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The 2016 calendar is getting away from me and it is now mid-May. The past four months have flown by but I understand that it has now been proved that time does go faster as you get older. At least this has been recently reported in several newspapers.

As some of you may know, your Institute has set up a joint committee with the Marine Corrosion Forum to address the issues associated with new entrants into the corrosion industry. One of the initiatives that this group is following is the presentation of the corrosion industry as a career choice for secondary school pupils. The first of what we hope will be a series of presentations was completed recently by Sarah Vasey at one of the Haberdashers Group of Schools. Planning is now in hand to deliver a series of these presentations to other schools in this group in the Autumn term. There are 10 secondary schools in the group.

The committee is now looking for younger ICorr members to volunteer as presenters for this project and for them to provide their own experience of the corrosion industry to increase the awareness of corrosion as a career choice amongst secondary school pupils who are about to make their choices of options for the GCSE courses and to those who are already studying science for A-Level.

If you are interested in getting involved in this project, please contact Dr Robin Jacob at robjacob@manfarm.demon.co.uk

Other initiatives are also being planned including ICorr attendance at school science fairs and the committee is also looking for volunteers to support an ICorr exhibition stand.

We are just entering the period when you will all receive your subscription renewal letter for the 2016/2017 membership year. This year the letter will also include a reminder for you to apply for your membership lapel badge marking your period of continuous membership.

If you want to receive your lapel badge please contact the ICorr office by telephone or e-mail and the complimentary badge appropriate to your membership will be sent to you.

The latest update regarding the location of the ICorr office is that we are being offered a 12-month lease on suitable office space in a building called Barrett House which is located near to the existing office in Northampton.

While the original intention was to buy suitable premises, the time for us to move is approaching rapidly and the two buildings that were thought to be suitable have been sold to others. Taking a lease on office space in Barrett House will give us some more time to find a suitable long-term accommodation and allow us to move out of the Newton Building this summer.

There are still a few issues to resolve but I am confident that the space in Barrett House will be ready for the office to move in to and due notice of the move will be sent to all interested parties when we are ready.

Finally, I would like to remind you all that the ICorr AGM for 2016 will be held in the Birmingham Council Chamber on Wednesday 30th November 2016. Although this is still several months away I would ask you to keep this date clear in your diary and plan to attend the AGM if possible.

John Fletcher
President of the Institute of Corrosion
AGM & DYNAMIC PRESENTATION

On 3rd March 2016 at Imperial College, Skempton Building, London Branch met for their traditional March meeting. The evening proceedings commenced with the London Branch AGM and reports were presented by Branch Chair, Jim Glynn and Branch Treasurer, Mike Allen. Reports confirmed that the Branch was in good health and had completed, through last year, a full and successful meetings programme; which included both technical and social occasions and had transitioned from the old meeting venue at The Naval Club to Imperial College. Hon Treasurer Mike Allen, provided details of the Branch accounts for Year July 14 -June 15, which indicated judicious use of the monies allocated from Sustaining Membership fees and a healthy surplus arising from the ever popular Christmas Luncheon and concluded with a prediction that the current year would be similar.

A Proposer and Seconder were requested from the attendees and the Branch Committee was encouraged to continue in the same vein for the next year. The Committee is made up of, Chair, Jim Glynn, Hon Treasurer, Mike Allen, Hon Secretary, Paul Brooks, Mash Biagioli, David Dore, Brian Goldie, David Mobbs, Trevor Osborne, John O’Shea, Sarah Vasey, Geoff White, George Winning and Polina Zabelina. Special thanks were offered by Jim Glynn to David Deacon, Derek Hoskins and Mike Moffat, who have all stepped down from the committee after long and dutiful service.

Subsequently after completion of the AGM, Jim Glynn gave the Chairman’s presentation. Jim was introduced by committee member Mash Biagioli, noting Jim’s early days in the optical emission spectrometer (OES) industry, his subsequent setting up of a UK office of a US offshore products and CP design company; and his current position as Beanny Ltd, dealing with protective coatings for the UK onshore industry.

Jim’s presentation provided an entertaining view of coatings and cathodic protection described by Jim as the ‘dynamic duo’ of corrosion protection, presenting successes and failures of both coatings and sacrificial and impressed current cathodic protection systems from his experience. Examples included, poorly fitted pipeline sacrificial anodes, coating disbondment around CP anodes, unsuccessful thermally sprayed aluminium on offshore risers, and successful major ICCP retrofit systems on both bare and coated offshore structures.

A vote of thanks to John was then given on behalf of the attendees, by Past President and Branch committee member, Trevor Osborne and appropriately, the meeting then adjourned to enjoy the traditional hospitality of the London Branch.

Details of forthcoming Branch technical meetings can be found on the ICorr website and in the Diary Date page of Corrosion Management and are held at Imperial College Skempton Building, at 18.00 for an 18.30 start. Enquiries can also be sent to icorrlondon@gmail.com

TOPSIDE MODEL FOR MIC

On 14th April 2016 at Imperial College, Skempton Building, London Branch met for their traditional April joint meeting with NACE UK. Branch Chair, Jim Glynn introduced Dr Matin Momeni of DNV-GL, the speaker for the evening. Matin’s presentation illustrated a new risk based method for assessing microbiological induced corrosion (MIC).

Initially, Matin reviewed the contributing factors to MIC and the existing models that have been used in the past; making the comment that most of these models focussed on pipelines and were difficult to adequately integrate into risk based inspection (RBI) concepts, where as the new model was equally valid for topside structures. In the new model, all the key parameters were identified for inclusion in a 2-step method involving first a screening flow chart and secondly a probability of failure (PoF) ranking tool.

Matin described the benefits of the new model as having the ability to be applied across a complete topside production system, of allowing a fast, audible identification of areas which require detailed assessment and including a consistent ranking tool, which was auditable and easy to update and integrate into a RBI process. At the conclusion of her presentation, Matin responded to numerous questions from the audience which touched on the problems associated with process ‘dead legs’, the correlation of predictions with future inspection findings and how the model would drive the inspection and cleaning regimes required.

A vote of thanks to Matin was then given on behalf of the attendees, by Branch committee member, George Winning and appropriately, the meeting then adjourned to enjoy the traditional hospitality of the London Branch.

The next technical meeting for London Branch is on 13th October 2016. Details of forthcoming Branch technical meetings can be found on the ICorr website and in the Diary Date page of Corrosion Management and are held at Imperial College Skempton Building, at 18.00 for an 18.30 start. Enquiries can also be sent to icorrlondon@gmail.com
ACROSS THE GENERATIONS - JACK TIGHE LTD

Anyone involved in the protective coating industry will have heard of Jack Tighe Ltd, since it is almost 60 years since Jack started his first business in 1954, with £100 loan and a garden shed in Kirton Lindsey, Lincolnshire. From those early days the Jack Tighe Empire has expanded into a multi £million Group of companies, which has been inherited by his children and grandchildren for successive Tighe generations.

The Group Managing Director – Martin Hillyard, provided us with some facts and figures which demonstrated the growth of the Tighe “Empire”. In his first year in 1954 Jack had a turnover of £9,000, which grew by 1982 to £42 million with over 2,500 thousand painters employed within the Tighe Group. At that time Jack decided to sell his company to the HAT Group for a give away figure of 12 £million and part of that sale had a restrictive clause so that he would not be able to continue trading in the paint industry for 5 years from the date of sale. However, his wife ran a small blasting and coating company, called Independent Painting Contractors Ltd, which turned over approximately half a million and Jack continued to assist his wife in the running of that company.

In 1987 Jack became free from those sale restrictions and although there was a national recession at the time, Jack was unphased by this, changed the name of his wife’s company to Jack Tighe Ltd and he re-purchased all of the offices and yards in Kirton Lindsey where he had started his original Empire.

From that re-birth, described by Martin Hillyard as, - “the Phoenix that rose from the Ashes”, the turnover was about half a £million in 1987, when Jack took it back over and it has now risen to in excess of 20 £million at the present time.

The majority of the Tighe contracts have been in the UK, although a number have been carried out overseas, including oil storage tanks for the British Antarctic Survey Agency in Antarctica.

The UK projects have ranged from bridges, power stations, refineries, shipping and naval contracts. The bridges have ranged from small pedestrian structures in confined urban environments, unusual configurations, such as the bridge across the M8 in Scotland (known as the silver twister) and the difficult access structures such as the Runcorn-Widnes bridge in Cheshire.

The shipping vessels have included small tonnage ships up to major Royal Naval vessels such as the Ark Royal and HMS Ocean. The chemical plant and pipeline network includes the complex Lindsey Oil Refinery and the extensive and large diameter Clune Hydro pipeline. More complex public structures and Stadia have included the recent extension at Kings Cross station in London and all the steelwork of the new Wembley Stadium.

Jack’s lifelong contribution to industry in the battle against corrosion was recognised by the Institute of Corrosion when he was presented with lifelong VIP certificate by the President at the 50th Anniversary of the Institute membership held at the Thames Barrier in May 2009 (which the Tighe Group blasted and painted in the 1970’s and is still in good condition today)

The most appropriate and relevant current projects relate to the Olympic 2012 site facilities, which includes bridges, stadia and in particular the architectural orbit which all visitors will see on arriving at the stadium complex in London and which was blasted and painted by the Tighe Group. This is particularly relevant, since in his youth Jack was an Olympic racing cyclist, so it is very fitting that from the original 1948 London Olympics to the London 2012 Olympics it typifies the PCE theme of “Across the Generations”.

The Directors and staff of the Tighe Group of Companies are saddened to announce the death of the founder, Mr Jack Tighe, who died peacefully aged 85 years on 22nd March after a long illness.

Jack Tighe has been in business since 1954 during which time he has built numerous very successful businesses, following a successful career as a national and international track cyclist, representing his country on many occasions.

In his first year in 1954 Jack had a turnover of £9,000, which grew by 1982 to £42 million with over 2,500 employees within the Tighe Group when he sold his company to HAT Group.

A small company Independent Painting Contractors Ltd (IPC) was not part of the sale agreement, so once the restrictive clauses expired he was able to build the company again, in 1990 he changed the name if IPC to Jack Tighe Ltd.

The current Tighe Group of Companies turnover is around £20m per annum and employs 250 people throughout the UK.

In 2009 Jack Tighe was given a life time achievement award by the Institute of Corrosion for being one of only ten people who the institute considered to have been the most influential in the Blasting and Coatings Industry in the past 50 years.

Jack Tighe

"Jack Tighe has been in the coating application business since the formation of BACE in 1959 and was actively involved in the formation of the Yorkshire Branch in the early 1960s. Many of his staff, have supported Institute events, with sponsorship, giving papers and supporting Institute activities."
Although he has been involved with many major contracts, his Company undertook the blast-cleaning and coating of the Thames Barrier Gates at Cleveland Bridge during the 1970s, which has proved to be so successful.

Jack is probably one of the best known names in the coating industry”.

David H. Deacon - 50th Committee Chairman

Not being one to stand still he has actively encouraged his staff to look at ways to expand the business, perhaps it was the sportsman in him and the drive to succeed that has made him successful in anything he turned his hand to.

Throughout his life he has been associated with the application of protective coatings to some of the most iconic structures such as the Millennium Dome, Millennium Stadium, Wembley Stadium, Kings Cross Station, Olympic Structures The Orbit, Kelpies, Hydro Electric Pipelines and Thames Barrier but to name a few.

Business continuity was always in his thoughts and in conjunction with his management team he has structured the group of companies in such a way as to safeguard the jobs of its employees and ensure business continuity upon his demise, in his words “it must be business as normal when I’m gone”.

Jack Tighe will be sadly missed by his family, friends and staff.

visit the ICorr website

www.icorr.org
ABERDEEN BRANCH MARCH MEETING  
PROSERV BIRCHMOSS FACILITY – ICORR INDUSTRIAL VISIT

Demonstrations

On 22nd March 2016, Proserv hosted a series of live demonstrations including their Friction Welding technology (both Hydraulic and Pneumatic Types) used for subsea anode and corrosion monitoring attachment. Also showcased was a subsea pipeline coating removal tool used for pipeline corrosion inspection and wireless through water communication, control and monitoring technology, NASCoM, that is used for corrosion monitoring.

A brief overview of each technology was presented before moving into the workshop for practical demonstrations of the systems and solutions.

Friction Welding (Subsea Hydraulic Type)

The frictional welding(subsea hydraulic type) displayed was an electro hydraulic system utilising a Zetechtics control system and is operated via laptop software.

Friction welding is a process that has been around for many years and used widely in manufacturing where none of the systems are portable. The subsea friction stud welding equipment on display is portable and uniquely able to perform welding onto all types of subsea structures commonly found in the oil and gas, renewable energy and defence industries. The technology is commonly used to replace failing CP systems which have exceeded their life expectancy by welding new connection studs to structures for the attachment of flying leads from remote seabed Anode skids or the direct attachment of discrete anodes for corrosion monitoring sensors. Pressure is applied during both the friction welding process and for a time after the welding process to forge the weld. This results in friction welding having minimal detrimental effects to the fatigue life of the parent material, with the friction weld itself also having an excellent fatigue life.

Friction Welding (Pneumatic Type)

Also on display was a pneumatic powered portable system that is commonly used offshore for topside welding applications.

The system can weld studs up to 16mm diameter where the finalised welds have excellent fatigue life and minimal detrimental effects to the parent material making them great for topside structural applications that are commonly found in late life of field projects in the North Sea. The process takes seconds to complete and it can be performed directly through a variety of coatings. The system has been deployed in Zoned Areas, e.g. in tanks containing residual hydrocarbons for replacement of tank sacrificial anodes. The system can also be deployed by rope access technicians and unlike arc welding can easily be performed in any orientation. This means it can remove the need for scaffolding which may hamper operations on the platform and increase costs. Other applications include cofferdam repairs, blast wall replacement, fastening equipment to decks where there is no access on the rear for a bolted connection and attaching UT, Permasense, or other) sensors to pipework, as per the image below:

PCR Tool (Pipeline Coating Removal)

Proserv showcased an innovative range of pipeline coating removal (PCR) tools. This electro/hydraulic controlled technology deploys a Jupiter Control System and operations can reach depths of up to 3000m, and is controlled via a ROV. All controls are operated from a dedicated laptop using proprietary software.
The normal objective is to remove all coatings for each zone, in a single tool stroke. Weight coatings (concrete) are easily removed but some coating types e.g. FBE can be very adherent and require higher jetting pressures to break the surface bond. In normal operations maximum pressure is up to 36,000 psi with variable flows to achieve optimum removal rates. The PCR tools are also equipped with re-bar cutting capability, this and the HP/UHP Water Jetting process will not damage the substrate or penetrate the pipeline due to stand off protection and activity is fully camera controlled.

It is possible to strip coating for NDT Inspection by UT or other means from Pipeline Diameters ranging from 2in to 56in maximum. The system will easily remove Bio-Growth in advance of coating removal. The tool can also be equipped with modular packages allowing pipe end preparation, bevelling and weld seam removal for scheduled pipeline repairs as well as Emergency Pipeline Repairs (EPR).

NASCoM (Acoustic CP Monitoring Device)

The NASCoM system offers an alternative to hard-wired umbilical CP monitoring systems (that are easily storm damaged), or an ROV wet-mate connection/ intervention.

In operation, the system sends coded messages between fixed transmitters and a portable receiver Transducer (pictured). Transmission is 85% effective in underwater structures (due to structural reflections) and 99% effective in open water. Normally readings would be taken in slack water conditions.

A typical multi-platform installation might have 9-10 acoustic monitoring points to assess ICCP Potential levels and the system can be set-up to Auto-sample CP data. The acoustic transmitters are affixed to structure and mounted in corrosion proof plastic housings.

All monitoring is controlled from Topsides.

The April 2016 meeting was a joint session with the MCF at the palm court hotel Aberdeen. After a safety brief, the branch chair introduced the ICorr president John Fletcher. John gave a short update on the institute and service life. He highlighted pertinent design features that were essential for good coating performance such as avoiding sharp edges and complex structures. He explained that labour was the major cost in new build projects with coating accounting for just 1% of total cost but that it remained essential in increasing the service life and that improper application could result in expensive recoats during operations. He further explained various industry problems such as improper understanding of coatings, lack of proper risk assessments and inaccessibility of areas of coating during service. He explained that standards could be vague and difficult to understand with numerous issues with specifications which were typically generic. Finally, he outlined typical content of a coating specification highlighting problems in requirements for Dry Film Thickness (DFT), coating application processes, inspection validation etc.

Following the presentation, there were questions on client expectations on coating performance, measurements of DFT, coating system application (one coat vs two coats) and discussions on how coating performance can be improved.

For information about the Aberdeen branch activities please contact our branch secretary via 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.
The disadvantages of biofilm formation are: (i) they form a better thermal insulator than calcium carbonate; (ii) MIC under biofilm leads to corrosion and pitting and (iii) biofilms lead to increased friction and resistance to free-flow, hence reducing heat transfer.

Next, Chris Parsloe, Parsloe Consultants and Pam Simpson, WWTL, gave a paper on, “Pre-commissioning Cleaning Process and What ‘Protective Bacteria’, has been developed as a ‘bio-coating’. The essential ingredients are: (i) organic compound such as Si(OC2H5)4; (ii) NH3; (iii) NaHCO3; (iv) Na2CO3; (v) NaCl; (vi) Na2SO3; (vii) chemical retarder; (viii) pH control. The process is defined as “The process of bringing the system into a satisfactory state”. For this to be true, the system needs to be free from debris, dirt and particulate matter, e.g. weld rods, coke cans(!) etc. If flow velocity is too low, any solids present will settle in the pipe; if too high, turbulent flow leading to erosion corrosion in the presence of oxygen, may occur. Factors affecting the rate of corrosion were then given and include: amount of dissolved oxygen; temperature; galvanic potential differences; pH; CO2 level; suspended solids; chloride; sulphate; bacteria; flow velocity; surface condition and stress. The effect of temperature on bacteria was then discussed – below 20°C, bacteria are slow to grow (or dormant), at 30 – 35°C, bacteria grow at their fastest rate whereas above 50°C, bacteria die or produce protection spores.

Next up, Alan Edwards of Alan Edwards and Partners spoke on, “The Role of CSCA in Improving Management of Water Quality”. Their objectives are, “To maintain clean conditions which will assist in maintaining efficiency and prolong the life of the system”. Problems which might arise include: insufficient plant data, poor-quality pre-commissioning cleaning, confusion on handover, poor or lack of prior record keeping – losing track, “invasion” from dead legs, inhibitor degeneration, biocide degeneration, glycol degeneration and undetected water-loss. If the water treatment is correct, “strainers” should not be needed. “Milestone” Standards include: BSRIA AG2/93, BSRIA BG29/2012, BS 8552/2012 and BSRIA BG50/2013. Mr Edwards then announced the imminent formation of CSCA (Closed System Control Association) whose objective is to maintain standards in closed circuit heating/cooling systems.

Robert Moorcroft, School of Materials, University of Manchester, presented a lecture on behalf of Prof. Robert Akid on, “Non-Biocidal Anti Fouling Coatings”. A sol-gel (solution of carbon or metal-oxygen groups which cross-link to form a stable gel), in conjunction with ‘protective bacteria’, has been developed as a bio-coating. The essential ingredients are: (i) organic compound such as Si(OC2H5)4; (ii) water which hydrolyses the ethyl group to form a polymer and (iii) acid (H+) to promote hydrolysis. Although bio-coatings may cure at room temperature, curing can take place at 90°C without impairing the viability of endospores added to the coating. The result is a biocide-free approach which is a combination of an anti-corrosion sol-gel coating and non-pathogenic protective bacteria. Successful field trials have been carried out in collaboration with King Fahd University of Petroleum & Minerals at Half Moon Bay, KSA, Plymouth Marine Laboratory (PML), UK and Sheffield Hallam University at Whitby Harbour, UK.

Les Bekesi of Lendlease addressed, “Design, Installation and Protection of Closed-Loop Systems”. When designing a system, what materials are being used together with their compatibility and with the water treatment. The effect of banned products like lead solder on potable water are obvious, but flux is known to promote bacterial growth. Similarly, EPDM flexi-hoses, approved by WRAS, banned by the NHS for potable water, but used all over for non-potable systems, will promote bacterial growth. Unfortunately, it is not possible to introduce water into systems until the last minute as walls and ceilings need to be closed. Testing and proving must be completed prior to the end of the project. Finally, it must be ensured that the contractors used to clean the system are competent and the results of their actions need to be checked.

In the afternoon session, there were meetings of the CED working groups: Nuclear; Coatings;...
The presentation centred around what the offshore industry was facing in the light of the current difficult conditions especially related to assets, skills shortages and slump in oil prices. The detail of the presentation was where we have come from, where we are now and the very important question of where the offshore business was going and how future integrity of offshore assets might be maintained beyond their design life.

Around 1975 there was major development in the North Sea but after 15 years and oil price of $20/barrel the oil majors found it no longer economically attractive.

- No CAPEX
- Maintenance budget were slashed
- Low staff morale
- No training and lack of recruitment
- Offshore assets were being run down

The government started pumping money into the offshore business just to keep it going and there was a resultant increased focus on cost reduction.

This all led to the ‘Rise of the Minnows’ and companies such as Talisman which rapidly grew through acquisition of assets:

- 4 operating sites in 1999
- 14 platforms and 1 FPSO by 2008
- ~ 2800 km subsea pipe
- 2 oil terminals

As some of these assets were in need of repair Risk based management was required.

Example of extension of asset life was given by the example of Flotta Oil Terminal. Commissioned in 1977 with a design life until 2010 has now been extended to 2030.

In what was termed the ‘complacent years’ between 2000-2014 the high oil price meant that there was little or no control on overheads there was a contracting culture which in turn meant that there was little staff loyalty.

Then the year that would not be forgotten ‘2015 annus horribilus’. Brent crude prices crashed by 50% and this resulted over the next years with 65,000 jobs being lost, 15% of the workforce. Capex dropped by £2-4 bn/yr but ironically North Sea oil production increased.

The presentation then shifted to why had the oil price crashed. Various reasons were explained:

- Supply outstripping demand
- Geopolitics
- Drop in demand from China & India
- US Shale Oil/Gas
- OPEC games
- Iran back on Stream
- Russia v the west

Etc.

This led to where is the offshore business going. Sir Ian Wood estimated that ~40bn barrels of reserves are still in the North Sea oil fields with 12-24 bn barrels recoverable in next 30 yrs. The focus needs to be on retention of existing infrastructure to access these reserves with new technology to maximise efficiency and develop a new breed of engineers who are willing to exploit the future of this business.
ABSTRACT

External corrosion is a well-known threat to structural integrity of buried pipelines in the oil and gas industry. Regulatory authorities along with a current slump in oil and gas prices are putting increasing pressure on pipeline operators to safeguard pipeline integrity and minimize maintenance cost. NACE standard SP0502 completely defines the pipeline external corrosion management, though, the order in which pipeline defect locations are interrogated is at the discretion of pipeline operators. This paper presents a novel cost effective approach to quantify the pipeline defects severity and to prioritize the pipeline excavations comprising minimal number of digs to precisely locate the pipeline defects. Buried carbon steel oil and gas pipeline network spanning over 70 kilometres is assessed to evaluate and obviate the threat of external corrosion. Alignment of indirect inspection data obtained from multiple indirect inspection surveys is also presented. Finally, the proposed criterion is assessed and found to be very effective showing 50% reduction in cost and improved pipeline integrity.

1. INTRODUCTION

Structural integrity of buried onshore pipelines in the oil and gas industry is of particular importance as their failure can result in safety hazards, substantial economic losses and environmental damage. United Energy Pakistan (UEP) is a private firm operating in Pakistan primarily focusing on exploration and production of oil and gas in the Sind province of Pakistan having buried onshore pipeline networks spanning over 1100 kilometres. Under the Integrity Management System, UEP uses Pipeline Integrity Management Scheme (PIMS) to identify the potential threats to the pipelines due to external corrosion and their continuous mitigation. As a part of PIMS, External Corrosion Direct Assessment (ECDA) is carried out on an annual basis in UEP to boost pipelines integrity in accordance with the NACE standard SP0502.

The historical distribution of major pipeline defects recorded on the pipeline system of UEP operations is summarized in Figure 1. Given the share of external corrosion, it is apparent that appropriate external corrosion control methods would have a foremost influence on the safety, environmental performance and economics of pipelines operations.

Pipeline External Corrosion Direct Assessment methodology is described in NACE SP0502. This standard practice does not provide absolute severity classification and excavation criteria, allowing pipeline operator to classify defects severity and develop excavation prioritization on their judgement and in accordance with the specific conditions of the pipeline. The objective of this paper is to present a workable newly developed approach that can be used as a basis to prioritize the excavations resulting in an enhanced pipeline integrity spending minimal cost.

2. THE FOUR-STEP METHODOLOGY

As stated in SP0502, ECDA involves four steps which are discussed in detail in the subsequent sections.

2.1 STEP 1: PREASSESSMENT

This step requires sufficient amount of data collection, integration and examination related to pipeline construction, operations and environment to decide whether ECDA is feasible for the pipeline to be evaluated along with the selection of indirect inspection tools.

2.1.1 DATA COLLECTION AND PIPELINE RISK RANKING

For current work, a comprehensive pipeline risk ranking assessment was carried out in which the data related to pipeline design, construction, soil, environment, corrosion control, cathodic protection and operational history is taken into account in combination with the data which has an impact on business, environment and people. The pipelines risk is calculated based on the probability and consequence of a corrosion event. Out of 40 pipelines, 10 high-risk pipeline regions were shortlisted through a rigorous risk-ranking process and categorized into different regions (discussed later). The regions consist of around 70 kilometres of buried onshore CS pipelines of different lengths. All pipelines shortlisted are of API 5 L grade, coated with fusion bonded epoxy.

2.1.2 ECDA FEASIBILITY ASSESSMENT

The data gathered in the data collection phase was amalgamated and scrutinized to check for any condition, which can make the use of indirect inspection tools impracticable or could impede the ECDA application, such as...
pavements, frozen grounds and inaccessible areas. However, majority of the pipeline regions were found to be feasible for ECDA assessment, except a few locations such as paved road crossings and water crossings which may pose a challenge to apply ECDA and requires an alternate integrity assessment method extending beyond the scope of this study.

### 2.1.3 SELECTION OF INDIRECT INSPECTION TOOLS & ECDA REGIONS DETERMINATION

Consistent with SP-0502, the regions where ECDA is to be applied, a minimum of two indirect inspections tools should be selected. However, based on their ability to accurately detect coating defects and corrosion activity, the following three techniques used for indirect inspections are chosen from the ECDA tools selection matrix given in SP 0502:

- **Pipeline Current Mapper (PCM)**
- **Direct Current Voltage Gradient (DCVG)**
- **Close Internal Potential Surveys (CIPS)** [7]

These tools are selected based upon the individual strengths associated with each tool. PCM works on a current attenuation principle and helps to detect the exact pipeline location, burial depth, casing shorts, unauthorized pipeline connections and spots the area of reduced coating quality, though it does not identify the exact coating defect location unless a secondary holiday pinpoint survey is used. On the other hand, DCVG overcomes the limitation associated with the PCM, and is used to pinpoint the coating defects by providing the approximate defect size, defect severity estimation and corrosion state of a coating holiday. Moreover, the DCVG survey is said to locate the coating holidays more precisely than any other survey [7]. Since DCVG doesn’t provide the pipe to soil potential profile of the pipeline, CIPS is performed to explore the ON and Instant-OFF potentials over the entire pipeline regions. In addition, CIPS also gauges the performance of the CP system. In short, the tools were selected such that the strength of one tool compensates the limitations of another.

An ECDA region is a region that has similar physical characteristics, corrosion histories, expected future corrosion conditions, and uses the same indirect inspection tool. In this work, the selected pipeline regions have different physical conditions, cathodic protection, corrosion history and construction year and are all buried in dissimilar soil environment. Therefore, 10 different non continuous regions are defined, details of which is presented in Table 1.

### 2.2. STEP 2: INDIRECT INSPECTIONS

The central focus of indirect inspection is to identify and address coating faults and corrosion activity along with the other associated defects without exposing the pipe surface. This is a key stage as it produces a direct examination plan that will minimize the direct examination costs while achieving the required confidence level. In this work, the three tools mentioned above were used one by one between short time intervals over the entire buried length of the pipeline to circumvent any changes in the survey conditions such as change in temperature and soil moisture content. The complete survey on a 70 Km pipeline network took around 25 days. Data collected from three surveys during indirect examinations were pooled and evaluated in combination with each other. It is noteworthy that correlating and aligning the data gathered from three different surveys plays a pivotal part in determining the effectiveness of indirect examinations and builds a solid footing for direct examinations. After identification of the faults, they are classified in accordance with their severity. For this study, a stringent severity classification criterion is devised and incorporated into prioritization criterion shown in Table 2. The criterion provides specific quantifiable and explicitly definable conditions and is developed on the basis of previous corrosion activities on pipelines, CP system performance and pipelines physical and operational history, complying with one of the aims of this work. A similar criterion has been described previously [1]; however, more realistic and stringent numbers are used here for accurate classification according to specific pipeline conditions.

### 2.2.1 DEFECT PRIORITIZATION CRITERION

Faulty regions identified during the indirect inspection step necessitate efficient excavations to expose the pipe surface so that measurements and pipeline health assessments can be made, which is the principal target of the direct examinations. Based on the likelihood of current corrosion activity, the magnitude and severity of prior corrosion and approach of optimal digs and reduced cost, severity classification and prioritization criterion is presented in this study as shown in Table 2. The severity and prioritization criterions are both incorporated into a single matrix, contrary to the previously proposed criterions which are described separately [1],[2]. Referring to Table 2, the results obtained through DCVG and PCM are plotted against CIPS to prioritize the pipeline excavation. The pipeline prioritization and excavation scheme (dig & no dig areas) is clearly defined in the criterion. Table 2 also contains the notes describing the excavation prioritization.

---

**Table 1 - ECDA Regions Details.**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Pipeline</th>
<th>Diameter (in)</th>
<th>Length (m)</th>
<th>Construction Year</th>
<th>Material &amp; Coating</th>
<th>Prior Corrosion</th>
<th>Cathodic Protection Type</th>
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<tr>
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<td>1997</td>
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</tr>
</tbody>
</table>
2.3. STEP 3: DIRECT EXAMINATIONS
2.3.1 PIPELINE EXCAVATIONS AND DATA ANALYSIS

In agreement with the decision matrix presented in Table 2, digs were performed on each pipeline region. For region F (refer Table 1 for description), all digs fit as an immediate excavation prioritization. Alignment of the data acquired from three different indirect inspection surveys are plotted against the pipeline distance measured from riser first flange as shown in Figure 2. The exposed pipe condition is also presented at the corresponding inspection digs. The ON potentials were well above -1000mV_{CE} throughout the entire pipeline. However, the OFF potentials were less than 850mV at some defect locations. Moreover, the current loss curve obtained through PCM shows a gradual loss with no abrupt current dips indicating a satisfactory overall pipeline coating. The pipeline was exposed from five different locations which were selected in accordance with the proposed criterion. At four out of five digs, coating defects were found. As shown in Figure 2, an anchor block (pre-casted steel reinforced concrete) was also found at dig-1 which could possibly lead to 49% DCVG defect; furthermore, a few excavation cuts were also found at this dig. Interestingly, at dig-2, a pilferage clamp was found. Indirect examination at this defect location has shown a DCVG defect of 38% with minor current loss rate and OFF potential value of around -790mV. The pilferage clamp itself was corroding, hence, indicating an anodic area. At the three remaining digs, coating damages and disbonded coating in the form of flakes were found, along with blister formation near the decayed coating area with no metal loss, thereby signifying an acceptable CP performance. In addition, water was found

Table 2 - Decision Matrix: Severity Classification and Excavation Prioritization Criterion.

Note: In case of two different prioritization levels, worst case is considered. For instance, if one prioritization is immediate and the other is schedule, then immediate will be considered.

Immediate excavation is to be carried out within a week.
Schedule excavation is to be carried out within a month.
For monitor prioritization, only CP system needs to be reviewed.
In case of severity dependent prioritization, severity of individual survey results and pipeline corrosion history is reviewed.

Figure 2: Combined Graph and Aligned Data Analysis.
inside the blisters having a basic pH which might have caused the coating disbondment. All the coating damage was repaired through liquid epoxy coat. After the coating repair, cathodic protection current demand of the pipeline was decreased by 20%. Similar data analysis and repair methodology was adopted for the 9 remaining pipeline regions. Overall cost of performing ECDA is around $1000 per Km which includes indirect surveys, dig excavations and inspection and coating repair cost. At the locations where corrosion activity was found, calculations were performed to estimate their remaining operational life along with Root Cause Analysis of the events to mitigate any corrosion in future.

2.3.2 ASSESSMENT OF PROPOSED SEVERITY CLASSIFICATION AND PRIORITIZATION CRITERION

The defect severity and prioritization criterion is evaluated to check if it is a true representation of the magnitude of corrosion and coating damage found after pipeline excavations. After performing the schedule and immediate excavations, the findings of the entire activity with reference to the actual corrosion and coating damage found is summarized in Figure 3 below.

As shown above, the proposed criterion is found to be very effective. Though, there is one location where criterion disagrees with the practical damage found, which could be possibly due to spatial errors during the excavations. Additionally, ECDA is a continuous improvement process, therefore the defect severity and prioritization criterion may be adjusted in the future for more accurate results.

2.4 STEP 4: POST ASSESSMENT

The post assessment activity comprises of defining the re-assessment intervals and determining the overall effectiveness of the ECDA process. Here, except at two locations no external corrosion damage was found. As stated in SP0502, the reassessment intervals at the corrosion areas were taken as one-half of the calculated remaining life. To estimate the remaining life due to corrosion damage, Fitness for Service evaluation was also performed for corrosion areas using API 579.

In order to validate the ECDA effectiveness, one dig was additionally performed on all ECDA regions categorized as “monitor” and “no indication” in Table 2. The excavated locations were found to be defect free, thus legitimizing the success of the complete process.

2.4.1 CONTINUOUS IMPROVEMENT IN PIPELINE INTEGRITY

ECDA is a continuous improvement process and its effectiveness is established on a long-term basis. Compare to previous ECDA surveys, the survey under discussion is far more effective and efficient as presented in the Figure below. As shown in Figure 4, significant cost reduction of 50% has been attained along with a dig efficiency of 97% as coating and corrosion damage is found at almost all digs. The dig efficiency achieved in this work is exceptional when compare to ECDA 2014 (88%) and ECDA 2013 (84%).

Finally, during ECDA 2015 comparatively less numbers of total corrosion and coating damages were found which were addressed timely signposting an improved net management of corrosion and enhanced pipeline integrity.

3. SUMMARY AND CONCLUSIONS

A decision matrix for the classification of defect severity and dig excavation priority is presented to support the ECDA exercise on buried onshore pipeline systems. An innovative approach of ECDA survey technique has been demonstrated as well, which when used with the proposed decision matrix has resulted in a dig efficiency of 97%.

This study is intended to provide the onshore pipeline operators with a value adding tool to evaluate the condition of their buried pipelines in an effective and consistent way. The use of this technique will help pipeline operators to perform a correct interpretation of ECDA survey results and to make the right selection for inspection dig locations, resulting not only in cost saving but will also improve the overall integrity of the pipeline.

4. ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the management of United Energy Pakistan for their support. Also, the work of the contractors involved in this process is gratefully acknowledged.

REFERENCES

WORLD'S MOST VALUABLE COMPANY CUT COSTS WITH CUTTING-EDGE POLYMER REPAIR SYSTEMS

Damaged concrete floor and expansion joints at airport repaired with minimal disruption

For the expansion joints, Belzona 2221, a tough polyurethane resin with outstanding flexible properties was applied. This material will accommodate high levels of movement and enable the expansion joints to successfully absorb any shock or impact and return to their original shape undamaged. Belzona 2921 (Elastomer GP Conditioner) was applied prior to this system in order to ensure an effective molecular bond with the concrete substrate. The sample application took 18 labour hours to complete and was left to cure for three days. In order to assess its performance, forklift trucks were then driven over the repaired areas. As the combination of epoxy and polyurethane systems successfully withstood these loads, the airport decided to continue with the application to the complete 150 linear meters (492ft) of damaged area.

Application of rebuilding material.

Field trial confirms flexibility and durability of polymer systems

Following an inspection by Belzona representatives, Bobby Satheesh, QA/QC Manager at Hajjan Trading & Industrial Services Co. Ltd. (Belzona authorised Distributor in Saudi Arabia) specified a solution. He said, “In order to give the airport complete confidence in the Belzona materials, we conducted a sample application to demonstrate the flexible and robust properties of the Belzona systems.

"A number of concrete areas were rebuilt with Belzona 4111 (Magma Quartz) and the expansion joints were repaired with Belzona 2221 (MP Fluid Elastomer). The two component epoxy resin system, Belzona 4111, contains selected quartz particles to create an extremely durable rebuilding material with a compressive strength (when tested in accordance with ASTM D695) of 92.7 MPa (13,450 psi). As the material is stronger than concrete, the substrate is able to withstand heavy loading without fear of degradation. Prior to the application of this material, surfaces were firstly coated with Belzona 4911 (Magma TX Conditioner) to ensure maximum adhesion was achieved.

“For the expansion joints, Belzona 2221, a

Cracked and spalled concrete. Deteriorated expansion joint.

Pouring of flexible elastomer into sample piece.

Pouring of flexible elastomer into sample piece.

Cold and fast curing systems enable rapid, simple and safe application procedure

Firstly, the concrete was prepared to reveal a sound substrate. Any old coating or previous patch repairs were fully removed. Loose contamination was brushed away and the substrate was then cleaned using Belzona 9111 (Cleaner Degreaser). The surface was then conditioned using two coats of Belzona 4911. Where the concrete edges or nosings were damaged, timber battens wrapped in polyethylene sheets were installed before direct application of Belzona 4111 using a trowel. The material was then tamped down firmly so as to ensure maximum contact with the surface.

Conditioning of concrete surface.

Quick application procedure keeps airport running smoothly

The extensive repair work was completed over a period of 126 days. The extremely quick cure time of the Belzona systems, (just 2-3 days instead of the 28 days required had the repairs been carried out using concrete) enabled over 40 areas suffering from various degrees of damage to be fixed with no hindrance to the airport operations. Furthermore, as the simple, cold-curing application procedure required minimal equipment during the installation, this meant that the application could be easily rescheduled to the night time, when the day time temperatures reached a scorching 55°C (131°F). Thoroughly satisfied with the material’s performance and the simple application procedure, the airport commissioned an additional 50 linear meters of damaged area to also be repaired by the Belzona systems.

For further information contact: Belzona Polymerics Ltd., Claro Road, Harrogate, HG1 4DS Tel: 01423 567641 Fax: 01423 505967 Email: sales@belzona.co.uk www.belzona.co.uk
THROUGH THE LOOKING-GLASS: 50 YEARS IN POLYMER REPAIR MARKET

Geoff Binks has dedicated 50 years to a major polymer coating and composite manufacturer, to ask him about his experience in the industry and maintenance sector.

Geoff was born and raised in Harrogate and joined Belzona in 1965 direct from Technical College with a chemistry background. He first worked in R&D on a broad range of products, particularly the Belzona Metals which saw radical development in 1968 with the introduction of the first Belzona Super Metal formulation.

In the early 1980s, Geoff joined a newly formed Technical Service Department, the Molecular Engineering Department (MED), responsible for field visits, inspecting and supervising applications and delivering in-plant training. Mr Binks’ exposure to all aspects of Belzona’s business, ultimately lead to his position as Technical Service Coordinator acting as a link between chemists, engineers, sales and marketing.

With his wide ranging knowledge and experience, Geoff provides global technical support to Belzona customers, distributors and staff. After celebrating 50 years in Belzona, we thought it would be a good time to ask this “Belzona Guru” a few questions about his experience and get his account on how the industry changed over the years.

1) Your career started in the 1960s. Can you describe some of the standard industry practices of that time in terms of repair and maintenance?

First of all, polymer repairs were almost unheard of. We had to show people exactly how the polymer works, changing from a liquid to a solid state.

Health & Safety was not a major priority at the time. This was throughout the industry, little PPE such as gloves or eye protection, as well as in our laboratory, where pranks were commonplace.

Can you share some of your favourite pranks?

I will not go into too much detail, but one prank involved polystyrene drinking cups being attacked with solvent leading to loss of containment!

2) How has the Belzona brand evolved over time?

We always say that Belzona does not corrode, which is of course true, but there was a time when Belzona Metals could corrode. Back in the early 60s we used iron powder in the polymer, which was able to rust, before silicon steel alloy was deployed into Belzona Metals in 1968.

The number and variety of products over the years has increased dramatically, with product ranges such as the Belzona Magma and Elastomer systems being introduced. Our old moto used to be “Total Maintenance Capability”, which meant that we endeavored to have a product for every problem a customer may be faced with. So, we ended up with a diverse offering of repair and protection materials covering a broad range of substrates and operating conditions.

Additionally, Belzona was mainly sold in small quantities, as pack sales. Now, however, we get increasingly involved in large scale projects, sometimes requiring several tons of Belzona materials. For example we recently did a job on a new Ichys platform installing riser bearings which involved over 25 tonnes of Belzona 1321.

3) How has the Oil and Gas industry changed over the last 50 years?

At first, the word “Oil and Gas” did not exist in our vocabulary. In the 60s we mainly concentrated on the UK market, and at the time oil was imported from America. Petrochem was the word used, referring to the work we did in the downstream refineries. We really became seriously involved with upstream Oil and Gas industry in late 1980s, when we successfully carried out a lining job on a separator in the North Sea.

4) What are your career highlights?

Left to right: David Blackwell, Ron Campbell, Geoff Binks. 1984 selecting images from the “Slide library”.

Being involved in the development of the first Belzona Super Metal in 1968. This set the standard for corrosion resistant, easier to mix and apply and had higher physical properties, particularly adhesion and heat resistance, than other materials available at the time. This product has remained one of our best sellers and is synonymous with the Belzona brand due to its performance and versatility. After working on product development for many years, my job evolved through technical service and technical writing to when the Molecular Engineering Department (MED) was created. At that time we also recruited Ron and Dave, our current Managing and Technical Directors.

One of my responsibilities at that time was managing the Belzona Slide Library, an impressive collection of 100,000 or more 35mm slides, vital in the creation of literature and customer presentations. This led to my involvement with marketing, working on creating technical and sales literature, particularly Know How in Action as well as our audio-visual (AV) presentations, the precursor to today’s videos. AV’s with titles such as “Dr Belzona”, “The Unconventional Alternative” and “Simply the Best” were the key tools used by Consultants. I guess another highlight would be the opportunities I have had to work in so many different areas of the business which has allowed me to meet many different people from many different industries and led to some, but not excessive, global travel.

5) What does the future hold for repair and protection against erosion and corrosion?

As heavy industries are beginning to decline, and planned maintenance increases, we will need to continue to adapt and ensure we target emerging markets and industries. Most of our current customers probably only use 10% of our product range, so there is always potential there.

Interviewed and written by Marina Silva

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ARC ENERGY RESOURCES BOOSTS ITS NUCLEAR CREDENTIALS

Andrew Robinson, Managing Director of leading weld overlay cladding and fabrication specialist Arc Energy Resources, has joined the advisory board of the National Skills Academy for Nuclear (NSAN). The move follows an initial approach from the organisation’s regional operations manager, with a view to helping companies that want to be involved in the nuclear sector and are currently working on their nuclear skills agenda.

Says Andrew: “NSAN is concerned that there may not be sufficient skills in UK engineering specifically for the nuclear sector, and the Academy has been formed to help redress the problem. The more we looked at the training available, the more we felt this was an organisation we would like to be involved with. We also made contact with them at a couple of conferences and they then emailed me with an opportunity to get more involved and to become a member of the NSAN advisory board. For manufacturers the board considers topics ranging from what employers want, to what is actually lacking, so it is a useful facility to have.”

The unit has an extensive range of online courses available to help interested companies. This includes NS4P - an online nuclear skills matrix that companies and their employers can log onto, to work towards a nuclear passport. Membership also gives Arc Energy Resources access to companies such as Cavendish Nuclear, BA Systems, the MOD, Babcock and Rolls Royce, as well as all the nuclear operators out there. And as Andrew says: “For manufacturers like ourselves it is really helpful to be around a table with companies such as these, discussing the issues we are collectively facing. It is also useful to find out if the perspectives taken by large companies and SME’s are different, and generally it does appear that the same issues are coming up.”

Also, from the NSAN point of view, with many bigger companies on board it is good for them to have input from smaller companies such as Arc Energy Resources that have qualified for the entry level Fit for Nuclear qualification. And for Arc Energy, with its location so close to the new nuclear site at Hinkley Point in Somerset, Andrew is keen to build its experience and ensure that these companies can help the main contractors with specialised engineering experience provided locally.

“Nuclear has a great deal of potential for us,” says Andrew: “and I believe Arc Energy Resources really has an important role to play.”

HERITAGE PAINTING AT TEMPLECOMBE STATION

Reopened in 1983 and has been restored by an enthusiastic team of volunteers over many years. It was feared that the bridge, originally built in 1893, would be lost, if plans could not be agreed to refurbish it.

Bagnalls worked closely with South West Trains office staff, Friends of Templecombe Station and Network Rail, to complete the preparation and repainting of the bridge structure. Our site supervisor, Nick Foley was on site, managing and directing the volunteers for four weeks and his experience and knowledge was very much welcomed by all involved. He said, “It was great to see the transformation take place. The volunteers all worked really hard removing mesh panels, preparing the steel surfaces and then applying the paint. The final result is something that the whole team can be very proud of.”

The Friends of Templecombe Station have spent many years restoring the gardens and station since its reopening. Alison Clements, representing the team of volunteers said “It is marvellous how South West Trains, Network Rail and their contractors, Bagnalls, have managed to cooperate with the Friends in finding a long term economical solution to save the footbridge and the gardens it accesses.”

All their hard work has paid off as Templecombe was chosen as the “Best Small Station” at the recent South West Trains “I Make The Difference Awards 2016” The station is also being entered into a National Best Station Awards later in 2016 which acknowledges the dedication of amateurs and locals who look after heritage stations and buildings across the UK.
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DIARY DATES 2016

Thursday 13th October
London Branch Meeting
Joint Meeting with LMS
Venue: Imperial College, Skempton Building, London SW7 2B8
Description: Corrosion of hip replacements – is it a problem?
Timings: 18:15 Doors Open, 18:30 Talk, 19:30 Social and networking
-Refreshments provided, 21:00 Finish
For further information please contact icorrondon@gmail.com or george.winning@element.com or call 07495671806.

Thursday 10th November 2016
London Branch Meeting
Details to be announced.

Thursday 8th December 2016
London Branch Christmas Lunch
To be held at ROSL, London, SW1A 1LR, (The Royal Overseas League Club is situated behind the Ritz).
Details to be announced.

Thursday 9th March 2017
London Branch Meeting - President Talk and AGM
Details to be announced.

Tuesday 28th - Wednesday 29th June 2016
Grey Water
An informative and entertaining two day event with presentations and workshops, revealing intriguing insights into various Water Management disciplines and delivered by Masters in their field.
Venue: National Conference Centre
Solihull, B92 0EJ
Further details: http://www.wmso.org.uk/conferences.php?id=470

Wednesday 6th July 2016
Marine Corrosion Forum meeting
Venue: National Motorcycle Museum, Birmingham. Further details:
www.marinecorrosionforum.org

Monday 5th - Tuesday 6th September 2016
57th Corrosion Science Symposium (organised by CSD)
Venue: University of Swansea
Description: Further details including abstract submission will appear here in due course.

Wednesday 26th October 2016
Marine Corrosion Forum meeting
Venue: London. Further details: www.marinecorrosionforum.org

Wednesday 30th November 2016
EC Seminar – Anticorrosive Coatings
Venue: Amsterdam, the Netherlands
Topics:
-How does corrosion occur?
-What surface preparation is necessary for an endurable coating?
-Which ingredients does a coating comprise and what are their roles?
-What are the current trends in corrosion protection coatings?
-What distinguishes water-borne from solvent-borne systems?
-How do self-healing coatings work?
Website: www.european-coatings.com/Events/European-Coatings-seminars-2016/Anticorrosive-coatings
Contact: Kristin Heuer – Kristin.heuer@vincentz.net
T: +49 511 99 10 272

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