

With increased operating costs, dynamic economic environments, aging plants and equipment, the implementation or optimisation of an asset integrity programme to extend service life of infrastructure may seem challenging, but is invaluable. Asset integrity management is regarded, in many best-practice organisations, as critical.

As outlined in Extrin's article: "Setting up a Corrosion Management System" in Corrosion and Materials - June 2013, by optimising a current asset integrity programme, the client achieves:



-  **Reportable method for proving risk reduction**
-  **Optimisation of asset life from an economic, functional and safety viewpoint**
-  **Issue identification and deterioration mechanisms**
-  **Prioritisation and management options**
-  **Latest industry best practices**
-  **Demonstration of due diligence and duty of care**

At Extrin, we commonly use a Corrosion Management Audit (CMA) which provides a qualitative corrosion assessment of assets and critical infrastructure including: Structural steel, Concrete, Electrical Equipment, Walkways etc. Assessment is conducted by qualified Engineers as per recommended practice in API 580 Risk Based Inspection.

-  **Size of the problem-** in a defined and quantifiable form
-  **Corrosion mechanism and the cause(s)**
-  **Personalised criticality table**, allocating a specific rating to each individual site issue dependant on: safety, environmental, structural and financial impacts.
-  **Assessment of plant assets which are critical for ongoing safety and production**
-  **Recommendations on mitigating the probability of failure** (inc. changes in metallurgy, addition of inhibition, coatings/linings, cathodic protection).
-  **Budget Estimate for the repairs-** summarized in tabular form to assist in future budget allocation
-  **Extrin Corrosion Awareness handbook**



The CMA provides the client with a five (5) year prioritised maintenance activity schedule to assist with budgeting, and can be coordinated in time with site shut down works.

Extrin also offer Corrosion Management Overview (CMO) and specific asset inspections tailor suited to the clients needs.



### **Analytical Services**

- Water Analysis
- Corrosion Product Testing
- Metallurgical Testing
- Product Trials
- Concrete Testing

### **QA/QC**

- Coating Inspections
- Project Management
- Repair Integrity Analysis
- Shutdown Planning and Maintenance Management



### **Microbial Investigation**

- Site Inspections
- Analytical Testing Mechanism Determination
- Remediation

### **Cathodic Protection**

- Complete System Design
- System inspections and testing
- Material Procurement
- Coordination of installation



### **Concrete Services**

- Durability Assessments
- Mix Design Review
- Protective Coatings
- Refurbishment works
- Project Management

### **Corrosion Training Services**

- Corrosion Awareness
- Corrosion Prevention
- Corrosion Detection
- Other Client-Specific Training Courses



### **Failure Analysis**

- Failure Catalyst Analysis
- Review and Recommendations
- Asset inspection and testing

### **Design and Durability**

- Durability Report
- Materials selection
- Concrete mix design
- Corrosion rate prediction
- Maintenance specifications



Visit our website for more information on our services and projects undertaken



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Extrin offers many concrete related services from durability design and specification through to project management of works as well as assessments and testing of deteriorated concrete and scope of works for remediation.

## **Durability Assessments and Mix Design Review**

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**Durability assessments** consider the ‘fitness for purpose’ of concrete mixes and designs, and ask the question:

“Is the design proposed suitable for achieving the concrete service life requirement? ”

The concrete mix, including constituents such as sand, aggregates, cement, silica fume and other pozzolans, admixtures, and of course water, can be greatly varied to improve properties such as strength, permeability and workability.

A **mix design review** can establish weaknesses in a design or provide options for improving any or a number of these properties.

## **Condition Assessment**

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The improvements in admixture technology over recent years has been remarkable. Even low dosages of some admixtures can result in improved concrete strength and reductions in permeability, resulting in extended concrete service life of major assets.

Marine environments as well as mine site environments with high salinity water can benefit from improved concrete performance.

Extrin are specialised in performing on site concrete condition assessments, using a variation of destructive and non destructive testing procedures to evaluate the existing state of concrete asset.



## **Protective Coatings**

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**Protective coatings** are another method of reducing negative effects on concrete. Recommendations of suitable coatings for the long term protection of concrete against these chemicals, and other causes of damage, such as impact and abrasion, can be undertaken by Extrin. Specifications for the correct preparation and application of recommended coating products is also part of our expertise.

Extrin are experienced in the **Project Management** of concrete refurbishment work including tender assessment, project management (monitoring productivity, performance and safety among other aspects) and related QA/QC services.



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## What is Cathodic Protection?

Cathodic protection systems use specialist electrochemical techniques to control the deterioration of embedded or immersed steel structures. Originally developed in the 1800's as a means of controlling corrosion on naval ships, cathodic protection has come a long way since and has therefore garnered widespread industry acceptance as a reliable tool for corrosion control of important plant assets.

Cathodic protection works by inhibiting the electrochemical degradation processes on the metal surface, commonly known as corrosion or rust. Protection is achieved by implementing either a Sacrificial Anode Cathodic Protection (SACP) or an Impressed Current Cathodic Protection (ICCP) system.

## Cathodic Protection Applications

CP Systems have countless industrial, commercial and residential applications, such as the following:

-  **Tank Internals and Floor Plates**
-  **Major Assets eg. Pipelines, Railways**
-  **Jetty and Wharf Protection**
-  **Reinforced Concrete Structures**
-  **Concrete Realkalisation**
-  **Removal of Chlorides**



## What Extrin Can Offer...



Cathodic protection is a highly specialised and technical niche. All Extrin engineers working on cathodic protection have extensive knowledge in the design and monitoring of cathodic protection systems. All leading Extrin Engineers are also trained by the Australasian Corrosion Association (ACA) and have successfully completed the "Advanced Cathodic Protection" course and exam.

Extrin have extensive experience in providing clients the following services:

-  **Cathodic Protection Design**
-  **Project Management**
-  **Monitoring and Compliance**
-  **Fault Finding**
-  **Materials Procurement**



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The deterioration of structures, structural elements and components over time is inevitable. It is however predicated on several factors namely, materials used in construction, severity of the surrounding environment and deterioration mechanisms present. Therefore, tools such as durability design, durability assessments and durability planning are vital elements in minimising the long-term corrosion risks of any asset.

**Durability design** is the practice of minimising the overall cost of the total design life of structural components taking into account the ongoing maintenance required to achieve long term performance and maximum design life. The most efficient designs from a durability and corrosion perspective are generated by incorporating corrosion mitigation techniques and engineered materials selection to enhance the effectiveness of the design process, in the effort to reduce long term expenditure on asset protection and maintenance.



Extrin has extensive experience in assessing durability issues for a wide range of assets from large scale mining structures, desalination plants and port facilities to smaller scale residential and commercial buildings. Extrin can provide practical advice of what material will be suitable for use within the proposed location, taking into account all macro and micro environments which will be present. Extrin has a diverse knowledge base and can provide comment on a wide variety of construction materials such as concrete, metals, composite materials and protective coatings.

Extrin understands the benefits of durability design and planning in construction. Our approach to Durability Planning encompasses the following key criteria:

-  **Risk of Deterioration**
-  **Cost of Preventative Measures**
-  **Cost of Control Strategies**

Our understanding of durability allows us to deliver a well-balanced and optimised whole life cost design.



## What extrin can do...



-  **Durability Plans**
-  **Materials Selection**
-  **Protective Coatings**
-  **Waterproofing membranes and sealants**
-  **Concrete Mix Design and Performance Criteria**
-  **Modeling of Deterioration Parameters**
-  **Cathodic Protection and Prevention**
-  **Chemical Attack Resistance Concrete**



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Analytical tests of the corrosion product and process water; investigation of the metallurgy and microbial influences are often an essential tool to solve corrosion-related problems, especially in the area of corrosion failure investigation. Below is a select list of services Extrin can provide in-house or at a variety of partner laboratories.

## Water Analysis



The ability of water to conduct electricity is affected by its ionic concentration, so Total Dissolved Solids (TDS) affect the water's ability to conduct electricity. This electrical conductivity is an important parameter in predicting corrosion.

Extrin can provide special laboratory testing which can **determine the corrosivity of water**, using the Langelier Saturation Index (LSI) and the Ryzner Stability Index (RSI). These are two common indices for predicting corrosion.

For good corrosion control, water should have a pH of 7.0 - 8.2.

## Corrosion Product Testing

### ✓ Scanning Electron Microscopy (SEM)

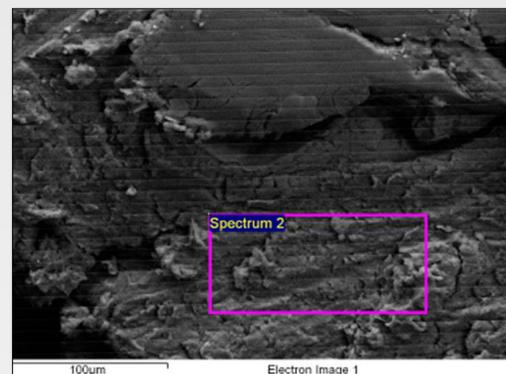
On of the most used analytical technique for the characterisation of corrosion product.

### ✓ Energy-dispersive X-ray Spectroscopy (EDS)

Valuable for the elemental analysis or chemical characterisation.

### ✓ X-ray Crystallography

Used for determining the atomic and molecular structure of a crystalline structure.



## Materials Testing



**Shear**



**Tension**



**Atmospheric Simulation**



**Compression**



**Flexural**

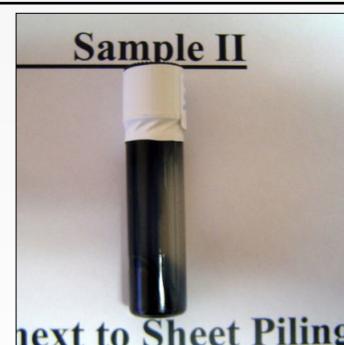


**Site Exposure Trials**

## Microbial Testing

The identification of microorganisms responsible for corrosion can be affected by many factors, freshness of the sample, collection procedure, transportation to the laboratory and the like.

Extrin can perform Microbial Testing varying from the very basic enumeration for a specific bacteria to the more complex DNA.





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## What is Microbial Corrosion?

Microbially influenced corrosion (MIC) is known to cause significant economic damage across a broad range of industries. Pipelines, storage tanks, thickeners, offshore platforms, marine port piling and underground structures have been reported to be quite vulnerable to biological corrosion which is thought to be mediated by different groups of microorganisms.

Of the diverse corrosion processes, the microbially influenced corrosion (MIC) of metals has been estimated to account for up to **50%** of the costs of damage.

Interestingly, microbial corrosion often presents as localised pitting, which, depending on the affected asset, is usually more severe than the general corrosion processes that are evenly distributed over the metal surface and for which “corrosion allowances” are usually assumed to accommodate.

Microbial corrosion under aerobic or oxygenated conditions involves complex chemical and microbial processes due to metabolic activities of different groups of microorganisms



## What Extrin can provide...



Site inspection of MIC areas by a specialist Extrin engineer



**Site Inspections**

Identification of MIC to assets which will assist in awareness and prevention



**Microbial Testing**

Assessment of the mechanism for asset inefficiency or failure which will improve plant performance



**Deterioration Mechanism**

Preventative techniques such as oxidising biosides and cell poisoning via interference with the cellular metabolism



**Remediation and Control**





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The service life of a protective coating system represents the economic value of that system. QA/QC Inspection is employed as a tool to ensure proper installation of the system, helping to achieve this engineered service life. The life of a coating system on a steel or concrete substrate depends principally on the quality of the surface preparation, with an estimated 70% of failures occurring due to inadequate surface preparation. The initial cost of surface preparation is recoverable in the form of increased service life of a coating that has been correctly installed as specified.

## How it is performed



QA/QC inspections performed by Extrin Consultants ensure that works conducted on client assets are performed as per the applicable site specifications, Australian and International Standards and are in line with Industry best practice. Extrin have certified NACE and ACA Coating Inspectors with many years of experience in protective coating specification and installation. Extrin's Inspectors understand various types of coatings and are able to undertake third party site based inspection using both basic and advanced assessment techniques required to maintain quality control.

## What Extrin Can Provide



### **Inspection of the prepared substrate to establish that:**

- There are no fabrication related defects
- The specified degree of surface preparation is attained
- No visible contamination has occurred since preparation



### **Witnessing the correct mixing, thinning and application of coatings**



### **Monitoring that the surface preparation and coating application are conducted under the correct environmental parameters.**



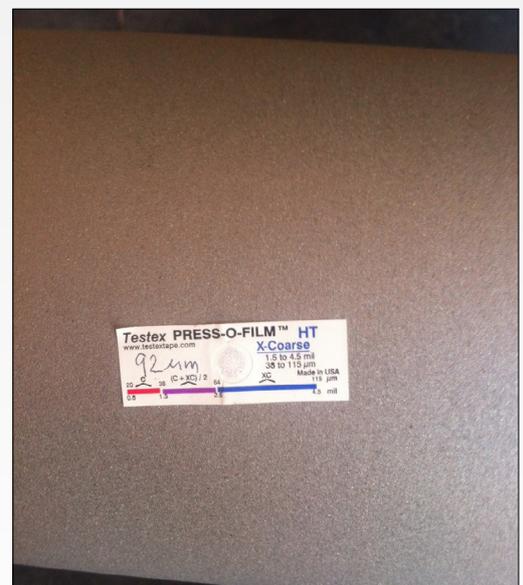
### **Performing any other task assigned by the Specification (e.g.: holiday detection, adhesion testing, testing for hardness and degree of cure.**



### **Measuring of coating thickness to ensure compliance with the specification**



### **Recording data and documenting the above tasks, in both written and photographic form**





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Failures occur and when it does, to prevent reoccurrence and to find the best practical solution, a failure has to be thoroughly studied and its causes identified. The art of collecting and analysing data to determine the cause(s) of a failure is called **Failure Analysis**

Failure Mode and Effects Analysis is a systemised approach used for eliminating failure for quality improvement activities. It may be focused on the design or process parameters. The strength of FMEA is usually derived from a cross-functional, team-based approach. The objective of FMEA as is understood is to capture the following aspects of a failure:

-  What might have gone wrong (the failure mode)
-  What might the result of that failure be (the failure effect)
-  How serious could the result of the failure have been (the failure severity).



Failures occur due to numerous reasons: It can be the result of design, where materials and shapes are not appropriate for the application. Failure can also be partly the result of operation and process, where the required procedures were not properly applied throughout the whole process. In most cases, failures that are the result of corrosion occur due to the **chemical, electro-chemical and microbial degradation mechanisms.**

## What Extrin Can Offer



Extrin offers a wide range of methodologies applicable for almost all types of failure (especially for corrosion failures) and are customizable, a few of these are listed below:

-  Comprehensive desktop studies
-  Site inspection visits with sample collection
-  Chemical analysis of a wide range of materials including ferrous or non-ferrous metals (copper, aluminium, zinc and their alloys), wood (especially, in wooden cooling towers), plastics and rubbers, and paints and coatings.
-  Photographic reports with full laboratory results
-  Microbial Testing in house or at site
-  Microscopic Examinations
-  Metallurgical tests (SEM, EDS, XRD, OES, PMI, etc.) in the partner third party laboratories



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With a proven reputation in corrosion mitigation, particularly in the Mining, Oil & Gas and Ports & Harbours sectors, Extrin willingly train industry personnel in aspects of corrosion in an effort to pass on knowledge and experience, and to educate interested and relevant site personnel to implement corrosion management practices to reduce corrosion-related risk.

Extrin have two key personnel undertaking Cert IV studies in Training & Assessment as well as other personnel with skills and attributes to conduct industry training. We have a well rounded and experienced team capable of training in all areas of corrosion.

## Training Options



Training can be provided “in the classroom” with the use of computer powerpoint and video presentations or “on-site” at the student/client work site. Ideally, a combination approach is recommended, where technical and practical sessions can be provided.

Extrin have provided training to the industry both overseas, as shown in photographs below, and locally at mineral processing plants as well as at Extrin’s premises in Canning Vale, Perth which is suitable for small groups (ie: 3 – 6 people).

Our Introduction to Corrosion course is a perfect starting point for any company looking to learn the fundamental aspects of corrosion understanding and awareness.

Extrin’s training program is also fully flexible and can be tailored to suit the client’s requirements.

## Available Courses

-  **Introduction to Corrosion**
-  **Protective Coatings & QA/QC**
-  **Concrete Remediation and Repair**
-  **Corrosion Awareness of Site Personnel**
-  **Modes of Corrosion**
-  **Concrete Technology**
-  **Microbial Corrosion**





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