

# The Institute of Metal Finishing

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## 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.

The various units which make up the Foundation Course and Module were revised in 2009, some extra units being added to take into consideration technological changes. There are currently 28 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 Pretreatment
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
Unit 25	Anodising of Aluminium & Alloys
Unit 26	Vacuum Metallisation
Unit 27	Vitreous Enamelling
Unit 28	Duplex Coatings of Galvanising plus Paint
Unit 29	Electroforming

\* Mandatory units

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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 & Pretreatment
- 6 Sacrificial Coatings
- 7 Services

+

## Technology Blocks

### **Electroplating**

**OR**

### **Organic Coating**

**OR**

### **Aerospace**

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

- 19 Conventional Paint Processes
- 20 Electrophoretic Paint Processes
- 21 Paint Application Methods
- 22 Coating Powders & Application
- 23 Testing Paint & Powder and Organic Coatings

- 19 Conventional Paint Processes
- 21 Paint Application Methods
- 23 Testing Paint & Powder and Organic Coatings
- 24 Chemical Conversion Coatings
- 25 Anodising of Aluminium & Alloys

\* counts as 2 units

+

## Optional Units

(but not from your selected Technology Block)

- |  |   |                                    |
|--|---|------------------------------------|
| 8 Surface Improvement                        | 9 Principles & uses of Electroplating         | 10 Plant & Equipment               |
| 11 Copper, Silver & Gold Plating             | 12 Nickel Plating                             | 13 Chromium Plating                |
| 14 Zinc & Cadmium Plating                    | 15 Electroless Plating                        | 16 Alloy Plating & Composites      |
| 17 Printed Circuit Board Processes           | 18 Maintenance of Solutions & Product Quality | 19 Conventional Paint Processes    |
| 20 Electrophoretic Paint Processes           | 21 Paint Application Methods                  | 22 Coating Powders & Application   |
| 23 Testing Paint & Powder & Organic Coatings | 24 Chemical Conversion Coatings               | 25 Anodising of Aluminium & Alloys |
| 28 Duplex Coatings                           | 26 Vacuum metallisation                       | 27 Vitreous Enamelling             |
|  | 29 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.

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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.

## 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 Metal finishing' and use of the insignia 'AssocIMF'.

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## 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.

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## 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 effect 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.

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- 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 Pretreatment \*

- 5.1 Appreciate the importance of cleaning and pretreatment 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 pretreatment.
- 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 pretreatment 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.

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- 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.

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## 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 tanks and the need for some tanks to
- 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.

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- 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 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.

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- 13.2 Be aware of the chemical composition of the various types of 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.

## 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 Be aware of the toxic nature of the chemical constituents in some zinc plating solutions.
- 14.4 Appreciate that cadmium is only permitted for specific applications
- 14.5 Understand the importance of passivation treatments in enhancing the corrosion resistance of zinc and cadmium coatings.
- 14.6 Know that the various coloured passivation films provide differing corrosion protection.
- 14.7 Know the various chemicals used in passivating solutions.

## 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.

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- 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.

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- 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.

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- 19.3 Know the components that make up a conventional liquid paint and the purposes for which they are used.
- 19.4 Be aware of the properties which make up a good paint.
- 19.5 Know that paints are classified according to the polymer from which they are formulated – e.g. alkyd, epoxy etc.
- 19.6 Know the difference between ‘Additive’ and ‘Condensation’ polymer types.
- 19.7 Appreciate the difference between ‘Convertible’ and ‘Non-convertible’ coatings and the different ways that a dry continuous film is produced.
- 19.8 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 dependant 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.

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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.

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## Unit 24 – Chemical Conversion Coatings and Adhesion

- 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 pretreatment 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.

## 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.

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25.6 Be aware of the importance of sealing anodised films.

25.7 Know how to jig components for anodising.

## Unit 26 – Vacuum Metallisation

26.1 Appreciate that coatings can be produced from a solid source using a gaseous phase.

26.2 Know how to differentiate between the techniques of Chemical Vapour Deposition (CVD) and Physical Vapour Deposition (PVD).

26.3 Have an understanding of how the processes are carried out and the type of equipment used.

26.4 Be able to differentiate between ‘first surface metallising’ and ‘second surface metallising’.

26.5 Be aware of the need for cleanliness of both components, equipment and personnel involved in the day-to-day operation.

## Unit 27 – Vitreous Enamelling

27.1 Define vitreous enamel.

27.2 List the applications of vitreous enamels.

27.3 Know the various substrates that are vitreous enamelled.

27.4 Describe how to pretreat substrates for the application of vitreous enamel coatings.

27.5 Describe the techniques for the application of vitreous enamel coatings.

27.6 Know the causes of common defects in vitreous enamel coatings.

## Unit 28 – Duplex Coatings of Galvanising plus Paint

28.1 Be aware of the benefit of the duplex system of hot dip galvanised zinc plus a paint top coat.

28.2 Understand how a hot dip galvanised coating protects steel.

28.3 Understand how paint coatings protect steel.

28.4 Understand why the duplex system has a longer life than the sum of the individual coatings.

28.5 Describe how to clean and pretreat the galvanised surface to maximise the adhesion of the paint coating.

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28.6 Know how to select a paint coating system for the duplex coating.

28.7 Understand how to apply powder coatings to galvanised steel.

## **Unit 29 – Electroforming**

29.1 Know the basic steps for the production of an electroformed component.

29.2 Appreciate the capabilities and limitations of electroforming.

29.3 Be aware of some of the applications of electroforming.

29.4 Know the electrolytes most often used for electroforming.

29.5 Describe the various types of mandrel used for electroforming.

\* Mandatory Units