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The regularity with which each issue of the Corrosion Management comes around reminds me that when one is busy time flies by unnoticed, only when there is time to reflect does the sobering concept of the irrevocability of time loss come to the fore. It was in one of these moments that I thought of how I have aged compared with some of the world’s most famous structures and engineering projects, the Forth Rail Bridge, the Sydney Harbour Bridge (The Coathanger) and the railways, the latter of which prompted ministers to enquire in the early 19th Century, when 3rd class fares were proposed to popularise their use, “will this damage the structure until it has served its useful life and eventually asked what we were doing, to which I replied proudly, preserving the integrity of the structure through preventive maintenance and corrosion management. His reply which was delivered after a short period of thought has stuck with me ever since, it was “you can’t beat nature young man” and he was right, we cannot, but we can surely give it a run for its money and preserve what we can for as long as we can.

The President Writes

The minimum of disruption in the service and amenity they afford. We are blessed with ancient monuments and structures in this country, and of course all around the world, but all this comes at a cost, i.e. maintenance and renewal. I once sat in on a fascinating presentation on the Cutty Sark project but felt I should remind the presenter that HMV Victory when dry docked in 1925 was a museum piece which has been progressively replaced, almost in its entirety since then. Wooden structures do not corrode in the sense that metals do but they are subject to wet and dry rot, worm infestation and damage by boring insects as well as general decay. In the case of the Victory damage has been extensive, and when one considers that 100 acres of woodland were cut down to build the ship, that is some 6,000 mature oak trees, there is a lot of scope for boring insects into which to get their teeth. This slow decay seems to extend to just about everything we come across, it does of course include metals, which is our primary concern but it also covers plastics, paints and coatings, wooden structures, whilst even rock suffers erosion, a form of corrosion in a sense, defined as “the gradual destruction or diminution of something”, think of the Grand Canyon, 27 miles long, up to 18 miles wide and a mile deep, and it only took the Colorado river 17 million years to carve it out, erosion whilst destructive seems to take considerably longer than some other forms of diminution.

So it seems all things decay, some take longer than others, but our efforts to control this process are just a delaying tactic to preserve the structure until it has served its useful life and is ready for replacement.

I once worked with a sage old gentleman whilst inspecting jetties in the Thames estuary. He was an experienced longshoreman who had seen what the Thames could do and as a result had a strong line in homespun philosophy. As we worked our way around the various structures and their piles inspecting and taking dip cell readings he began taking an interest and eventually asked what we were doing, to which I replied proudly, preserving the integrity of the structure through preventive maintenance and corrosion management. His reply which was delivered after a short period of thought has stuck with me ever since, it was “you can’t beat nature young man” and he was right, we cannot, but we can surely give it a run for its money and preserve what we can for as long as we can.

Trevor Osborne,
President of the Institute of Corrosion

PARLIAMENTARY MEETING

On Tuesday May 14th at 5.30pm the Technical Secretary and your President attended a meeting on Water Quality (subtitled Water Purity, although water being one of the strongest solvents in the world (not to say the universe) is never pure). The meeting was held in the Thatcher Room at Portcullis House, part of the Houses of Parliament in front of an erudite audience composed of politicians, academics and people from learned societies. Your President asked a question of the main speaker. Having listened to a lot of general matters, he asked him whether corrosion of the inside (or even the outside) of the pipe was ever considered as a factor affecting water purity, the answer gave the impression that this has not been much considered, nor had the cost impact of deterioration of the asset or the impact this has on water bills.

No doubt we have work to do to educate people, a hard road but worth the effort, after all that’s what these meetings are about, sharing information and inviting debate. Following the meeting interesting discussions were had over few drinks with a lecturer from Brighton University and with Peter Farr from the Institute of Metal Finishing where it seems we have much in common.

This was the third meeting attended by the President and we are now seeking to promote a meeting on corrosion, together with the positive aspects of training and education perhaps?
The London Branch joint meeting on 11th April was joint with NACE (GB) and at the start, John O’Shea, London Branch Chairman, presented engraved glasses to Mike Moffat and David Mobbs for their dedicated services to the Committee.

Guest speaker was Alex Delwiche, Engineering Manager of Deepwater EU Ltd – his subject – designing CP systems and understanding CP data in arid environments for pipelines, primarily concerned with the deserts of North Africa and the Middle East.

He mentioned the challenges of local customs and working cultures in which ‘other things’ prevent work being carried out in a satisfactory manner, with the theft of ‘desirable’ items sometimes being an added obstructive nuisance.

Alex emphasised the importance of soil resistivity measurements in CP design work, but in arid climes, difficulties were caused by the surface of the ground being very dry, sandy, dusty or rocky, but yet the water table could often be found just 1–2m below the surface. Watering the pins using the 4–pin Wenner method can lead to false readings, but more reliable results may be obtained using electromagnetic methods. Even when suitable resistivity conditions could be established, the terrain could preclude the installation of ground beds in preferred locations.

Measuring CP potentials can also be problematic because of arid conditions and although watering the electrode can help, it does not solve the problem in all cases, although increasing the size of the electrode can be an advantage, but on many occasions the question to be asked is: what is actually being measured?

Further dilemmas are presented at block valve compounds and foreign crossing points where readings may not represent the true status of the pipeline CP system. A situation was cited where natural pipeline potentials ranged from –900mV to –1000mV with associated difficulties in discovering the reason(s), bearing in mind different work ethics impacting on the complexity of identifying the owner of a foreign pipeline possibly causing the problem, in turn making interaction testing difficult if not impossible.

Yet further predicaments are faced when carrying out DCVG coating surveys because water contact is required between the ground and the electrodes, and that in itself requires the use of water tankers which themselves become unreliable in the harsh conditions, struggling to drive over the terrain and suffering unreliability from the ravages of dust and heat.

Equipment is subject to the further ravages of lightning strikes, as well as the egress of sand causing damage. The suitability of sophisticated equipment, and system failures were discussed – the latter often aggravated by the damaging environment, and lack of maintenance due to local culture and working customs.

If attention is paid to corrosion control at the design stage, it may still be challenging, but it can be managed with suitable skills and knowledge, but it is much more difficult to apply corrosion control as remedial action later. Trevor emphasised problems with sub-sea pipelines, high humidity, and difficulties of wind-blown sand being among the many demanding problems faced by the corrosion engineer.

Of course if corrosion was never a problem, there would be no need for coatings, inspection, CP monitoring or retrofits etc., and as a result there would be fewer worries about assets meaning less dedicated staff would be required. But it is well known that the scenario is different, and if the asset owner wishes to have corrosion free structures, investment must be made in expertise right through from the design stage to the completion of the project, and this in turn means a budget commitment to enable the structure to be fit for purpose during its projected working life.

From a purely mercenary standpoint, those in the corrosion control industry are in a fortunate position with almost guaranteed employment because corrosion is insidious, and in the current industrial climate there is not enough effort being made to reduce its drain on the GDP. Trevor completed his presentation by quoting from John Ruskin; ‘There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people who consider price only are this man’s lawful prey. Quality is never an accident. It is always the result of intelligent effort.’
REPORT ON CED WORKING DAY

‘Inspection and Monitoring Techniques to Manage the Corrosion of Valuable Assets’ held at Warrington on Wednesday, 17 April 2013

By David Nuttall Photos courtesy of Douglas Mills

A total of 81 delegates attended this Working Day, which was organised jointly by the Institute of Corrosion (ICorr) and the British Institute of Non-Destructive Testing (BINDT). It was held at The Centre, Birchwood Park, Warrington. Also present were ten exhibitors, displaying their cutting-edge NDT equipment. Additionally, there were laboratory tours of the AMEC facilities, showcasing their microscopy, NDT, mechanical testing and corrosion laboratories. The CED Working Groups (Cathodic protection, Monitoring, Nuclear, Coatings, Oil-field chemicals, Water treatment, and Corrosion in Concrete) met in the afternoon although some were merged on the day. Some very useful business was conducted in these groups.

Nick Smart (AMEC) welcomed the delegates. This was followed by introductions to ICorr by Douglas Mills (University of Northampton) and to BINDT by Cameron Sinclair (British Institute of NDT).

The first lecture, entitled, ‘Stress Corrosion Cracking Test Pieces for Inspection Qualification and NDT Development’ was given by David Ludlow (AMEC). Stress corrosion cracking (SCC) is a major concern for the nuclear industry and numerous SCC defects found in primary components have been reported. Conventional test pieces used for calibrating inspection systems use machined flaws (e.g. electrical discharge machining to represent crack type defects) and this may result in the inspection system becoming insensitive to the detection and sizing of SCC defects. AMEC have developed an accelerated crack development technique, called MISTIQ, for producing SCC in austenitic stainless steels and nickel alloys, including dissimilar metal welds. The use of SCC test pieces is a step improvement over conventional test pieces and has been used in a wide range of work, from inspection development, parametric studies for model validation and generating evidence for technical justifications.

The presentation gave a background to SCC in the nuclear industry and described the development of the MISTIQ process. Then several SCC test piece case studies were presented to demonstrate how they have been used to develop and improve inspection and monitoring techniques.

Next, Gareth John (Intertek CAPCIS) lectured on, ‘Corrosion Monitoring and Inspection for Oil and Gas Production – What and Why?’ The aims of monitoring and inspection are to obtain information that will enable a corrosion audit to be carried out on the state of operating equipment. In this discussion, internal corrosion by hydrocarbons and external corrosion (subsea, buried surfaces and under insulation) were covered (neither atmospheric corrosion nor cathodic protection were covered). More recently, emphasis has been placed on MIC, CUI and hydrogen damage. NACE TR 3T199 (published in 1999, but new version due 2014) provides a wide range of different methods to detect corrosion. It views the methods from the point of view of intrusive (WLC, ER, LPR, ZRA, EN and EIS) and non-intrusive (UT, MFL, EC, EFM, AE, LR-UT and Magnetic Tomography) methods. The use of on-line and off-line methods and improvements to these standard techniques (including guided waves, Digital Radiography, ILI, Magnetic Flux Leakage) were also discussed. It was concluded that: (a) at least two different on-line techniques at each...
of two measuring locations should be carried out; (b) these should be augmented with off-line techniques; (c) it should be ensured that techniques have sufficient resolution; (d) calibration and data collection should be carried out at timely intervals; (e) different monitoring procedures need different amounts of time to collect data.

The next speaker was Ross Fielding (Deepwater EU Ltd) who spoke on, ‘Cathodic Protection Monitoring for Offshore Pipelines’. Conventional ROV maintenance can be an expensive and onerous exercise. Permanently installed monitors are more accurate and provide more credible results; automated underwater vehicles (AUVs) are under development.

Many subsea pipelines are not ‘piggable’ but in-line tools could carry the burden of CP inspection on candidate pipelines. Acoustic devices are being trialled – again they also have limitations. Although the initial cost of installing CP may be relatively cheap, retrofits cost four to five times the cost of initial installation.

The final lecture, ‘Use of Guided Wave Testing for the Detection and Monitoring under Insulation’ was given by Peter Philipp (Independent Consultant). In the 1930s, Lamb Waves were discovered; in the 1990s, dispersion curves were developed by Imperial College; in 1999, the first commercial equipment was available and in 2004, a subsea, C-scan was available. Physically, a spiral wave ‘looks for reflections’ along the tube, which detects cracks and defects. With a range of 5 – 150m in each direction, the technique can accommodate pipe diameters over the range 1 – 60 inches. However there is a ‘dead zone’ in which no results are obtainable 0.5m either side of the ring. It is effective over the temperature range –40°C to +180°C and gives a 100% volume coverage for CUI, thus significantly reducing costs, which is an added advantage. Standards involving GWT are: ASTM-2011, BSI 9690 Pts 1 and 2, TUV Certification, NACE TG 410 2012/13 and ASME Article 18-2012/13. Future developments include: buried pipe applications and absolute calibration.

The session finished at 4:30 pm with a Closing Panel Discussion, chaired by Douglas Mills and Nick Smart who also thanked the speakers, the organisers from ICorr and BINDT and the delegates for attending. The presentations from the meeting will be made available in the members area of the ICorr web site. The meeting was generally well received and it is hoped that it paves the way for future collaboration between ICorr and BINDT.

MAYFAIR WALKING TOUR ON 2ND MAY

Thirty London Branch members and guests were lucky to have good weather for the Mayfair Walking Tour on 2nd May. The theme this year concerned famous and infamous people and their one time dwellings in the area, the houses being marked with a commemorative wall plaque. Our now regular Blue Badge Guide, Ingrid Wallenborg, informed us generously with details of history and scandal – and with no small whit - associated with a variety of residents with relevant dates ranging from the early 1700s near to the present day. Among others, the residencies of Madame d’Arblay, Anthony Eden, Beau Brummell, Somerset Maugham and Harry Selfridge, department store magnate were featured. A relaxing refreshment break was enjoyed midway during the walk in Shepherd Market and the tour concluded at The Naval Club where a chilli and rice supper was very welcome, and where due thanks were given to Ingrid for another interesting evening. Thanks are due to John O’Shea, London Branch Chairman, for arranging the event.
ABERDEEN BRANCH MEETING FOR MARCH 2013
VISIT TO INTERTEK ABERDEEN LABORATORY

On the 26th of March, Aberdeen branch members visited the Intertek laboratories. Intertek microbiologists gave presentations on test techniques and delegates were shown various laboratory test equipment. After a safety brief, delegates were divided into groups and taken to various sections of the laboratory facility.

Lorna Richardson gave delegates a tour of the sampling and analysis laboratory where analysis of bacteria, fibre count, portable water quality tests, cross contamination checks and other basic tests were performed.

Members also visited the Molecular Microbiology Laboratory. The session host, Heike Hoffmann, described various types of microorganisms and various molecular analysis methods including FISH, RNA and qPCRs. Delegates were also shown equipment used in identifying and quantifying bacteria, methanogens and other microorganisms populations in oilfield applications.

Next, delegates were taken to the Project Based Analysis laboratory. During this session, Michael Horne described various chemical trial techniques, screening methods including a demonstration of laboratory and field based techniques used as part of microorganism population control and corrosion mitigation strategies. He also touched on biofilm formation, Linear Resistance Polarisation corrosion monitoring, biocide kill rates and the need for laboratory tests to replicate as much (as possible) the actual conditions in the field.

Garry Edgar then presented the apparatus used for the Most Probable Number (MPN) culturing technique. He described how Sulphate Reducing Bacteria (SRB) culturing was done, how the results of the tests were interpreted and reported. He emphasised the importance of matching temperature, salinity and other parameters with field conditions. Garry showed delegates field samples, bacteria growth media and other test apparatus.

Questions from the delegates covered sample transit time, sampling method, accuracy of techniques and limitations of test methods.

To end the visit, Doug Finnie and Alistair Park gave members a general tour of the other Intertek hydrocarbon analysis laboratories where tests like oil condition monitoring, gas composition analysis, hydrocarbon accounting, fractional distillation and corrosion forensics are performed.

For information about the Aberdeen branch actives please contact the branch secretary via icorrabz@gmail.com. Alternatively a calendar of local events of interests to corrosion professionals in the Aberdeen area and the opportunity to sign up to the branch mailing list is available at https://sites.google.com/site/icorrabz/home.
The April 2013 meeting was a joint session with the Marine Corrosion Forum (MCF) held on the 16th. The guest speaker was Dr. Torben Lund Skovhus from the Danish Technological Institute (DTI Oil & Gas). He started by summarising the latest development in oilfield microbiology primarily in the area of establishing a link between microbe populations and Microbiologically Influenced Corrosion (MIC). He noted that the Most Probable Number (MPN) method often shows a poor correlation to MIC threat. He outlined the key drivers for MIC investigations and emphasised the need for a multi-disciplinary approach to MIC management and control.

He used a genealogical tree diagram to illustrate the various micro-organisms including Bacteria, Archaea and Eukarya. He observed that common analytical techniques used in the oil industry did not identify all the microorganisms that could promote MIC. “Sulphate Reducing Bacteria (SRB) are problematic, but are not the only kind of microorganism that could cause MIC”, Torben noted.

Torben went on to describe the Danish Technological Institute MIC assessment model that was covered in the NACE 2010 paper 10252. He referenced a case where the model has been used to accurately predict the failure of a pipeline in the Danish sector a few years ago.

He discussed the various Molecular Microbiological Methods (MMM) used in the enumeration of microorganisms such s DNA/RNA techniques, FISH, qPCR, etc. In brief he explained the main benefits and limitations of these techniques recommending the newly published NACE TM0212-2012 as a good reference document. He distinguished between ‘water’ and ‘solid’ samples, explaining how these could be retrieved in the field and the type of data that could be obtained from analyses of these samples.

Torben presented case studies of how MIC had been managed using techniques he described earlier in his presentation. He referenced NACE Paper 2247, outlining the benefits to the operator such as a change in mind set, practical benefits of MMM, improved communication, adequate biocides testing, application of a database and assessment of the effects of various types of microbes.

Torben concluded by urging the audience to take advantage of molecular techniques, use solid samples to get better data, focus on communication between disciplines, align various monitoring activities and define meaningful Key Performance Indicators (KPIs). Questions were on the use of sulphate reduction to mitigate MIC, calcium nitrate treatment, sampling techniques, use of biostuds for monitoring and material resistance to MIC.

Frances Chalmers thanked the speaker for his presentation and also thanked members for attending. For information about the Aberdeen branch activities please contact the branch secretary via icorrabz@gmail.com. Alternatively a calendar of local events of interests to corrosion professionals in the Aberdeen area and the opportunity to sign up to the branch mailing list is available at https://sites.google.com/site/icorrabz/home.
Despite a thriving corrosion protection industry in the region, and the presence of many individual ICorr members, for many years the Midlands Branch lay dormant. In January 2010 an inaugural meeting of the reformed Midlands Branch, once one of the most active branches in the Institute, was held and a fine turnout of ICorr members demonstrated the appetite for meetings in the region to recommence. Thanks must go to Ross Fielding for driving the Branch forward in his 2-year chairmanship. Since January 2012 Jim Preston has taken over the Chair and he, together with the branch committee, has been arranging an ongoing series of events and meetings.

Many branch members have an interest in cathodic protection and much expertise in protection of reinforced concrete is based in the area. The renowned Midland Links motorways run through our region and these continue to provide many of our members with corrosion control challenges. Not surprisingly, Branch meetings have included presentations on various developments in the corrosion control of reinforcement in concrete.

In addition to this focus on corrosion control in concrete, the branch strives to provide a varied programme, and presentations of academic studies have been featured at several meetings. The branch has been keen to renew and reinforce links with local universities and, since 2010, ICorr meetings have been held at the Universities of Birmingham, Aston, Nottingham and Coventry. The range of academic interests in corrosion and material related matters in universities across the region is broad, and continues to reflect the industrial background of the region.

As well as the more usual evening events, the branch has found that a series of half-day events or workshops on particular themes have been popular. Recent themes have included ‘marine corrosion’, ‘the future of galvanic anodes’ and ‘surface analysis for corrosion issues’. Our next such event in September will feature presentations focusing on cathodic protection power supplies and monitoring systems.

The branch is fortunate to have the support of many sustaining company members, several of which have either hosted or sponsored events, and in so doing have made sure that no-one goes home hungry! The continued support of local businesses in our industry is critical to the future success of the branch and we thank our supporters to date.

Midlands Branch events are advertised on the Institute website and by e-mail circulation to members who have the branch as their affiliation – we hope to welcome you to one of our meetings soon.

**MIDLANDS BRANCH: FORTHCOMING ATTRACTIONS**

26th September 2013:
½ day meeting: Ironbridge, Shropshire ‘Power Supplies for Cathodic Protection’.

28th November 2013:
½ day meeting: Birmingham Council Chambers and ICorr AGM.
The Midlands Branch hosted a one-day workshop at Aston University in conjunction with Midlands Surface Analysis (MSA) and Loughborough Surface Analysis (LSA) addressing surface analysis and depth profiling techniques and how they can be used to help with a variety of challenges relating to corrosion. The workshop had a good turnout of industrial practitioners and those with an academic interest in the techniques.

John Sullivan of MSA explained some of the techniques used for analysis of surfaces and interfaces including X-ray photoelectron spectroscopy (XPS) and auger electron spectroscopy (AES). John explained the relative merits of each technique and used a variety of case studies to illustrate the effectiveness of both XPS and AES in resolving the cause of corrosion related failures across a range of industries. The XPS technique, in providing both quantitative detection of elements and their distribution across the surface has assisted in resolving failure cases varying from powder coatings to electronic components. John explained how with AES the surface of the sample can be eroded by a beam of inert gas ions. By monitoring the signals from elements of interest as a function of time, depth profiles for those elements are produced. John noted that it is the only technique to effectively and quantitatively monitor element concentration for areas below the micron range.

Next it was the turn of Mike Petty of LSA to describe secondary ion mass spectrometry (SIMS) and 3D optical interference profiling (3DP). Mike explained the science of sputtering behind the SIMS technique; the resulting molecular fragments reflect the surface chemistry of the sample. Examples of use of the technique to resolve material concerns over a range of industries were also presented.

Finally John Sullivan concluded the explanations of the various techniques with a discussion on Atomic Force Microscopy (AFM) and nano-indentation testing.

After lunch delegates were able to explore the labs at Aston University where MSA were able to demonstrate the XPS, AES and AFM equipment in use.

Visit the new ICorr website www.icorr.org
The Institution of Corrosion is proud to launch the new the ICorr Job Board where you will find all of the best corrosion industry jobs in one place. At the time of writing we have 72 jobs being advertised for positions in the corrosion industry. The majority of these are based in the UK however there are also some overseas positions. The Ambition for the Job Board is that it establishes itself as the main platform for advertising corrosion industry jobs in the UK.

Visit www.icorr.org and click on the Job Board tab to:

- Search for and quickly apply to great, relevant jobs
- Set up Job Alerts so you are immediately notified any time a job is posted that matches your skills or interests
- Create an anonymous job seeker profile or upload your anonymous CV so employers can find you
- Access job searching tools and tips

If you need to employ corrosion industry professionals, the Icorr Job Board will put your job in front of our members!

- Place your job in front of our highly qualified members
- Search our CV database of qualified candidates
- Manage jobs and applicant activity right on our site
- Limit applicants only to those who are qualified
- Fill your jobs more quickly with great talent

Job seeking is always free, members and sustaining member companies enjoy a 15% discounts when posting jobs. To get your 15% discount please visit the member’s area of the website where you will find the discount code. Alternatively you can contact our website administrator Jonathan Phillips on 0114 2730132 or jonathan@squareone.co.uk

In order to keep members informed of all the latest jobs we will be publishing a monthly ‘Jobs of the Month’ email. If you would like to subscribe to this email you can send you email address to jonathan@squareone.co.uk or register for the ICorr website member’s area. We will also be publishing the jobs of the month on the Linked in Group.

Our hope is that this new resource will make a significant difference for our members as they navigate their career paths. Thank you for your ongoing support.
EFFECT OF STRESS LEVEL ON THE CREVICE CORROSION INDUCED SSC OF SUPER DUPLEX STAINLESS STEEL TUBING EXPOSED TO H₂S/CO₂ SOUR ENVIRONMENT

Pekka Pohjanne, VTT Technical Research Centre of Finland, Espoo, Finland Lucrezia Scoppio, Pipe Team srl., Milano, Italy Perry Ian Nice, Statoil ASA, Stavanger, Norway

SUMMARY

Recent studies have shown that crevice corrosion can trigger stress corrosion cracking (SCC) of stainless steels in dilute chloride or chloride-sulphate solutions, even at ambient temperatures, usually considered to be harmless. Various types of test specimens and crevice geometries have also been used to study the SSC/SCC behaviour of nickel base alloys in H₂S-CO₂ service. Because of the increasing use of duplex stainless steels in the offshore oil production, a question has invoked whether the crevice corrosion impairs the sulphide stress cracking (SSC) resistance of the super duplex stainless steels. Understanding from this is required since crevices are present in well tubulars and equipment, like gaps and contact areas between collars and overlapping joints, under gaskets or seals, under deposits which have been shown to be detrimental to stress corrosion cracking resistance in chloride environments.

For answering this question the SSC resistance of wrought seamless super duplex stainless steel tube UNS S39274 was evaluated in 0.02 MPa pH₂S at 90°C given in the ISO 15156 part 3 SSC limit for duplex stainless steel tube UNS S39274 was evaluated in 0.02 MPa partial pressure H₂S – 0.5 MPa partial pressure CO₂ with 120 g/l chlorides at 90°C. The SSC performance was studied with C-ring specimens with two edge geometries, to avoid edge cracking, and with different crevice materials and geometries. The results show that the SSC resistance of the super duplex stainless steel UNS S39274 is dependent on the applied stress. It is susceptible to SSC in the threshold conditions (0.02 MPa pH₂S at 90°C) given in the ISO 15156/ NACE MR0175 when loaded to yield stress or above. The results showed also that crevices enhance localised corrosion and can induce SSC in super duplex stainless steel. The present results indicate also that crevices result in slightly lower threshold stresses than without crevices i.e. with crevice < without creviced. From experimental point of view, the edge rounding proved to be an effective method to reduce the stresses at the C-ring edges and thus to avoid edge cracking, which often complicates the interpretation of the test results.

1. INTRODUCTION

Super duplex stainless steels are popular alloys in various applications in oil and gas production, where both high mechanical strength and excellent resistance to localised corrosion and sulphide stress cracking (SSC) are required. Two factors control the sensitivities of corrosion resistant alloys to SSC, (1) resistance to localised corrosion and (2) resistance to cracking in the presence of hydrogen [1]. The localised corrosion risk of duplex stainless steels in sulphide solutions increases when the H₂S and chloride content increase and pH decrease and by the addition sulphur [2-4]. It is also increased by plastic straining and cold work [5, 6]. Localised corrosion may also increase cracking risk of duplex stainless steels by exposing material to hydrogen, since the main cathodic reaction in the de-aerated sulphide solutions is hydrogen evolution [2, 5]. In general crevice corrosion is considered to be more detrimental than pitting corrosion since the environmental threshold values are lower for crevice corrosion than for the pitting corrosion. Crevice corrosion mechanisms studies of duplex stainless steels in sour gas environments are scarce. Azuma et al have shown that the presence of H₂S raises the depassivation pH and makes active dissolution easier [4]. The solution in the crevice is proposed to be acidified because of the hydrolysis of the dissolved metal ions or metal sulphide formation.

Recent studies in dilute chloride or chloride-sulphate solutions have shown that crevice corrosion can trigger stress corrosion cracking (SCC) of stainless steels, even at ambient temperatures, environments usually considered to be harmless [7-9]. The recent failures in duplex stainless steel well tubulars in the offshore oil production, has raised the question whether the crevice corrosion impairs the SSC resistance of the super duplex stainless steels [10]. Crevice induced SSC can be a feasible failure mechanism in well tubulars and equipment as crevices feature in these types of components i.e. threaded connections etc. Threads may also act as local stress concentrator and thus increase the cracking risk further [11].

For answering this question the SSC resistance of wrought seamless super duplex stainless steel tube UNS S39274 was evaluated with C-ring specimens with two edge geometries, to avoid edge cracking, and with different crevice materials and geometries in 0.02 MPa partial pressure H₂S – 0.5 MPa partial pressure CO₂ with 120 g/l chlorides at 90°C, that represents the stated NACE MR0175/ ISO15156 part 3 SSC limit for duplex stainless steels with 40 < PREN < 45 as used for down hole tubular components [12, 13].

2. EXPERIMENTAL

2.1 Test material

The test material was wrought seamless super duplex stainless steel tube UNS S39274 with nominal OD 88.9 mm and WT 7.34 mm and with minimum yield and tensile strengths of 860 MPa and 895 MPa respectively. Chemical composition is presented in Table 1.

2.2 Test specimens

The SSC tests were conducted using C-rings manufactured from a tubing joint cut-off, Figure 1. The manufacturing process was realised so that the target stress level can be obtained as closely and reproducibly as possible i.e. the aim was to minimise the wall thickness and residual stress level variations in the specimens. This was achieved by machining all specimens so that the minimum wall thickness was located at the specimen apex. The side surfaces of the C-ring specimens were wet polished with 600-grit emery paper, whereas the outer and inner surfaces were left intact to be tested in as received condition.

For the crevice effect studies two different set-ups were used: a) polytetrafluoroethylene (PTFE) crevice former with six long crevices and b) a silicon tube, Figure 2. The silicon tube

Table 1: Chemical composition of the UNS S39274 (wt%)

<table>
<thead>
<tr>
<th>C&lt;sub&gt;m&lt;/sub&gt;</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
<th>N</th>
<th>Cu</th>
<th>W</th>
<th>PREN&lt;sup&gt;TM&lt;/sup&gt;</th>
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<td>0.03</td>
<td>24.0-26.0</td>
<td>6.0-8.0</td>
<td>2.50-3.50</td>
<td>0.24-0.32</td>
<td>0.2-0.8</td>
<td>1.5-2.5</td>
<td>39 to 47</td>
</tr>
</tbody>
</table>

<sup>PTM PREN = %Cr + 3.3%M + 16%N</sup>

Continues on next page
was selected because it has previously applied to evaluate the crevice corrosion induced stress corrosion cracking of stainless steels at ambient temperature [9]. In both cases the crevice formers were assembled on the outer surface of the specimens at the specimen apex, where the tensile stress is highest. This was done under the test solution to minimize the trapped air in the crevices. UNS N06625 bolts and support plates were used for fastening. In all cases the applied torque was calculated to fulfill the torque limit of 0.28 Nm given in the ASTM G48 [15]. C-ring specimens with rounded edges (R = 5 mm) were applied in one test to evaluate whether edge cracking, which often complicates the interpretation of the results, can be avoided with edge rounding. The aggressiveness of the test environment was evaluated using non-creviced C-ring reference specimens.

The load of the specimens at the apex was varied from 90 to 117% of the axial yield strength (YS) of the tube at 90 ºC, Table 2. The mechanical properties of the test tube were determined from full thickness longitudinal strip specimens at 90 ºC. The loading hoop stress measurements as a function of specimen diameter were performed with strain gauges for both geometries to obtain correct loading curves. The results were compared to the analytical loading hoop stress solution calculated according to the standard ASTM G38 – Standard Practice for Making and Using C-Ring Stress-Corrosion Test Specimens [16]. Young's modulus of 211000 MPa and 196000 MPa and Poisson ratios 0.30 and 0.28 were used for ferrite and austenite, respectively.

In this calculation it was also assumed that the austenite – ferrite phase ratio was 50% - 50%. UNS N10276 bolts, nuts and washers were used for loading the test specimens and polyetheretherketone (PEEK) washers to insulate the bolts, nuts and washers from the specimens.

The microstructure of the test material and the austenite – ferrite ratio was evaluated from metallographic cross sections. This was done once per delivered tube lot.

2.3 Test environment and equipment

The tests were performed in 0.02 MPa pH₂S – 0.5 MPa pCO₂ with 120 g/l chlorides at 90 ºC. Reagent grade NaCl, NaHCO₃ and de-ionised water were used for the test solution. Pre-mixed gas (3.9% H₂S + bal. CO₂) was used for purging to obtain the 0.2 bar pH₂S – 5 bar pCO₂ with 120 g/l chlorides at 90 ºC. The test duration was 30 days.

The tests were performed in PTFE-lined autoclaves, which were filled (filling rate 80%) with the test solution. After this the test solutions were de-aerated by purging with N₂ typically for 48 hours. After that the test specimens were placed to the autoclaves and N₂ purging was continued for about 24 hours. Then the autoclaves were heated to the test temperature of 90 ºC. The autoclaves were pressurised with pre-mixed H₂S-CO₂ gas mixture and to obtain the target partial pressure values of H₂S and CO₂ the pressurising was done according to the pressure cycling method by Crolet and Bonis [17]. To ensure that the volume of gas injected was big enough to obtain the target partial pressures in autoclaves' gas phase a total number of 40 pressure cycles were manually performed to both autoclaves separately. After which the autoclaves were shifted to a computer control i.e. the test pressure was automatically kept stable by adding fresh premixed gas mixture to the gas phase of the autoclaves, when necessary.

3. RESULTS

3.1 Test material C-ring specimens

The microstructure of the test material is typical to the duplex stainless steel tube. According to the image analysis the austenite – ferrite ratio of the test material was approximately 55%/45%.
The results from the strain gauge measurements showed that the linear load–deflection curve given in the ASTM G38 standard is valid for the current super duplex stainless steel tube material.

The dimensional measurements performed during C-ring manufacturing process showed that the outer surface of the tube is in tension after the tube manufacturing process, which then relaxes when C-rings are manufactured. This is illustrated in Table 3, where the results of the specimens for the test No. 5 are presented. The minimum wall thickness values were closely-spaced but the wall thickness measurements of the O-rings showed variations close to 10% from the nominal tube wall thickness.

### Table 2: Applied stress levels and specimens

<table>
<thead>
<tr>
<th>Test method</th>
<th>Applied stress [%YS\textsubscript{5%}]</th>
<th>Estimated stress at the C-ring apex, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Center</td>
<td>Edge</td>
</tr>
<tr>
<td>Specimens with PTFE crevice</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>C-rings without edge rounding</td>
<td>117%</td>
<td>117%</td>
</tr>
<tr>
<td>Specimens with silicon tube crevice</td>
<td>90%</td>
<td>60%</td>
</tr>
<tr>
<td>C-rings without edge rounding</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>C-rings with rounded edges</td>
<td>117%</td>
<td>117%</td>
</tr>
<tr>
<td>Reference specimens without crevice</td>
<td>90%</td>
<td>60%</td>
</tr>
<tr>
<td>C-rings without edge rounding</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>C-rings with rounded edges</td>
<td>117%</td>
<td>117%</td>
</tr>
<tr>
<td></td>
<td>90%</td>
<td>60%</td>
</tr>
</tbody>
</table>

*From the axial yield strength of the tube at 90 °C and residual stresses ignored.*

### Table 3: Dimensions of the C-ring specimens for the test No. 5.

<table>
<thead>
<tr>
<th>C-ring No.</th>
<th>Type</th>
<th>Min. WT at the apex [mm]</th>
<th>Outside diameter [mm]</th>
<th>ΔΨ</th>
<th>Change in the stress at the apex [MPa]*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before opening “O-ring”</td>
<td>After opening “C-ring”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-rings without edge rounding</td>
<td>T5C1 – S</td>
<td>Silicon tube crevice</td>
<td>6.22</td>
<td>89.32</td>
<td>91.08</td>
</tr>
<tr>
<td></td>
<td>T5C6 – S</td>
<td>Silicon tube crevice</td>
<td>6.22</td>
<td>89.34</td>
<td>90.90</td>
</tr>
<tr>
<td></td>
<td>T5C8 – S</td>
<td>Steel gauge mea.</td>
<td>6.22</td>
<td>89.28</td>
<td>91.22</td>
</tr>
<tr>
<td></td>
<td>T5C13 – S</td>
<td>Ref. without crevice</td>
<td>6.24</td>
<td>89.31</td>
<td>90.86</td>
</tr>
<tr>
<td></td>
<td>T5C2</td>
<td>Metallography</td>
<td>6.23</td>
<td>89.30</td>
<td>91.21</td>
</tr>
<tr>
<td>C-rings with rounded edges</td>
<td>T5C3 – R</td>
<td>Silicon tube crevice</td>
<td>6.21</td>
<td>89.29</td>
<td>91.21</td>
</tr>
<tr>
<td></td>
<td>T5C9 – R</td>
<td>Steel gauge mea.</td>
<td>6.22</td>
<td>89.27</td>
<td>90.38</td>
</tr>
<tr>
<td></td>
<td>T5C11 – R</td>
<td>Silicon tube crevice</td>
<td>6.22</td>
<td>89.27</td>
<td>91.20</td>
</tr>
<tr>
<td></td>
<td>T5C14 – R</td>
<td>Ref. without crevice</td>
<td>6.24</td>
<td>89.31</td>
<td>91.11</td>
</tr>
</tbody>
</table>

*Calculated according to ASTM G 38 [15], austenite-ferrite ratio 60%-69%.

### 3.2 Sulfide Stress Cracking Test Results

The results of the SSC tests with C-rings are summarised in Table 4. The tests showed that the SSC susceptibility of the studied UNS S39274 is dependent on the applied stress, as shown also in Figures 3 and 4. Cracks were observed in all specimens when loaded to or above the yield strength and the severity of cracking increased when stress increased. In general the cracking was most intense at the apex and at the edges of the specimens, where the stress is highest. No cracks were observed on the flat surfaces when the specimens were stressed below the yield strength.

In the creviced C-ring specimens crevice corrosion and cracking was observed under the crevice formers, Table 3 and Figure 4. In addition pitting corrosion and cracks was observed adjacent to the formers. The severity of cracking and localised corrosion increased when stress increased. Tests showed also that the silicon tube was much more effective corrosion/cracking initiator than the PTFE crevice block. In the areas where crevice corrosion was observed the ferrite phase was preferentially dissolved. In all cases the cracks initiated in the ferrite phase and continued growing in the ferrite or in the ferrite/austenite phase boundary, Figure 5. In general the cracking was most intense at the apex and at the edges of the C-ring specimens, where the stress is highest. The edge cracking was prohibited when the C-ring specimens with rounded edges were applied.

### 4. DISCUSSION

#### 4.1 Test material and specimens

The accurate loading of duplex stainless steel C-ring specimens requires pertinent manufacturing procedures. The maximum variation in wall thickness in the C-rings was measured to be close to 10% from the nominal wall thickness, which still fulfils the requirements of the tubing manufacturing. In the worst case this could result to a ±40 MPa deviation in the final target loading. This effect can be minimised by measuring and manufacturing all specimens based on individually measured dimensions.

During cutting of the C-rings from the test tube the specimens the diameter changes. In the O-rings there are high tensional residual hoop stresses of up to 45% Rp\textsubscript{0.2} at room temperature. This is an important point to consider when designing a well.

The stress state of the duplex stainless steel varies with the phase ratios. According to the image analysis the austenite – ferrite ratio of the test materials was approximately 55%/45%, thus it was justified to use the phase ratio 50%/50% in the loading calculations.

The validity of the applied deflection curve was verified by strain gauge measurements. The comparison to the ASTM G38 standard showed that the linear load – deflection curve given in the standard is valid for the current super duplex stainless steel tube material.

#### 4.2 Effect of stress level on the SSC behaviour

The test results showed that the SSC susceptibility of the studied super duplex stainless steel tube material depends on the stress level. The accuracy of the applied stress and the specimen dimensions is crucial for the accuracy of the test results.
stainless steels is dependent on the applied stress level. Stressing to yield strength and above (plastics strain, cold work) is detrimental to the SSC resistance in 0.2 bar pH2S – 5 bar pCO2 with 120g/l chlorides at 90°C. And no SSC is taking place when the stresses are not higher than 90% YS, provided that no crevices are present. These results are in agreement with the literature. Klyk-Spyra and Sozanska [18] have shown that type 2205 duplex stainless steel is sensitive to SSC in NACE Standard TM0177 method A test when the tensile stresses are greater than 90% YS90°C and that the cracking was enhanced when stress was increased above YS. Ikeda et al. [19] has reported that even 1% cold work can be detrimental to the SSC resistance of DSS. The tests showed also that the edge rounding is an effective method to reduce the stresses at the C-ring edges and thus to avoid edge cracking, which in many cases complicates the interpretation of the results.

### 4.3 Role of crevice corrosion in SSC

Crevice enhanced localised corrosion and SSC in super duplex stainless steel and its effect is increased when the stress is increased, Figures 4 and 5. The tests with specimens loaded to 90% YS90°C suggest that the threshold stress is lower than the <σth un-creviced. The present results indicate also that crevices result in slightly lower threshold stresses than without crevices i.e. <σth crevice SSC 90% YS 90°C. In C-ring specimens the silicon tube provided a much more efficient crack initiator than PTFE. It seems that this set-up is also less sensitive to surface roughness and alignment problems in assembly.

The cracks in the crevices initiated at the ferrite phase and continued growing in the ferrite phase or in the ferrite/austenite phase boundary.

### 5. CONCLUSIONS

The sulfide stress cracking (SSC) susceptibility of the UNS S39274 wrought seamless super duplex stainless steel tube has been examined at 0.02 MPa partial pressure H2S – 0.5 MPa partial pressure CO2 with 120 g/l chlorides at 90°C, which represents the NACE MR0175/ISO15156 environmental limit for duplex stainless steels with 40 < PREN < 45 used as down hole tubular components (Table A.25). Crevice induced SSC was investigated because crevices are present in well tubulars and equipment, like gaps and contact areas between collars and overlapping joints, under gaskets or seals, under deposits which have been shown to be detrimental to stress corrosion cracking resistance in chloride environments.
edges exceeds the yield strength, which complicates the interpretation of the results. The edge rounding is an effective method to reduce the stresses at the C-ring edges and thus to avoid edge cracking.

4. REFERENCES


Vital Energi of Blackburn is currently carrying out Biomass, Combined Heat and Power (CHP) and multi-utility infrastructure works at The University of York’s new Heslington East Campus. In order to obtain effective and long term sealing from the entry of gas and water in all electrical service cable ducts, Vital Energi has chosen Winn & Coales Densoseal 16A sealant. Additionally, it was considered to be the most suitable sealant for use in renewable energy applications.

Densoseal 16A is a non-setting, self-supporting mastic which may be applied to wet surfaces and will seal ducts and conduits against ingress of water and gas. It is suitable for CHP and biogas projects. It complies with British Telecom Specification M212C. It is suitable for sealing cable ducts, conduits and service entry pipes or sleeves, particularly below ground level, to prevent entry of water or gas into buildings. It may also be used for profiling mechanical joints on hot pipes to allow application of tapes.

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WINN & COALES INTERNATIONAL IS AGAIN RECOGNISED BY THE QUEEN’S AWARDS FOR GROWTH IN WORLD SALES

Three years after achieving its first Queen’s Award for Enterprise for International Trade in 2010, London based specialist anti-corrosion, waterproofing and sealing products manufacturer Winn & Coales International Ltd, was today again honoured with the same award, recognising its growth in world sales over the last three years.

The new award announced on the Queen’s birthday is the result of the combined efforts of the company’s UK, based staff, subsidiary companies and global network of agents offering proven and cost-effective solutions for its customers corrosion and sealing related problems.

Winn & Coales International, established in 1883 remains an independent company and is celebrating its 130th Anniversary this year. The company’s Denso anti-corrosion and sealing systems have been used to protect buried and sub-sea pipeline, exposed steelwork and storage tanks in highly corrosive environments worldwide for over 80 years.

Chairman David Winn OBE said “Winning this award the first time was an important milestone for the company but winning it again in 2013 is absolutely amazing and recognises without doubt, our success in establishing our products reliability and quality across the world despite the recessionary times we are all going through. It is a also a reward for all of the effort and finance we continually invest in developing new innovative products to solve our customers ever changing needs”.

DENSO UK GAINS ENVIRONMENTAL STANDARD ISO 14001:2004

Denso anti-corrosion and sealing specialist products manufacturer, Winn & Coales (Denso) Ltd are proud to announce that they have now achieved the internationally recognised environmental standard ISO 14001:2004.

Obtaining this standard for their factory and operations base in West Norwood, London is an important step forward for the company and shows their commitment to environmental responsibility.

This new environmental standard goes hand in hand with the quality management standard ISO 9001:2008 they have held and maintained for the last 25 years at the London premises and demonstrates the company’s aim in constantly improving its day to day operations and customer satisfaction through better manufacturing operations and safer products.

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DENSO TAPE PROTECTS BLUEBELL RAIL WHEEL ASSEMBLIES

The well-known, volunteer-run, Bluebell Line was the UK's first preserved standard gauge passenger railway, re-opening part of the Lewes to East Grinstead line of the old London Brighton & South Coast Railway in 1960. Maintaining the line’s locomotives, coaches and signalling systems is carried out at its Sheffield Park Station.

A key aid in helping this preservation of Bluebell’s locomotives has turned out to be Winn & Coales Denso Tape, which has been in regular use there for over 20 years. This is primarily on wheel assemblies, particularly on main bearing journals and crank pins. The use of Denso Tape is two-fold. First to prevent corrosion after pretreatment of the surfaces; secondly, as work is carried out in the open yard it stops abrasive damage from grit resulting from shotblasting in adjacent areas, and from coal dust.

Perhaps an unusual application for Denso Tape (although its range of uses has become legendary) was to stop water leaks in tender tanks. As the Bluebell engineers could not reach the leaking areas for welding, they applied small sections of wood wrapped in Denso Tape in the leaking areas. The first application was ten years ago; and there are still no leaks.

Denso Tape is a non-woven synthetic fibre fabric impregnated and coated with an adhesive compound based on petrolatum. For further information contact: www.castolin.com and www.monitorcoatings.co.uk

CASTOLIN EUTECTIC ACQUIRES MONITOR COATINGS GROUP

BAD SODEN - 11 April 2013. Castolin Eutectic today announced its acquisition of privately-held Monitor Coatings Group. With facilities in the UK, Singapore and China, Monitor Coatings is a technology leader for surface engineering in extreme environments.

Serving customers in the oil and gas, steel, power and aerospace industries, Monitor Coatings has earned its reputation and market position on technology solutions that offer the highest level of performance available in the market today and operates to the highest quality standards recognized throughout the world, including ISO9001, AS9100 and NADCAP accreditation.

In the oil & gas industry, directional drilling has opened up affordable access to even the remotest sources of oil. The techniques involved pose new challenges in material wear. By developing ultra-dense, high wear-resistant coatings based on a novel thermal spray and densification process, Monitor Coatings has developed unique high-tech processes that offer ultimate protection for that drilling equipment. This technology prolongs the life of drilling tools and provides sustainable, durable equipment to the market, thereby significantly reducing costs and minimising the environmental impact.

This acquisition will come to reinforce Castolin Eutectic’s own position as a leader in wear protection for a wide range of industries. Castolin Eutectic is an integrated manufacturer of welding, brazing and coating consumables; it operates a network of service workshops in 25 countries and employs over 1,400 technicians and experts worldwide in welding, brazing and coating technologies.

"Castolin Eutectic and Monitor Coatings create the leading force in industrial wear and corrosion protection. With this step we further strengthen our technology and service activities – core to our growth strategy," said Siegfried Schabel, CEO of MEC Group.

“Partnering with Castolin Eutectic gives us the ability to grow faster and serve our customers even better. Castolin Eutectic’s strong international presence and know-how, together with Monitor Coatings’ innovative technology will bolster the offer to our combined client base,” says Dr Bryan Alcock, CEO and founder of Monitor Coatings Group.

Castolin Eutectic and Monitor Coatings processes are at the forefront of technological development in thermal spray and hard-facing coatings. These include: High Velocity Oxy-Fuel (HVOF), Thermo-Chemical Conversion Coatings (densification), Air-Plasma and Low-Pressure Plasma coatings (including ceramics such as thermal barrier coatings and Nano-particle derived coatings), Arc spray coatings, Laser cladding and Plasma Transfer Arc (PTA) cladding solutions.

Castolin Eutectic is a division of MEC Group, with sales of EUR 580 million and 2,700 employees, operating three divisions: Castolin Eutectic, Messer Cutting Systems and BIT Analytical Instruments.

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T: 0161 2306666

JB Specialist Refurbishments Ltd
The Old Village Hall, Sawtry, Huntingdon, Cambridgeshire PE28 5TZ
T: 01536 266607

Leighs Paints
Tower Works, Kestor Street, Bolton, Lancs, BL2 2AL
T: 0161 2306666

Livis Ltd
Livis House, 50 Victoria Park, Dartford, Kent, DA1 5AY
T: 01322 230058

Malakoff Limited
North Ness, Lerwick, Shetland, ZE1 0LZ, UK
T: 01595 695544

Matthew James Services
Unit 4, Shibdon Business, Coven Road, Blaydon, Newcastle-Upon-Tyne, NE21 5TX
T: 0191 414 5700

Moore Steel Developments Ltd
Station Road, Thorney, Peterborough PE6 OQE
T: 01733 270729

Paint Inspection Ltd
Trafalgar House, 223 Southampton Road, Portchester, PO6 4PY
T: 0845 4638680

Parks Fabrication Ltd
Park Farm, Holme-upon-Spalding-Moor, York, Y043 4AG
T: 01430 861628

PPC Ltd
Unit 2, Oyster Industrial Estate, Jackson Close, Drayton, Portsmouth PO6 1QN
T: 023 9221 3957

Possilpark Shotblasting Co Ltd
Dalmarnock Works, 73 Dunn Street, Glasgow, G40 3PE
T: 0141 556 6221

Radleigh Metal Coatings Ltd
Unit 30 Central Trading Estate, Cable Street, Wolverhampton, WV2 2HX
T: 01902 870606

R.L.P. Painting
Heathfield House, Old Bawtry Road, Finningley, Doncaster, DN9 3DD, UK
T: 01302 772222

Shirley Industrial Painters & Decorators Ltd
Grand Union House, Bridge Walk, Accocks Green, Birmingham, B27 6SN
T: 0121 706 4000

Taylor Engineering (UK) Ltd
Unit 7 & 8 Burraan Buildings, Curran Road, Cardiff CF10 5NE
T: 02920 371959

Tinsley Special Products
Enterprise House, Durham Lane, Eaglescliffe, Stockton-on-Tees TS16 0PS
T: 01642 784273

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6th June 2013
**London Branch Golf Day**
London Branch Golf Day at Silvermere, Surrey
Contact: Derek Hoskins
dhoskins@waitrose.com

13-14th June 2013
**London Branch Offshore Cathodic Protection Conference**
At the Royal Overseas League in London there will be a two day Offshore Cathodic Protection conference, at this conference industry leaders will present papers on leading edge issues in this important area of corrosion control technology; this will be a must attended event. Please register your interest and to receive the early conference program at: admin@icorr.org

30th September-2nd October 2013
**Short Course: Corrosion Control in the Oil & Gas Industry**
Venue: Amsterdam
Details can be obtained from Colin Britton
T: +44 (0) 1480 860943
E: cbrit79727@aol.com

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Details of all Branch activities, dates and venues can be found at www.icorr.org

London Branch publish a monthly Newsletter

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