A journal of the Institute of Corrosion

Corrosion Management

Issue 191 May/June 2026

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Cover image courtesy of Hans Sonke Materials & Corrosion Engineer (TA 2), Global SME: Materials & Corrosion in CCUS / Corrosion Prediction
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The President Writes

Photo: Dr Yunnan Gao.

Dear Members,

Since my last column, I have had the privilege of attending several flagship ICorr events and engaging with colleagues, members, and partners across both the UK and the international corrosion community. These activities continue to demonstrate the growing influence of the Institute of Corrosion and the important role our members play in advancing corrosion science, engineering, and asset integrity worldwide.

A major highlight during this period was the successful delivery of the 2nd China-UK Corrosion Summit, held in Beijing on 12-13 April 2026 and hosted by the University of Science and Technology Beijing (USTB). Jointly organised by ICorr and the Chinese Society for Corrosion and Protection (CSCP), the summit brought together leading corrosion experts, researchers, and industrial representatives from both countries. The event provided an outstanding platform for technical exchange and international collaboration, with presentations covering a wide range of topics in corrosion science, materials engineering, and industrial asset integrity. The summit further strengthened the growing partnership between ICorr and CSCP and reinforced our shared commitment to global collaboration in tackling corrosion challenges. Closely linked to this international collaboration was the joint statement issued by ICorr, the European Federation of Corrosion (EFC), and CSCP to mark World Corrosion Awareness Day 2026. The statement highlighted the importance of corrosion management in protecting infrastructure, supporting sustainability, and safeguarding public safety across industries worldwide. It also reinforced the need for continued investment in professional competence, research, and international cooperation to address future engineering challenges.

On 24th April, I attended the ICorr flagship event commemorating World Corrosion Awareness Day - the NetCorr Conference: Corrosion Challenges in CCUS Applications, organised by the ICorr Corrosion Engineering Division (CED) in partnership with the Royal Academy of Engineering (RAEng) at the University of Leeds. This important one-day conference focused on the rapidly developing area of carbon capture, utilisation, and storage (CCUS) infrastructure and the associated corrosion risks in dense-phase CO_2 systems. The event brought together experts from industry, academia, research organisations, and regulatory bodies to discuss operational challenges, corrosion testing methodologies, impurity effects, and future integrity management strategies for CCUS networks. The laboratory tours and technical discussions clearly demonstrated the increasing importance of corrosion engineering in supporting the transition towards net-zero energy systems. Earlier that same week, I also attended the Cambridge Corrosion Conference 2026, jointly organised by the ICorr Midlands Branch and the European Federation of Corrosion Working Party 15. The conference theme, Digitalisation, AI, and Monitoring in Corrosion, reflected the growing impact of digital technologies on corrosion and integrity management. The hybrid event successfully brought together researchers and industry practitioners to discuss digital monitoring systems, artificial intelligence applications, corrosion in energy industries, and initiatives supporting Women in Corrosion. The conference highlighted how innovation and emerging technologies are reshaping the future of corrosion management.

On 1st May 2026, I visited the University of Manchester to meet ICorr scholarship students and learn more about the impact of the institute's support for emerging engineering talent. It was highly encouraging to hear directly from students about how the scholarship programme has supported their academic development and career aspirations. Supporting future engineers and corrosion professionals remains one of ICorr's key priorities. I also recently attended the Professional Engineering Committee (PEC) meeting and National Engineering Policy Centre (NEPC) plenary at the Royal Academy of Engineering in London. These discussions with leaders from other Professional Engineering Institutions reinforced the importance of collaboration across the engineering profession, particularly in addressing challenges such as engineering skills, sustainability, infrastructure resilience, and the transition to net zero. Corrosion management and asset integrity remain directly relevant to these national priorities, and ICorr continues to play an active role in supporting professional competence, knowledge sharing, and engineering best practice.

On 21st May 2026, I delivered an online ICorr President's Talk, introducing engineers, students, and corrosion professionals to the institute and the value ICorr brings to the global engineering community. The webinar highlighted ICorr's support for professional development, technical excellence, chartership pathways, and international collaboration opportunities available to members at all career stages. I am also pleased to report that the 2026 Young Engineering Programme continues to progress very successfully, with the recent case study event held in Manchester on 28th May attracting strong engagement from participants and industry supporters alike.

Finally, I would like to acknowledge the excellent work of our regional branches. Over recent months, five of our eight UK branches have successfully held their AGMs and elected new chairs for the forthcoming session. I warmly welcome the new chairs to the ICorr leadership team and thank the departing chairs sincerely for their dedication, contributions, and impact on the institute. I look forward to working closely with all branch committees as we continue building ICorr from strength to strength and delivering value to the global corrosion community.

As always, I welcome you to share your thoughts, insights, and aspirations for the institute by reaching out to me at **president@icorr.org** Thank you for your continued support, and I look forward to seeing many of you at our future gatherings.

With best regards, **Dr Yunnan Gao, President, Institute of Corrosion, president@icorr.org**

From the Editor

Dear Members,

Welcome to the May–June 2026 issue of *Corrosion Management Journal*, where our focus is on corrosion challenges in hydrogen and carbon capture systems. As industries move towards Net-Zero targets and low-carbon technologies, hydrogen energy and carbon capture and storage (CCS) systems are expanding rapidly. These emerging technologies present new materials and integrity challenges that require careful understanding and effective corrosion management.

In this issue, we present a range of technical contributions that explore corrosion risks, inspection methods, and protection strategies associated with hydrogen infrastructure, CCS operations, and industrial storage systems.

We begin with an important article by Johannes Sonke of Shell, *"Corrosion Challenges for Carbon Capture and Storage – Acid Formation and Precipitation Requires Control of CO_2 Composition"*. The article explains how impurities and reactive species within captured CO_2 streams can lead to acid formation and severe corrosion during transport and storage. It highlights the importance of understanding and controlling CO_2 composition, establishing Integrity Operating Windows (IOWs), and maintaining strict process monitoring to avoid corrosive conditions. The author also discusses the possible use of corrosion resistant alloys in high-risk areas and emphasises the need for continued research into these complex corrosion mechanisms.

Hydrogen-related degradation is addressed in the article *"Rapid Hydrogen Content Screening in Structural Metals and for Engineering Applications"* by our ICorr members Tom Hillman and Professor Dirk Engelberg of The University of Manchester. As hydrogen infrastructure continues to grow, hydrogen embrittlement remains a major concern for structural steels and engineering components. The article introduces laser-induced breakdown spectroscopy (LIBS) as a promising localised and quasi-non-destructive technique for hydrogen detection in metals. The study demonstrates how handheld LIBS devices may support future structural maintenance and fitness-for-service assessments through rapid hydrogen measurement.

In another valuable contribution, our ICorr member Kamal Mohamed El Sayed Moussa, of ZAHR (SABIC), Kingdom of Saudi Arabia, discusses *"Pipelines and Cables Direct Current (DC) Mapping for the Assessment of Cathodic Protection Systems of Above Ground Storage Tank Bottom Plates"*. The article examines soil-side corrosion beneath above-ground storage tanks and explains how asphalt foundations contributed both to corrosive conditions and shielding of cathodic protection current. The study highlights the importance of correct CP system design, current drain testing, electrical isolation, and appropriate backfilling materials to achieve effective protection and prevent severe bottom plate deterioration.

This issue also features a contribution in our Fellow's Corner by George Sergi, FICorr, Technical Director at Vector Corrosion Technologies Ltd., entitled *"CP in Concrete – An Explanation of the Exponential Ageing Model"*. The article discusses the long-term performance of galvanic anodes used for cathodic protection in reinforced concrete structures. Drawing on field and laboratory evidence, the author explains how exponential ageing behaviour can be used to predict service life and support the design of reliable long-term cathodic protection systems.

I hope you find this issue informative and valuable. As always, I welcome your feedback and future contributions. Please feel free to contact me regarding any queries or article proposals at **editor@icorr.org**

Dr Shagufta Khan, FICorr
Consulting Editor, *Corrosion Management Journal*

Obituary: Charles Watkinson (1946 – 2026), Founder and Chief Executive, Corrocoat Ltd

The corrosion community has lost one of its true entrepreneurs with the passing of Charles Watkinson—a man whose determination, technical ingenuity, and vision built globally respected businesses from modest beginnings.

Corrocoat's story, inseparable from Charles himself, began in 1974 with a decision that would define his life. Faced with an ultimatum to relocate permanently to London or lose his job, he chose instead to resign and return to Yorkshire, determined to establish his own company despite the risks of a mortgage, a young family, and a recession in which he was told he was "mad" to be starting a business. Undeterred, within days, he had named the company, secured premises at Hunslet Mills in Leeds, and set about finding work.

Those early months were, in his own words, "fraught." Work refurbishing pumps for BP Shipping sustained the fledgling company, while operating from a leaking-roof workshop meant problems were solved as they arose—sometimes "running around with buckets to catch the rain." It was an environment that demanded resilience and ingenuity—qualities that would come to define both Charles and the company he created.

Following early changes in partnership, Corrocoat Ltd was formally established in 1975, beginning what Charles later described as a "long and winding, sometimes tortuous, sometimes stressful, sometimes hilarious road." Growth required new premises, new people, and new ideas. A pivotal moment came when Cunard insisted that Corrocoat support operations in the Netherlands—prompting the company's first step overseas. From that single requirement grew an international network spanning Singapore, South Africa, and ultimately more than 30 countries.

Alongside Corrocoat's development, Charles's technical creativity led to the founding of Glassflake Ltd in the 1980s. He pioneered the 'spinning cup method' for producing Glassflake — an innovation that proved highly significant in advancing materials used in corrosion protection systems. From a small pilot plant, he spent more than four decades building Glassflake into an international organisation with multiple production lines worldwide.

Central to both businesses was a commitment to research and development. Charles championed continuous investment in improving coating performance, refining engineering techniques, and advancing glass-flake technology. This ensured that Corrocoat and Glassflake remained at the forefront of corrosion protection, combining practical field experience with ongoing innovation.

Photo: Charles Watkinson CEO.

Under his leadership, Corrocoat became synonymous with high-performance, practical corrosion engineering solutions delivered on a global scale. Yet despite employing more than 1,000 people worldwide, the company retained the spirit of its origins: hands-on, adaptable, and grounded in real engineering challenges.

Charles never lost sight of the people behind that success. Reflecting on the company's 50-year journey, he expressed deep gratitude to employees—many of whom had been with Corrocoat since its earliest days—as well as to customers whose trust enabled its growth. That sense of loyalty and shared achievement was central to his leadership. His passing marks the loss of a founder who not only built companies but helped shape the international corrosion protection landscape through determination, innovation, and an unwavering commitment to doing things his own way.

Charles would have wanted the business to continue as normal, and his leadership team and colleagues remain committed to honouring that wish. His legacy lives on in the company he built, the people he inspired, and the industry he helped shape.

He will be remembered with respect and gratitude by colleagues, partners, and friends across the global corrosion community.

ICorr Awards – Call for Nominations (May 2026)

Each year the Institute of Corrosion bestows a range of internationally renowned awards in recognition of excellence in corrosion science and engineering and to acknowledge 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. Below is a brief description of two forthcoming awards, together with details of how to nominate potential candidates.

U R Evans Award 2027

The U R Evans Award is the premier scientific award of the Institute of Corrosion. It is presented annually in recognition of 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 Corrosion Science Symposium (CSS). The CSS actively encourages the participation of early-career researchers (PhDs and postdocs) of the corrosion community, who particularly value the opportunity to engage with, and hear from, a corrosion scientist of international repute. The form of the award symbolises the ongoing fight against corrosion in which the community is engaged. The recipient is also granted honorary life fellowship of the institute. Nominations may be submitted at any time by email to the ICorr CSD Chair, Julian Wharton, at **CSDchair@icorr.org**

Galloway Award 2026

The Galloway Award is presented to a student author for the best publication describing original research in corrosion science and engineering, as judged by a sub-committee of the CSD. The student should be the primary author of the work and normally the first author.

A summary of the winning paper is published in Corrosion Management, and the prize consists of a certificate and a cash award of £300. The Institute does not retain copyright of the material, and this does not prevent separate publication of the work in a scientific journal. Submissions (in the form of a paper published within the past 12 months or a draft publication) may be sent via email at any time to the CSD Chair, Julian Wharton **CSDchair@icorr.org** **Supervisors are welcome to nominate students.**

For further details on the Institute awards, including lists of past recipients, please visit **https://www.icorr.org/icorr-awards/**

Digital Content Update

We are excited to announce that a new Digital Content Officer (DCO) - Ilona Kusuma is joining our team.

For all digital media enquiries, please get in touch through: **media@icorr.org**

Do reach out to say hello and stay tuned, as we will be updating the way we deliver our digital content across social media, newsletters and website.

For Bi-Monthly Corrosion Management Journal (CMJ) content, please contact: **editor@icorr.org**

Industrial Coatings Inspectors (Global) Ltd- New Sustaining Member

Industrial Coatings Inspectors (Global) Ltd is a specialist inspection and corrosion management company providing technically robust solutions for the assessment, protection, and life extension of industrial and infrastructure assets.

Our services are centred on delivering high-integrity supervision, survey, monitoring and inspection data to support risk-based maintenance and asset management strategies.

We operate across multiple sectors including rail, infrastructure, commercial property, and industrial facilities, with particular expertise in protective coatings and passive fire protection systems. Our work frequently involves the inspection and assessment of structural steelwork, where coating performance is critical to both durability and fire resistance.

Our core service offering includes

• Protective Coating Inspection and Surveys

In accordance with ISO 12944, ISO 19840, and ISO 2808, we undertake detailed coating condition assessments, dry film thickness (DFT) measurements, and defect analysis aligned with ISO 4628 standards.

• Adhesion Testing and Failure Analysis

We carry out pull-off adhesion testing in line with ISO 4624, providing quantitative data on coating performance. Our inspections also include failure mode identification (adhesive/cohesive) and root cause analysis linked to surface preparation (ISO 8501/8502/8503) and application practices.

• Intumescent Coating Surveys (Passive Fire Protection)

We specialise in the inspection of intumescent coatings to structural steel, referencing ASFP guidance, BS 8202-2, and relevant fire test standards (BS EN 13381). Our surveys verify applied thicknesses against section factors, assess condition, and evaluate system integrity in line with fire design requirements.

• Corrosion Assessment and Asset Integrity Reporting

We provide structured inspection reports incorporating photographic evidence, measured data, and engineering-based recommendations. Our outputs are designed to support lifecycle planning, remediation prioritisation, and compliance with client and regulatory requirements.

• Site-Based Inspection and QA/QC Support

Supporting both new-build and maintenance projects, we deliver on-site inspection services to ensure coatings are applied and maintained in accordance with specifications and industry best practice.

At Industrial Coatings Inspectors (Global) Ltd, we place strong emphasis on technical compliance, traceability, and consistency in reporting. Our inspectors combine practical site experience with a detailed understanding of coating systems, inspection methodologies, and applicable standards. This enables us to provide clients with clear, defensible data to support critical decision-making.

We work closely with asset owners, contractors, and consultants to ensure that corrosion risks are effectively managed, and that protective systems—whether for durability or fire protection—perform as intended throughout the asset lifecycle.

As members of the wider corrosion management community, we are committed to continuous professional development and contributing to the advancement of industry standards and best practices.

ICorr ETGB is Delighted to Welcome Dr Roger Francis to Our Team

Roger brings an exceptional depth of expertise, with 50 years of corrosion engineering experience across marine environments, desalination, oil and gas, chemical and process industries, power generation, and mineral processing. His work with corrosion resistant alloys and complex materials challenges is recognised globally.

He is the author of **seven influential books** and **over 100 technical papers**, and his contributions to the profession have been honoured with the **AMPP T.J. Hull Award** and the **ICorr Paul McIntyre Award** for excellence in education and standards.

Roger's extensive knowledge, publications, and long-standing commitment to advancing corrosion engineering will significantly strengthen ICorr Engineering Training Governing Board (ETGB) technical leadership and enrich our training portfolio. We are proud to have him join us and look forward to the impact he will make. His immediate involvement is expected to result in the development of the Galvanic Corrosion Awareness training course with piloting in H2, 2026. More comprehensive, technically detailed, and scientifically rigorous versions of the courses geared towards specific industries, such as oil and gas, and aggressive chemicals such as acids, can be provided on request.

For more info on the activities of the ICorr Engineering Training Governing Board (ETGB) please contact the chairman on: **ETGBchair@icorr.org**

Correx Ltd. Updates

Raising Standards in Industrial Coatings: The Continuing Evolution of ICATS

As the new managing director of Correx Ltd, I am proud to support the ongoing development of the Industrial Coating Applicator Training Scheme (ICATS), a scheme that continues to set the benchmark for excellence within our industry.

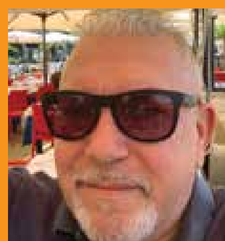
For many years, ICATS has been recognised as the *"Rolls-Royce"* of industrial coating applicator certification. That reputation is not given lightly—it has been earned through a relentless focus on quality, robust assessment, and a commitment to ensuring that individuals working in our sector meet the highest possible standards.

Raising the Bar with Recertification

As our industry evolves, so too must the standards we uphold. That is why, from **1st May 2026**, all individuals who successfully complete the ICATS Industrial Coating Applicator course will be required to recertify every five years. This is a significant step forward. It ensures that those holding ICATS certification are not only competent at the point of qualification but remain current with industry practices, technologies, and expectations throughout their careers. In my view, this is essential for maintaining confidence across clients, asset owners, and the wider supply chain.

A Fresh Approach Online

We are also investing in how we communicate and engage with the industry. The ICATS website is currently being refreshed to provide a more modern, accessible, and user-focused experience. This update will make it easier for individuals and organisations alike to navigate training pathways, understand certification requirements, and recognise the value that ICATS brings. It reflects our broader commitment to continuous improvement—not just in training delivery, but in how we support the whole industry.



New CORREX Managing Director – Paul Brooks.

Looking Forward

The development of ICATS is very much ongoing. Over the coming months, we will be introducing new courses designed to meet emerging industry needs and broaden the scope of the scheme. These additions will ensure that ICATS remains relevant, responsive, and aligned with the challenges faced across corrosion protection and industrial coatings.

A Personal Perspective

Having spent many years in the corrosion industry, I have seen first-hand the consequences of poor workmanship and the value of getting it right. High-quality training and certification are not optional—they are fundamental to protecting assets, ensuring safety, and delivering long-term value. ICATS represents exactly that standard. It is a scheme the industry can trust, and one that we at Correx Ltd, in partnership with the Institute of Corrosion, are committed to strengthening for years to come.

Paul Brooks, Managing Director, Correx Ltd
PBrooksMD@correx.org

2nd China-UK Corrosion Summit in Beijing, China on 12th-13th April 2026

The 2nd China-UK Corrosion Summit was successfully held on 12th–13th April 2026 in Beijing, hosted by the University of Science and Technology Beijing (USTB). The summit was jointly organised by the Institute of Corrosion (ICorr) and the Chinese Society for Corrosion and Protection (CSCP), with participation from the European Federation of Corrosion (EFC).

Following the success of the inaugural summit held in Manchester in September 2025, this second summit marked a significant advancement in strengthening collaboration between the UK and China corrosion communities. The event brought together leading experts from academia, industry, and research institutions, providing a high-level platform for technical exchange and future cooperation. The summit theme, "Advancing AI-Driven Corrosion Protection for Infrastructure", reflected the growing importance of digitalisation and artificial intelligence in corrosion engineering. As highlighted in the CSCP report (https://www.cscp.org.cn/site/content/3208.html in Chinese), the event demonstrated both the depth of technical expertise and the strong commitment to international collaboration.

Photo 1: 2nd China-UK Corrosion Summit Delegates Photo.

Opening Ceremony

The summit opened with welcome speeches from senior representatives of the organising bodies.

Photo 2: ICorr President, Dr Yunnan Gao, Giving an Opening Speech.

Dr Yunnan Gao, President of ICorr, highlighted the progress made over the past two years in building a strong and sustained partnership between ICorr and CSCP, and emphasised the importance of continued international collaboration.

Professor Xiaogang Li, President of CSCP, welcomed delegates and underlined the importance of global cooperation in addressing corrosion challenges affecting infrastructure, energy, and materials performance.

Photo 3: CSCP President, Professor Xiaogang Li, Giving an Opening Speech.

Professor Gareth Hinds, President of EFC, spoke on the value of international partnerships and the role of trilateral collaboration in advancing corrosion science and engineering.

Photo 4: EFC President, Professor Gareth Hinds, Giving an Opening Speech.

Technical Programme

The summit featured a comprehensive technical programme comprising 13 presentations, including 7 speakers from the UK and 6 from China. The presentations covered a wide range of topics aligned with the summit theme, with a strong emphasis on the integration of artificial intelligence, data science, and advanced engineering approaches in corrosion management.

Dr Yunnan Gao started the technical programme by delivering a presentation introducing ICorr, outlining its role in professional development, certification, and international engagement.

Photo 5: 2nd China-UK Corrosion Summit All Speakers.

UK Presentations

- Professor Gareth Hinds (National Physical Laboratory) Presented on corrosion challenges in electrochemical energy conversion and storage systems, highlighting degradation mechanisms in emerging

continues on page 10

technologies such as fuel cells and batteries. The work emphasised the importance of materials durability in enabling the transition to low-carbon energy systems.

- Professor Xiaorong Zhou (The University of Manchester) Introduced a novel large language model approach for interpreting electrochemical impedance spectroscopy data from organic coatings. The study demonstrated how AI tools can enhance data interpretation and improve coating performance evaluation.

- Dr Henry Tan (University of Aberdeen) discussed uncertainty-informed digital twins for corrosion and integrity management. His work showed how integrating probabilistic modelling improves decision-making in safety-critical infrastructure.

- Professor Dirk Engelberg (The University of Manchester) Presented advances in high-throughput corrosion testing, referred to as "Corrosion Screening 4.0". The approach enables rapid material evaluation and supports accelerated innovation in corrosion-resistant materials.

- Stephen Tate (Institute of Corrosion) Outlined the application of AI-assisted corrosion management in the UK gas transmission and distribution networks. The presentation demonstrated how digital tools are being implemented to enhance asset integrity and operational efficiency.

- Yanyi Lee (Inductosense) explored corrosion monitoring technologies combined with machine learning techniques. The work highlighted real-time monitoring solutions and their role in predictive maintenance strategies.

- Michael Nixon (Nixon Cathodic Protection Services Ltd) presented on impressed current cathodic protection systems for historic structures. The talk emphasised practical challenges and solutions in preserving heritage assets while maintaining structural integrity.

China Presentations

- Professor Chaofang Dong (University of Science and Technology Beijing) presented a data-driven approach to the design and optimisation of coatings for titanium bipolar plates in PEM water electrolysers. The work demonstrated how computational methods can accelerate materials development.

- Professor Junhua Dong (Institute of Metal Research) discussed first-principles studies on cathodic reduction mechanisms in atmospheric corrosion rust layers. The research provided fundamental insights into corrosion processes at the atomic level.

- Professor Likun Xu (Luoyang Ship Materials Research Institute) Explored interface damage mechanisms and performance improvement of titanium-based MMO anodes. The study focused on enhancing durability and performance in demanding environments.

- Professor Li Liu (Northeastern University) presented research on deep-sea metal corrosion and protection technologies. The work addressed challenges associated with extreme marine environments and long-term material performance.

- Professor Anqing Fu (CNPC Tubular Goods Research Institute) discussed corrosion issues in CCUS-EOR CO_2 injection and production tubing. The presentation highlighted mitigation strategies critical for supporting carbon capture and storage technologies.

- Dr Zhong Li (University of Science and Technology Beijing) investigated microbiologically induced stress corrosion cracking of X80 steel under biofilm conditions. The research provided insights into the role of microbial activity in pipeline degradation.

Overall, the presentations demonstrated a shared commitment to advancing corrosion science through innovation, with particular focus on AI-enabled monitoring, predictive modelling, materials performance, and infrastructure integrity.

Recognition and Engagement

During the summit, Professor Xiaogang Li was recognised as the World Corrosion Organisation (WCO) Corrosion Awareness Award 2025 winner, acknowledging his outstanding global contributions.

Photo 6: WCO Winner of the Corrosion Awareness 2025, Professor Xiaogang Li (Left).

A joint leaders' photograph was taken featuring representatives from ICorr, CSCP, and EFC.

Photo 7: ICorr-CSCP-EFC Leaders. L-R: CSCP General Secretary - Professor Xuequn Cheng, ICorr President - Dr Yunnan Gao, CSCP President - Professor Xiaogang Li, EFC President - Professor Gareth Hinds.

Laboratory Visits and Technical Exchange

On the second day, UK delegates visited research and teaching facilities at USTB, providing valuable insight into ongoing work in corrosion science and materials engineering.

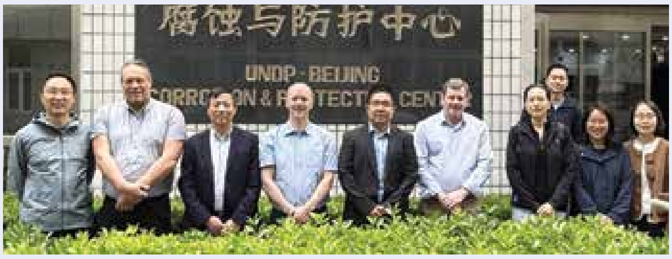


Photo 8: Visit of the Corrosion Centre of the USTB by Some UK Delegates.

These visits enabled deeper technical exchange and strengthened institutional links.

Conclusion and Future Outlook

The 2nd China-UK Corrosion Summit successfully reinforced the growing partnership between ICorr and CSCP. The event demonstrated the importance of international collaboration in advancing corrosion science, particularly in the integration of AI and digital technologies.Looking ahead, the next UK-China Corrosion Summit will be held in the UK in 2027, continuing this important bilateral initiative.

ICorr looks forward to further strengthening collaboration and engagement with the global corrosion community.

President's Report - RAEng and PEC Engagement

The President of the Institute of Corrosion, ICorr, recently attended the Professional Engineering Committee (PEC) meeting and National Engineering Policy Centre (NEPC) plenary at the Royal Academy of Engineering, held at Prince Philip House in London on 30th April 2026.

This joint event brought together professional engineering institutions (PEIs), policymakers, and industry representatives, providing a useful forum to reflect on the role of the profession and its contribution to national priorities.

The morning PEC session focused on how institutions can work more effectively together. Feedback from the recent PEC survey highlighted the continued importance of sharing best practices, improving coordination across the engineering landscape, and maintaining a strong collective voice for the profession.

There was clear recognition that PEC provides significant value through open exchange between institutions, enabling benchmarking, alignment of positions, and mutual learning. At the same time, a number of common challenges were identified, including the engineering skills gap, the need to reinforce the value of professional registration, and the importance of maintaining relevance in an increasingly digital and rapidly changing environment.

The afternoon NEPC plenary shifted the focus to engineering's role in informing UK policy. A discussion with the Minister for industry emphasised the contribution that engineering institutions can make to key national priorities, particularly in areas such as clean energy and industrial strategy.

More broadly, discussions aligned with the established NEPC policy framework, including the need for a long-term industrial strategy, progress towards net zero, strengthened engineering skills provision, and the resilience of national infrastructure.

These themes are directly relevant to ICorr. Corrosion management and asset integrity are fundamental to infrastructure resilience and the safe, efficient operation of assets across all sectors. The discussions also reinforce the importance of professional competence, training, and knowledge sharing – areas where ICorr continues to play an active role.

Photo 1: Professional Engineering Committee (PEC) Meeting at the Royal Academy of Engineering in London on 30th April 2026.

Photo 2: National Engineering Policy Centre (NEPC) Plenary at the Royal Academy of Engineering in London on 30th April 2026.

Overall, the event highlighted the importance of stronger collaboration across institutions, greater engagement with policy development, and a continued focus on skills and sustainability. ICorr remains well positioned to contribute to these priorities while supporting the wider engineering profession.

ICorr Corrosion Engineering Division Conference 2026

Summary Report: Corrosion Challenges in CCUS Applications

Date: 24th April 2026 (Corrosion Awareness Day)
Venue: Sir William Henry Bragg Building, University of Leeds
Theme: NetCorr – Corrosion Challenges in CCUS Applications

Introduction

The ICorr Corrosion Engineering Division (CED) Conference 2026, titled NetCorr – Corrosion Challenges in CCUS Applications, was held at the Sir William Henry Bragg Building at the University of Leeds on Corrosion Awareness Day 2026. The event brought together professionals from industry, academia, regulatory bodies, and research organisations to discuss one of the most pressing technical challenges associated with the energy transition: corrosion management within Carbon Capture, Utilisation and Storage (CCUS) infrastructure.

The conference focused on the integrity, reliability, and long-term operational challenges associated with dense-phase CO_2 systems, impurity management, corrosion testing methodologies, materials selection, and the practical realities of deploying CCUS at industrial scale.

The event was organised by the Institute of Corrosion (ICorr) Corrosion Engineering Division in partnership with the Royal Academy of Engineering and the University of Leeds.

Photo 1: Delegates at NetCorr – Corrosion Challenges in CCUS Applications.

Conference Overview

The conference attracted 54 registered professionals from across the corrosion, energy, integrity management, and materials engineering sectors. The programme included:

- 7 technical presentations
- 1 industry panel discussion
- 3 laboratory and facility tours
- Representatives from industry, academia, research institutions, and regulatory bodies
- Attendance from ICorr leadership, including the ICorr President, Vice President, and Past President

The event theme, *"Corrosion Challenges in CCUS Applications"*, highlighted the critical role corrosion science and engineering will play in enabling safe and sustainable Net Zero infrastructure.

Photo 2: Danny Burkle (ICorr CED Chair, Cortest)Introducing This Year's Theme.

Sponsors and Supporters

The conference was supported by the following organisations:

- Cortest
- Intertek CAPCIS
- Industrial Coatings Inspectors Global Ltd
- Corrocoat
- OGC Energy
- University of Leeds

Additional support and partnership were provided by:

- Institute of Corrosion (ICorr)
- Royal Academy of Engineering

The conference organisers acknowledged the importance of sponsor support in enabling technical collaboration, knowledge sharing, and professional networking within the corrosion engineering community.

Photo 3: ICorr CED Conference 2026 Sponsors.

Opening Remarks

The conference opened with a welcome from Danny Burkle (ICorr CED Chair, Cortest), followed by remarks from ICorr President Yunnan Gao.

Danny framed the day's theme by emphasising that CCUS corrosion is not simply a materials problem - it is a chemistry, flow, and systems problem. He highlighted real-world failures including the 2020 Denbury Gulf Coast pipeline rupture and delays to the Gorgon CCS project caused by corrosion risk.

A key message throughout the opening session was that corrosion engineering is central to the successful deployment of CCUS, hydrogen, offshore renewables, and geothermal technologies. The audience was reminded that while corrosion failures within CCUS infrastructure may currently appear infrequent, the consequences can be significant, including pipeline failures, loss of containment incidents, and project delays.

Speakers emphasised that corrosion is not simply a materials challenge, but also a societal and infrastructure challenge linked directly to safety, environmental protection, and the wider energy transition.

The conference also recognised Corrosion Awareness Day 2026, reinforcing the importance of raising awareness of corrosion prevention and the value corrosion professionals bring to society and industry.

Photo 4: A welcome from our ICorr President, Yunnan Gao.

Technical Programme Summary

Photo 5: ICorr CED Conference 2026 Speakers.

CCUS – The Big Picture Problem

Danny Burkle (Cortest) opened the technical programme with an overview of the wider corrosion challenges associated with CCUS deployment. The presentation explored the scale of infrastructure required for Net Zero ambitions and highlighted the operational risks associated with transporting and storing dense phase CO_2.

Real-world examples of failures, pipeline ruptures, and containment incidents were discussed to demonstrate that corrosion risk in CCUS systems is already becoming an operational reality. The presentation also emphasised the importance of understanding when and where corrosion mechanisms become critical, rather than simply whether corrosion can occur.

Key challenges identified:

- **Impurity chemistry:** Parts-per-million levels of SOx, NOx, O_2, and H_2S can form strong acids.
- **Phase behaviour:** Stratified flow creates localised attack at low points.
- **Non-linear corrosion:** Small condition changes can trigger large jumps in corrosion rates.
- **Testing gaps:** No standardised methodology; results vary by an order of magnitude between labs.

Managing Corrosion Risk in CCS Infrastructure

Chris Scales (HSE Energy Division) discussed the importance of integrity management, regulation, and risk assessment within future CCS infrastructure.

The presentation highlighted the challenges associated with scaling up CCUS infrastructure while maintaining safe operation and regulatory compliance. The role of industry standards, inspection methodologies, and operational monitoring was discussed alongside the need for practical approaches to corrosion management within emerging CCS projects.

Chris outlined the new regulatory framework under the Carbon Capture, Utilisation, Storage and Offshore Hydrogen Production Regulations 2026, effective 6 April 2026. CCS projects now require formal safety cases demonstrating risks are managed to levels "as low as reasonably practicable" (ALARP).

He emphasised:

- CO_2 is heavier than air - releases offshore will slump rather than disperse.
- Joule-Thomson cooling during depressurisation creates structural risks.
- Corrosion management is a critical element in safety case acceptance.
- Operators must engage early with regulators during design phases.

Are Current CO_2 Specifications Realistic?

Steve Paterson (Arbeadie Consultants) delivered a presentation focused on CO_2 specifications and impurity management within CCS projects.

A major topic of discussion throughout the conference was the balance between operational practicality, economic viability, and corrosion risk reduction. The presentation explored whether current impurity specifications are achievable for emitters and whether overly restrictive specifications could negatively impact project viability.

Discussions during both the presentation and panel session highlighted:

- The importance of understanding impurity interactions.
- No universal agreement exists on safe impurity limits.
- The challenge of controlling oxygen and acidic species.
- The need for alignment between emitters, transport operators, and storage operators.
- Lessons being learned from global CCS projects such as Northern Lights and ADM.
- Concerns around the gap between design assumptions and operational reality.
- Round-robin testing across laboratories is needed to validate results.

The audience discussion demonstrated strong industry interest in how specifications will evolve as projects move from design into long-term operation.

CO_2 Capture and Conditioning

George Winning (Wood PLC) explored impurity reactions, CO_2 conditioning, and the importance of understanding changing CO_2 streams from different emitters.

The presentation discussed:

- Different capture technologies (amine absorption, physical solvents, membranes, cryogenic) produce different impurity profiles.
- Pre-treatment and post-treatment add costs that must be balanced against specifications.
- Chemical treatments such as scavenging and inhibition show promise for upset conditions.
- Online monitoring at ppm levels presents practical challenges.
- Challenges associated with developing standardised specifications.

Reference was made to Joint Industry Projects (JIPs) focused on impurity specifications and corrosion risk management.

A recurring theme was that future CCS networks will require collaboration between emitters, transport operators, regulators, and researchers to ensure specifications remain technically achievable while maintaining infrastructure integrity.

Corrosion Testing Challenges in CCUS

Richard Barker (University of Leeds) from the University of Leeds discussed corrosion mechanisms and testing challenges associated with CO_2-rich environments.

The presentation focused on:

- Electrochemical behaviour in CO_2 systems.
- Localised corrosion risks.
- Scale formation and breakdown.

continues on page 14

- The complexity of reproducing realistic service environments within laboratory testing.
- The need for representative testing methodologies for CCS applications.

Richard described the challenges of laboratory testing in supercritical CO_2:

- Impurity depletion in closed systems produces misleading integrated measurements.
- Water splashing during pressurisation and condensation during depressurisation create artefacts.
- Absorption/desorption on infrastructure creates lag times.

The session reinforced the importance of high-quality experimental work in understanding corrosion mechanisms and supporting future material selection and design decisions. Leeds is developing continuous-injection infrastructure to support improvement in testing methodologies in this area.

Autoclave vs Full Ring Pipe Testing

Paul Wood (Intertek Capcis) compared autoclave testing with full ring pipe testing methodologies. Paul presented comparative testing, examining pipe-section versus autoclave tests for shut-in pipeline conditions. Autoclave tests produced corrosion rates ten times higher than pipe-section tests due to different solution volume-to-surface-area ratios. The waterline region showed the highest attack rates (0.96 mm/year), while submerged regions showed minimal corrosion.

The presentation explored the advantages and limitations of different testing approaches, particularly in relation to:

- Simulating realistic operating conditions.
- Reproducing flow and stress conditions.
- Scaling laboratory results to field performance.
- Understanding material performance under dense phase CO_2 conditions.

The discussion highlighted the importance of selecting appropriate test methodologies depending on the specific corrosion mechanism and operational scenario being assessed.

Standardised Test Methodology for Dense Phase CO_2

Shravan Kairy (NPL) from the National Physical Laboratory (NPL) presented work focused on standardised corrosion testing methodologies for dense phase CO_2 systems.

Shravan addressed the need for standardised test methodology. Literature data shows order-of-magnitude variation in reported corrosion rates for identical conditions, largely due to procedural differences. He emphasised the need for consistency and repeatability across corrosion testing programmes to improve data quality, comparability, and industry confidence.

NPL's validated methodology includes:

- Gradual pressurisation (40 minutes) with stirring for rapid impurity equilibration.
- System dilution before depressurisation to avoid water condensation artefacts.
- No corrosion detected when water remains below solubility limits.
- NPL aims to publish a Good Practice Guide by 2027 and draft international standards by 2029.

The session highlighted the growing importance of collaborative testing frameworks as CCS infrastructure expands globally.

Facility Tours

Following the morning technical sessions, attendees participated in laboratory and facility tours hosted by the University of Leeds.

The tours were split into four groups and included three parallel activities:

1. Bragg analytical facilities tour.
2. Virtual corrosion laboratory tour - Overview of corrosion research programmes.
3. Chemistry corrosion laboratory tour focused on CCUS research featuring the new continuous-injection reactor infrastructure under development.

The tours provided attendees with direct insight into ongoing corrosion and materials research activities being carried out within the university. Delegates were able to view analytical equipment, discuss experimental methodologies, and gain a better understanding of the practical research supporting future CCUS deployment.

The facility tours were particularly well received as they allowed attendees to connect the technical presentations with real-world experimental work and infrastructure.

The Bragg Centre highlighted access schemes through the Henry Royce Institute, including SME access and the Royce Industrial Collaboration Programme.

Panel Discussion Highlights

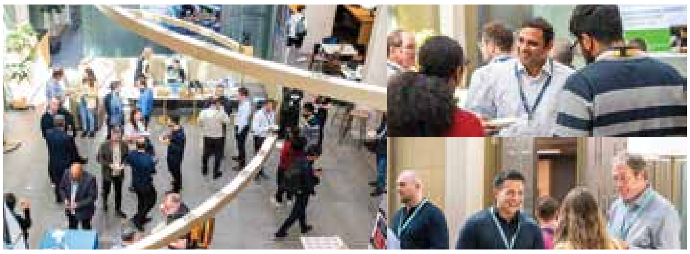
The conference concluded with an open panel discussion involving Steve Paterson, George Winning, and Richard Barker. The discussion encouraged audience participation and focused on several key themes:

- The realism and practicality of current CO_2 impurity specifications.
- The gap between design assumptions and operational performance.
- Monitoring and controlling impurities during operation.
- Lessons from existing global CCS projects.
- Material selection challenges.
- The balance between risk reduction and economic feasibility.
- The need for industry collaboration and knowledge sharing.

The panel format created valuable interaction between industry, academia, and delegates, with open discussion around both technical and commercial challenges facing the CCUS sector.

Networking and Exhibiting

Throughout the day, delegates had multiple opportunities to network with fellow corrosion professionals, researchers, equipment suppliers, and industry representatives during registration, refreshments, lunch, and between technical sessions.

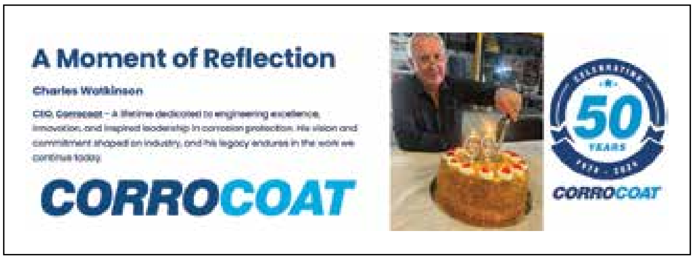


The conference environment encouraged open discussion and collaboration across industry, academia, and regulatory organisations. Sponsors and supporting organisations also showcased their capabilities and services, allowing attendees to discuss current projects, technical challenges, testing approaches, and future collaboration opportunities linked to CCUS and corrosion management.

Tribute and Reflection

During the conference, attendees also took part in a moment of reflection following the recent passing of Charles Watkinson, CEO of Corrocoat.

A tribute recognised his more than 50 years of contribution to corrosion engineering, coatings technology, and the wider corrosion industry. Colleagues reflected on his leadership, innovation, and commitment to advancing corrosion protection technologies globally. The tribute served as a reminder of the long-standing expertise and dedication within the corrosion engineering community.



Conclusion

The ICorr CED Conference 2026 successfully brought together leading experts from across the corrosion and CCUS sectors to discuss the technical, operational, and strategic challenges associated with corrosion management in dense phase CO_2 infrastructure.A consistent theme throughout the day was the importance of collaboration between industry, academia, regulators, and research organisations. Speakers highlighted that achieving safe and reliable CCUS deployment will require not only advances in materials and testing, but also practical alignment between specifications, operations, monitoring, and long-term integrity management.The event provided attendees with valuable technical insight, networking opportunities, and direct engagement with current research and industrial practice. Through both the technical presentations and facility tours, the conference reinforced the critical role corrosion science and engineering will play in supporting the global energy transition and future Net Zero infrastructure.

Key Takeaways

1. Specifications are not enough. Systems must be designed assuming off-spec conditions will occur.
2. Water location matters more than concentration. Acid formation occurs at phase boundaries, cold spots, and low points - not uniformly.
3. Testing standardisation is urgent. Without reproducible methods, material selection decisions cannot be made with confidence.
4. Regulation is now formal. UK CCS projects require accepted safety cases; corrosion management is central to these.
5. Collaboration is essential. No single organisation has all the answers; shared data and aligned methodologies are needed.

Key Conference Statistics

- **54 registered professionals**
- **7 technical talks**
- **6 sponsors and supporters**
- **3 facility tours**
- **1 open panel discussion**
- **Hosted at the University of Leeds on Corrosion Awareness Day 2026**

Acknowledgements

The event was organised by Dr Danny Burkle (CED Chair) CEDchair@icorr.org with support from Joshua Owen and the Bragg Centre team at the University of Leeds. Special thanks to Stephanie Foster for venue coordination and to all sponsors whose support made the event possible. **Next Major Event: EUROCORR Dublin 2026**, Convention Centre Dublin, 6–10 September 2026. See: Registration - Eurocorr 2026 to register advance interest. CED will also present at the ICorr National AGM to be held at the National Physical Laboratory (NPL) in London on Wednesday 18th November 2026, which will feature the Paul McIntyre award ceremony which recognises a senior corrosion engineer who has not only made significant technical contributions, but has also championed European collaboration and international standards – reflecting the values and legacy of the late Professor Paul McIntyre.

Report prepared by Danny Burkle. Photograph captured by Chijioke Godwins.

CED DIVISION: Danny Burkle (Chair), Email: cedchair@icorr.org

World Corrosion Awareness Day 2026 – Joint Statement from ICorr, EFC and CSCP

Every year on 24th April, the global corrosion community marks World Corrosion Awareness Day (WCAD), a vital initiative dedicated to raising awareness of corrosion as a major, yet preventable, global challenge. In 2026, the Institute of Corrosion (ICorr), the European Federation of Corrosion (EFC), and the Chinese Society for Corrosion and Protection (CSCP) are proud to stand together in a unified international effort to promote greater understanding, collaboration, and action.

A United Global Voice on Corrosion

Corrosion is often underestimated as a minor or cosmetic issue. In reality, it has far-reaching consequences—impacting public safety, infrastructure integrity, environmental sustainability, and economic resilience worldwide. Echoing the global call led by the Association for Materials Protection and Performance (AMPP), alongside the World Corrosion Organization (WCO) and the International Corrosion Council (ICC), this year's WCAD reinforces a clear message: Corrosion is preventable - and prevention is essential. Through proactive management, knowledge sharing, and the application of engineering best practices, corrosion risks can be significantly reduced—protecting critical infrastructure, extending asset life, and ensuring safety across industries.

Strengthening International Collaboration: China-UK Partnership

A key highlight of this year's activities is the strengthening of international collaboration between the UK, Europe, and China. During the 2nd China-UK Corrosion Summit in Beijing on 12th-13th April 2026, the presidents of ICorr, EFC, and CSCP formally signed a joint statement, reaffirming their shared commitment to the following:

continues on page 16

- Advancing corrosion science and engineering
- Promoting international cooperation
- Supporting knowledge exchange across borders
- Raising global awareness of corrosion prevention

This milestone reflects the growing importance of cross-regional collaboration in addressing corrosion challenges in an increasingly interconnected world. The announcement of this joint statement in Chinese made by CSCP is at **https://www.cscp.org.cn/site/content/3210.html**

Joint Statement for World Corrosion Awareness Day

Chinese Society for Corrosion and Protection
European Federation of Corrosion
Institute of Corrosion, UK

April 12 2026, Beijing, China

On the occasion of the 2nd China-UK Corrosion Summit on April 12, 2026, Chinese Society for Corrosion and Protection, European Federation of Corrosion, and Institute of Corrosion, UK fully recognized that: corrosion threatens global infrastructure safety, constrains efficient resource utilization, impacts the ecological environment, and hinders sustainable development, yet has not received due attention from all sectors of society. Therefore, "promoting policy, popularizing science, cultivating talent, advancing R&D, and emphasizing application" is of urgent necessity.

We unanimously agree that silent, imperceptible corrosion permeates all aspects of human production and daily life, with international studies showing annual economic losses accounting for 3% to 5% of national GDP, affecting energy consumption, carbon emissions, and life and property safety. Fortunately, corrosion is controllable—scientific protection can reduce such losses by 15% to 35%—so enhancing societal awareness and shifting corrosion protection from post-incident remediation to pre-incident prevention via full lifecycle management is the shared mission of our three organizations and global corrosion protection practitioners. Hereby, we jointly call upon: governments, industry organizations, research institutions, and the public to pay greater attention to corrosion issues by integrating corrosion protection into policy formulation, engineering standards, education systems, and public outreach; strengthening relevant disciplinary development and improving talent cultivation systems to enhance public awareness of corrosion protection; and improving industry standards and specifications, building international exchange and cooperation platforms across industries and disciplines, and accelerating technological innovation, academic sharing, and technology transfer. Through practical actions, we will inject strong momentum into the fight against corrosion and lay a solid "rust-proof" foundation for sustainable human development.

We look forward to working together with global colleagues to extend the service life of infrastructure and industrial assets, reduce resource waste and redundant construction, lower the environmental impact of corrosion, and contribute to the achievement of the UN 2030 Sustainable Development Goals.

This statement reflects the shared values and cooperative intentions of our three organizations in the field of corrosion and protection. We will take the 2nd China-UK Corrosion Summit as a new starting point to continue our hand-in-hand efforts with all sectors of society to pay attention to corrosion and safeguard the future.

This joint statement is written in Chinese and English, and both texts shall be equally authentic.

Chinese Society for Corrosion and Protection (CSCP)	European Federation of Corrosion (EFC)	Institute of Corrosion UK (ICorr)
Xiaogang Li	Gareth Hinds	Yunnan Gao
Xiaogang Li President of CSCP 2026.04.12	Gareth Hinds President of EFC 2026.04.12	Yunnan Gao President of ICorr 2026.04.12

Photo 1: Joint Statement for WCAD from ICorr, EFC and CSCP.

Photo 2: Leaders of ICorr, EFC and CSCP Commemorating WCAD. L-R: CSCP General Secretary - Prof Xuequn Cheng, ICorr President - Dr Yunnan Gao, CSCP President - Prof Xiaogang Li, EFC President - Prof Gareth Hinds.

Photo 3: Delegates of the 2nd China-UK Corrosion Summit Commemorating WCAD.

Global Engagement Across the Corrosion Community

This year's WCAD activities have been marked by strong international engagement. Just days ahead of WCAD, the Cambridge Corrosion Conference, jointly organised by ICorr and EFC Working Party 15, brought together leading experts from academia and industry to exchange knowledge and advance research in corrosion science. Meanwhile, ICorr continues its tradition of hosting its flagship WCAD technical event in the UK. In 2026, ICorr is partnering with the Royal Academy of Engineering (RAEng), marking an important step forward in strengthening collaboration across the engineering community. The CED Day with a theme of "NetCorr - Corrosion Challenges in CCUS Applications", was held at the University of Leeds on the 2026 WCAD. This event highlights the critical role of corrosion management in enabling emerging technologies such as carbon capture, utilisation, and storage (CCUS), which are essential to achieving global net-zero targets. See the detailed report on this event in the current issue of the journal.

Photo 4: ICorr-RAEng 2026 WCAD Event in Leeds Conference Flyer.

A Continuing Commitment

World Corrosion Awareness Day is not a single-day initiative – it is part of a sustained global effort. As a leading professional body, ICorr remains committed to the following:

- Advancing corrosion science, engineering, and best practices
- Supporting education, training, and professional development
- Engaging with industry, academia, and policymakers
- Working closely with international partners to raise awareness worldwide

Together with EFC, CSCP, and global organisations, ICorr will continue to strengthen collaboration and expand outreach, ensuring that corrosion prevention remains a key priority for governments, industries, and communities alike.

Looking Ahead

As we mark WCAD 2026, we reaffirm our shared vision: a safer, more sustainable, and more resilient world enabled through effective corrosion management.

We encourage professionals, organisations, and the wider public to engage with WCAD activities, share knowledge, and support efforts to prevent corrosion.

To learn more about ICorr's ongoing initiatives and past WCAD activities, please visit: **https://www.icorr.org/world-corrosion-awareness-day-family/**

Cambridge Corrosion Conference 2026 Highlights Advances in Digital Corrosion Management

In advance of World Corrosion Awareness Day on 24th April, the ICorr Midlands Branch jointly hosted the Cambridge Corrosion Conference 2026 with the European Federation of Corrosion (EFC) Working Party 15 and CorrosionRadar on 21–22 April 2026 in Cambridge, UK.

Photo 1: Day 1, Keynote by Dr Chiraz Ennaceur (CEO, CorrosionRADAR) on the Future of AI Led Corrosion Management.

The two-day conference attracted delegates from across the UK and Europe and provided an excellent platform for discussion between industry and academia on current and emerging corrosion challenges.The conference was opened by ICorr President Dr Yunnan Gao and Dr Prafull Sharma, Immediate Past Chair of the ICorr Midlands Branch. Dr Gao also presented an overview of ICorr activities and achievements during 2025–2026.

The technical programme focused on digital monitoring, artificial intelligence (AI), corrosion under insulation (CUI), inspection technologies and corrosion challenges linked to energy transition systems. The event included presentations from major organisations including Cenosco, Emerson, Inductosense, Dow, Worley, Becht, Eddyfi Technologies, Moeve and Linde Engineering.

The opening keynote, "Future of Corrosion Engineering with AI", was delivered by Dr Chiraz Ennaceur, CEO of CorrosionRADAR. The presentation explored how digital technologies and AI are influencing future corrosion management practices, while also highlighting the continued importance of engineering expertise, reliable data and human oversight.

Several presentations focused on AI applications and digital inspection systems. Rowan Vaduganathan of Cenosco presented "Integrating Machine Vision and AI into Risk Based Inspection Workflows", while Stefano Cuomo from Inductosense discussed "From Inspection to Prediction: Redefining Corrosion Monitoring with Online Sensors and Hybrid Models". Gerrit Buchheim of Becht delivered two presentations on "Machine Learning for Complex HF Alky Corrosion" and "CML Optimisation." Philipp Schempp from the Technical University Cologne also presented on "Corrosion Prediction with Machine Learning."

Corrosion monitoring and CUI management formed another major theme throughout the conference. William Fazackerley of Emerson presented "New Novel Area Monitoring Solution for Localised Damage," and Ogbonnaya Agwu of Dow discussed "CUI Monitoring at a Petrochemical Plant". Theo Knijff from Kai-Con presented recommendations for implementing CUI monitoring strategies, while Kus Slawomir of Corrology Innovations discussed thermal and visual image data analysis for targeted CUI inspection planning.

The conference also addressed corrosion challenges associated with renewable and low-carbon energy systems. Dr Hosseini from London Petrotech delivered a keynote presentation on "Corrosion Integrity Challenges in Floating Offshore Wind." Florian Hairer from Linde Engineering presented "Hydrogen: HEE and Standardisation – Status and Outlook", highlighting material and integrity challenges linked to hydrogen systems.

Other technical highlights included presentations on UT corrosion monitoring by Xavier De Schepper of Eddyfi Technologies, microwave inspection of non-metallic tanks and piping by Alessandro Demma of Omnia Integrity, and refinery corrosion case studies presented by Martin Vosecky of Nalco Water and Pedro Rangel of Moeve.

The event concluded with a series of open discussions covering topics such as AI for corrosion rate prediction, refinery corrosion mitigation, corrosion education and the future of inspection technologies. Delegates also participated in networking activities and an industrial tour of CorrosionRADAR facilities.

CR corrosion® RADAR

Overall, the Cambridge Corrosion Conference 2026 successfully highlighted the growing role of digitalisation, AI and advanced monitoring technologies in corrosion engineering. The conference demonstrated the importance of collaboration between researchers, technology providers and industry in developing safer, more reliable and sustainable asset integrity solutions for the future.

Photo 2: Day 2, keynote by Dr Mohammad Hosseini (MD, London Petrotech) on Corrosion Integrity Challenges in Floating Offshore Wind.

ICorr President Visits the University of Manchester to Celebrate Scholarship Impact

On 1 May 2026, Institute of Corrosion President Dr Yunnan Gao visited the University of Manchester to review the continuing success of the ICorr Scholarship Programme and to meet students and staff involved in corrosion education and research.

The visit included meetings with Dr Beatriz Mingo and Professor Dirk Engelberg from the Department of Materials, during which the annual review of the ICorr-funded scholarship programme was presented. Since 2023, ICorr has committed £25,000 per year over a five-year period to support MSc and MEng students specialising in corrosion-related disciplines. The review highlighted the growing success of the initiative, with strong student engagement and increased application numbers across both programmes.

Dr Gao also met with Professor Scott Heath, Vice-Dean for Students, Teaching and Learning in the Faculty of Science and Engineering, and held discussions with ICorr Scholarship recipients Ayrton Spiller and Jana Al Shami. During a tour of the university campus, Dr Gao was also accompanied by ICorr Scholarship recipient Charles Foxall.

The university expressed its appreciation for ICorr's continued support in helping to develop the next generation of corrosion professionals. In February 2026, scholarship recipients Ayrton Spiller and Jana Al Shami were formally recognised during the Faculty of Science and Engineering Scholarship Awards Ceremony, reflecting the growing visibility and impact of the partnership between ICorr and the University.

The visit concluded with recognition of ICorr's contribution on The University of Manchester President's Circles of Philanthropy, The Beyer Circle Board, where the Institute is proudly acknowledged for its support of student development and engineering education.

Photo 1.

Photo 2.

Photo 1 and 2: ICorr Scholarship Certificate Presented by Professor Scott Heath to Ayrton Spiller (in Photo 1) and Jana Al Shami (in Photo 2) During the Faculty of Science and Engineering Scholarship Awards Ceremony in February 2026.

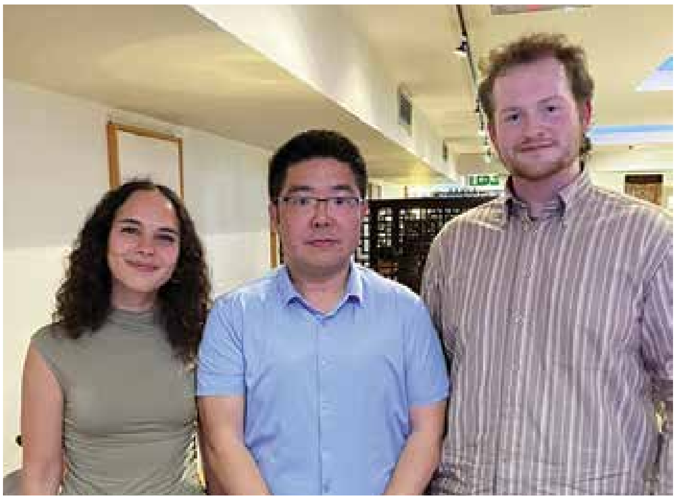


Photo 3: ICorr President Dr Yunnan Gao Meeting with ICorr Scholarship Recipients Ayrton Spiller and Jana Al Shami in Manchester on 1 May 2026.

Photo 4: ICorr President Dr Yunnan Gao Touring the University of Manchester Campus Accompanied by ICorr Scholarship Recipient Charles Foxall on 1 May 2026.

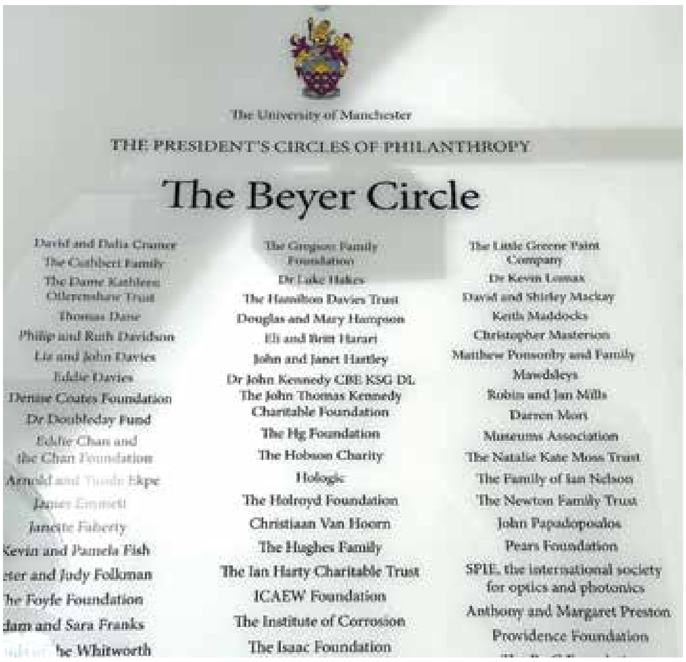


Photo 5: The University of Manchester President's Circles of Philanthropy, The Beyer Circle Board, Including the Name of the Institute of Corrosion.

ICorr Aberdeen Updates

On Thursday 5th March 2026 the Aberdeen Branch held a Joint Hybrid Event with the British Institute of Non-Destructive Testing (BINDT) with a Total of 42 Attendees.

This event, entitled 'Subsea Cathodic Protection Survey from Data Collection to Meaningful Interpretation,' was kindly hosted by Altrad at its new premises in Howe Moss Crescent, Dyce, and jointly chaired by Stephen Tate (ICorr Aberdeen) and Ray Wilson (BINDT).

Photo 1 & 2: Left- Ray Wilson (Chair - BINDT) and Right- Stephen Tate (ICorr Aberdeen and Immediate Past President).

About the Presenters

Ben McGinnis, Altrad Operations Manager – Cathodic Protection, has over 12 years' experience in corrosion monitoring and cathodic protection services, with experience across data analysis, field operations, project engineering, project management, and operational leadership. He has worked across oil and gas, renewables, maritime, and defence sectors, supporting subsea and topside integrity programmes and CP survey delivery in complex operational environments.

Photo 3: Ben McGinnis, Altrad Operations Manager and Ross Burgoyne, Altrad Project Manager.

Ross Burgoyne, Altrad Project Manager – Cathodic Protection, is an ICorr Young Engineer Programme (YEP) graduate with a bachelor's degree in Earth Science from the University of Glasgow with over 6 years' experience in cathodic protection, transitioning into Product Supply in 2023 and currently working as a Project Manager in Altrad CP Products.

Presentation Details

Subsea cathodic protection (CP) surveys are a long-established element of offshore asset integrity management, providing insight into the performance of corrosion protection systems throughout an asset's life. While the fundamental principles of cathodic protection are well understood, the way in which CP survey data is collected, interpreted, and applied in practice can vary depending on asset type, operating environment, and survey objectives. This presentation provided a high-level overview of subsea CP surveys and discussed the role of CP surveys within wider integrity management programmes, also considering how different survey approaches can support an understanding of CP system performance.

The presentation highlighted the importance of context, limitations, and interpretation when reviewing survey results, recognising that CP survey data represents a snapshot in time rather than a future-proof prediction of asset condition. The presentation also reflected on broader industry considerations, including skills, experience, and knowledge retention within subsea corrosion and inspection disciplines.

Photo 4: Presentation Explaining the Differences in Offshore CP Survey Types – Local Contact Measurement (Highest Confidence), Field Gradient (System Level CP Behaviour) and Potential Variation (Trends and Relative Protection Performance).

By sharing practical perspectives on how CP survey information is used in real-world settings, the presentation provided a clear and balanced overview of subsea CP surveys and their role in supporting effective corrosion risk management.

Photo 5: Ben McGinnis and Ross Burgoyne Explaining the Current Issues of Attracting New Talent to the Offshore CP Industry.

Looking to the future, the 2 presenters explained how the offshore CP industry could be advanced by the adoption of new technologies now appearing.

Figure 1: The Future of Subsea CP Surveys.Attracting New Talent to the Offshore CP Industry.

continues on page 20

This was a fascinating presentation generating many questions from the joint ICorr/BINDT audience. Ben and Ross provided a great insight into Altrad's offshore survey activities, and the Aberdeen ICorr Committee are extremely grateful to BINDT North-East Scottish Branch for inviting us to join with them on this occasion, and they may be contacted below.

https://www.bindt.org/branches-and-committees/north-east-scottish-branch/

The April Aberdeen event was kindly hosted by 3T Training Services in Dyce on **Tuesday, 28th April 2026**, which provided a 'state-of-the-art' meeting room that offered an excellent and conducive environment for the session. This presentation was delivered by Lily You from One Garnet Group (a new ICorr sustaining member), who presented on "How Surface Preparation Quality Determines Coating Performance and Why Abrasive Selection is a Decisive Factor".

Photo 6: Guest Speaker - Lily You of OneGarnet Group, China.

Presentation Details

Many industrial coating failures originate not from poor materials or inadequate film thickness, but from defects at the steel-coating interface resulting from insufficient preparation. Her presentation explored the critical role of interface control in corrosion protection, emphasising how abrasive blasting and abrasive material selection directly influence surface conditions and long-term coating performance.

Key Factors for Coating Failure

- Despite better coating and application methods, nearly 50% of premature failures are attributed to insufficient surface preparation.
- Even minor contaminants (such as oil, dust, or soluble salts) can weaken adhesion, accelerate corrosion and degrade overall performance.
- Surface preparation, the often-overlooked foundation of coating systems, decisively impacts long-term durability.

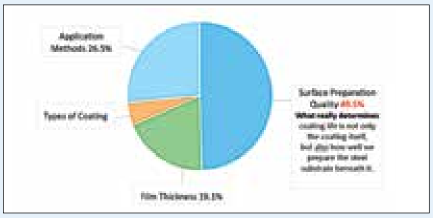


Figure 2: Key Factors Affecting Coating Life.

Reasons for Blasting Cleaning

- Remove contamination (clean the surface).
- Accept paint coating (help it bond).
- Increase surface area for greater coating life (help it last).

Lily highlighted the benefits of available natural OneGarnet abrasives (Hard Rock and JadeCut) compared to other manufactured abrasive materials.

Figure 3: Comparison of Garnet with Other Manufactured Products for Blasting.

Photo 7: OneGarnet Mined Rock and Final Products.

Photo 8: Lily You, Business Development Manager at OneGarnet Group (April 2026), A New ICorr Sustaining Member, Together with Stephanie Okoye (ICorr Aberdeen Chair) and David Cai, European Executive Chairman of OneGarnet Group.

Photo 9: Event Closure with Lauren Sayer (3rd from Left), Johnny Morton (Centre), and Yunnan Gao.

This was a hugely successful event, and we offer our sincere thanks to all involved and especially to 3T in Dyce, our generous hosts for the evening. Many thanks to Nicky Adams and all the team. The Aberdeen Branch continues its Technical Programme with 3 more Events. Look-ahead for the remainder of the 2025-2026 programme:

Date	Event Type	Company / Speaker	Topic	Time	Location
Tuesday 30th June 2026	Webinar Evening Technical Event	Tony Rizk, Chair of ICorr ETGB	Corrosion at Home	Start Time: 18:00	Online Webinar
Tuesday 25th August 2026	Annual Corrosion Awareness Day (All Day Event at LR, Aberdeen Offices.	Various LR Speakers + Guests.	Corrosion Awareness Training for Aberdeen Local Branch Sponsors and Guests.	Start Time: 08:30 – 16:30	IN-PERSON at Lloyd's Register (LR), Four Business Park, Prime, Kingswells Causeway, Kingswells, Aberdeen AB15 8PU.

All Aberdeen presentations are uploaded at: **https://www.icorr.org/aberdeen/**

See local technical programme. Please contact: **icorrabz@gmail.com** if you wish to join the Aberdeen branch mailing list, or contact: **ABZchair@icorr.org** if you wish to join its committee or to make a technical presentation.

ICorr Central Scotland Branch Updates

ICorr Central Scotland Branch welcomed Dr Yuri Tkach of Wood Plc as its speaker in April 2026. This came after a month's hiatus in the **2025/2026 technical events programme.** The hybrid event, which was held on **29th April 2026**, drew remarkable attention and saw attendees join from South America, Europe, the Middle East and Asia. Speaking on the topic "Fracture assessment of girth welds operating in severe sour environments", Dr Yuri discussed the challenges being faced in assessing the cracking resistance of pipeline steels being operated in severe sour environments. Sharing his expertise as a technical authority and fracture mechanics specialist, he reviewed failures of thermomechanically controlled processed (TMCP) steels in extreme sour service and how this prompted careful exploration of service limits of such materials in high H_2S environments.

He also explained how fracture resistance parameters are obtained from accelerated testing and the uncertainty in applying these parameters in Engineering Critical Assessments (ECAs) done in accordance with BS 7910 and DNV-RP-F108. These ECAs are conducted to confirm the acceptability of flaws observed during production welding of pipelines. The uncertainty arises as these input parameters may not fully account for potential time-dependent effects (such as deterioration of girth weld fracture toughness) experienced while operating in sour environments. The talk was very well received owing to the topical nature of the subject, as a growing number of fields being developed across the globe contain high H2S levels. A key takeaway from the session was that ECA of girth welds in pipelines operating in severe sour conditions should commence early in the design phase of such projects to prevent premature failures.

Future Events

Speakers for future events are always welcome – please contact the Branch with your abstract and presentation topic via **cschair@icorr.org**


(a)


(b)

Photo 1: Cross-section of (a) online and (b) in-person attendees at the April 2026 technical event listening to Dr Yuri's presentation (Image courtesy of ICorr Central Scotland).

ICorr London Updates

The final meeting of the 2025/2026 season, which was joint with the local TWI branch, was on 16th April 2026, when Stuart McKay, Engineering Manager for Europe, the Middle East and Asia at Henkel's CSNRI Composites, presented "Composite repairs for damaged pipework – approvals, methodology and application."

Stuart's main focus is providing repair solutions for damaged pipework and structures across a range of industries, but mainly oil and gas. He has a degree in mechanical engineering and has been providing composite engineering solutions since 2012. He is also heavily involved in the research and development of composite repairs to steel structures.

Photo: Stuart McKay Delivering His Talk.

Stuart introduced the use of composite materials for the repair and rehabilitation of damaged pipework, which has become an increasingly critical solution within the oil and gas industry, resulting in significant reductions in downtime, cost, and operational disruption. He stressed that continued industry adoption and performance validation have driven advancements in composite repair design, improving structural reliability, efficiency, and long-term integrity. These advancements have been critical in developing international standards, including ISO 24817 and ASME PCC-2 Article 4.1.

His presentation examined the engineering basis of composite repair design, reviewed industry approval and qualification requirements, and discussed field application practices with a focus on durability and long-term performance. A pdf of Stuart's presentation is available on the ICorr website. **https://www.icorr.org/wp-content/uploads/2026/05/ICORR-London-Copy-for-Sharing_April.pdf**

The presentation was well received and generated an interesting Q&A session. As is tradition, Stuart was presented with an ICorr pen as thanks.

The first technical presentation of the upcoming 26/27 season will be on **8th October 2026**, and details of the speaker will be put on the events page of the website in due course.

For more information about London branch events, please see the ICorr website: **https://www.icorr.org/events/**, and for information about branch activities and to suggest future speakers, contact the chair at **londonchair@icorr.org**

ICorr Midlands Updates

March and April 2026 were highly productive months for the ICorr Midlands Branch, marked by a major technical event, a leadership transition, and a well received technical webinar.

In advance of World Corrosion Awareness Day (24 April), the branch jointly hosted the Cambridge Corrosion Conference with EFC Working Party 15 on 21–22 April 2026. The in-person conference attracted a strong audience from across the UK and Europe and was very well received by delegates from both industry and academia. The conference was opened by ICorr President Dr Yunnan Gao and Dr Prafull Sharma, Chair of the ICorr Midlands Branch. The technical programme addressed several key and emerging topics in corrosion engineering, including the application of artificial intelligence in corrosion management, advances in corrosion monitoring—particularly for corrosion under insulation (CUI)—and corrosion challenges associated with renewable energy systems.

Photo 1: Delegates at the Cambridge Corrosion Conference Following the Closing Ceremony.

Photo 2: Dr Prafull Sharma chairing a panel discussion on the applications and challenges of AI in corrosion management at the Cambridge Corrosion Conference.

The branch gratefully thanks Dr Philipp Schemmpp, Chair of EFC Working Party 15, and Gino De Landtsheer, Vice Chair, for their collaboration in co-hosting the event. The committee also acknowledges CorrosionRADAR for hosting and supporting the conference.

Photo 3 & 4: Dr Philipp Schemmpp (Left), Chair, and Gino De Landtsheer (Right), Vice Chair of EFC Working Party 15.

The ICorr Midlands Branch Committee AGM was held prior to the conference on 21 April 2026, with full committee attendance. During the meeting, Dr Prafull Sharma presented a review of branch activities over the past year, highlighting the progress achieved and the successful delivery of the Cambridge Corrosion Conference. Dr Sharma also announced his decision to step down as branch chair. With unanimous committee support, Ali Oskuie, former branch secretary, was appointed as the new branch chair.

Ali Oskuie is a PhD qualified corrosion engineer and a corrosion and asset integrity specialist with over 14 years of experience in corrosion engineering, risk based inspection, and fitness for service assessment. He has led engineering consultancy teams delivering multiple asset integrity projects across refineries and petrochemical facilities. Ali currently works at Worley as an Asset Integrity Specialist. The committee expressed its sincere thanks to Dr Prafull Sharma for his dedicated leadership and significant contributions during his tenure as chair. The committee is pleased to confirm that Dr Sharma will remain an active member of the branch committee, ensuring that the branch continues to benefit from his experience and expertise.

Photo 5&6: Dr Prafull Sharma (Left) the outgoing Midlands Branch Chair and Dr Ali Oskuie (Right) the incoming Chair.

Key priorities for the coming year were reaffirmed, including increased engagement with students and promotion of ICorr student membership, expanded industry outreach across the Midlands, strengthened industry–academia links through initiatives such as internships, and the continued delivery of webinars as an effective platform for promoting corrosion awareness both nationally and internationally. Discussions are currently underway to appoint a new branch secretary and vice chair, with decisions to be finalised at the next committee meeting.

On Thursday, **9th April 2026**, a technical webinar entitled 'The Application of Reliability Models in Asset Integrity Management' was delivered by Ali Oskuie, covering the application of statistical models in asset integrity engineering, and was received very positively. Looking ahead, the branch has a strong webinar programme planned, including a May webinar by the ICorr President entitled "Discover ICorr: Services, Activities, and Opportunities for Corrosion Professionals." Further details will be shared shortly via branch social media channels and ICorr member communications. Additional technical webinars planned for the coming months will address non intrusive inspection of buried pipelines, corrosion challenges in the hydrogen production industry, and risk assessment of AC interference on onshore pipelines.

Participation in Midlands Branch Activities

Do please contact: **midlandschair@icorr.org** if you wish to present or be involved with the Midlands Branch in any way.

ICorr North-East Updates

North – East Branch Tour of Rosen Testing and Laboratories Facilities

Photo: Participants at Rosen Visit.

ICORR North-East committee members and guests visited the ROSEN Testing Facility (RTF) in Brunswick, Newcastle on **26th March 2026**, where they were given a brief overview of their materials and integrity testing capabilities, with a particular focus on coatings.

We were hosted by Steve Parry (Test Facility Lead), Ian Laing (Laboratory & Testing Services Manager), and Jack Thompson (Engineering Technician), who provided an overview of the facility and its capabilities. The ROSEN facility supports corrosion control and integrity management across pipeline and energy assets, combining materials expertise with practical testing and failure investigation. The laboratories cover a wide range of services, including corrosion assessment, metallurgical analysis, mechanical testing, welding engineering, hydrogen-related materials testing, salt spray and QUV testing and root cause failure analysis.

The coatings laboratory was of particular interest, supporting coating qualification and performance testing. Capabilities include surface preparation assessment, coating application checks, adhesion testing, impact and flexibility testing, hardness, abrasion resistance, holiday detection, and corrosion/environmental exposure testing such as salt spray.

Alongside this, the wider facility carries out metallurgical and chemical analysis, mechanical testing, and hydrogen-related materials testing to support evolving industry requirements. The visit provided a very useful insight into ROSEN's testing capability available on site and how it supports integrity management across many different sectors.

Branch Email Address

You will notice that general communications from the NE Branch will come from a different email address **NEBranch@icorr.org**, however **nechair@icorr.org** remains for all direct communications with the Chair for future presentations or sponsorships of the branch. Thank you for your continued support.

ICorr North-West Updates

Proposed Academic Seminar Series (North-West and Yorkshire and Humber Branches Collaboration)

The NW Branch, in collaboration with the Yorkshire & Humber Branch, is developing a new academic seminar series aimed at strengthening engagement with universities and fostering closer links between academia and industry.

Photo: Izabella Gajewska – New NW Branch Chair.

The proposed format involves **two events per year**, rotating between **Manchester and Leeds**, with target timings in **June/July and November/December.** Each event will feature a balanced programme with an approximate 50/50 split of speakers from each region, ensuring strong representation and collaboration between the two academic communities.

The seminar themes will focus on contemporary technical challenges, with an example topic being **"Corrosion challenges in additively manufactured metals."** In addition to established academics, the series will actively encourage participation from **early-career industry professionals**, providing a platform for emerging voices and promoting knowledge exchange across sectors. The events are intended to be **research-focused seminars,** initially involving universities in Leeds and Manchester, with potential to expand participation in the future.

The **first seminar is provisionally scheduled for 26 June at the University of Manchester.** Planning is currently underway, including the development of a draft agenda.

Registration will initially be **free of charge** to maximise accessibility and attendance. A nominal fee may be introduced in the future to support catering and improve attendance commitment. Although progress has taken slightly longer than anticipated due to recent scheduling constraints, further details, including the confirmed agenda and speakers, will be shared in due course. Anyone wishing to attend or get involved should contact **nwchair@icorr.org**

Izabela Gajewska
ICorr North-West Branch Chair

ICorr Yorkshire and the Humber Updates

The Yorkshire and Humber Branch played an active role in supporting this year's CED Day, which was hosted at the Bragg Centre for Materials Research at the University of Leeds on 24th April 2026.

Photos: Advanced Testing Equipment at the Bragg Centre for Materials Research.

This event proved highly successful, featuring a series of laboratory tours and talks exploring the impact of corrosion on carbon capture and storage applications. Attendees also benefited from a strong regional presence, with a number of exhibitors and presenters from across the Yorkshire and Humber region who kindly helped sponsor the event - Cortest, Capcis, Corrocoat, Industrial Coatings Inspector's, OGC and the University of Leeds.

Looking ahead, plans are underway to expand collaborative student seminar series in partnership with the North-West Branch as well as between the University of Leeds and the University of Manchester. These seminars aim to provide a supportive platform for students and early career researchers to showcase their work and engage with peers and professionals from across both regions.

Further details on these events will be announced in the coming months, alongside the development of several industry focused events scheduled for later in the year.

If you wish to present or have any questions about the Yorkshire and Humber branch activities, please contact the Chair.

Email: **yorkshirechair@icorr.org**

YICorr: Building Momentum Through Collaboration, Learning and Early Career Engagement

YICorr continues to go from strength to strength, with a growing programme of activity that reflects the energy, commitment, and enthusiasm of the early career corrosion community. Recent months have seen strong engagement across technical events, mentoring initiatives, and collaborative activities with branches and partner groups, reinforcing YICorr's role as a vibrant and integral part of the Institution.

Young Engineers Programme (YEP): A Flagship Success

The Young Engineers Programme (YEP) has been a standout success over the last 15years for ICorr, delivering excellent attendance, high levels of engagement, and consistently positive feedback from participants. The quality of technical content and the accessibility of the 2026 sessions have been particularly well received, creating an environment that encourages discussion, learning, and professional growth.

A key contributor to this success has been the calibre of speakers involved. Jane Lomas, Paul Lambert, Alan Denney, and George Winning were exceptionally well received as presenters, with attendees highlighting both the technical depth of their talks and the relevance to real-world corrosion challenges. Their contributions have played a significant role in setting the tone and standard for the programme. We are exceptionally grateful to BP and Mott MacDonald for providing the essential support that makes this programme possible

Looking ahead, this year's case study will be revealed to members, and teams formed in May. The YEP case study has kindly been provided by Intertek and will be an interesting challenge for this year's participants!

Photo: George Winning Presenting on Production Chemistry.

Sponsorships

To sustain and expand YICorr activities, sponsorship engagement remains a key priority to support sponsorship discussions, particularly in relation to flagship activities such as YEP. We would encourage any interested parties to reach out to the YEP committee at **YoungICorrChair@ICorr.org**

Mentorship Programme: Strengthening Professional Connections

The YICorr Mentorship Programme continues to make positive progress, with emails received from a number of individuals keen to take part as mentees. The programme offers an important opportunity to support early career corrosionists through knowledge sharing, guidance, and professional development.

Expressions of interest are warmly welcomed from any experienced members who may be willing to act as mentors. Your experience and insight would be invaluable in supporting the next generation of corrosion professionals and strengthening cross generational links within the Institution.

Expanding the Programme: Collaborative Activities

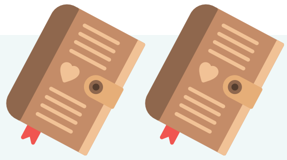
YICorr has been actively involved in a range of collaborative initiatives that demonstrate the value of working across branches and committees, nationally and internationally. A Student Lecture Series, delivered in collaboration with the North-West and Yorkshire branches, will provide opportunities for early-career researchers to share their work in a professional yet friendly environment to develop their science communication skills and to allow our industry members to continue their professional development at the bleeding edge of corrosion science. In addition, the "Skills for Corrosionists" events will be delivered jointly with the YEFC and the Midlands Branch, which have focus on developing professional competencies and essential business skills to boost their career growth. These activities have been particularly well received and underline the importance of equipping early career professionals with a broad skill set.

Looking Ahead

Overall, YICorr activity is characterised by strong momentum, growing collaboration, and clear enthusiasm from members at all career stages. With continued support from the board, mentors, and industry partners, YICorr is well placed to build on this success and continue delivering meaningful, high-impact opportunities for the early-career corrosion community.

Visit the YICorr website for all the latest news

www.icorr.org/events/



YEP Journeys – Diary Reflections from AMPP Nashville

Ben Hudson

How AMPP 2025 Shaped My Journey as a CP Engineer in the UK

Photo 1: Ben Hudson

In 2024, I was interviewed, accepted and won the Young Engineers Programme (YEP) on a case study independently of my full-time work at Premtech Ltd, a National Gas-owned design consultancy focused on innovative gas transportation and the transition to hydrogen transport and storage across the UK. My team winning the YEP provided the opportunity to attend the AMPP 2025 conference in Nashville. This provided me with direct access to lectures on current research, case studies, and emerging practices within cathodic protection (CP) engineering. As a developing engineer, these sessions demonstrated how the discipline is evolving from static, conservative design approaches towards systems that actively account for interference, environmental variability, and continuous performance monitoring. The key insights I gained from the 2025 AMPP conference have encouraged me to reconsider my approach to CP design and provided a clear direction for further developing both my technical knowledge and engineering perspective.

One of the clearest takeaways from my time at the conference is the impact electrical interference has on a CP system. Pipelines installed parallel to high-voltage lines can experience induced AC, which accelerates corrosion and affects CP performance. The lectures showed how corrosion rates can increase by a factor of two to three once AC current density exceeds approximately 10 A/m^2, while seasonal changes in soil moisture can introduce variations of around 20% in interference levels. Additionally, lightning strikes can induce large currents (circa 5–20 kA) into nearby pipelines, with effects extending along the line and contributing to coating degradation over time and sometimes causing equipment failure. For UK pipelines, where shared corridors with power infrastructure are common, these interactions should be treated as design considerations and not isolated risk cases. The design should be able to achieve adequate protection criteria along the pipeline route under steady and transient real-world operating conditions.

Following on from this, the conference also reinforced how varying soil conditions influence CP performance and interference behaviour. Moisture content and resistivity can vary significantly across UK soils, with induced AC current densities found to vary up to 400% across typical soil resistivities, with seasonal moisture changes introducing further variation of around ±25%. Phase permutation of nearby transmission lines was shown to reduce induced AC levels by approximately 30–35%, while conductive backfills such as graphite-enhanced materials achieved reductions of around 20%. The range of cross-mixed ground conditions reinforces the requirement for site-specific design over standardised assumptions, where mitigation strategies must be selected based on recent ground data and expected seasonal variation. Whilst external factors are important, strong system design remains fundamental. Advances presented at the conference showed that 3D soil resistivity modelling can optimise anode placement and reduce overprotection by approximately 25%, improving both efficiency and cost effectiveness. Further to this, by using rectifier voltage and current data to estimate coating resistance was shown to be a practical method of monitoring asset condition, with field trials showing early identification of defects without the need for physical inspection. By applying the fundamental principles of CP, effective and reliable results can be obtained using new improved tools and better using available data.

Over the course of the conference, a recurring theme was the role of collaboration to prevent corrosion. Previous projects have identified that early collaboration to reroute transmission line conductor spacing in pylons are shown to reduce AC interference on pipelines by over 40%, with further reductions achieved through coordinated phased works. Similarly, hybrid CP systems combining impressed current and sacrificial anodes were shown to increase available protection current by around 20% and improve overall system performance. As engineers, this highlights the need for early coordination across sectors to allow interference to be reduced more efficiently and can minimise the need for additional mitigation on the pipeline itself.

A notable development across the sessions was the transition towards continuous monitoring. New technologies, including distributed sensors and machine-learning analysis, allow stray current sources and interference effects to be identified with much greater accuracy within complex environments. Advanced monitoring systems have demonstrated the ability to locate stray current sources within approximately ±50 m, enabling targeted mitigation rather than broad intervention. For a developing engineer, the ability to interpret system data and use it to inform decisions is becoming a core part of CP practice, alongside traditional design skills.

Photo 2: YEP 2024 Winners Celebrating in Nashville for AMPP25.

In summary, my time at AMPP 2025 provided me with a clear career direction for a future in corrosion control. Good systems are defined by initial design conditions, but great systems consider how well they respond to their environment over time. For UK pipeline applications, the principles discussed above address the challenges of varied soils, shared infrastructure, and ageing assets. For a developing engineer, they also mark the transition from theoretical understanding to practical real-world application, and applying these lessons will support my development and design of more effective, reliable systems across UK pipeline networks. Being able to attend the 2025 AMPP through the ICorr YEP initiative provided valuable exposure to these ideas at an early stage in my career, and for that I would like to thank the ICorr and YEP organisers for making this possible and offering me an insightful experience that definitely won't corrode over time.

Engineering Training Governing Board (ETGB) Updates

The Engineering Training Governing Board (ETGB) is ICorr's dedicated body for the governance and delivery of corrosion related engineering training. Since its establishment in 2024, it has rapidly evolved into a key strategic arm of the Institute. The ETGB training portfolio continues to grow, offering high quality, industry focused courses that directly support the corrosion community and reinforce ICorr's position as a global leader in professional development and technical excellence.

Recently, ETGB represented ICorr at the Parliamentary and Scientific Committee (P&SC) at the House of Commons in London, contributing to the session on *"How microbes are a crucially overlooked part of environmental and biodiversity legislation."* The event brought together leading scientists, engineers, academic institutions, and policymakers to explore the increasingly recognised influence of microbial systems across a wide range of industrial sectors.

In recent months, ETGB has also delivered two successful training courses:

1. Fundamentals of Corrosion Engineering (FOCE) – a five-day course (2–6 March) including the ICorr certification examination, supporting candidates working toward MICorr status.

2. Corrosion Mechanisms in Stainless Steel (CMiSS) – a one day course (22 April) covering metallurgical principles, corrosion mechanisms, and case studies. The session also included a visit to the state of the art High Temperature Processing facilities at the University of Warwick's WMG department.

In this issue, we also highlight two additional ETGB courses: the under development Council approved Corrosion Management course and the established R-Tech supported Boiler Failures course.

Corrosion Management Course Briefing

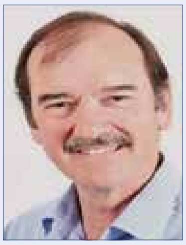


Photo: Steve Paterson, Corrosion Management Course Tutor.

This priority course is currently under development for delivery in early 2027, following ICorr Council approval.

There is a clear gap in the availability of an accessible, industry aligned programme that is both current and forward looking in its approach to corrosion prevention and control. This new course will offer a system based, practical, and affordable corrosion management framework tailored to the needs of corrosion professionals.

The course will deepen understanding of how corrosion management integrates with wider asset integrity practices and will equip participants with the strategies and tools needed to implement an effective corrosion management system. Although examples are drawn from oil and gas production, the principles apply across all sectors where corrosion poses a significant risk. Sector specific needs will be addressed through in class discussions and targeted handouts. Participants will gain a clear understanding of how proactive corrosion control supports stronger asset integrity and more reliable operations.

The course is suitable for both experienced and early career professionals working in materials, corrosion, inspection, quality, or asset integrity, as well as those looking to broaden their expertise in this field.

Boiler Materials Failures; Mechanisms, Inspection and Prevention

When boiler components fail in service, consequences can be catastrophic for human safety, the environment, and operational continuity. Even lower-level failures can lead to production rescheduling, emergency repairs, and unplanned outages. This course emphasises that understanding failure types is essential to improving plant safety, reliability, availability, performance, and reducing maintenance costs.

With over 1,000 investigations, this course provides extensive case studies across materials, mechanisms, and applications. Participants learn to identify, inspect, and prevent failures across waterside, fireside, and general mechanisms, including corrosion, embrittlement, overheating, fatigue, and welding defects. For each mechanism, the course covers causes, identification in service, affected materials and locations, and prevention and monitoring strategies, supported by real-world case studies. The course is delivered by tutor Sarah Bagnall, R-TECH Group.

All course fees are carefully aligned with ICorr non profit ethos, ensuring excellent value for organisations investing in staff development. We also offer an attractive package for group bookings, whether for scheduled UK deliveries or on site training at company premises worldwide.

For further information, registration, or to express interest in developing a corrosion related training course, please contact Dr Tony Rizk, ETGB Chair, at **ETGBchair@icorr.org**

CPGB Updates

Following a highly successful year in 2025, ICorr's Cathodic Protection Governing Board (CPGB) is progressing a range of improvements to its courses and training facilities to support continued industry demand.

Opportunities to Get Involved

CPGB is currently seeking additional tutors across all Cathodic Protection (CP) application sectors. Prospective tutors must hold ICorr Level 4 certification in the relevant sector. Tutors are remunerated in accordance with agreed rates.

In addition, volunteers are invited to join the Governing Board. The board meets remotely on a monthly basis and is responsible for reviewing, managing, and approving course content, examinations, and facility updates.

Focus on Marine Metallic Structures Training

Whilst CP training is also available in the 'on-land metallic structures' and 'reinforced concrete structures' application sectors, this update highlights the training offered in the 'marine metallic structures' sector. This includes a wide range of assets, such as:

- Harbour facilities (piers and jetties)
- Ships (external hulls)
- Offshore renewables (wind farms, wave and tidal)
- Floating structures (buoys and semi-submersible platforms)
- Subsea infrastructure (wellheads, manifolds and piping)
- Offshore pipelines

As part of the ICorr CP Training and Certification Scheme, courses in this sector are delivered at:

- ISO 15257 Level 2 (Technician)
- ISO 15257 Level 3 (Senior Technician)

To ensure strong tutor engagement, class sizes are limited to a maximum of eight candidates.

Photo: Monitoring of a Marine CP Installation.

Upcoming Course Dates

Limited places remain on the following scheduled courses at our Telford training facility:

- **ISO 15257 Level 3: 8th – 11th June 2026**
  (Examination: 12th June 2026)
- **ISO 15257 Level 2: 6th – 9th July 2026**
  (Examination: 10th July 2026)

Additional courses may become available in Autumn 2026, subject to demand.

Course Information and Booking

For enrolment enquiries, please contact Eva Whittaker, Cathodic Protection Scheme Manager (CPSM), at **cpsm@icorr.org**

Further details, including the CP Training and Certification Brochure, scheme overview, upcoming courses, and online booking, are available at **www.icorr.org/cathodic-protection-courses/** and **https://www.icorr.org/wp-content/uploads/2023/09/ICorr-CP-Training-and-Certification-Brochure.pdf**

Certification Requirements

Applicants should note that passing the relevant examination is only one component of certification. Candidates must also demonstrate appropriate practical site experience and successfully complete a competence assessment conducted by ICorr's Professional Assessment Committee (PAC), which operates independently of CPGB. Full details are available in the 'Eligibility for Certification' section of the course information webpage.

Further Enquiries

For general queries or to express interest in becoming a tutor or joining CPGB, please contact Ben Magee, CPGB Chair, at **cpgbchair@icorr.org**

STGB Report

Photo: Johnny Morton.

The Surface Treatment Governing Board (STGB), re-established in 2024, has continued to meet monthly, maintaining strong engagement and steady progress across training governance, documentation standardisation, quality assurance, and scheme management.

Our activities have recently been characterised by major focus on **Requirements* Documents (Rec Docs) unification, course integrity, and addressing operational challenges** such as global delivery, tutor performance tracking and recruitment (developing new procedures for these).

Requirements for the training and certification of personnel engaged in painting, coating and lining inspection and related fields undertaken in onshore, offshore and the marine industries.

Committee Membership

- **Johnny Morton** – STGB Chair / Fabric Maintenance Technical Authority
- **Lee Millar** – STGB Vice Chair / Pipelines Coating and Corrosion Team Lead
- **Grant Wright** – STSM / Fabric Maintenance Technical Authority
- **Stephen Tate** – Immediate Past President / Committee Member (QMS and Trustees)
- **Jane Lomas** – Coatings Technical Expert / Committee Member
- **Chris Fyfe** – FM Technical Expert / Committee Member
- **Dave Wickham** – PFP Technical Expert / Committee Member
- **Nigel Peterson White** – Examiner/Technical Expert / Committee Member

The Committee continues to seek new members to diversify expertise and industry representation.

Recent Activities

Although several challenges persist—especially committee recruitment (technical -subject area experts – linings and high-temperature coatings currently sought), the Board is making structured progress, maintaining strong oversight of ICorr Surface Treatment certification and training standards across all courses.

Between September 2024 and May 2026, the STGB has remained highly active, focusing on documentation harmonisation, governance refinement, and quality assurance improvements.

Key Priorities in Q2 2026

1. Implement Tutor Performance Tracking and QA compliance records.
2. Progress course updates for Protective Coating Inspector (PCI) at all levels.
3. Review and Improve Practical Training and Examinations.
4. Strengthen Governance of Course Approvals.

STGB have during April 2026 also implemented its new Training logo linked to ICorr branding to establish a clear identity for its activities.

To apply to join STGB Committee or enquire about ICorr Surface Treatment training courses, please contact **stgbchair@icorr.org**

Registration Open : ICorr Microbiologically Influenced Corrosion (MIC) Training Course, 12th–16th October

Microbiologically Influenced Corrosion (MIC) remains one of the most significant, yet frequently underestimated threats to asset integrity across many industrial sectors. ICorr will deliver its flagship MIC Training Course on 12–16 October, offering participants the scientific insight and practical skills needed to recognise, evaluate, and manage MIC effectively.

Course Pathways

Participants may choose from three structured learning routes:

1. ICorr Certified MIC Technologist – A full five day programme including the ICorr certification examination.
2. MIC Technologist – A four day programme without the examination.
3. MIC Awareness – A one day introductory session providing a solid foundation in MIC mechanisms, risks, and mitigation strategies.

Who Should Attend

This course is suitable for engineers, managers, consultants, and technical specialists working in: Oil & Gas, Water Treatment, Nuclear Energy, Power Generation, Design & Engineering, Infrastructure, Manufacturing, Asset Integrity, Corrosion, Inspection, Microbiology.

Course Value

The programme delivers a comprehensive understanding of MIC science, diagnostics, and control methods, supported by ICorr recognised certification pathway. Completion contributes to Continuing Professional Development (CPD) and supports progression toward Chartered Engineer (C Eng) status.

Course Dates

12th–16th October, early registration is recommended to secure a place on this well established and highly regarded programme.

Registration and Enquiries

Registration: **admin@icorr.org**,
Further information: Dr Tony Rizk, ETGB Chair – **ETGBchair@icorr.org**

Industry News

Industry News from ICorr Corporate and Sustaining Member Companies

Jotun Celebrates 100 Years

Global paints and coatings manufacturer Jotun is celebrating its 100th anniversary. The company was officially established on 17 April 1926, when founder Odd Gleditsch Sr and his partners signed the founding documents and purchased a small chemical factory in Sandefjord, Norway.

Over the past century, Jotun has grown from a local business into one of the world's leading manufacturers of paints and coatings. The company marked this important milestone by thanking its employees, customers, shareholders, and partners who have contributed to its success over the years.

Today, Jotun operates in four main business segments: Decorative Paints, Marine Coatings, Protective Coatings, and Powder Coatings. Through these divisions, the company provides solutions designed to protect and enhance buildings, homes, ships, and industrial structures worldwide.

Chairman of the Board - Odd Gleditsch d.y. and President and CEO - Morten Fon shared a special birthday message to celebrate the occasion and reflect on the company's achievements over the last 100 years.

Source: https://www.jotun.com

AkzoNobel's New Drone Inspection Tool Improves Aircraft Paint Maintenance

AkzoNobel's Aerospace Coatings business has introduced an advanced drone inspection tool that is expected to improve aircraft paint maintenance through greater precision and better data analysis. The latest development is part of the company's Aerofleet Coatings Management service, a digital system first launched in 2023 to help airlines manage coating maintenance more efficiently across their fleets.

The updated system now includes a second drone-based inspection tool called the Iris CMX, developed in partnership with Donecle. The new drone uses a special three-in-one contact sensor to directly measure coating performance on aircraft surfaces. It can collect highly accurate data on dry film thickness, colour and gloss, providing more reliable and repeatable inspection results.

The Aerofleet system already included the Iris GVI drone, which performs a full-surface visual inspection of an aircraft. The drone flies in a planned grid pattern over the aircraft and captures up to 600 high-definition photographs. The software then analyses the images to identify coating damage, wear or other maintenance concerns.

By combining the two drone systems, airlines can now obtain both detailed visual information and precise measurement data. This allows maintenance teams to better understand the actual condition of aircraft coatings and decide more accurately when repainting is required. Traditionally, repainting decisions have often been based on flight hours or fixed maintenance schedules rather than the true condition of the coating.

Patrick Bourguignon, Director of AkzoNobel's Automotive and Specialty Coatings business, explained that the Aerofleet service was designed to give airlines greater confidence in maintenance planning.

The Aerofleet system now combines three important sources of information. These include flight and environmental data such as flight routes, ultraviolet (UV) exposure and humidity levels, visual inspection results from the Iris GVI drone, and high-precision coating measurements from the Iris CMX drone.

Both drones can operate at the same time, with one drone inspecting each side of the aircraft. A trained inspection team can complete a full inspection of a narrowbody aircraft in around 30 minutes, significantly reducing inspection time compared with traditional methods.

The service is particularly suitable for airlines operating fleets of more than 100 aircraft. AkzoNobel says the system can help reduce unnecessary repainting, lower maintenance costs and improve aircraft availability. By extending coating life where possible, airlines may also reduce material use and environmental impact.

AkzoNobel has a long history in paints and coatings across many industries, dating back to 1792. The company operates globally and owns several well-known brands, including Dulux, International, Sikkens and Interpon.

Source: https://www.akzonobel.com

Other Industry News

National Gas Unveils Plans for Major Hydrogen Pipeline Network

National Gas has announced plans to develop more than 300 miles of hydrogen pipelines along the East Coast of England as part of the first phase of Britain's proposed national hydrogen network, known as Project Union.

The underground pipeline will connect key industrial regions, including Teesside, Yorkshire, the Humber and the East Midlands. The project aims to support the UK's transition to low-carbon energy by providing hydrogen infrastructure for industries that are difficult to electrify.

According to National Gas, the East Coast was selected for the first phase because of its strong industrial base, existing energy infrastructure and growing hydrogen production potential. The network will help connect hydrogen production, storage and industrial demand centres across the region. Project Union plans to create up to 1,500 miles of hydrogen pipeline across Great Britain by repurposing existing natural gas pipelines and constructing new sections where required. The project is expected to improve energy security, support industrial decarbonisation and contribute to the UK Government's net zero target for 2050. National Gas stated that the project could support around 3,100 jobs during peak construction and generate approximately £300 million annually in direct economic value.

The project is currently in the Front-End Engineering Design (FEED) phase, which includes environmental assessments, design work and public consultation planning. Public consultations on the East Coast plans are expected to begin later this year. Project Union forms part of the wider East Coast Hydrogen partnership involving National Gas, Northern Gas Networks and Cadent.

Source https://www.nationalgas.com

Shell Announces Agreement to Acquire ARC Resources Ltd

Shell plc has announced an agreement to acquire Canadian energy company ARC Resources Ltd. during the second half of 2026 in a major deal aimed at strengthening its natural gas and liquefied natural gas (LNG) business in Canada.

ARC Resources is a leading energy producer focused on the Montney shale basin in British Columbia and Alberta. The company produces natural gas, oil and natural gas liquids from one of Canada's most important energy regions.

Shell Chief Executive Officer Wael Sawan described ARC as a high-quality and low-cost producer that complements Shell's existing operations in Canada. He added that the acquisition will strengthen Shell's position in the Canadian energy sector for many years.

The deal is also expected to support Shell's LNG business, including its involvement in LNG Canada, a major liquefied natural gas export project in British Columbia aimed at supplying global energy markets.

Source: https://www.shell.com

Network Rail - Innovative Severn Tunnel Upgrade to Transform Key Rail Link Between South Wales and England

This vital project will see Network Rail, and contractors ARQ, complete the transformation of the Severn Tunnel's overhead power system, designed specifically to withstand the tunnel's harsh, corrosive environment - making it more resilient, reducing the frequency of maintenance, and helping to minimise disruption for passengers.

The New System

Running beneath the Severn Estuary, the 4.35 mile Severn Tunnel is one of the toughest environments on the UK rail network, where moisture and saltwater accelerate wear on equipment.

Since electrification, the overhead power system has been prone to corrosion and electrical wear, leading to more frequent maintenance.

To address this, Network Rail's Wales and Borders team has developed and successfully trialled an innovative new system. It uses a single 7km copper contact wire supported at regular intervals by modified bridge arms, to eliminate previous corrosion issues and improve performance.

Engineers will now install this system along the full length of the tunnel - using a world-first approach on this scale - to create a more resilient railway and reduce the need for frequent maintenance.

The Programme of Work Involves:

- Replacing 838 bridge arms that support the overhead electric wires in the Severn Tunnel
- Renewing 9,000 metres of overhead wiring in the Severn Tunnel

Nia Watkins, Regional Asset Manager at Network Rail Wales and Borders route, said: "Running beneath the Severn Estuary, the 4.35-mile Severn Tunnel is one of the most challenging environments on the UK rail network, making this work essential to maintain safe, reliable services and support its long-term future.

"Using an innovative solution developed by our teams at Network Rail, this complex and highly coordinated upgrade is being delivered at a world-first scale across the tunnel's full length - making the railway more resilient and reducing the risk of future disruption for passengers and freight."

Source: https://www.networkrailmediacentre.co.uk/news/innovative-severn-tunnel-upgrade-to-transform-key-rail-link-between-south-wales-and-england

Fellow's Corner

This series of articles is intended to highlight industry-wide engineering experience, guidance and focussed advice to practising technologists. It is written by ICorr Fellows who have made significant contributions to the field of Corrosion Management.

CP in Concrete - An Explanation of the Exponential Ageing Model

George Sergi, FICorr, Technical Director at Vector Corrosion Technologies Ltd

INSTITUTE OF CORROSION

Meet the Author

Dr George Sergi

George Sergi is the technical director at Vector Corrosion Technologies Ltd. He has long been involved in research and development for concrete durability consulting and problem-solving in the construction and concrete repair industry and is skilled in materials science, highways, bridge inspection, and steel-reinforced concrete repair and protection. George holds a PhD from Aston University for his work on the corrosion of steel in concrete. He was previously the head of corrosion at the Building Research Establishment (BRE), technical manager at FOSROC Constructive Solutions and lead bridge consultant for Birmingham City Laboratories.

The following summary is intended to provide specific clarification on the use of the Exponential Ageing Model for CP in Concrete, as referred to by C M Stone and G K Glass in their article "A critical assessment of the half-life Ageing term and failure to predict future galvanic anode behaviour", Corrosion Management, Issue 187 [1].

Regarding long-term monitoring data from a hybrid anode installation at Whiteadder Bridge [1] they argued that:

1. The observed current decay did not follow an exponential relationship over the full-service life.
2. A constant residual current dominated long-term behaviour.
3. Early high current output was governed by curing or resistivity changes in the activator rather than anode ageing.
4. Changes in steel passivity, rather than anode condition, governed long-term current trends [3].

These interpretations are examined below in the context of electrochemical fundamentals, field data from multiple installations, and laboratory evidence.

An Explanation of the Pre-Passivation Regime Within the Ageing Factor (AF) Model

The (AF) model does **not assume indefinite exponential decay**. It describes the **pre-passivation regime,** during which:

- Corrosion products are at least partially transported away from the zinc/activator interface.
- The anode remains electrochemically active.
- The zinc surface area decreases progressively due to consumption.
- Both geometric modelling and long-term field data consistently show that, during this regime, current output halves at approximately constant time intervals. This behaviour has been observed across multiple installations and for:
    - o Different anode geometries
    - o Varying exposure conditions

For the Whiteadder Bridge data [1], the first 8–9 years of operation exhibited a clear exponential decline, yielding an AF of approximately 3 years, which confirms the existence of an exponential ageing regime.

Transition to Passivation Stage

The deviation from exponential decay at later ages, resulting in an asymptotic or quasi-constant current, is not evidence against the AF concept and instead reflects **a transition to a passivation-controlled regime,** in which:

- A continuous corrosion product layer forms at the zinc/activator interface.
- The zinc surface becomes effectively passive.
- Current output is limited to a low level governed by oxide conductivity.

This behaviour is well known in electrochemistry and is analogous to passive steel behaviour. The same transition has been observed in:

- Laboratory depolarisation and potential-shift studies [4]
- Non-alkali-activated anodes
- Overdriven alkali-activated anodes

Steel Passivation – Effect on Anode Current

It has been proposed [3] that decreasing current is driven by increasing steel passivity. This interpretation is electrochemically inconsistent. As steel becomes more passive, its potential shifts in the positive direction. For a galvanic system, this **increases the driving voltage** between zinc and steel, which would, all else being equal, tend to increase rather than decrease anode current.

Observed reductions in current therefore, cannot be attributed to steel passivation alone and must originate primarily from changes at the anode interface.

Post Passivation Behaviour

Once passivation occurs, current output becomes largely independent of remaining zinc mass or theoretical surface area, and exponential modelling is no longer applicable. The AF model is therefore not intended to describe post-passivation behaviour, a limitation that is now explicitly recognised.

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Activator Resistivity Changes

It has been suggested that early current decay resulted from curing or resistivity changes in the activator putty. For this mechanism to account for the observed reduction, the resistivity of the activator would need to increase by several orders of magnitude over a relatively short period.

Such behaviour is inconsistent with:

- Known curing behaviour of cementitious or polymeric activators
- Independent laboratory measurements of activator resistivity
- Observations from alkali-activated systems where similar activators exhibit stable resistivity but very different ageing behaviour

By contrast, the formation of zinc oxide/hydroxide corrosion layers several millimetres thick provides a physically plausible, experimentally supported explanation for the observed current limitation.

Zinc Potential Evolution

Potentiodynamic scans and long-term exposure tests demonstrate that:

- Aged anodes show substantially less negative potentials (≈ −750 mV).
- New alkali-activated zinc anodes exhibit corrosion potentials < −1100 mV vs Ag/AgCl.
- Non-alkali-activated anodes can shift to even more positive values within a short period.

This progressive ennoblement of the zinc potential directly reduces the galvanic driving force and is consistent with corrosion-product-induced passivation and anode-controlled ageing. Some independent studies by BAM/ibac [4] corroborate this behaviour.

Implications for Future CP Design and Interpretation

The apparent contradiction between exponential decay and long-term constant current disappears once ageing is recognised as a multi-regime process:

1. Geometry-controlled exponential decay (AF regime)
2. Resistance-influenced decay due to gradual pore blocking
3. Passivation-controlled residual current

Well-designed alkali-activated anodes delay the onset of Regime 3 above beyond the design life, allowing the AF model to be used reliably for long-term prediction. Note. Systems that enter Regime 3 early must instead be designed based on the residual current.

Galvanic Anode Monitoring – Design Considerations

An Explanation of the Exponential Ageing Model

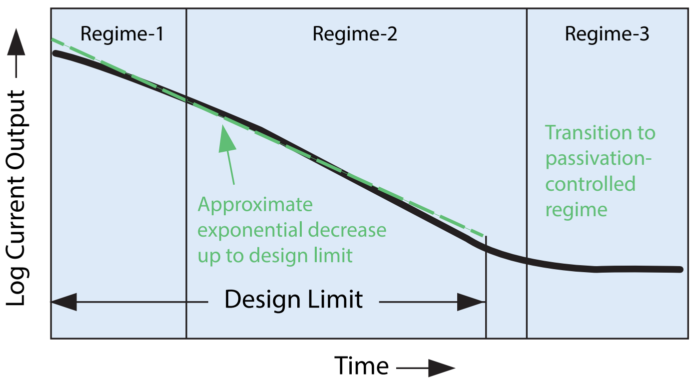

Figure 1: Deploying the Ageing Factor up to the Design Limit.

Discussion

- Exponential decay of galvanic anode current has been experimentally observed and theoretically justified.
- Any deviation from exponential behaviour typically results from passivation and should not be interpreted as failure of the ageing model.
- Differences between systems arise from activator chemistry, anode geometry, and degree of over-driving.
- The AF remains a valid and necessary design parameter within its defined applicability.

Galvanic Anode Monitoring – Lessons Learnt

- Current Density halves at regular time intervals found to be 3-15 years, depending on anode activator and type and degree of anode overdriving, a term described as "Ageing Factor".
- Exponential decline of current density up to the Design Limit is consistent with "Half-Life" principle.
- Humidity and particularly temperature, modify current output significantly.

Conclusions and General Guidance

The normal service life of installed galvanic anodes is expected to be at least 15 years and possibly 20-30 years.

- Current output of galvanic anodes is sustained for many years with a gradual exponential drop at a measured rate (Ageing Factor - AF).
- The Ageing Factor can be built into the design of the anode system to predict minimum service life.
- Enough knowledge has now been gained about anode behaviour over time to allow design to any required level of steel protection.

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Corrosion Challenges for Carbon Capture and Storage – Acid Formation and Precipitation Requires Control of CO_2 Composition

Johannes Sonke, Shell

INSTITUTE OF CORROSION

Meet the Author

Johannes Sonke

Hans has built his career on a strong practical background and a natural curiosity, leading him to a wide range of roles in materials and corrosion across operations, engineering, research, and technology. He is committed to developing and applying deep technical knowledge to deliver practical and effective solutions.

Hans is currently the global expert for Materials and Corrosion in Carbon Capture and Storage (CCS) at Shell, where he provides guidance and support to many CCS projects worldwide. To address specific corrosion challenges, he is actively involved in research collaborations with several institutes and universities. In recent years, his work has focused particularly on the effect of CO_2 purity on corrosion behaviour. Hans has published extensively on corrosion issues related to oil and gas production as well as CCS. He is also actively involved in standardisation work, including serving as Chair of SC 20 / SC 26 and a TCI for CCS at AMPP.

Introduction

To mitigate CO_2 emissions from a wide range of industries, Carbon Capture and Storage (CCS) projects have been initiated to process, transport and inject CO_2 captured from multiple emitters. These CO_2 sources have a wide variety of compositions, and it has been discovered through testing in recent years that mixing the CO_2 streams can cause their impurities to react and cause precipitation of a highly corrosive acidic phase well below the water dewpoint. It was found that a group of impurities (H_2O, H_2S, SO_2, NO_x and O_2) can react to form products that include H_2SO_4 , HNO_3 as well as elemental sulphur[1-3],, which with their low solubility[4] can trigger precipitation that causes severe corrosion[6,7].

Figure 1 presents a schematic overview of these so-called CCS hub projects with a wide range of industry CO_2 sources.

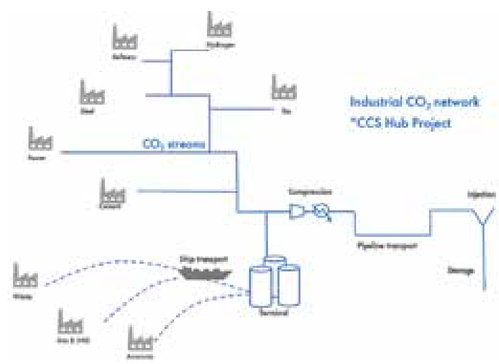

Figure 1: Schematic Overview of a Possible CCS Hub Project that Gathers, Processes, Transports and Injects CO_2 from Multiple Sources and Industries.

With the tight economics of CCS projects, it is inevitable that carbon steel will be selected for the long pipeline networks required to connect the CO_2 emitters to the storage location. This makes the management of corrosion a critical factor for the commercial viability of these projects. Corrosion control starts with setting of limits for impurities in a defined CO_2 specification. To safeguard long term integrity, control of both CO_2 composition and process conditions, in combination with highly sensitive monitoring, will be required. As new energy transition technologies like CCS are developed, diligence is needed in identifying new potential corrosion threats to avoid in-service surprises.

A standard practice has been developed by AMPP (AMPP SP 21632-2025)[8] that outlines the basic requirements for corrosion control for CCS projects. These include:

- Prevention of precipitation/drop-out of strong acids present due to interaction between impurities in transported CO_2 streams by validation of impurity limits for H_2O, H_2S, SO_x, NO_x, and O_2.
- Continuous monitoring to control the levels below the validated conditions for liquid precipitation for all operating scenario's,
- Assessment of the risk of potential off-spec scenario's,
- Incorporating the worst-case for combinations of these impurities and conditions.

The generic guidance provided by AMPP SP 21632-2025 and recent literature needs to be addressed in detail during project design and operations.

Corrosion control starts with understanding the corrosion mechanisms, including the main triggers for corrosion to occur in practice. When these are identified, the worst-case compositions and conditions can be identified and tested, leading to the development and implementation of an appropriate corrosion management strategy.

This article outlines the basic principles of the corrosion mechanism associated with acid formation and precipitation and the critical factors that need to be controlled to enable effective corrosion management, and to offer guidance for tackling the challenges associated with managing newly recognised corrosion mechanisms in CCS.

Corrosion Mechanism "Reactive Phase Behaviour"

The corrosion mechanism caused by chemical reactions and precipitation in CCS is complex and uncertain. The initial reaction can form a separate phase contributing to or leading to further reactions

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within that phase known as "reactive phase behaviour". In some cases (reaction) products adsorbed on metal surfaces cause corrosion before precipitation occurs.

The corrosion mechanism is visualised in Figure 2.

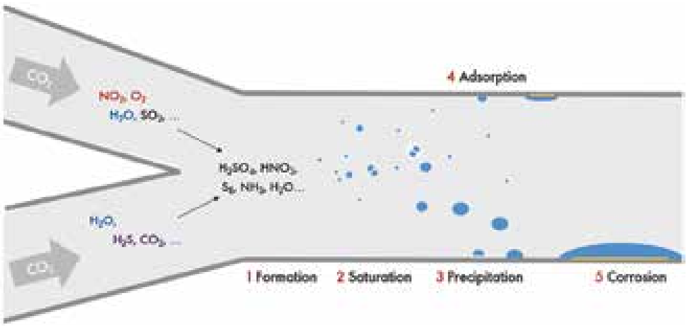

Figure 2: Corrosion Mechanism Caused by Mixing of Impure CO_2 Streams Leading to Formation of Reaction Products that Can Adsorb or Coalesce and Precipitate as a Corrosive Phase.

The corrosion mechanism is initiated when two impure CO_2 compositions, containing H_2O, H_2S, SO_x, NO_x, and O_2., interact, allowing their respective impurities to react and generate various reaction products.

The observed reactions appear to be triggered primarily by the presence of H_2S which acts as a strong reducing agent, and NO_2, which can initiate a radical chain reaction, With sufficient oxygen, these reactions can result in the formation of H_2SO_4 and HNO_3 formation [1,2,3]. Chemical equilibrium calculations (CEC) can be used to determine the likely reaction products, which can be illustrated in a stability diagram that maps hydration and oxidising strengths as shown in Figure 3. Acid formation is anticipated only when sufficient oxidising and hydration strength is present,[6,7,9,10].

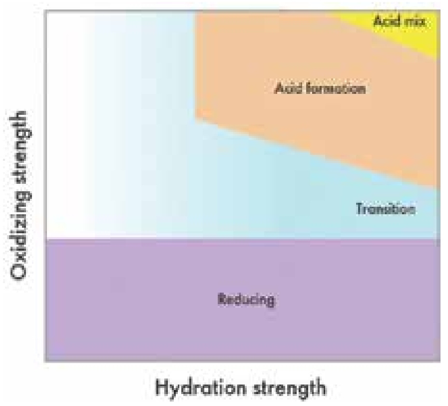

Figure 3: Visual representation of chemical reactivity as a "stability diagram" for speciation of reaction products based on the presence of different concentrations of impurities. Acids can be formed - in the orange area typically H_2SO_4 and in the yellow area both H_2SO_4 and HNO_3. The blue area indicates water saturation, and the purple area covers reducing conditions where for e.g. elemental sulfur can form.

Reaction products can coalesce to form a separate phase that can grow until the point of saturation. Due to the very low solubility of H_2SO_4 in CO_2 precipitation can be expected[4], even at low concentrations, however, discrepancies between precipitation by this mechanism and solubility measured by H_2SO_4 uptake have been identified[7]. Reasons for this include incomplete conversion of reaction products due to blocking of some chemical reactions, chemical kinetics and supersaturation before precipitation. The separate phase likely contains not only pure H_2SO_4 but also a combination of acids and water that have a strong affinity to each other potentially creating a highly corrosive phase. Comprehensive understanding of this process is currently lacking. Once acid precipitation occurs it can settle at the bottom and cause corrosion. Continuous accumulation by replenishment significantly increases corrosion rates, while discontinuous acid formation may be less severe but is unpredictable due to uncertainty around composition of precipitants, location, and duration.[6,7].

Recent findings also show that corrosion can sometimes be initiated via adsorption prior to precipitation, particularly when NO_X predominates and there is an excess of H_2O. This effect has been demonstrated in particular in gas phase CO_2.[7,9] In these situations corrosion is likely to occur around the full circumference of the pipe and affect a larger area. The process appears to result from direct adsorption and salt formation rather than strong acid formation, which may not significantly influence this mechanism. Consequently, the corrosion rate is likely to be lower, although this has not yet been fully investigated.

Condition Driving Corrosion

Effective control of corrosion requires an understanding of the triggers and critical aspects that drive the corrosion mechanism. By managing these main triggers, it is possible to prevent corrosion and develop effective mitigation strategies. The primary factors for this corrosion process include:

- Chemistry of reaction between H_2O, H_2S, SO_x, NO_x, and O_2
  - Chemical reactions initiate mainly due to the presence of NO_2 as a radical and H_2S (and to a lesser extent SO_2) as a strong reducing agent; radical chain reactions are initiated at low concentrations when these both are present.[1,2,3,6,7].
  - The presence of oxygen (O_2) promotes acid formation, and excess O_2 further pushes the equilibrium towards acid formation with an increase in conversion rate. Sufficient oxidising strength is essential for acid formation and minimal levels can lead to precipitation.[7,9]
  - While water is required for acid formation, it is not needed for H_2SO_4 formation. Even at very low concentrations, water does not appear to control this process if other hydrogen donors are available. However, too much water, even below the dewpoint, can encourage precipitation or early-stage corrosion especially when NO_x is prevalent or in gas phase.[9] Therefore, strict control over water content is critical.
- Phase behaviour
  - Lower temperatures result in the lowest solubility for acids and even at low temperatures reaction kinetics are not sufficiently slowed to prevent acid formation reactions from taking place.
  - There is a considerable difference between the thresholds for acid formation and precipitation compared to acid solubility from uptake, likely due to chemical kinetics and coalescence. The effect of flow remains understudied, and all these uncertainties create unpredictability in this mechanism.
- Corrosion
  - High rates of continuous acid formation and precipitation can lead to severe corrosion (and possibly loss of containment) with observed rates exceeding 100 mm/year [6,7]. This level of corrosion is unacceptable, so to prevent such events requires stringent control measures, real-time CO_2 composition monitoring, and alarms that immediately trigger shutdown of the source of the problem.
  - Nevertheless, many uncertainties remain. In some cases, salts may form before acids, or corrosion may precede acid formation[9], typically across larger areas, with significantly lower corrosion rates. Such scenarios might be acceptable during specific upset conditions, but then a more detailed understanding is required.

Corrosion Control

To effectively manage corrosion the following actions can be taken:

1. Identify non-corrosive CO_2 compositions by determining threshold concentrations for precipitation, considering all impurities and lowest operating temperatures. Chemical Equilibrium Calculation (CEC) can be used to assess reaction tendencies, oxidising/hydration strength[7,9,10]. and equivalent sulphuric acid concentration C_{acid} . These help identify worst case scenarios for acid formation and precipitation that can be tested to verify that no precipitation occurs under all operating scenario's[11].

2. Composition controls should include alarms to critical impurities at the emitter side source before acids form, as dissolved acids are hard to detect. This requires special techniques for control since the limits can be low and stringent. Collaboration with emitters will help anticipate possible effects of upsets and enable early intervention.

a. Exceedance of individual limits may be acceptable during an upset if outside the acid formation and precipitation ranges. CEC can be used for assessment of these incidences, and acceptance may be provided H_2S and NO_x are not present at the same time.

3. If an upset causes acid formation and precipitation, the impact on integrity can be evaluated based on oxidising/hydration strength and sources like H_2S and NO_x, also considering the consequence of possible delayed reactions if one impurity increases after mixing.

4. Inspection and corrosion monitoring using automated and highly sensitive probes (e.g. UT) should target low temperature areas prone to precipitation, such as a gas sphere, low-point of a vessel or pipework, considering a CRA (Corrosion resistant alloy) or cladding for such sections is suggested. For pipelines this is often too complex or costly to address fully, and it is recommended to keep conditions in dense phase with shut-in during upset scenarios and keep phase transitions to the minimum (since acid solubility seems much lower in gas phase than in dense phase).

Summary and Conclusions

Progression towards the energy transition and the development of an emerging industry, such as CCS-Hub facilities, introduces distinct corrosion challenges. Due to the rapid expansion of this sector, prompt and effective measures are essential to mitigate excessive corrosion. To safeguard asset integrity and prevent premature failures that may adversely affect the industry's reputation.

Effective corrosion control requires active management of the composition of the CO_2 during its capture, transport and storage, especially with respect to purification and process controls. As part of a comprehensive corrosion management strategy the following steps are recommended:

1.Understand and continuously review the composition of the sources of CO_2 feeding into the project to identify a possible risk of chemical reactions that can cause acid precipitation and corrosion.

2. As carbon steel is usually the most cost-effective option. it is necessary to establish and enforce an IOW (Integrity Operating Window) that requires inclusion and clear definition of composition and impurity thresholds that avoid corrosive conditions.

3. Consider using CRAs in areas where a high acid precipitation risk may exist, since corrosion rates due to continuous acid precipitation can be extreme.

4. Maintain operations within the non-corrosive conditions through strict automated monitoring and control of composition.

5. Develop upset management protocols, identifying scenarios where deviations may be acceptable as long as they are not resulting in significant acid precipitation.

6. Implement broader corrosion management initiatives such as:

   a. Review of compositional upsets, especially individual components to evaluate their potential impact and determine locations for inspection.

   b. Perform focussed automated inspection and corrosion monitoring at critical locations (e.g. tank bottoms or cold sections).

   c. Develop mitigation strategies, including possible closely monitored composition to prevent acid formation and precipitation, recognising that this is currently a largely unexplored topic.

Due to the numerous unknowns associated with this corrosion mechanism due to reactive phase behavior, ongoing research is being conducted to identify its key triggers. To date, only a limited range of non-corrosive composition thresholds have been established for specific conditions.

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Rapid Hydrogen Content Screening in Structural Metals and for Engineering Applications

Tom Hillman and Prof Dirk Engelberg, University of Manchester

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Meet the Author

Tom Hillman

Tom, our ICorr member, is a PhD student, who is finalising his PhD thesis at the University of Manchester with a BSc in chemistry and physics from Keele University. His research has focused on establishing multi-technique-informed pitting corrosion detection and monitoring techniques – such as hyperspectral imaging (HSI) – for remote inspection of marine infrastructure. He has developed the use case for hydrogen mapping with laser-induced breakdown spectroscopy (LIBS) to detect occluded corrosion reactions. Additional research focuses include development of rapid, low-cost hydrogen detection routines; depassivation mechanisms; and leveraging atomic hydrogen for engineering applications.

INSTITUTE OF CORROSION

Meet the Author

Prof Dirk Engelberg

Dirk Engelberg, our ICorr member, is a professor in materials performance and corrosion at the University of Manchester. He obtained a Dipl.-Ing. (FH) in Surface Engineering and Materials Science from Aalen University (Germany) before moving to Manchester in 2000 for an MSc in Corrosion Science and Engineering and a PhD in Metallurgy and Materials Science. He joined the Corrosion and Protection Centre as an academic lecturer in 2010, which is now part of Metallurgy and Corrosion (Corrosion@Manchester) in the Department of Materials. Dirk's research is centred on (i) understanding material degradation related to the storage, disposal, and decontamination of nuclear waste; (ii) applied electrochemistry and high-throughput screening techniques; (iii) development of innovative solutions for net-zero engineering; and (iv) localised corrosion, stress corrosion cracking, and hydrogen embrittlement. Dirk is also an expert in microstructure engineering and leads several cross-disciplinary projects combining mechanical, civil, and chemical engineering with chemistry, physics, and materials-based research.

Introduction

Under the Net-Zero drive, Hydrogen energy and infrastructure have seen tremendous growth with electrolyser technologies having seen a 3-4 fold increase in investment over the past years alone [1]. It is therefore expected for hydrogen to grow in its proliferation as a means for energy production and storage. However, being the smallest atom and having an extremely high diffusivity leads to deleterious effects on the mechanical properties of steels, typically referred to as hydrogen embrittlement (HE). Here, the localised presence of diffusible hydrogen atoms within the microstructure can result in local embrittlement and lead to premature component failure [2], [3], [4]. This is not limited to hydrogen storage or transport alone: hydrogen generation from cathodic sites under atmospheric corrosion conditions may also induce crack nucleation in certain alloy classes [5], [6], [7], [8], [9], [10].

It is therefore pertinent to establish techniques for localised hydrogen concentration detection and quantification in metals and engineering structures. Existing analytical methods are, however, limited. Some require the destruction of the test specimen – such as TDA/TDS [11], [12], [13] and hot/melt extraction [14], [15], [16], [17] – or adequate surface preparation – SKP [8], [18], [19] or GD-OES [20], [21]. Destructive techniques may require temporary shutdown for hydrogen contents to be measured and limits on surface condition may stymie the range of regions of interest [22], while the low diffusivity of hydrogen in widely used austenitic steels place potentially untenable detection times for devices such as gas sensors [23], [24].

Laser-induced breakdown spectroscopy (LIBS) is a localised, "quasi-nondestructive" technique for the acquisition of atomic spectra (Figure 1). A high-power laser is fired at the sample surface, often alongside a purge of inert gas (Ar, He, Ne, or other combinations [25]). A small volume (order of a few μm^3) of the specimen's surface is ablated and ionised, and optical photon emission – characteristic of the elements that make up the material – from the plasma recombination is then captured by a charge-coupled device (CCD).

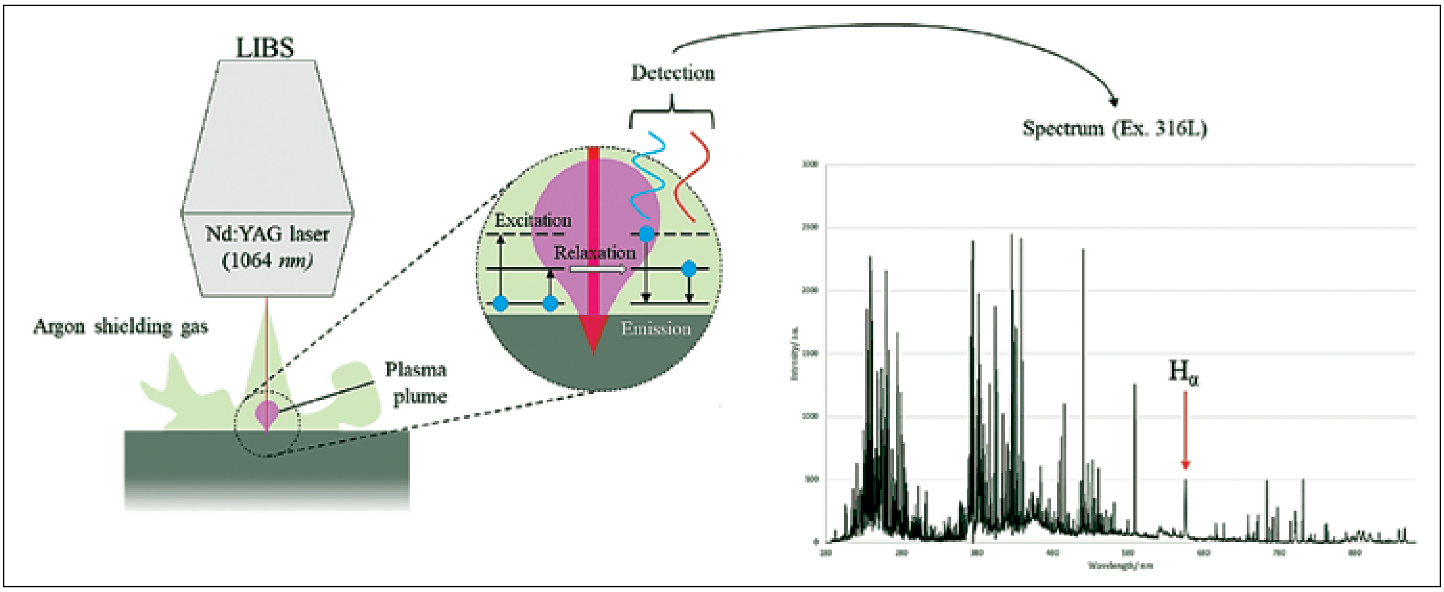

Figure 1: Sketch of the Working Principle of LIBS. The H_α Line Used for Hydrogen Determination is Highlighted.

A utility of LIBS is that it is scalable, and this has been exploited for use in geological and alloy identification for in-situ inspections [26], [27]. Additionally, the LIBS technique itself can capture the hydrogen H_α line at 656.2nm [28] and has been increasingly studied in recent years, with applications ranging from tritium monitoring in fusion reactor walls to hydrogen uptake in steel welds [28], [29], [30], [31]. In this article, the use case for localised hydrogen detection and quantification is demonstrated with a portable, hand-held LIBS device.

Experimental and Calibration

Initially, three 'hydrogen in steel' calibration standards of concentrations 0.95ppm (SciLab), 2.3ppm (SciLab) and 6.23ppm (LECO) were cold mounted in an epoxy resin and cured for 48 hours before grinding to P1200 with Silicon carbide (SiC) paper to expose the steel surfaces of each. LIBS spectra were acquired using 14 locations per standard. Two LIBS shots were applied per location, with the first as a "cleaning" shot and the second shot for spectra acquisition. This was done for each location to ensure minimal contribution of hydrogenated surface contaminants.

Figure 2: Mounted Hydrogen in Steel Standards with LIBS Shot Ablation Visible on Each of the Standard Surfaces.

Subsequently, four X52 steel coupons with dimensions 50.0mm × 5.0mm × 1.2mm were cut from a pipe section with an SiC abrasive cutoff wheel before surface grinding to P1200 with SiC paper. Coupons were rinsed with DI water before washing with ethanol and drying under cold air. Each coupon was cathodically charged in 0.1M NaCl under a current density of 15 mA cm^2 for 122, 165 and 203 minutes to establish different hydrogen concentration depth profiles. Coupons were rinsed after hydrogen charging with DI water and ethanol and then dried under cold air prior to LIBS acquisition. Two LIBS shots were recorded for each charging time, with spectra obtained close to the center point of the charging surface of each coupon. The first shot was taken as surface concentration measurement with the second shot assumed to be more indicative of the immediate sub-surface hydrogen concentration, allowing influences of surface conditions to be compensated for. The time interval from specimen hydrogen charging to LIBS surface analysis was recorded and kept to a minimum—typically less than 60 seconds—to avoid excessive hydrogen effusion.

LIBS spectra were obtained with a SciAps Z300 handheld LIBS unit equipped with a Nd:YAG 1064 nm laser with energy 5-6 mJ per pulse and Ar purge. Spectral integration time and delay were 1 ms and 250 ns, respectively. All LIBS spectra were processed in the same way: Voigt peak profiles were fitted to the H_α line at 656.2 nm and Ar(I) line at 763.5 nm, respectively, for each analysis and averaged. The resultant H_α peak intensities were normalised to the Ar(I) peak intensities. This peak was chosen for normalisation (over any of the Fe peaks), as it allows for comparison between spectra taken from different materials (such as carbon steel and stainless steel) and is in principle, independent of matrix composition. In this way, hydrogen abundance is normalised to the plasma composition only.

Results and Discussion

The calibration routine with results of both LIBS shots (1st cleaning + 2nd results) is summarised in Figure 3, indicating a larger variation of the surface concentration shot. This could be due to differences in the top surface sample condition and composition, for example, due to adherent water or near-surface physical/chemical discontinuities. The plot also highlights the efficacy of using an internal standardisation routine for LIBS calibrations for hydrogen abundances in stainless steels. The relationship between measured hydrogen concentration and LIBS signal was then approximated using these standard readings and applied to spectra obtained on the cathodically hydrogen-charged X52 line pipe steel samples. Expected hydrogen concentration readings in mild steel and carbon steels are typically in the sub-ppm range (<1 ppm), up to a few ppm, considering analysis of chemical/physical surface discontinuities.

The results in Figure 4 demonstrate the expected effect of charging time under constant current on the X52 coupons. A change of the measured hydrogen concentration for X52 samples in the as- received condition (before hydrogen charging) to material cathodically charged is clearly present. However, the variation of the obtained signal is quite large and overshadows clear trends of longer hydrogen exposure times. As expected, there is a marked increase in the calculated hydrogen abundance with hydrogen exposure. Of note is that the determined ppm values from the X52

continues on page 40

samples fall above the calibration range used and are far larger than typically expected in mild/carbon steel. It is not certain at this point how linear the relationship is between hydrogen abundance and the $H_{\alpha}/Ar_{(763.5)}$ peak height ratio far above the tens of ppm range. In the current stage, LIBS can be used to qualitatively determine differences between charged and uncharged microstructure conditions, but more work is needed to obtain quantitively reliable hydrogen readings. Further work is currently underway to (i) isolate the effect of relative humidity (adsorbed surface water) on the obtained hydrogen signal, (ii) to deconvolute effects of multiple LIBS shots on hydrogen redistribution, and (iii) application of LIBS to measure diffusion coefficients.

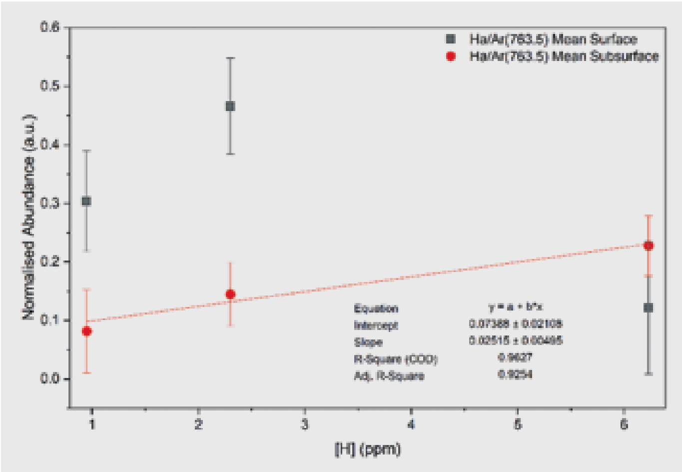

Figure 3: Calibration Plot of Analysed Hydrogen Standards for Normalised Hα Peak Intensity to the Ar763.5 Peak.

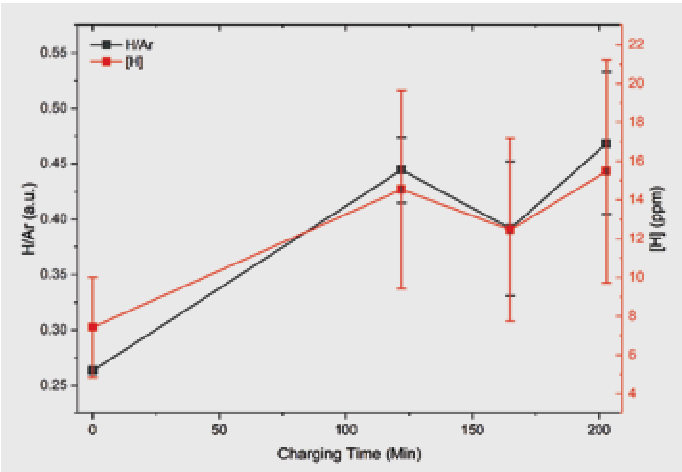

Figure 4: (Left) Measured H/Ar Peak Ratios; (Right) Calculated Hydrogen Abundances.

Conclusions

A handheld LIBS device has been calibrated on hot/melt hydrogen calibration pins, and qualitative differences in hydrogen content readings have been demonstrated on cathodically charged X52 coupons from a pipe section. The adoption of LIBS as a PMI (Positive Material Identification) technique in industry is strong, with advanced applications emerging, particularly in mining, manufacturing, and quality control. This article demonstrated that with correct calibration standards and data treatment, existing routines can readily be adapted into localised hydrogen measurement techniques. The application of these techniques for structural maintenance applications and fitness-for-service inspection is currently under development but shows great promise at this stage.

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Pipelines and Cables Direct Current (DC) Mapping for the Assessment of Cathodic Protection Systems of the Above Ground Storage (ATS) Bottom Plate Soil Side

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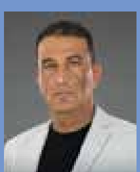
Meet the Author



Kamal Mohmed El Sayed Moussa

Kamal our ICorr member is a principal engineer in corrosion and metallurgy, a subject matter expert in corrosion engineering with a focus on cathodic protection, protective coatings, material performance, and water chemical treatment. My role encompasses providing solutions for corrosion mitigation through material selection, failure analysis, cathodic protection, protective coating, and water chemical treatment to ensure asset integrity and durability in operational and new projects. With over 25 years in the petroleum and petrochemical industries, I specialise in corrosion monitoring and mitigation, leveraging state-of-the-art technologies for sustainable designs. My work reflects a commitment to optimising operational performance through cost-effective and innovative approaches.

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Introduction

This document considers the effectiveness of cathodic protection for tanks designed and constructed on asphalt /sand mix backfilling, utilising DC current mapping and other assessment tools to verify and extend asset life till the installation of effective cathodic protection system.

Above ground storage tank (AST) bottom plate soil-side corrosion is a major cause for AST bottom deterioration with subsequent environmental impact of leaks in petrochemical facilities. AST construction, prior to the 1987's, were often on a continuous asphalt/sand mix pad (API 651clause 5.3.6) with the belief that asphalt helps in the compacted back filling leveling and would minimise the external corrosion of the bottom plates soil side, as it is a physical barrier.

The subject case of above ground storage tanks (AST), where shells were typically supported by concrete ring walls, and the bottom plates supported by a compacted base, with top layer of 100 mm liquid asphalt/sand mix. (Asphalt bases are now restricted by current API 651 standards). These old tank bottoms were bare carbon steel with higher protective current demand.

An impressed current cathodic protection (ICCP) system using a distributed anodes outside the concrete wall ring was historically installed to provide CP to the AST soil side bottom. The CP design current was maintained to the AST and the recorded tank-to-soil potential measured around the perimeter only of the AST during the annual CP survey met the CP polarised potential criterion.A seal was placed between the AST chime plate and the concrete ring wall to prevent contaminated rainwater access underneath the AST. Due to tank bottom plate foundation seal ageing and damage, contaminated rainwater commonly ingresses under the AST, contaminated water was then encapsulated in the gap between the bottom plate metal and the asphalt layer. An asphalt pad is prone to hardening and cracking over time, in addition if there is no HDPE liner below the tank, ground water can reach the bottom through capillary action and corrode the bottom plate along the cracked line of the asphalt where CP cannot effectively protect the bottom plate.

Severe bottom plate 'soil side' spot metal loss is typically found during bottom plate MFL/UT routine scan.

The CP design did not consider that pipelines and earthing (electrical grounding) cables in contact with the AST would provide a circuit (current drain) to other facilities and would allow the underground plant structures to pick up this current and return it via the piping/cable network.

After many years of cathodic protection installation, AST bottom plate MFL scan reports revealed severe spot tank bottom plate soil side corrosion, and more than 60 patch repairs were installed as per API 653 requirement for one tank. The calculated tank bottom plate soil side short term corrosion rate was found extremely high (approaching 0.45 mm/year or 17.7 mils/year). This clearly indicated that the CP system was not effective in mitigating corrosion or in distributing protection to the required zones.

Case Study Background

Below data and inspection history of these subject tanks covered by the study:

Table 1 - Tanks Original Construction Details Year 1987.

Tank ID	Material of construction (MOC)	Foundation and backfilling Base	Diameter (m)	Leak detection with HDPE sheet barriers	Cathodic Protection for bottom plate soil side	Service
SS-T-X	Carbon Steel	Concrete ring wall with 100 mm liquid asphalt/sand mix backfilling	29	Not Installed	Not Installed	Fire water
SS-T-Y	Carbon Steel		8.7	Not Installed	Not Installed	Demin water

(A) The AST tanks were constructed with a concrete ring wall and asphalt/sand mixed backfilling, as a corrosion mitigation method at that time (Figure 1). This design comprising asphalt/sand mix as a backfilling material under tank bottom plate to provide levelling and act as a barrier for corrosion mitigation, this is now restricted by NACE SP0193-2016-SG and API 651 standards.

API 651

"A pad of new asphalt may provide many of the same advantages and disadvantages as a concrete pad for reducing corrosion and eliminating the need for cathodic protection. Proper support to prevent cracks and to prevent accumulation of water between the pad and the tank bottom is an important consideration. Asphalt degrades with time and can provide a path for water and dissolved contaminants to come into contact with the steel tank bottom, allowing corrosion to occur. Cathodic protection, if applied, may or may not aid in stopping corrosion when the asphalt becomes deteriorated. In fact, deteriorated asphalt may shield cathodic protection current in a manner similar to a disbanded coating on a pipeline. The condition of the external surface of the tank bottom as well as the asphalt can be determined if coupons are cut from the tank bottom. For new tank construction, use of asphalt pads is discouraged."

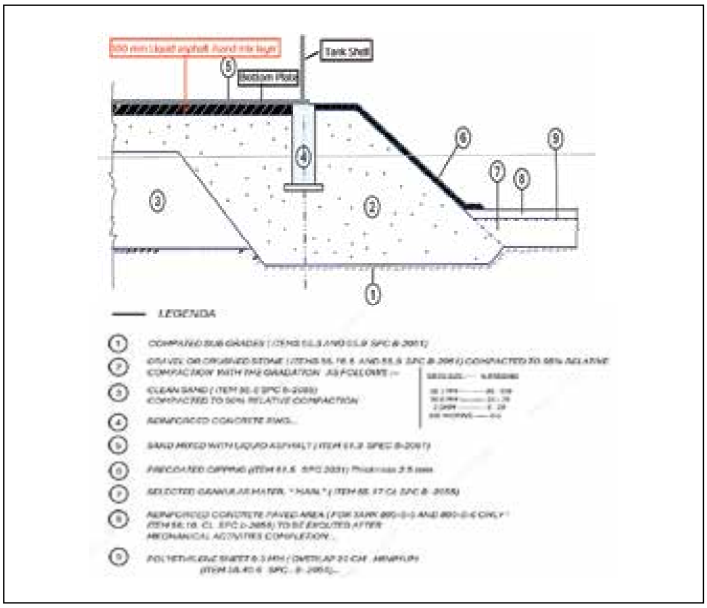


Figure 1 - Details of AST Concrete Ring Wall and Continuous Liquid Asphalt/Sand Mix Pad.

Inspection Finding and Repair History

(SS-T-X Fire water tank), the latest bottom plate MFL scan and UT verification year 2018 revealed new twenty locations with severe metal loss at soil side. The maximum short term corrosion rate calculated was 0.40 mm/year. A total of 60 patch repairs has been recorded on the AST bottom plate and annular plate. (SS-T-Y Demin water tank), The latest MFL scan and UT verification 2019 of the bottom plate revealed average metal loss of 60% to 70% thickness on all areas (long term corrosion rate was 0.2 mm/year) ,19 patches have been welded then bottom plate already replaced.

SS-T-X Fire water tank coupon analysis

1) Asphalt/sand mix layer still intact after 20 years in service.
2) Metal loss more than 60% measured at many locations.
3) Heavy scales found on the asphalt layer underneath the bottom plate indicating sever corrosion.

SS-T-Y Demin water tank CP measurement inside the tank

1) CP instantaneous off' potential below asphalt found -1.23 V via CSE ref electrode reflecting the potential of the underground metal (piping) shorted with tank shell.
2) CP instantaneous off' potential outside tank concrete wall found -1.3 V via CSE ref electrode reflecting the potential of the underground metal (piping) shorted with tank shell.
3) CP on potential above asphalt found zero Volt via CSE ref electrode indicating electrical isolation between anodes and tank bottom plate soil side.

Photos: Bottom Plate Metal Loss During PM Inspection Coupon Cut for Analysis.

Details of the ICCP system installed in 2008 are given in Table 2. It was designed using an arbitrary current density of 20 mA/m^2 (2 mA/ft^2) which is a common empirical value for bare steel in soil (where electrical isolation exists). The design employed shallow distributed canister anodes installed as a ring around the AST concrete ring wall, which were serviced with a 35 A rated transformer rectifier (TR).

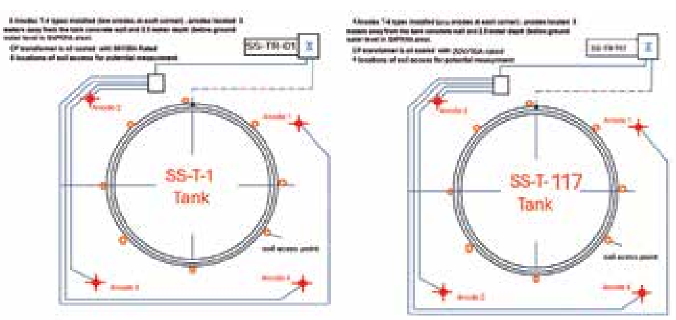
Table 2 - Impressed Current Cathodic Protection System Details Installed 2008.

Tank ID	TR ID	TR rating		No. of Anodes	Type of Anodes
		V (Volts)	A (Amps)		
SS-T-X	SS-TR-X	50	35	8	T-4 High silicon cast iron
SS-T-Y	SS-TR-Y	20	10	4	T-4 High silicon cast iron

The operating details of the ICCP system are given in Table 3. As the minimum design current was 13 A, the TR was operated at 13.3A.

Table 3 - AST ICCP Design and Operating Current.

Tank ID	Diameter (M)	Surface Area (m2)	Current Density mA/m2	Minimum Design Current (A)	Operating Current (A)
SS-T-X	29	660	20	12	13.3
SS-T-Y	8.7	60	20	1.2	5



SS-T-X, 29-meter Dia with 8 anodes

SS-T-Y, 8.7-meter Dia with4 anodes

Figure 2 - Cathodic Protection System Layout.

Survey Methods

A CP survey should include current measurements in all connecting metallic paths such as piping and earthing cables (electrical grounds).

The effectiveness of cathodic protection (CP) was further evaluated by using a clamp-on meter to measure the direct current (DC) in the connected pipes and cables in order to assess the amount of CP current lost to other underground structures. The results revealed that most of the CP current was indeed impressed onto the adjoining underground plant network and very little to the ASTs themselves. Thus, contrary to the total current and potentials at the circumference of the tank indicating effective CP, the more remote AST soil side bottom plates did not receive sufficient CP current, as the measured tank- to-soil potential during the CP survey only reflected the potentials of the underground plant piping which electrically shorted with the tank shell and not representative of the underneath tank bottom plate.

Table 4: SS-T-01 Last Plate Metal Loss During PM Inspection Coupon Cut for Analysis.

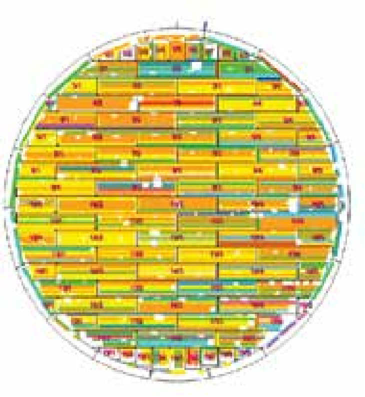
T.P. No	Structure No.	Unit	Location	Structure to Soil Potential (mV)	
				ON Potential (Acceptable Value: More Negative than -1000 mV)	Instant OFF Potential (Acceptable Value: More Negative than -850 mV)
1	SS-T-X	110	Counterclockwise direction from CPR #1	-1036	-905
2	SS-T-X	110	Counterclockwise direction from TP # 1	-1125	-939
3	SS-T-X	110	Counterclockwise direction from TP No.2	-893	-736
4	SS-T-X	110	Counterclockwise direction from TP No.3	-1204	-936
5	SS-T-X	110	Counterclockwise direction from TP No.4	-1054	-931
6	SS-T-X	110	Counterclockwise direction from TP No.5	-1095	-866
7	SS-T-X	110	Counterclockwise direction from TP No.6	-996	-875
8	SS-T-X	110	Counterclockwise direction from TP No.7	-1040	-930
9	SS-T-X	110	Under tank soil access beside TP 3 (south side)	-572	-542

Key Findings

- The more positive potential readings (Table 4) on the under-tank soil access (TP 9) indicates that there is not enough CP current penetrating from the anodes outside the ring wall to the bottom plate due to a very high resistance path introduced by the layer of concrete and asphalt.
- The more negative potential readings on the test stations (TP 1 to TP 8) taken on the soil access outside the ring wall is influenced by the underground fire water pipeline connected to the tank. Also, some changes in reading due to soil voltage gradient from the anodes.
- From the above premises, it is concluded that the more accurate potential reading of the soil side bottom plate is the one taken from under tank soil access. A better potential profile can be taken if there was a monitoring tube installed underneath the tank to allow readings to be taken at the center of the tank.
- Nonetheless, since the instant-off potential from available soil access underneath the tank, located close to the borders or tank shell, is not meeting the potential criteria, this indicates that the center of the tank most likely is not receiving enough CP current to meet the criteria.

Conclusion: AST's are not isolated from adjoining structures and the Tank bottom plate soil side is electrically insulated shielded from the cathodic protection anodes by the (cracked) asphalt layer and additionally the tank did not receive proper protection (bottom plate to soil instant off potential record being – (ve) 542 mv w.r.t CSE which almost the native potential of CS bottom plate.

continues on page 44

Location and % of thickness loss	Color for % thickness loss
	Discontinuity Colour Scheme 20%-29% 30%-39% 40%-49% 50%-59% 60%-69% 70%-79% 80%-89% 90%-100% Weld Discontinuity

A) The latest MFL scan and UT verification 2024 of the bottom plate revealed 20 locations with severe metal loss. The maximum short term corrosion rate calculated was 0.45 mm/year A total of 60 patch repairs have been recorded on the AST bottom plate and annular plate since construction.

B) Visual inspection during tank opening revealed that all the 20 locations were soil side corrosion.

Figure 3: SS-T-X (Tank Bottom), Last MFL Scan 2024 – These will Not Reproduce Well as Presently Supplied.

Field Tests and Measurements

CP survey results are given in Table 5. For SSTR-04 tank

The instant OFF potentials criterion is more negative than -850 mV via CuCuSO4 ref electrode.

Table 5: Conventional Cathodic Protection (Tank-to-Soil Potentials).

T.P. No	STRUCTURE NO	LOCATION	Structure to soil potential (mV)	
			ON Potential (Acceptable Value: More Negative than -1000 mV)	Instant OFF Potential (Acceptable Value: More Negative than -850 mV)
1	SS-T-01 (Tank Bottom)	Counterclockwise direction from CPR #1	-1155	-1032
2	SS-T-01 (Tank Bottom)	Counterclockwise direction from TP # 1	-1196	-963
3	SS-T-01 (Tank Bottom)	Counterclockwise direction from TP # 2	-992	-891
4	SS-T-01 (Tank Bottom)	Counterclockwise direction from TP # 3	-1248	-941
5	SS-T-01 (Tank Bottom)	Counterclockwise direction from TP # 4	-1118	-931
6	SS-T-01 (Tank Bottom)	Counterclockwise direction from TP # 5	-1090	-944
7	SS-T-01 (Tank Bottom)	Counterclockwise direction from TP # 6	-1043	-963
8	SS-T-01 (Tank Bottom)	Counterclockwise direction from TP # 7	-1103	-995
9	SS-T-01 (Tank Bottom)	Under tank soil access beside TP 3 (south side)	-603	-597

The measured potential under tank bottom plate showing native potential and the on -off conditions almost equal which indicates that bottom plate metal did not receive protective current from the transformer rectifier (electrically isolated by concrete wall and the asphalt layer).

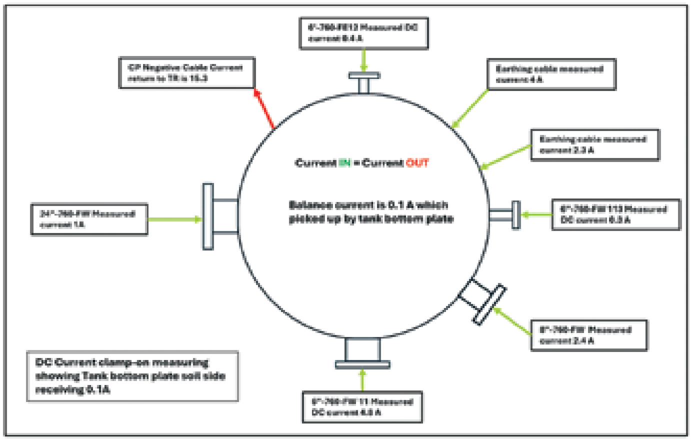


Figure 4: Scheming forPipelines and Cables DC Current Flow.

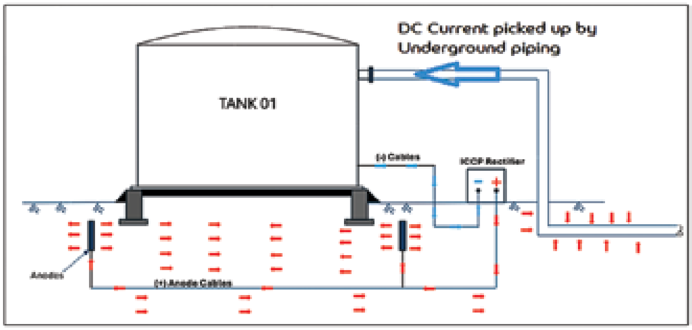


Figure 5: Simplified Schematic Drawing Showing the DC Current Passes.

Pipelines and Cables DC Current Mapping by Using Clamp-On Meter.

The actual current being impressed on to the AST bottom plates was determined by measuring the current return on the piping and earthing (ground) cables connected to the AST. The difference between this current and the TR output is the **balance** current impressed on to the AST.

The results of this test on Tank T-4 are given in Table 5. The current paths are illustrated in Figure 2.

Additional assessment method was by using a clamp-on meter.

Tank SS-TR-X Pipeline and Cable Current Measurement

Table 6: Transformer Rectifier SSTR-4 Operating at 7V/15.3.

Pipeline / Cables ID	Measured DC Current. (Amps)	DC Current Direction	DC Current Direction
6”-760-FW12	0.4	Towards tank body and attachments	Protective CP current picked up by non-isolated underground plant structures and piping and returned to AST through pipe wall metal and earthing cables.
6”-760-FW113	0.3	Towards tank body and attachments	
16”-760-FW11	4.8	Towards tank body and attachments	
24”-760-FW	1.0	Towards tank body and attachments	
8”-760-FW	2.4	Towards tank body and attachments	
Earthing cables	4.0	Towards tank body and attachments	
Earthing cables	2.3	Towards tank body and attachments	
Total current	15.2	Towards tank body and attachments	
Transformer output current (A)	15.3		
Net Current to AST	0.1	Majority of TR output current is returning to the AST through pipelines and cables as picked up by other underground structures	

Notes:

1. Tank designed and constructed on concrete ring wall with asphalt/sand mix backfilling.
2. Tank was not provided with leak detection system.
3. Tank was not provided with HDPE barrier.
4. Tank service is conductive fire water, and all the connected pipelines were not provided with electrical isolation kite.
5. Earthing cables were not provided with decoupler to prevent CP current to be picked up by earthing network and all the underground connected metals.

Analysis

Although the CP design assumed all current would be impressed on to the AST bottom plates, they only received less than 1% of the total current. This can be explained by a study of the relative resistance of the two circuits: one to the AST bottom plates and the other to the plant underground structures. A simplified explanation is given below.

- Asphalt/sand mix layer acting as electrical insulator and preventing CP current to reach the tank bottom plate.
- Available CP current will take the least resistance path to other underground metal which electrically shorted with tank metal.
- The measured' structure to soil' potential outside the tank ring wall reflecting the potential of the nearby underground fire water network which shorted with the tank metal.
- Such CP design is not correct or effective if we have additionally an electrical insulator (e.g., asphalt) between anodes and the bottom plate soil side.

Recommendations

- Future CP design shall consider the electrical isolation of all the connected pipelines (e.g. using isolation flange kite) and decoupler to isolate the earthing cables.
- A pre-design drain current test shall be conducted along with pipelines and cables DC current mapping.

Conclusions

There are several learnings from this study relevant to future Tank Protection projects.

The case tanks were considered without cathodic protection system and volatile corrosion inhibitor (VCI) was introduced along with corrosion probes to mitigate and monitor the tank bottom plate soil side corrosion until the bottom plate replacements were achieved, with a new cathodic protection system of grid MMO anodes and chloride free sand backfilling.

- The **deteriorated** asphalt base contributed to the corrosive environment by keeping contaminated water in the **annulus** underneath the AST bottom plate and shielding the CP current by its high resistance path to AST tank bottom plates, **especially at the centre of the tank base.**
- Although asphalt is no longer an acceptable backfilling material, the use of sand can result in a similar undesirable distribution of current between the AST and the plant if many tanks shared one transformer rectifier and soil resistivity beneath the tanks were different.
- A CP designer must consider the **likely** loss of CP current to structures not intended for CP and alter the design or include features in it to ensure that the AST receives the intended current.
- Tank foundation configuration, existing of nonmetallic HDPE sheet, oily sand, asphalt shall be considered during **future** CP system design with distributed anodes outside the concrete ring wall **and with suitable center tank monitoring soil side.**
- CP **pre-design** surveys of the existing ASTs should use current drain test considering pipeline and cables DC current measurements to **more accurately determine** actual current being impressed on to the AST bottom plates.
- For current situation volatile corrosion inhibitor (VCI) method **when regularly implemented** along with corrosion probes can be used until bottom plate replacement along with popper backfilling, leak detection system, and CP system with grid MMO anodes and complete electrical isolation of all piping and cables.

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Website: www. ceocor.lu

ELSEVIER SCIENCE LTD
Tel: 01865 843000

GALVANISERS ASSOCIATION
Tel 0121 355 8838 Email: Ga@hdg.org.uk

INSTITUTE OF MATERIALS FINISHING (IMF)
Unit 2 The Coutyard, Roman Way, Birmingham B46 1HQ
Contact Helen Wood Email: helen@materialsfinishing.org
Tel: 0121 622 7387 www.materials-finishing.org

OIL & COLOUR CHEMISTS' ASSOCIATION (OCCA)
4th Floor Clayton House, 59 Picadilly, Manchester M1 2AQ
Contact Ann-Marie Etherington Email: admin@occa.org.uk
Tel 0161 257 6488 www.occa.org.uk

MARINE CORROSION FORUM
Website: www. marinecorrosionforum.co.uk

QUALITY CONTROL

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

TRAINING AFFILIATES

ARGYLL RUANE LTD
Email: kristian.hampson@argyllruane.com
Web: www.argyllruane.com

CORRODERE ACADEMY
Tel: 01252 732236 **Web:** www.corrodere.com
Email: andrew@corrodere.com

ICATS / CORREX
(MD - Paul Brooks) **Email:** PBrooksMD@correx.org
Email: correx@icorr.org

Institute Events & Training

DIARY DATES 2026

Latest event details are posted at:
https://www.icorr.org/events/
General enquiries to:
Institute of Corrosion admin@icorr.org

EUROCORR

6th – 10th September 2026 in Dublin/Ireland
Web: Eurocorr 2026
Email: gareth.hinds@npl.co.uk

BRANCH EVENTS

25th June 2026, Midlands Branch
Online technical meeting.
Contact: Midlandschair@icorr.org

26th June 2026, North-West Branch
In-Person ICorr Regional Research Exchange: North-West, Yorkshire & Humber Branches
Contact: nwchair@icorr.org

30th June 2026, Aberdeen Branch
Online technical meeting.
Contact: ABZchair@icorr.org

9th July 2026, North-East Branch
Summer Social Walk
Contact: nechair@icorr.org

28th August 2026, Aberdeen Branch
In-Person technical talks (CAD Day).
Contact: ABZchair@icorr.org

YICORR/YEP

25th June 2026, YEP
In Person Event - YEP Session 6 – Coatings & Linings.
Contact: youngicorrchair@icorr.org

COURSES AND EXAMS

Cathodic Protection (CP) Training Scheme

Buried Level 1
20th–22nd July 2026, Argyll Ruane Ltd., Sheffield
7th–9th September 2026, Argyll Ruane Ltd., Sheffield
28th–30th September 2026, Argyll Ruane Ltd., Sheffield
19th–21st October 2026, Argyll Ruane Ltd., Sheffield
30th November–2nd December 2026, Argyll Ruane Ltd., Sheffield

Buried Level 2
26th–30th October 2026, Argyll Ruane Ltd., Sheffield

Buried Level 3
29th June–3rd July 2026, Argyll Ruane Ltd., Sheffield
21st Sept- 25th Sept 2026,
12th–16th October 2026, ICORR Training and Examination Centre
2nd–6th November 2026, ICORR Training and Examination Centre

Concrete Level 2
14th–18th September 2026, ICORR Training and Examination Centre

Concrete Level 3
1st–5th June 2026, ICORR Training and Examination Centre
16th–20th November 2026, ICORR Training and Examination Centre

Marine Level 2
6th–10th July 2026, ICORR Training and Examination Centre

Marine Level 3
8th–12th June 2026, ICORR Training and Examination Centre

EXAMS

All based at Northampton HQ
CP Level 4, 10th September 2026
CP Level 4, 26th November 2026

ETGB

Supports ICorr membership, Chartership and CPD requirements, offering a comprehensive range of courses at its Northampton HQ Training Centre and now globally through its supporting partners.

Fundamentals of Corrosion for Engineers (FOCE)
14th - 18th September 2026, Northampton HQ
Microbiological Induced Corrosion (MIC)
12th - 16th October 2026, Northampton HQ

STGB

Other than final certification, these courses are operated and administered by our two approved Training Partners – Argyll Ruane and Corrodere.

Hot Dip Galvanising Inspector Level 2
Online, sign up anytime

Protective Coatings Inspector Level 1
10th–17th August 2026, Sheffield
14th–21st September 2026, Sheffield
12th–19th October 2026, Sheffield
2nd–9th November 2026, Sheffield

Protective Coatings Inspector Level 2
7th–14th September 2026, Dunfermline
16th–23rd November 2026, Sheffield

Insulation Inspector Level 2
Online, sign up anytime

Passive Fire Protection (PFP) Coating Inspector (Cementitious) Level 2
Online, sign up anytime

Passive Fire Protection (PFP) Coating Inspector (Epoxy) Level 2
Online, sign up anytime

ICorr Recertification Programme Available for all core methods
Online, sign up anytime

Transition to ICorr Programme
Online, sign up anytime

ICorr Training Partner Coating Training and Practical Workshops

- Inspection Level 1
- Coating Inspection Level 2
- Coating Inspection Level 3
- Insulation Inspection Level 2
- Pipeline Coating Inspection Level 2
- Hot Dip Galvanising Inspection Level 2
- Thermal Metal Spraying Inspection Level 2
- Transition to ICorr Level 1
- Transition to ICorr Level 2

All above available Online. Sign up anytime. Refer: Corrodere Academy | Accredited Coatings & Corrosion Training Corrodere Academy and Coating Inspection Courses | Corrodere Academy and Corrodere Events Calendar - Corrodere Academy

BRANCH CONTACT DIRECTORY

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