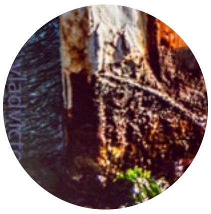
The International Institute of Marine Surveying

The IIMS proudly presents a brand new standalone **Professional Qualification in Marine Corrosion**, a new standard by which those who inspect corrosion can be judged against

PROFESSIONAL QUALIFICATION IN MARINE CORROSION

Marine corrosion and prevention in small vessels, ships and offshore structures



Introduction
to the Professional Qualification

After many months of detailed discussion and product development behind the scenes, IIMS is pleased to announce the launch of a new standalone professional qualification in marine corrosion - subtitled *marine corrosion and prevention in small vessels, ships and offshore structures*. The programme has been written primarily with marine surveyors in mind, those whose job it is to inspect, understand and report on corrosion. The new qualification is pitched at education level 4, examples of which are certificate of higher education (CertHE), higher apprenticeship, or higher national certificate (HNC).

The developer and content producer behind this new qualification is Mike Lewus, a name known to some members as he has presented at various IIMS events and seminars in recent years. Mike has an encyclopaedic knowledge of corrosion and has spent many years as a technical lead with the British Stainless Steel Association.

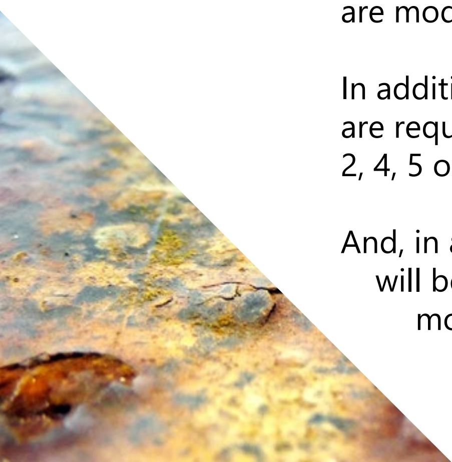
Each module will be presented in person by Mike, who has an engaging presentation style, over half a day and an online multiple choice test for each module will follow, requiring a 70% pass mark. The lecture schedule will be published soon and modules will be presented at different times of day, night and at weekends to facilitate delegates. If for any reason you cannot take the lecture live, you can study the video recording that will be made and then sit the module test. The aim is to complete the qualification within a one month time frame.

Who should study
for this qualification?

The course is intended for marine surveyors of yachts and small craft, ships and off-shore structures. It is also relevant for design engineers, material specifiers, other professional engineers and students of marine science and engineering. To gain the professional qualification 7 of the 10 modules must be undertaken and passed to achieve the IIMS professional qualification. Assessment is by multiple choice tests, with a pass mark of 70% required for each module. There are four core modules that all delegates are required to study and they are modules 6, 7, 8 and 9.

In addition to the four core modules, yacht and small craft surveyors are required to study module 3 and to choose two others from modules 1, 2, 4, 5 or 10.

And, in addition to the four core modules, commercial ship marine surveyors will be required to study module 1 and then choose two others from modules 2 to 5 or module 10.



Professional Qualification in Marine Corrosion

Course Synopsis

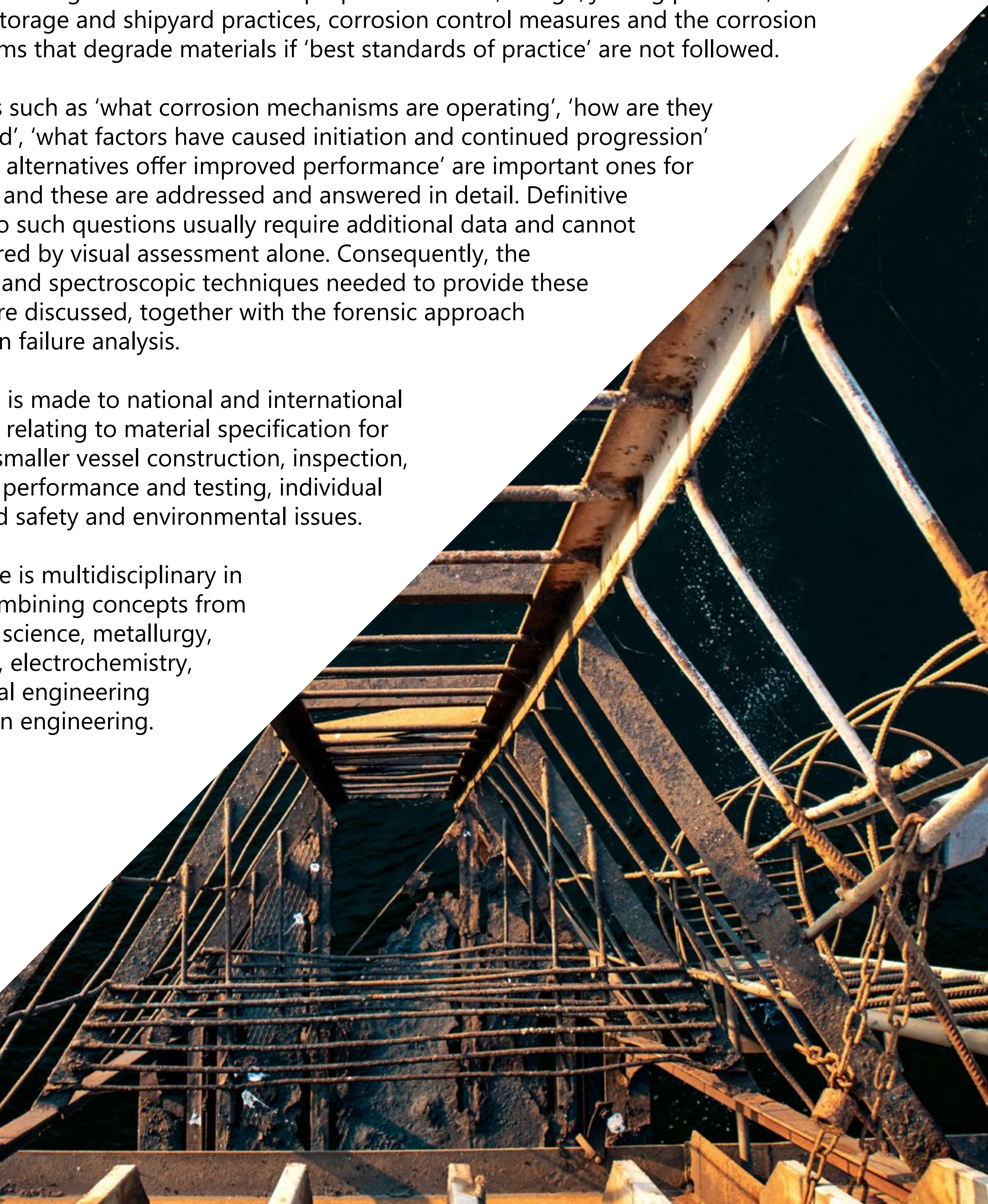
The opening modules of the course centre on ship, smaller craft and offshore platforms architecture, design, materials for construction and corrosion control strategies. The corrosion related topics are covered in more detail in the core modules.

The course centres on steels and non-ferrous metal alloys used in complex marine structures and particularly focuses on alloy type, composition, structure and properties, suitability for prevailing service conditions and the factors that undermine performance. An over-arching theme concerns how material performance is optimised through selection of fit-for-purpose materials, design, joining practices, material storage and shipyard practices, corrosion control measures and the corrosion mechanisms that degrade materials if 'best standards of practice' are not followed.

Questions such as 'what corrosion mechanisms are operating', 'how are they recognised', 'what factors have caused initiation and continued progression' and 'what alternatives offer improved performance' are important ones for surveyors and these are addressed and answered in detail. Definitive answers to such questions usually require additional data and cannot be answered by visual assessment alone. Consequently, the analytical and spectroscopic techniques needed to provide these insights are discussed, together with the forensic approach adopted in failure analysis.

Reference is made to national and international standards relating to material specification for ship and smaller vessel construction, inspection, corrosion performance and testing, individual health and safety and environmental issues.

The course is multidisciplinary in nature combining concepts from corrosion science, metallurgy, chemistry, electrochemistry, mechanical engineering and design engineering.



Professional Qualification in Marine Corrosion

Course Structure and Assessment

The course is designed to be flexible, with FOUR core modules that must be studied by all delegates (numbers 6-9), ONE further obligatory module for ship and yacht and small craft surveyors (module 1 or 3 respectively) plus any two other modules from the remaining five available to study.

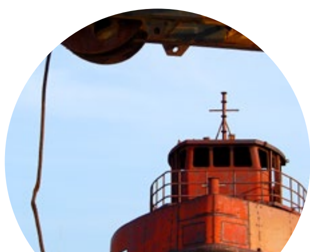
For example, CORE MODULES for both ship, yacht and small craft surveyors are modules 6-9. Modules 1 or 3 are obligatory modules for ship, yacht and small craft surveyors respectively and two further modules are required. These are to be chosen from modules 2-5 and 10 for ship surveyors and from modules 1, 2, 4, 5 and 10 for yacht and small craft surveyors. Although seven modules are required for the IIMS professional qualification in Marine Corrosion, all ten modules can be studied if desired.

Each module is associated with a set of 25 multiple choice questions, which will be completed online remotely. A pass mark of 70% must be attained on each module to achieve an overall pass. Resits will be allowed if necessary.

The course modules are well integrated with introductions to certain important topics given as needed in non-core modules, but covered in much greater depth in the core modules. For example, subjects such as steel and non-ferrous alloy grades, mechanical and corrosion resistance properties introduced in modules 1, 3 and 4 for small vessels, ships and offshore structures, are covered more comprehensively in core modules 7-9.

Though a prerequisite mathematics ability is required, the study material covered in modules 1-10 is largely descriptive in nature. Some calculations are used to underline certain structure, stability and testing concepts, but a level 3 (GCSE) or 4 (A-Level) educational standard is sufficient to tackle the examples shown.

The corrosion science, materials, chemistry, electrochemistry mechanical engineering concepts and testing principles discussed, are consistent with a level 4/5 educational standard. Consequently this course suits both professional workers in the field of marine surveying who wish to benefit from CPD material and undergraduate students or similar.



About your

Course Tutor

Mike Lewus is a Director of Metal Metropol Ltd and boasts an impressive career record to date.

Over recent years, Mike and the International Institute of Marine Surveying have forged a close working relationship which has led to him presenting at Conferences and online seminars on the subject of corrosion for the benefit of members.

This new professional qualification, which anyone is welcome to study, is a collaboration between Mike and the Institute and elevates the learning potential about marine corrosion to a far higher level for members of the IIMS and the wider maritime sector.

Mike's teaching experience and credentials include successful delivery of the following courses:

- Fundamentals of Metallurgy
- Principles of Heat Treatment
- Mechanical Testing Techniques
- Marine Corrosion and Prevention
- Failure Analysis

Academic Qualifications:

- PhD Materials Engineering (1987): Loughborough University of Technology
- MSc Applied Statistics (2004): Sheffield Hallam University
- BSc (hons) Applied Science (1982): Sheffield Hallam University

Teaching Qualifications:

- Post Graduate Certificate in Education (PGCE) (2003): Sheffield Hallam University

Other Professional Qualifications and Activities:

- Director of Metal Metropol Ltd.
- Professional member (MIMMM) of IOM3 (Institute of Materials, Minerals and Mining)
- Fellow of RSS (Royal Statistical Society)

Work Experience:

- Over 25 years in coatings and steel related R&D at USA and UK universities, including 20 years at Swinden Technology Centre (R&D labs of British Steel, Corus and Tata Steel)
- 4 years at the University of Sheffield and AMRC Training Centre, developing and building CPD materials related training courses
- 7 years as technical advisor at British Stainless Steel Association including, building and delivering training courses in stainless steel and corrosion

Module 1

Ship types, structure, strength, stability and corrosion control strategies

(Obligatory for commercial ship surveyors to study)

Module Synopsis

This module contrasts the architecture of different ship types including merchant, passenger and military ships with a focus on ‘ship mission’ (purpose, cargo, passengers, manning level, cruising range and running speed), steels and non-ferrous metals used in construction, form and typical dimensions, forces ships are subjected to and longitudinal and transverse strength requirements.

Other critical design aspects covered in this module are stability at small to large heel angles, changes due to cargo loading and movement, compartmentalisation, ballast, propulsion and corrosion control systems. Aspects of national and international regulations concerning safety, structure testing and damage scenarios are described and typical modes of failure are described. Example calculations are provided to underpin important design, stability and corrosion principles.

Module Scope & Content

Contrast the architecture of merchant, passenger and military ships

Key design aspects: active forces on a ship and longitudinal and transverse strength requirements

Stability over a range of heel angles, changes due to trim, cargo loading and movement

Outfitting: superstructure, engine installation, interior equipment; electrical and plumbing, interior space, finishing and furnishing

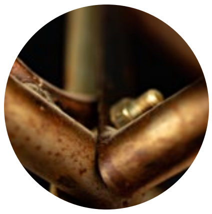
Lloyds register rules and regulations for design construction and lifetime maintenance (link to Module 5)

IMO regulations on individual safety, security of shipping and marine pollution (link to Module 5)

Examples of some of the learning outcomes from Module 1

- Appreciate the architectural requirements of a ‘typical’ merchant, passenger and military ship.
- Be able to explain quantities such as centre-of-gravity, centre-of-buoyancy, meta centre, metacentric height, righting moments and how these relate to stability.
- Understand how a ship is affected by wave motion, sea state and how buoyancy and ship weight vary along ship length.
- Understand how ship design and propulsion affects stability.
- Be clear about safety regulations for ‘freeboard’, subdivision and floodable length and the situation expected after damage.
- Know how poor design can undermine the corrosion resistance of materials and what other corrosion control strategies are used on ships.

Module 2



Processing, construction methods and testing of steel products used in ship building

(Optional module but strongly recommended for commercial ship surveyors)

Module Synopsis

This module considers the process steps used to manufacture semi-finished and finished steel products used in ship construction. It focusses on ship plate and sections, providing a grounding in how processing effects metallurgical structure and presence of defects. Also covered are the variety of cutting methods available including, mechanical cutting, turning and milling, oxy-acetylene, plasma, laser and water jet cutting and compares the advantages and disadvantages with particular reference to productivity and material wastage.

Common arc welding methods used in ship building are described namely, SMAW, SAW, GMAW (MIG/MAG), GTAW (TIG) and OAW; their advantages and disadvantages are discussed with particular reference to consumable requirements.

The module particularly focuses on defects that have a detrimental impact on corrosion resistance and fatigue and how these can be minimised or eliminated. Relatively new innovations such as double hull practice to reduce spillage risk, use of ceramic backings and robotic welding is also discussed. Shipyard practices are discussed, including material storage, cutting, plate and section preparation, machining, assembly and launching.

Module Scope & Content

Terminology associated with mechanical testing techniques, what they mean in terms of elastic and plastic response, strength and propensity to crack

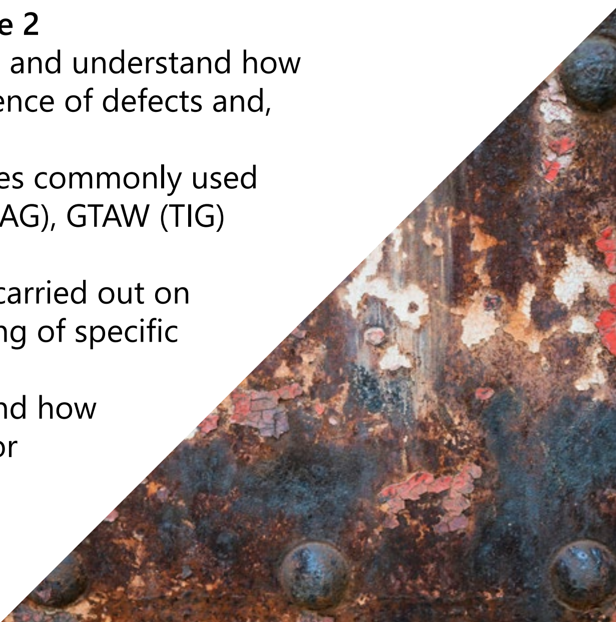
Detailed description of the tensile test, hardness test and impact test procedures and what the measurements made tell you about the suitability of the material for different structural ship components

NDT techniques used to assess quality of welds and impact of defects on fatigue life

A typical non-destructive evaluation test plan including radiography, ultrasonic testing, magnetic particle and dye penetrant testing

Examples of some of the learning outcomes from Module 2

- Know the process steps for flat and long steel products and understand how these affect metallurgical structure, surface finish, presence of defects and, influence strength and corrosion properties.
- Describe the underlying principles of welding techniques commonly used in ship building including SMAW, SAW, GMAW (MIG/MAG), GTAW (TIG) and OAW and appreciate the benefits of 'best practice'.
- Be able to describe the mechanical testing techniques carried out on metal alloys used in ship building and know the meaning of specific strength, toughness and ductility parameters.
- Know how shipyard practices impact material quality and how to minimise costs associated with remedial measures for improving surface condition



Module 3

Small craft structure, strength, stability and corrosion control strategies

(Obligatory module for yacht and small craft - and narowboat - surveyors)

Module Synopsis

This module discusses the typical design features of yachts, boats and narrowboats, including hull geometry and form, keel and rudder, sails and rigging and the materials used for construction are described. Particular emphasis is put on the metals used for applications above and below the waterline. Other critical design aspects including centre of buoyancy, meta centre, water plane area, transverse and longitudinal stability at small and large angles, forces acting on hull and sails, scantling loads, longitudinal and transverse strength requirements, influence of waves on righting moments and the variables which affect these forces are discussed.

Engine and propeller aspects concerning design and performance of optimum and non-optimum systems, resistance in calm and rough weather is also covered. A section is included on narrowboat design, stability and maintenance. Methods used to minimise corrosion above and below the waterline are introduced with the differences relating to protection requirements in seawater, brackish water and fresh water highlighted. Worked-through calculations are provided to underpin important design, performance and corrosion protection concepts. Case studies on failures above and below the waterline are presented.

Module Scope & Content

Hull design and form including forces on hull, basic concepts of wave, frictional, heel and viscous pressure resistance

Stability aspects and vector of forces acting on yachts and boats

Keel and rudder designs including theories of flow around wing, influence of shape and section, lift and induced resistance on yacht

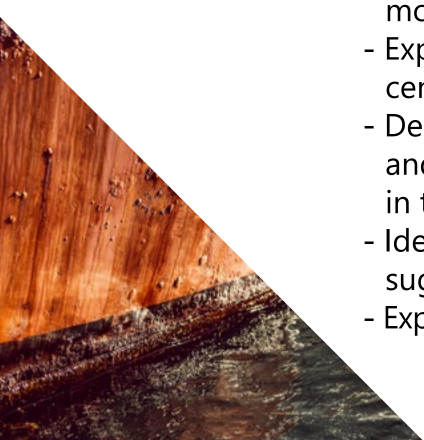
Sail and rig design including flow around sails, mast interference and methods for reducing mast disturbances and a model for sail aerodynamics

Introduction to the typical design features of a narrowboat

Corrosion control strategies for yachts, boats and narrowboats

Examples of some of the learning outcomes from Module 3

- Be able to describe the key features of a yacht including hull form, keel and rudder shape, sails and rigging and understand how they influence forces, moments and performance.
- Explain what is meant by the centre of effort of the underwater body and centre of effort of the sails and the relevance for stability.
- Describe the factors that influence corrosion rates in atmosphere, splash zone and subsea and know which materials are used to mitigate the corrosion risks in these zones.
- Identify common corrosion mechanisms that occur on yacht components; and suggest how these can be minimised.
- Explain the corrosion control strategies that are used to protect critical yacht parts.



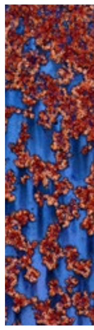
Module 4

Off-Shore structures, strength, stability and corrosion control strategies

(Optional module but strongly recommended for commercial ship surveyors)

Module Synopsis

This module introduces the design features of offshore platforms including shallow and deep water types and other structural configurations such as floating, production, storage, offloading and tension-leg platforms. The wind, wave and installation loads and mass damping requirements are discussed. The related subject of moment carrying capacity of tubular elements, box sections, welded sections, estimation of collapse loads and the ultimate load carrying capacity of tension and flexural members is included.



The structure of wind turbines using monopile, gravity and jacketed foundations and some on-shore pier structures are also included. Methods used to minimise corrosion above the waterline, within splashzone, tidal zone and below the waterline are described.

Both corrosion case studies and worked-through calculations are provided to underpin important design, performance and corrosion protection concepts.

Module Scope & Content

Types of offshore marine structures; oil and gas platforms, wind turbines etc.

Elements of assembly including fabrication, construction and installation techniques

Fatigue and fracture of structural elements

Loads on marine structures; wind and wave loads, the nature of fluid-structure interactions and benefits of mass damping

Strength of structural elements such as tubular, box, welded sections, back-to-back angles and ultimate load carrying capacity of tension and flexural members

Explain the prevalent corrosion mechanisms that can occur on offshore structures and the corrosion control strategies used to mitigate the risks

Examples of some of the learning outcomes from Module 4

- Be able to describe the different types of offshore platforms and comment on their purpose, structure and stability.
- Appreciate the wind and wave loading on offshore structures and explain how mass damping can provide a benefit with respect to stability.
- Explain the corrosion control strategies used to protect offshore platforms and wind turbines.
- Explain why fatigue and fracture of structural components is an issue and what measures are used to mitigate the risks.
- Understand what techniques are used to assess the reliability of marine structures.

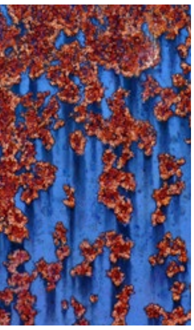
Module 5

International regulations for the construction of ships, safety and environmental protection

(Optional module)

Module Synopsis

This module discusses the importance of national and international regulatory bodies concerned with the safety of individuals at sea, protection of vessels and protection of the environment. It describes the current regulative authorities, their jurisdiction, scope and specific rules that must be adhered to and includes IMO and Lloyds Register, SOLAS, CLL and MARPOL. Risk assessments complement maritime policy and techniques such as 'structured what-if technique' (SWIFT), decision tree analysis. Probability and Consequence matrices are described.



Case studies and calculations relating to risk analysis are given and, test cases of regulation breaches and the consequences detailed.

Module Scope & Content

National and International regulatory authorities; who they are, their jurisdiction and what aspects of shipping and other maritime practices they cover

Specific regulations pertaining to an individual's health and safety

Specific regulations pertaining to safety of vessels (SOLAS)

Specific regulations pertaining to protection of the environment (MARPOL)

Lloyds Register and its activities

Safety analysis and risk assessment techniques; i.e. failure probability distributions, hazard analysis, Boolean algebra, what-if and fault tree analysis

Learning the significance of importance of IMO conventions and ship related outcomes including, CLL, SOLAS, MARPOL and the Ballast Water Convention.

Examples of some of the learning outcomes from Module 5

- Be familiar with the national and international maritime regulatory authorities, their jurisdiction, regulation scope and the details.
- Know how to use safety analysis and risk assessment techniques i.e. failure probability distributions, hazard analysis, Boolean algebra, what-if and fault tree analysis.
- Appreciate how classification societies rules on weld inspection differs, including ABS (American bureau of shipping), RINA (Italian naval register), KR (Korean Classification org.), NK (Nippon Kaiji Kyokai CR: Central Research of Ships), DNV (Norway) and Lloyds Register (UK classification society).
- Recognise weld types in different ship members and be able to suggest a non-destructive inspection plan, based on a classifying organisation.

Module 6
The marine environment

Core module to be taken by all delegates

Module Synopsis

This module gives a comprehensive overview of the marine environment, its division into zones, the characteristics of each zone and factors that affect corrosion rates of metals exposed to the zonal conditions.

Detailed consideration is given to atmospheric and oceanographic factors that influence sea state and the types of waves that prevail; this is especially relevant to the forces exerted on ship and smaller vessel hulls and the consequential design, strength and material selection decisions that are made. The conditions that occur in shallow coastal regions, deeper sea/oceans and seaways are contrasted.

Physical, chemical and biological factors are described with reference to those that impact corrosion processes i.e. salinity, ionic concentration, conductivity, flowrate, dissolved oxygen, pollutants, biological organisms and propensity for biofilm formation. The relevance of an increasing amount of available data for ocean waves in the form of wave height frequency distribution by sea and wind velocity profiles are discussed.

Module Scope & Content

Zones in the marine environment – atmosphere, splash zone/tidal range, subsea etc. and factors in each zone that influence corrosion rate, including: -

Atmosphere: salinity (vertical and inland distribution), vertical wind speed distribution (relative gust energy), spectrum of ocean wind velocity

Sea level/splash zone: tidal range & splash zone; frequency spectrum of sea surface level (relative energy)

Waves: Profiles and wave trochoid, sinusoidal waves: basic relationship to describe action of waves in shallow and deep water

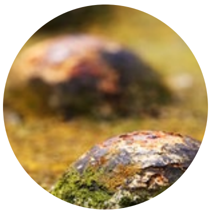
Orbital motion of waves and decay in shallow and deep water

Wave height distributions referencing several 'seas' and 'oceans', circulation of water and tides including velocity profile subsea

Seawater composition, variation in density, salinity, level of dissolved gases, ionic concentration, conductivity, flowrate etc.

Examples of some of the learning outcomes from Module 6

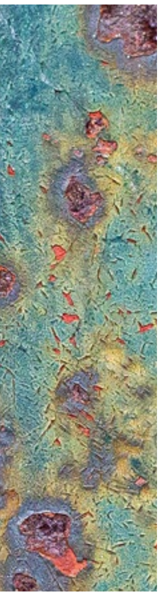
- Identify the zones that make up the marine environment and know how the characteristics of each zone influence engineering and corrosion control decisions for sea going vessels and off shore structures.
- State the definitions of fresh, brackish and sea water and know how their physical, chemical and biological properties differ in terms of impacting corrosion and preventative measures used.
- Be familiar with the meteorological conditions that impact performance of sea going vessels, how risks from these conditions can be minimised through design and where data can be sourced.
- Appreciate how marine pollution from marina management, ships (fuel and dumping), air and land affect corrosion can detrimentally affect the environment.



Module 7

Steels and non-ferrous alloys used in marine applications; composition and properties

Core module to be taken by all delegates



Module Synopsis

This module introduces the range of ferrous (cast iron, mild, high strength and stainless steels) and non-ferrous metals (copper alloys (brass, bronze, copper-nickel, gunmetal), nickel alloys, aluminium alloys, titanium alloys that are commonly used in marine applications with reference to their grade designation system, composition, mechanical properties, corrosion resistance and corrosion related metrics.

The ability of some metal alloys to passivate hence provide a corrosion protection mechanism in some conditions and the factors that result in destabilisation of protective passive films are discussed. A brief introduction to the corrosion mechanisms that undermine each alloy type are described and their suitability in different marine zones is covered. The metal alloys are also ranked in terms of propensity to suffer biofouling and how pollutants can impact performance.

Lastly, fabrication practices and compatibility with other metal alloys are considered.

Module Scope & Content

Focus on: Iron, non stainless steels, including structural carbon steel and low alloy steels for pressure vessels

Stainless steels (ferritic, martensitic, austenitic, duplex, PH)

Copper alloys (brasses, bronzes, Cu-Ni alloys)

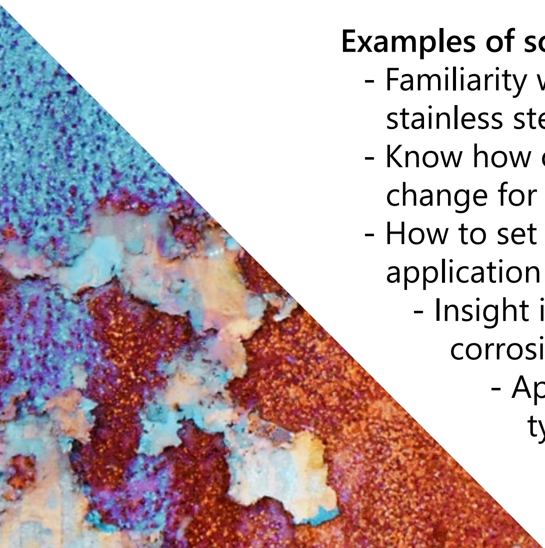
Nickel Alloys (Ni-Cu and Ni-Cr-Mo alloys)

Aluminium Alloys (mainly 5000 and 6000 alloy series) with particular reference to common grades, their designations and composition, mechanical and corrosion resistance properties, plus grades specified for use in marine environment zones

The prevalence of specific corrosion mechanisms by alloy type are covered along with fabrication practices, as well as compatibility with other materials from a galvanic corrosion perspective and propensity for biofouling and need for protection

Examples of some of the learning outcomes from Module 7

- Familiarity with the common designation systems relating to iron, non stainless steel, stainless steel and non-ferrous alloy grades.
- Know how compositions, mechanical properties and corrosion resistance change for alloy types suited to different marine conditions (zones).
- How to set about the task of specifying a suitable grade for a specific marine application i.e. basic knowledge of some material selection methods.
- Insight into the manner in which established grades can be attacked by corrosion processes and how such outcome affects further selection.
- Appreciate the corrosion mechanisms that undermine different alloy types and alternative materials that offer improved performance.



Module 8

Corrosion mechanisms that degrade metals in the marine environment

Core module to be taken by all delegates

Module Synopsis

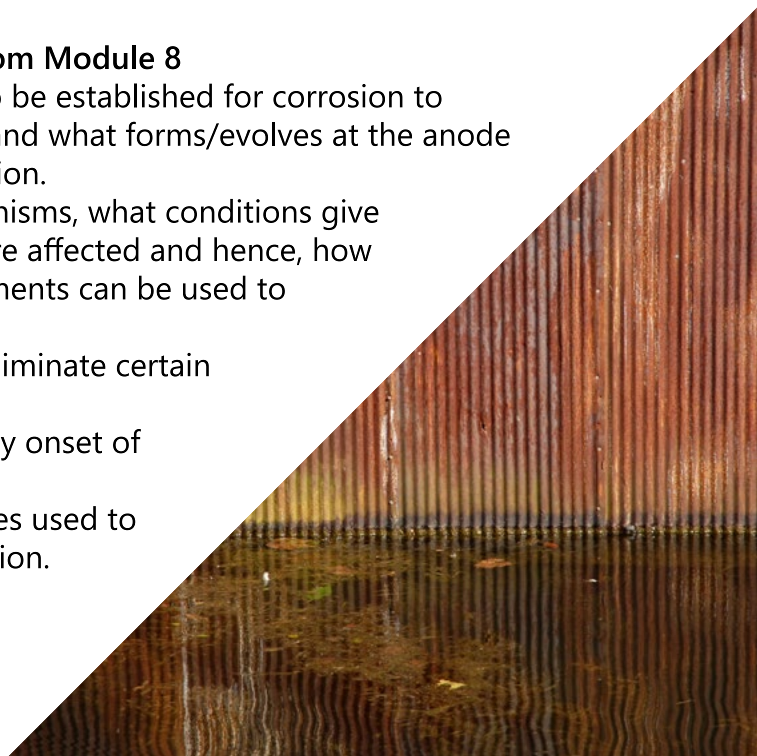
This module gives a detailed description of the corrosion mechanisms that occur in different metals and discusses how structure, composition and surface influence corrosion rates. The characteristics of uniform, localised and crack initiating corrosion mechanisms are detailed. A distinction is made between passive and non-passive metals and what conditions promote instability of the passive layer and onset of localised corrosion. Some corrosion mechanisms propagate cracks which can lead to catastrophic structural failure including, corrosion fatigue, stress corrosion cracking, hydrogen cracking; these mechanisms are discussed in detail with a particular emphasis on which metal alloys are more or less resistant.

The popular subject of galvanic corrosion is discussed comprehensively, with an emphasis on the influence of design, material combination, service conditions and risk mitigation. A final topic includes corrosion mechanisms which combine wear processes such as erosion corrosion and cavitation and highlights factors that make a metal more resistant to attack.

Module Scope & Content

Introduction to corrosion mechanisms including:
- Uniform corrosion, galvanic corrosion
- Localised corrosion forms of 'passive layer metals' (aluminium, stainless steel, titanium): pitting corrosion, crevice corrosion, intergranular corrosion
- Cracking mechanisms: corrosion fatigue, stress corrosion cracking (SCC), hydrogen damage
- Other mechanisms: exfoliation, dealloying
- Microbially induced corrosion (MIC)
- Wear related: erosion corrosion, fretting and cavitation

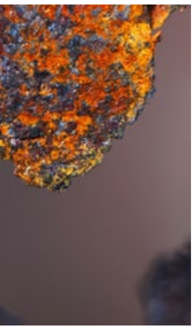
Examples of some of the learning outcomes from Module 8
- Understand the basic conditions that need to be established for corrosion to occur and explain what Redox reactions are and what forms/evolves at the anode and cathode during an electrochemical reaction.
- Categorise the spectrum of corrosion mechanisms, what conditions give rise to their initiation, which marine metals are affected and hence, how material selection in specific marine environments can be used to optimise performance.
- Understand how design can reduce and/or eliminate certain corrosion mechanisms.
- Know what material defects can facilitate early onset of cracking processes.
- Know the principles of and discuss approaches used to mitigate the risks of different forms of corrosion.



Module 9

Corrosion control and prevention of metals used in the marine environment

Core module to be taken by all delegates



Module Synopsis

This module describes the measures widely used to control and suppress corrosion in ferrous and non-ferrous alloys. The starting point is at the design and material selection stage, consequently, systematic material selection techniques, based on ranking the order of desired properties for candidate materials and calculating a material performance index and hence a ranking are introduced.

The importance of good design particularly for open and closed structures above the waterline are considered. In contrast, materials that are suitable for applications below the waterline, with and without cathodic protection, are identified. The principles of sacrificial anode cathodic protection and impressed current cathodic protection are described. Example calculations for anode mass, current requirements and anode arrangement on vessels is given to underpin relevant principles.

Different types of inhibitors and the protection mode, the systems they protect, how they are applied and the mechanism of corrosion suppression are described. Finally the nature, application and performance of a wide range of marine coatings including corrosion protective and antifouling systems is covered.

Module Scope & Content

Design aspects

Material selection methodologies

Cathodic protection: sacrificial anode and impressed current techniques

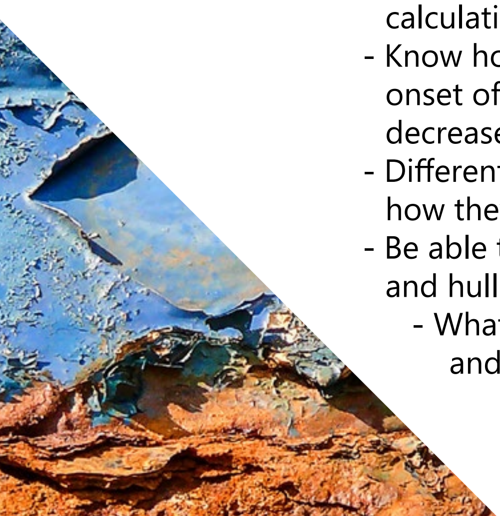
Corrosion inhibitors: Inorganic – anodic and cathodic; organic – film forming; environmental - scavenging and biocidal

Protective coatings: anodic, cathodic, barrier and conversion etc.

The value of maintenance

Examples of some of the learning outcomes from Module 9

- In what circumstances do metals behave in an anodic or cathodic manner, which one corrodes and how could the corrosion rate be estimated by calculation.
- Know how design features for open and closed structures can accelerate the onset of corrosion and consequently, explain what changes can be made to decrease risk and improve material performance.
- Differentiate between different types of inhibitors where they are used and how they suppress corrosion.
- Be able to calculate the mass of an anode needed to protect a ships stern gear and hull and, suggest an arrangement for the anode(s).
- What maintenance strategies are typically used to protect metal structures and components.



Module 10

Failure analysis *(Optional module)*

Module Synopsis

This module considers failure analysis and its important facets. It begins with a discussion about the forensic nature of well conducted analyses and ends with several case studies taken from ship, smaller craft and offshore platform related applications.

The core material covers the characteristics and reasons for common failure types including ductile, brittle and intergranular failures and, failures resulting from well-established cracking mechanisms i.e. corrosion fatigue, stress corrosion cracking and hydrogen cracking. Equally important are the corrective actions that can be taken to avoid failures and consequently materials that are resistant to specific failure types and the tests and associated metrics that quantify a materials resistance are also described.

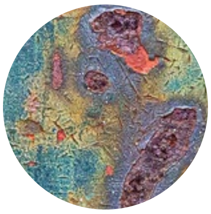
Systematic techniques such as root cause analysis, fault-tree analysis, failure modes and effects analysis are useful tools for identifying unknown causes of failure and these techniques are introduced. A failure investigation relies on the collection of data from a wide array of methods including, macroscopic and microscopic examination, spectroscopic techniques and non-destructive testing methods. These are described in detail and their merits discussed.

Module Scope & Content

- Root cause analysis and understanding the physical and human roots of failure
- General: Failure mechanisms – how they occur and their characteristics
- When should a failure analysis be carried out, how deep should it go, how long should it take?
- Ductile failures, brittle failures, intergranular failures, overload failures;
- Failure due to other crack inducing mechanisms including, fatigue/corrosion fatigue, stress corrosion cracking and hydrogen cracking
- Fatigue stress concentration, crack nucleation and growth; structural change by high cycle fatigue, diagnosing HCF, guides to interpreting the fatigue
- Front: torsional low cycle fatigue
- Corrosion induced failures
- Wear induced failures
- Analytical tools used to investigate failures including optical and electron microscopy and, other spectroscopic techniques and, non-destructive testing methods
- Case studies of failures from small vessels, ships and offshore structures

Examples of some of the learning outcomes from Module 10

- Distinguish between ductile, brittle and intergranular metal failures.
- Be able to set up a failure analysis strategy, identify microscopic investigations that can assist and identify the most appropriate spectroscopic and/or other techniques that can be employed.
- Know about the characteristics of different cracking mechanisms including fatigue, stress corrosion cracking, hydrogen cracking and mechanisms that occur in weld seams.
- Know how to assess toughness of metals and the metrics that quantify resistance of a material to crack propagation.
- Design and implement an appropriate strategy for investigating the likely cause of a failure in an engineering component.



Your investment
in the Professional Qualification in Marine Corrosion
and the next step

The cost of the qualification is £950, which covers attending the live lectures or video recorded delivery of the seven modules and tests (including resits) you are required to study. IIMS members and students are offered a discounted price of just £895. You can either pay up front on enrolment, or in two equal instalments with 50% payable on booking and 50% due before the start of the programme. If you wish to study additional modules over and above the seven you are required to take, you may do so at a cost of £80 per module.

At this stage IIMS is not seeking your formal commitment to study, rather we are asking you to lodge your EXPRESSION OF INTEREST to study for this professional qualification. Registering your interest now does not obligate you in any way. The first course is to be held around June and the second one in November 2021. Once you have expressed your interest, we will be in touch in the coming weeks to see if you wish to progress and formally enrol for the Professional Qualification in Marine Corrosion, or not.

The qualification is managed by the Institute's wholly owned subsidiary, the Marine Surveying Academy, but formally awarded by certification by the International Institute of Marine Surveying.

To register your expression of interest go to **http://bit.ly/39gVOGV**.

PROFESSIONAL QUALIFICATION IN MARINE CORROSION

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