

A journal of the Institute of Corrosion

Corrosion Management

Issue 188 November/December 2025

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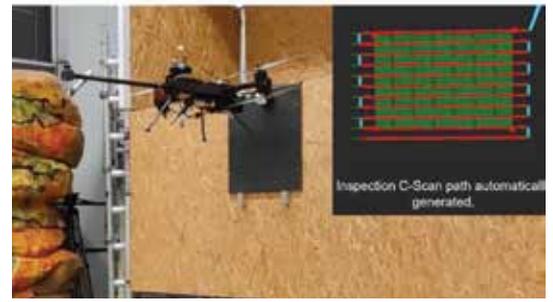
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The President Writes



Photo: Dr Yunnan Gao.

Dear Members,

As we approach the end of 2025, this President Writes marks both the final issue of the year and the completion of my first year as President of the Institute of Corrosion. It has been a busy, fulfilling, and inspiring year, during which our community has continued to grow stronger and more internationally connected. Before reflecting on recent highlights, I would like to take this opportunity to wish all our members a very happy and peaceful festive season with families and loved ones when the time comes.

Since my last update, the past two months have once again been filled with activity, collaboration, and milestones for the Institute. The ICorr Annual General Meeting (AGM) was successfully held on 4th November in Manchester, hosted by the North-West Branch in partnership with the prestigious Henry Royce Institute. The day began with a series of technical presentations that offered an engaging afternoon of learning, knowledge sharing, and professional discussion. It was an excellent opportunity for members and colleagues from across the corrosion and materials science community to connect, exchange ideas, and reflect on the future direction of our industry and Institute. During the AGM, two of ICorr's most prestigious awards were presented, recognising outstanding contributions to corrosion science and engineering. The H.G. Cole Award to Brian Wyatt, as the highest honour that ICorr can bestow on an individual for exceptional services to the development of the Institute and the Paul McIntyre Award which recognised a distinguished senior corrosion engineer Professor Damien Féron who has demonstrated excellence not only as a leading practitioner in the field but also in fostering European collaboration and advancing international standards. My warmest congratulations go to this year's distinguished recipients, whose achievements exemplify the values and excellence that define ICorr.

In November, I had the honour of attending the 13th China Corrosion Conference, where I was deeply privileged to receive the International Collaboration Award from the Chinese Society for Corrosion Protection (CSCP). During the conference, I also presented ICorr Fellow certificates to two newly elected Fellows from the Chinese corrosion community - an

important milestone in strengthening our professional ties. In my presentation to the conference, I introduced the activities of ICorr and Young ICorr, highlighting our continued commitment to developing the next generation of corrosion professionals. The recognition and engagement received during the event reflect the growing international influence and reputation of ICorr. Later in the month, I was invited by the Chairman of the Materials Engineering Association (MEA) of Saudi Arabia to attend the 19th Middle East Corrosion Conference in Dhahran, Saudi Arabia, where I was delighted to sign a Memorandum of Understanding (MoU) between ICorr and MEA. This agreement marks the beginning of a new chapter of cooperation between our organisations and reinforces our shared goals of advancing corrosion science, technology, and best practice globally. The conference also provided an invaluable opportunity to interact with attendees from across the international corrosion community, further extending ICorr's global network.

Meanwhile, across all our UK and two overseas branches, India and UAE, ICorr have been very active in hosting technical events during the final quarter of the year. I would like to make special mention of the Yorkshire and Humber Branch, which will celebrate its re-launch event on 20th November after being dormant for some time. This is a fantastic step forward and a testament to the dedication of our volunteers and members who continue to drive engagement at the regional level.

Looking ahead, the festive season will bring one of our most anticipated annual traditions - the ICorr London Branch Christmas Dinner, which will take place on 4th December 2025. This event is always a highlight of the year, offering a wonderful opportunity for members, colleagues, and friends from across the corrosion community to come together and celebrate our shared achievements. As 2025 draws to a close, I would like once again to express my heartfelt gratitude to our magnificent HQ Team and to all ICorr members for your continued support, enthusiasm, and dedication to the Institute.

Please stay engaged with our upcoming activities and visit the ICorr Events Calendar at www.icorr.org/events for the latest updates. As always, I warmly welcome your thoughts, insights, and aspirations for the Institute. Please feel free to reach out to me directly at president@icorr.org

Wishing you all a joyful festive season and a successful year ahead in 2026.

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

From the Editor

Welcome to the November–December 2025 issue of Corrosion Management. The theme for this edition, “Corrosion in the Downstream Energy Sector” highlights one of the most demanding areas of our industry. The downstream sector contends with some of the harshest corrosion environments, marked by fluctuating process conditions, aggressive media, and the ever-present need for safety, efficiency, and sustainability.

In this issue, we delve into how corrosion science and technological innovation are evolving to meet these challenges head-on.

Our first technical article, “A Framework for Evaluation of Ultrasonic Corrosion Inspection and Monitoring Strategies for Large Steel Structures,” by Dr Yifeng Zhang and Dr Frederic Cegla of Imperial College London, presents a thoughtful approach that bridges traditional risk-based methods and cutting-edge sensor technologies. Their work offers valuable guidance for optimising inspection frequency, improving data reliability, and strengthening long-term integrity management.

In the second article, “Combatting Corrosion,

Vibration, and Fatigue Under Pipe Supports: SmartPad System Advances for Offshore and Industrial Piping,” Hani Almufti of Cogbill Construction (RedLinePS, USA) introduces the innovative SmartPad System—a non-metallic, composite-based solution designed to tackle corrosion, vibration, and fatigue simultaneously. Supported by laboratory data and real-world case studies, this work exemplifies how smart materials and integrated design are redefining corrosion control strategies.

Finally, “Influence of Overprotection on AC Corrosion: Analysis of a Real Case,” contributed by Ivano Magnifico, explores how excessive cathodic protection can inadvertently accelerate AC corrosion. Drawing from field data and practical insights, his analysis offers an important reminder about the fine balance required in protection systems.

Preceding these technical features, our Fellow's Corner opens with an inspiring reflection from Dr Gareth Hinds, FICorr, who invites us to reconsider corrosion not merely as a destructive force, but as a natural process that can, under controlled conditions, be

harnessed for beneficial purposes—from surface treatments and protective patinas to artistic and industrial applications.

Together, these contributions highlight the diversity and depth of corrosion-related challenges faced in the downstream energy industry, and the innovative thinking driving their solutions.

As we close another year, I would like to extend my sincere thanks to our authors, and readers for their continued engagement and support. May this issue spark fresh ideas, foster collaboration, and inspire further progress in corrosion science and engineering in the year ahead.

I very much welcome your contributions and feedback on our Journal, do please email me with your thoughts at: editor@icorr.org

With warm regards,
Dr Shagufta Khan, FICorr
Editor, *Corrosion Management Journal*



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ICorr and MEA of Saudi Arabia Sign Memorandum of Understanding to Strengthen International Collaboration in Corrosion Engineering and Training

The Institute of Corrosion (ICorr) is pleased to announce the signing of a Memorandum of Understanding (MoU) with the Materials Engineering Association (MEA) of Saudi Arabia <https://mea.org.sa/en/>, marking a major step forward in fostering collaboration and mutual advancement within the global corrosion and materials engineering community.

The signing took place on 12th November 2025 during the 19th Middle East Corrosion Conference (MECC), held in Dhahran, Saudi Arabia, a premier regional event that brings together industry leaders, researchers, and professionals dedicated to advancing corrosion science and engineering.

Representing ICorr, Dr Yunnan Gao, President of the Institute of Corrosion, formally signed the MoU alongside Dr Tariq A. Alghamdi, Chairman of the Materials Engineering Association. The agreement sets out a framework for collaborative initiatives, knowledge exchange, professional development, and joint technical activities between the two organisations. Speaking at the signing, Dr Yunnan Gao commented:

"This MoU represents an important milestone for ICorr as we continue to strengthen our international partnerships.

Working closely with MEA will enable us to share expertise, promote best practices, and create new opportunities for our members to engage in global professional activities. Together, we aim to advance corrosion prevention and materials integrity for the benefit of the wider industry." The collaboration is expected to include joint seminars, technical exchanges, training programmes, and opportunities for members from both organisations to participate in collaborative events.

The Institute of Corrosion looks forward to building a strong and lasting relationship with the Materials Engineering Association,



Photo: MEA Signing Ceremony - Dr Yunnan Gao, President of the Institute of Corrosion alongside Dr Tariq A. Alghamdi, Chairman of the Materials Engineering Association (MEA).

reinforcing the shared commitment of both organisations to excellence and innovation in corrosion management and materials engineering.

For more information about ICorr's international collaborations and upcoming initiatives, please visit www.icorr.org

icats

Visit the ICATS website
www.icats-training.org

ICorr Branch Updates



ICorr Aberdeen Updates

On Tuesday 30th September 2025, the Aberdeen Branch held its Annual Joint Meeting with the North Scottish and Highlands and Islands Branch of TWI and welcomed William Vickers, of Ionix Advanced Technologies, with a talk entitled 'From Snapshots to Continuous Insight: Driving Maintenance Efficiency and Safety with Automated UT Monitoring.'

About the Speaker

William completed his PhD in Ceramics at the University of Leeds in 2013. Having worked at all levels of the business, he is now responsible for ensuring that all the products and services of Ionix address the needs of its customers. He has been responsible for the successful delivery of international projects and collaborations and is an expert in the application of sensors and monitoring systems in extreme environments.



Photo: William Vickers.

The presenter clearly explained the background to the development of these new technologies. Corrosion monitoring has traditionally relied on techniques such as electrical resistance (ER) probes and corrosion coupons. While widely used, these methods are invasive, require process penetration, and often deliver delayed or indirect assessments of asset condition. As operational priorities shift toward increased safety, reliability, and efficiency, many plant operators are turning to non-invasive ultrasonic testing (UT) as a safer and more direct alternative for monitoring wall thickness. Despite the technical advantages of UT, the adoption of automated ultrasonic corrosion monitoring has been limited by practical implementation challenges. These include investment costs, system complexity, requirements for manual intervention, and difficulties in achieving long-term data continuity across diverse site conditions. HotSense, developed by Ionix Advanced Technologies, is a field-proven solution designed to overcome these challenges. Based on proprietary piezoelectric materials, these advanced sensors enable automated ultrasonic wall thickness monitoring in extreme environments, with continuous operation from -200°C to +550°C. The system is certified for use in Zone 0 hazardous areas and has been successfully deployed in a wide range of industrial settings where traditional sensors and probes are not viable. As the probes work over a wide range of temperatures, they are suitable for permanent installation on pipes which are in, say, high-temperature zones on pipework which is known to be vulnerable to wall loss through internal corrosion/erosion of wall thickness. The permanent installation of probes is then not subject to variations experienced in manually monitoring the positions. This, in turn, means that the data is from a consistent position, and the accuracy and ability to detect and constantly monitor the degradation are dramatically improved.

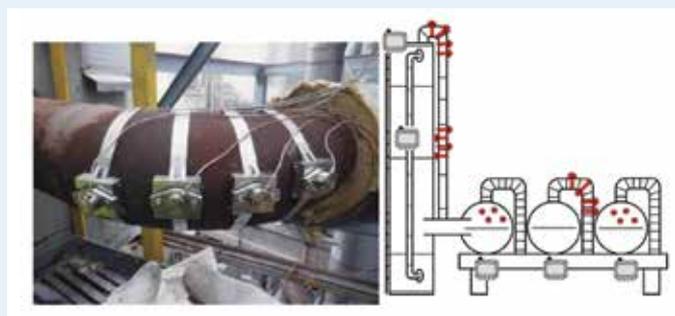


Figure: Installation Plan and Fixings.

Having installed the probes at appropriate positions within the plant, data can be taken from the system on a continuous basis, linking the probe system to data systems within the company or monitoring the system wirelessly and remotely. The system needs to be maintained by the company or an outside contractor in order to get the benefit. Occasionally, batteries need to be changed and devices checked by service contractors. These systems commonly fail through lack of ownership or responsibility of the user company.

In practice, monitoring of corrosion is a long-term project, and interest can be lost, or personnel changes can cause loss of continuity. To get the best from the system monitoring, this is usually done by an external service provider using the installers to manage settings, calibrations and alerts on system status with reporting and rapid response to site. The result then is a reliable system with no lost data, full maintenance and continuity of system ownership.

On Tuesday 28th October 2025, the Aberdeen Branch held its 2025 Annual General Meeting along with a special presentation by consultant Dr Janardhan Saithala.

About the Speaker

Janardhan Saithala, PhD, is a materials and corrosion engineer with 18+ years across upstream and midstream assets, specialising in plant assessments, pipeline integrity, failure analysis, and material selection for sour and CCUS environments. He has led complex RCA programmes and advises on risk, standards compliance, and lifecycle cost reduction.



Photo: Janardhan Saithala.

Janardhan gave a most interesting talk with 4 case studies presented, explaining the role of the Corrosion Engineer in each instance.

Some key takeaways were that

- Corrosion Engineers need to share their experiences and solutions more.
- Corrosion Engineers need to work closely with all other disciplines, and their Training needs to emphasise this more.

Precision vs Accuracy

Manual	Automated
Operator Variability	Same System
Different Techniques	Same Measurement
Different Probes	Same Probe
Different Position	Same Position
Calibration at High Temp	Automated Calibration
+/- 0.5mm	+/- 0.010s mm

Figure: Comparison of UT Methods.

continues on page 8

Further that

- Neglecting corrosion in operations is most definitely poor risk management. For example, a wrong material selection and simple failure of a low-cost gasket can lead to massive expenditure later.
- Operational parameters may differ from design circumstances and should be more closely monitored.
- Realising that there are often Gaps in Specifications and standards.
- Remembering that corrosion Modelling alone cannot represent every component of a system or piece of equipment.
- That testing following failure is essential for avoidance of future failures.
- That there is often a weak understanding of requirements by procurement personnel.

An extensive Q&A dealt with many questions on the root causes of the discussed case studies.



Photo: Example of Leak Areas Identified During a Pressure Test.

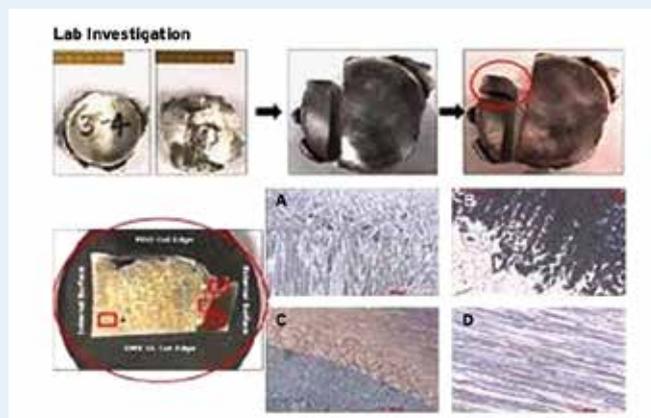


Photo: Example of Post-Failure Laboratory Examinations.

The Aberdeen Branch has an excellent and hard-working local committee of volunteers:

A new committee was formed after an audience vote to lead the 2025-2026 Technical programme as follows:

2025-2026 Session Executive Committee

1. Chair: Stephanie Okoye (from January 2026)
2. Vice Chair: Eilidh MacDonald (retiring June 2026)
3. Secretary (External): Dr Nigel Owen
4. Secretary (Internal): Dr Priscilla Ogunlode
5. Financial Officer: Johnny Morton
6. Sponsorship Officer: Dr Olubayo Latinwo
7. Event Co-Ordinator and CPD Officer: Fatemeh Faraji
8. Website Officer: Dr Yunnan Gao (ICorr President)
9. University Liaison: Dr Steve Paterson
10. Committee Member: Stephen Tate (ICorr Immediate Past President)
11. Committee Member: Dr Bryn Roberts
12. Committee Member: Adesiji Anjorin

We offer our special thanks to **Mei Ling Cheah**, Immediate Past Chair and Senior Engineer at Rosen Group, for all her support this year throughout the 2024/2025 session, and also to **Eilidh MacDonald**, STGB member and Quality Engineer at Subsea7, for kindly extending her term of support to the branch.



2025-2026 Upcoming Events

27th January 2026
Annual Joint Event with the Energy Institute.

5th March 2026
Special Joint Event with BINDT.

Please contact icorrabz@gmail.com if you wish to join the branch mailing list and please contact ABZchair@icorr.org if you wish to join its committee or to present.



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www.icorr.org



ICorr India Updates

The branch held an online webinar on “Guarding Against Corrosion: Best Practices for Reinforced Concrete Design and Maintenance” on Monday, 15th September 2025.

The session was presented by Dr S R Karade, Former Chief Scientist, CSIR–Central Building Research Institute (CSIR–CBRI), Roorkee, and was very well received by attendees.



Photo: Dr S R Karade.

Dr Karade explained that the deterioration of concrete structures can result from:

- **Human factors** – design deficiencies, overloading, poor workmanship, and inadequate maintenance
- **Inherent properties** – shrinkage, thermal expansion, porosity, alkali–aggregate reaction (AAR), and creep
- **Exposure conditions** – pollution, seawater, biological attack, chemical attack, and stray currents

He then discussed the basics of corrosion in a clear and accessible manner, explaining in detail the mechanism and causes of steel corrosion in concrete. Topics such as carbonation, chloride attack, and other contributing factors were covered comprehensively.

The session concluded with a discussion on corrosion prevention and control measures, followed by an engaging Q&A session.

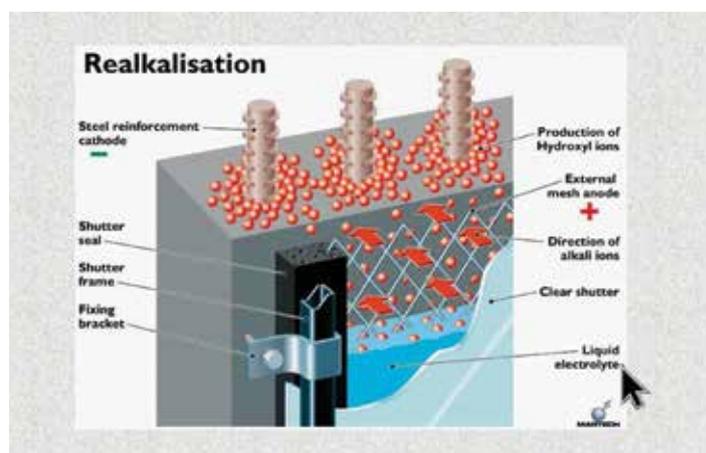


Photo: Slides from Dr Karade's Presentation.

Look Ahead –2025/2026 Session

- **December 2025** – Prof Shashi Bhushan Arya, Associate Professor, Department of Metallurgical and Materials Engineering, NIT Surathkal.
- **January 2026** – Prof Shweta Goyal, Vice-Chair, ICorr India Branch.

You can stay updated on ICorr India activities and programmes by following us on LinkedIn <https://www.linkedin.com/in/institute-of-corrosion-india-branch-india-branch-ab3003379/>

If you have any queries regarding branch affairs, please contact us at INDIAChair@icorr.org



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ICorr London Updates

The branch started its 25/26 season of technical presentations with a joint meeting with the London Materials Society (LMS), on 9th October 2025, when Professor Ivan Parkin, UCL presented “Adventures in Materials Science from self-cleaning glass to radiative cooling coatings.”



Photo: Professor Ivan Parkin Presenting “Adventures in Materials Science from Self-Cleaning Glass to Radiative Cooling Coatings.”

Professor Parkin is an inorganic materials chemist who became Faculty Dean of Mathematical and Physical Sciences in October 2016 at University College London (UCL). Prior to his appointment as Dean, he was Head of Department for UCL Chemistry. Ivan is a fellow of the Royal Society of Chemistry and a fellow of the Institute of Mining Materials and Metallurgy. He is a Chartered Chemist and Chartered Scientist. Ivan gave an overview of the research in his group over the last 30 years, looking at photocatalysis and the commercialisation of self-cleaning window glass. He also discussed the development of new materials for various functional applications from healthcare to batteries to carbon dioxide capture and storage, and miniaturised gas sensors.

There was standing room only for this presentation with attendees from industry and academia, both undergraduates and post-doc researchers (~60), which was well received and generated a lively discussion. Prof. Parkin was thanked for his talk and presented with an ICorr pen as thanks.

A full programme of talks is planned for 2026, including joint meetings with the local AMPP chapter, and TWI. **Full details will be on the events page of the website.**

For London Branch updates and enquiries contact: lonchair@icorr.org



ICorr Midlands Updates

On 9th October 2025, the ICorr Midlands Branch hosted a webinar on “Advancing Subsea Pipeline Corrosion Inspection” presented by Neil Cowin, a Chartered Engineer with over 35 years of pipeline integrity experience.

The session explored challenges in inspecting subsea non-piggable pipelines and demonstrated how techniques such as Pulsed Eddy Current (PEC) and Alternating Current Field Measurement (ACFM), typically used topside, can provide valuable subsea data. An active Q&A addressed the use of PEC in detecting MIC and the influence of CP-induced coating disbondment. The event was well received, and Neil will prepare a related article for *Corrosion Management Journal*. Encouraged by positive feedback, the committee plans a follow-up webinar on pipeline corrosion in early 2026.

In November, the branch will host a webinar on Vapour Corrosion Inhibitors (VCIs) for mitigating soil-side corrosion and preserving spare parts, with details to be announced via ICorr’s social media channels. Preparations are also underway for the joint in-person event in Cambridge on 21st–22nd April 2026, supported by CorrosionRADAR and the European Federation of Corrosion (EFC).



Photo: Neil M Cowin, Integrity Manager for Topside Facilities, Pipelines and Subsea Engineering.

Also, Following Committee’s October meeting, Ben Knight stepped down from the committee, and Abish Babu joined as Social Media and Webinar Coordinator. Wishing both gentlemen luck in their future endeavours.

SUMMARY OF FINDINGS

- Summation of practical results**
 - Mitigated SCC and LPF incidents but continued to investigate pipeline integrity to identify a % impact.
 - Flexibles have been difficult to inspect effectively, due to complex geometry, importance has been to define geometry of similar assets. Assessment of feasibility of the operation plan is a defined measure and periodic inspection technique in Mainwells.
 - Design basis has been to rely on internal inhibition and coatings and use CP for protection.
 - NDE focus over 20-year previously was a % suitable. Thermography was utilised as well as SCFM, ECI and PEC because of its accessibility through % coatings. It has advanced since.
 - Assessment by integrative review of the scaled profile will always provide different perspective. For best pipeline condition its difficult.
- Summation of techniques**
 - Development of NDE Techniques

PROJECT REQUIREMENTS

85% weight engineering change to allow pigging for 10

85% pigging pipelines are now pigginable

85% process pipelines are now pigginable

Developing NDE technology for monitoring of HP before external surface pipeline coating.

Corrosion Threats in Coated Pipelines

- Coating Types**
 - Across bonded epoxy (PBE)
 - Concrete Cladding
 - 3-Layer Epoxies + Cathodic Protection (CP)
- Primary Corrosion Drivers**
 - Profound water penetration (with ECI, H₂, sulfides, and dissolved)
 - Microbiologically Influenced Corrosion (MIC) associated bacteria in mainwells for leak studies
 - Paper phase & combination effects
 - Exacerbation by CO₂, H₂S, and chloride salts
- Inspection Risks**
 - Damage to water coatings in regions of waterfalls
 - Reduced CP protection effectiveness
 - High corrosion rates observed on carbon steel (SS) and other (SS, HSS, stainless, duplex (SS-SS))
 - Coating risk in 40-200 °C temperature range
- Inspection History**
 - Pipelines coated in PBE prior before cement II layer systems
 - Early inspection limited (partial UT with sampling based on the 10000-50000 period NDE coverage)
 - Also limited not fully covered for SCC/PECC, water coating, and evaluation

Subsea NDE assessments on covered many practices. Visual inspection, SUT, radiography, LRUT, PEC, ECI, ACFM, Thermography.

Photo: Excerpts from Neil Cowin’s Presentation Slides.

For Midlands Branch updates and enquiries contact: midlandschair@icorr.org

ICorr North-East Updates



The North-East branch commenced its 2025-2026 Technical programme on 11th September 2025 with two key presenters from Safinah and Sherwin Williams.

Speakers

Simon Daly is currently a consultant for Safinah in Gateshead. He is the chair for ISO TC67/WG11/TG3, responsible for several standards, including ISO 18796-2 relating to coatings use in pressure vessels. He is also the lead United Kingdom (UK) expert for oil and gas coatings and leads the UK's mirror committee PSE/17/67/11 in this area.

Michael Harrison is Global Product Director for Linings at Sherwin Williams and has over 35 years' experience in formulating, testing and specifying storage tank linings. He served as Project Lead for the update of ISO 16961 'Petroleum and natural gas industries — internal coating and lining of steel storage tanks' under the 2025 ISO/IOGP initiative.

This special session covered recent updates to ISO 18796 and 16961 - Internal lining of Carbon Steel Process Vessels and Storage Tanks.

The selection of coating systems for the internal lining of process vessels and storage tanks is similar and relies heavily on having accurate design information of the process conditions to allow the correct coating pre-qualification requirements to be identified and ensure the correct coating is selected.

- ISO 16961 looks at the requirements for the internal linings and coatings for steel storage tanks and provides guidance on general requirements, system selection, application and pre-qualification requirements.
- ISO 18796-2 looks specifically at the requirements for pre-qualification of internal coatings. It outlines the type of data

required to be collected to allow accurate selection of pre-qualification testing, the pre-qualification tests and acceptance criteria and a form for the collation of data to ensure that the necessary due diligence required has been completed.

An informative Q&A provided answers to many burning questions from the audience.



Photo: Simon Daly of Safinah Presenting.

Session 2025-2026

Next Event: Tuesday 2nd December - Christmas Darts Night, Newcastle upon Tyne. For NE Branch updates and enquiries contact chair at nechair@icorr.org

ICorr North-West Updates

The ICorr North-West Branch Can Reflect Upon a Highly Successful Year.



As 2025 draws to a close, the ICorr North-West Branch can reflect upon a highly successful year, going from strength to strength.

The NW Branch has recruited new members and held several successful events, building links with the University of Manchester and showcasing ground-breaking research.

The first significant event of the year was the **ICorr Young Engineer Programme/Research Showcase at the Henry Royce Institute on 19th February 2025.**

This flagship event, co-hosted by the ICorr North-West Branch, Young ICorr, and the University of Manchester, brought together members, students, industry experts, and early-career professionals for an afternoon of knowledge-sharing and networking.

Event Highlights included

• Case Study Presentations

Roger Francis (RFMaterials Ltd) and Ben Hudson (Premtech Ltd, Young Engineer Programme 2024 winner) shared insights into real-world corrosion challenges and solutions.

• Keynote Address

Danny Burkle (LBBC Baskerville), Chair of the ICorr Corrosion Engineering Division, emphasised the value of ICorr membership and the Young Engineer Programme.

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• **Postgraduate Research Showcase**

- o **Finlay Spence** – Mild steel corrosion in oxygenated water
- o **Harry Tookey** – Salinity effects on carbon steel corrosion and inhibitors
- o **James Osbiston** – Computational approaches to corrosion inhibitor performance
- o **Tom Hillman** – Laser-induced hydrogen measurement in steels

The event was a resounding success, with high levels of engagement and insightful discussions.



A Joint Event with the Institute of Asset Management followed in the Spring

Title: “Why Do Assets Fail? Spotlight on Corrosion”

Date: 1st April 2025

Venue: University of Manchester

This joint session explored infrastructure asset failures, with a particular focus on corrosion-related challenges.

Speakers Included

- **Dave Champness** – Shared a personal perspective on asset management and corrosion.
- **Paul Russell (MAPEI)** – Discussed product sustainability and extending structural lifespan.
- **Darren Henson (United Utilities) and Carlos Sanchez (HSE)** – Presented case studies on corrosion management and mitigation strategies.



Photo: Darren Henson Presenting From United Utilities.

Hosting of the UK-China Corrosion Summit, 3rd-5th September 2025

Event: Inaugural UK-China Corrosion Summit

Location: Manchester Metropolitan University, Dalton Building

Partner: Chinese Society of Corrosion and Protection (CSCP)

The North-West Branch proudly hosted the first-ever UK-China Corrosion Summit, welcoming a distinguished delegation from the Chinese Society of Corrosion and Protection (CSCP). This international collaboration marked a significant milestone in fostering global knowledge exchange in corrosion science and engineering.



Photo: A Full House for The UK-China Corrosion Summit, 3rd-5th September 2025.

Visit the ICATS website www.icats-training.org

Keynote Speakers Included

- **Andrew Duncan** (Lead Consultant, Intertek CAPCIS) – “Artificial Intelligence: A Benefit or Threat to Material Science and Corrosion”
- **Dr Yu-You Wo** (Ningbo Zhonghe Technology Limited) – “AI-Driven Inspections on Offshore Wind Turbines from an Engineer’s Point of View”
- **Professor Henry Tan** (University of Aberdeen) – “AI-enabled Digital Twins and Bayesian Decision Models for Corrosion Risk-Informed Maintenance of Subsea Pipelines”
- This summit highlighted the growing role of artificial intelligence in corrosion monitoring and management, offering attendees a glimpse into the future of the industry through expert insights and international collaboration. Day two of the summit took in a visit across the hills to Sheffield and the excellent training centre at Argyll Ruane, an approved partner of ICorr, where both Coatings and NDT training were showcased.



Photo: ICorr Training Partner Visit – Argyll Ruane Ltd (ARL).

ICorr AGM

Event: ICorr AGM

Location: Manchester Henry Royce Institute

The final event of the year was the ICorr AGM, held on 4th November at the prestigious Henry Royce Institute. The theme of the technical presentations was “Material Systems for Demanding Environments” (MS4DE). Presenters included Steve Hodges of Johnson Matthey and Andrew Piercy from Intertek, as well as a research showcase from the HRI. Awards were presented to Damien Feron and Bryan Wyatt for their contributions to the world of corrosion. The day was a tremendous success, with over 80 attendees from industry and academia enjoying the presentations.

A full report of the National AGM will follow in the next issue of the Magazine.

Branch Committee

The branch continues to grow and recruit skilled individuals. We are delighted to welcome **Dr Reza Tohid** to the North-West Branch Committee. A Corrosion and Integrity Management Expert with a PhD in corrosion science, Reza brings a wealth of experience from his time with the Aberdeen Branch and is a valuable addition to our team. Reza has already shown excellent leadership and corrosion knowledge in seeking sponsors and leading the prestigious ICorr National AGM held in Manchester.



Photo: Dr. Reza Tohid

ICorr Yorkshire and the Humber Updates



Since the Yorkshire and Humber Branch relaunch, the committee have held regular meetings making future plans for events in the region.

Full details for the first event of the 2025-2026 session were sent out to all UK members, and was scheduled for **Thursday, 20th November 2025**, at the **Bragg Centre for Materials Research, University of Leeds**. Themed “**Corrosion Challenges in Additively Manufactured Metals**”, the event brought together leading voices from academia and industry to explore the unique corrosion issues associated with this rapidly advancing field.

The programme featured presentations from **Dr Yogi Pardhi**, Global Head of Additive Manufacturing at Sulzer Ltd; **Luke Ansell**, ICorr Summer Intern 2025; and **Sumia Manzoor**, a PhD researcher at the University of Leeds. In addition to these keynote talks, the event included flash presentations from regional members, designed to foster networking and knowledge exchange across the corrosion community.

Attendees had the opportunity to tour the Bragg Centre’s state-of-the-art facilities and the University’s corrosion



Photo: The Bragg Centre for Materials Research, University of Leeds.

research laboratories. The event concluded with the **Branch AGM** and election of the new committee. **For further information or to enquire about presentation opportunities, members are encouraged to contact the branch at: yorkshirechair@icorr.org**

Corrosion Science Division (CSD) Updates



The 67th Corrosion Science Symposium (CSS) was held jointly with Electrochem2025 at the University of Northumbria, between the **31st August and 2nd September 2025**.

The CSS has been held annually since its launch in 1960 by Prof. L.L. Shreir.

The symposium is always an ideal opportunity for students and early-career researchers in corrosion science from across the UK and Europe to congregate, discuss their work, share ideas and, above all, enjoy themselves in a stimulating/friendly environment. This year there were 10 talks and 13 posters, and the UR Evans award plenary talk was given by Prof. Herman Terry (Vrije University, Brussels).



Photo: Plenary Lecture by Professor Ritu Katakly.

In his plenary lecture, Prof. Herman Terry (Vrije Universiteit Brussel) explores why this goal has long seemed utopian—and how recent advances are bringing it closer to reality. The quest to accurately predict the lifetime of metals remains one of the most pressing challenges in corrosion science. Current industry practice relies on accelerated laboratory tests and long-term field exposure to estimate durability. However, laboratory tests often fail to replicate real-world conditions, while field trials can take up to a decade, slowing innovation. Prof. Terry's research aims to bridge this gap by developing a comprehensive platform for predicting the long-term performance of organic-coated metals under realistic environmental ageing. His team combines cutting-edge electrochemical techniques, in situ surface analysis, and advanced finite element modelling, now enhanced with sensors and

machine learning. The lecture also introduces VIPCOAT, an EU Horizon 2020 project creating an open innovation platform to design sustainable coating systems and accelerated life tests. Initially targeting aeronautics, VIPCOAT will expand to other sectors, leveraging standardised European Materials Modelling Ontologies. The plenary talk expertly underscored a paradigm shift: from empirical testing toward data-driven, predictive corrosion science, thus paving the way for more sustainable and efficient materials design.



Photo: UR Evans Award to Professor Herman Terry by ICorr President Dr Yunnan Gao.

Highlights from Electrochem2025: Advances in Corrosion Science

The Corrosion Science and Engineering symposium at Electrochem2025 featured several outstanding contributions.

Harry Tookey (University of Leeds) presented an insightful study on the effect of salinity on corrosion product characteristics and inhibitor performance in geothermal environments.

His work demonstrated how varying NaCl concentrations influence FeCO_3 formation on X65 carbon steel and inhibitor efficiency, offering practical guidance for corrosion control in high-salinity systems.

Anjali John (University of Warwick) gave a talk on the initial stages of anodic corrosion of boron-doped diamond electrodes. Using advanced *in situ* and *ex situ* techniques, her research provided a rare glimpse into early corrosion mechanisms under extreme electrochemical oxidation conditions, critical for improving electrode durability in advanced oxidation processes.



Photo: Talk by Anjali John (University of Warwick).



Photo:
Mohammadhasan Sarabchi - Corrosion Inhibitors & Geothermal Energy EPSRC Researcher at University of Leeds.

Mohammadhasan Sarabchi (University of Leeds) addressed the challenge of corrosion inhibition in geothermal systems with his presentation on optimising multi-component surfactant mixtures. By combining kinetic modelling with electrochemical testing, he identified formulations that deliver rapid adsorption

and strong persistence, paving the way for more sustainable and effective inhibitor strategies. These talks exemplify the innovative approaches currently providing new insights in corrosion science – bridging fundamental understanding with real-world applications.

Harry Tookey was awarded the Shreir Prize 2025 for the best early career research presentation.



Photo:
Harry Tookey was awarded the Shreir Prize 2025.

For further information about Corrosion Science Division (CSD) activities, please contact:

Julian Wharton (Chair) Email: csdchair@icorr.org

Advertisement



Who Are We?

Premtech is a dynamic, innovative company that provides engineering consultancy and design services to organisations in the energy sector. Now part of National Gas, Premtech is passionate and committed to the learning and development of our people making sure they have the right skills and knowledge to be successful and to help achieve their potential.

We are seeking a Cathodic Protection (CP) Engineer to join our CP design department. This role is open to graduates with a suitable engineering degree, engineers with a couple of years of industry experience, or established professionals in CP. The successful candidate will have the opportunity to work on diverse projects, gaining valuable experience in all aspects of CP system design.

Key Responsibilities

- Support in the design and development of CP systems for pipelines, AGI's and tanks.
- Prepare technical reports, design drawings, and specialised documents.
- Support project delivery at various stages, from concept through to commissioning.
- Collaborate with clients, contractors, and other engineering disciplines.
- Maintain awareness of relevant standards and industry codes.

Skills and Qualifications

- Degree in Electrical, Mechanical, Chemical, Materials or a related engineering discipline.
- Interest or knowledge in corrosion control and CP.
- Strong problem-solving, analytical, and communication skills.
- For experienced applicants: proven CP design experience and familiarity with standards such as AMPP, ISO, and BS EN will be advantageous and any certification with ICORR or AMPP.

What We Offer

- A structured career path tailored to your level of experience.
- Mentoring, training, and support toward ICORR certification and chartered status.
- Competitive salary package based on skills and experience along with a range of benefits.

A successful candidate will be enthusiastic and conscientious about the work you produce, leading by example with good attention to detail. You will also have the ability to learn quickly and work methodically under your own initiative and as part of a team.

**We're
 Recruiting
 CP Design Engineers**

www.premtechltd.co.uk

To apply, please send your CV and covering letter to:
recruitment@premtchltd.com



Young ICorr Updates

The Young ICorr Committee has been hard at work developing many schemes, events, and initiatives to support the early career members of ICorr – here's an update of what we're working on and how you can get involved!

Social Buzz: Manchester Pub Quiz Success

Our recent **Pub Quiz social event in Manchester** was a hit! With a fantastic turnout and glowing feedback, it proved the power of informal networking in bringing young professionals together. Laughter, learning, and lively competition made for an unforgettable evening.



Photos: YICorr Chair Pub Quiz.

Other Young ICorr Initiatives

Skills for Corrosionists – Online Training Programme

In partnership with the **Midlands Branch**, we're launching the **Skills for Corrosionists** online training series in the new year. These sessions are designed to empower participants with essential non-technical skills, including entrepreneurship, communication, personal branding and leadership, to complement their technical expertise. Register at: <https://www.eventbrite.com/e/icorr-skills-for-corrosionists-webinar-series-launch-entrepreneurship-tickets-1838991335589>

Expanding Horizons: European Collaborations

We are working closely with the EFC to develop **Young ICorr and Young EFC events for Eurocorr 2026**, boosting our international presence and fostering cross-border collaboration.

Regional Engagement: Yorkshire and North-West

Young ICorr is also teaming up with the **Yorkshire and North-West branches** to deliver tailored events for young members – bringing opportunities closer to home and strengthening our regional networks.

Mentorship Matters: Launching Soon

We're gearing up to launch the **Young ICorr Mentorship Scheme**, offering structured career guidance and support for early-career professionals. We're currently seeking mentors and mentees for the pilot phase – if you're passionate about nurturing the next generation or would like one-to-one guidance in your career, we'd love to hear from you!

Introducing the Young ICorr Awards - Celebrating the Future of Corrosion

We're thrilled to announce the launch of the **Young ICorr Awards**, a prestigious new initiative from the Institute of Corrosion that shines a spotlight on the next generation of corrosion professionals. These awards recognise outstanding early-career engineers and scientists who are making significant contributions to corrosion prevention, research, and innovation. With categories including **Young Corrosion Engineer of the Year** and **Young Corrosion Scientist of the Year**, this is a unique opportunity to gain national recognition, connect with industry leaders, and accelerate your professional journey.

Visit the Young ICorr section of the website to nominate!

Young Engineers Programme (YEP): Global Reach

Following a successful launch at **Eurocorr 2025**, the **Young Engineers Programme** has attracted many applicants worldwide – the successful candidates have been chosen, and we're now focused on assembling a stellar team of mentors, lecturers, and a compelling case study. Interested in contributing? Get in touch!

Sponsorship Drive: Fuelling the Future

To support YEP and Young ICorr's growing initiatives, we've developed a comprehensive sponsorship proposal and are actively engaging with companies to secure funding. This support will be vital in expanding our reach and impact. If you or your company are interested in supporting the future of corrosion, please get in touch!

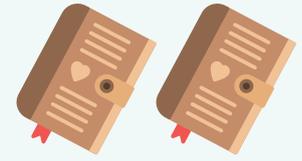
The Young ICorr Committee is buzzing with activity and ambition. We're always open to new collaborations and welcome anyone interested in joining our journey.

For further information about YICorr activities, please contact:



Dr Kathleen Purnell
Email: youngicorrchair@icorr.org

YEP Journeys – Reflections from Nashville



Editor's Note: We are pleased to have the opportunity to publish the 2nd of our series of dairies from the YEP 24 winners.

Kishan Nittur Ramesh, 2024 YEP Winner

My YEP Journey: From Aspiration to Achievement

Participating in the **ICorr Young Engineer Programme (YEP) 2024** has been a profoundly enriching chapter in my professional career. When I applied to participate in the programme, I was hoping to enhance my technical capabilities, expand my understanding of the corrosion industry, gain insights into global best practices, and connect with the industry experts. The programme exceeded my expectations and has helped significantly in each of the above aspects.

The programme featured monthly technical sessions delivered by industry experts and included a real-world case study for participants to work as groups tasked to find a solution. In addition to enhancing my technical expertise, the programme has also fostered essential soft skills such critical thinking, time management, teamwork and communication skills.

One of the most significant milestones of this journey was being part of the **winning team in the YEP 2024 case study presentation competition**. This achievement awarded us with the incredible opportunity to attend the **AMPP Annual Conference and Expo 2025 in Nashville, USA**. Additionally, we were honoured at the **EMERging Leader's Bash** in recognition of this achievement. This was a proud moment not just for myself, but also for my fellow teammates, mentors, and everyone who supported us along the way.

The experience of an international travel to attend a technical conference of such a scale and as a young professional was both surreal and rewarding.



Photos: 2024 Winners Celebrations at AMPP Nashville 2025 and Across The YEP Generations.

AMPP 2025 – Learning, Connecting, and Growing in Nashville

Walking into the AMPP Corrosion Conference and Expo 2025 in Nashville was a defining moment for me. The scale, energy, and international nature of the event created an electrifying atmosphere — one where professionals, researchers, students, and industry leaders from across the globe came together to explore advancements shaping our industry.

A standout moment of the AMPP Conference was the keynote address delivered by former NASA astronaut Mike Massimino titled **“The Team’s Success is Your Success: You Cannot Do This Alone, You Will Succeed or Fail as a Team.”**

Drawing upon his experiences as an astronaut, engineer, and a public figure, Massimino shared powerful stories about the teamwork, resilience and innovation and emphasised their importance in achieving success. He shared some key tips on teamwork, resilience, leadership and the power of speaking up. Mike emphasised on how amazing things can be achieved when we work as a team and highlighted to have trust in three things:

- Trust your gear.
- Trust your training.
- Trust your team.

These can help everyone stay mission ready.

Deeply inspired by Neil Armstrong from a young age, he was determined to follow his footsteps. Despite facing multiple setbacks, he stood undeterred until he finally joined NASA in 1996. He also shared valuable insights into how NASA's models for teamwork and leadership transcend space missions, offering valuable lessons applicable to everyday life. A key takeaway was the importance of speaking up, especially in high-stakes situations—regardless of one's level of experience. Mike Massimino's keynote address at AMPP 2025 was an electrifying experience filled with inspiring and impactful stories, leaving a lasting impression and motivating me on various levels.



Photo: Keynote Address Delivered by Former NASA Astronaut Mike Massimino.

Over the course of the conference, I had the opportunity to attend a variety of technical sessions, poster presentations and exhibitors.

continues on page 18

A few of the technical sessions that stood out for me were as below

Effect of Galvanized Bolts on External Crevice Corrosion of SS316 gaskets

Several leakages were reported in 22% Cr Duplex Stainless Steel Ring Type Joint (RTJ) flange assemblies fitted with SS316 gaskets used for high pressure piping, caused by external crevice corrosion in marine environments on the Johan Sverdrup Oil Field Development in North Sea. This corrosion issue escalated and raised the concern of crevice corrosion being a credible threat resulting in changing of all SS316 gaskets to austenitic and super austenitic stainless steel (904L SS & 6% Mo SS). However, crevice corrosion continued to plaque the 22% Cr DSS flanges. Later in 2022, it was concluded that the cause of crevice corrosion on the 316 gaskets and 22Cr flanges was related to the material selection of the bolts, which had been changed from hot dip galvanized (HDG) steel to 25% Cr super duplex stainless steel (SDSS).

During the initial assessment, it was implied that the 316SS RTJ gaskets with reduced levels of chromium, nickel and molybdenum were more susceptible to crevice corrosion as the manufacturers cut corners to reduce the manufacturing cost yet achieve the same material standards. However, A series of tests were launched to study why the change in bolting material caused corrosion and also to discuss effective protective measures. The study involved three testing programs: two full scale exposure tests in salt spray chambers with natural seawater replicating the marine environment and a small-scale electrochemical testing.

During Phases 1 and 2, a comprehensive visual inspection was conducted on over 5,000 uninsulated and 800 insulated RTJ flange assemblies, assessing combinations of 316SS and 6Mo gaskets with 25Cr and HDG fasteners. Approximately 80% of the uninsulated flanges with 316SS gaskets and 25Cr bolts showed crevice corrosion, while those with HDG fasteners exhibited no corrosion. Some crevice corrosion was also observed on 904L gaskets and on the 22Cr flanges with 6Mo gaskets & 25Cr bolts. On the contrary to expectations, 74% of the insulated flanges displayed light to heavy corrosion, indicating the insulation protection was limited. As the Zinc paint and spray were found ineffective in preventing corrosion, they were removed, HDG bolts installed, and zinc wire was attached. Additional protective measures included HDG nuts on 25% Cr studs and mounted anodes. These modifications significantly reduced corrosion: only minor surface rust was observed, likely from external contamination, with no crevice corrosion detected on sealing surfaces. Small-scale electrochemical testing in Phase 3 testing assessed galvanic interactions and crevice repassivation of gasket materials. Results showed 6% Mo stainless steel had excellent crevice corrosion resistance, while SS316 and 22% Cr duplex had lower protection potentials. Zinc and HDG bolts provided effective galvanic protection to SS316, with HDG bolts showing slightly reduced performance due to scale formation.

The test results indicated that the effective galvanic protection of SS316 gaskets is achieved by using HDG bolts, zinc wire, or sacrificial anodes, provided good electrical contact is maintained. HDG bolts continue to offer cathodic protection even after partial zinc loss, while zinc wire offers retroactive protection if contact is sustained. Zinc paints or sprays are unreliable. Oil-based products may delay corrosion but lack proven long-term performance. Both 904L and 22% Cr duplex stainless steels are susceptible to crevice corrosion, whereas 6% Mo stainless steel shows strong resistance.

Dynamic Decision Making in Corrosion Management

Corrosion management in oil & gas industry has been a critical and complex challenge, especially in environments with CO₂, H₂S and elevated water cut. These conditions demand the corrosion engineers to be more vigilant to employ effective interventions. This technical session highlights & illustrates the lifecycle & dynamic decision making in corrosion management of a 10" sour wet gas

pipeline from commissioning in 2018 to 2024 and emphasises the evolution of operational strategies.

In the years of operation between 2018-2024, the sour service pipeline designed to handle production from 5 wells faced multiple operational challenges due to the changing conditions of the production from the wells. Initially, the pipeline was incorporated with three corrosion control barriers: Continuous Cl injection, Monthly Cl batching, and Monthly operational pigging to manage H₂S corrosion in wet conditions. With only one well in operation at feeding the pipeline at much lower velocity than the design capabilities and no initial water production, various adaptive strategies were implemented to minimise the operational costs & reduce the safety risks.

During the initial operations, oil-based corrosion inhibitors were continuously injected to prevent the oil wetting. However, during 2018-2019, the Cl batching was removed, and Automated Ultrasonic Testing (AUT) monitoring was introduced, saving \$200,000 annually. Later in 2020, pigging frequency was optimised from monthly to three monthly due to minimal corrosion risk, improving operations and saving.

\$8.3 million annually. As the Basic Sediment & Water (BS&W) breakthrough were detected, a switch from oil-based to water-based Corrosion Inhibitors were adopted. During 2021–2022, the pipeline experienced several operational challenges including issues with Main Inlet Valve (MIV) passing and pig launcher & receiver door sealing that disrupted 67% of the planned pigging operations, leading to degradation of the internal surface of the pipeline. Inspections were carried out using Automated Ultrasonic Testing (AUT) & In Line Inspection (ILI) to determine the extent of the internal wall loss. The AUT inspections revealed 15% and ILI revealed 27% wall loss. A simulation was conducted using the inspection data to predict the corrosion rate, which led to the restoration of monthly pigging and enhanced monitoring. By early 2023, high chloride levels (above 33,000 ppm) and water ingress raised corrosion concerns, leading to the reintroduction of Cl batching, increased AUT monitoring, ongoing chloride & water monitoring and installation of a non-intrusive monitoring tool.

The sour wet gas pipeline has experienced various changes in the operating conditions over the six years requiring a flexible and adaptive corrosion management approach. Various adaptive strategies such as optimised pigging, using more effective corrosion inhibitors, deploying relevant inspection techniques and monitoring systems have proven beneficial. The program has delivered measurable benefits, including cost savings and extended asset life, highlighting the importance of dynamic, data-driven corrosion management for long-term reliability and safety.

For example:

- MIC in Seawater Cooling Water on Coated CS & CuNi Pipework
- Engineering Principles and Cost-Effective Solutions for Corrosion Control
- Are Pipeline Operators Over relying on ILI?

Real-World Impact and Application

Since returning from Nashville, I have had few opportunities to apply the insights gained from AMPP 2025:

- Working at PIM Ltd, I have been able to actively contribute to the Integrity Management of the topside equipment ongoing corrosion risk assessments and asset integrity management initiatives.
- Drawing from the conference content, I was also able to suggest improvements to our monitoring strategies and initiate discussions around the implementation of more sustainable coating options.

Exposure to global case studies and best practices has also deepened my understanding of failure mechanisms and assessment frameworks — enabling me to approach complex technical scenarios with a broader, more solutions-oriented perspective.

Professional Networking and Global Insights

One of the most valuable aspects of attending AMPP 2025 was the opportunity to connect with a diverse range of professionals. From early-career engineers to highly experienced technical experts and industry veterans, the event fostered an environment of knowledge-sharing and open dialogue.

During networking sessions, I was fortunate to meet several individuals who generously offered lasting insights, career guidance, and even opportunities for future collaboration. I was also pleased to reconnect with members of the ICorr community and fellow YEP alumni, reinforcing the strength and reach of this professional network.

These interactions reminded me that while technical conferences are essential for staying current, they are equally powerful as spaces for inspiration, mentorship, and community.

A Journey to Remember

Besides the valuable technical and professional development, the trip itself was a joyous and memorable experience. Exploring Nashville with my fellow teammates added a social and cultural dimension to the journey. Whether it was visiting local landmarks, sharing meals after a full day of technical talks, or simply reflecting on our individual takeaways as a team — the experience fostered camaraderie and left me with lasting memories.

Being part of an international conference, especially as a young engineer representing a winning team, was an empowering experience — one that I will always remember with pride and gratitude.

Final Reflections: The Power of Opportunity

Reflecting on the entire experience — from starting the ICorr YEP programme to attending AMPP 2025 — I feel a deep sense of fulfilment and optimism for my career ahead. I feel incredibly grateful for the growth it has brought into my career. These experiences have strengthened my technical foundation, expanded my global outlook, and clarified the kind of engineer I aspire to be — one who is adaptable, collaborative, curious, and committed to continuous

learning. To anyone considering applying for future ICorr YEP programmes, I would offer the strongest encouragement: **this is a unique opportunity that will challenge and inspire you in equal measure.** The programme is thoughtfully designed, widely respected, and genuinely impactful, which pushes you to think critically, work collaboratively, and develop both technical and soft skills that will stay with you throughout your career. It challenges you to grow, equips you with real-world tools, and surrounds you with a network of peers and professionals who want to see you succeed.

In a world where engineering challenges are becoming more complex and interconnected, initiatives like YEP play a vital role in preparing young professionals to contribute meaningfully. The Young Engineer Programme is more than a professional development programme — it's a catalyst for transformation. It empowers young professionals to take bold steps, embrace new challenges, and build a career rooted in technical excellence and global impact. I feel fortunate to have been part of this experience.

While the official journey concluded in Nashville, the lessons, connections, and momentum I gained from it will continue to influence my path for years to come. I am excited about what lies ahead and remain committed to using everything I've learned to contribute meaningfully to both my organisation and the wider corrosion community.

Acknowledgements

I'm incredibly grateful to **Institute of Corrosion** for providing me this golden opportunity and to BP for sponsoring this programme and our trip to Nashville. I would like to thank AMPP and all the authors for providing me an opportunity to attend such useful and informative technical sessions. My heartfelt thanks to all my fellow teammates, mentor Ali Morshed and Danny Burkle for supporting us all along and making this journey a success.

A special thanks to **PIM Ltd**, my employer, for their unwavering support throughout this journey — from encouraging me to apply for the programme, to backing my participation in the final competition and the trip to Nashville. Their commitment to my development has been instrumental, and I'm sincerely grateful for their belief in my potential.

Corrosion Around Us

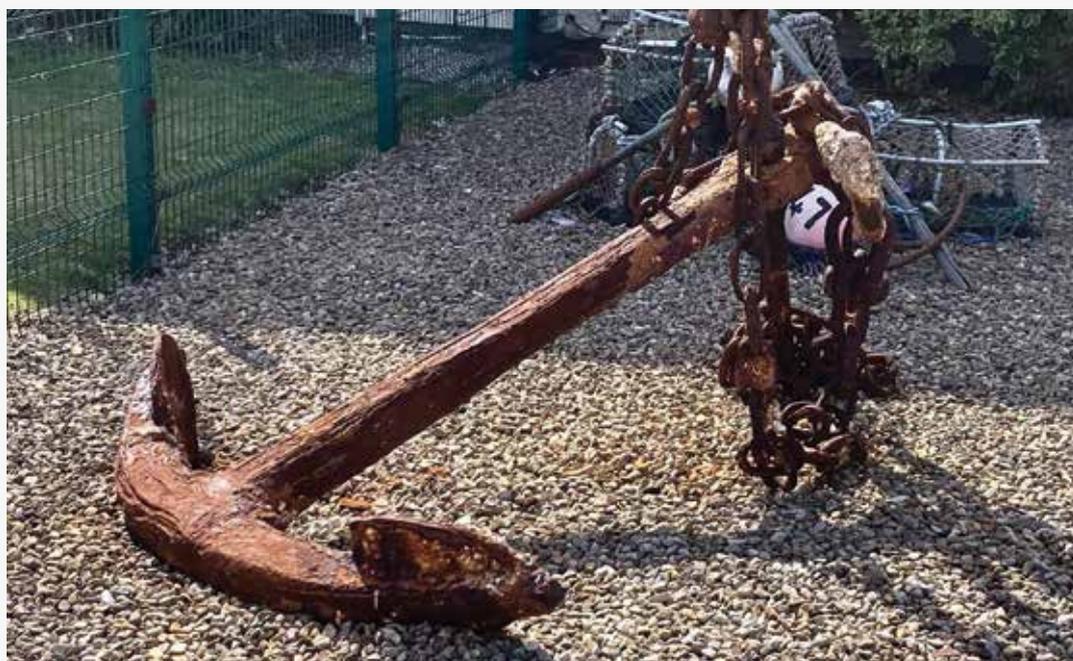


Photo: The Amble Anchor - Northumbria (Image Courtesy of Stephen Tate).

Industry News

News from ICorr Corporate Members and Other Industry News

AkzoNobel Becomes Exclusive Supplier for Solar Absorbing Wall Technology

After developing a pioneering coating which can help warm up or cool down a building, AkzoNobel has now become exclusive paint supplier to the Calosol heat-retaining façade technology it helped to create. The innovative panel system – which transforms the façades of homes and buildings into a source of energy – was created together with Dutch partners Emergo and TNO. At the heart of the technology is a special AkzoNobel coating which can harness energy from the portion of sunlight invisible to the human eye. Which means the system can capture solar energy as long as there's daylight – even when it's raining.

Suitable for new-builds or renovation projects – which can be disconnected from the gas network – estimates suggest using the Calosol technology can result in 20-30% less electricity being needed, compared with a traditional air-to-water heat pump and potential to make homes and buildings energy neutral, or even energy positive. The technology can also contribute to green building certifications such as BREEAM (Building Research Establishment Environmental Assessment Method) and LEED (Leadership in Energy and Environmental Design).

The Calosol heat-retaining façade technology is the perfect complement to our sustainable prefab roof and aesthetic façade solutions," explains Hendrik-Jan Weggeman, Director of Emergo.

"It's particularly effective for the renovation of residential homes and other structures such as public buildings that have important heating needs, including swimming pools. It provides added value to property owners, architects and housing corporations, expanding the possibilities for sustainable renovations.



Source: <https://www.akzonobel.com/en/media/media-releases/akzonobel-becomes-exclusive-supplier-solar-absorbing-wall-technology>

Integrated Global Services (IGS) Expands Surface Protection Portfolio with Weld Overlay Solutions

Richmond, VA – 08th October, 2025 – Integrated Global Services (IGS) today announced the expansion of its Automated Field Welding Services with the opening of a new operational hub in Radom, Poland. The facility will support welding procedure development, project qualifications, and specialised mock-ups, serving customers across Europe and other global regions. The expansion broadens IGS's global operational capabilities and complements its existing HVTS® (High Velocity Thermal Spray) technology. Together, these services will offer a range of surface protection solutions to address corrosion and erosion challenges in demanding industrial environments.

Expanding Surface Protection for Global Industries

IGS is expanding its automated field welding capabilities with three complementary services:

- **Weld Build-Up** – Restoration of base material to original specifications
- **Weld Overlay** – Engineered protection against corrosion and erosion

- **Specialty Welding** – Advanced, code-compliant repair and upgrade services

These services are initially available across the Middle East, Africa, Europe, Latin America, and Asia-Pacific, supported by the new hub in central Europe.

Weld Overlay Applications Across Industries

Weld Overlay is designed for high-risk operating environments and is suitable for a wide range of industries, including:

- **Refineries** – Protection from naphthenic acid, H₂S, CO₂, HCl, and ammonia corrosion
- **Chemical Processing** – Acid and erosion resistance
- **Waste-to-Energy Boilers** – Protection against high temperatures, corrosive gases, ash, chlorides, and sulphates
- **Biomass Boilers** – Resistance to alkali corrosion
- **Pulp & Paper** – Protection of black liquor recovery boilers and digesters

Contact: Ella.boyden@integratedglobal.com
<https://integratedglobal.com/>

CorrosionRADAR Launches Clarity AI-powered Software

Houston, Texas, 29th October 2025– CorrosionRADAR, the global provider of Corrosion Under Insulation (CUI) Risk Monitoring Solutions, has launched Clarity, an AI-powered software for the predictive analytics of CUI during the CUI Seminar – Houston Chapter hosted at NASA.

Clarity transforms remotely monitored corrosion and moisture data into clear, actionable insight of CUI Risks, helping operators improve visibility, optimise maintenance, and extend asset life.

CorrosionRADAR is an industry leader in data and predictive analytics for CUI, enabled by its proprietary remote monitoring solutions and the largest live global dataset, powering smarter integrity decisions. By leveraging this, the Clarity Software ensures operators have CLARITY in every decision they make, advancing data-driven CUI management across global energy and industrial operations.

Key features of the Clarity Software include:

- 1. Automated Reporting with Role-Based Control & Historical Insight** – Automated, compliant, data-driven decisions with role-based reporting and complete audit trails.
- 2. 3D Isometric Visualisation** – 3D asset models map CUI Risk, driving intuitive insights.
- 3. Continuous Corrosivity and Moisture Monitoring** – Early warnings and trend analysis to anticipate risk before it escalates
- 4. Machine Learning Intelligence** – Transform sensor data into predictive intelligence, enabling you to stay ahead of CUI threats.
- 5. Next-Generation Software** – A redesigned interface with faster performance and a clean, intuitive layout

Clarity can be integrated seamlessly site-wide and is already used by the largest energy operators worldwide, supporting their goals for the digitalisation of industrial assets – a key enabler for Smart Site transformation.



Dr Prafull Sharma, Chief Technology Officer and Co-Founder of CorrosionRADAR, said: “For the energy sector, Clarity represents a step forward in the journey toward smarter, data-led integrity management, a foundation for transitioning to being a Smart Site and a more intelligent, efficient future.

“At CorrosionRADAR, we designed Clarity with the operator in mind. It utilises Predictive Analytics Models, Machine Learning and AI, delivering insights that enable faster, more confident decisions to transform information into understanding. Making corrosion and moisture risk visible, allowing teams to focus their efforts where they matter most.”

With the launch of Clarity, predictive CUI monitoring enters a new era of digitalisation and data-led decision-making.

For further information, visit www.corrosionradar.com or email Marketing@corrosionradar.com

Evonik Strengthens Asian Presence with New Aluminium Specialty Plant in Japan

Evonik has inaugurated its first state-of-the-art fumed alumina production facility, “Alu5”, in Yokkaichi, Japan — marking a significant milestone in the company’s strategy to expand its aluminium oxide business across Asia.

The new facility will produce **AEROXIDE®**, Evonik’s advanced fumed aluminium oxide, known for enhancing performance and durability in applications such as electromobility, lithium-ion batteries, coatings, and consumer electronics.

Claus Rettig, President of Evonik Asia Pacific, highlighted, “Alu5 is a cornerstone of our growth strategy in Asia. Local manufacturing reduces lead times and carbon footprint while

strengthening supply security and supporting sustainable innovation.”

The project reflects close collaboration between Evonik’s **Custom Solutions** (Coating Additives) and **Advanced Technology** (Smart Effects) segments, aligning with the company’s broader vision for sustainable growth in specialty chemicals.

Source: <https://www.evonik.com/en/news/press-releases/2025/10/evonik-strengthens-asian-presence-with-new-aluminum-specialty-pl.html>

Cortec® Solutions Helped Midwest Wastewater System Cut Corrosion Costs by \$10,000+ in One Year



Why Are Wastewater Environments So Corrosive?

Wastewater treatment environments not only face the threat of constant moisture exposure, but also the presence of corrosive gases like H₂S. Together, these elements accelerate the oxidation of metallic components, making infrastructure maintenance a constant challenge. Even pumping stations throughout a city's sewer system are exposed to harsh environments and require special attention to slow down corrosion.

What Can Be Done to Protect Electronics?

Although extremely intricate and sensitive, electronics are also relatively easy to protect with the right tools. In the case of the Midwest wastewater treatment facility with HMIs failing at pumping stations throughout the city's 258-mile (415 km) sewage system, three forms of corrosion protection were used:

passive absorption, active vapor-phase protection, and active contact protection.

1) Passive Protection: Remove the Source of the Problem

One Corrosorber® cup was placed inside each compartment to absorb H₂S, thus reducing the corrosiveness in the environment.

2) Active Vapor-Phase Protection: Condition an Entire Space

Since there was no way to completely remove the corrosive elements in the environment, each HMI panel also received a VpCI®-111 Emitter. These are Vapor phase Corrosion Inhibitors adsorbing on metal surfaces, where they form a protective molecular layer that hinders corrosive reactions with surrounding elements as long as the enclosure stays shut.

3) Active Contact Protection: Apply a Protective Film

For an added layer of protection, workers powered down the HMI panels to apply a light mist of ElectriCorr™ VpCI®-239, which leaves a long-term protective film suitable for use in vented enclosures or especially severe environments.

The Huge ROI of Corrosion Protection

After one year of protection, the city wastewater system no longer had further corrosion-related HMI failures, a significant drop from the typical two to four failures annually. Instead of spending \$15,000-40,000 for an HMI replacement, the municipality experienced a huge return on investment (ROI) by paying less than one percent of that cost for preventative corrosion solutions.

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Fellow's Corner

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 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.

Can Corrosion Be a Help Rather Than a Hindrance?

Gareth Hinds, PhD, FICorr, EFC President, ICorr Past President



Meet the Author



Dr Gareth Hinds

Dr Gareth Hinds is Senior NPL Fellow and Fellow of the Institute of Corrosion. He is Science Area Leader in the Electrochemistry Group at the National Physical Laboratory in Teddington, United Kingdom. His primary expertise is in the development of novel in situ diagnostic techniques and standard test methods for assessment of corrosion and material degradation in energy applications. Gareth is a Fellow of the Royal Academy of Engineering and holds visiting professorships at UCL, the University of Strathclyde, Harbin Institute of Technology and the Institute of Corrosion Science & Technology, Guangzhou. He is the author of over 200 publications and is currently President of the European Federation of Corrosion.

Corrosion is often viewed in a negative light. It can lead to premature failure of metallic components and infrastructure, with significant economic, environmental and safety-related consequences. As ICorr members, we're only too familiar with the need to combat this ever-present threat. However, in the right circumstances corrosion can also be exploited as a force for good! This Fellows Corner article takes a closer look at some examples.

Galvanic Cells

Corrosion is an electrochemical phenomenon involving the transfer of electrons and ions between conducting surfaces in contact with an electrolyte. It can therefore be harnessed in a controlled way to produce electrical power. When a battery is discharging, it acts as a galvanic cell, analogous to galvanic corrosion of two dissimilar metals, with the negative electrode acting as the anode and the positive electrode as the cathode. Control is achieved by isolating the electrodes from each other using an insulating porous separator, typically a polymer or ceramic. When the battery terminals are connected to an electrical load, usable DC current will flow.

The first battery was the Voltaic pile [1], which was invented by Alessandro Volta in 1800. This consisted of alternating discs of zinc and copper separated by strips of cloth soaked in brine. The anodic reaction was corrosion of zinc, with hydrogen evolution on copper as the cathodic reaction. The Voltaic pile played a central role in the discovery of water electrolysis by Carlisle and Nicholson [2] in 1800 (only a few months after its invention) and in the isolation of chemical elements (Na, K, Ca, B, Ba, Sr and Mg) by Humphry Davy [3] in the early 1800s.



Figure 1: Statue of Alessandro Volta In His Birthplace of Como, Italy, Featuring His Voltaic Pile [1], The Forerunner of The Modern Battery.

continues on page 24

Please Note: this article considers only spontaneous (galvanic) reactions in order to be consistent with real corrosion processes. Electrolytic processes are excluded. The scope is also restricted to electrochemical corrosion of metals to keep things relatively simple.

Volta mistakenly thought that the operation of his battery was a consequence of static electricity and seems to have used it mainly to deliver electric shocks to unsuspecting volunteers. It wasn't until the 1830s that Michael Faraday demonstrated the electrochemical basis of its operation. Nevertheless, Volta's invention and its subsequent evolution formed the basis for electricity generation throughout most of the 19th century, until the discovery of the electrical generator in 1870.

Today, batteries are playing a vital role in decarbonisation of our energy system, most notably in electric vehicles and grid storage. Unlike most forms of corrosion, the electrochemical reactions in some batteries are reversible. Examples include lithium-ion and lead-acid batteries, which can be charged and discharged many times over their lifetime. If only all corrosion reactions behaved in the same way!

Another well-established electrochemical technology that operates under the same galvanic principle is the use of sacrificial anodes to prevent corrosion. Anodic dissolution of the more active metal (usually an alloy of magnesium, aluminium or zinc) allows the more noble metal (normally steel) to remain protected under conditions in which it would otherwise freely corrode. This is the basis for cathodic protection of a wide range of infrastructure, including pipelines, storage tanks, marine structures and reinforced concrete.

Like batteries, cathodic protection has a long history, dating back to 1824 when Humphry Davy used iron anodes to protect copper sheathing on the hull of HMS Samarang [4]. While this did prove highly effective in preventing the copper from corroding, it was soon observed that marine biofouling had increased dramatically, as copper ions were no longer being released in sufficient quantity to kill the microorganisms. Since biofouling creates drag that slows down the ship, the Royal Navy decided that on balance it was better just to let the copper corrode, highlighting yet another beneficial effect of corrosion!

Surface Modification

Corrosion of a metal surface can be advantageous if it leads to the formation of a highly protective film. This is the case with weathering steels used in the construction industry. When exposed to atmospheric conditions, these steels initially corrode like mild steel but over time a dense, stable, patina forms that effectively prevents any further corrosion and is self-healing if damaged. This leads to huge cost savings in that no painting is required and maintenance costs are minimal.

Weathering steel was introduced in 1933 by US Steel as a high strength material for coal wagons in the railway industry. The steel composition had been developed by trial and error over many decades and it was entirely by chance that its corrosion resistant properties emerged. It was trademarked as 'Corten' steel – 'Cor' for 'corrosion resistance' and 'ten' for 'tensile strength'. The mechanism behind the establishment of a corrosion-resistant patina is still not fully understood but it's clear that wetting and drying cycles are required and that copper is the most important alloying element.

Of course, care should be taken not to use weathering steels in environments where a protective patina does not form. This will often be the case if the steel remains continuously wet or is exposed to high levels of chloride. Similarly, service experience shows that the patina forms more effectively in industrial and urban environments than in rural environments where atmospheric corrosion rates are much lower.

The most famous example of the use of weathering steels in the UK is probably the Angel of the North statue in Gateshead, which is seen by an estimated 33 million people every year due to its elevated position close to major North-East road and rail arteries [5]. Erected in February 1998, it was designed by sculptor Anthony Gormley and stands 20m tall with a wingspan of 54m. Most of Gormley's work is in bronze, but in this case weathering steel had to be used to provide sufficient strength to withstand periods of high wind.



Figure 2: The Angel of the North Statue In Gateshead [5] Was Constructed From Weathering Steel Due To Its Combination of Mechanical Strength And Corrosion Resistance. Image Source: Saw2th CC BY SA 2.0.

The widespread use of aluminium, stainless steel and other corrosion resistant alloys also depends on the formation and self-healing properties of a protective oxide layer in a range of aqueous environments. Here, the balance between metal ion dissolution and oxide formation governs the level of protection offered by the passive film. Passivation is a direct consequence of corrosion; without this critical phenomenon many engineering alloys would be completely useless!

Another advantageous surface modification that can arise from corrosion is crack tip blunting. Stress corrosion cracking, where stress and a corrosive environment combine with a susceptible microstructure to generate fracture well below the yield stress of the material, is a common failure mechanism in many industrial applications. Initiation and propagation of stress corrosion cracks depends on the presence of stress raisers such as corrosion pits and crack tips. However, when the corrosion rate is sufficiently high, dissolution of the metal can round off the sharp edges of the crack tip, significantly reducing the stress concentration factor and arresting crack growth. This can be useful as a means of mitigating crack development, but a balance is clearly needed as if the corrosion rate is too high other issues will emerge.

Selective Material Removal

Chemical etching is a well-established manufacturing process whereby corrosion is actively employed to achieve selective removal of material from a metallic component to realise the desired final shape. A masking material is often used to protect areas of the surface where material removal is not desired.

Very precise control of component shape can be achieved through the application of a photo-resistive material, a light-sensitive polymer that is stable in the etchant, to the entire surface. Prior to the etching step, exposure to light through a patterned mask can either weaken or strengthen the photoresist material, allowing removal of selected areas with an appropriate solvent.

The etching process can be used to manufacture highly intricate and complex shapes for a range of important applications, including aerospace, automotive, medical, microelectronics and energy conversion and storage devices. This avoids the issues of burrs and residual stresses that can be introduced by mechanical milling.

The earliest known application of chemical etching comes from ancient Egypt, where it was used to inscribe jewellery with hieroglyphs and images of deities. This was carried out in a relatively crude manner using rudimentary acids and abrasion. The process became more sophisticated over time with the invention of acid

baths in the 15th century and modern etchants developed during the Industrial Revolution.

In metallography, acid etching is a well-established technique for microstructural characterisation of metals and alloys. A common etchant is nitric acid, which tends to remove material in the grain boundaries more rapidly than the grains themselves, making the microstructure easier to see in an optical microscope. This allows visualisation of grain size, phase segregation and inclusions that can be linked to the properties of the material.

Aesthetics

The products of corrosion can display a wide range of pleasing colours due to the optical properties of metal oxides. Energy is absorbed and released by electrons as they transition between energy states in the metal atom when interacting with light. Every metal oxide exhibits a distinctive colour that depends on the metal, its oxidation state and the surrounding chemical environment. For example, iron oxides are mostly reddish-brown, cobalt oxide is blue and magnesium oxide is white.

The green-blue patina that forms over time when copper is exposed to atmospheric corrosion is copper carbonate. This patina is not only visually attractive but also highly protective of the underlying metal. Famous landmarks incorporating this feature include the Statue of Liberty, the Kremlin Palace and Berlin Cathedral. However, one of the major drawbacks of the use of copper in less high-profile structures is that it is often targeted by thieves for its high resale value. In February 2017 for example, St Peter's Church in Kirby Bellars near Melton Mowbray, Leicestershire, faced a £70k repair bill after the theft of a large amount of copper from its roof [6]. Sadly, this is becoming an increasingly common issue, particularly in rural communities.



Figure 3: The Striking Colour of The Domes on Berlin Cathedral is A Result of Prolonged Atmospheric Corrosion of Copper.

Pigments are products of corrosion that exhibit colour and have been used in art since antiquity. Use of pigments dates back 400,000 years to early humans who used yellow ochre (hydrous iron oxide) for ritual painting. Red ochre (anhydrous iron oxide) features heavily in cave paintings from the Neolithic period, such as those found at Lascaux in France. Early pigments used by artists were based on minerals and clays, although these have now been largely supplanted by modern synthetic variants.

Corrosion can even be an art form in itself. Jean Kittel, a researcher at IFP Energie Nouvelles in Lyon, France, has created a collection of artwork based on corroded metal, including copper, bronze and iron [7]. This impressive work was highlighted recently when two of his pieces were selected as prizes for a scavenger hunt that took place to mark 2025 World Corrosion Awareness Day [8].



Figure 4: Artwork By Jean Kittel [7] In Which A Corroded Polishing Disc is Printed With Prussian Blue And Sanguine Inks. Image Provided By Jean Kittel.

Material Functionality

The presence of a corrosion reaction can add considerable value if it leads to an improvement in the functionality of a material. Often the corrosion process is intentionally incorporated into the material or component design for maximum benefit.

Biodegradable medical implants are designed to be dissolved completely via corrosion once their primary function has been completed, thereby avoiding the need for a second surgery to remove them. The majority of these are organic or polymer-based but this is not possible for orthopaedic implants, where metals are required due to their higher load-bearing capacity.

In contrast to their well-established corrosion-resistant counterparts, such as titanium and cobalt-based alloys, metallic biodegradable implants are typically based on magnesium and zinc alloys that are much more susceptible to corrosion in the environment of the human body [9]. This is still an emerging area, with further research required to optimise design and implementation.

Just a small amount of corrosion of the steel reinforcement bars (rebars) in reinforced concrete enhances adherence of the concrete to the steel [10]. This is due to a combination of increased surface area and the expansion of the iron oxide to fill voids between the steel and the concrete. Of course, all benefit is lost at higher corrosion rates as the expansion of the oxide then creates stresses that lead to debonding and cracking of the concrete.

In alkaline water electrolysis, stainless steel catalysts can become activated by corrosion, leading to higher rates of hydrogen production [11]. Selective etching of the surface, particularly of chromium, leads to the formation of a nanostructured, porous surface layer that is rich in catalytically-active nickel and iron oxides. Again, caution is required as there is a trade-off between activity and stability that can be challenging to manage.

More generally, corrosion accelerates nutrient cycling in ecosystems by breaking down minerals in rocks and making them available to living organisms. So it's also a vital component in keeping us alive and healthy!

Summary

It's clear that there are many positive aspects of corrosion that, when used and controlled in the right way, are highly beneficial in a range of important applications. As always, there's a balance, and care needs to be taken that any downsides are well mitigated.

However, there's one additional major benefit that shouldn't be overlooked. Let's not forget that corrosion keeps most people reading this in business! Metals will always revert to their oxides if we do not intervene judiciously. For this I guess we ought to be thankful!

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A Framework for Evaluation of Ultrasonic Corrosion Inspection and Monitoring Strategies for Large Steel Structures

Yifeng Zhang, PhD, and Frederic Cegla, PhD



Meet the Authors



Dr Yifeng Zhang



Dr Frederic Cegla

Dr Yifeng Zhang is a Postdoctoral Research Associate in the Non-Destructive Evaluation (NDE) Group at Imperial College London. His work focuses on ultrasonic Structural Health Monitoring (SHM) and inspection technologies that enhance structural integrity and operational efficiency across the energy and petrochemical sectors.

Dr Frederic Cegla is a Reader/Associate Professor in the non-destructive evaluation (NDE) Group at Imperial College London. His research focuses on developing and applying advanced technologies for non-destructive evaluation NDE, SHM, and process monitoring — linking cutting-edge sensing and wave physics with practical solutions for industry.

Introduction: The Challenge of Corrosion Surveillance

Corrosion remains one of the most persistent challenges in managing industrial assets such as power plants, processing facilities, pipelines, and ships. Unlike sudden failures, it develops gradually, often across vast areas and over decades of service.

The result is a degradation process that is both spatially and temporally diverse. Non-destructive evaluation (NDE) techniques such as ultrasonic testing and thickness gauging are widely used to provide critical information that underpins the safety, reliability, and

availability of various assets. In practice, it is rarely feasible to perform complete (100%) inspection coverage of large downstream or marine facilities. Instead, inspection areas are typically prioritised using risk-based assessment (RBA) programmes, which focus resources on regions with the highest likelihood or consequence of corrosion. Because of these practical constraints, current ultrasonic methods have evolved along two main directions.

Scheduled one-off inspections — often combined with visual assessments and performed using scanning systems — can cover large areas but occur infrequently due to the need for plant shutdowns or limited access [1–2]. In contrast, permanently installed automated monitoring sensors offer improved measurement repeatability and high temporal resolution but are typically deployed only at a few selected locations [3–4] owing to cost and installation complexity.

Towards Hybrid Inspection and Monitoring

Recent advances in robotics and sensor technologies are creating powerful synergies that blur the line between traditional one-off inspection and continuous monitoring. It is envisaged that autonomous robotic platforms will in future manipulate ultrasonic probes across complex geometries, while monitoring sensors will be deployed in hard-to-reach areas that once required significant manual effort.

Prototypes of resident inspection robots — designed to remain on the asset and operate semi-independently — are moving from research labs towards field demonstrations [5–6].

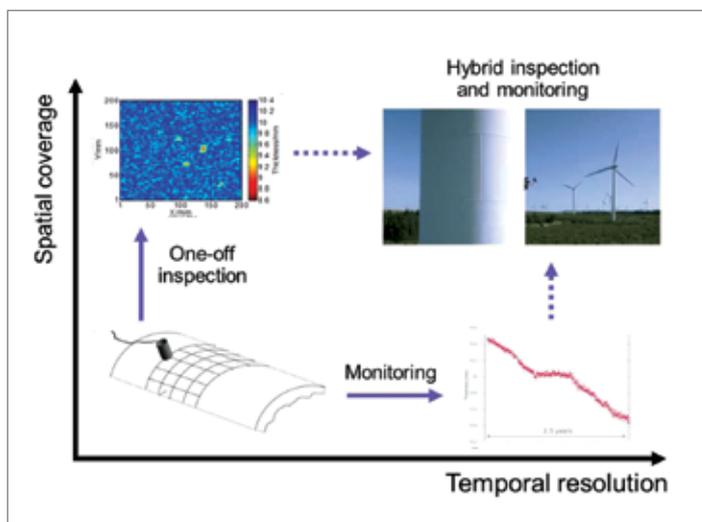


Figure 1: Ultrasonic Thickness Measurement Techniques, Trade-Offs Between Spatial Coverage and Temporal Resolution.

continues on page 28



Figure 2: Integration of EMAT With Robotic Platforms (Image Courtesy of The Offshore Robotics for The Certification of Assets (ORCA) Hub, From Research That Led To The Formation of Sonobotics Ltd).

These developments point towards a hybrid surveillance model that combines the strengths of both worlds as part of the agreed inspection programme. For example, resident robots could perform encoded ultrasonic scans across a structure, leaving behind monitoring sensors in critical regions for long-term trending. There, instead of choosing between wide but infrequent inspections and highly localised monitoring, a mixed approach could provide a more complete picture of corrosion progression in both time and space. The opportunities are clear, but so are the challenges. How many robots or sensors are needed to ensure sufficient reliability and compliance with the agreed overall inspection programme? How does the hybrid scheme align with existing approaches? What are the cost implications and likely return on investment? These questions must be addressed before hybrid inspection-monitoring schemes can achieve widespread adoption.

While current best practices for NDT in the energy sector follow established standards such as API 581 and guidance provided by organisations such as ESR-HOIS, a forward-looking study funded by the UK Research Centre in NDE (RCNDE) explored new methodologies to systematically evaluate and optimise hybrid inspection-monitoring strategies. [7–8]. This article highlights the main findings of the study, introducing a generic framework applicable across diverse industries and corrosion scenarios.

A Framework for Evaluating Hybrid Inspection–Monitoring Schemes

The proposed framework comprises four essential steps, each of which plays a role in simulating how corrosion evolves, how it is measured, and how the acquired data are interpreted.

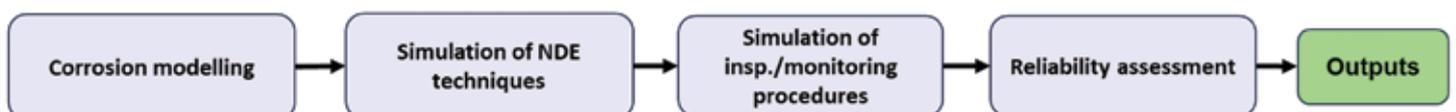


Figure 3: An Overview Of The Proposed Evaluation Framework.

1. Corrosion Modelling: Capturing the Degradation Process

The framework begins by establishing a model that accurately captures corrosion damage progression. Corrosion manifests differently across industries—from uniform wall thinning in pipelines to localised pitting in offshore structures and complex mixed morphologies in chemical processing facilities. It is recognised that no single model would suffice for all applications, and different scenarios demand models of varying complexity and fidelity.

While corrosion mechanisms vary widely, ultrasonic NDE measurements share a common dependency: the corroded surface profile. Since wave reflection from the corroding surface dictates the characteristics of measured ultrasonic signals, a suitable corrosion model must capture both the relevant surface morphology and its temporal evolution.

This approach decouples electrochemical complexities from NDE simulation requirements, enabling the corrosion model to be readily updated or substituted for different scenarios.

2. Modelling the NDE Technique

The second stage involves accurately representing the NDE method itself. Like all measurement systems, NDE techniques inherently contain errors and uncertainties. For instance, as part of the HOIS Joint Industry Project [9–10], the measurement error and uncertainties of several manual and automated corrosion mapping methods were evaluated, and the findings were found to vary significantly depending on the choice of equipment.

For normal-incidence ultrasonic thickness measurements, the signal depends on multiple factors: transducer characteristics (e.g. size, shape, operating frequency) and surface conditions (e.g. roughness) [11–12]. Signal processing algorithms further influence measurement outputs, with algorithm selection typically based on the expected defect type. Understanding and quantifying these error sources is crucial, as they propagate through to all subsequent analyses and decision-making processes.

While finite-element simulations can accurately capture wave propagation phenomena, their computational demands make statistical analysis of stochastic corrosion processes challenging. Surrogate models — either physics-based or data-driven—offer a practical alternative by balancing computational efficiency with accuracy. These simplified models enable systematic evaluation of NDE techniques while maintaining sufficient fidelity to represent real-world performance.

In practice, multiple models may be required to represent different equipment types, and these can later be integrated and refined as field experience accumulates. Ultimately, the chosen NDE model must reflect the technique’s inherent limitations and uncertainties as encountered in field applications.

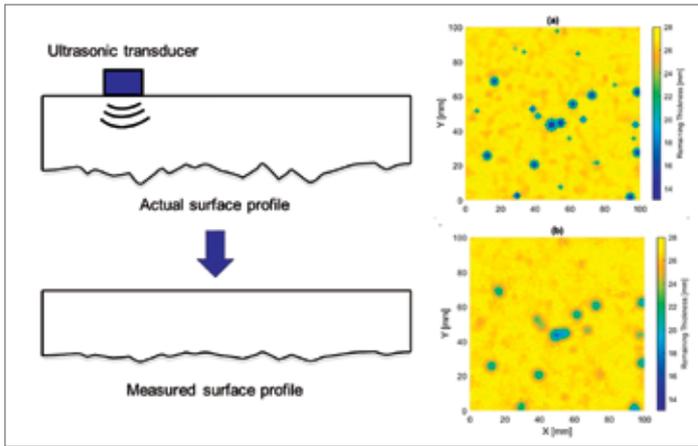


Figure 4: Illustration Of The Ultrasonic Scanning Measurement: Comparison Between The True Underlying Surface And The Thickness Measurement Map Predicted By A Surrogate Model.

3. Simulation of Data Acquisition Processes

The third stage models the data acquisition process, addressing real-world constraints such as operational access, spatial scanning resolution, limited probe availability, and restricted temporal measurement frequency. By focusing on data subsampling in time and space, the framework accounts for the incomplete nature of field measurements caused by sparse grids, irregular intervals, and missed data points. These constraints ensure a realistic representation of field deployment scenarios, enabling accurate assessments under practical conditions.

4. Defining Metrics of Reliability and Risk

Once simulated data are available, the next step is to establish performance assessment criteria. This involves defining a clear corrosion assessment objective, such as detecting defects above a specified threshold or tracking the location and extent of the minimum remaining thickness. Ideally this data collection should be combined and reported along with prevailing operating parameters / modes e.g. cyclic operation to provide added value.

Quantitative metrics, such as the probability of detection (POD) or receiver operating characteristic (ROC) analysis, are then applied. These metrics are evaluated on an ensemble of representative surfaces using Monte Carlo-style simulations to assess the effectiveness of various NDE data acquisition techniques and procedures. A proof-of-concept demonstration is detailed in Reference [7], where the objective was set to tracking the minimum remaining thickness within a defined tolerance. The study introduces a metric called the unreliability function (URF) to quantify the reliability of inspection and monitoring schemes. Using an ensemble of realisations that mimic field measurement characteristics, the study evaluates the reliability of three strategies: surface scanning, monitoring with permanently installed sensors, and a hybrid approach combining surface scanning with movable monitoring sensors. For the given scenario, the findings reveal that partial surface scanning followed by sensor repositioning/optimisation creates a hybrid strategy that substantially improves performance despite reduced operational demands: fewer sensors per location, limited coverage, and longer inspection cycles.

Conclusion and Outlook

Although manual inspection will continue to play an essential role in ensuring the structural integrity of critical infrastructure, advances in automation and robotics now make it feasible for an increasing proportion of inspection and monitoring activities to be performed

automatically. In practice, adopting a hybrid inspection–monitoring strategy provides a promising means of optimising data collection and enhancing overall asset integrity.

The framework presented here outlines a structured approach for evaluating hybrid inspection–monitoring schemes that leverage recent advances in robotics, sensing, and modelling. By clearly defining the interfaces between corrosion modelling, data acquisition, and performance evaluation, it supports the development of more flexible surveillance methods for industrial assets. Successful implementation requires coordinated efforts among corrosion engineers/scientists, NDE engineers, asset owners, and regulators. Key priorities include adapting models to specific industrial settings, validating performance through field studies, and developing accessible tools for practitioners. This progression from theoretical framework to practical implementation will enhance operational safety, asset availability, and economic efficiency.

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Combatting Corrosion, Vibration, and Fatigue Under Pipe Supports: SmartPad System Advances for the Energy and Process Sectors



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Meet the Author



Hani Almufti

Hani Almufti is Engineer and Manager of Strategic Development at Cogbill Construction (RedLineIPS), where he leads product strategy, materials selection, and technical guidance for metallic and non-metallic pipe support systems. He holds a B.S. in Industrial Engineering and is a Master's candidate in the same field. With 15+ years in pipe supports—including a decade focused on offshore energy corrosion—he specialises in corrosion under pipe supports (CUPS) and the performance of FRP/composite and metallic supports. His expertise spans corrosion mitigation, reliability engineering, and process improvement, with a sustained focus on reducing risk, noise/vibration, and lifecycle cost across onshore and offshore assets.



Photo 1: Installed System On Pipe Gantry.

1. Introduction

Pipe-support interfaces are convergence points for several degradation modes in industrial and offshore piping: corrosion under pipe supports (CUPS), vibration, structure-borne noise, and fatigue. On offshore platforms and FPSOs, major operators have reported that these risks are heightened by salt-laden atmospheres, hull motion, and restricted access, while the pipe-pad contact remains difficult to inspect [1].

Conventional mitigations—welded metallic pads, thermoplastic half-rounds, and epoxy-bonded plates—can re-establish galvanic paths, trap electrolyte, or require hot work and cure time. Maintaining seal integrity, alignment, and controlled slip becomes increasingly challenging as coatings wear and thermal cycles accumulate [1].

The RedLineIPS SmartPad System is a fully non-metallic support interface comprising a load-spreading FRP saddle, a bonded closed-cell elastomeric gasket (Hydroseal), and FRP bands/buckles.

Together, they electrically isolate the pipe from the steel support, seal the pipe-pad contact to discourage moisture films, provide viscoelastic damping at the interface, and relocate thermal slip to a controlled, low-friction plane on the saddle/support side. This paper outlines the design rationale, installation approach, and third-party proofs, and summarises field experience from a Gulf Coast of Mexico chemical plant retrofit programme.

2. The SmartPad System

2.1 Composite FRP SmartPad (Saddle Wear Pad)

2.1.1 Construction and geometry

Structural fibre-reinforced polymer (FRP) saddle fabricated from continuous-strand mat (CSM) in a vinyl-ester matrix, moulded to standard pipe curvatures of 1/2" to 72" NPS. The crown radius and contact width are sized to spread load over a broad arc, keep local bearing pressure low, and maintain stable seating under thermal and dynamic loads.

2.1.2 Functions at the pipe-pad interface

- **Load distribution:** Spreads the pipe's weight over a wider area so no small spot takes all the pressure—reducing dents and coating damage.
- **Electrical isolation:** Non-conductive composite interrupts metal-to-metal continuity (limits galvanic coupling to support steel).
- **Coating protection:** Smooth, inert bearing surface reduces abrasion during thermal slip and vibration.
- **Offshore durability:** Vinyl-ester chemistry with UV inhibitors tolerates chloride-rich, marine atmospheres.



Photo 2: SmartPad Exoskeleton with Grooves for Bands.

2.1.3 Typical Material Properties

- **Resin system:** Vinyl ester; reinforcement: CSM; glass content: ~35–40 wt%.
- **Compressive strength (ASTM D695):** ~25,000 psi (172 MPa) [2].
- **Flexural strength (ASTM D790):** >30,000 psi (207 MPa).
- **Continuous service temperature:** -60°F to 400°F (-51°C to 204°C).
- **UV resistance:** High (integral inhibitors).
- **Fire behaviour:** Fire-retardant formulation (rating available on request).

2.1.4 Manufacture and Integration

Hand lay-up with controlled cure to achieve low void content and uniform fibre wet-out. Finished edge radii and surface roughness are controlled to minimize coating gouge. Saddle curvature and contact-width tolerances support repeatable fit and clamp preload. The FRP saddle provides the load-bearing, isolating substrate for the bonded closed-cell gasket and FRP banding within a fully non-metallic load path.

2.2 Hydroseal Closed-Cell Gasket



Photo 3: FRP Saddle and Closed Cell Gasket.

2.2.1 Construction and Placement

Factory-bonded to the SmartPad’s pipe side, the closed-cell elastomer compresses under band preload to form a continuous, conformal contact that accommodates normal surface roughness and remains uniform through thermal and vibration cycles at the **pipe-pad interface**.

2.2.2 Functions at the Pipe-Pad Interface

- **Moisture Exclusion / CUPS Control:** Very low water uptake; compressed contact suppresses crevice geometry and ion/oxygen transport, limiting crevice/under-deposit and MIC precursors.
- **Vibration and Noise Attenuation:** Viscoelastic damping lowers transmitted shear and micro-slip; the compliant, non-metallic layer acts as an acoustic impedance break to reduce structure-borne noise and alternating stress.
- **Assists Galvanic Isolation:** In combination with the FRP saddle, maintains a fully dielectric contact path.

2.2.3 Typical Material Properties

- **Type:** Closed-Cell Elastomer (e.g., silicone / EPDM)
- **Density:** 14–18 lb/ft³ (≈225–290 kg/m³)
- **Compression-deflection @25% (ASTM D1056):** ≈7.5 psi (≈52 kPa) [3]
- **Hardness (ASTM D2240, Shore 00):** 40–60
- **Water absorption (ASTM D471):** <0.1% by volume
- **Operating temperature:** -60°F to 570°F (-51°C to 300°C)
- **Compression-set resistance:** Excellent

2.2.4 Durability and Integration

Under FRP-band preload, the gasket maintains stable compression, preserving seal and damping through thermal/vibration cycling and tolerating minor surface irregularities from prior repairs. Within the fully non-metallic load path, the gasket supplies sealing, compliance, and energy dissipation that complement the saddle’s stiffness and protect the coating at the **pipe-pad interface**.

2.3 SmartBands

2.3.1 Construction and Locking

Continuous long-strand FRP straps in a UV-resistant resin, paired with a matching-pitch FRP square-tooth buckle for incremental, non-backdrivable engagement. Radiused edges and smooth faces limit stress risers and coating damage.



Photo 4: Non-Metallic Straps and Buckles.

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2.3.2 Functions at the Pipe-Pad/Support Interface

- **Dielectric clamping:** All-composite load path preserves electrical isolation (avoids galvanic reintroduction).
- **Preload delivery/retention:** Long-strand reinforcement improves load transfer and creep/fatigue resistance, maintaining clamp force through thermal and vibration cycling.
- **Surface compatibility / constructability:** Non-marring inner face; smooth outer face for clean tensioning. Installs with a calibrated handheld tool—no hot work or adhesives.

2.3.3 Typical material properties

- **Material:** Continuous-strand FRP; UV-resistant resin.
- **Tensile capacity (per band):** ~1,200 lbf (≈5.3 kN).
- **Thermal range:** -40 °F to 250 °F (-40 °C to 121 °C).
- **Electrical behaviour:** Dielectric, non-metallic.
- **Environmental durability:** Corrosion-immune; outdoor/UV rated for coastal/offshore service.

2.3.4 Installation and Preload Control

Bands routed in moulded circumferential grooves in the saddle engage the FRP buckle and are tensioned to specification with a calibrated tool. Groove geometry sets bend radius, keeps the strap flush/recessed, and prevents lateral migration; the low-profile routing avoids snagging and maintains uniform bearing. Preload is confirmed by tool indication (or witness marks). For underside inspection, bands are single-use—they are cut and replaced with new bands; replacements are low-cost, and reinstallation typically takes minutes per support. Grooved routing also localises relative motion to the engineered slip plane at the saddle-support interface [4].

2.3.5 Durability and Integration

The continuous-strand architecture resists creep and tooth-root fatigue under cyclic loads. UV-stabilised resin supports long outdoor exposure; the all-composite assembly is unaffected by chloride corrosion. SmartBands provide the clamping force that maintains the Hydroseal seal and the saddle's load-sharing contact within a fully non-metallic load path.



Photo 5: Example of Corrosion Under Pipe Support.

3. Corrosion Mechanisms at Support Interfaces

3.1 Crevice / Differential Aeration

- **Mechanism:** A narrow, shielded gap at the pipe-pad interface traps a thin electrolyte. Oxygen is depleted inside the gap while adjacent surfaces remain aerated, creating an anode/cathode differential. Wet-dry cycling concentrates chlorides and lowers pH, undermining coatings and accelerating localised metal loss [1].

- **SmartPad Mitigation:** A factory-bonded, closed-cell Hydroseal gasket forms a continuous conformal contact under preload, denying voids where films persist. The FRP saddle spreads load to keep contact pressure uniform through thermal cycles, disrupting the differential-aeration cell associated with CUPS.

3.2 Galvanic at the Support

- **Mechanism:** Electrically coupled dissimilar (or conditionally different) metals sharing an electrolyte drive anodic dissolution; small-anode/large-cathode area ratios intensify attack at supports [1].
- **SmartPad Mitigation:** A fully dielectric load path—FRP saddle, Hydroseal gasket, and FRP SmartBands™/buckles—breaks metal-to-metal continuity. The sealed interface also limits shared electrolyte, cutting off both prerequisites for galvanic corrosion.

3.3 Microbiologically Influenced Corrosion (MIC)

- **Mechanism:** In intermittently wet crevices, biofilms (e.g., SRB) create chemically distinct microenvironments (sulfides, acidity, differential aeration) that localise attack [1].
- **SmartPad Mitigation:** The low-uptake, closed-cell contact shortens wet-film residence time and reduces attachment sites. Smooth, non-porous, electrically isolating surfaces further discourage biofilm establishment and persistence at the pipe-pad interface.

3.4 Fretting-Assisted Corrosion

- **Mechanism:** Sub-millimeter relative motion from vibration/thermal cycling abrades coatings and oxides; freshly exposed steel corrodes between slips, forming a wear-corrosion feedback loop focused at the supports [1].
- **SmartPad Mitigation:** Viscoelastic damping in Hydroseal stabilises the pipe-pad contact and lowers micro-slip. Required thermal movement is relocated to the low-friction saddle-support interface, while the FRP saddle's load distribution reduces shear at the pipe wall.

3.5 Under-Deposit/Capillary Thin-Film

- **Mechanism:** Deposits or capillary-held films trap chloride-rich, oxygen-poor moisture that behaves like a crevice beneath the footprint [1].
- **SmartPad Mitigation:** The bonded, continuous interface leaves no seam for solids to wedge; closed-cell elastomer resists wicking. Moisture remains on exposed, cleanable surfaces rather than beneath the pipe.

4. Vibration

4.1 Sources and frequency content

Piping vibration originates from rotating/reciprocating equipment (pumps, compressors, blowers), pulsation in positive-displacement services, turbulence at fittings/reducers, two-phase/cavitation, hydraulic transients, alignment/soft-foot issues, and support stiffness mismatches. Field spectra commonly fall in the 10–100 Hz band with ~0.25–2.5 mm (0.01–0.10 in) peak-to-peak motion; response amplifies near span/support natural frequencies (cf. ISO 20816-1) [5].

4.2 Why the pipe-pad interface matters

Rigid, metal-to-metal load paths transmit dynamic energy as micro-slip and contact shear at the pipe-pad interface. This accelerates coating wear (promoting CUPS), excites support steel (structure-borne noise), loosens hardware, and increases alternating stress $\Delta\sigma$ —shortening fatigue life per S-N behaviour.

4.3 SmartPad mitigation mechanisms

- **Interface damping (Hydroseal).** The closed-cell elastomer provides viscoelastic damping in the 10–100 Hz range, reducing transmitted shear/micro-slip and smoothing contact pressures [6].
- **Relocated slip (FRP saddle).** The moulded saddle furnishes a controlled, low-friction slip plane at the **saddle–support** interface so thermal movement does not abrade the coating at the pipe–pad interface; broad bearing further lowers work per cycle.
- **Stable dielectric clamping (SmartBands™ in recessed grooves).** Calibrated, all-composite preload maintains uniform contact without re-introducing metallic short circuits, low-profile routing resists lateral migration and secondary rattles.

5. Sound (Structure-Borne Noise)

5.1 Mechanism

Dynamic forces excite the pipe wall; a rigid, metal-to-metal path at the **pipe–pad interface** transmits that energy into support steel and deck members, which then radiate airborne noise. Frictional micro-slip at a hard contact can also generate “stick–slip” (squeal) components. Acoustic transmissibility rises when the interface impedance closely matches the supporting structure.

5.2 Sources and Frequency Content

The same drivers as vibration—rotating/reciprocating equipment, pulsation in positive-displacement (PD) services, turbulence, two-phase/cavitation, hydraulic transients, alignment/soft-foot, and support stiffness issues—dominate. On process/offshore lines, most structure-borne content is ~20–200 Hz, overlapping habitability and communication bands [5].

5.3 SmartPad Noise-Control Mechanisms

- **Impedance break + damping (Hydroseal):** The closed-cell elastomer introduces a compliant, non-metallic layer at the pipe–pad interface, lowering mechanical impedance and adding viscoelastic loss. Result: reduced transmissibility and less friction-generated noise from micro-slip.
- **Controlled slip on the support side (FRP saddle):** The moulded FRP surface provides a low-friction slip plane at the **saddle–support** interface, keeping relative motion off the coating and suppressing stick–slip at the pipe–pad contact. Broad bearing further lowers contact forces that drive radiation.
- **Dielectric, Low-Profile Clamping (SmartBands in recessed grooves):** All-composite bands maintain the decoupled path (no metallic short-circuit) and sit flush to avoid secondary rattles; calibrated preload keeps contact uniform.

6. Structural Integrity (Fatigue & Stability)

6.1 Overview

The **pipe–pad interface** largely governs fatigue performance at supports. A hard, rigid contact concentrates routine loads and transmits vibration into repeatable stress cycles, leading to local denting, coating loss, misalignment, and ultimately crack initiation in the pipe wall or supporting steel [7].

6.2 Principal contributors at supports

- **Thermal restraint.** Limited slip forces the pipe to bear against the interface; daily temperature swings add alternating load.
- **Small real contact area / edges.** Narrow bearings or sharp transitions elevate local pressure and seed dents.

- **Dynamic excitation.** Equipment- and flow-induced vibration increases the stress range each cycle.
- **Fit-up variability.** Misalignment or uneven bearing amplifies local stress and accelerates coating abrasion.

6.3 Why this matters for fatigue

Fatigue life follows S–N behaviour and is controlled by the alternating stress amplitude ($\Delta\sigma$). Dents, coating scrapes, and other stress raisers reduce cycles to initiation; once the coating is breached, corrosion further degrades the section, compounding risk [7].

6.4 SmartPad mitigation mechanisms

- **Load distribution — FRP saddle.** Broad bearing lowers peak contact pressure and mitigates edge effects; the non-conductive substrate avoids metal-to-metal paths that undermine coatings.
- **Compliance & damping — Hydroseal gasket.** A firm, closed-cell elastomer equalises contact pressure, absorbs vibration, and cushions small impacts, reducing contact shear and $\Delta\sigma$ per cycle [6].
- **Controlled movement without abrasion — saddle–support slip plane.** Thermal growth is taken on the moulded FRP surface (optional low- μ liner if needed), minimising stick–slip and fretting at the **pipe–pad** contact.
- **Stable alignment & clamp — SmartBands in recessed grooves.** Calibrated, all-composite preload keeps contact uniform and resists lateral migration; the dielectric, low-profile routing avoids galvanic short-circuits and loose hardware. *(For underside inspection, bands are single-use—cut and replaced; this is a low-cost operation).*



Photo 6: Full System Assembly.

7. Third-Party Testing: SmartPad Suitability for Industrial Service

Independent third-party testing was performed on specimens, as follows:

Test	Specimen & Setup	Peak Applied Load	Reported Outcome
Compression (component)	FRP pad on NPS 16, STD wall (3/8 in) × 14" long pipe	113,300 lbf [503 KN]	No pad failure reported
Compression (assembly)	FRP SmartPad on 4.5" with 1/4" wall × 14" long pipe	26,400 lbf [117 KN]	No pad failure reported
Shear Test (assembly)	FRP SmartPad on 4.5" with 1/4" wall × 14" long pipe	1,057 lbf [4.7 KN]	No reported pad/band failure

continues on page 34

7.1 Results - Proof Loads, No Failures Observed

- **Pad-only Compression:** FRP saddle on NPS 16, STD wall pipe sustained 113,300 lbf axial compression without pad failure.
- **Assembly Compression:** Banded SmartPad-on-pipe (4.5 in OD × ¼ in wall) sustained 26,400 lbf axial compression without pad failure.
- **Assembly Shear:** Same assembly sustained 1,057 lbf lateral (shear) without pad or band failure.

7.2 Interpretation

For the geometries/fixtures tested under monotonic loading, neither the composite saddle nor the banded assembly was the limiting element. The components tolerated high localised bearing and incidental lateral restraint typical of pipe-support reactions when installed and preloaded to specification.

7.3 Scope and Limits

These are static proof tests on short specimens. They do not establish design allowables or characterise fatigue, creep/relaxation, or environmental durability. Apply normal owner engineering practices (codes, load combinations, temperature, vibration/fatigue assessment) [8,9].

7.4 Implication for Use

Combined with the corrosion mechanisms described in section 3 (sealed dielectric interface, viscoelastic damping at the pipe-pad contact, and load spreading/controlled slip), the proofs support the SmartPad System's mechanical suitability as a non-metallic pipe-support interface for industrial and offshore service, subject to project-specific engineering review.

8. Case Study — Coastal Texas Chemical Plant (Anonymised)

Background

A large Gulf Coast complex retrofitted the RedLineIPS SmartPad System to mitigate CUPS, structure-borne noise, and nuisance vibration at pipe/support interfaces in a salt-laden, high-humidity environment.

8.1 Scope

- **Units:** Olefins recovery, utilities/cooling water, brine handling.
- **Lines:** Carbon-steel piping from 2"–24" NPS; cooling-water return, light condensate, brine.
- **Quantity:** ~5,000 supports installed during routine windows (no hot work).
- **Configuration:** FRP saddle + bonded Hydroseal closed-cell gasket + FRP SmartBands/buckles.

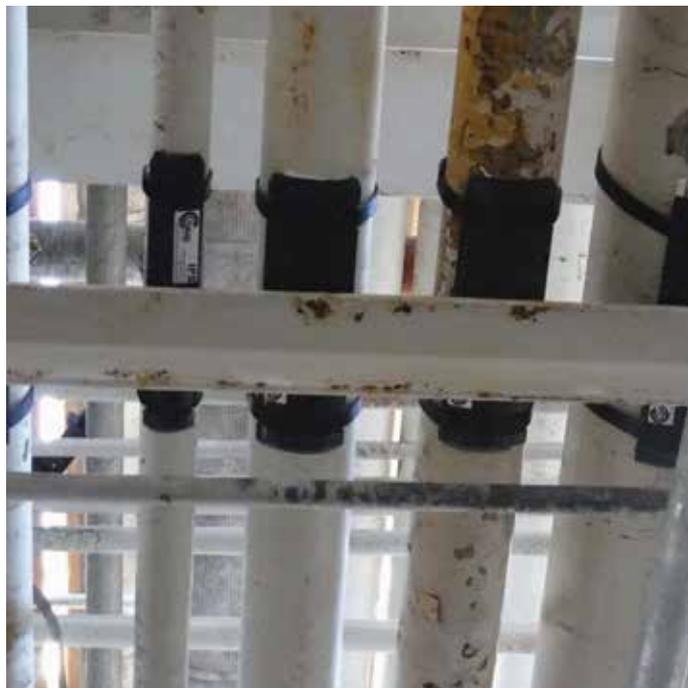


Photo 7: Installed System at Formosa Plant.



Photo 8: Installed System at Formosa Plant.



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8.2 Measurement and Methods

- **Noise:** Handheld Type 2 sound level meter, A-weighted, slow response, 30–60 s spot readings at ~0.5 m from each support, matched operating states pre/post.
- **Vibration:** No instrumented campaign (outage/time constraints). Operators recorded short smartphone videos before/after to gauge visible movement and compared them during like operating conditions.
- **Corrosion:** Visual exam during the 2024 turnaround (~5–6 years in service), plus borescope checks at pad edges and selective UT checks adjacent to the footprint (where feasible) [8,9].
- **Structural Integrity:** Visual walkdowns of support welds, nearby brackets, and welded appurtenances (valves/instrument stubs) during the same outage.
- **Note:** Measurements were practical field checks, not a controlled academic study. The results below reflect typical site practice and repeated observations across many supports.

8.3 Results

- **Noise:** Consistent –6 to –10 dB(A) near treated supports (e.g., ~86–90 → ~78–82 dB(A) at cooling-water lines).
- **Vibration:** “Calmer” interfaces with reduced visible shake; fewer buzzing brackets.
- **CUPS:** No rust staining/under-deposit buildup/edge blistering; borescope showed clean, dry interfaces; UT adjacent to footprints showed no loss beyond normal scatter.
- **Structural:** No visual cracking at support welds or welded attachments; no new denting noted.

8.4 Operations & Maintenance Feedback

- **Installation:** Average ~5–7 minutes per support using handheld tensioner; no hot work permits, fire watch, or post-weld coating cure.
- **Aftercare:** No band re-tensioning required in the first multi-year cycle; routine walkdowns only.
- **Housekeeping:** Keeping the beam top clean and smooth at installation improved slip behaviour and minimised dirt trapping.

8.5 Lessons Learned

- Specify slip needs up front. Where thermal movement is large, include the optional low-friction liner at the pad–beam interface.
- Banding technique matters. Uniform, adequate tension delivers the best seat conformity and long-term stability.
- Document a few reference supports. Short, repeatable noise checks and periodic video captures make trend comparisons easy between turnarounds.

8.6 Limitations

- Vibration was not instrumented; improvements are qualitative. A future accelerometer campaign could quantify transmissibility changes.

- Noise checks were spot readings (Type 2 meter) rather than a controlled survey; nonetheless, results were consistent across multiple supports and operating states.

8.7 Outcome

Over approximately six years at a plant on the Gulf of Mexico coast—within a salt-laden environment—the SmartPad retrofit across ~5,000 supports delivered:

- Quieter supports (typical 6–10 dB(A) reductions).
- Visibly lower vibration at the pipe–pad interface.
- No observed CUPS at treated interfaces on turnaround.
- No observed cracking at support welds or welded attachments in treated spans.
- Site Comment (anonymised): “The SmartPads have made the squealers go quiet and the shaky seats calm down. Most importantly, we’re not seeing the rust rings we used to fight under supports.”

9. Conclusion

Pipe-support interfaces are where corrosion (CUPS), vibration, structure-borne noise, and fatigue converge. There is strong evidence to date that the trialed RedLineIPS SmartPad System addresses the shared initiators—retained electrolyte, metal-to-metal electrical continuity, uncontrolled micro-slip at the coating, and concentrated bearing stress—using a fully non-metallic stack: a load-spreading FRP saddle, a bonded closed-cell elastomeric (Hydroseal) layer that seals and damps, and FRP SmartBands/buckles that provide stable, dielectric clamping. Acting together at the pipe–support interface, these elements reduce the conditions that drive CUPS, interrupt mechanical/acoustic transmission, and lower alternating stress amplitudes relevant to fatigue.

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Influence of Overprotection on AC Corrosion. Analysis of a Real Case



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Meet the Author



Ivano Magnifico

Ivano Magnifico holds a master’s degree in Electronic Engineering and serves as the Gas and Oil Product Manager at Automa, an ICorr Corporate Member. A certified Cathodic Protection Specialist, he combines technical competence with deep knowledge of market analysis and industry standards. With over 15 years of experience in remote cathodic protection monitoring and a patent for an intelligent reference electrode, Ivano has made significant contributions to the field. He is a member of the Board of Directors of CEOCOR (European Committee for the Study of Corrosion and Protection of Piping Systems) and serves as the Delegate of the AMPP Italy Ivano Magnifico Chapter. In addition, he is an active participant in ISO and AMPP standard working groups on cathodic protection.

Introduction

The risk of AC corrosion has always been linked to the parallelisms of underground pipelines with High Voltage AC lines, especially in those geographical areas where the morphology of the territory creates obligatory so-called “technological corridors” and therefore forces the coexistence of different services over long distances.

Recently, the greater diffusion of AC-powered railway networks has further increased the AC interfering sources, while the use of more performing coatings on underground pipelines has on the one hand increased their insulation from the surrounding soil, and on the other has increased the risk of overprotection compared to old, less performing, or more degraded coatings.

This paper, starting from a real case found in a gas distribution network, will present the normative criteria to be used to keep the AC corrosion risk under control, and will highlight how the simultaneous presence of cathodic overprotection may result in an autocatalytic cycle leading to accelerated AC corrosion, in which monitoring becomes essential in order to be able to carry out on time the appropriate corrective actions.

There are several mechanisms through which an AC source can interfere with a metal structure (Fig. 1): by inductive coupling, as an effect of the magnetic field generated with respect to an underground structure; by capacitive coupling, in the case of an aerial structure; and by conductive coupling in the presence of a fault current in the ground, in the case of an underground pipeline.

In the case of underground pipelines, under normal operating conditions, the mechanism that can generate AC interference is inductive coupling: normally the interference effect is greater as larger the length of the sections where the pipeline and the AC source (high voltage AC lines, railways operated in AC) follow a parallel path.

AC Corrosion Protection Criteria

International industry standards specify which electrical parameters shall be monitored and their maximum allowed values. The standard ISO 18086:2019 “Corrosion of metals and alloys - Determination of AC corrosion - Protection criteria” indicates two steps for the verification of permissible AC interference levels (Fig.2):

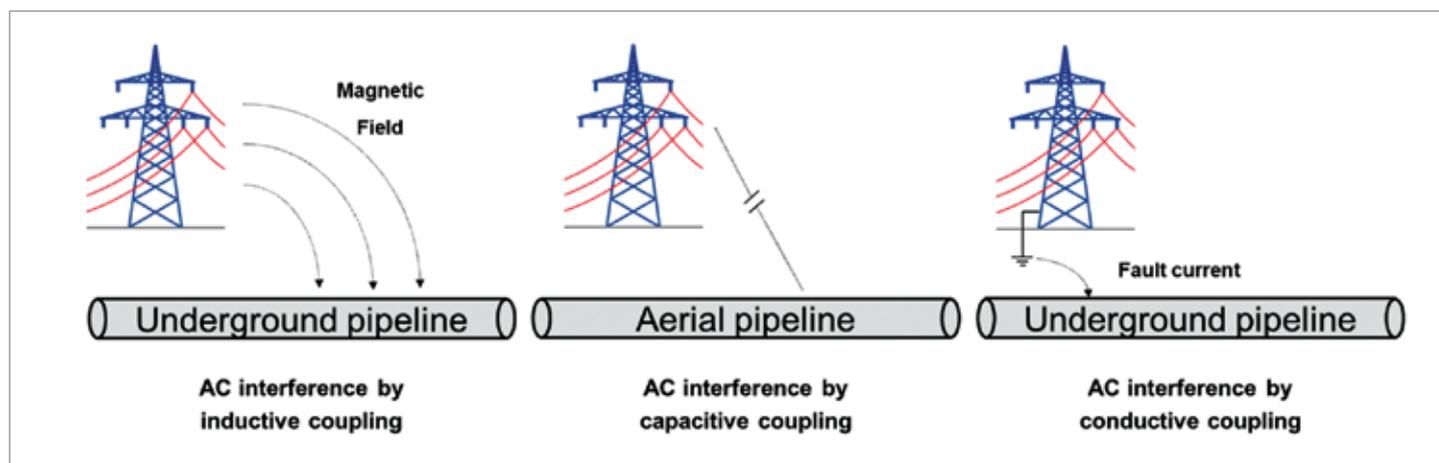


Figure 1: AC Interference Mechanism.

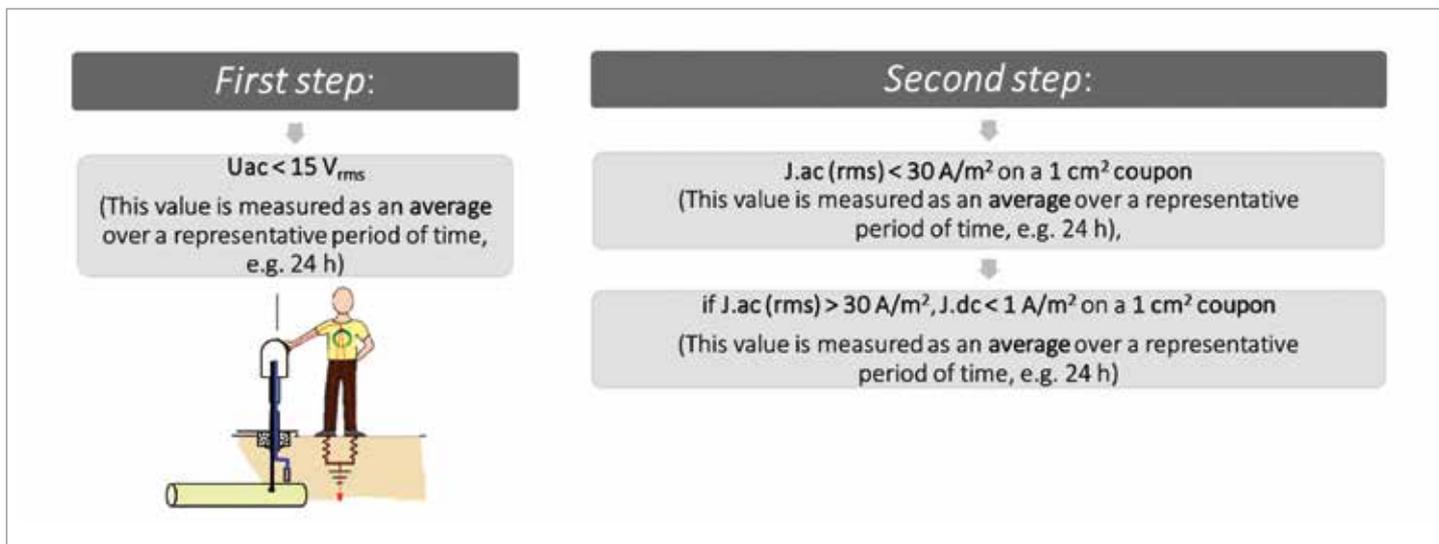


Figure 2: AC Corrosion Risk Assessment According To ISO 18086.

The first step relates to a safety criterion for maximum permissible touch voltage (15V threshold) and does not have a direct rule in AC corrosion risk assessment. This value considers a hand-to-hand or hand-to-foot resistance for an adult male human body of 1500 Ω, yielding a current flow of 10 mA when 15 V is applied [2].

The criterion is based on current density measurements carried out through a coupon whose surface is defined by the standard to be 1 cm², connected to the structure. Both AC current density and DC current density must be measured, as the level of cathodic protection can affect the AC corrosion phenomenon.

NACE standard SP21424-2018 “Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring” [3] expresses similar values, where depending on the measured DC current density (J_{dc}) value, different levels of AC current density (J_{ac}) are allowed:

- If J_{dc} > 1 A/m² then J_{ac} < 30 A/m²; or
- If J_{dc} < 1 A/m² then J_{ac} < 100 A/m²

This standard imposes a maximum AC current density limit even if the DC current density is less than 1 A/m², while the coupon surface of 1 cm² is indicated as generally used but not mandatory.

The Spread Resistance is the ohmic resistance through a coating defect towards remote earth and controls the DC (I_{dc}) or AC (I_{ac}) current passing through a defect at a given voltage (U_{dc} or U_{ac}):

- $U_{ac} = R_s \cdot I_{ac}$ or $U_{ac} = R_s \cdot J_{ac}$ (1)

where R_s is the normalized Spread Resistance expressed in Ω·m².

On coating defects, where cathodic protection current reaches the steel surface, cathodic reactions occur involving oxygen reduction and hydrogen evolution. Both reactions generate hydroxide ions (OH⁻) leading to increased pH at the interface and alkalinity.

Since Spread Resistance depends [4] on both defect size (decreases as surface decreases) and pH value at the interface (decreases as pH increases), the DC current density reaching the defect affects it:

- Lower current density leads to decreased pH value and increased Spread Resistance.
- Higher current density leads to increased pH value and decreased Spread Resistance.

This is where overprotection can have an effect on AC corrosion:

- Presence of a very electronegative IR-free potential (due to high DC current densities);
- Decrease in the Spread Resistance value;
- Possibility of significant AC current density even with low measured AC voltage.

Regarding the choice about which size of coupon to use, increasing the surface area of the coupon results in a lower average current density since the spread resistance increases linearly with increasing defect diameter and the current density decreases linearly with surface area.

Therefore, the current density is typically underestimated when the surface area of the coupon is chosen to be larger than the maximum defect size on the structure: for this reason, in the case of AC corrosion, the standards indicate the use of a 1 cm² coupon.

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AC Corrosion Mechanism in the Presence of Over-Protection [3]

For pipelines with applied cathodic protection, AC corrosion development requires simultaneous coexistence of induced AC, excessive cathodic protection, and small coating defects. Under these conditions:

1. Induced alternating current leads to alternating current discharge on coating defects.
2. AC current density is regulated by alternating voltage and spread resistance associated with the coating defect, through Ohm's law.
3. Spread resistance depends on:
 - a. Coating defect size.
 - b. Soil resistivity near the defect.
 - c. Soil chemistry.
 - d. Cathodic protection current density in the coating defect.

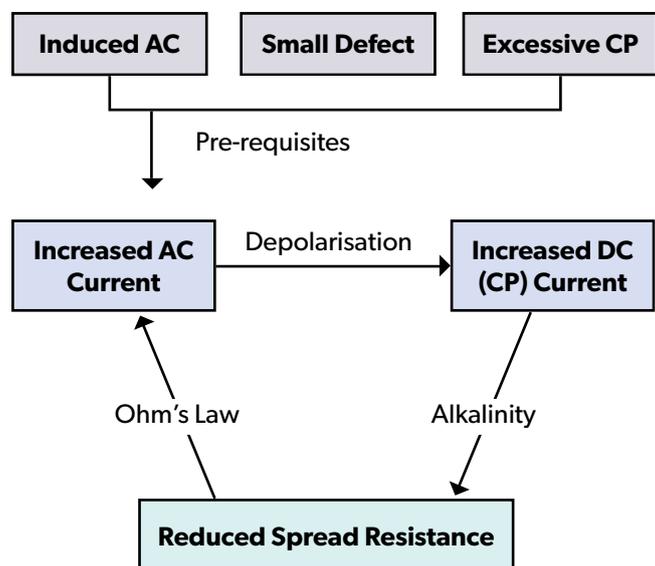


Figure 3 - Autocatalytic Nature of AC Corrosion on Cathodically Protected Pipelines Described by Sp21424.

As shown in Fig.3, the AC current density can lead to the depolarisation of the defect: this requires a higher DC current density to maintain a certain cathodic protection potential. Increasing the level of cathodic protection to mitigate AC corrosion, in this case, has the opposite effect: the increase in DC current density further decreases the Spread Resistance at the coating defect due to the production of OH⁻ ions (alkalinisation). Through high levels of cathodic protection, the Spread Resistance decreases, thus increasing the density of alternating current, restarting the cycle: this scenario results in an autocatalytic cycle leading to AC corrosion.

It therefore becomes clear that, in order to leave this cycle, it is necessary to control both the AC current density and the DC current density.

Analysis of A Real Field Case

The case that will be shown has been detected on a measurement point of the distribution network of a large European city, with the following features:

- An extensive cathodic protection system forming a ring around the city center with radiating offshoots.
- Multiple crossings with DC powered railways and surface metro.
- Multiple parallels with the HVAC network.
- Cathodic Protection guaranteed by two T/Rs.

The analysed measuring point (MP):

- Located in a CP system area with several km of parallelism with HVAC line.
- Local soil resistivity between 25 and 50 Ω·m.
- Equipped with permanent CSE reference electrode with integrated 10 cm² coupon (measured current density is underestimated compared to 1 cm² coupon).
- Equipped with a G4C-PRO remote monitoring device capable of performing instant-off measurements on coupon and current density measures.

The measurements shown in Table 1 correspond to daily reports calculated on measurements performed continuously at a frequency of 1 Hz (1 measure per second) for each measuring channel. The minimum, average and maximum daily values are shown over a period of 4 days:

- **Eon.dc**: ON potential (DC) expressed in V CSE;
- **Eon.ac**: ON potential (AC) expressed in V;
- **Eoff**: instant-off on coupon, equivalent to IR-Free potential (measured, every second, after a 1 ms wait from switch opening and over a 20 ms interval) expressed in V CSE;
- **mIon**: DC polarisation current of the coupon expressed in mA; as the coupon size is 10 cm² the shown value corresponds to the current density in A/m²;
- **mIon.ac**: AC polarisation current of the coupon expressed in mA; as the coupon size is 10 cm² the shown value corresponds to the current density in A/m² (**note**: the current density value measured on a 1 cm² coupon would be significantly greater than that measured on the 10 cm² coupon).

Data	C...	UM	Min	Med	Max
31/10/2019 ...	Eoff		-1.429	-1.315	-1.104
31/10/2019 ...	Eon.ac		+0.192	+0.413	+0.957
31/10/2019 ...	Eon.dc		-2.100	-1.491	-0.999
31/10/2019 ...	mIon		-13.679	+16.793	+69.451
31/10/2019 ...	mIon.ac		+17.586	+38.527	+90.603
30/10/2019 ...	Eoff		-1.422	-1.315	-1.101
30/10/2019 ...	Eon.ac		+0.162	+0.424	+0.840
30/10/2019 ...	Eon.dc		-2.146	-1.497	-1.034
30/10/2019 ...	mIon		-10.755	+17.175	+71.289
30/10/2019 ...	mIon.ac		+15.679	+39.407	+78.597

Data	C...	UM	Min	Med	Max
29/10/2019 ...	Eoff		-1.443	-1.307	-1.107
29/10/2019 ...	Eon.ac		+0.148	+0.375	+0.765
29/10/2019 ...	Eon.dc		-2.268	-1.460	-0.989
29/10/2019 ...	mIon		-12.774	+14.793	+85.839
29/10/2019 ...	mIon.ac		+13.495	+34.810	+76.386
28/10/2019 ...	Eoff		-1.447	-1.323	-1.105
28/10/2019 ...	Eon.ac		+0.090	+0.415	+1.021
28/10/2019 ...	Eon.dc		-2.448	-1.533	-0.997
28/10/2019 ...	mIon		-11.915	+18.952	+89.670
28/10/2019 ...	mIon.ac		+8.681	+36.390	+91.151

Table 1- Daily Reports of the MP Analysed.

In the absence of coupons, the only available measures would be Eon.dc and Eon.ac, and, on these values, the only possible evaluation would be that relating to the first step of ISO 18086, which would be absolutely respected considering that the highest AC average value along the four days shown (0,424 V) is well below the indicated threshold of 15V.

Generally, such a low AC voltage value would never suspect a real risk of AC corrosion, but as can be detected from the DC and AC current densities, we are faced with unacceptable interference levels:

- mlon: between 15 A/m² and 17 A/m²:
 - o greater than the threshold of 1 A/m² for which (according to ISO 18086) the AC current density value would be indifferent.
- mlon.ac: between 35 A/m² and 39 A/m²:
 - o greater than the threshold of 30 A/m² indicated by ISO 18086 and NACE SP21424.

The explanation for this situation is given precisely by the significant level of cathodic overprotection present, represented by IR-Free potential values more negative than -1.3 V CSE and very high DC current density values, being the MP in a site suffering cathodic DC interference generated by metro and railway systems.

This results in a reduction of the Spread Resistance value, up to the point of generating an AC current density higher than the allowed limits even in the presence of a very low AC voltage.

The main evidence of the dependence of this condition on overprotection has been clearly shown when, due to a malfunction, one of the two T/Rs protecting the Cathodic Protection system did shut down, changing the values measured on the Measurement Point as in Table 2:

Data	C...	UM	Min	Med	Max
22/01/2020 ...		Eoff	-1.334	-1.063	-0.888
22/01/2020 ...		Eon.ac	+0.098	+0.389	+0.901
22/01/2020 ...		Eon.dc	-1.844	-1.067	-0.792
22/01/2020 ...		mIon	-3.806	+0.072	+19.266
22/01/2020 ...		mIon.ac	+2.389	+12.341	+26.542
21/01/2020 ...		Eoff	-1.419	-1.197	-1.005
21/01/2020 ...		Eon.ac	+0.038	+0.243	+0.731
21/01/2020 ...		Eon.dc	-1.889	-1.254	-0.951
21/01/2020 ...		mIon	-9.063	+6.872	+59.259
21/01/2020 ...		mIon.ac	+4.655	+20.682	+68.503

Data	C...	UM	Min	Med	Max
20/01/2020 ...		Eoff	-1.416	-1.310	-1.087
20/01/2020 ...		Eon.ac	+0.092	+0.236	+0.492
20/01/2020 ...		Eon.dc	-1.857	-1.440	-1.023
20/01/2020 ...		mIon	-8.631	+16.332	+58.170
20/01/2020 ...		mIon.ac	+9.635	+28.438	+61.525
19/01/2020 ...		Eoff	-1.396	-1.310	-1.116
19/01/2020 ...		Eon.ac	+0.076	+0.238	+0.535
19/01/2020 ...		Eon.dc	-1.793	-1.427	-1.095
19/01/2020 ...		mIon	-4.726	+14.276	+49.089
19/01/2020 ...		mIon.ac	+8.603	+28.496	+61.727

Table 2 – Daily Reports of The MP Analysed.

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On day 21/01 the shutdown of one of the two T/Rs obviously brought a reduction of the DC protection current, with the result that, at a positive shift of the IR-free potential from -1.3 V CSE to -1.06 V CE, AC current density has become less than half, from average daily values of 28 A/m² to values of 12 A/m², possibly again compatible with the acceptance criteria expressed in ISO

18086 and NACE SP21424 (it should be remembered that, being the measure made on a 10 cm² coupon, the result is certainly underestimated compared to the use of a 1 cm² coupon as required by the aforementioned standards). The trend is also evident in Fig. 4, where it is shown the evolution of the daily average values in the two weeks when the switching off of the T/R happened:

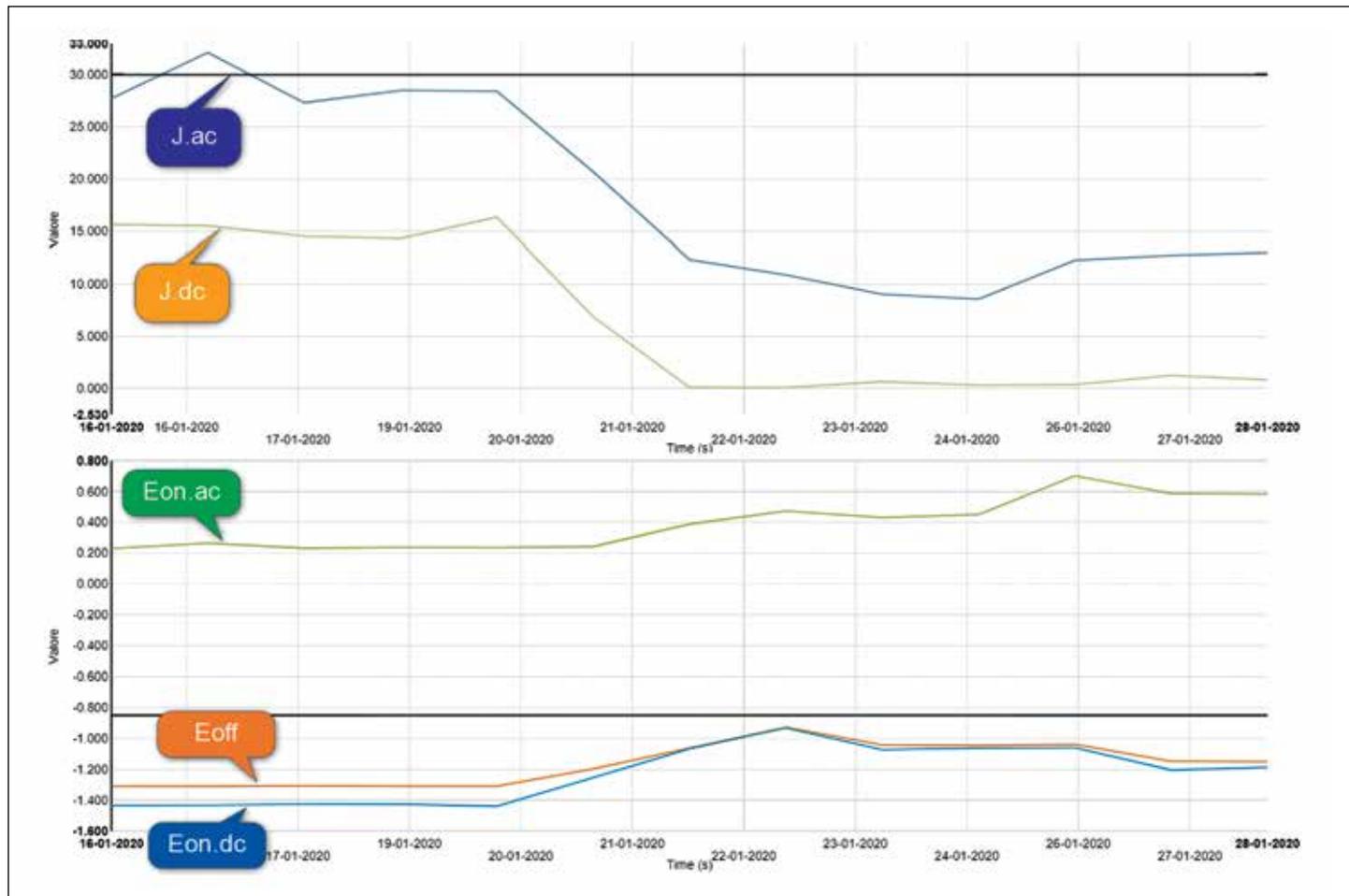


Figure 4: Trend of The Daily Average Values Measured on The Analysed MP in Correspondence with the Malfunctioning of the T/R.

In correspondence to the decrease of the cathodic current density (J.dc) there is obviously a simultaneous positive shift of the values of the IR-Free potential measurement (Eoff): this leads to the reduction of the values of the AC current density (J.ac) to permissible values (and a slight increase in the AC voltage values in terms of absolute value, which is almost three times compared to the values measured under overprotection conditions).

Unfortunately, from a cathodic protection system management point of view, this presents some critical issues that, from a global perspective, do not allow for an easy management of the problem by simply reducing the current supplied by the T/Rs, since this would lead to problems in reaching protection levels in other areas of the system. For this reason, solutions were evaluated to locally

mitigate the AC interference, the installation of which is currently being managed.

It is interesting to note that, even in the long term, this behaviour is confirmed (Fig.5):

- As long as the IR-Free potential remains in protective values, but without overprotection, the AC current density remains within the allowed limits.
- As soon as the value of the IR-Free potential returns to overprotection values, the AC current density also exceeds the eligibility limits thus confirming the strong influence that overprotection has on AC corrosion.

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Figure 5: Trend of the Daily Average Values Measured on the Analysed MP Over a Period of 19 Months.

Conclusions

As also verified in the real field situation, in the presence of alternating interference, an overprotection condition is able to significantly accelerate the phenomenon of alternating current corrosion: an increased cathodic protection current density increases alkalinity at the defect interface and lowers its Spread Resistance value.

A too low Spread Resistance value, in the presence of alternating interference, may lead to average AC current density values higher than the allowed limit values, even in the presence of AC voltage values much lower than the threshold indicated by the first verification step of ISO 18086 ($V_{ac} = R_s \cdot I_{ac}$).

For this reason, even if it turns out to be the driving force, it is not possible to establish a reliable criterion based only on the value of the AC voltage, since the process is driven by the value of the Spread Resistance and therefore will be dependent on the size of the defect, the type of soil and the local change of alkalinity generated by the DC current density that arrives on the defect/coupon.

The use of coupons is fundamental to monitor both over-protection and DC and AC current densities, and for this reason a remote monitoring device that allows a continuous monitoring of all these electrical parameters simultaneously becomes necessary, especially if it may allow managing two coupons simultaneously: the one with variable size (e.g. 10 cm²) for the verification of protection and overprotection levels and DC current density, and the 1 cm² one for the verification of AC current density.

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- [4] L V Nielsen et al., "Effect of coating defect size, coating defect geometry, and cathodic polarisation on spread resistance: Consequences in relation to AC Corrosion Monitoring"; Proceedings CEOCOR Congress 2010, Bruges, Belgium.



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Tel: 01527 594630 Email: dean.kenny@lakecm.co.uk

LBBC BASKERVILLE

Tel: 0113 2057423 www.bbcbaskerville.com

LLEWELLYN RYLAND LTD

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

PRESSERV LTD

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

SCANGRIT

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RECIPROCAL ORGANISATIONS

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ELSEVIER SCIENCE LTD

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GALVANISERS ASSOCIATION

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Contact Helen Wood Email: helen@materialsfinishing.org

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OIL & COLOUR CHEMISTS' ASSOCIATION (OCCA)

4th Floor Clayton House, 59 Picadilly, Manchester M1 2AQ

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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.corroderere.com

ICATS / CORREX

(Kevin Harold -ICATS courses) Email: kevin@paintel.com
(Admin) Email: correx@icorr.org

DIARY DATES 2025/6

Latest event details are posted at: <https://www.icorr.org/events/>

BRANCH EVENTS

2nd December 2025, North-East Branch

Social Event - Darts Night

Email: nechair@icorr.org

4th December 2025, London Branch

Christmas Luncheon, ROSL, Piccadilly.

19th January 2026, YICorr

In-person YEP Launch Event

Email: youngicorrchair@icorr.org

26th January 2026, Central Scotland Branch

Technical event (hybrid mode)- Feasibility of applying post-mortem analyses, artificial intelligence and TRIZ to evaluate microbial corrosion (MIC/MID).

Email: cschair@icorr.org

27th January 2026, Aberdeen Branch

Annual Joint Event with the Energy Institute. (In-Person)

Email: ABZchair@icorr.org

12th February 2026, Wales and South-West Branch

In-person Inaugural CorMat Dinner

Email: swchair@icorr.org

26th February 2026, YICorr

In-person YEP Session 1

Email: youngicorrchair@icorr.org

5th March 2026, Aberdeen Branch

Special Joint Event with BINDT. (In-Person)

Email: ABZchair@icorr.org

26th March 2026, YICorr

In-person YEP Session 2

Email: youngicorrchair@icorr.org

21st-22nd April, 2026, Midlands Branch

In-person Joint EFC Event

Email: midlandschair@icorr.org

OTHER EVENTS

26th-28th November 2025

CEFRACOR Conference

COURSES AND EXAMS

ICorr Fundamentals of Corrosion for Engineers (FOCE) Training Course

2nd- 6th March 2026 - Northampton

ICorr Microbiologically Influenced Corrosion (MIC) Training Course

11th-15th May, 2026 - Northampton

Cathodic Protection (CP) Training Scheme

An International Certification Scheme that evaluates the competence levels of CP personnel in accordance with BS EN ISO 15257:2017. The scheme is designed for the competence assessment and certification of CP technicians, engineers and specialists performing inspection, testing, performance assessment, investigation, and design in various cathodic protection fields and is entirely operated and administered by the Institute of Corrosion.

For all information, please visit the ICORR website / Training / Cathodic Protection, Training, Assessment and Certification Scheme.

STGB

ARGYLL RUANE

Hot Dip Galvanising Inspector Level 2

Online. Sign up anytime.

Protective Coatings Inspector Level 1

8th – 15th December 2025 (Sheffield)

12th – 19th January 2026 (Sheffield)

23rd Feb – 2nd March 2026 (Sheffield)

16th – 23rd March (Dunfermline)

Protective Coatings Inspector Level 2

17th – 24th November 2025 (Dunfermline)

02nd – 09th March (Sheffield)

Protective Coatings Inspector Level 3

16th – 20th February 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.

Corrodere Academy



ICorr Training Partner

Coating Inspection Level 1

Online - enrol anytime. Practical workshop and assessment dates available at corrodere.com/events

Coating Inspection Level 2

Online – enrol anytime. Theoretical workshop and assessment dates available at corrodere.com/events

Coating Inspection Level 3

Online – enrol anytime. Advanced workshop and assessment dates available at corrodere.com/events

Insulation Inspection Level 2

Online – enrol anytime

Pipeline Coating Inspection Level 2

Online – enrol anytime

Hot Dip Galvanising Inspection Level 2

Online – enrol anytime

Thermal Metal Spraying Inspection Level 2

Online – enrol anytime

Transition to ICorr Level 1

Online – enrol anytime

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