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By the time I had finished my management qualification, I was operating as a Development Group Leader with mechanical engineers, quality engineers, buyers and cost accountants all working in my group developing new integrated microwave components for new radar systems. However, by this time I was married and had a young son and my next promotion appeared to be many years in the future.

An opportunity to join Elcometer arose in 1982 and I started my employment as Projects Manager responsible for co-ordinating the development of new coating inspection products through production to the launch with all the relevant support documentation at a time when Elcometer’s electronic product range was in a period of significant growth.

Over the next few years I had a series of roles within Elcometer as UK Sales Manager, Quality Manager and General Sales Manager, taking my current role as the Technical Support Manager in 1998.

I joined the Institute of Corrosion’s North West Branch in 1985 in response to Bill Cox’s request to the founder and owner of Elcometer, Ian Sellars, that Elcometer should be more involved in the local organisation, soon after I joined the North West Branch committee. After several years’ involvement in branch activities, I became Chairman of the Branch and was involved in the support for the Branch’s Young Persons Paper Competition award along with several colleagues who are still very active in the NW Branch.

I was asked to join ICorr’s Professional Development Training and Certification Committee PDTC and in 2006 I became Vice-Chairman and, in 2011, I took over as Chair. This role has now passed to Chris Atkins and I trust that you will support Chris as you have supported me in this role.

I was elected as a Fellow of the Institute of Corrosion in July 2009 and registered as a Chartered Scientist in May 2013. I was also founding Chairman of the Institute of Corrosion’s North West Branch in 1985 in response to Bill Cox’s request to the founder and owner of Elcometer, Ian Sellars, that Elcometer should be more involved in the local organisation, soon after I joined the North West Branch committee. After several years’ involvement in branch activities, I became Chairman of the Branch and was involved in the support for the Branch’s Young Persons Paper Competition award along with several colleagues who are still very active in the NW Branch.

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I was elected as a Fellow of the Institute of Corrosion in July 2009 and registered as a Chartered Scientist in May 2013. In November 2012 the AGM elected me to the post of Vice President and my Presidency is due to run until the AGM in November 2016.

I, like those who proceeded me in this post, am very proud to have been given this role and I now seek your support to further develop the Institute and make it as relevant to the membership as possible.

In addition to my ICorr activities I am a member of the American standards organisation ASTM and I have been Chairman of the D01 Main Committee on Paints and Related Coatings since January 2010. My third and final period as Chairman of D01 will come to an end in January 2016.

Over the years I have been a member of some coating related standards committees for BSI, CEN and ISO and I was part of the working group which prepared the protective coating test standards, ISO 19840 for coating thickness, ISO 16276 parts 1 and 2 for adhesion testing and ISO 29601 for high and low voltage porosity testing.

My main role within Elcometer these days is writing technical articles on inspection and testing methods for coatings and presenting conference papers on the relevant standard test methods for inspection and test and the development of associated test and inspection equipment. As a member of both SSPC and NACE in the USA, I normally attend their conferences in the first quarter of the year.

My objective for the next two years as President is to build on the fine work carried out by previous Presidents and current Officers and Chairs of the various ICorr groups who made the Institute the strong and thriving body it is today. I aim to try to continue the recent increase in the individual membership numbers by making the corrosion and coatings communities and the general public more aware of the services and opportunities ICorr provides.

The Institute of Corrosion still has a vital role to play in making people aware of the dangers and risks of corrosion. As corrosion is a natural process it is not going to be removed from our lives but we can significantly mitigate the effects by applying good practice and providing training for the next generations who will have to deal with the issues.

I am looking forward to the task of representing the Institute wherever there is an opportunity and helping the very able team that has been assembled to carry out the day-to-day tasks. I hope to meet as many of our members as I can over the next two years.

John Fletcher
President of the Institute of Corrosion
THE LIFE OF HECTOR CAMPBELL
(24TH JULY 1921 – 12TH AUGUST 2014)
SOME MEMORIES BY DOUGLAS MILLS AND ROGER FRANCIS

We first met Hector Campbell at BNF (British Non Ferrous) Metals Technology Centre in Wantage, Oxfordshire in 1974. Both of us had just joined the organisation as junior research scientists fresh out of university. Douglas was set to work on three projects: one involving the famous (or notorious as it had a habit of breaking down) May Jet test (measuring impingement corrosion), another an investigation of stress corrosion of cobalt containing bronze alloys and the third and most significant an examination of artefacts brought up from the sea bed near where Sir Cloudesly Shovell’s fleet of warships hit the rocks off the Scilly isles in 1707. The latter project was financed by the Royal Society and involved the examination inter alia of pieces of eight, musket balls, pewter plates, copper spikes, bronze cannon and brass dividers. The study was of great interest to metallurgical archaeologists, and it demonstrated Hector’s wide knowledge of metallurgical processing over the centuries, as well as providing data on long term corrosion rates of various metals in seawater.

Hector established a world-wide reputation for BNF in the corrosion field, particularly in the field of corrosion of copper and its alloys. He invented a piece of equipment called the Campbell condenser rig test. This was the project that Roger worked on when he arrived at the BNF. And this piece of equipment is still in use today. He was known and respected all over the corrosion world. A few examples make the point. Dr Sato and Dr Nagata from Sumitomo Light Metals Research Laboratories in Japan made regular visits to see him. He also worked with the Danish Corrosion Centre (now the FORCE Institute), particularly Kate Nielsen and Curt Christensen. Finally, Peter Elliott in the USA, who has been a technical witness in several lawsuits involving corroded copper and copper alloys, is grateful for the defining work done in this area by Hector and his colleagues at BNF.

Hector qualified as a chemist and during World War II he worked on quality issues in an electroplating shop. After the war he took a position in the corrosion department of BNF, then in London. An early project was on the corrosion of uranium and Hector delighted in describing putting bars of uranium in the vice and sawing coupons off using a hack saw, with no Geiger counter or protective gear, other than a lab coat. Soon after the government established nuclear research laboratories at Harwell and the work moved there.

Then began a long period of looking at corrosion problems of copper and copper alloys, as well as other materials, in fresh waters and seawater. The work resulted in the publication of numerous technical papers and research collaborations around the world.

When BNF moved to Wantage, Oxfordshire, Hector became head of the Metal Users Consultancy Service, looking at service failures and offering advice on materials selection and use. In addition to the mundane there were also many interesting corrosion problems.

Throughout his time at BNF, Hector represented the UK on a number of BS and ISO committees, drawing up standards in the field of corrosion.

Hector retired from BNF in the 1980’s and became a consultant, with both CAPCIS (now Intertek) and the University of Surrey, where he was made an Honorary Senior Research Fellow. However, he still found time to take on the Consulting Editorship of the British Corrosion Journal (now CEST). The journal had been struggling, but Hector used his strong persuasive powers and contacts to solicit quality papers, whilst also including non-technical articles about events, people etc in the corrosion world to increase its readability. He revived the journal’s fortunes. Hector handed over the editorship of BCJ to Tony Mercer in 1989 and gradually phased out his consultancy work. He was still regularly phoned up for technical advice through his 80’s and into his 90’s. This shows both the respect and reputation that he had achieved.

Hector was very modest and rarely talked about himself. However, he could sometimes be persuaded to talk about his early career over a glass or two of malt whisky. Hector’s beloved wife Molly died in 2007. In his latter years he moved up to Barnsley to be near his daughter. But he still kept independent, living there in a nice bungalow. We both made visits to see him and he got us to take him out to his favourite pub some ten miles away. We did wonder why we passed rather a lot of pubs on the way. But it was good when you got there with a reduced rate for pensioners! He is survived by three children, Malcolm, Linda and Paul. He was both a first class chemist and a very good corrosion scientist and engineer. He will be much missed in the corrosion world.

Note: thanks are due to Maney Publishing for allowing reproduction of parts of the obituary of Hector published in CEST (CEST 2014, Vol 49, No 8).
Technical Topics No.47:
CORROSION AND ART
By Douglas J Mills, Technical Secretary

It’s the holiday season (or is likely to be before this CM arrives on your mat). So for this month’s TT, I thought I’d tackle a more light-hearted topic which is Corrosion and Art. If you Google this you get a large number of pictures, in fact the covers of many corrosion books often havearty pictures showing attractive, multi-coloured corrosion product. This is not surprising. The colours of the oxides that comprise “rust” vary from red through orange to many shades of brown, grey and black (even green and blue when other metals are present). And of course these oxides are used as pigments eg for artists paints; in anticorrosive paints; and in other things like concrete (I nearly went to work once for a company called Mineral Pigments Ltd based in Baltimore who were very much into this field).

And even quite normal types of corrosion (not necessarily multi-coloured), if distributed in an interesting way can be classified as art (we have seen in this in the concentric ring corrosion (CRC) afflicting items in storage at the Armouries which I talked about in last month’s TT and which we are currently grappling to understand).

Back in 2000 at the EuroCorr held in London Alec Groysman (who has entertained EuroCorr conferences with topics such as Corrosion and Music, Corrosion and Love, Corrosion is Everywhere), started this series with a talk entitled “The Philosophy of Relationship
between Corrosion and Art”. In that lecture he made a valiant attempt to marry two apparently quite different things: Corrosion, a branch of science and engineering dealing with the study of degradation of materials and preventive measures to control and stop this destructive phenomenon; And Art, which deals with the creation or expression of what is ‘beautiful’ in the surrounding world, especially in visual form. Art in Groysman’s definition includes sculpture, drawing, painting, graphics, architecture, photo, design, music, ballet, literature and poetry. In his paper he tried to find a relationship between various forms of art, corrosion and anticorrosion protection and the philosophy of existence and life. I am not going to attempt such an ambitious task in this article! Rather I thought I’d concentrate on just two aspects. One is where items are deliberately allowed to corrode outside in the wind and rain in the interest of producing something that looks nice. Corten steel (copper containing) is a prime candidate material for this. Of course you have to get the environment right. As readers may well be aware environments are classified according to corrosivity from C1 (indoor dry) to C5 (immersion in sea water). C3 (rural / non industrial) is normally Ok for “art” corrosion (it is the C4 environments (industrial and marine atmospheres) that are likely to cause unexpectedly high rates of corrosion and unsightly brown stains can appear from the run off). The pictures show two examples in a town called Domme located in the Dordogne area of France with an environment that I would assess as C3. As can be seen the blocky, uncoated carbon steel sculpture has an interesting brown appearance and texture. Of course one attraction of this type of art form is it will change with time. The other “watch mechanism” sculpture is more complex. Being composed apparently of several different metals it looks a prime candidate for galvanic corrosion. Assuming these remain I will be able to go back and re-examine them on occasions as my brother-in-law owns a house nearby. Perhaps I will even make some electrochemical measurements! The other area I would like to touch on is use of corroded materials in “sculptures” (artists like to talk about their work as if it has a life of its own and something that has corroded has certainly had that!). My friend Kate is an artist with an interest in this and one of her “sculptures” is shown here. I this case I believe that the creative process is in the original spotting of an item with an appearance that looks interesting, requisitioning it, and then exhibiting it in the best possible manner. Of course there are many buildings and statues which rely on the pleasant green/blue patina of copper. Another example from Kate’s collection shows the right colour although the metal looks more like aluminium (as aluminium corrosion products are normally white it must contain some copper!). Certainly it is unlikely these sort of “sculptures” will corrode much further in the C1 environment. So what “life” they had is now relatively static (like being in an old people’s home!) What else to talk about? Well the next CED meeting has been pretty definitely fixed for Aberdeen on May 26th. It will take the theme of issues related to the Oil and Gas industry. It is on the day after the late May Bank holiday. I would recommend readers to combine going to this meeting with a holiday in Scotland which is what I intend to do! Any comments as usual please contact Douglas@harrbridge.freeserve.co.uk

Acknowledgement: thanks to Kate for allowing a couple of her artworks to be shown in this article.
The first meeting of the 2014/15 session was a joint session with TWI. The guest speaker was Alan Foxton of Wood Group Kenny. Alan made a distinction between “Corrosion” and “Welding” emphasising that both disciplines were different, focusing on different areas of materials science but ultimately related. His talk focused on hydrogen and posed the following questions: Where does hydrogen come from? How does hydrogen affect metals? What can professionals do to control these effects?

He explained the difference between atomic hydrogen (H+) and hydrogen molecule (H₂) explaining with equations how susceptible metals crack when exposed to wet H₂S containing environments. Alan explained that atomic hydrogen was relatively small in size but when it recombined to a hydrogen molecule, an internal strain is generated within the metal matrix. “This strain is cumulative with other calculated strains (e.g. bolt tension), so materials are locally stressed to failure (Cracking)”, Alan observed.

Alan introduced the various H₂S related cracking mechanism explaining the main differences and highlighting the main causal factors. He introduced two widely used standards on the subject: European Federation of Corrosion (EFC 16) and the ISO 15156 / NACE MR0175 that provided guidance on the specification of materials for application in sour environment for carbon steels based on how the environment is classed in the pH v pH₂S domain diagram. Alan explained that the atomic hydrogen was generated from various sources such as acid solutions, Cathodic Protection, galvanising, welding during fabrication, and bacteria activity in the environment among others.

Alan concluded that the understanding of hydrogen may have changed over the years, but its effects remain significant and potentially disastrous. Also the main issues are too easily ignored by other disciplines and that it was up to professionals to intervene and advise at any opportunity. There were questions on various aspects of hydrogen related cracking as the meeting drew to a close.

For information about the Aberdeen branch activities please contact our branch secretary, Frances Chalmers, ICorrABZ@gmail.com. Alternatively a calendar of local events of interest 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.
ICORR ABERDEEN BRANCH MEETING
ADVANCES IN CORROSION AND SAND/EROSION MONITORING TECHNIQUES

The October 2014 meeting was attended by over 50 delegates and held at the Palm Court hotel. The branch chair, Edward Whyte gave a short safety brief and introduced the guest speaker as Derek Morton of Rohrback Cosasco Systems.

Derek covered the application of various corrosion monitoring devices and wireless technology for transmitting data. He explained with diagrams and photographs the various corrosion monitoring techniques with focus on the type, working principle, benefits and disadvantages. He covered weight loss coupons, electrical resistance (ER) probes, high sensitivity probes, linear polarisation resistance (LPR) probes, galvanic probes and sand probes.

Derek explained that these devices could be installed either intrusively or non-intrusively. He used graphs to illustrate corrosion monitoring data emphasizing how the data trends changed with variations in plant operating conditions. He gave a brief history of online monitoring and explained how the technology has evolved. He explained further the working principle of smart wireless transmitters installed with monitoring devices that allow data to be sent to remote locations and touched on the challenges of sending data in practice.

Derek explained that the use of high sensitive monitoring devices such as Ultracorr®. He presented a case study that illustrated how corrosion monitoring devices were used in extremely low and high temperature environment in Russia. He explained the advantages of these devices and how the operator benefited from wirelessly transmitted data when the area of interest became inaccessible during winter.

To conclude, the speaker explained the need to apply an Integrated Corrosion and Erosion Monitoring. He presented a diagram that illustrated how various monitoring devices can be installed in a process system to retrieve valuable data to help the operator make useful integrity management decisions.

Questions after the meeting were focused on temperature limitation when applying high sensitivity monitoring devices, use of electrochemical noise devices, acoustic monitors, the future of corrosion coupons, and interpretation of monitoring data.

Corrosion monitoring devices, hardware and components were put on display after the meeting for members to view and ask questions. Continuous professional development certificates were also distributed to members immediately after the meeting. For information about the Aberdeen branch activities please contact our branch secretary, Frances Chalmers, ICOrrABZ@gmail.com. Alternatively a calendar of local events of interest 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.
During 2012-2013 the Institute of Corrosion embarked upon a new initiative to address what has been perceived as a shortage of young or entrant engineers showing an interest in materials and corrosion. The initiative was developed by a group of ICorr members who formulated a programme and solicited speakers who then presented on a broad range of materials and corrosion control related subjects, these included:

- Basic corrosion
- Welding
- NDT
- Coatings
- Cathodic protection
- And non destructive examination

These presentations paved the way to the attendees being given case studies to consider, the attendees were placed into groups of four or five with each group being mentored by one of the subject presenters. The subjects the attendees had to consider in the case studies were:

- Wet gas pipelines
- Vessel welding
- d.c. interaction

This programme was instigated to address the changing demographics in materials and corrosion engineering. As time has gone by the number of engineers entering materials engineering has declined, this is for many reasons including knowledge of the materials engineering, declining course availability and other courses that are considered as more exciting or rewarding. This decline in availability has in fact had a positive impact in creating demand for engineers having materials knowledge and training and therefore it can be a lucrative and rewarding career. The other driver for the programme was to better inform all engineering disciplines of the issues related to materials engineering and to raise awareness of the importance of asset integrity through correct materials selection, joining processes, inspection and corrosion control. These are important subjects for all disciplines to embrace, correct selection of materials and corrosion control are important to all engineering projects and can impact all areas where engineers work in one form or another.

Given the success of the programme in 2012-2013 it is the intention of ICorr to repeat it bi-annually, the next event will be starting again in the first quarter of 2015 and we are proud to announce that this event will now be run with the support of BP who will be sponsoring the event. BP sponsorship will take the form of a prize which will allow the winning team to attend either the NACE national conference in Vancouver, Canada in 2016 or Eurocorr 2016 in Montpellier, France.

The first module, The Fundamentals of Corrosion, will be presented by an industry leading expert. The programme due to venue size and administration issues will be limited to twenty attendees and requirements for attendance are that the candidate should be in employment in an engineering discipline, be working with an engineering company or manufacturer of engineering based products and they should complete the application form which can be downloaded from the ICorr website, candidates shall also provide a current CV. The organising committee will impartially review applications and the successful candidates informed in writing of the outcome of the review process.

Presentation dates for the new course will be:

- January 21st 2015
- February 18th 2015
- March 25th 2015
- April 22nd 2015
- May 20th 2015
- September 23rd 2015
- October 15th 2015
- November 12th 2015 – Presentation of case studies

To reintroduce the programme the format has been updated to reflect the lessons learned from the first course. This make over will introduce new topics and speakers to provide a more apposite approach and to obtain a broad based perspective by having other industry professionals present their first hand knowledge and to discuss the selected subjects, the topics now selected are:

- The Fundamentals of Corrosion: Jane Lomas
- Material Selection: Don Harrop
- Health and Safety: Andrew Duncan
- Welding and NDT: Alan Denney
- Cathodic Protection: Brian Wyatt
- Careers in Oil and Gas: Bill Hedges
- Paint and Coatings: Neill Wilds
- Presentation Skills: David Mobbs
- Routes to Professional Membership and Chartered Status: Trevor Osborne

To supplement these main presentations there will be short ad hoc informative sessions presented during the networking break and buffet which will follow each of the main presentations. In this way available time will be best used and the subject matter delivered maximised. These breakout presentations will be soft subjects and will include paths to chartership, working in the industry and the benefits and possibility for attainment and other opposite subjects.

As for the previous format there will be a group of mentors who will develop the case study content and requirements and a panel of judges, presently those committed to the programme, all names known in the industry, are committed members of ICorr, these key people are:

**Steering Group**
- Trevor Osborne (President of ICorr and MD of DCS UK Ltd.)
- David Mobbs (WGK)
- Polina Zabelina (BP)
- Sarah Vasey (International Paint)
- Alan Denney (AKD Materials Consulting Ltd)

**Judges**
- Don Harrop (BP retired Independent Consultant)
- Bill Hedges (BP Corrosion SETA)
- Rob Doggett (Independent Consultant)
- Trevor Osborne (ICorr President and MD of DCS UK Ltd.)

We look forward with excitement to this second round of presentations and subsequent case studies, and know we will have a full complement of young engineers to take part in this interesting and informative programme, I look forward to meeting all who participate.

**Trevor Osborne**

Download the registration form [www.icorr.org](http://www.icorr.org) and email back to sarah.vasey@akzonobel.com before 22nd December 2014.
LONDON BRANCH NEWS

SOMETHING IN THE AIR, TONIGHT

Under the chairmanship of John O’Shea, the London Branch began their new season of technical presentations, with a joint meeting with the London Materials Society (LMS) on 9th October at The Naval Club, Mayfair. This first presentation was provided by Dr Fred Parrett, Director and Owner of Parrett Technical Developments.

Dr Parrett gave a wide ranging presentation on both dead (i.e. dust) and alive (i.e. viruses, bacteria moulds) airborne particles. The general stages for all particle investigations were described, being, determination of sources, identification of health implications, methods of measuring particle levels and finally, effective means of control.

On the subject of dust monitoring and control which could arise from such sources as volcanic activity, metrological upsets, demolition and quarry works, Dr Parrett described the development of the Parrett dust monitoring / sampling pump, together with the particular use of dust suppression in the bulk material handling industry, using fine bubble chemical foam systems.

Also described was the presence of airborne micro-organisms or bio aerosols which can plague the pharmaceutical and food industries, other clean room establishments and hospitals. Dr Parrett described the difficulty to set standards for sampling and control methods and made reference to the Bioaerosols Samplers developed by his company. Dr Parrett mentioned that prevention was the best control, but there were also filters, disinfection of air and UV radiation for control of such airborne particles.

On behalf of the 40+ attendees, a vote of thanks was given to Dr Parrett by Julian Barrett, Hon. Treasurer LMS, after which, all enjoyed the traditional hospitality of the London Branch.

The next Branch technical meeting will be on 13th November 2014, where Hesham Mahmoud (WGIM) will make a presentation on Topline Corrosion and Mitigation. All are welcome at The Naval Club, 38 Hill Street London, at 17.45 for a 18.15 start. Please note that The Naval Club requires gentlemen to wear jacket and tie when attending evening meetings.

LONDON BRANCH NEWS

PROFILE OF DAVID DEACON

David Deacon is a qualified Paint Technologist and after working in the Advisory Department of BISRA and as a Technical Service Manager with Burmah Castrol, he started as a Coating Consultant in 1970 and has now had over 50 years of experience, which has taken him to projects in 57 countries worldwide. His presentation will cover, specifically London structures within the “M25 Belt” and will include both significant coating successes and examination and remedial work of embarrassing coating failures. Some of the structures covered will include the Thames and Barking Barriers, the QE11 Bridge, Tower Bridge Centenary, the refurbishment of the Cutty Sark and the Lloyds Building, as well as Stadia, including the old and new Wembley.

David’s previous presentation to the London Branch in 2009 on similar subjects will give updates where relevant, but will include some new structures, such as the Triplets Project.
THE CALL IS NOW OPEN!

EUROCORR 2015

EARTH, WATER, FIRE, AIR, CORROSION HAPPENS EVERYWHERE!

6-10 September 2015
Graz / Austria

Abstract submission, instructions and the submission tool can be found under
www.eurocorr2015.org

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Phone: +43 3842 402 2290
Fax: +43 3842 402 2292
Email: eurocorr2015@asme.at
WHY STEEL RUSTS?

To make some steel it’s plain to see,
We take some mud, add energy,
And that is why steel simply must,
Do what it can to return to rust.

How it gets to make this trip,
Is simple and without a slip,
Voltage forms upon the plate,
Current passes to its mate.
The bit that’s lower, termed anode.
Accompanies a high cathode.
The anode’s the bit that loses mass,
To the cathode it’s electrons pass.

At the cathode reduction’s a fact,
Oxygen, water, electrons react,
Alkalinity’s what they produce,
O H minus that is of some use.
Completing the circuit the ions must pass,
The electrolyte is the bit that comes last,
And so the circuit completes you see,
Corrosion produces electricity.

For concrete it doesn’t quite work like that,
Steel doesn’t rust and that’s a fact,
A passive film protects, you see,
Because of the alkalinity.

Sometimes in concrete steel does rust,
The passive film we cannot trust,
There’s two things that this can decide,
Carbonation or bad chloride.
Carbonation the pH will fall,
Alkalinity levels hit the wall,
The steel is then able to rust,
Gently and without a fuss.

Repairing this is not too bad,
Replace the loose and you’ll be glad,
The simple thing with carbonation,
Is damage matches contamination.
Now repairing chloride is a tricky thing,
Incipient anodes form in a ring,
Repair the rust without paying heed,
To future repair this will lead.
Contain’ beyond the repair results
in new anodes and new rust,
After a couple of years have passed,
More is needed, they just don’t last.

To deal with chlorides there’s two things done,
Take ‘em all out, the battles won,
But most of the time the price is too high,
Propping, closures, the bills hit the sky.
The other choice is plain to see,
You use electrochemistry,
You take control with a new anode,
And make the steel a shiny cathode.

Don’t worry ’bout contamination,
Just repair delamination,
With cp the salt can remain,
Repairs are cheaper and quicker it’s plain.

And so with thought and a little care,
Anything can have successful repair,
Hope you’ve had an enjoyable time.
Chris Atkins, on a train between Runcorn and London.

If you liked it please consider donating to the Legacy Rainbow House by texting able 14 and an amount to 70070, or look it up on Just Giving. Many thanks, Chris Atkins.

visit the ICorr website
www.icorr.org
INVESTIGATION INTO THE IMPACT OF LITHIUM ADDITIONS ON THE CORROSION RESPONSE OF AL-Cu ALLOYS FOR AEROSPACE APPLICATIONS

David M. Carrick*, pSimon C. Hogg† and Dr Geoffrey D. Wilcox*, †Department of Materials, Loughborough University, Leicestershire, LE11 3TU, United Kingdom

Abstract

Two Al-Cu alloys for aerospace applications, one of which has an addition of between 1.6 and 2.0 wt.% of Li have been investigated for their corrosion properties. The alloys are AA2024-T3 (Al-Cu) and AA2099-T8E77 (Al-Cu-Li). Microstructural analysis via Field Emission Gun Transmission Electron Microscope (FEGTEM) and Field Emission Gun Scanning Electron Microscope (FEGSEM) utilising Energy Dispersive Spectroscopy (EDS) and Electron Backscatter Detector (EBSD) techniques have been used to characterise the two microstructures and phases contained within them. Anodic polarisation and immersion testing in a 3.5 wt.% NaCl solution have been carried out and a comparison of the corrosion mechanisms has been made. AA2024-T3 had a fine, equiaxed grain structure, whereas AA2099-T8E77 had a substantial amount of large recrystallised grains. Immersion testing revealed AA2024-T3 developed small shallow pits and large networks of IGC, whereas AA2099-T8E77 showed small levels of IGC but large pit cavities on the macro scale. Anodic polarisation indicated that AA2024-T3 was more noble, highlighting that the Li-containing AA2099-T8E77 alloy was more susceptible to corrosion. The corrosion pits on AA2099-T8E77 were seen to propagate to a depth of ~ 80 to 110 µm, with a maximum of 126 µm recorded. For AA2024-T3 the maximum depth recorded was 85 µm and the average depth was between 60 and 70 µm following anodic polarisation.

1. Introduction

There has been a recent resurgence in the development of Al-Li alloys, driven primarily by the need to save weight and improve performance of aerospace structures. Development of these as commercial alloys began in the late 1950s with AA2020 [1]. In the 1980s Alcoa’s AA2090 and other second generation Al-Li alloys, such as AA8090 (Alcan), were developed. These, however, never received widespread industrial use due to their poor anisotropy, low fracture toughness, poor corrosion resistance and often manufacturing issues.

Third generation Al-Li alloys, however, have addressed some of the limiting factors behind Li additions. This has been achieved by effectively managing a number of factors, including the control of impurity elements, such as H, Na, K and P that are present during the preparation of Li-containing alloys, as well as using grain refining elements such as Mn, Zr and Zn, which aid in precipitating Li phases away from the GB locations, helping to alleviate issues associated with intergranular corrosion and poor fracture toughness. Reducing the amount of Li and improved casting abilities have also played a significant role in improving fracture toughness and corrosion resistance of Li containing alloys [2]. Henon et al [3] has shown that by altering the artificial aging conditions and the subsequent microstructure of Al-Cu-Li alloys, the susceptibility to intergranular corrosion (IGC) can be reduced.

Li is, however, a highly reactive metal which poses concerns for Al alloy corrosion resistance [4]. However, Li additions offer the advantages of improving specific modulus and strength, provided the Li stays within solid solution and does not precipitate out [5]. The metastable Al-Li strengthening phase (δ’) is the reason for the enhanced mechanical properties. δ’ causes significant planar slip, as such; Zr additions are typically made to disperse the slip through shear resistant Al, Zr dispersoids. These help by assisting in pinning grain boundaries by providing a strong obstacle to dislocation movements during thermal and mechanical processing of the alloy [6].

Copper has been shown to have a significant impact on the strength and hardness of age-hardening Al alloys. Cu is more noble than Al but by increasing its concentration, a major anodic shift in open circuit potential (OCP) will occur [7]. The S-phase (Al,Cu,Mg) that exists in 2XXX series alloys also promotes corrosion due to the heterogeneous Cu distribution [8], [9]. Localised galvanic cells are therefore developed between Cu rich intermetallic particles (IP) and Cu depleted matrix regions.

Ren et al [10] observed a change in the OCP of the S-phase, related to the preferential dissolution of Mg and enrichment of the Cu on the surface of a solid S-phase specimen galvanically coupled to pure Al. A similar mechanism was also seen to take place with regards to the T1-phase (Al,CuLi) in Li containing alloys, where the Li became active causing the Cu to become noble [10]. Micro-segregation of Cu impurities has also been observed to increase the tendency of pit formation at OCP [11].

Copper is a metal frequently alloyed with Al-Li systems to form strengthening precipitates. Typically these are in the form of T1 (Al, Li) or (Al,Cu,Li), and (Al,Cu) [1], [11]–[14]. These θ-type and T-phases are, however, known to be detrimental to alloy corrosion resistance [15]. This is related to the potential differences between the Li and Cu contents. It has been shown that when these phases are subjected to an aggressive ionic species such as Cl ions, the Li will be preferentially dissolved. Once the Li has been removed, the Cu re-distributes over the surface of the Al alloy [11]–[13]. Ma et al [6] examined an AA2099 alloy and found that rod like Al-Cu-Mn-Li dispersoids (~1 µm x 200 nm) and spherical Al,Zr dispersoids (25–30 nm diameter) were present.

The T1 phase is the main strengthening phase in Al-Cu-Li alloys and as such its impact on corrosion properties is highly important. It has a tendency to precipitate towards the sub-grain and grain boundaries (GB) which can cause issues with IGC, however, grain refiners can help to precipitate these phases into the bulk of the grains. This process can cause an electrochemical shift in the potential of the grain compared to surrounding grains and has been noted to potentially be the cause of selective grain dissolution [16], [17].

Questions regarding whether the Li or the Cu is the main contributing factor behind the poor corrosion resistance noted in Al-Cu-Li alloys still need answering. This paper will discuss some findings related to this question.

2. Experimental procedure

This study investigates AA2024-T3 and AA2099-T8E77, termed alloy 1 and alloy 2 respectively. The nominal composition of each is shown in Table 1. Both were supplied as plate, from which samples of ~ 2 mm in thickness were cut. The rolling orientation was noted and the normal direction analysed. Specimens were mechanically prepared ground to 1200 grit using SiC paper in de-ionised water. All samples were then rinsed in de-ionised water and ultrasonically cleaned. Specimens were then tested immediately after preparation. All
experiments examined a 1 cm² exposed area and were conducted at room temperature (~20°C) in quiescent conditions.

Anodic polarisation and immersion tests were carried out using a 3.5 wt.% NaCl solution made with de-ionised water. For immersion testing samples were mounted in conductive Bakelite so a connection to the sample could be made and a 1 cm² area was exposed using lacomit varnish to avoid any galvanic interference from the Bakelite mount. A minimum of ten samples were examined for 96 hours during immersion for both alloys to ensure a high degree of accuracy. A BOB 8 data logger running PicoLab software was used to record the change in OCP every minute. Upon completion samples were rinsed with de-ionised water and then ultrasonically cleaned in de-ionised water to remove any NaCl on the surface.

For anodic polarisation a Solartron ECl 1286 potentiostat connected to a computer running CorriWare software was used to monitor the anodic polarisation. A three electrode cell was utilised with a working electrode (Al alloy), Ag/AgCl reference electrode and Pt counter electrode. Specimens were immersed for 300 s to record the change in OCP with respect to OCP. Following polarisation and immersion, samples were cross-sectioned and polished to a colloidal silica finish (0.25 µm) to examine the corrosion rate of 30 mV/min was utilised, from -100 to 500 mV with respect to OCP. Following polarisation and immersion, samples were cross-sectioned and polished to a colloidal silica finish (0.25 µm) to examine the corrosion rate. Image software was also used to examine the size and distribution of the IP within the matrices of the two alloys. An FEI Tecnai F20 FEGTEM with high angle annular dark field (HAADF) and EDS facilities was also utilised to examine the precipitates and GB locations. A Thermo Scientific K-Alpha XPS (X-ray Photoelectron Spectroscopy) was used to examine the oxidation behaviour of pre-immersion and prolonged immersion test samples.

### Table 1: Nominal compositions of AA2024 [18] and AA2099 [19] [wt.%].

<table>
<thead>
<tr>
<th>Elements</th>
<th>AA2024</th>
<th>AA2099</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>3.8 – 4.9</td>
<td>2.4 – 3.0</td>
</tr>
<tr>
<td>Li</td>
<td>/</td>
<td>1.6 – 2.0</td>
</tr>
<tr>
<td>Mg</td>
<td>1.2 – 1.8</td>
<td>0.1 – 0.5</td>
</tr>
<tr>
<td>Fe</td>
<td>&lt; 0.5</td>
<td>0.07</td>
</tr>
<tr>
<td>Zn</td>
<td>&lt; 0.25</td>
<td>0.4 – 1.0</td>
</tr>
<tr>
<td>Mn</td>
<td>0.3 – 0.9</td>
<td>0.1 – 0.5</td>
</tr>
<tr>
<td>Zr</td>
<td>/</td>
<td>0.05 – 0.12</td>
</tr>
</tbody>
</table>

### 3. Results and Discussion

Prior to any corrosion analysis, characterisation of the alloys and their respective IPs was conducted. EDS analysis revealed that alloy 1 contained two types of IPs; the first rich in AI (90 at.%) and Cu (~4 at.%) with traces of Mn, Fe and O (< 1 at.%) and the second containing Al, Cu, Mn, Fe and Mg. Approximately 80% of the particles analysed were less than 2 x 2 µm, however, ~ 4% of the particles analysed were in excess of 15 x 10 µm, some were seen to be even in excess of 18 x 14 µm. For alloy 2, only one type of IP could be identified, this was an Al (~65-85 at.%), Cu (~2-9 at.%), Mn (~5-10 at.%), Fe (~5-10 at.%) and Zn (~1-30 at.%) system. It was seen for these particles that ~ 80% of them were also less than 2 x 2 µm, however, some were in excess of 16 x 8 µm but these were very rate occurrences. The volume fraction (νv) of IP on alloy 1 was shown to be substantially greater than that seen on alloy 2 and the size of the particles in general was also shown to be greater in alloy 1. Care must be taken in determining the νv, however, as using Image J analysis software, surface contaminants can be identified as particles.

EBSD analysis showed a relatively homogenous grain size for alloy 1. Analysis also showed that the grain size was relatively fine, with the largest recorded having a diameter of 40 µm. Compared to alloy 2, some sub-grains were observed, however, the vast majority of the microstructure was comprised of extremely large recrystallised grains. Figure 1a and 1b illustrate alloy 1 and alloy 2 microstructures respective. For alloy 2 the largest grain diameter seen was 330 µm, however, this did not encompass the entire grain as it spanned an area greater than the maximum detection limit for EBSD analysis. The smallest grains observed for alloy 2 were 100% greater than those observed in alloy 1. The reason behind this difference is due to the aging cycle conducted on alloy 2 to help alleviate GB precipitates. Both alloys undergo solution heat treatments and strain hardening, however, alloy 1 is then naturally aged, whereas alloy 2 is artificially aged [20].

FEGTEM analysis also confirmed that alloy 1 had smaller grains than alloy 2. Characterisation of alloy 1 showed that Cu rich films were present on the GBs; these films were discontinuous, however, some were seen to be between 500 nm and 1 µm in length. Alloy 2 also revealed Cu rich films forming on the GBs, but the νv was less than that seen for alloy 1, however, the longest region of particles recorded was close to 800 nm. Analysis of these films showed they comprised of θ and θ' precipitates in a close proximity. Care must be taken in determining these results, with the νv of Cu-rich particles on the GBs appearing...
to be greater on alloy 1, but this could be because more grain boundaries were visible per selected area.

Analysis of the precipitates present within the matrix, showed that those in alloy 1 were rich in Al-Cu-Mg-Fe-Mn but Al-Mg-Mn-Si particles were also observed. These precipitates were blocky and rectangular in morphology. Figure 2a and 2b show micrographs of the precipitate distribution and Cu rich films in alloy 1. Figure 2c also shows the Cu rich precipitates and films present on the GB regions in alloy 2.

In comparison alloy 2 exhibited particles rich in Al-Cu-Mn and S phase. The $T_1$-phase was also identified throughout the matrix and close to grain boundaries. The $T_2$-phase is shown in Figure 2d as plate like in shape and was ~ 100 nm in length. The $T_2$-phase is well documented to have a detrimental impact on the corrosion resistance of Al alloys; therefore the large population of $T_2$ precipitates could be responsible for a reduction in corrosion resistance and selective grain attack.

### 3.1 Corrosion Analysis

Immersion testing of both alloys shows that alloy 1 has a more noble OCP than that of alloy 2. Figure 3a shows the OCP recordings for both alloys over a 96 hr period. Interestingly at the start of immersion the potential for alloy 1 shows a reduction from ~ -622 mV±7 mV up to ~ -600±3 mV within the initial 15 minutes of immersion. The potential for alloy 2, however, shows an increase in potential from ~ - 650±7 mV to -685±3 mV within 20 minutes of immersion. This shows that the initial reactions taking place on the surface of the two alloys are different. Using information from Vargel et al [20] we can see that alloy 1 is undergoing passivation whereas alloy 2 is showing signs of attack in the initial immersion periods.

Over the initial 24 hrs, both alloys show stable OCP with minor fluctuation throughout, which is to be expected. Macro observations of the surface show evidence of attack and oxidation on both alloys. No evidence of pitting corrosion or IGC can be seen on alloy 1, whereas on alloy 2, substantial pitting corrosion cavities can be observed.

After 48 hours, differences between the OCP profiles can be seen with alloy 1 tending towards the potential of alloy 2, which has not shown any change in its OCP remaining stable close to -685 mV. Macro observations continue to show large millimeter sized pit corrosion cavities on alloy 2. On alloy 1, similar results are also observed with a darkening of the surface, showing increased levels of attack taking place, but still no significant visible pitting corrosion can be seen.

This process continues to take place on both alloys up to the end of the 96 hr immersion study. Over time the sizes of the pit cavities seen on alloy 2, show a slight increase, however, the growth of the pits does not appear to be exponential and after the initial 24 hrs appears to show a very slow and gradual increase in attack. Similarly on alloy 1, no pitting corrosion can be seen; however, it is very evident that significant levels of attack have taken place on the surface.

With regards to the OCP trends, after 48 hrs alloy 1, shows a continual reduction in potential up to 96 hours. Over the 96 hr immersion period the potential was shown to increase by ~ 150 mV for alloy 1, whereas alloy 2, has shown a very stable OCP with small fluctuations throughout the 96 hr immersion period. The final potential recorded for alloy 2 was ~ -685 mV, which is what the potential was after 20 minutes of immersion. These plots can predict the level of attack, however, they suggest that alloy 2 has a higher resistance to attack, but following visual and FEGSEM inspections it is clear that this is not the case. The increase in potential of alloy 1, is more likely to be attack of the IP particles present within the matrix and since the $v_f$ of IP in alloy 1 is more substantial than that of alloy 2, the OCP plots will be recording the activity of the IP themselves instead the overall AI alloy potential.

FEGSEM analysis on alloy 1 samples, showed extensive galvanic attack of Cu rich IP, with a large number of pit initiation sites being seen on the surface, some with remnants of IP present, as shown in Figure 3b. EDS analysis confirmed that these sites were rich in Al-Cu-Mg-Fe-Mn. Mg rich particles also showed a higher resistance to attack suggesting Mg de-alloying through sacrificial cathodic protection. Also seen in Figure 3b are ring patterns surrounding the pit nucleation sites. These rings are the remnants of corrosion product ‘domes’ that form on the surface following hydrogen evolution from the breakdown of the Al alloy. These ‘domes’ are scattered over the surface of alloy 1 and with increasing immersion time they increase, however, there physical size does not ($Ø = ~ 100 \mu m$).

Alloy 2, showed similar features with Cu rich IP being the preferential sites for attack, however, due to the reduced $v_f$ of IP it is thought that they were not the primary contributing factor to the corrosion that took place. It was observed that smaller features were also acting as anodic sites within the matrix (similar sites were observed on alloy 1 also), as shown in Figure 3d. Ma et al [6], observed a similar behavior and showed that pit regions of a similar size were formed from Al-Cu-Fe-Mn constituent particles. Ma et al [6] also showed that nanometer sized Al-Cu-Mn-Li dispersoids were linked to the propagation of the pitting corrosion. The ‘domed’ features seen on alloy 1, were also seen on alloy 2, however, their frequency was much less. The majority of pit cavities seen, showed very little corrosion product, suggesting very quick breakdown of material with the material going into solution. The largest pit site seen was over 3 mm in length and 500 µm wide, compared to those seen on alloy 1, where the ‘domes’ had a diameter of ~ 100 µm as shown in Figure 3d.

Cross sectioning of alloy 1 showed clear IGC which over time became substantial networks progressing below the surface. Pit nucleation sites, below the ‘domes’ were seen to only progress to a maximum depth of 16 µm as seen in Figure 3c. In comparison alloy 2 showed extensive pitting corrosion, progressing to ~ 40 µm after 96 hrs of immersion. Coupled with the large scale surface cavities observed, large scale mass material removal takes place on alloy 2, whereas on alloy 1, a friable, weakened layer forms close to the surface that could cause catastrophic failure of an industrial component. IGC was also observed on alloy 2 but it was not as readily visible, but this could be due to the frequency of GB regions. Interestingly, however, alloy 2 demonstrated selective grain attack, as shown in Figure 3e, which literature suggests is related to the $v_f$ of $T_1$-phase precipitates within the selected grain [16], [17].

XPS was conducted on the surface pre and post immersion and a comparison of the retrospective Al metal [Al(m)] and Al oxide [Al(ox)] peaks was conducted to examine the rate of oxidation growth. Figure 4 shows the difference between the two alloys for pre-immersion, after 24hrs and 96hrs of immersion. It is believed that an increased level of oxidation could signify increased levels of attack, due to oxygen being a primary component in the corrosion products that form on an AI alloy. The results showed that over time the overall surface chemistry being associated with the Al and O peaks stayed the same, suggesting the formation of uniform corrosion layer. The counts / second, however, changed and with time, clear differences between the oxidation behaviours of alloy 1 and alloy 2 could be seen. After 96 hrs alloy 2 showed a similar level of Al(m) content to that of alloy 1 after only 24 hrs. This suggests a higher degree of attack on alloy 1, which is exactly what is observed with regards to IP galvanic cell formations. Since alloy 2 has a smaller $v_f$ of IP, a reduced level of oxidation is expected and is what is observed.

Figure 5a shows the anodic polarisation resistance curves of both alloys. The difference between pitting potential ($E_{pit}$) and the free corrosion potential or OCP ($E_{corr}$) provides an
estimation of the corrosion resistance of the alloy, in that the greater the difference, the more corrosion resistant the alloy [20].

The more noble nature of alloy 1 to alloy 2 shows it to be more corrosion resistant, agreeing with theory [20]. Figure 5a. also suggests that alloy 2 will pit more readily, due to its E_{pit} value being more negative than that of alloy 1. The number of corrosion sites noted on alloy 1 was similar to that of alloy 2, however, cross sectioning revealed that the pit sites on alloy 2 propagated to a depth of ~130 µm whereas on alloy 1 the maximum depth recorded was ~85 µm. This was expected, with the increased current density being passed for alloy 2, demonstrating a larger amount of charge for the same time period.

IGC was observed on alloy 1; however, it was not readily seen on alloy 2. The pits on both alloys in general were a similar size (~100 x 100 µm). Both alloys showed characteristic crystallographic pitting corrosion, with pit growth leading to the majority of these combining to form large scale corrosion regions. Intragranular was also observed on both alloys following anodic polarisation as shown in figure 5b. Figure 5c shows a cross section of alloy 2 looking in the longitudinal plane showing the depth of attack.

The results from immersion and anodic polarisation confirmed that Cu containing Al alloys have a poor corrosion resistance. Cu is a noble metal [7], [20] and as such causes an anodic shift in the electrochemical activity of the surrounding Al-rich matrix, reducing the overall corrosion resistance. Of the phases that are detrimental to corrosion, alloy 1 has the potential to include a number; α’, and the Σ-phase, whereas alloy 2 could also include; δ’ and T₁-phases. XPS showed a higher tendency for alloy 1 to oxidise, depth profiling information is, however, required to assess whether this oxidation is uniform in thickness, but also whether it is thicker on alloy 1 compared to alloy 2.
4. Summary

Two Al-Cu alloys have been examined: AA2024-T3 and AA2099-T8E77, the latter containing Li. Immersion testing and anodic polarisation have been conducted to examine the corrosion properties of each and the potential effect of Li on the corrosion resistance of 2XXX series Al alloys. It was found that when compared, both alloys formed crystallographic pitting corrosion as well as intergranular corrosion. AA2099-T8E77 was, however, seen to be more prone to pitting corrosion with a more negative \( E_{corr} \) and \( E_{pitting} \). Cross-sectioning of the alloys following prolonged immersion testing and anodic polarisation reaffirmed this with the corrosion pits on AA2099-T8E77 propagating to a maximum depth of 126 µm whereas on AA2024-T3 the pits only grew to a depth of ~85 µm after anodic polarisation. AA2099-T8E77 showed pits of ~40 µm deep, 3 mm in length and 500 micron wide after 96 hrs of immersion, compared to 16 micron deep on AA2024-T3 for the same time period. AA2024-T3 did, however, show mass networks of IGC below the surface. Prolonged immersion testing showed that AA2099-T8E77 has a relatively stable OCP, which although showed minor fluctuations stayed at a potential close to -685 mV. AA2024-T3, however, showed an ever increasing potential traversing from -600 mV to -790 mV over a 96 hr period. This was believed to be associated difference in the volume fraction of IP within AA2024-T3. Hydrogen bubbles were seen to sit on the surface of both alloys during immersion, but more so on AA2024-T3, forming ‘domes’ of corrosion product. XPS also showed that AA2024-T3 had a higher degree of oxidation on the surface, which was expected due to the large grain size in AA2099-T8E77.

AA2024-T3 also showed a higher degree of oxidation following XPS analysis, due to the reaction of the large volume fraction of IPs within the matrix.

6. Acknowledgements

D. M. Carrick would like to acknowledge the Loughborough University Graduate School for the provision of a studentship and the Department of Materials for the research facilities, as well as Dr Geoffrey Wilcox and Dr Simon Hogg for their supervision and guidance through this project. A special note must also be given to a past friend Mr Keith Padgett.

7. References


DENSO PROTAL CHOSEN FOR NATIONAL GAS GRID PROTECTION

W.G.Beaumont & Son Ltd of Romford are a chosen contractor for National Gas Grids for applying surface coating protection of weld joints and fittings in refurbishment programmes carried out in various areas of the UK.

A typical contract for National Grid carried out by W.G.Beaumont using Denso Protal 7300 is shown in the photographs. Once the pipe support was removed, the pipe was blasted to Sa2 1/2 and two coats of Denso Protal 7300 was applied. The support itself was blasted, painted and neoprene rubber fitted before replacing it to its original position. On the pipe risers W.G.Beaumont removed the existing coating, blasted to Sa2 1/2 and applied two coats of Protal 7300 to a minimum of 500mm above and below ground. These areas were then ready to be overcoated as per National Grid’s specification.

The company uses Denso Protal 7300 on all projects. This was recently developed by Winn & Coales (Denso) Ltd to enable it to be applied to wet, damp or dry surfaces – which is a great asset in Britain’s unpredictable climate. Denso Protal 7300 is a VOC free, 100% solids epoxy high build liquid coating that can be applied by applicator pad, brush or roller in one coat. It achieves up to 1250 microns in this single coat to give excellent gouge, abrasion and impact resistance.

DENSO TAPE SYSTEM PROTECTS NATIONAL GRID NON-RETURN VALVES

A Winn & Coales Denso Tape system has been chosen to give corrosion protection to three large non-return valves at the National Grid Carnforth Compressor Station in Lancashire.

The contract for this project was carried out by the civil engineering company J Anderson & Son Ltd (JAS) based in Wath on Dearne, Rotherham, South Yorkshire. JAS has been supplying a service to National Grid for 35 years.

JAS began this project by removing the valve pit lids and arranging scaffold access so the existing bolts retaining the valves could be removed along with the old Denso Paste. They then brought in heavy cranes to lift out the existing valves and replace with new before National Grid bolted them back into place.

On completion of these works JAS then repacked the voids around the bolts with new Denso Paste followed by Denso Profiling Mastic to give a smooth uniform surface. Denso Tape was then applied in an overlapping format, followed by a final Denso PVC outerwrap.

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Email: enquiries@tinsleyspecialproducts.com
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Workplace training is carried out by ICATS certificated trainers who are qualified to train and assess operatives. Training is carried out in-house and may be undertaken by a certificated trainer employed by an ICATS registered training organisation. However it is more usual for registered companies to nominate experienced employees to ICATS for prior approval as company trainers. Subject to meeting the acceptance criteria, nominees attend a 2 day ICATS Company Trainer course held at various locations in the UK.

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<td>Unit D, East Shibdon Business, Cowen Road Blaydon, Newcastle-Upon-Tyne, NE21 5TX</td>
<td>0191 414 5700</td>
</tr>
<tr>
<td>Matthew James Services</td>
<td>Unit 4, Shiddon Business, Cowen Road Blaydon, Newcastle-Upon-Tyne, NE21 5TX</td>
<td>0191 414 5700</td>
</tr>
<tr>
<td>Mark Smith Inspection Services Ltd</td>
<td>14 Seaham Close, South Shields, Tyne &amp; Wear, NE34 7ER</td>
<td>0191 456 9925</td>
</tr>
<tr>
<td>MCL Coatings Ltd</td>
<td>Pickering Road, Halebank Industrial Estate, Widnes, Cheshire, WA8 8XW</td>
<td>0151 423 6166</td>
</tr>
<tr>
<td>Miller Fabrications Ltd</td>
<td>Baronhall Works, Overtown Road Wishaw, Lanarkshire, ML2 8EW</td>
<td>01698 373770</td>
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<tr>
<td>Moore Steel Developments Ltd</td>
<td>Station Road, Thorley, Peterborough PE6 0QE</td>
<td>01733 270729</td>
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<tr>
<td>New Image Contracts Ltd</td>
<td>Askern House, High Street, Askern Doncaster, DN6 0AA</td>
<td>01302 708070</td>
</tr>
<tr>
<td>N L Williams Group Ltd</td>
<td>Westside Industrial Estate, Jackson Street, St. Helens, Merseyside WA9 3AT</td>
<td>01744 265262</td>
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<tr>
<td>Northern Protective</td>
<td>16 High Reach, Fairfield Industrial Estate, Bill Quay, Gateshead, Tyne &amp; Wear, NE10 0UR</td>
<td>0191 438 5555</td>
</tr>
<tr>
<td>NSG UK Ltd</td>
<td>Fourth Avenue, Deeside Industrial Park, Deeside, Flintshire CH5 2NR</td>
<td>01244 833138</td>
</tr>
<tr>
<td>Nusteel Structures</td>
<td>Lympne Industrial Estate, Lympne, Hythe, Kent, CT21 4LR</td>
<td>01303 268112</td>
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<tr>
<td>Offshore Marine Services Ltd</td>
<td>Brumby House, Jalan Bahasa, PO Box 80148, 87011 Lubuan F.T. Malaysia</td>
<td>+6356214244410</td>
</tr>
<tr>
<td>Optimal Rail Ltd</td>
<td>Unit 5, Moorgate Crofts Business Centre Alma Road, Rotherham S60 2DH</td>
<td>01709 331153</td>
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<tr>
<td>Ormac Coatings Ltd</td>
<td>Newton Chambers Road, Thorncliffe Park Estate, Chapeltown, Sheffield, S35 2PH</td>
<td>0114 246 1237</td>
</tr>
<tr>
<td>Over Rail Services Ltd</td>
<td>Unit 10 Millhead Way, Purdyd Industrial Estate, Rochford, Essex, SS4 1ND</td>
<td>07976372866</td>
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<tr>
<td>Paint Inspection Ltd</td>
<td>Milton House, 7 High Street, Fareham PO16 7AN</td>
<td>0845 4638680</td>
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<tr>
<td>Paintel Ltd</td>
<td>Trianon, Westover, Ivybridge, Devon, PL21 9JH</td>
<td>01752 719 701</td>
</tr>
<tr>
<td>Painting &amp; Labour Services Ltd</td>
<td>Unit 1, Queens Road, Immingham DN40 1QR</td>
<td>01469 578105</td>
</tr>
<tr>
<td>PCM Nigeria Plc</td>
<td>99 Rivoc Road Trans Amadi, Port Harcourt, Rivers State, Nigeria</td>
<td>+2348055297828</td>
</tr>
<tr>
<td>P H Shotblasting &amp; Spraying Services</td>
<td>43a Drumraine Road, Castlecaulfield, Dungannon, Co Tyrone, BT70 3NY</td>
<td>028 8776 7722</td>
</tr>
<tr>
<td>Pipeline Induction Heating</td>
<td>The Pipeline Centre, Farrington Road, Rosendale Rd Industrial Estate, Burnley BB11 S3W</td>
<td>01282 415323</td>
</tr>
<tr>
<td>Port Painters Limited</td>
<td>Unit 3, Ringside Business, Hoel-Y-Rhosog Cardiff, CF3 2EWx</td>
<td>02920 777070</td>
</tr>
<tr>
<td>Company Name</td>
<td>Address</td>
<td>Telephone</td>
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<tr>
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<tr>
<td>Possilpark Shotblasting Co Ltd</td>
<td>Dalmarnock Works, 73 Dunn Street, Glasgow, G40 3PE</td>
<td>0141 556 6221</td>
</tr>
<tr>
<td>Prestec UK Ltd</td>
<td>168 Birmingham Road, Shenstone Wood End Staffs W514 0NX</td>
<td>0121 308 8001</td>
</tr>
<tr>
<td>Pro Steel Engineering Ltd</td>
<td>48a Severnbridge Industrial Estate, Symondscilffe Way, Caldicot, Monmouthshire, NP26 5PW</td>
<td>01292 424949</td>
</tr>
<tr>
<td>Pyeroy Limited</td>
<td>Kirkstone House, St Omers Road, Western Riverside Route, Gateshead, Wear, NE11 9EZ</td>
<td>0191 4932600</td>
</tr>
<tr>
<td>R H Painting Limited</td>
<td>Alexander House, Monks Ferry, Birkenhead Wirral, CH41 5LH</td>
<td>0870 7892020</td>
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<tr>
<td>R.L.P. Painting</td>
<td>Heathfield House, Old Bawtry Road, Finningley, Doncaster, DN9 3DD, UK</td>
<td>01302 772222</td>
</tr>
<tr>
<td>SCA Group Ltd</td>
<td>Woolsbridge Ind. Park, Three Legged Cross, Dorset, BH2 1 6FA</td>
<td>01202 802820</td>
</tr>
<tr>
<td>Severn River Crossing Plc</td>
<td>Bridge Access Road, Aust, South Gloucestershire, BS5 4BD</td>
<td>01454 633351</td>
</tr>
<tr>
<td>Sherwin-Williams Protective &amp; Marine Coatings</td>
<td>Tower Works, Kestor Street, Bolton, Lancs, BL2 2AL</td>
<td>044 (0) 1204 521771</td>
</tr>
<tr>
<td>Shirley Industrial Painters &amp; Decorators Ltd</td>
<td>Grand Union House, Bridge Walk, Acock’s Green, Birmingham, B27 6SN</td>
<td>0121 706 4000</td>
</tr>
<tr>
<td>Shutdown Maintenance Services Ltd</td>
<td>Kingsnorth Industrial, Hoo, Rochester, Kent, ME3 9ND</td>
<td>01634 256969</td>
</tr>
<tr>
<td>Sitecote Ltd</td>
<td>33 Kielder Close, Ashton in Makerfield, Wigna WN4 0JE</td>
<td>07714678719</td>
</tr>
<tr>
<td>Solent Protective Coatings Ltd</td>
<td>Tredgar Wharf, Marine Parade Southampton, Hants, SO14 5F</td>
<td>02380 221480</td>
</tr>
<tr>
<td>South Staffs Protective Coatings Ltd</td>
<td>Bloomfield Road, Tipton, West Midlands, DY4 9EE</td>
<td>0121 522 2373</td>
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<tr>
<td>Specialist Blasting Services Ltd</td>
<td>Smiths Quay, Hazel Road, Woolston, SO19 7GB</td>
<td>023 80438901</td>
</tr>
<tr>
<td>Specialist Painting Group Ltd</td>
<td>Unit 3 Propser House, Astore Park, Padholme Road East, Fengate, Peterborough, PE1 5XL</td>
<td>01773 309500</td>
</tr>
<tr>
<td>Stainless Restoration Ltd</td>
<td>Unit M1, Adamson Industrial Estate, Croft Street Hyde, Cheshire, SK14 1EE</td>
<td>0161 3686191</td>
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<tr>
<td>Stamford Construction Limited</td>
<td>Barham Court Business Centre, Teston, Maidstone, Kent MW18 5BZ</td>
<td>079112037033</td>
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<tr>
<td>Standish Metal Treatment Ltd</td>
<td>Potter Place, West Pimbo, Skelmersdale, Lancs, WN8 9PW, UK</td>
<td>01695 455977</td>
</tr>
<tr>
<td>Stobbarts Ltd</td>
<td>Tarn Howe, Lakes Road, Derwent Howe Industrial Estate, Workington, Cumbria CA14 3YP</td>
<td>01900 870780</td>
</tr>
<tr>
<td>Story Contracting Ltd</td>
<td>Burgh Road Industrial Estate, Carlisle, Cumbria CA2 7NA</td>
<td>07730 764414</td>
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<tr>
<td>Stream Marine Training Ltd</td>
<td>Kintyre House, St Andrews Crescent, West Campus, Glasgow International Airport, Paisley, PA3 2TQ</td>
<td>0141 212 8777</td>
</tr>
<tr>
<td>Tees Valley Coatings</td>
<td>Riverside Park Road, Middlesbrough, Cleveland TS2 1UT</td>
<td>01642 228141</td>
</tr>
<tr>
<td>TEMA Engineering Ltd</td>
<td>5-6 Curran Road, Cardiff, CF10 5DF, UK</td>
<td>020920 344556</td>
</tr>
<tr>
<td>Tinsley Special Products</td>
<td>Enterprise House, Durham Lane, Eaglescliffe, Stockton-on-Tees TS16 0PS</td>
<td>01642 784279</td>
</tr>
<tr>
<td>T I Protective Coatings</td>
<td>Unit 6, Lodge Bank, Crown Lane, Horwich, Bolton, Lancs, BL6 5HU</td>
<td>01204 468080</td>
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<tr>
<td>Torishima Service Solutions Europe Ltd</td>
<td>Sunnyise Works Gartsherrie Road Coatebridge MLS 2DJ</td>
<td>0123642390</td>
</tr>
<tr>
<td>Transvac Systems Ltd</td>
<td>Monsal House, 1 Bramble way Alfreton, Derbyshire, DE55 4RH</td>
<td>01773 831100</td>
</tr>
<tr>
<td>Vale Protective Coatings Ltd</td>
<td>Building 152 - Langar North Industrial Estate, Harby Road, Langar, NG13 9HY</td>
<td>01949 869784</td>
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<tr>
<td>Walker Construction (UK) Ltd</td>
<td>Park Farm Road, Folkstone, Kent, CT19 5DY</td>
<td>01303 851111</td>
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<tr>
<td>Wardle Painters Ltd</td>
<td>Unit 5, Wimborne Building, Atlantic Way, Barry Docks, Glamorgan, CF63 3RA, UK</td>
<td>01446 748620</td>
</tr>
<tr>
<td>Wescott Coatings &amp; Training Services Ltd</td>
<td>The Quadrus Centre, Woodstock Way, Boldon Business Park, Boldon NE35 9PF</td>
<td>0191 5197380</td>
</tr>
<tr>
<td>W G Beaumont &amp; Son</td>
<td>Beaumont House, 8 Bernard Road, Romford RM7 OHX</td>
<td>01708 749202</td>
</tr>
<tr>
<td>William Hare Ltd</td>
<td>Brandsholme House, Brandsholme Road, Bury, Lancs, BL8 1JJ, UK</td>
<td>0161 609 0000</td>
</tr>
<tr>
<td>Xervon Palmers Ltd</td>
<td>331 Charles Street, Royston, Glasgow G21 2QA</td>
<td>0141 5534040</td>
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</tbody>
</table>

Visit the ICATS website www.icats-training.org
DIARY DATES 2014/2015

Thursday 11th December 2014
26th London Branch Christmas Luncheon
Venue: Royal Over-Seas League, Park Place, St James Street, London, SW1A
Contact: Mike Allen
mike.allen9@btinternet.com

Thursday 8th January 2015
London Branch meeting
Speaker: David Dare, ‘17th Century murder in the church – a forensic examination of an English Civil War crime’.
Venue: Naval Club, 38 Hill Street, London
17.45 for 18.15 start

Monday 15th December - Thursday 18th December 2014
Corrosion Control in the Oil and Gas Industry
Venue: London
Mobility Oil & Gas Petroleum Engineering, Consultancy & Technical Training Services. Upcoming Course.
Contact: +442030867082 or training@mobilityoilandgas.com

Monday 23rd February - Friday 27th April 2015
Advanced Cathodic Protection
http://mobilityoilandgas.com/advanced-cathodic-protection/
Venue: London
Mobility Oil & Gas Petroleum Engineering, Consultancy & Technical Training Services. Upcoming Course.
Contact: +442030867082 or training@mobilityoilandgas.com

Thursday 9th April 2015
London Branch joint meeting with NACE (GB)
Speaker: Geoff White, ‘Case study – measurement of line current as an aid to solving cathodic protection problems’.
Venue: Naval Club, 38 Hill Street, London
17.45 for 18.15 start

Tuesday 21st April - Friday 24th April 2015
Corrosion Control in the Oil and Gas Industry
Mobility Oil & Gas Petroleum Engineering, Consultancy & Technical Training Services. Upcoming Course.
Venue: Houston
Contact: +442030867082 or training@mobilityoilandgas.com

Sunday 3rd May - Thursday 7th May 2015
Advanced Cathodic Protection
http://mobilityoilandgas.com/advanced-cathodic-protection/
Venue: Dubai
Mobility Oil & Gas Petroleum Engineering, Consultancy & Technical Training Services. Upcoming Course.
Contact: +442030867082 or training@mobilityoilandgas.com

London Branch publish a monthly Newsletter; to be included on the circulation list please contact Sarah Vasey sarah.vasey@akzonobel.com

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