

Introduction to the Surface Finishing Foundation Certificate

The course/module for the Foundation Certificate is designed to provide personnel in surface finishing and related technologies the opportunity to improve and increase their knowledge and thus should be able to deal with shop floor problems more effectively. Further, it is of value to line-management and sales personnel to improve and increase their knowledge of the processes operated within the company and provides a foundation for those who may wish to go on and study for higher qualifications.

A tutored course was first introduced in 1988 and later made available as a Distance Learning module. It has proved to be of immense value to those who wish to embark on the continuing education and training programme of the Institute either by the tutored or distance learning route. It is also the underpinning knowledge for NVQs.

There are currently 29 units available for study as shown below:

Unit 1	*	Surface Finishing
Unit 2	*	Corrosion
Unit 3	*	The Environment & Surface Finishing
Unit 4	*	Health and Safety
Unit 5	*	Cleaning and Pre-treatment
Unit 6	*	Sacrificial Coatings
Unit 7	*	Services
Unit 8		Surface Improvement
Unit 9		Principles & use of Electroplating
Unit 10		Plant and Equipment
Unit 11		Copper, Silver and Gold Plating
Unit 12		Nickel Plating
Unit 13		Chromium Plating
Unit 14		Zinc & Cadmium Plating & Passivation
Unit 15		Electroless Plating
Unit 16		Alloy Plating & Composites
Unit 17		Printed Circuit Board Processes
Unit 18		Electroplating – Care & Maintenance of Solutions & Product Quality
Unit 19		Conventional Paint Processes
Unit 20		Electrophoretic Paint Processes
Unit 21		Paint Application Methods
Unit 22		Coating Powders & Application
Unit 23		Testing Paint & Powder & Coatings
Unit 24		Chemical Conversion Coatings and Sol Gel Coatings
Unit 25		Anodising of Aluminium & Alloys
Unit 26		Vacuum Coating Processes
Unit 27		Duplex Coatings of Galvanising plus Paint
Unit 28		Electroforming
Unit 29		Nanotechnology

* Mandatory units

Institute of Materials Finishing

The **7 Mandatory units** must be studied plus **5** from one of the **Technology Blocks** and a further **3 Optional units** from those units not already selected for study.

Mandatory Units

- 1 Surface Finishing
- 2 Corrosion
- 3 Environment & Surface Finishing
- 4 Health & Safety
- 5 Cleaning & Pre-treatment
- 6 Sacrificial Coatings
- 7 Services

Plus Technology Block

Electroplating **OR**
8 Surface Improvement
9 Principles & Use of Electroplating *
10 Plant & Equipment
18 Care & Maintenance of Solutions and Product Quality

Organic Coating **OR**
19 Conventional Paint Processes*
20 Electrophoretic Paint Processes
21 Paint Application Methods
23 Testing Paint & Powder and Organic Coatings

Aerospace
19 Conventional Paint Processes*
21 Paint Application Methods
24 Chemical Conversion and Sol Gel
25 Anodising of Aluminium & Alloys

* counts as 2 units

Plus 3 Optional Units

(but not from your selected Technology Block)

8 Surface Improvement
11 Copper, Silver & Gold Plating
14 Zinc & Cadmium Plating
17 Printed Circuit Board Processes
20 Electrophoretic Paint Processes
23 Testing Paint & Powder &
26 Vacuum coating processes
29 Nanotechnology

9 Principles & uses of Electroplating
12 Nickel Plating
15 Electroless Plating
18 Maintenance of Solutions & Product Quality
21 Paint Application Methods
24 Chemical Conversion and sol gel coatings
27 Duplex Coatings

10 Plant & Equipment
13 Chromium Plating
16 Alloy Plating & Composites
19 Conventional Paint Processes
22 Coating Powders & Application
25 Anodising of Aluminium & Alloys
28 Electroforming

Study time of the units is anticipated to be approximately 40-45 hours. In addition, there is some 'homework' referred to as Self Marked Assessments (SMAs) and Marked Assignments (MAs), that will require further study time. SMAs and MAs are situated at various positions in your module.

Self Marked Assessments (SMAs)

A series of multiple-choice questions each of which has one correct answer and three incorrect answers to test that you have understood some of the material studied.

You answer these SMAs, preferably from what you have learnt in study, without reference to the units. Check your answers against the answers given in Appendix 7.

Whilst the SMAs give no marks to your final pass mark they do give a good indication of how well you have understood what you have studied. The questions in the SMAs are an example of the type of question you can expect in the multi-choice section of the end of course/module examination.

Marked Assignment (MA)

Assignments are designed to test that you have understood some of the study material and can use the knowledge to suggest answers to a specific problem or situation. In the traditional system of learning these would be called 'homework'.

These assignments are marked and given a mark that contributes up to a maximum of 20% towards your final examination pass mark, so you are rewarded for your efforts.

Please note: marked assignments are compulsory and must be submitted by the due date for you to be eligible for the final examination. This is fully explained in Appendix 2 and Appendix 5.

The Examination

The 90-minute examination consists of two sections:

Section A 30 multi-choice questions each of which have five possible answers, only one of which is correct. There is no penalty for selecting a wrong answer and there are no trick or ambiguous answers. You only have to tick the answer you consider to be correct.

Section B 5 short essay type questions.

Marking MAs 20%, Section A - 40%, Section B - 40%

Pass Mark **40%, Pass with Merit - 60%, Pass with distinction - 75%**

A certificate is supplied upon passing the examination, suitably inscribed pass, merit or distinction. Further, on passing the examination and you have sufficient background experience you can apply to be awarded the qualification 'Associate of the Institute of Materials Finishing' and use of the insignia 'AssocIMF'.

NOTE: Candidates whose first language is not english may use a dictionary book during the examination, other types of dictionary, e.g. electronic ones and technical dictionaries, are not

permitted. The examination's invigilator will check that the dictionary is suitable before the start of the examination. (Examples of suitable dictionaries are standard English dictionaries and dictionaries providing translation from English to another language and vice versa.)

INTRODUCTION TO DISTANCE LEARNING

Distance Learning differs from the traditional method of learning that you will have used at school or college, where you work at a fixed rate that is determined by your teacher or lecturer. Their rate of teaching may be too fast or too slow for different students, so you either get bored or cannot keep up. Furthermore, if you miss a lesson, you will have to catch up before the next lesson, or you will quickly fall behind.

Distance Learning is not a new concept and has been around for several decades and it allows you to work at your own pace and in your own time. The Institute of Materials Finishing has been offering their courses for many years and after listening to our students, we realised that the preferred method of teaching was by offering scripted lecture notes.

Although you will be often working alone in your studies, the Institute makes sure that you have enough support if and when you have any problems.

As you are aware, you have been allocated an 'Industrial Counsellor' who, hopefully, is a member of your company. One of the roles of the Industrial Counsellor is to help you understand what you are being taught. We fully accept that not one will fully understand every part of their course the first time they see it. Every person is different and has different skills and attributes, so they will find different parts of the course either easy or more difficult. When you meet a difficulty, you should ask the Industrial Counsellor to help you; it is their role to help you to understand the content of the lessons. If a suitable person is not immediately available within your company then the Institute will have made arrangements for you to be linked to a suitable local member of the Institute who has agreed to be available to assist you. Even if this person cannot immediately answer your problem, he or she will know someone who can. Most importantly, do not become disheartened in your studies. If, on any occasion, your Counsellor is unable to help, you should contact the Education Manager at The IMF's Head Office who will arrange for a Professional Member to contact and assist you.

You will find it very useful to have a pencil or pen and paper with you when you are studying, as you can quickly write down any extra notes or explanations; these can be very useful when you come to revising or are seeking further help.

This module is made up from a set of lessons of various lengths that are composed of written text with some illustrations where relevant. You may need to read the text several times to fully understand it and before moving on to the next lesson.

FOUNDATION OBJECTIVE SYLLABUS

Unit 1 – Surface Finishing *

- 1.1 A definition of surface finishing.
- 1.2 Know the various surface finishing technologies that are available.
- 1.3 Understand that coatings may be deposited onto a substrate and that substrate surfaces may be changed from the metal to a metal compound.
- 1.4 Be able to describe several surface finishing processes and in particular: Anodising, Conversion Coating, Electroless Plating, Electroplating, Galvanising, Mechanical Plating, Paint Lacquer & Varnish, Powder Coating, Thermal Spraying, Vacuum Deposition and Vitreous Enamelling.

Unit 2 – Corrosion *

- 2.1 Understand the term corrosion.
- 2.2 Understand that there is an Electrochemical Series (ECS) which lists metals in the order of their standard electrode potentials both positive and negative.
- 2.3 Appreciate that the ECS and the electrode potential of common metals are useful in surface finishing.
- 2.4 Appreciate that the ECS can predict which metal will corrode when dissimilar metals are in contact in the presence of an electrolyte, which may be only moisture containing traces of salts.
- 2.5 Name the common types of corrosion.
- 2.6 Understand the term 'sacrificial corrosion'.
- 2.7 Understand how double and triple metal layers may be deposited to improve the corrosion protection afforded to the substrate.
- 2.8 Appreciate that the use of conversion coating treatments can delay the commencement of corrosion and prevent undercutting corrosion when a surface has been damaged.
- 2.9 Understand how coatings protect substrates from corrosion.
- 2.10 Be aware of the use of various accelerated corrosion tests for evaluating the quality of coated products.

Unit 3 – The Environment and Surface Finishing *

- 3.1 Appreciate how liquid, solid and gaseous wastes can pollute the environment.
- 3.2 Identify the common sources of wastes and the legislation for their control
- 3.3 Know that the discharge of waste waters containing metals and other chemical compounds are subject to “Consent to Discharge” limits.
- 3.4 Appreciate why water rinsing is an important operation in all chemical processing and that the discharge of such waters may produce pollution if not treated.
- 3.5 Know how water consumption can be reduced without detriment to the process.
- 3.6 Identify methods of reducing losses from process solutions.
- 3.7 Be aware of the methods used for the treatment of effluent.
- 3.8 Appreciate how both water and process chemicals can be recovered for reuse.
- 3.9 Know the sources of energy used in surface finishing and how such energy use may be minimised.
- 3.10 Know how to contain spillages
- 3.11 Have a basic knowledge of the legislation to which the surface finishing industry is accountable.

Unit 4 – Health and Safety *

- 4.1 Understand the terms Health and Safety and the factors that can affect them.
- 4.2 Recognise the difference between a “Hazard” and a “Risk”
- 4.3 Know the issues that are necessary in managing Health and Safety.
- 4.4 Be aware of the hazardous substances used in the surface finishing industry.
- 4.5 Know that all UK companies are required to maintain a COSHH manual that identifies all materials that are used in the company.
- 4.6 Know where health and safety information on a material in use can be obtained.

- 4.7 Appreciate the dangers of some specific chemical substances and how any accidental spillage should be treated.
- 4.8 Be aware of the need to use Personal Protective Equipment.
- 4.9 Know where emergency treatment can be obtained
- 4.10 Be aware of the need for correct labelling of all process equipment and containers for solutions.
- 4.11 Be aware of the dangers associated with fire, the needs for fire protection and the siting of fire extinguishers.

Unit 5 – Cleaning and Pre-treatment *

- 5.1 Appreciate the importance of cleaning and pre-treatment for ALL surface finishing technologies.
- 5.2 Know how to remove different types of soil
- 5.3 Know how to remove soils with organic solvents and aqueous based solutions.
- 5.4 Have an awareness of the different chemicals present in aqueous based solutions and the function served by each constituent.
- 5.5 Appreciate the benefits of the use of electrolytic cleaning.
- 5.6 Recognise the problems of hydrogen embrittlement and how this phenomenon can be minimised during cleaning and pre-treatment.
- 5.7 Be aware that mechanical treatments can be used for cleaning and preparing substrates for surface finishing.
- 5.8 Recognise the benefits of etching and activation of substrate surfaces prior to coating.
- 5.9 Be aware of the use “strike plating” to overcome problems associated with hydrogen overvoltage, passive surfaces and reactive surfaces.
- 5.10 Know that the durability of organic coatings is affected by the quality of the pre-treatment of the substrate.

Unit 6 – Sacrificial Coatings *

- 6.1 Understand what is meant by the term "sacrificial coating".
- 6.2 Be aware that zinc is the predominant metal used for the protection of iron and steel against corrosion.
- 6.3 Be aware that zinc is a sacrificial metal under aqueous corrosion conditions.
- 6.4 Know the various processes for the application of zinc-based coatings.
- 6.5 Be able to compare and contrast the various zinc coating processes and be able to select the appropriate process for specific applications.

Unit 7 – Services *

- 7.1 Be aware of the use of services (gas, electricity and water) in the surface finishing industry.
- 7.2 Understand that 'water discharge' whilst not a supplied service is a controlled requirement for discharge to sewer or river.
- 7.3 Appreciate the need to treat water used in surface finishing installations to agreed limits prior to discharge to sewer or river.
- 7.4 Understand that water is a costly material to purchase and further costs are incurred on discharge.
- 7.5 Appreciate that the various water boards have the authority to seal the drains within a company in the case of excessive, unauthorised discharge.
- 7.6 Have knowledge of the various methods for treating toxic substances in discharges both for dissolved and solid substances to prevent discharge to the environment.

Unit 8 – Surface Improvement

- 8.1 Understand that components may need attention to their surface prior to coating, i.e. removal of scale and rust and where a final decorative appearance is required.
- 8.2 Be aware that surface improvement can be achieved by manual and automatic means using chemical and/or mechanical techniques.
- 8.3 Appreciate how surface improvements may be achieved by various techniques and the equipment used to achieve the required result.

- 8.4 Know that the use of 'mass finishing' techniques for relatively small components can significantly reduce the piece cost of surface improvement.
- 8.5 Know the principles of shot peening and the benefits conferred by this treatment
- 8.6 Be aware of the use of thermochemical treatments.

Unit 9 – The Principles and use of Electroplating

- 9.1 Know the definition of electroplating.
- 9.2 Have an awareness of the effects of electroplating.
- 9.3 Appreciate the advantages and disadvantages of electroplating.
- 9.4 Know how electroplating works and be able to give a simple explanation.
- 9.5 Know how to electroplate components using racks or barrels.
- 9.6 Appreciate the use of masking and stopping-off techniques.
- 9.7 Recognise the requirements for an electroplating solution and the function of its chemical constituents.
- 9.8 Understand reactions that can occur at a cathode.
- 9.9 Understand the meaning and significance of Cathode Current Efficiency and why some types of solution are more or less efficient than others due to the production of hydrogen.
- 9.10 Appreciate the reasons for the use of soluble and insoluble anodes.
- 9.11 Know the definition of pH; understand the importance of pH in electroplating and how to measure and control it.
- 9.12 Know how quantitative electrolysis can be used to calculate plating times, current required and deposit thickness.
- 9.13 Understand the meaning and significance of the terms "covering power", "throwing power" and "burning".
- 9.14 Understand how deposit thickness and uniformity can be affected by changes in current density and cathode current efficiency.

Unit 10 – Plant and Equipment

- 10.1 Have an awareness of materials for the construction of plating tanks.
- 10.2 Understand how to connect the electrical equipment used for electroplating and the function of this equipment.
- 10.3 Recognise the need for equipment for heating, cooling, solution agitation, extraction etc and the reasons for its use.
- 10.4 Understand the need for filtration and be aware of the various types of equipment available.
- 10.5 Understand how to select the materials of construction for Jigs and Racks.
- 10.6 Be aware of the types of semi-automatic and fully automatic plants available for rack and barrel processing.
- 10.7 Be aware how plant can be arranged to give optimum production.
- 10.8 Know the methods available for the drying of components after processing.

Unit 11 – Copper, Silver and Gold Plating

- 11.1 Be aware of the use of copper for decorative and engineering coatings and as an undercoat for other deposited metals.
- 11.2 Be aware of the various types of copper, silver and gold plating solutions available, their formulations and applications.
- 11.3 Appreciate how the colour of gold coatings can be modified by the addition of other metals to the plating solution

Unit 12 – Nickel Plating

- 12.1 Be aware of the use of nickel plating for decorative and engineering applications.
- 12.2 Recognise the function of the chemical constituents in a nickel plating solution.
- 12.3 Know the reasons for the use of addition agents.
- 12.4 Recognise that different types of anode material are available and be aware that anode

baskets and bags are used.

- 12.5 Be aware that nickel can be deposited without the use of electricity.
- 12.6 Identify the principal chemical constituents and their function in electroless (autocatalytic) nickel plating solutions.
- 12.7 Describe the advantages and disadvantages of electroless nickel plating.
- 12.8 Be aware that electroless nickel is an alloy whose hardness can be modified by heat treatment.

Unit 13 – Chromium Plating

- 13.1 Know the uses and properties of electrodeposited chromium coatings for both decorative and engineering applications.
- 13.2 Be aware of the chemical composition of the various types of chromic acid-based chromium plating solution and their limitations.
- 13.3 Recognise the health and safety implications associated with the use of hexavalent chromium compounds.
- 13.4 Be aware of the advantages of using the trivalent chromium plating solutions.
- 13.5 Know the properties of hard chromium deposits that make them suitable for engineering applications.
- 13.6 Know how the properties of hard chromium deposits vary with the type of chromic acid based plating solution used.
- 13.7 Appreciate the need for good surface preparation for engineering chromium deposits.
- 13.8 Know how to strip chromium deposits.

Unit 14 – Zinc and Cadmium Plating and Passivation

- 14.1 Appreciate the importance of zinc for corrosion protection.
- 14.2 Be aware of the various types of zinc plating solutions available and their formulation.
- 14.3 Appreciate the advantages and disadvantages of the various types of zinc plating solution.

- 14.4 Be aware of the toxic nature of the chemical constituents in some zinc plating solutions.
- 14.5 Know that zinc alloys can be plated as a more corrosion resistant alternative to pure zinc coatings.
- 14.6 Be aware that zinc-nickel can be deposited from both acid and alkaline solutions and that the properties of the deposit vary with the type of solution used.
- 14.7 Appreciate that cadmium is only permitted for specific applications
- 14.8 Know how to electroplate cadmium.
- 14.9 Understand the importance of passivation treatments in enhancing the corrosion resistance of zinc and cadmium coatings.
- 14.10 Know that the various coloured passivation films provide differing corrosion protection.
- 14.11 Know the various chemicals used in passivating solutions.
- 14.12 Know that safer alternatives to chromate based passivates are available.

Unit 15 – Electroless Plating

- 15.1 Identify examples of electroless plating by immersion, homogenous chemical reduction and autocatalytic deposition.
- 15.2 Appreciate the advantages, disadvantages and practical use of such processes.
- 15.3 Be able to define the term “autocatalytic” and be aware of general formulations of plating solutions of this type.
- 15.4 Be aware of the range of autocatalytic plating processes for the production of nickel coatings.
- 15.5 Know that autocatalytic nickel-phosphorus deposits may be classified according to phosphorus content and be aware of the properties of the coatings with different phosphorus contents.
- 15.6 Be aware that the properties of electroless nickel can be modified by heat treatment.
- 15.7 Be able to identify the main constituents of electroless plating solutions.
- 15.8 Know that solution concentration and operating conditions affect deposit properties and deposition rate.

- 15.9 Know the importance of maintaining solution constituents at optimum concentration.
- 15.10 Know the main uses of autocatalytic copper deposition. Identify the main constituents of the solution and their function.
- 15.11 Be aware that solution concentrations must be maintained at optimum levels.

Unit 16 – Alloy Plating & Composite Coatings

- 16.1 Know why alloys are used in metallurgy and identify the problems associated with producing alloy electrodeposits.
- 16.2 Be aware of the main alloy electrodeposits and the reasons for the use of these alloys.
- 16.3 Understand that for alloy deposition to be possible the standard electrode potentials of the co-deposited metals must be close together in simple salt solutions or brought close together by complexing.
- 16.4 Know the methods used to replenish the metal content of alloy plating solutions and understand how variables of current density, agitation, temperature, pH and solution formulation influence the composition of the electrodeposited alloy.
- 16.5 Be aware of the structure of composite coatings.
- 16.6 Know that the particles used in composite coatings take no part in the electrochemical reactions.
- 16.7 Know that the particles used in composite coatings must be inert, not react chemically with the plating solution used and must not be oxidised at the anode.
- 16.8 Know that particles for use in composite coatings must be sized such that they can be completely encapsulated by the metal coating.

Unit 17 Printed Circuit Board Processes

- 17.1 Appreciate the practical importance of printed circuit boards (PCBs).
- 17.2 Understand that the conducting tracks of a PCB can be produced by subtractive or additive methods.
- 17.3 Be able to list the main stages in the production of a PCB by the subtractive method.
- 17.4 Know the essential characteristics of a clad laminate and identify the problems caused by

- drilling holes for interconnection purposes in terms of burr removal, resin smear and the need to render the walls of holes electrically conductive.
- 17.5 Recognise the need for a catalyst, activator and autocatalytic deposition of copper as a pre-requisite for electrodeposition of copper using the copper sulphate process.
 - 17.6 Know the function of photo-chemical plating resists and the methods used to remove non-crosslinked resist prior to electrodeposition of copper and etch resist.
 - 17.7 Appreciate that the main hole wall electrical conduction is achieved by copper plating and be able to state why this system is used. Be able to identify the reasons for the use of high throw versions of the plating solutions.
 - 17.8 Know the functions of the electrodeposited etch resist and be able to give examples.
 - 17.9 Identify suitable methods for the removal of copper by etching.
 - 17.10 Understand why reflowing of the etch resist is a requirement and how it is done.
 - 17.11 Recognise the need to apply solder masks and why gold plating of edge connectors is required.

Unit 18 – Electroplating Care & Maintenance & Product Quality

- 18.1 Appreciate the need to maintain process solutions at their optimum conditions.
- 18.2 Know how samples should be taken for test purposes.
- 18.3 Be aware of the use of test methods, chemical analysis and the use of small-scale tests.
- 18.4 Be aware that process solutions can become contaminated.
- 18.5 Recognise the need for purification of process solutions.
- 18.6 Define product quality.
- 18.7 Appreciate the importance of Product Technical Specifications.
- 18.8 Be aware of the use of “Standards” from British, European and International sources.
- 18.9 Appreciate the need for quality assessment and the use of equipment to carry it out.

Unit 19 – Conventional Paint Processes

- 19.1 Know the difference between the terms Inorganic and Organic and that paints are synthesised from organic compounds but that some inorganic compounds may be used as 'additives' for specific requirements.
- 19.2 Be aware that paints are loosely classified according to their use e.g. primer, undercoat, finish etc.
- 19.3 Know the components that make up a conventional liquid paint and the purposes for which they are used.
- 19.4 Understand the production methods used to manufacture paints.
- 19.5 Be aware of the properties of the various types of paint .
- 19.6 Know that paints are classified according to the polymer from which they are formulated – e.g. alkyd, epoxy etc.
- 19.7 Understand the performance characteristics of these different types of paint and why a particular type is selected for a particular use.
- 19.8 Appreciate the difference between 'Convertible' and 'Non-convertible' coatings and the different methods of drying/curing to produce a continuous film.
- 19.9 Know that the solvents emitted in the use and drying of paints can be dangerous to the environment and the health and safety of people and that their use is the subject of legislation under the EU Solvents Emission Directive.

Unit 20 – Electrophoretic Paint Processes

- 20.1 Appreciate the difference between 'Electrophoretic' and 'Autodeposition' painting.
- 20.2 Know how electrophoretic paints are made using water soluble resins and are deposited onto substrates by electroplating technology and the substrate may be the anode or cathode in a DC electrical cell.
- 20.3 Be aware of the benefits of using electrophoretic paints.
- 20.4 Be able to specify equipment needed for the construction of an electrophoretic paint plant.
- 20.5 Know what ultrafiltration is and the reason for its use.
- 20.6 Know why autodeposition can only be used on ferrous substrates.

20.7 Be aware of the benefits that an autodeposition coating imparts to a substrate.

Unit 21 – Paint Application Methods

21.1 Know the various methods for the application of paints.

21.2 Know that the method of application is dependent on production requirements i.e. short runs, mass production, colour changing etc.

21.3 Understand the difference between conventional and electrostatic spraying and the benefits of using electrostatic methods.

21.4 Be able to select the appropriate coating technique for various batch sizes.

Unit 22 – Coating Powders and their Application

22.1 Know how coating powders are manufactured.

22.2 Know that powders are split into two categories – thermoset and thermoplastic.

22.3 Be aware which polymer types are thermoset and thermoplastic and how they differ after being melted or cured.

22.4 Know the two different techniques that are used to apply powders and the types of products/components for which they are best suited.

22.5 Know the various types of heating equipment and heating media used for melting/curing powders.

22.6 Know the benefits of using powders over conventional liquid paints and know some of their applications.

Unit 23 - Testing of Paints and Powders and their Coatings

23.1 Appreciate the need for 'in-house' testing of both incoming materials and out-going customer products.

23.2 Know that a customer may be an external company or another part (maybe off-site) of your own company group.

23.3 Realise that all information from testing (both positive and negative) must be recorded.

- 23.4 Be aware that customer approved samples must be kept in conditions that avoid deterioration i.e. wrapped, in a secure location accessible only to senior quality personnel.
- 23.5 Be aware that it is now common practice for a customer to visit your production facility and will probably wish to see your day-to-day quality control records.
- 23.6 Know how to test the quality of incoming materials.
- 23.7 Know how to test the coated product.
- 23.8 Know the benefits of using accelerated corrosion tests but be aware of the limitations of these tests.

Unit 24 – Chemical Conversion Coatings and Sol Gel Coatings

- 24.1 Appreciate that chemical conversion processes produce a non-metallic coating on the surface of the substrate.
- 24.2 Know the reasons for the use of chemical conversion coatings.
- 24.3 Know that whilst the terms 'Chromating' and 'Phosphating' are the generic terms used, there are proprietary names used by the various chemical manufacturers.
- 24.4 Be aware that different substrates require different chemical formulations to produce a chromate coating.
- 24.5 Be aware that chromate coatings can be produced by using chromium compounds in the hexavalent form which is a Category 1 Carcinogen and that solutions containing the alternative trivalent form of chromium are preferred.
- 24.6 Know that there are three basic types of coating produced by phosphating.
- 24.7 Know the reasons for the use of phosphate coatings and the benefits they give to the coated product.
- 24.8 Know that the main use of phosphating is for the pre-treatment of ferrous substrates, but that it can also be used on aluminium and zinc materials.
- 24.9 Know that the phosphate coating weight per square metre varies with the type of process selected.
- 24.10 Know that phosphating is a water-based process which can be used by immersion and spray techniques.

- 24.11 Know that combined 'clean and phosphate' processes are available.
- 24.12 Understand the difference between a conversion coating and a sol gel coating.
- 24.13 Know how to deposit a sol gel coating and the different types of structure of sol gel coatings.
- 24.14 Know some of the applications and benefits of sol gel coatings.

Unit 25 – Anodising of Aluminium and Aluminium Alloys

- 25.1 Know that anodising is an electrolytic method of producing an oxide film unlike electroplating which deposits a metal.
- 25.2 Be aware of the applications and uses of anodised aluminium.
- 25.3 Be aware of the types of anodising solution and their formulation for the production of an anodised film on aluminium.
- 25.4 Know the similarities and differences between anodising and electroplating.
- 25.5 Be aware that an anodised film can be coloured by various methods.
- 25.6 Be aware of the importance of sealing anodised films.
- 25.7 Know how to jig components for anodising.

Unit 26 – Vacuum Coating Processes

- 26.1 Appreciate that coatings can be produced from a solid source using a gaseous phase.
- 26.2 Understand the principles of chemical vapour deposition and how the process is carried out.
- 26.3 Know the advantages of chemical vapour deposition and some applications of this technique.
- 26.4 Understand the principles of physical vapour deposition (PVD) and the different types of process available.
- 26.6 Know the different types of coating and their properties that are produced by PVD.
- 26.7 Know some of the applications of PVD coatings.

Unit 27 – Duplex Coatings of Galvanising plus Paint

- 27.1 Be aware of the benefit of the duplex system of hot dip galvanised zinc plus a paint top coat.
- 27.2 Understand how a hot dip galvanised coating protects steel.
- 27.3 Understand how paint coatings protect steel.
- 27.4 Understand why the duplex system has a longer life than the sum of the individual coatings.
- 27.5 Describe how to clean and pre-treat the galvanised surface to maximise the adhesion of the paint coating.
- 27.6 Know how to select a paint coating system for the duplex coating.
- 27.7 Understand how to apply powder coatings to galvanised steel.

Unit 28 – Electroforming

- 28.1 Know the basic steps for the production of an electroformed component.
- 28.2 Appreciate the capabilities and limitations of electroforming.
- 28.3 Be aware of some of the applications of electroforming.
- 28.4 Know the electrolytes most often used for electroforming.
- 28.5 Describe the various types of mandrel used for electroforming.

Unit 29 – Nanotechnology

- 29.1 Describe nanomaterials and explain the concept and dimensions of the nanoscale with reference to everyday items.
- 29.2 Relate a brief history of nanotechnology.
- 29.3 Outline the change in physical properties that occur going from bulk material to the nanoscale.
- 29.4 Explain the applications of nanomaterials in the field of surface engineering, biomedical and IC's.

29.5 Gain a detailed knowledge of two of these applications, (i) corrosion resistance by Sol-gel coatings and (ii) dye sensitised solar cells.

* Mandatory Units