corrosion inhibitors, biocides or oxygen scavengers) a common mitigation method for internal protection of carbon steels.
- Use of coatings and linings.
- Anodic/Cathodic protection used to limit and control corrosion in both internal and external situations.
- Control of process parameters and environment, e.g., by limiting temperature and chloride content can reduce the risk of SCC.

Steve then highlighted the costs and significance of corrosion and demonstrated how implementing corrosion prevention best practices could result in savings of between 15% and 35% with the NACE 2016 study quoting savings of 3.4% of global GDP (Gross Domestic Product), giving immense motivation for corrosion engineers to contribute in achieving such savings and associated improvements in integrity of infrastructure and protection of the environment.

continues on page 6

2. Materials Selection

Rob Howard, Ph.D., of Lloyd's Register discussed materials selection critical to the Oil and Gas processing industry making reference to a process diagram from well to the final product, he looked at the common types of corrosion witnessed in the process equipment: A selection of materials for corrosion resistance was reviewed showing how we can move from martensitic and austenitic stainless steels up to duplex and onto Ni and titanium alloys to get sufficient resilience, albeit with some heavy cost implications.

Rob Howard graduated with a degree in Materials Engineering from the University of Cape Town in 1995. and worked as a post-doctoral researcher at the Corrosion and Protection Centre, University of Manchester. He joined Lloyd's Register (LR) in 1998, and at present, he is the team leader for the Offshore Materials team in LR, whose main function is to provide technical support to surveyors and clients and to review design specifications for oil and gas and offshore wind projects.

He explained how the choice of equipment materials is influenced by parameters such as corrosivity, flow rates, and chloride and hydrogen sulphide levels. However, equally important are the heat treatment condition and mechanical properties required, the corrosion resistance, issues such as weldability, and ongoing costs for inspection, maintenance, and repair of the materials selected. Rob referenced a number of international sources that are particularly useful for materials selection and stressed the need to examine the manufacturer's capability and quality control of the product:

- Norsok M-001 (edition 5, Sept 2014)
- ISO 21457
- ISO 15156 (NACE MR-0175)

3. Oilfield Microbiology Analysis and Data Trending

Carol Devine, PhD, BSc (Hons) of NICMB has over twenty-five years' experience in oilfield microbiology. She has a particular interest in microbiologically influenced corrosion (MIC), sulphate-reducing bacteria (SRB), seawater injection systems, and molecular microbial ecology in general. NCIMB preserves, stores, and supplies a collection of cultures to industry and universities. It has the largest collection of industrial, marine, and food bacteria in the UK and has approximately 10,000 strains, 300 genera, and 2000 species, and is still growing.

Oilfield equipment is commonly damaged by the presence and activity of microorganisms in systems for production, seawater cooling, water injection, cooling / heating, and the handling of produced water (PW), firewater, reinjection (PWRI), diesel storage, and ballast water. The organisms are either planktonic from bulk water phases or sessile biofilms on surfaces.

Carol explained the role of the oilfield microbiologist in generating useful and appropriate data in order to:

- Predict which particular systems, vessels, pipelines, and locations are under threat from microbiologically influenced corrosion (MIC).
- Prioritise areas for treatment according to budget and available time.
- Apply and monitor appropriate strategies to mitigate against the effects of MIC or biofouling.
- Techniques for analysis were explained: triplicate MPNs, qPCR, and metagenomic analysis (NGS) to assess the threat of MIC and quantify, identify, and assess the activity that needs to be monitored on a continuous basis to see trends from production changes and implement actions to control and prevent system infestation, which affects flow and efficiency in the process.

4. Corrosion Mitigation by Cathodic Protection

Dr. Nigel Owen, B.Sc., D.I.C, Ph.D., MIMMM, MICorr, Aberdeen Foundries has worked in the aluminium industry for over 35 years on alloy development and manufacturing processes. He spent his later years at Aberdeen Foundries as Sales, Technical, and Plant Manager, manufacturing sacrificial anodes. He now oversees the manufacturing, testing, and design of all subsea and marine sacrificial anode systems.

The company has recently relocated to modern high-tech facility at Stonehaven.

Nigel explained how the galvanic table shows naturally what materials provide a suitable basis for sacrificial anodes. Aluminium, zinc, and magnesium are the most common base metals for the development of the alloys. With a sufficiently electronegative potential, what materials provide a suitable basis for sacrificial anodes. Aluminium has a high current output per kg consumed and has therefore become the material of choice for anodes, particularly on large structures.His presentation covered:

- Alloys for Sacrificial Anodes
- Design of a CP system to protect a structure
- Applications of anodes
- The selection of the CP system
- The benefits and drawbacks of sacrificial and impressed systems, and their applications
- The process of designing a sacrificial anode system was explained from the assessment of cathode material areas and the effect of coating to the calculation of anode mass and current output for a structure in an immersed environment.
- A comparison was made between sacrificial and impressed current systems in terms of their benefits or advantages given current demand situations and maintenance requirements. Performance is determined by the conductivity (salinity) and the temperature (water depth or geographic region) of the deployment.

5. Corrosion Mitigation by Coatings

Colin Thomson, HND, FM Lead at Bilfinger Salamis, has over 20 years of experience working in oil and gas fabric maintenance (FM) after serving in the Merchant Navy. He has supported various clients FM requirements including, BP, and Conoco Phillips, ExxonMobil and Petrofac. He skilfully explained how FM prevents corrosion, degradation and wear which could otherwise lead to safety and or operational issues. Coatings acts as a barrier to the environment therefore all locations where coatings are damaged must be maintained to prevent metal loss. Colin also brought everyone up to date with modern FM strategies and also instantaneous barrier methods such as anti-corrosion tapes (ACTs) and Corrosion Inhibiting Waxes.

Various key properties of coatings were highlighted including: Anti-Fouling, Environmental Protection, Fire Protection, Process flow aids, Safety and Thermal protection / insulation.

The complete range of surface preparation techniques was evaluated along with all factors affecting coating 'life expectancy, for example:

- Anchor pattern (too rough or too smooth)
- Chemical salts
- Condensation
- Existing coatings
- Fabrication defects (weld spatter, sharp edges)
- Mill scale
- Oil, grease and soil
- Surface corrosion

continues on page 8

CALL FOR PAPERS

ETCC 2024
EUROPEAN TECHNICAL COATINGS CONGRESS

ETCC2024 -European Technical Coatings Congress- will take place on 23–24–25 September 2024 in the Palace of the Popes of Avignon (France). For all information visit our website: www.etcc2024.org

The Congress has a tradition of more than 70 years ! Since 1950 the member Associations of FATIPEC have organized more than 35 scientific and technical congresses. In 2012, the traditional "FATIPEC Congress" was continued with the now well-known name **"ETCC – European Technical Coatings Congress".**

Papers can be submitted for one of the following topics:

- Advances in Sciences of Paints, Adhesives, Printing Inks and Related Products
- Formulations
- Corrosion Protection
- Biobased Solutions
- Sustainability
- Circular Economy
- Carbon Footprint and Decarbonation
- Life Cycle Assessment
- Advances in Processing and Production
- Wood as a substrate
- Measuring and Testing

- Abstract submission, deadline: January 31st, 2024

- Notification of abstract authors: March 15th, 2024

Final paper due to **MAY 31st.** Presentations can be published in journals, mainly such with a high impact factor, as example in "Progress in Organic Coatings" (www.journals.elsevier.com/progress-in-organic-coatings).

Should you have any questions, please do not hesitate to contact us by e-mail: admin@etcc2024.org

6. Corrosion and Chemicals Management

Jennifer Watson, HNC, Senior Account Manager/Production Chemist at Champion X is currently based within the BP office supporting Glen Lyon FPSO and has over 20 years of experience in oil and gas operations offshore and onshore. She enthusiastically described all the key chemical mitigations deployed within the energy sector, including:

- Biocides for preventing MIC
- Corrosion inhibitors for internal corrosion
- Drag reduction
- Oxygen and H_2S scavengers pH stabilization

Jen also discussed all commonly used monitoring processes and analysis methods for rates, chemical residuals, and other dosing checks. Most importantly, she emphasised the need for having appropriate chemical and Corrosion Control Matrices (CCCM) in place. These are the basis for understanding individual threats and how they should be mitigated by chemical applications or other barriers.

A magnificent outdoor lunch followed in perfect weather with an opportunity for all to network.

One of many networking opportunities in this very vibrant event.

7. Integrity Management and Risk Based Inspection

Simon Hurst, BSc, MSc has been with CAN since 2008 and is currently the Engineering Director, where he is responsible for the ENGTEQ business stream, and is the nominated technical manager under their UKAS accreditation for Integrity Management and Pressure Systems Inspection. He commenced his talk by defining Integrity Management - BS ISO 55000:2014 states that it enables an organisation to achieve its objectives through the effective and efficient management of its assets. The application of an asset management system provides assurance that those objectives can be achieved consistently and sustainably over time.

Simon went on to define some of the key components of Asset Integrity Management including the following:

- Ageing and life extension
- Anomaly Management
- Corrosion Control Matrices
- Failure Investigations
- Integrity Operating Windows
- Risk Based Assessments leading to risk-based inspection

CAN-ENGTEQ have very kindly offered to sponsor and host our 2024 Aberdeen Corrosion Forum.

8. Corrosion and Chemicals Management

Dean Smith is an experienced Operations manager in the corrosion monitoring industry, having started his career as a retrieval technician in 2007 and worked his way up to field services management and eventually operations management. He emphasised that erosion and corrosion pose significant challenges to oil and gas production, impacting safety, efficiency, and profitability, and that effective monitoring techniques, combined with ongoing innovation and investment, are essential to mitigate these challenges and ensure the sustainability of the industry.

Prior to the practical demonstrations, Dean gave a run-through of the key services of Rysco UK which cover the following:

Design and Supply of Internal Corrosion Monitoring Systems including: High and low pressure access systems:

- Custom Equipment Design and Manufacturing
- Electronic Monitoring, e.g., Electrical Resistance Instruments
- Injection and Sampling Systems
- Mechanical Monitoring, e.g., Corrosion Coupons

Field Services including: High and Low Pressure Monitoring Device Retrieval.

- Hot Tapping
- Monitoring Data Analysis and Reporting
- Monitoring System Audits
- Sampling and Lab Analysis

Online Reporting including: Custom Reporting Dashboards via Business intelligence Software and Interactive Mapping.

Sponsor's Process Equipment Demonstrations

Three separate demonstrations followed for which the 52 strong gathering was split into 3 rotating groups.

Richard Rae of Rysco U.K explains integrated corrosion data management.

Retrieval tool demonstration with Dean Smith and Rhys McWilliams.

Corrosion coupon review with Tommy McCann - operations manager, Rysco Canada.

A Corrosion Quiz covering multiple aspects of the Speaker Presentations followed by a vote of thanks from the President and CPD awards closed this very successful event attended by over 50 delegates.

Delegates enjoying the Corrosion Quiz.

ICorr Aberdeen welcomes suggestions for further Industrial visits during its upcoming sessions.

Abstracts of potential papers for the Aberdeen Technical Programme are always welcome, and anyone wishing to join committee should correspond with the 2023/2024 Technical Programme Co-ordinator: Adesiji Anjorin anjorin@gmail.com

Further Information about the Aberdeen Branch, and past presentations, may be found on their website page: Aberdeen Branch - Institute of Corrosion (icorr.org), and to join the Aberdeen Branch mailing list, please contact: icorrabz@gmail.com

London Branch

The summer webinar series continued in August with a presentation on "AI Powered Corrosion Monitoring", by Leroy Dias of SteelCorr.

Corrosion is a serious threat to all assets, and more so to ships, as they operate in a very harsh environment. By using AI to monitor corrosion, we can mitigate some of these threats by identifying the issues and fixing them before they can pose a problem. AI can process a large number of images quickly and objectively, thus eliminating the human centric risk of missing critical areas.

Leroy explained the use of this tool in relation to ships. Using an AI model embedded in a code allows us to analyse the findings and send actionable insights to ship owners so that they can make better decisions. The findings are also used by owners to estimate the resources needed. The mobile app allows the ship's crew to easily upload photos even in off-line mode, thus saving hours of crew time. Shore based managers do not need to go through lengthy reports to figure out how their asset is being maintained, as the app provides a historic repository of data, and AI tells them where to look.

Leroy has worked for more than 20 years in the corrosion and coatings industry with a paint contractor and paint manufacturer. He then founded a start-up company, SteelCorr in Dubai, who created and commercialised the first AI powered corrosion monitoring app for the maritime industry that is currently being used by 150+ ships worldwide.

A recording of the July webinar by Ennery Leon can be found on his YouTube channel, "Enery Corrosion".

Midland Branch

On September 14th, the Midlands Branch paid a 'much in demand' visit to UoM (University of Manchester).

Professor of Corrosion Control **Stuart Lyon** provided a presentation on the work of the University and the Corrosion Group, including 65 years of corrosion history at Manchester.

The Corrosion and Protection Centre in the School of Materials at Manchester University has a world-wide reputation for education, training, and research in all aspects of corrosion science and engineering.

Metallurgy and corrosion research at UoM focuses on all classes of metallic materials, utilises very modern facilities, and greatly benefits industries of all types.

ICorr will be providing student bursaries to support UoM corrosion courses over the next five-year period.

Richard Rae of Rysco U.K explains integrated corrosion data management.

Midland branch attendees on the University of Manchester (UoM) laboratories visit.

Stuart's presentation was very well received, and the tour of the facilities was considered excellent, with industry-leading facilities on display.

All attendees were very impressed with the event.

The ICORR Midland Branch expresses its sincere thanks to UoM for making this visit possible. The Q&A generated some very pertinent observations. Chris Googan: Corrosion Science and Engineering: Where Do They Join Up – Chris showcased a number of corrosion control issues he has come across over his career which could have been solved with better communication.

Izabela Gajewska discussed Best Management Practice to Transfer Knowledge and how it can help Young Engineers and their Companies, whilst also touching on the advantages that AI may provide in the future with knowledge transfer between engineers.

ICorr Annual General Meeting

In support of the Institute's AGM, the Midlands Branch organised a very well received multi-subject Corrosion Awareness Event covering: Automated CUI Monitoring Case Studies, Corrosion Control Solutions for Reinforced Concrete and Steel, Holistic Corrosion Data Management, Recent Advances in NDT and also an update of Recent Activities in the World of PFP.

The relaunched Branch is planning further technical meetings for later in the session..

For other general inquiries about events or supporting the branch, please feel free to get in touch with Bill Whittaker, Midlands Chair, midlandschair@icorr.org

North-West Branch

The North-West Branch continues to build its technical programme for 2023–2024 under its new chair, Greg Brown, an MSc Postgraduate Student in Corrosion Control Engineering of the University of Manchester (UoM) who joined Mott MacDonald in 2015 and is now based in Spring Bank House, **Altrincham**, as shown below.

Greg Brown - ICorr's North-West Chair

Mott Macdonald Offices - Altrincham

Upcoming technical meetings are expected to include Reinforced Autoclaved Aerated Concrete (RAAC) with other corrosion related research presentations from staff and students at nearby UoM, who are involved in October with the ICorr student bursaries scheme. Members should check the ICorr events calendar https://www.icorr.org/events/

Please email: Greg on: Greg.Brown@mottmac.com if you would like to participate in the North-West Technical Programme or join its local committee.

Inaugural Annual-Corporate Sponsorship Dinner

On **Friday 15th September 2023**, the Institute held its Inaugural Annual Corporate Sponsorship Dinner at the Guinea Club in Mayfair, London, which was a huge success and greatly enjoyed by attendees from AkzoNobel, BP, Carboline, and ICorr branches, along with colleagues from PFP Net who are currently working alongside us on training course development.

Our corporate sponsorship guests ready and waiting outside the Guinea club in Mayfair.

With excellent organisation provided by David Mobbs, around 30 guests and ICorr representatives were rewarded for their patience by an outstanding 5-course corporate luncheon with something for everyone.

Prior to the main event, the ICorr President, Stephen Tate, outlined some key growth areas for the institute, highlighting:

- A new CEng direct scheme, with key players Anthony Setiadi (London branch) and Yunnan Gao (Vice President), was introduced to the corporate audience.
- An expanded membership base driven by planned new branches in the UK and overseas over the next 12 months.
- Increasing global presence via EFC and WCO, through much hard work by past president Gareth Hinds.
- The 2024 Young Engineer Programme (YEP) again generously supported by BP.

The importance of our younger members to the future of the institute cannot be overstated. Student bursaries, internships, and new apprenticeships (via Correx) have all been successfully rolled out recently.

Our corporate guests all seated and raring to go.

The corporate membership offering continues to attract a range of companies seeking closer involvement with ICorr. Recently joining has been Flexitallic, founded in 1912 and established as a specialist in flange sealing, prevention of flange face corrosion, and reducing LOC (loss of containment) risks. Sadly Flexitallic, were unable to attend on this occasion due to other exhibition and conference commitments.

The Flexitallic demonstration from Offshore Europe 50th year exhibition at TECA Aberdeen, 5-8 September 2023.

continues on page 12

As an institute, we are truly grateful to all our existing corporate members for their ongoing support to our divisions and branches. Our 2024 event is expected to be even larger, with details to be announced before year's end.

How much does it cost to join us?

We encourage all larger companies in the corrosion prevention industry to consider this higher grade of membership. The cost of this prestigious sponsorship is based on the number of employees in their tailored programme package (a minimum of 5) and starts from £1,900 per year.

Corporate membership in the Institute of Corrosion offers several tangible benefits for medium- to large-sized organisations, including:

1. Access to career development and progression programmes (CDPP/YEP) and to the institute's online resources and libraries.
2. Advertising in corrosion management magazine and on the ICorr website members directory free of charge (and exclusively displaying company logo).
3. Discount of 10% on all conferences, symposia, and selected ICorr training courses.
4. Free annual networking event for all your nominated ICorr members.

Most especially, it offers members the highest level of participation within our progressive organisation as we increase our profile and engagement globally.

If you are interested in corporate membership for 5 or more employees, do please contact our office on 01604 438222 or if you prefer, liaise directly with the President at: president@icorr.org who will be happy to assist in any way with your queries.

U.R. Evans Award 2023

Each year, the Institute of Corrosion bestows a range of internationally renowned awards in recognition of excellence in corrosion science and engineering and to reward outstanding service to the Institute and the wider corrosion community. Many of these awards are open to nomination by both members and non-members of the Institute.

The U.R. Evans Award is the premier scientific award of the Institute of Corrosion and is presented annually for outstanding international achievements in pure or applied corrosion science. The recipient is selected by a Corrosion Science Division panel and presented with an engraved sword at the annual ICorr Corrosion Science Symposium (CSS), held this year in conjunction with Electrochem 2023 at the magnificent Wills Memorial Building, University of Bristol, with an opening reception at the SS Great Britain and a dinner at the Bristol Museum.

Ulick Richardson Evans was described in the Biographical Memoirs of Fellows of the Royal Society as the "Father of the modern science of corrosion and protection of metals". His major contribution to the subject involved placing on a firm foundation the electrochemical nature of corrosion. His learnings were documented 1922-1924:

1. The mechanism of the so-called "dry corrosion" of metals - Transactions of the Faraday Society (RSC Publishing)
2. U. R. Evans: Metals and Metallic Compounds: London, U.K.: Edward Arnold, 1923.

and most notably

3. U. R. Evans: The Corrosion of Metals: London, U.K.: Edward Arnold, 1924.

The Institute will next year, celebrate the 100th anniversary of this best-known work

Ulick R Evans 1976 at Cambridge, just 4 years before his death.

This symposium is one which seeks to encourage the participation of the junior members of the corrosion community who would appreciate the visit of, and address by, a corrosion scientist of international repute. The form of the award symbolises the fight in which we are all engaged and the recipient is granted Honorary Life Fellowship of the Institute.

Corrosion Science Division (CSD) Chair, Julian Wharton at the magnificent Wills Memorial Building reception room.

Professor Nick Birbilis has been a hugely respected leading light in the fields of corrosion research and education throughout his career displaying incredible energy and passion for the discipline as his very extensive and high quality, publication record attests. He has made many pioneering and seminal contributions through research activities conducted both from within his own research group and the numerous collaborative efforts he has involved himself in.

He is the Executive Dean of the Faculty of Science, Engineering and Built Environment at Deakin University near Melbourne, Victoria; this role plays to Nick's strength in using interdisciplinary techniques to solve technological problems important to society in general.

Before the move to Canberra, Nick had spent his early years as an academic at Monash University on Melbourne's Clayton Campus; joining as a lecturer in the Department of Materials Engineering in 2006. He was promoted to associate professor in 2011 and became one of the youngest, aged 36, ever engineering professors in Australia in 2014. In 2016 he was awarded the 'Woodside Innovation Chair' at Monash, an industrially funded personal chair associated with durability of next generation materials. Nick served as head of the Department of Materials Engineering from 2013 until 2018.

Prior to his to his academic journey, Nick graduated with a Bachelor of Engineering in 2001, and a PhD in 2004 (both obtained during study at the Department of Materials Engineering Monash University); notably Nick served as a consultant to AECOM Technology Corporation during his PhD, a role he still plays. Immediately before embarking on his academic career, at the University of his PhD graduation, he spent two years as a postdoctoral researcher at Ohio State University with Professor Rudy Buchheit studying aspects of the corrosion of aerospace aluminium alloys.

Professor Nick Birbilis, recipient of the 2023 UR Evans Award at Electrochem, Bristol, England.

His current research is centred on microstructure-corrosion relationships, especially the exploration of the metallurgical factors that dictate both the initiation and propagation of localized corrosion. Nick's research portfolio also includes:

- Additive manufacturing and 3D printing of metals;
- Alloy design, with a view to science-based improvement in corrosion resistance: notably the development of stainless (corrosion-resistant) magnesium alloys;
- Cathodic activation of anodically polarized Magnesium (Negative Difference Effect);
- Computational materials science;
- Functional corrosion resistant coatings;
- Metallic biomaterials.

In publishing and Volunteering roles, Nick has been the Associate Editor of Electrochimica Acta since 2010 and in 2017 was named the editor in chief of *npj* Materials Degradation. Nick is also active in several professional societies, including the ISE, ACA (serving as the Victorian division president) ECS and AMPP (where he was chair of the research committee and sits on many committees).

He has received several awards, ATSE Barnham Medal, NACE HH Uhlig & Whitney awards. Nick has organised many sessions at international and national conferences, and was the chair of the GRC conference on aqueous corrosion in 2018. He has also presented numerous invited seminars and lectures at conferences related to his discipline. Nick is a Fellow of the Electrochemical Society and of AMPP (formerly NACE).

In conclusion, Nick has been a tireless servant to the study of corrosion, some of Nick's key contributions include:

- Development of Stainless and Super formable magnesium alloys (Nature Communications).

Defining the size of microstructural features that act as initiation sites for pitting corrosion in engineering alloys (a web-based tool for analysis of electrochemical data related to such phenomena that has been made available online);

- Corrosion Detector – a machine learning model for detection of corrosion (Nick presented work that led to the development of this model at the GRC in 2018).

The Institute offers its many congratulations to Nick on receipt of this award.

Above Left: Research Posters in the Wills Memorial Great Hall of Bristol University.

Above Right: Professor Nick Birbilis UR Evans Award presentation on 11th September 2023.

Engraved inscription to Professor Nick Birbilis.

Future nominations for this award may be submitted at any time via email to the CSD Chair, Julian Wharton at J.A.Wharton@soton.ac.uk

EUROCORR 2023

The **EUROCORR 2023** conference and exhibition very successfully took place in Brussels from 27-31 August, 2023, under the general theme of 'Driving corrosion prediction and protection towards a circular economy'.

Historically, a flagship event of the international corrosion calendar, it was preceded by the **EFC Corrosion Summer School** with a huge range of lectures.

It was a very vibrant occasion, as clearly illustrated below, with over 1000 delegates attending, including many ICorr representatives, and continuing the recovery of in-person attendance since the COVID pandemic.

We must particularly congratulate Steve Paterson for his honorary fellowship award at the EFC Conference, which is very well deserved.

EUROCORR is famed for its high technical standard and its popular social programme. Young EFC activities continue to increase, and social media followers have now topped 3000.

The **Young EFC**, which was created in 2016 by the EFC, aims to support young researchers and engineers in the field of corrosion and material protection. Its vision has several cornerstones, namely:

- Building a bridge between young corrosion researchers and senior experts.
- Creating a network of young corrosionists.
- Organising and participating in conferences, workshops, and other events.
- Promoting the interests of young researchers to the European Federation of Corrosion and the European Commission.
- Supporting the career at an early stage.

For further details see: European Federation of Corrosion - Young EFC (efcweb.org) Also note that the following EFC Green Books are about to be published or are in preparation:

a. Corrosion management of seawater cooling systems (publication pending).

b. Corrosion modelling with cellular automata (publication pending).

c. Bridging the gap: corrosion science for heritage contexts.

d. Corrosion resistant low alloy structural steels.

e. Electronics use in harsh environments: challenges and perspectives.

EuroCorr 2023 presented a wealth of Networking opportunities.

EFC has great plans for the future and following a successful bid in Brussels on 27th August under the proactive leadership of past president Gareth Hinds, ICorr will be the co-host in 2026 at Dublin with IOM3.

Also note EUROCORR 2024 will take place in Paris, France from 1st to 5th September 2024 followed by Stavanger in 2025.

For further details see: European Federation of Corrosion (efcweb.org)

YEP Participant Diaries

The Third of the Series of YEP-AMPP Journals, by Jamie Hillier, Project Engineer, STORK, Aberdeen.

Young Engineers Programme 2022: Key Learnings

Technical and personal development were the key focus of the Young Engineers Programme (YEP). Engineers with less experience are first given the opportunity to attend monthly evening lectures presented by industry experts. Ultimately, the aim of using this knowledge was to solve a technical case study: developing a corrosion management strategy for a poorly managed North Sea platform facility. The main aim of the case study was to advise an operator if they should purchase these facilities, considering both operational and commercial feasibility of the pending takeover.

When the case study was revealed and I met my group, I was confident we had the right skills to do the job. Between us, there was experience in subsea pipeline design, topside integrity, inspection, and business strategy. Most importantly, we all got along well together.

Jamie Hillier 2nd from right with the winning YEP team in November 2022.

There were many key areas of the case study to be solved, including: creating a facility process flow diagram (PFD), integrity review of all topsides and subsea components, risk assessment of the assets, subsea pipeline design, a sour service material review, identification of mitigation solutions to corrosion, and development of an overall business strategy.

Creating a PFD for an entire facility was a bigger challenge than it first seemed. In total, a system with 109 components including pipework lines, vessels, and subsea pipelines, had to be mapped out. As a subsea engineer myself, most of the topsides process system requirements were totally new to me. Seeing how the vessels were all connected really grew my understanding of the function of a processing system, as well as the issues faced if one part of the system went offline. Once the facility PFD was completed, I saw our next big challenge; performing a risk assessment of it all.

Although I had lots of previous experience with risk assessment and integrity reviews, this was not for processing vessels and pipework. Understanding the corrosion threats to aluminium bronze sprinklers and 316 stainless steel gas coolers was a steep learning curve. Learning from my team, mentor, and lectures was key. This is where I really started seeing the benefits of the young engineer programme. Developing a strong network which I could learn from. Part of the case study involved subsea pipeline design and material selection for a new field tie-back located 10 kilometres from the existing platform. The main considerations here were costs due to the proposed pipeline length. I have some experience with material selection projects in industry, so I knew the best material would be carbon steel. Corrosion resistant alloys would be too expensive and likely unnecessary as the fluids had very limited water content. Proving this was straightforward. A corrosion risk assessment was performed, which showed minimal carbon steel material loss over the pipeline life of 10 years with the injection of an inhibitor. Carbon steel was therefore chosen, and a cost estimate was carried out to show the commercial feasibility (including procurement, installation, and through-life operational costs) of this solution.

Performing this process was a good opportunity for me to implement my learnings from industry. Additionally, it gave me confidence in the progress I've made since being a fresh graduate. I felt I knew exactly what needed to be done to solve the problem and assess the feasibility of the solution, both technically and commercially.

There was, however, an additional challenge for the new tie-back field: the introduction of slightly sour fluids containing up to 50 ppm H_2S and 60,000 ppm chlorides, which could flow at up to 110°C. The biggest challenge here was performing a sour service review according to ISO 15156 for the entire facility. A review concluded that there were 316L stainless steel tubes in two gas coolers, which may present an issue due to the process conditions.

There were two big lessons I learned from this review. The first was how to use the standard guidance to identify which materials in the process stream would be incompatible with the new reservoir composition. The second was how to assess the impact of any unsuitable materials. If H_2S couldn't be removed, what would be the consequence for these components? Would the facilities have to be shut down or replaced, and could the use of an H_2S scavenger solve the problem? All these questions and more had to be addressed. An H_2S scavenger was considered, but this could not guarantee full removal of H_2S, 100 % of the time. The final solution involved replacing the tubes with a more suitable material: duplex stainless steel. This prevented the need for a facility shutdown if the tubes were exposed to H_2S. However, in the end, a H_2S scavenger was deployed to the facilities anyway for commercial/legal reasons. The 3rd party gas export system, which the platform exports into, had a very low H_2S limit; the use of scavenger was still required to adhere to this.

One of the largest corrosion issues confronted was the reported deep pitting in the first 2 km of the 150 km pipeline, which exports oil from the facilities to an onshore terminal. Root cause analysis determined the probable cause was microbial corrosion, due to similar corrosion observed upstream and the deep, axial nature of the pipeline defects as they were at the bottom of the line. Considering the impact of this, it was a huge issue. Replacement of a 150 km pipeline would be a huge cost, and the shutdown for any localised repairs would be very costly too.

The final solution to this was to do a hot-tap bypass repair, which would allow replacement of the pitted 2 km while maintaining live export through the system. While the cost estimate for this project was placed at around £20 million, the offset in avoided production loss actually made this a sensible solution. Combining this with a future biociding and pigging strategy for the line, the risk of corrosion was reduced, and operation to the end of life was made possible.

continues on page 16

Throughout the project, there were many technical issues like those mentioned above that needed a solution. I found huge value in getting exposure to all parts of an operational facility, the risks faced at each stage, the corrosion concerns throughout, and how to develop technical solutions for specific problems. There were huge technical learnings and the development of knowledge throughout the whole process.

The biggest learnings I found were related to problem solving and how to work as a team to solve a big picture issue. We couldn't just recommend any solution. We really had to focus on whether our answers were both technically and commercially viable, therefore allowing a new operator to purchase the facilities. Considering these factors, a solution was the biggest area of development for me. It involved a lot of team discussion and adjustments to our approach to ensure we were proposing the best solutions.

The final problem to be solved was then selling to the YEP judges why our solutions were the best. To do this, we developed an entire cost model to show how our proposed solutions would reduce risk, operate safely and allow the operator to reap the financial benefits. Trying to put this sales pitch together for our solutions was where I really found huge benefit. The focus had moved away from the engineering analysis to how to develop a strategy to convince someone else why our solution was the best. We really had to understand what would convince them we were the best team. I knew we had to lean on the cost model primarily, but also show them how we would help the operator reduce risk. On a personal level, we also had to make them like us as individuals who they could trust with their projects for the next 10 years.

The final convincing strategy was to pitch maintaining the facilities in such a way that their life could be prolonged, allowing future use of the infrastructure for energy transition projects. In the end, our sales pitch, technical solutions and personal engagement won over the judges and our group was picked as the winner.

Overall, the programme was a huge success. I developed my technical, communication, leadership, and teamwork skills to a huge extent. I got to play so many different roles that I simply would not get exposure to during my usual day job as a subsea engineer. At times I felt like a leader, a follower, a technical consultant, and a salesman. The value of the programme was really demonstrated to me through the opportunity to play these roles. I felt I learned so much by approaching the problems from many different perspectives, all while getting to do it as part of an amazing team that made the project an experience I won't forget.

AMPP Conference

The AMPP conference was an amazing experience. Getting to attend an event like the AMPP conference in Denver, with the Colorado Rockies as a backdrop, was something I'll never forget.

Prior to attending, I compiled a list of all the sessions I wanted to attend. The more I looked, the more challenging it became. The scale of the conference really started to become apparent. With an expected 6000–8000 attendees and around 500 papers being presented, plus technical committees and more, there was too much content to choose from. I decided my focus would be on expanding my knowledge related to internal and external pipeline corrosion, but I would also attend as many sessions as possible on topics new to me. My final list ended up having so many sessions on it that there were often 2 or 3 I wanted to attend that were on at the same time. I could only be in one place at a time, so I knew I'd have to choose what felt most interesting that day.

Before the conference, AMPP (Association for Materials Protection and Performance) invited the YEP attendees to be part of their Leadership Development Programme. This kicked off on the Saturday before the conference, and I didn't really know what to expect from the course.

All I knew was that there was going to be an emotional intelligence workshop and some team activities. Waking up bright and early but still jet-lagged, we went to the venue where the programme would start. We met with some of AMPP's most enthusiastic individuals who were running the course. before quickly getting going with the content. The course had 12 other participants. Some were YEP winners like me; the rest were people involved in AMPP activities. My first impression was surprise at the diversity of the group. There were people from all backgrounds and levels of experience from all over the world.

Jamie Hillier on far left at the AMPP Denver Filmore Presentations in March 2023 by ICorr President Stephen Tate.

Before starting the course, a lot of focus was put on getting to know and trust the other participants. A few basic exercises covered this by getting individuals to introduce themselves and discuss what positive skills they could bring to the table. After this, we dived straight into learning about AMPP as an organisation, including meeting many of the board members who were very excited to see us in person. I was most impressed that so many of them were eager to introduce themselves and offer their support.

Team structures, models, and strategies were then discussed to kick off the course content. The focus of this was the Drexler-Sibbet team model, which covers team development in seven stages. The main thing I took from this was that there needs to be a significant investment in team understanding and building trust. Without this, it can be difficult to make good progress when implementing a project or strategy. There was also a big emphasis on returning to these aspects of building a team and moving backwards when things aren't working to better understand the direction that needs to be taken to meet everyone's needs. This model wasn't something I'd seen before, but it made a lot of sense when explained. Without understanding what the team needs and why it can be hard to progress.

The first physical team activity involved trying to cross a 6x6 set of squares on a mat by following a set sequence of squares. It sounds simple, but the catch was that you couldn't speak to your team, and some squares were set as traps, though they all looked the same. If you stepped on a trap, you'd get an error and have to go back to the start. All team members had 5 minutes to cross the mat, with the goal being that everyone had to make it across from each of the 3 teams.What I learned most from this exercise was that how you define your goals and success is key. It was never stated that the team that got the most errors was the loser, but most of the teams associated the marks with losing. Really, the focus should have been on getting everyone across rather than making the fewest errors. There was also nothing in the task to say you were competing against the other teams. The only goal was to get everyone across the mat in five minutes. You could have asked the other teams for help figuring out the best way to learn from their mistakes too. A better definition of success and goals was the real lesson for me here. If your only goal was to make no errors in the exercise, then you would never be able to consider the activity a success.

For most of the day, the course involved a workshop on emotional intelligence. There were huge amounts of learning from this, as so many areas were covered. We learned about emotional reactions vs. logical reactions, improved communication skills, how to show empathy, and how to recognise the different reactions people may display in difficult situations and why.

The main thing I took away was how to develop yourself in four key areas of emotional intelligence: self-awareness, self-management, social awareness, and relationship management. Understanding strengths and weaknesses and how to develop them in each area was such an important lesson. There were a few exercises in pairs for this. Mostly, this focused on you identifying how you react emotionally in certain situations. Then, based on feedback learned in the course, how could you improve your reaction, manage yourself, and manage the relationship better? I was amazed at how quickly people were able to show vulnerability in this exercise with people they hardly knew and demonstrate the self-awareness needed to improve their reactions in difficult situations. It really showed me how quickly the content of the course could be implemented for direct and measurable improvement.

There was also a large focus on how to communicate effectively and show empathy in difficult situations. This focused a lot on being a good listener and how to ask the right questions to help people or get the most from them in difficult conversations.

Throughout the day, I really felt like the participants in the course got to know each other really well and made some lasting professional connections. This showed more throughout the week, as we all spent more time together at the conference and in the evenings. Overall, the leadership course was a great way to kickstart my AMPP conference experience.

The conference kicked off on Sunday. One of the first talks I went to was one of the most interesting: the analysis of corrosion coupons in relation to pipeline ILI results. From the analysis of hundreds of coupons and three ILI runs, a comparison was drawn between the corrosion rates found on the coupons and the ILI data. The conclusion was short and simple: there is no real correlation between coupons and pipeline wall thickness measured in an ILI. I found this interesting as it showed that while corrosion coupons are a good indicator of the potential for corrosion, they may not represent the corrosion happening.

I attended several other talks on corrosion coupons over the course of the conference. One focused specifically on how to handle and treat coupons once removed. Removal of corrosion products, medium of storage, and time taken to analyse the coupons were all factors considered. The analysis showed that the treatment and handling of coupons could have a significant effect on the corrosion rates found. All of these talks I attended on coupons, and the discussion and questions after, really showed why coupons aren't completely reliable. However, they still have a use as canary in a coal mine' for corrosion.

On Monday, I attended various talks related to life extension, CP retrofit, and ICCP (Impressed Current Cathodic Protection) systems of jackets and pipelines in the Santa Barbara channel. This was a series of three presentations focused on these topics. I have worked on many similar projects, so I was keen to know what others in the industry were doing to solve the problems.

The first presentation related to the anode retrofit, and eventually ICCP retrofit, of jacket platforms. I found this interesting, as the initial solution in 2006 was to do a diver support retrofit of individual bars on the jacket. In projects I've worked on, we've always done this with ROV vessels, as it is safer and saves money. Various other solutions were posed, including giant submerged blocks of anode material, until an anode sled design solution was discussed, which is more similar to designs I have seen in recent times. The second talk related to the optimisation of retrofit ICCP system placement to protect the jackets. This was interesting as it explained how CP gets modelled using Boundary Element Modelling (BEM) and how this is used to choose the position of the ICCPs on the seabed and prove which areas of the jackets can be effectively protected. The last talk related to the CP retrofit of pipelines using anode sleds from ROV vessels. This sounds much more familiar than projects I have worked on, but I found some differences interesting. For example, given the 300-metre water depth of the pipelines, trawling interaction on the retrofit sleds was much less of a concern compared to the North Sea. This meant long ladder arrangements could be pursued, with a much reduced risk of these being damaged by fishing.

Overall, I found these talks extremely helpful. They covered a lot of topics relevant to my regular job and gave me some additional factors to think about based on what other people in the industry are doing.

I went to a huge number of talks throughout the week on various other topics, including the formation of internal iron carbonate scales in various flow conditions, CP protection of offshore wind, the performance of inhibitors, the prediction of sour corrosion distribution in pipelines, and many more. The vast array of papers was really interesting, and I learned huge amounts from all the various AMPP conference speakers.

For several days of the conference, the annual corrosion exhibition was going on. Having only been to local exhibitions in Aberdeen, like Offshore Europe and Subsea Expo, the size and scale of the AMPP exhibition were incredible. There seemed to be hundreds of exhibits, all offering corrosion-related products and services. It took several days to make my way thoroughly around the exhibit hall.

Highlights included spending time discussing technologies on the market with various vendors. This included talking through pigging solutions for wax-filled pipelines, retrofit ICCP system solutions, and remote UT monitoring sensors. Being able to discuss these technologies and then bring back learnings from them into projects I'm working on would've been worth the trip to Denver alone.

The peak of it all was getting up on the stage at the Filmore Auditorium to officially receive our awards for winning at the AMPP Scholarship Awards ceremony. Getting to accept the award in front of all those I'd met on the YEP and on the AMPP Leadership Programme was such a fantastic experience, as you can see from the smile on my face. Following this with a night of dancing, limbo, and signing with all those involved was the perfect way to celebrate the whole experience.

Jamie Hillier receives his YEP winners certificate from ICorr President Stephen Tate.

Overall, the YEP experience and trip to the AMPP conference were unforgettable. I don't think I'll ever get to take part in an industry competition as fulfilling as this, especially one with such an amazing prize. I gained so much in terms of technical knowledge and interpersonal skills through the programme, the conference, and the exhibition. If anyone is on the fence about signing up for the YEP, I'd urge them not to hesitate. You could be signing up for a once-in-a lifetime trip if you put in the work to win the competition.

CEOCOR 2023 Congress

The International **CEOCOR 2023 Congress** took place in Bratislava, Slovakia, from 30th May to 2nd June, and consisted of two workshop days and two days of presentations.

Professor Alison Davenport (the University of Birmingham) presenting her keynote lecture, "Shedding Light on Localised Corrosion".

Over the two days of presentations, technical papers were presented on a wide range of topics relating to corrosion, coatings, cathodic protection, water, and oil and gas networks. The first lecture at the congress was a comprehensive keynote speech entitled "Shedding Light on Localised Corrosion" by ICorr award-winner Prof. Alison Davenport from the University of Birmingham. Prof. Davenport showed how synchrotron X-rays can provide evidence for the mechanism of pitting corrosion, which depends on a delicate balance between active dissolution and passive film formation. This balance is determined by the local variation in interfacial potential and solution chemistry within a pit, which influences whether or not it will continue to grow or die. In her lecture, Prof. Davenport also considered the implications for practical applications.

Izabela Gajewska of Intertek's Production & Integrity Assurance team (formerly known as CAPCIS but shortly to be renamed as below) was another speaker at the congress. Izabela is a previous winner of the UK Institute of Corrosion's YEP- Young Engineer Programme (2020) and an active member of the Young ICorr. Her paper and presentation, both entitled 'Best Management Practices to Transfer Knowledge and How They Can Help Young Engineers and Their Companies', were well received. The presentation covered the importance of engaging young corrosion professionals and the key role that knowledge transfer plays in this activity. Izabela also addressed the rapidly developing impact of artificial intelligence on the learning process and competence development, and the key aspects for businesses to consider.

Izabela Gajewska (Intertek P&IA, formerly CAPCIS) presenting on "Best Management Practices to Transfer Knowledge And How They Can Help Young Engineers And Their Companies".

Reflecting on her experience at the 2023 event, Izabela shared, "The congress was an amazing experience sharing corrosion learnings va good opportunity for networking with corrosion experts from around the world. The event ended with a social event at the Bratislava Castle with a beautiful view of the city, which was a special and relaxing moment to finish a fantastic week!"

Izabela was one of an increasing number of young corrosion engineers benefiting from the knowledge transfer and open sharing of expertise within CEOCOR. Next year, we will be meeting in Leuven, Belgium on 14th – 17th May 2024. Save the dates in your diary, and check https://ceocor.lu for early information to follow soon.

Cocktail Party at the Bratislava Castle closing CEOCOR 2023 Congress. CEOCOR President Markus Büchler (bottom-middle) and CEOCOR Secretary General René Gregoor (bottom-right).

More about CEOCOR

CEOCOR (European Committee for the Study of Corrosion and Protection of Pipes and Pipeline Systems – drinking water, wastewater, gas and oil) was founded in 1956. The original members were Belgium, Luxembourg, and the Netherlands. The member countries have grown to include many European countries and includes the UK. The organisation is a not-for-profit body and has been recognised as an international organisation since 1981.

The purpose of CEOCOR is to provide the basis for scientific and technical guidance in the field of corrosion, through studies, recommendations, and publications. Many of these have contributed to European standards related to corrosion and protection of buried pipelines.

The present structure has two commissions. Commission 1 deals with the interaction between transported or stored water and metallic or cement-based materials, so primarily internal surfaces. Commission 2 deals with external corrosion and cathodic protection against corrosion, mainly for water, oil, and gas pipelines and relevant infrastructure including AC and DC stray currents and electrical interferences.

CEOCOR has amazing success in the production of guidance documents that have systematically been referenced in many standards across the corrosion industry.

Possibly quite surprisingly, the UK had no representation on CEOCOR until 1994, when Ken Lax attended in Nürnberg. At that time, the working group meetings were conducted in English, French, and German. There was no simultaneous translation, but there were translators who provided ad hoc translations between the languages. Ken recalled that he was an active participant in many of the sub-working groups. As far as he was aware, it was CEOCOR who produced the first textbook on AC corrosion in 2001, and he was an active member of that group. In Ken's words, "CEOCOR was a good opportunity to have frank and open technical discussions outside of the framework of a standards working group. Many of us were members of the same CEN, CENELEC, and ISO working groups. In the standards meetings, we often had to maintain a technical opinion that was in accordance with instructions from our national mirror groups, rather than personal experience. Many contentious issues in the standards were resolved amicably in the CEOCOR framework."

Over the last decade the UK has begun to build up a larger membership and importantly, a greater technical involvement in CEOCOR working groups. Prior to my involvement, Ken Lax and Brian Wyatt were and remain stalwarts of CEOCOR activities and this has since extended into UK contributions to British, European and International standards work. Brian Wyatt fondly remembers being present in Florence for his first congress and being welcomed by the then president of CEOCOR Lucio Di Biase. In his words, "I was blown away by the quality of the papers and discussions. I was horrified by what the UK had been missing." Since that time UK member numbers have increased thanks to fervent support of CEOCOR. I am proud to say that this has ensured that the UK continues to provide a significant contribution. In 2014, I was asked to become a member and to represent ICorr on the Board of Directors, a position I have been privileged to have ever since.

The format of the committee is that there are members from most European countries. Each country may have up to two members on the Board of Directors, but as many members who can contribute to the technical work as they wish. Membership is not at all exclusive and is currently only 150 Euros per year.

Collaborating and contributing to the guidance documents are where the real technical discussions originate and currently there are six working group documents in Commission two under various stages of development. The extensive catalogue of documents produced by CEOCOR are available to members and the public is accessible via the website, https://ceocor.lu/. Membership details are also available on the website.

The working groups for both commissions meet twice a year, at the annual congress and then in the autumn months in Brussels. This year's congress was in Bratislava, Slovakia, next year it will be held in Leuven, Belgium between the 14th and 17th May 2024. In 2025, it is planned to be held in Italy. There is a rotation system whereby member countries take it in turns to host the Congress. The last congress in the UK was a great success and was held in Stratford-upon-Avon in 2018. ICorr were pivotal in the setting up of this event, which was sponsored by National Grid, now National Gas. It is hoped that the UK can host again soon.

During congress, there are two days of high-quality paper presentations dedicated to the technical aspects of the commissions. This provides the perfect opportunity for many in the corrosion industry across Europe to come together and share experiences and information. The presentations are given by technical experts from across the globe.

The congress provides a partner's programme, which is intended to integrate all who attend and nurture friendships and reacquaint people. This helps foster the quite unique experience of being involved with CEOCOR. Involvement is actively sought from all levels of experience. Currently, a very active participant has been Chris Lynch, (a member of CPGB along Brian Wyatt and Corrpro Europe's Senior Engineering Manager) who knew after his first involvement there was something very special about CEOCOR and since then this feeling has stayed with him. He has always been pleased at the involvement of everyone attending and how information is shared. Discussions are amiable and well natured often humorous. Everyone is made welcome and encouraged to contribute and all look forward to attending.

Chris hopes to carry on representing the UK on behalf of ICorr and to continue working on the important guidelines and documents that CEOCOR create.

There is much we can do, and he encourages anyone reading this to consider joining CEOCOR and enjoying the benefits of so doing. It really is something quite different and extremely rewarding.

Volunteering Opportunity as A Professional Assessor With The Institute's Professional Assessment Committee

The Institute's Professional Assessment Committee provides a vital service in ensuring that the very highest standards are achieved by those who apply to become Professional Members of the Institute. This often involves identifying apparent gaps in their training and development record, which may require further information to be provided or, in some cases, additional training to be sought before the applicant is able to satisfy the assessor's requirements.

The role of the professional assessor can therefore be very demanding and requires experienced Professional Members who are willing to donate some of their time to carefully evaluating applications, identifying shortfalls, and determining whether an applicant has satisfied the requirements for the applied grade, needs to provide further information, or requires an interview, usually with the Chair of the Committee. This will, in some instances, result in an application being turned down, but rarely without guidance on the shortfall and assistance with the required path for a later successful reapplication.

If you think you would be interested in providing this service to the institute, we would be most pleased to hear from you. You would be expected to carry out perhaps two or three assessments per month and will be provided with one-to-one assistance if required during the early stages as you familiarise yourself with the assessment system. If you would like to discuss the possibility of helping the institute as a Professional Assessor please contact Paul Lambert, Chair of the PAC, on pac.chair@icorr.org

Industry News

Safety Issues with Reinforced Autoclaved Aerated Concrete (RAAC)

After receiving a UK government warning to shut down buildings made of reinforced autoclaved aerated concrete (RAAC), more than 100 schools in England are hurrying to make alternative pupil accommodation arrangements before the start of the new school year.

Autoclaved aerated concrete (AAC), or (RAAC) when reinforced, is very different in structure from normal dense concrete. It is made using fine aggregate, chemicals to create gas bubbles, and heat to cure the product. It has no coarse aggregate. Consequently, it is relatively weak and has low capacity for developing bonds with embedded reinforcement. Lightweight masonry blocks and structural units (such as roof planks, wall and floor units) are two main forms of structural elements where AAC and RAAC are used and that may suffer from water ingress and corrosion of steel reinforcement.

It has long been known that RAAC roofs and other RAAC constructions have a limited lifespan (typically 30 years), but recent structural collapse incidents indicate that the issue may be more significant than previously believed with continual risk of dropped objects that may injure pupils and that many building owners could be unaware of the presence of RAAC on their property.

The Standing Committee on Structural Safety (SCOSS) raised a safety alert in 2019 and is now operating under the name Collaborative Reporting for Safer Structures (CROSS). It continues to raise awareness about RAAC structural safety. A UK Building Research Establishment (BRE) Information

Paper IP10/96 addresses issues with RAAC roof planks, suggests that they be examined by a structural engineer, that the proper steps be taken to fix any problems, and that long-term inspection schedules be recommended. Building owners and managing authorities can access more details by clicking the link below.

www.bbc.co.uk/news/uk-england-northamptonshire-66713205

by our very own HQ in Northampton.

Our North-West Branch will host a special event on this topic in October.

Lake Chemicals and Minerals Celebrates 20 Years of Innovation and Sustained Growth

Lake celebratory dinner at Warwick Castle.

On September 12, 2023, at the magnificent Warwick Castle, the Redditch-based chemical distribution business Lake Chemicals and Minerals Ltd, a part of LEL Group and an ICorr sustaining member celebrated its 20th anniversary.

With the opening of their first unique manufacturing plant for entrepreneurial operations in 2022, they have started a journey of growth and transformation that highlights their dedication to excellence and social responsibility.

Their cutting-edge manufacturing facility, and innovation facility located in the centre of Redditch, not only exemplifies Lake's commitment to innovation, but also illustrates their crucial role in the regional economy. They have also been participating in philanthropic efforts including giving to St. Richard's Hospice and the Redditch Food Bank.

Source: *Lake Chemicals Press release*

Intertek Revives the CAPCIS Brand, Recognising 50 Years of Expertise In Corrosion And Materials Testing And Consulting

Manchester, United Kingdom

Intertek, a leading total quality assurance provider to industries worldwide, has announced the revival of the CAPCIS brand, leveraging its global reputation as a leading authority in corrosion and materials assurance and honouring this specialist team's 50-year legacy that started in 1973 at the University of Manchester Institute of Science and Technology (UMIST).

Acquired by Intertek in 2007, Intertek´s Production and Integrity Assurance business provides independent third-party testing and consultancy services worldwide to businesses in the energy, transport, aerospace, marine, manufacturing, and infrastructure sectors.

Corrosion can cost up to 2-4% of a company's total revenue each year. As energy, utilities, and infrastructure assets age, and operate in ever more challenging environments, the need for systemic risk-based corrosion monitoring and materials assurance solutions has never been greater. Intertek are, therefore, proud to launch Intertek CAPCIS, a move which strengthens its expertise in providing quality services through a trusted, single-source partnership for every stage of the materials and corrosion lifecycle, from prevention to failure analysis, helping to reduce uncertainty and risk across a wide range of assets.

In addition to corrosion and materials testing, Intertek CAPCIS delivers in-depth expertise worldwide on integrity management across a wide range of services such as failure investigation and material selection, and production chemistry, and oilfield microbiology in primarily upstream oil and gas. Intertek´s Production and Integrity Assurance is operating with a diverse team of highly specialised experts, and state-of-the-art facilities in the UK, UAE and Malaysia.

Tim Walsh, Intertek CAPCIS Director said:

"Bringing back the CAPCIS brand in our 50th year of operation further reinforces Intertek's reputation in the materials and corrosion industry".

Earlier this year, Intertek CAPCIS expanded its corrosion and materials testing capabilities with an investment in the latest technology, implementing a new suite of Instron Electropuls E10000 electrically actuated load frames. This new equipment complements Intertek CAPCIS' existing testing services by introducing torsional force application and enabling uniaxial (tension or compression) or bend testing of lighter weight, lower strength materials.

Source: ***Intertek Press release***

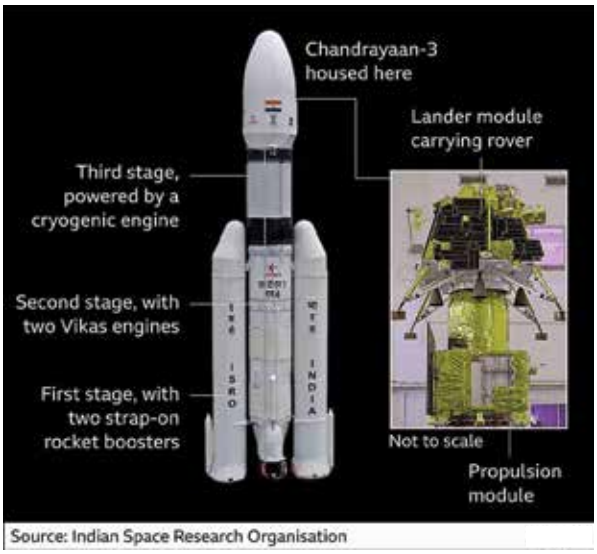
Jindal Stainless special alloy steel grade in motor casing in Chandrayaan-3

Jindal Stainless, developed and supplied a special, high strength alloy steel grade that has been used in the motor casing of India's ambitious third lunar mission, the Chandrayaan-3. The special alloy was supplied to the Indian Space Research Organisation (ISRO) and the accelerated development of alloys was accomplished with the help of advanced refining processes in only three years.

The general public observing live telecast of Chandrayaan-3.

This heat-resistant material protects the motor from high temperatures as well as shocks. The alloy steel grade's excellent qualities, which remain resilient under the worst heat conditions, highlight its dependability and adaptability for crucial space missions.

Source: ***Jindal Stainless Steel Newsletter***



The LVM3 launch rocket and Chandrayaan-3

Latest Literature

Accelerated Laboratory Test for Coating Performance Evaluations Under Simulated Thermal Insulation Conditions

The energy crisis of the 1970s forced plant designers to include much more insulation in their designs. Since then, Corrosion Under Insulation has been a critical issue for chemical process industries. CUI is external corrosion that occurs on the underlying metal beneath insulated equipment, due to the penetration of water through the insulation layer. It affects thermally insulated equipment in the onshore and offshore oil and gas industries, as well as the petrochemical, specialty chemical, fertiliser, and related industries. ExxonMobil considers the economic impact of CUI to be 40–60% of all piping maintenance expenditures.

With this in mind Qing Cao, Thunyaluk Pojtanabuntoeng and their research team from Curtin Corrosion Centre, Australia, have developed a new experimental design to investigate the degradation of an organic polyamine-cured epoxy coating under accelerated laboratory test conditions. A systematic CUI evaluation protocol for high-temperature organic coating performance evaluation is also described in their work. The research team has proposed a combination of electrochemical, spectroscopic, mechanical, and microscopy techniques to quantify coating performance under insulation. This will help in providing insights into predicting coatings' service lifetime. In their research work, a modified vertical pipe was set up to study coating performance on carbon and stainless-steel substrates under insulation in a thermal cyclic test setting. The method involved specially designed apparatus to simulate CUI systems and characterization techniques, such as visual inspection, adhesion test, peel-off test, scanning electron microscopy, electrochemical impedance spectroscopy, chemical analysis using Fourier-transform infrared spectroscopy, and differential scanning calorimetry. The results from this research showed that polyamine-based epoxy coatings experienced thermal degradation starting at temperatures above 130 °C under mineral wool insulation in accelerated cyclic CUI tests. More information can be found in the following paper: Qing Cao et al., Evaluation of epoxy-based coating degradation under thermal insulation at elevated temperatures on different steel substrates, Progress in Organic Coatings, Volume 180, July 2023, 107544, https://doi.org/10.1016/j.porgcoat.2023.107544.

Ask the Expert

Question:

Under what conditions can MIC occur and what are the effective methods to prevent MIC?

Answer:

Microbiologically Influenced Corrosion (MIC), or bio-corrosion, is the phenomenon of accelerated electrochemical reactions caused by the metabolic activities of microbial colonies. It is predominantly manifested in the form of highly damaging localised corrosion.

The pre-requisite for bacteria's growth is the availability of free water, an energy source, a respiration substance, and tolerable physiochemical conditions. Bacteria are omnipresent and tolerate a wide range of temperature, pressure, pH, salinity, shear stress, and redox potentials, enabling them to thrive in the operation systems of various industries. Sessile colonies can even form in systems with only traces of water.

Microorganisms develop into a biofilm on the liquid-metal interface. Several factors affect microbial adhesion to a solid surface, including type of metal/alloy content, surface finish, water cut, and shear stress. Biofilm is a conditioned structure of both organic and inorganic matter with a significant chemical gradient, and it is the cause of bio-corrosion.

Localised MIC on crude gathering system.

Conditions that lead to MIC

A mature biofilm is a complex and self-sustaining system. Bacteria are symbiotic, and some groups secrete organic compounds that can be used by other groups to accelerate corrosion. Acetogens are a group of hydrogenotrophic bacteria that use hydrogen to reduce CO_2 to acetic acid and iron as an electron donor. Acetic acid is an energy source for different heterotrophic corrosion-causing bacteria. Sulphate Reducing Bacteria (SRB) uses hydrogen generated by the corrosion process under anaerobic conditions. Microorganisms also work in a cyclic manner, and a biofilm can consist, e.g., of both sulphur reducers and sulphur oxidizers within the different layers of the biofilm. MIC is often caused by the collective action of different groups of colonising microbes.

Localised corrosion is caused by the biofilm micro-environment on the metal surface. Zones underneath the biofilm are anodic compared to the surrounding cathodic area leading to pitting. The corrosion mechanism depends on the dominant group of bacteria.

Bio-sulphide reacts with iron to form iron sulphide (FeS), which is cathodic to steel. The potential difference between the FeS cathode and the steel anode accelerates corrosion. Sulphide is also a major risk to other alloys and disrupts the continuity of the protective layer, leading to pitting.

Acid Producing Bacteria (APB) lower the pH leading to a fast-localised acid-driven corrosion. Additionally, generated organic acids can be used by other co-existing corrosion causing microbes to accelerate the electrochemical process.

Iron Oxidising/Reducing Bacteria (IOB and IRB) destabilise the thin oxide layer.

Denitrifying bacteria (DNB) produce intermittent ammonia and/or nitrite. Ammonia is a stress corrosion cracking concern for copper alloys. Nitrite accelerates corrosion in systems with relatively higher chloride and sulphate concentrations. Thiobacillus species (denitrificans and thioxidans) reduce nitrogenous compounds and oxidise sulphide that may result in the formation of elemental sulphur or sulphuric acid on metal surface.

Methods to prevent MIC

The risk of MIC can be prevented by prohibiting the formation of a biofilm on metal surface through regular cleaning and treatment. Another option is to use super alloys that are resistant to MIC. Both options are impractical and unaffordable, particularly in large industrial systems. Several cost-effective and practical techniques are available to control the phenomenon within the limits that can be tolerated by system materials.

Three practices are the key for a successful treatment:

1. The risk of MIC is adequately considered at the design stage.
2. Properly performed hydrostatic testing and treatments.
3. Commencing microbial testing and treatment from day one of commissioning where a risk is identified.

Commonly used technologies for the control of MIC include:

- Chemical treatment and system flushing is by far the most common. It is based on dosing toxic chemicals to kill all colonising microbes. The treatment is system specific and should be regularly reviewed. Alternating treatment is used to minimise bacterial immunity to chemicals.
- Nutritional treatment is based on limiting nutrient availability e.g., selective removal of sulphate limits SRB activities. Current technology is unlikely to eliminate bio-sulphide generation.

continues on page 24

- Biological control is based on stimulating "friendly" groups of bacteria to suppress the co-exiting detrimental groups.
- Surface coating creates a protective barrier between metal and biofilm.
- Raising (in the negative direction) the applied potential by -100 mV as a part of cathodic protection disperses cells from the surface due to generation of hydroxyl radicals.
- Mechanical removal is a highly effective technique particularly if pigging is tailed by a high concentration of biocide as a slug.

Some technologies can be collectively used to ensure a higher level of MIC control.

Short term cost saving along with intermittent equipment use has been identified as the common root cause of several MIC high-profile failures. The most effective control strategy requires MIC to be recognised by company standards/best practices. The phenomenon should be a part of the company corrosion management system and incorporated into corrosion control matrices. Anti-microbial treatments require to be monitored and regularly assessed during operation. Corrosion engineers should be encouraged to develop a database of likely microbial involvement and mitigation in corrosion monitoring.

Refer: https://www.icorr.org/challenges-of-managing-microbiological-corrosion/

Dr. Tony Rizk
ICorr MIC training course lead

Corrosion Around Us...

A clear case of neglect / lack of inspection and maintenance by the responsible Highways Authority, below is an overbridge on the main A9 Trunk Road linking Inverness to Edinburgh/ Glasgow/Stirling (via Perth) and carrying much heavy freight. At 273 miles long, the A9 is Scotland's longest road and one of the country's most important transport links. It begins at Junction 5 of the M9 motorway, running through Falkirk and Stirling before becoming a trunk road to the North. It connects Stirling, Perth, Inverness and Thurso and intersects several other major routes on its way north. Cause appears to be a failed bridge decking seal causing erosion of concrete cover to reinforcement and subsequent steelwork corrosion.

Close-up of ongoing erosion and corrosion to bridge support. Photo: Submitted by Stephen Tate, ICorr President.

A Comprehensive Integrity Management Approach to Addressing Process CUI Risk

Philip Enegela, PhD, FIMMM, FICorr, Integrity Lead, INEOS O&P UK and Chukwudi Nwankwo, MSc, CEng, MICorr, Corrosion Engineer.

Introduction

The requirements of heat conservation, personnel and frost protection, as well as noise prevention have made insulation a ubiquitous material in the process, power, oil and gas and petrochemical industries. While it may be installed on plants for process or economic reasons, the presence of insulation can present a suitable environment for corrosion. This article reviews the state of the art in corrosion under insulation (CUI) management, highlights the need for proactive management of cold-duty insulation, and discusses results from the validation of a novel CUI monitoring technology from an end-user's perspective.

Significance of Corrosion Under Insulation

Over the last four decades, CUI has been a significant issue in the oil and gas, petrochemical and chemical industries. Energy conservation factored heavily in plant design considerations and resulted in extensive insulation installation on most assets. CUI failures have plagued industry ever since, and now account for around 20% of major oil and gas accidents according to the UK's Net Zero Technology Centre [1]. CUI is estimated to cost the global economy $2 trillion annually.

CUI is a form of external corrosion which occurs due to the presence of trapped water and corrosive species (such as chlorides) in contact with insulated equipment. A variant of this type of degradation occurs under fireproofing (corrosion under fireproofing, CUF). Fireproofing is applied to process equipment, pipework, and structural items to minimise the spread of fires, allowing personnel to escape to safety. Fireproofing materials, which may be cementitious or intumescent in nature, may absorb moisture or provide receptacles for water to collect, resulting in corrosion.

CUI results in thinning and local metal loss of materials which are in the "active state" (such as carbon and low alloy steels) and external stress corrosion cracking (ESCC) of normally "passive" materials such as stainless steels and aluminium. CUI may progress at a very rapid rate and culminate in unexpected equipment failure, as it is rather insidious and may not be detected until a loss of containment event occurs.

The uncertainty associated with identifying and localising areas with CUI damage affects the cost of maintenance work programmes by significantly increasing outage, scaffolding and insulation replacement costs.

Major advances have been made in understanding SCC and CUI in recent years. The role of species such as chlorides and sulphates, as well as the effect of operating conditions ((e.g. cyclic service, dead legs) and environmental factors (such as relative humidity and contaminants) on ESCC are well understood and documented [2, 3]. However, while there is better understanding of the relationship between these factors and their overall effect on CUI, there appear to be some misconceptions about specific aspects in industry, such as:

- "Threshold" temperature at which SCC occurs on commonly used austenitic stainless steels: Ambient SCC of stainless steels has been reported; the type and level of salt contamination are important factors which lower pH and increase relative humidity, resulting in more severe local chemistries within the insulation system. This demonstrates that using temperature as the main criterion for assessment of SCC probability is rather simplistic.

- CUI in cold service: Equipment and pipework operating in "cold service" are not immune to CUI. Although corrosion rates may be low, this can be enhanced by temperature swings.

Figure 1: A stress corrosion crack on an insulated, contaminated seamless 304 stainless steel pipe operating at 80°C

Why CUI Failures Occur

Many CUI failures have occurred due to several reasons, including, but not limited to:

- Aged and highly absorbent insulation;
- Excessive and unnecessary use of insulation;
- Inadequate appreciation of CUI risk;
- Inadequate corrosion management and inspection strategies;
- Lack of expertise within organisations;
- Poor equipment design and/or barrier (coating) systems;
- Poor incident investigation and information sharing;
- Poor investment in CUI mitigation programs and new technologies;
- Poor quality/improper application of coatings and insulation systems;
- Repeating previous mistakes (lack of learning from previous incidents in industry).

Prevention and management of CUI are therefore important aspects of asset integrity management, as it is the main external damage mechanism affecting many assets. Ageing assets are prime candidates for CUI failures, because the protective coatings which were applied prior to commissioning are unlikely to last for the full asset design life. CUI will ensue once these barrier coatings are compromised. Failures or near misses may then occur within the next 6-10 years, depending on the equipment thickness and built-in corrosion allowance. Inspection, coating, and insulation repair costs following failures may be several orders of magnitude more than the original equipment / asset cost, excluding production losses. Thus, doing nothing is simply not an option!

continues on page 26

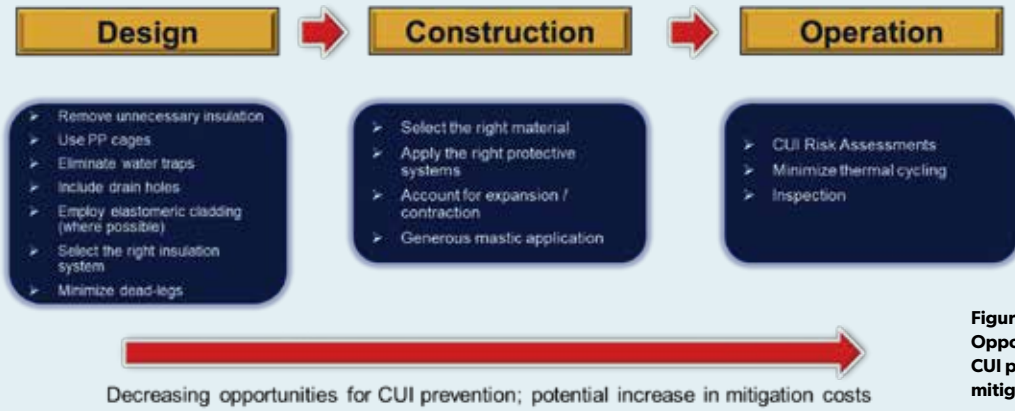


Figure 2: Opportunities for CUI prevention and mitigation.

Prevention and Mitigation of CUI

CUI prevention really starts during equipment design. Eliminating unnecessary insulation and water traps are imperative to avoid CUI. Corrosion engineers should be involved during the front end engineering and detailed engineering design phases of projects engaging with the relevant discipline engineers for material, barrier (coating) and insulation system selection, and life cycle cost considerations. It is noteworthy that opportunities for CUI prevention abound at the design phase and may cost less if implemented at that stage, compared to mitigation during the plant operation phase.

Selecting Barrier and Insulation Systems

Organic coating systems are commonly employed for CUI mitigation. Multi-layer coating systems (consisting of primers, intermediate and sealer top coats) have been used as effective barriers for CUI mitigation. These coating systems usually comprise a mix of inorganic / organic zinc coatings, epoxies, polyurethanes / polysiloxanes. Galvanising and foil wrapping have also been widely adopted. Thermally sprayed aluminium (TSA) coatings correctly applied to carbon and stainless steels have proven to be low-maintenance, long-term barrier systems for CUI mitigation, and are thus considered cost-effective from a total life cycle cost management perspective. Issues such as deposition techniques (e.g., wire thermal spray systems), porosities, coating adhesion, and sealing are now better understood. Although TSA is usually applied in coating shops following new equipment fabrication, on-site application to existing equipment (with adequate controls to mitigate any perceived hazards) has been successfully carried out in some onshore facilities.

Selecting the right coating system for the equipment's temperature range is integral to the longevity of the barrier system. For example, inorganic zinc coatings provide limited corrosion protection under insulation between 4 °C – 175°C due to the rapid consumption of zinc dust in the coating system, leading to premature failure. General guidance regarding coating systems is provided in NACE SP0198 [4] and NORSOK M-501 [5]; additional guidance on testing and qualification of coating systems under insulation is available in I SO 19277 [6].

The compatibility of insulation systems with equipment metallurgy should be reviewed prior to application. Issues such as water absorption propensity, leachable ions, contamination, and SCC should be robustly assessed during insulation system selection. Older insulation materials often absorb and concentrate contaminants.

Quality

Poor application of coating systems and insulation installation can result in water ingress, corrosion and premature CUI failures. Thus, coating and insulation applicator skill/quality of workmanship can influence CUI. Independent verification is recommended to be completed prior to acceptance.

Adopting a Total Quality Management approach is an essential part of CUI mitigation. Inspection and Test Plans (ITPs) should drive quality assurance / quality control activities, particularly during surface preparation, coating application, and insulation installation. Adequate surveillance and adherence to hold points ensure that the desired surface roughness and cleanliness are achieved prior to coating application, and contamination levels are minimised in accordance with ISO 8501-1, ASTM D-4285 and ISO 8502 Parts 6 and 9. A good ITP should also specify environmental conditions and sampling plans (relative humidity, environment, metal temperature, dew point, and lighting) and stipulate acceptable dimensions for coating repairs. Employing the services of an independent qualified, qualified, experienced coating, insulation, and fireproofing inspector is useful in ensuring high quality coating application and insulation installation.

Special Considerations for Managing Cold Duty Insulation

In cold service, the presence of water and ice reduces insulation efficiency considerably and can result in corrosion. This occurs due to condensation or "sweating", driven by the difference between the process temperature and the warmer environmental temperature. Preventing the system's temperature from dropping below its dew point is crucial in preventing sweating, this is achieved by applying suitably thick insulation.

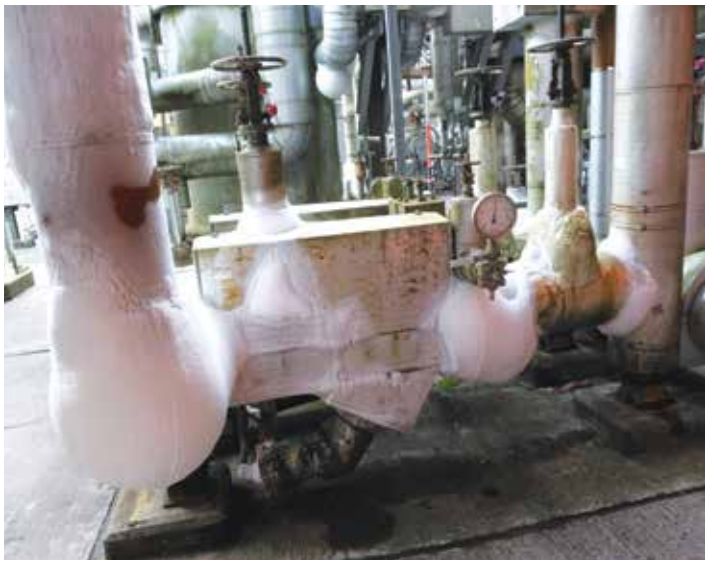


Figure 3: Ice formation on insulated pipework in cold service.

Proper management of cold-duty insulation is essential in preventing CUI in cold systems. This is challenging, as removal of insulation in service will cause condensation. Also, such equipment is normally only available during planned turnaround maintenance activities. Thus, early remediation of issues on cold-duty insulation systems can be beneficial in mitigating CUI mitigation and reducing downtime.

Moisture transmission (through air movement in cold-duty insulation) can be prevented by making the systems air-tight. All equipment in cold / cryogenic service should be protected from CUI by the application of protective coatings suitable for the operating temperature range.

Adequate design, installation and maintenance practices can help mitigate CUI in cold-duty systems.

Selection & Design	Installation	Maintenance & Operation
Use "Closed-Cell" insulation (preferred) to prevent air movement	**Use proper tools & high quality insulation materials**	**Identify and repair damaged cold duty insulation & ensure vapour barrier integrity**
Apply vapour barriers	**Seal insulation seams and unavoidable protrusions properly to prevent thermal bridges**	**Remove dead legs (where possible); register dead legs, update assessments and be aware of intermittent dead legs**
Eliminate protrusions into the insulation system	**Employ qualified and experienced applicators**	**Conduct maintenance activities on piping within fireproofed skirt supports**

Table 1: Activities for CUI prevention and mitigation in cold systems.

Managing CUI

A good CUI management strategy should be underpinned by an understanding of risk and the condition of equipment. This can be achieved by following a Plan-Do-Check-Act (PDCA) model (Figure 4). Upon determination of the CUI risk associated with equipment, campaigns can be planned and executed to ensure items in the highest risk category are remediated before failures occur.

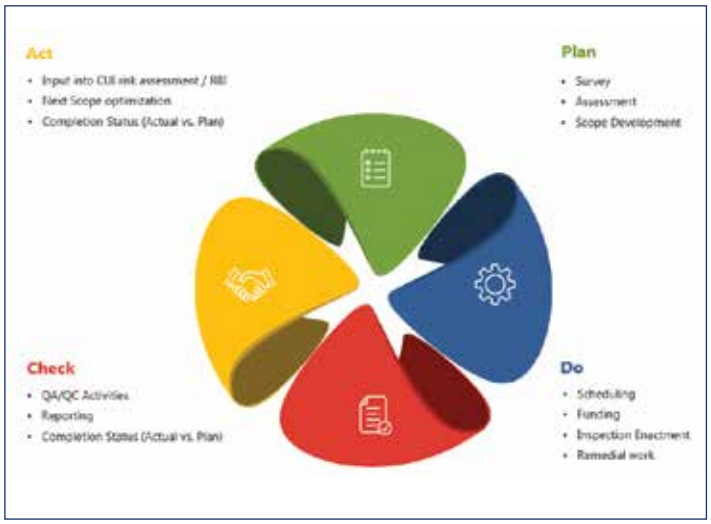


Figure 4: PDCA model for CUI Management.

Why Do CUI Management Programs Fail?

The following are some reasons why CUI programs fail:

- Knee-jerk reactive "interventions" following a spike in loss of containment events, mainly aimed at reducing failures. This is unsustainable and generally loses momentum once small gains are realised.
- poor records / documentation (coating and insulation certificates, inspection reports);
- Incorrect / incomplete asset registers and line lists;
- Reliance on outdated software systems (e.g., RBI programs) and incorrect CUI risk assessments;
- Poor planning and execution;
- Delays to reinstatement and use of temporary coverings;
- Lack of funding.

An Integrated Integrity Management Approach to Address CUI Risk

The prevalence of CUI on large facilities with several miles of pipework makes it a significant challenge to address during normal operations. As such, a modern risk-based approach is essential for identifying pipework and equipment with CUI risk levels above the tolerable threshold (as determined by the owner/user).

Risk prioritisation of work scopes is essential; however, the highest risk items may not be immediately accessible/available for inspection, fabric maintenance, weld repair or replacement. It is important that these WO items are tagged with latest execution dates in computerised maintenance management system (CMMS).

Three pillars are identified herein as central to an integrated approach to CUI management. These are identified as Management Commitment, Risk Assessment and Program Execution. To ensure success at every stage, roles and responsibilities should be set out, clearly defining requirements from each team member or stakeholder.

Management Commitment

Management buy-in is critical for the success of any CUI management program. Such programmes should be seen as long-term investments to ensure safe production. Having dedicated budgets for CUI work programs demonstrates commitment and sets a corporate culture which drives long-term CUI risk minimisation.

This will ensure work programmes are adequately resourced, executed and routinely audited to check their effectiveness. Auditing a CUI program's effectiveness should be done on an annual basis, as a minimum, using measurable key performance indicators (KPIs) - it may be more useful to perform monthly checks to identify trends. Feedback provided to management on successes achieved (e.g., CUI discoveries), execution progress and budgetary constraints can encourage further investment.

CUI Key performance indicators (KPIs) should be designed to identify the extent of integrity issues posed to the asset and quantify the financial implications of having these issues. It is prudent to tailor these metrics to specific businesses, as risk tolerance levels can differ widely. A mix of tailored leading and lagging CUI KPIs will highlight potential integrity issues prior to loss of containment events and clearly outline the scale and impact on the business. Table 2 below sets out some example KPIs.

continues on page 28

KPI Description	Type
Number of leaks due to CUI	Lagging
Number of wall thickness anomalies* / "discoveries" due to CUI	Leading
Number of CUI repairs (temporary / permanent)	Lagging
Number of CUI inspections/campaigns completed	Leading
Cost of CUI repairs	Lagging
Number of insulation/coating repairs completed (without leaks occurring)	Leading
Lost production due to CUI	Lagging
Number of non-conformances /quality issues identified following insulation system installation	Leading
Reduction in reliability/ impact on revenue	Lagging
Number of CUI risk assessments updated following inspections	Leading

Table 2: Example of CUI Key Performance Indicators
* A component is considered as anomalous if its remaining wall thickness is below its original design thickness for pressure retention (i.e., nominal wall thickness excluding the mill tolerance and corrosion allowance).

CUI Risk Assessment

A dedicated assessment team, consisting of personnel with knowledge and experience of the asset/facility of interest, should be empowered to conduct a thorough, unbiased risk assessment. Factors such as the applied coating system, insulation age, type and condition (including defects noted and maintenance activities completed), degree of exposure, water wetting (deluge or other), and operating temperature trends (including excursions) utilisation and cycling should be reviewed to provide a true assessment of CUI probability applicable to the equipment. CUI probability assessment methodologies provided in documents such as API 583 [7] and DNV-RP-G109 [8] can be used. A robust consequence of failure assessment should be done to ensure the effects of failures are understood. The overall risk is determined from a combination of CUI probability and consequence.

Outputs from this risk assessment process will constitute the work program/inspection schedule. Where a full risk-based inspection (RBI) policy is in place in the company, the RBI team is best placed to fulfil the assessment team's function.

As pipework and associated supports/penetrations constitute the majority of components which may suffer CUI failures frequently, a detailed assessment of each line/tag may provide the granular detail required to focus inspection resources. Large equipment (e.g., towers) may be split into sections, so areas with high CUI risk can be differentiated from others with low or medium risk.

It is important that the team continuously updates/revalidates existing assessments and work order prioritisation based on the most recent findings and operating parameters.

CUI Work Program Execution

Execution of the work program is a crucial pillar of the CUI management strategy. Success at this stage is highly dependent on inputs from the aforementioned stages – without management support and a sufficient budget, limited progress will be made in executing the program. Inadequate CUI risk assessment will develop a work program which does not identify the highest risk areas, resulting in what may be perceived as a "waste of resources".

Planning and delivery of work scopes ensures that the right resources are deployed when / where necessary. This requires agreement between relevant parties (e.g., Maintenance Planners and Plant Operations Managers) to ensure items are available for inspection and remediation.

Figure 5 below shows a workflow which can aid successful CUI program execution.

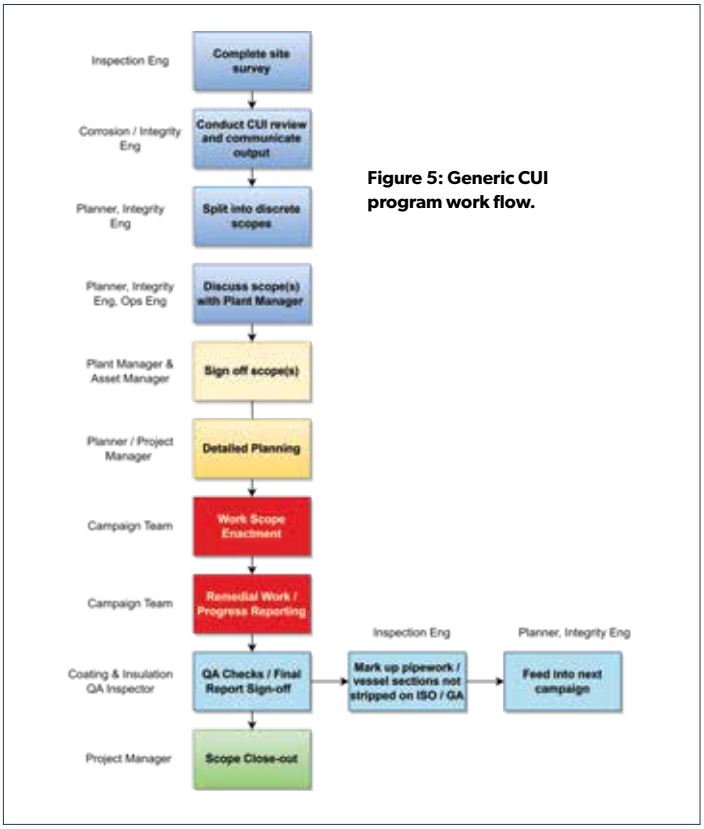


Figure 5: Generic CUI program work flow.

CUI Monitoring – A New Tool in The Toolkit

Corrosion monitoring has been used very effectively in managing integrity for decades. Internal corrosion monitoring data is used to update RBIs, complement existing inspection data or drive additional inspection to confirm actual degradation rates. Indirect measurements using corrosion coupons give an indication of the amount and nature of degradation being experienced by the equipment of interest. The validated CUI monitoring technology essentially piggybacks on this mature concept by using sensors for detection of moisture and degradation. This recent innovation, independently tested by industry body HOIS, was financially supported by the Aberdeen based Oil and Gas Technology Centre (OGTC), now Net Zero Technology Centre (NZTC). Onshore and offshore trials have been implemented by Total Energies in the U.K., Saudi Aramco in the Middle East and Sitech in the Netherlands.

Field trials of a similar CUI monitoring system were conducted by INEOS to confirm its ability to detect moisture and corrosion. The system (shown in Figure 6) consists of a moisture sensor and a corrosion sensor (31 m in length each for the test case) helically installed around a selected carbon steel heat exchanger with an average pitch of 20 cm. The operating and design temperatures of the exchanger are 95°C and 150°C respectively. A detailed engineering design drawing was produced, to ensure the sensors were correctly installed for accurate monitoring. This exchanger was fully stripped for CUI detection using conventional external visual inspection. Fabric maintenance was completed prior to installation of the sensors; subsequently, the exchanger was re-insulated prior to its return to service.

In parallel, accelerated testing (using 3.5% NaCl) was done on an uncoated "dummy" pipe (with new insulation) and a test capsule (with aged insulation). The sensors were extended from the heat exchanger to these test areas using conduit pipes to exclude the external environment. Accelerated testing was conducted for a 6-month period to observe trends.

Figure 6: Installation of sensors following heat exchanger visual inspection.

Monitoring results obtained from the heat exchanger identified the exact location and dates of water ingress into the insulation system, and alternate wetting and drying within the first month of installation (Figure 7). This confirmed the poor quality of work achieved during insulation installation, particularly at one of the large nozzles on the heat exchanger. It is noteworthy that the insulation system had been subjected to quality checks prior to recommissioning the equipment. Evidently, poorly sealed areas can degrade quickly. Thus, the moisture sensor was highly effective in identifying defective insulation joint sealing. It can be used to check insulation quality during service and identify areas of water ingress, aiding prompt rectification and CUI prevention.

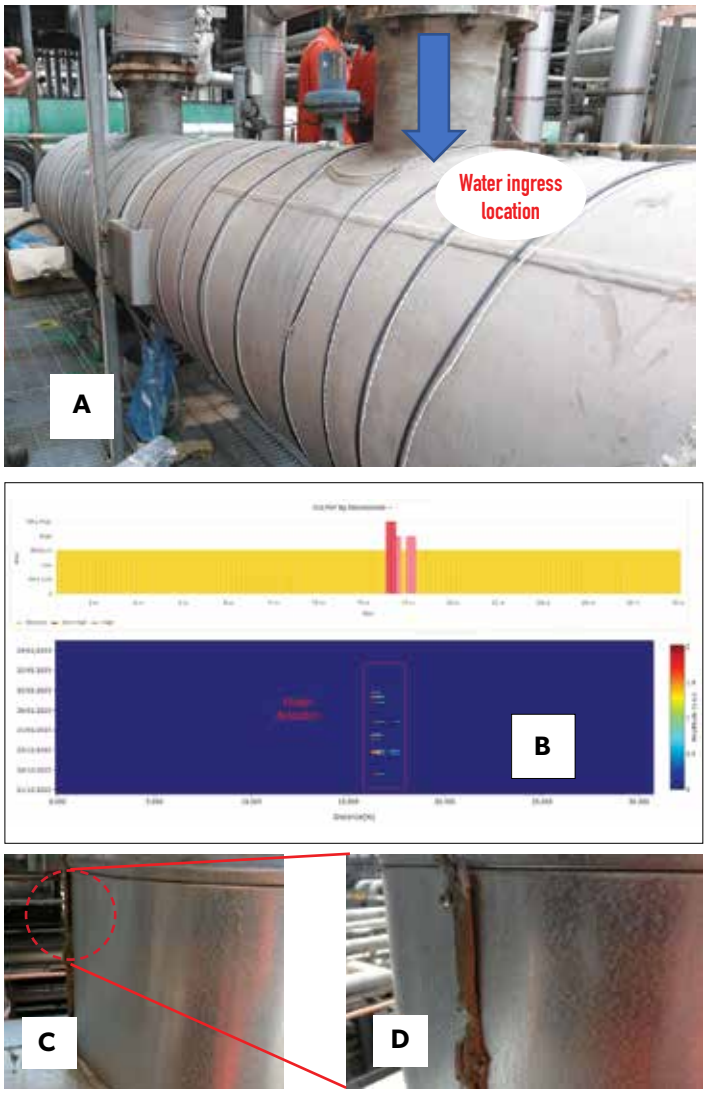


Figure 7: (a) Localization of water ingress location by moisture sensor (b) Water wetting probability factor on CUI monitoring dashboards (c, d) Defective cladding / water ingress location.

The accelerated testing results demonstrated the need for installation of new insulation on equipment during remediation programs. Due to its hydrophobicity, the new insulation on the uncoated dummy pipe repelled the NaCl solution, and the pipe remained uncorroded for the first 4 months of testing. In contrast, the aged insulation in the test capsule absorbed the NaCl solution very quickly (within the 1st month of testing).

Figure 8: Addition of test solution (3.5% NaCl) to (a) the dummy pipe and (b) test capsule.

Concluding Remarks

A pragmatic approach to CUI management is required across industry to prevent further failures. While prevention of CUI is achievable (most successfully at design stage), many operating assets are at the stage where CUI risk needs to be aadequately managed, particularly for hydrocarbon-containing systems. A data-driven, dynamic CUI risk management approach, complemented by new developments such as fully automated CUI monitoring, is the future. This approach will be successful if the required resources are devoted to work programs. Engagement of qualified and experienced professionals to ensure the integrity of barriers and insulation systems is also essential for successful CUI management. The practice of self-certification by vendors should be particularly avoided.

Images

All images copyright INEOS.

References

1. Net Zero Technology Centre, "A Spotlight on CUI-fighting Technology", *Oilfield Technology,* Spring 2023 edition, pg. 47.
2. Kappes, Mariano A., "Localized corrosion and stress corrosion cracking of stainless steels in halides other than chlorides solutions: a review". Corrosion Reviews, vol. 38, no. 1, 2020, pp. 1-24. https://doi.org/10.1515/corrrev-2019-0061.
3. F. Elshawesh, A. El Houd & O. El Raghai. "Corrosion and cracking under insulation of type 304 stainless steel at ambient temperature", *Corrosion Engineering,* Science and Technology, 38:3, 2003, pp. 239-240, DOI: 10.1179/147842203770226997.
4. NACE SP0198-2017, "Control of Corrosion Under Thermal Insulation and Fireproofing Materials - A Systems Approach". ISBN: 1-57590-049-1.
5. NORSOK M-501:2022, Surface Preparation and Protective Coating, 7th Edition.
6. ISO 19277:2018, Petroleum, petrochemical and natural gas industries - Qualification testing and acceptance criteria for protective coating systems under insulation.
7. API 583: 2014, Corrosion under Insulation and Fireproofing.
8. DNV-RP-G109, Risk based management of corrosion under insulation. 2019 Edition (Amended 2021).

Asset Operating Integrity and Repair of Damaged or aged PFP

Chris Fyfe CSci, PFP Senior Field Auditor & Coach and Dave Wickham MSc, MIFireE, Chartek Fire Engineer, Protective Coatings, International Paints Ltd

Background

As the oil and gas industry matures and many of the production facilities reach the end of their design life, asset and operating integrity and fabric maintenance (FM) has become increasingly important. Design and engineering technology in the 1960's and 1970's was based upon the original hydrocarbon extraction predictions, which were significantly less than the current anticipated reservoir yield.

The extended field life now poses many operational challenges, among them is the efficacy of in-situ passive fire protection (PFP) which in many instances was installed when the facility was first commissioned. In some instances, the PFP may have deteriorated to a point where it may not provide the required level of protection in a fire event.

Where the PFP defect severity rating has been considered anomalous and the frequency is considered extensive this can create difficult economic maintenance and repair (M&R) decisions. M&R resources are not limitless and, where repair priorities have been identified, selecting the most efficient repair solutions becomes extremely important.

The importance of selecting cost effective intervention systems that demonstrate compliance with the performance standard and fire rating, but that can also be installed during operational activities by the incumbent asset integrity inspectors or fabric maintenance (FM) contractor with limited surface preparation requirements is seen as advantageous for anomaly reduction and performance standard compliance.

On mature downstream facilities in-situ PFP in many cases comprises structural steel encased in dense concrete or light weight cementitious (LWC) PFP. Where these types of PFP are damaged or degraded they can expose the substrate to weather cycling that leads to corrosion under fireproofing (CUF). Portland cement-based PFP systems were originally specified at that time because they were a relatively cheap material that satisfied some of the most onerous fire scenarios. It was further believed that due to the alkalinity of the system, the substrate would be pacified offering good anti-corrosion protection. However, what seems not to have been understood is that these systems need a regular maintenance schedule. This lack of maintenance can result in a degradation of the system allowing for moisture penetration, which can result in carbonation of the free lime in the portland cement, carbonation will reduce the alkalinity and reduced alkalinity makes for a favourable environment for CUF. Therefore, during RBI assessments consideration to cementitious PFP defects should not be under-prioritised. A small crack, although may not be detrimental to fire performance may allow moisture ingress and structural or pressure system degradation.

Once the moisture permeates to the substrate further cracking may be initiated by CUF and corrosion creep. Iron oxide or rust expansion is in the region of 7:10 times its original volume this can impart outward stress on the PFP resulting in further fissures developing and resulting in propagation of the problem.

Further degradation of the system can extend the area of defective PFP and can develop into dropped object hazards adding further to the concerns about PFP functionality.

Epoxy PFP can be regarded as relatively maintenance free when installed correctly, therefore in the context of this paper M&R will focus on anomalies in dense concrete and LWC/CUF corrosion risks in that context and provides an overview of an ongoing work programme to develop solutions that aim to focus M&R scheduling to only those locations that are critical to the operational safety of the facility (i.e., where the severity of a defect has been categorised as high, a repair solution can be presented to downgrade, defer and in some cases remove the severity rating).

PFP Performance

Decisions regarding 'repair or replace' may be driven by internal company strategies or asset integrity anomaly reporting requirements that follow external guidance, for example, HSE 12/2007.

In many cases, these rely on the knowledge of the inspector for prioritising defect severity. Often, PFP inspector training programmes are designed for new build applications and may have little or no learning for in-service situations. Therefore, in many instances, defect severity grading is rated higher than what may be required due to the unknown level of performance that a defective PFP system may offer. However some damaged PFP in many instances may still afford an acceptable level of fire resistance.

What was installed during the plant construction many years previously may not represent current safety requirements. For example, in a typical downstream facility the PFP specification may have been based on prescriptive guidance such as API 2218 and for example, a 90 minute fire resistance period. It is likely that in the intervening years there have been many changes to the site layout, de-commissioning of plant, changes in inventory and operating pressures, all requiring a re-assessment of the site fire hazards. In some areas 90 minutes will no longer represent the required fire resistance period and a lesser (or perhaps greater) period is specified. Let's say that a 60 minutes fire resistance period is sufficient for a particular area of site then PFP installed to meet a 90 minutes requirement may meet a 60 minute requirement even when damaged. But herein lies the difficulty – how to determine what level or extent of damage is acceptable for the revised fire scenario?

Damage and degradation mechanisms fall into many different categories and can be comprehensive. A database of all PFP anomalies types and sizes does not exist therefore any acceptance or grading of PFP defects should be supported with fire test data to support a robust fire integrity assessment. The Energy Institute supports this approach. An example showing the use of actual test data to assess PFP performance is shown below in Fig 1 and Photo 1.

Photo 1. Damaged concrete encased steel column pre-test

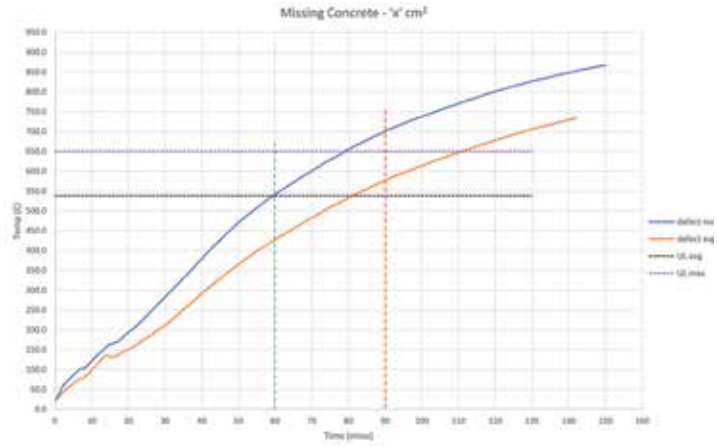


Figure 1. Defect fails 90 mins fire resistance but passes a 60 min fire resistance (UL1709)

PFP Anomalies

Failure of PFP can be divided into two categories, damaged PFP where the initial breakdown may be caused by mechanical damage (i.e., process or impact damage) or degradation (i.e., gradual breakdown due to weathering such as freeze-thaw [aged PFP]). Remediation of damaged PFP is more straight forward than that of degraded PFP. In the case of damaged PFP where this is picked up during risk-based inspection activities there are more opportunities to implement an effective repair as the damage may be limited and the adjacent PFP still in good condition. However, left unrepaired damaged PFP can rapidly increase in severity and become non-functional PFP with associated corrosion-under-fireproofing (CUF). In most cases, this causes loss of the PFP bond to the steel substrate and possibly a dropped object hazard developing. Whilst the reinforcing mesh in the PFP may provide some physical integrity, degraded PFP is normally associated with heavily corroded mesh. This is more of a problem for LWC than dense concrete given the former materials have a higher propensity to absorb water than concrete, this is not to say that disbonded dense concrete will not give rise to dropped object hazard, just that it might take longer to develop.

Degraded LWC will likely have commenced due to the loss of topcoat and the underlying material then becoming waterlogged. There is some debate about the fire performance of waterlogged LWC, some test evidence showing that there may be little or no reduction in fire performance due to an extended moisture plateau, but waterlogged material promotes CUF, which in turn leads to greater loss of physical integrity and dropped object hazard. When waterlogged material becomes extensive removal and replacement becomes the only safe solution. Some LWC manufacturers report that deterioration cannot be reversed or rectified, implying repairs are not a solution. Examples of typical damage and deterioration of concrete and LWC are shown below in photos 2-5.

Photo 2. Loss of topcoat and waterlogged LWC

Photo 4. LWC - Scaffolding impact damage

Photo 3. Concrete – FLT impact damage

Photo 5. Concrete – Dropped object hazard due to extensive CUF

PFP Repair Solutions

Repair solutions for damaged or deteriorated PFP should provide assurances of reliability and first and foremost have demonstrable fire resistance that has been independently verified. Whilst the most robust remediation is removal and replacement with new PFP, this is far from the most economically low cost solution. The decision to repair or replace can be based on weighing the risk (the knowledge of damaged PFP performance and/or availability of verified fire protection solutions) against the money and time required to remediate (as low as reasonably practicable [ALARP]).

Deciding 'repair or replace' is based on the results of risk-based inspections, the criticality of the asset and the severity of the defect – the damage acceptance criteria. This in turn determines what to repair, what not to repair. An 'acceptable' defect is assigned a lower priority, the higher priorities requiring a selected repair solution adequate for the hazard and confidence in its fire performance. An approach in this way is detailed in the simple flowchart below (Fig 2).

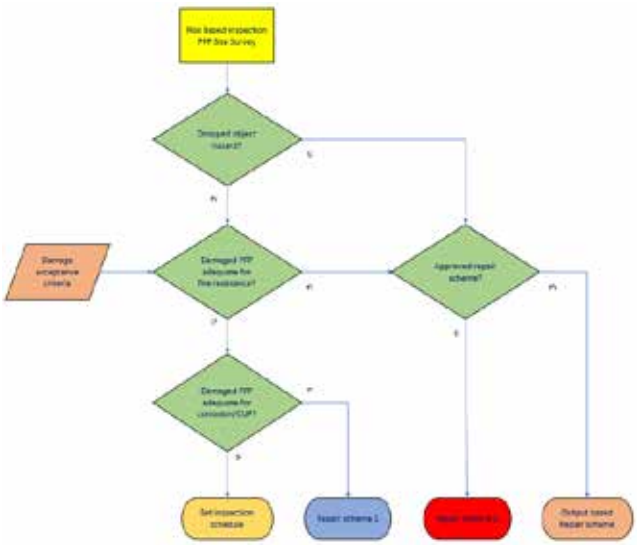


Figure 2. Selecting the appropriate repair solution

continues on page 32

When identified early in the inspection cycle, minor damage that is fit for purpose to meet fire protection requirements can be repaired to stop the advancement of CUF (repair scheme 1). The repair may involve surface treatment and repair with any suitable material (for example, a silicone sealant or similar material). However, left unrepaired, CUF can lead to deterioration of PFP that, depending on the extent, PFP type and criticality, may lead to a partial or total loss of required fire resistance - not only loss of fire resistance but also the creation of a dropped object hazard. Where the loss of fire resistance will not meet the fire scenario then a repair that demonstrates fire performance installed in the adjacent PFP material is required (repair scheme 2). It is important to ensure that the abutment between different materials has been evaluated by fire testing as these interface areas are more prone to failure under fire conditions and equally important is the integrity of the repair against water ingress and weathering.

Repairing damaged concrete and LWC PFP on a like-for-like basis can incur significant costs, mainly due to installations costs of labour and access requirements. In the case of dense concrete removing damaged material may involve the removal of large areas adjacent to the defect and the use of timber formwork. The reinforcing mesh that is likely to be corroded needs to be removed and new mesh tied into the existing mesh before the concrete is poured into the formwork. LWC repairs can also involve removing larger areas of material adjacent to damage to ensure repositioning, pinning, tying in of new mesh and mixing material. When undertaking these remedial works, working at height becomes more difficult and costly due to access (scaffolding) costs and restricted working area increasing the time required to effect successful repairs.

Consideration of these issues has been the driving force behind the focus in this area to provide asset integrity personnel with PFP repair solutions that offer proof of fire and durability performance combined with significantly reduced application times.

Two new products, Products A and Product B, that have undergone extensive testing are being introduced to the market in 2023. Description about these new products are given below.

Product A: A 1-component moldable fire rated putty that is specifically tested for smaller areas of damage and cracks in both concrete and LWC. This has been tested under hydrocarbon pool fire and jet fire exposures and also fire testing after immersion conditions according to ISO2812-2 (see figures 3, 4 and 5). No mesh reinforcement is needed, application is simply by hand and no specialist PPE is required.

Some initial scoping tests have been undertaken for repairing cracks in epoxy PFP where the repair maintains the same fire protection as non-damaged material.

Successful product trials are ongoing at a site in Europe where the material was used to repair cracked LWC (June 2022) – no reported issues of any change or degradation of the material. The abutment continues to show good integrity. See photo 6.

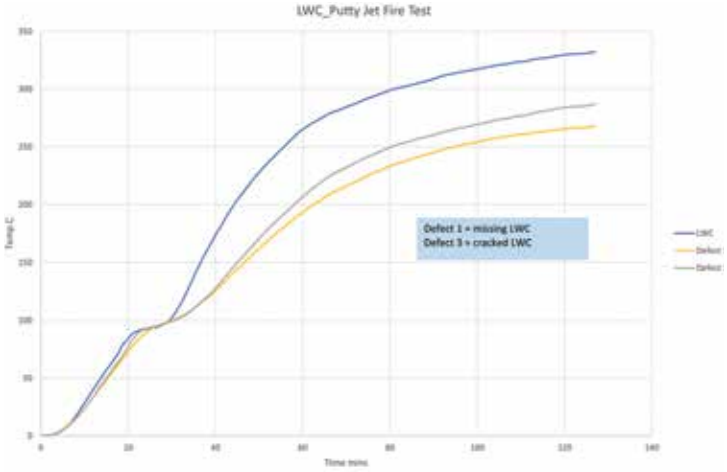


Figure 3. Repairs to damaged LWC

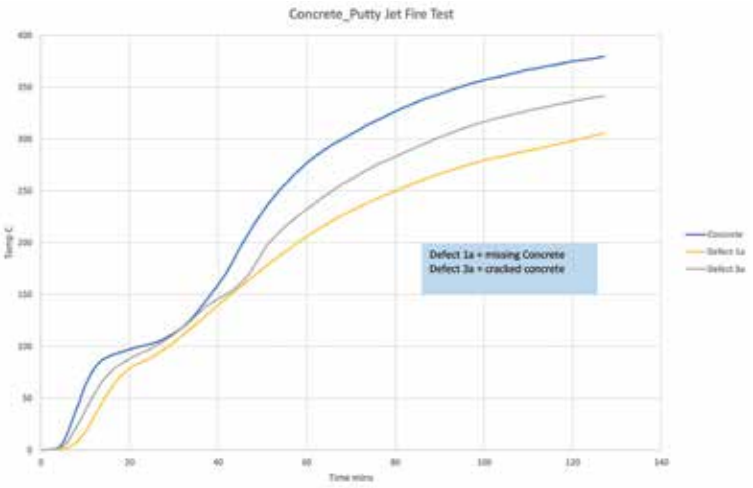


Figure 4. Repairs to damaged concrete

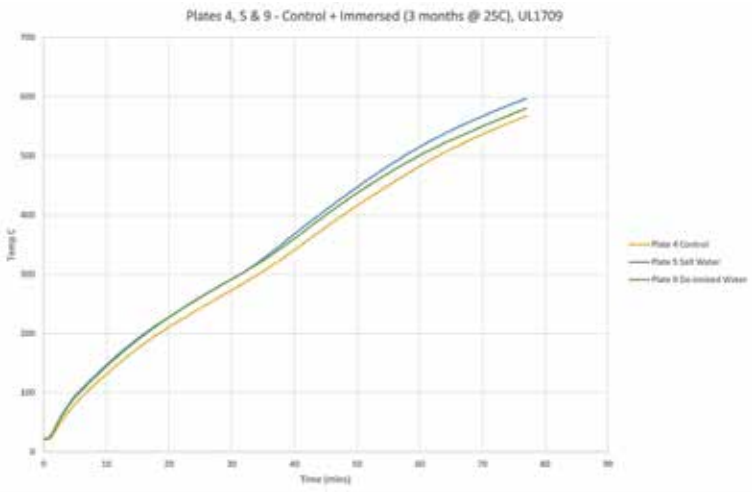


Figure 5. Fire tests after immersion

Product B: For larger defects (including waterlogged LWC that requires more extensive removal), a fire rated structural repair mortar can be used, this has also been tested under pool and jet fire exposures (see figure 6) and has durability performance in accordance with EN13687-1, EN13697-1 and EN13507. Like the above product A application is by hand and no specialist PPE. Application trials have also been implemented at a European downstream facility. See photos 7 and 8

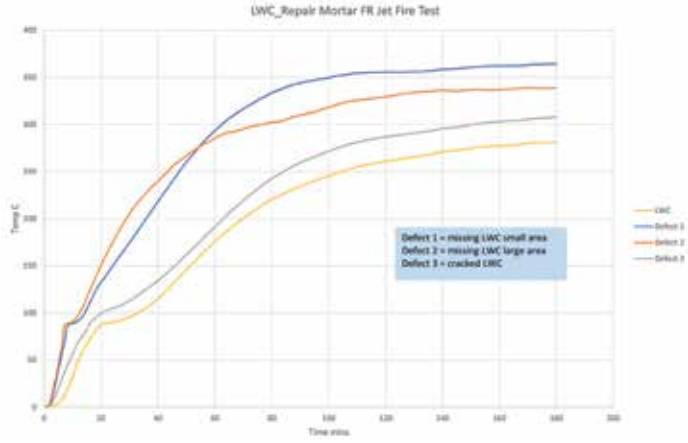


Figure 6. Repairs to damaged LWC

Left: Photo 7. LWC degradation (vessel skirt)

Acove: Photo 8. Product B vessel skirt LWC repair

Both **products A and B** represent significant savings in application time and costs. Considering product A when factoring in the installation savings into overall costs, savings of 39% can be achieved for working at grade and 69% when working at height. 90% more crack repairs could be completed in a working week when compared to concrete when using product A.

In addition to new repair solutions for damaged PFP, dropped object hazards are a major concern where concrete and LWC may have become detached from the substrate. Often, these are simply wrapped in netting to prevent the PFP from falling but unless the structure is redundant there is no reinstatement of the fire protection. Damaged concrete encased steel columns wrapped in an experimental cladding system and overlaid with an epoxy PFP are being trialled currently as a new solutions offer. Alternatively the disbonded concrete or LWC can be encased in a precast epoxy PFP box or precast PFP pipe shell.

Summary

Repairs to damaged or deteriorated PFP may be urgently needed to maintain plant and operator safety. In older facilities this damage could be extensive and need considerable remediation expense that stretches the available M and R budget. Driving down costs for PFP M and R need not be at the expense of fit-for-purpose or corner cutting. Knowing what PFP anomalies are critical and assurance that if requiring repair, the solution has demonstrable performance for its intended end-use will provide asset integrity with the tools to maintain safe operations while minimising limited M and R budgets.

The work described in this article is an on-going programme of developing new solutions that maximise the returns for continued safe and reliable operation of plant and personnel.

Photographs and details of repair systems discussed are courtesy of AkzoNobel.

References

1. HSE 12/2007: 'Advice on acceptance criteria for Damaged Fire Protection (PFP) coatings'.

2. 2218: 'Fireproofing Practices in Petroleum and Petrochemical Processing Plants', 3rd Edition, 2010.

3. Energy Institute: 'Guidelines for in-service management of passive fire protection coating systems', 1st Edition, 2021.

4. IChemE: 'Fire resistance of passive fire protection coatings after long-term weathering', paper by Roberts et al, 2009.

The Institute values the support of the companies and organisations who are Corporate or Sustaining Members.

A detailed listing of these members is published annually as a stand-alone supplement to the January/February issue of Corrosion Management, and a regularly updated searchable listing is published on the Institute's website.

CORPORATE MEMBER COMPANIES

BP
Chertsey Road, Sunbury on Thames, Middlesex TW16 7LN Tel: 0203 401 9908
Email: chris.williams3@uk.bp.com

FLEXITALLIC
Scandinavia Mill, Hunsworth Lane, Cleckheaton BD19 4LN Tel: 01274 851 273
Email: contactus@flexitallic.eu www.flexitallic.com

INTERNATIONAL PAINT LTD
International Paint Ltd,
Stoneygate Lane, Gateshead,
Tyne and Wear England, NE10 0JY

CARBOLINE
Unit 2, Dorsey Way, Leicester, LE19 4DB

GOLD SUSTAINING MEMBER COMPANIES

CATHODIC PROTECTION CONSULTANCY SERVICES

SGK
Technoparkstr 1, Zurich 8005, Switzerland
Tel: +41 44 2131590 Email: sgk@sgk.ch

CATHODIC PROTECTION AND MONITORING

BAC
Stafford Park 11, Telford TF3 3AY, UK
Tel: +44 (0) 1952 290321 Email: sales@bacgroup.com
www.bacgroup.com

CATHODIC PROTECTION CO LIMITED
Venture Way, Grantham, Lincolnshire, NG31 7XS, United Kingdom
Tel: +44 (0) 1476590666 Email:sales@cathodic.co.uk

3C CORROSION CONTROL COMPANY AB
Fabriksvägen 21 E, 268 73 Billeberga, Sweden
Tel: +46 418 411 900 Fax: +46 418 411 935
Email: info@3ccc.se Website: www.3ccc.se

CORROSION CONTROL INCORPORATED
494 Fairplay Street, Rutledge, Georgia 30663, USA
Tel: +706 557 9624
Email: brianwyatt@controlcorrosion.co.uk

CORROSION TECHNOLOGY SERVICES EUROPE LTD
11 & 12 Merlin Park, Mildenhall, Suffolk IP28 7RD
Tel: 01638 711955 Fax: 01638 711953
Email: enquirieseu@ctsonline.com www.ctsonline.com

CORRPRO COMPANIES EUROPE LTD
Adam Street, Bowesfield Lane, Stockton On Tees, Cleveland
Tel: 44(0) 1642 614 106 Fax: +44(0) 1642 614 100
Email: ccel@corrpro.co.uk www.corrpro.co.uk

INTERPROVINCIAL CORROSION CONTROL CO. LTD
930 Sheldon Court, Burlington, Ontario L7L 5K6, Canada
Tel: 905-634-7751 Email: contact@rustrol.com
www.rustrol.com

MGDUFF INTERNATIONAL LIMITED
1 Timberline Estate, Gravel Lane, Quarry Lane, Chichester, West Sussex, PO19 2FJ
Tel: +44 (0) 1243 533336 Fax: +44 (0) 1234 533422
Email: sales@mgduff.co.uk www.mgduff.co.uk

MILLER FABRICATIONS LTD
Overtown Road, Waterloo, Wishaw, Scotland, ML2 8EW
Tel: 01698 373 770 www.millerfabrications.com

OES GROUP LTD
Coupe House, Station Lane, Birtley DH2 1AJ
Tel: 0191 815 5035 Email: sales@oesgroupltd.com
www.oesgroupltd.com

COATING APPLICATOR

OWENS CORNING FOAMGLAS® INDUSTRY
31-35 Kirby Street, Hatton Garden, London, EC1N 8TE
Tel: 07789 507094 Email: kevin.bauld@owenscorning.com

CONSULTING TESTING AND INSPECTION

AKAKUS OIL OPERATIONS
EL-Tahaddi Street (Airport Road), PO BOX 91987,
Tripoli, Libya Tel: 0021821-4802630
Email: lfituri@akakusoil.com www.akakusoil.com

SGK
Technoparkstr 1, Zurich 8005, Switzerland
Tel: +41 44 2131590 Email: sgk@sgk.ch

SUPPLIERS COATINGS

CHEMCO INTERNATIONAL LTD
East Shawhead Ind. Est, Coatbridge, Scotland ML5 4XD
Tel: 01236 606060 www.chemcoint.com

DENSO (WINN & COALES DENSO LTD)
Denso House, Chapel Road, London SE27 0TR
Tel: 0208 670 7511 Fax: 0208 761 2456
Email: mail@denso.net www.denso.net

HEMPEL UK LTD
Berwyn House, The Pavillions, Cwmbran, Torfaen, South Wales, NP44 3FD, United Kingdom
Tel: 01633 874024 Fax: 01633 489012
Email: Sales.uk@hempel.com Web: www.hempel.com

JOTUN PAINTS (EUROPE) LTD
Stather Road, Flixborough, Scunthorpe,
North Lincolnshire DN15 8RR
Tel: 01724 400 125 Fax: 01724 400 100
Email: enquiries@jotun.co.uk Web: www.jotun.co.uk

PPG PROTECTIVE & MARINE COATINGS
Huddersfield Road, Birstall, Batley, West Yorkshire,
WF17 9XA Tel: 01924 354700
Email: PMCcustomerservice@ppg.com www.ppgpmc.com

SHERWIN-WILLIAMS PROTECTIVE & MARINE COATINGS
Tower Works, Kestor Street, Bolton, BL2 2AL, UK
Tel: +44 (0)1204 521771 Email: enquiries.pm.emea@sherwin.com sherwin-williams.com/protectiveEMEA

SUPPLIERS SPECIALIST

HODGE CLEMCO
36 Orgreave Drive, Handsworth, Sheffield, S13 9NR
Tel: 0114 2540600 Email: sales@hodgeclemco.co.uk
www.hodgeclemco.co.uk

RYSCO INTERNATIONAL INC
101 – 8024 Edgar Industrial Cr Red Deer, Alberta, Canada, T4P 3R3 Tel: +1 877 899 5988
Email: tommy.mccann@ryscointernational.com
www.ryscocorrosion.com

SIG IRELAND
USIG House, Ballymount Retail Centre, Ballymount
Dublin, D24 ED81 Ireland Tel: 00353 1 6234541
Email: eoin_rylands@sig.ie www.sig.ie

SUSTAINING MEMBER COMPANIES

CATHODIC PROTECTION CONSULTANCY SERVICES

BEASY
Tel: 02380 293223 www.beasy.com

CESCOR UK LTD
Tel: 0208 996 5111
Email: Dimitrios.mamalopoulos@cescor.co.uk

CORROSION ENGINEERING SOLUTIONS LTD
Tel: 01442 767 899 www.corrosionengineering.co.uk

CORROSION CONTROL LTD
Tel: 01785 711560 Fax: 01785 711560
Email: brianwyatt@controlcorrosion.co.uk

SEGCORR LTD
Tel: 07484838232 Email: paul.segers@segcorr.com

CATHODIC PROTECTION AND MONITORING

AQUATEC GROUP LIMITED
Tel: 01256 416010 Email: inquiry@aquatecgroup.com

CORRINTEC CATHELCO
Tel: +44 (0) 1246 457900 www.cathelco.com

CCSL
Tel: 01952 230900 www.corrosioncontrolservices.co.uk

CORROCONSULT UK LIMITED
Tel: 01952 740234 www.corroconsult.com

DEEPWATER EU LTD
Tel: +44 (0) 1483 600482 www.stoprust.com

DUVINE
Tel: +44 (0)1440 706777 www.duvine.co.uk

ICR INTEGRITY LTD
Tel: 01224 822822 www.icr.world.com

IMPALLOY LTD
Tel: 01922 714400 www.impalloy.com

JENNINGS ANODES UK LTD
Tel: 0191 5108843 www.jenningsanodes.co.uk

METEC CATHODIC PROTECTION LIMITED
Tel: 0191 7316010 714411
Email: sales@metecgroup.com

OMNIFLEX UK LTD
Tel: 0161 491 4144 www.omniflex.com

PHOENIX CPC LTD
Tel: 07486076800 www.phoenixcpc.com

PMAC Inspection Ltd
Tel: 01224 703032

R&R CORROSION LTD
Tel: 01358 729644 www.rrcorrosion.com

SAITH LTD
Tel: 01425 207555 www.saithlimited.com

SILVION LIMITED
Tel: 01476 590932 www.silvion.co.uk

VECTOR CORROSION TECHNOLOGIES
Tel: 01384 671400 Email: davids@vector-corrosion.com

MILLER FABRICATIONS LTD
Overtown Road, Waterloo, Wishaw, Scotland, ML2 8EW
Tel: 01698 373 770 www.millerfabrications.com

COATING APPLICATORS

ALFRED BAGNALL & SONS LTD
Tel: 01274 714800
Email: info@bagnalls.co.uk www.bagnalls.co.uk

APB GROUP LIMITED
Tel: 01538 755377 www.apbgroup.co.uk

AW RAIL SERVICES LTD
Tel: 01303 257462

BRIDGECOAT LTD
Tel: 02392 666161 Email: info@bridgecoat.co.uk

CC INFRASTRUCTURE SERVICES
Tel: 0845 685 01333 www.cc-is.co.uk

CORROLESS EASTERN LTD
Tel: 01362 691484 Email: info@corrolesseastern.co.uk
www.corrolesseastern.co.uk

CORROSERVE
Tel: +44 (0) 113 2760 760 www.corroserve.com

D.F. COATINGS LTD
Tel: 02380 445634 Email: info@dfcoatings.co.uk

D&P COATINGS LIMITED
Ellesmere Port, England
linkedin.com/in/d-and-p-coatings-ltd-862036259

DYER & BUTLER LTD
Tel: 02380 742222 www.dyerandbutler.co.uk

F A CLOVER & SON LTD
Tel: 020 89486321 Email: ian@cloverpainting.com

FIRESAFE SERVICES (NE) LIMITED
Tel: 01670 351666 Email: info@firesafelimited.com

FORWARD PROTECTIVE COATINGS LTD
Tel: 01623 748323 Email Pete@forwardpc.co.uk
www.forwardpc.co.uk

FOUNTAINS (PART OF THE OCS GROUP)
Tel: 07593 611577 Barry Crewick
Email: barry.creswick@fountainsgroup.co.uk

HANKINSON PAINTING GROUP
Tel: 0870 7892020
Email: Stephen.hankinson@hankinson.co.uk

HERRINGTON INDUSTRIAL SERVICES LTD
Tel: 0191 516 0634 www.herringtonltd.co.uk

HRS RAIL LTD
Tel: 01797 329421 www.hrsrail.co.uk

JACK TIGHE LTD
Tel: 01652 640003 Email: sales@jacktighe.com

JPV (PAINTERS) LTD
Tel: 01277 201515 www.jpvpainters.co.uk

KUE GROUP LIMITED
Tel: +44 (0)1274 721188 www.kuegroup.com

NUSTEEL STRUCTURES
Email: scott.arnold@nusteelstructures.com
www.nusteelstructures.com

OAG INTERNATIONAL UK LTD
Tel: +44 (0) 151 318 6999 www.oag-group.com

PCS
12, Eoloda Street from Gisr Elniile, Sekeel, Guza, Egypt
12992 Tele: +2 01069083431 www.PCS.com
Email: alihassan_804@hotmail.com

PIPERCREST LTD T/A HALLS SPECIALISED SERVICES
Tel: 01375 361408 www.hallsspecialisedservices.co.uk

SAFINAH LTD
Tel: 01670 519900 Email: enquiries@safinah.co.uk

SCA GROUP LIMITED
Tel: 01202 820820 www.sca-group.com

SOLENT PROTECTIVE COATINGS LTD
Tel: 02380221480 Email: info@solentpc.co.uk
www.solentpc.co.uk

SPECIALIST COATINGS & INSPECTION LTD
Tele: 01793 380389 Email: cosmin@specialistcoatings.net
www.specialistcoatings.net

SPECIALIST PAINTING GROUP LTD
Tel: 01733 309500 www.specialistpaintinggroup.co.uk

STANDISH METAL TREATMENT LTD
Tel: 01695 455977 Email: stuart.croft@standishmetal.co.uk

SURFACE TECHNIK DUDLEY LIMITED
Tel: 1384 457610 www.surfacetechnik.co.uk

TAZIKER INDUSTRIAL
Tel: 0844 8800 385 www.ti.uk.com

TPS360
Cardiff, Wales www.tps360.co.uk/

WEDGE GROUP GALVANIZING LTD
Tel: 0845 271 6082 www.wedge-galv.co.uk

WESCOTT INDUSTRIAL SERVICES LTD
Tel: 0191 497 5550 www.wescottis.com

W G BEAUMONT & SON LTD
Tel: 01708 749202
Email: tom.costello@wgbeaumont.co.uk

CONSULTING TESTING AND INSPECTION

AW CORROSION SOLUTIONS LTD
Tel: 01732 700924
Email: enquiries@awcorrosion.co.uk

CAN
Tel: 01224 870100 Fax: 01224 870101 www.cangroup.net

EQUILIBRANT LTD
Tel: 02890 767227 www.equilibrant.co.uk

ERIMUS INSULATION
Tel: 07968828825 www.erimusi.com

HYDROCOMM LTD
Tel: 07779333781 Email: hydrocomm@btinternet.com

HYDROSAVE UK LTD
Tel: +44 (0) 1536 515110 www.hydrosave.co.uk

LBBC BASKERVILLE
Tel: 0113 2057423 www.bbcbaskerville.com

PAINT INSPECTION LIMITED
Tel: 0845 4638680 www.paint-inspection.co.uk

PLANT INTEGRITY MANAGEMENT LTD
Tel: 01224 798870
Email: info@pim-ltd.com www.pim-ltd.com

SAFINAH LTD
Tel: 01670 519900 Email: enquiries@safinah.co.uk

SONOMATIC LTD
Tel: 01925 414000 www.sonomatic.com

SPECIALIST COATINGS & INSPECTION LTD
114 Eastlake, Swindon, SN25 2RZ
Tel: 01793 380 389 / 0747 654 3218
info@specialistcoatings.net; www.specialistcoatings.net/

STEEL PROTECTION CONSULTANCY LTD
Email: wil.deacon@steel-protection.co.uk
www.steel-protection.co.uk

SUPPLIERS COATINGS

CORROCOAT
Tel: +44 (0) 113 2760 760 www.corrocoat.com

HEXIGONE INHIBITORS LTD
Tel: 01792 439422 www.hexigone.com

INDESTRUCTIBLE PAINT LTD
Tel: 0121 7022485 www.indestructible.co.uk

TPS360
Cardiff, Wales www.tps360.co.uk/

SUPPLIERS GENERAL

ASCOTT ANALYTICAL EQUIPMENT LIMITED
Tel: 01827 318040 Email: hmorley@ascott-analytical.com

CORRODERE ACADEMY
Tel: 01252 732220 www.protectivecoatingseurope.com

FUTURE PIPE LIMITED
Tel: 0207 8388660 www.futurepipe.com

GMA GARNET (EUROPE) GMBH
Tel: 01606 836223

INFRASTRUCTURE ANALYTICS LTD
Tel: 028 9532 0131 Email: info@ infrastructureanalytics.co.uk

LAKE CHEMICALS & MATERIALS LTD
Tel: 01527 594630 Email: dean.kenny@lakecm.co.uk

LBBC BASKERVILLE
Tel: 0113 2057423 www.bbcbaskerville.com

LLEWELLYN RYLAND LTD
Tel: 0121 4402284 Email: research@llewellyn-ryland.co.uk

PRESSERV LTD
Tel: 01224 772694 Email: stuart.rennie@presserv.com

SCANGRIT
Tel: 01469 574715
Email: sales@scangrit.co.uk www.scangrit.co.uk

RECIPROCAL ORGANISATIONS

ELSEVIER SCIENCE LTD
Tel: 01865 843000

INSTITUTE OF METAL FINISHING
Tel: 0121 6227387 www.uk-finishing.org.uk

MARINE CORROSION FORUM
www. marinecorrosionforum.co.uk

CEOCOR
www. ceocor.lu

QUALITY CONTROL

ELCOMETER
Tel: +44 (0) 161 371 6000 www.elcometer.com

TRAINING AND COATING INSPECTORS

CORRODERE ACADEMY
Tel: 01252 732220 www.corrodere.com

IMechE
Bryan Ravenshear Email:Bryan.Ravenshear@imeche.org

ICATS
Kevin Harold Email:kevin@paintel.co.uk

Institute Events
DIARY DATES 2023

BRANCH CONTACT DIRECTORY

ABERDEEN:
Adesiji Anjorin (Chairman)
Email: ICorrABZ@gmail.com
Dr Nigel Owen (Secretary External)
Email: ICorrABZ@gmail.com

LONDON:
Polina Zabelina (Chair)
Email: icorrlondon@gmail.com

MIDLANDS BRANCH:
Bill Whittaker
Email: midlandschair@icorr.org

NORTH EAST:
Matt Fletcher (Chair)
Email: nechair@icorr.org

NORTH WEST:
Greg Brown (Chair)
Email: greg.brown@mottmac.com

YORKSHIRE:
Richard Green
Email: richard@protectivetreatments.com

CSD DIVISION:
Julian Wharton
Email: J.A.Wharton@soton.ac.uk

CED DIVISION:
Danny Burkle
Email: d.burkle@lbbcbaskerville.co.uk

YICORR:
James McGladdery
Email: james.mcGladdery@uknnl.com

BRANCH DATES

11th October 2023: North-West Branch
Online event on Reinforced Autoclaved Aerated Concrete (RAAC). Chris Atkins will provide an introduction to the material, what the problems are and the interesting approach to corrosion protection included. Chris is a Fellow of the Institute of Corrosion and a member of the Institution of Structural Engineers' RAAC study group, and a member of the Construction Leadership Council's RAAC group.

12th October 2023: London Branch
Increasing the use of sensor technology to monitor coating performance.

31st October 2023: Aberdeen Branch
Routine monitoring to combat microbiological issues in oilfield process systems – understand the option for better visibility by Dr. Heike Hoffmann, Consultant Microbiologist, Intertek Aberdeen.

1st November 2023: Midland Branch
ICorr Annual General Meeting and Conference at Thinktank, Birmingham.

9th November 2023: London Branch
Presentation on "the application of CO_2 corrosivity, and humidity, modelling to gas pipeline internal corrosion management" by Steve Hodges of Intertek.

28th November 2023: Aberdeen Branch
Electro-Chemical Noise as a means of monitoring / assessing organic coatings, along with the advances made to date.

30th November 2023: North East Branch
Social event - Guided Tour of Newcastle – beer and sandwiches (sponsored).

7th December 2023: London Branch
34th Christmas luncheon. Venue: R.O.S.L. Park Place, St James's Street SW1A 1LR

ADDITIONAL DIARY DATES

23rd - 27th October 2023
HQ Event Northampton – MIC Extended Course.

13th-17th November 2023
Fundamentals of Corrosion for Engineers Course (FOCE), Corrosion House, Northampton.
More information regarding this course can be found using following link:
https:/ /ww w.icorr.org/fundamentals -of-corrosion- for- engineers/

7th December 2023: HQ Event Northampton – CP L4 Examination

For more information about CP courses and certifications please visit: www.icorr.org, Training then 'Cathodic Protection, Training, Assessment and Certification Scheme

6-7th November 2023: Buried Level 1

13-16th November 2023: Buried Level 2

Schedule of IMechE Courses

6th November 2023
Protective Coating Inspector Level 1- Sheffield

13th November 2023
Protective Coating Inspector Level 2 - Sheffield

11th December 2023
Protective Coating Inspector Level 1 - Sheffield

11th December 2023
Insulation Inspector Level 2 - Fife

14th December 2023
PFP Inspector (Epoxy) Level 2 - Fife

Schedule of Corrodere courses for 2023

24th-25th October 2023
ICorr Coating Inspector – Level 3, Mandatory Workshop and Assessment - Online

7th-8th November 2023
ICorr Coating Inspector – Level 1 & 2, Practical Workshop and Assessment - Online

28th-29th November 2023
ICorr Coating Inspector – Level 3, Mandatory Workshop and Assessment - Online

12th-13th December 2023
ICorr Coating Inspector – Level 1 & 2, Practical Workshop and Assessment - Online