



**LEARNING SYSTEMS**  
Australia Pty Ltd

## **Operator THEORY Training Course Overview**

This is an eight-week (40 day) in class (or self-paced) course designed to develop the trainee operator's underpinning knowledge to enable understanding of the operation of the various systems within a power station. The course is split up into the following subjects, which may be subject to modification as required by the client:

### ***Week One Subjects:***

#### **Introduction to power stations**

This module provides the learner with a brief introduction to the operation of a thermal power station including an introduction to the major parts of plant.

#### **Module 1 - Introductory Mathematics**

In this module the addition and subtraction of fractions and decimals and the multiplication and division of decimals will be revised. Further, the meaning of algebra and algebraic equations will be described, while the significance of the Pythagoras' Theorem together with definitions of the prime trigonometrical functions will be covered. *This is a prerequisite for the electrical principles modules.*

#### **Module 2 - Electrical Principles One**

In this module, the nature of electricity and the units for measuring current, voltage and resistance will be explained. This is followed by an introduction to Ohm's Law and its practical application to series and parallel circuits. Direct current electrical energy and power, the heating effect of an electric current, and batteries will also be discussed. This module deals principally with direct current and serves as an introduction to alternating currents and A.C. circuits treated in subsequent chapters.

#### **Module 3 - Electrical Principles Two**

An important effect of an electric current, which is necessary for the operation of many pieces of electrical equipment, is the magnetic effect. Magnetism and electricity are very closely associated, and in this module, some aspects of magnetism and magnetic fields will first be discussed. This topic will be followed by an explanation of electromagnetic induction and the principle of operation of generators, motors and transformers.

#### **Module 4 - Electrical Principles Three**

Inductance and Capacitance are two further basic electrical properties, which have a significant influence on A.C. circuits and the performance of various A.C. equipment.

#### **Week One Assessment (Assessment No 1)**

A 3 hour written assessment covering all aspects of subjects covered in modules one through four.

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## ***Week Two Subjects:***

### **Module 5 - Electrical Principles Four**

This module covers the principles of alternating current circuits and includes:

- Methods of specifying alternating currents and voltages,
- Inductive reactance, capacitive reactance and impedance,
- Power in resistive, inductive and capacitive circuits,
- Effects of resistance, reactance and impedance in A.C. circuits, principles of three-phase A.C. circuits.

### **Module 6 - Electric Motors**

This module will describe the principle of operation and the general constructional features of D.C. and A.C. motors. In particular, the A.C. induction motor and the various variable speed controlled A.C. motors will be explained.

### **Module 7 - Transformers**

This module will describe the power transformer, its principal components and the fittings, which may be provided, on the larger capacity transformers. This will be followed by a description of the main features of potential and current transformers and the practical points relating to the inspection and operation of power transformers.

### **Module 8 - Electrical Protection**

This module will describe the protection of electrical equipment under the following topics:

- The functions of electrical protection schemes,
- The types of electrical faults and their significance,
- The various types of protective devices employed in protection schemes,
- The protection schemes employed for the protection of motors and transformers,
- The action required following the operation of a protective scheme on a motor and a transformer.

### **Week Two Assessment (Assessment No 2)**

A 3 hour written assessment covering all aspects of subjects covered in modules five through eight.

## ***Week Three Subjects:***

### **Module 9 - Switchgear (415V, 3.3kV, 6.6kV and 11kV)**

This module is designed to familiarise the operator with the design, function and operation of the high and low voltage switchgear used in a power station. At the end of this module the operator will be required to demonstrate general knowledge regarding this switchgear.

### **Module 10 - High Voltage Equipment**

This module is designed to familiarise the operator with the design, function and operation of the high voltage switchgear and associated equipment within high voltage switchyards.

### **Module 11 - DC and UPS Systems**

This module is designed to familiarise the operator with the design, function and operation of the various DC systems and UPS systems used in a power station. At the end of this module the operator will be required to demonstrate general knowledge regarding this equipment.

## **Module 12 - Generators**

This module shall take the learner through the theory of electromagnetic induction to large hydrogen cooled generators, excitation systems and an introduction to PQ charts and leading and lagging operation.

## **Week Three Assessment (Assessment No 3)**

A 3 hour written assessment covering all aspects of subjects covered in modules nine through twelve.

## ***Week Four Subjects:***

### **Module 13 - Mechanics**

This module includes the following topics:

- Velocity and acceleration and the vector representation of velocity,
- The three laws of motion,
- Mass, force, frictional force and centrifugal force,
- Momentum, energy and power.

### **Module 14 - Properties of matter**

The module properties of matter include the following topics:

- The states of matter, density and specific gravity,
- Absolute pressure, gauge pressure, pressures in gases and liquids and the measurement of pressure,
- Archimedes' Principle,
- Pumping fluids against static and frictional heads and the energy of fluids in motion.

### **Module 15 - Thermodynamics**

In this module the learner shall be introduced to Thermodynamics, the branch of Engineering Science, which relates heat to other forms of energy. In the power plant cycle, the combustion of fuel produces heat, which by a series of processes is converted to electrical energy.

### **Module 16 - Power Station Chemistry**

In this module, the learner shall be introduced to Chemistry (as used within a power station). This is the branch of science which is concerned with the composition of substances, the relation of the properties of substances to their composition and how various substances interact with each other. This module will explain the more important basic concepts in chemistry and will include the following topics:

- Atoms, elements, molecules and compounds,
- Mixtures and solutions,
- Chemical reactions and combustion,
- Acidic, neutral and alkaline solutions.

## **Week Four Assessment (Assessment No 4)**

A 3 hour written assessment covering all aspects of subjects covered in modules thirteen through sixteen.

## ***Week Five Subjects:***

### **Module 17 - Principles of Automatic Control**

This module describes the functions of the basic elements that go to make up an automatic control system. The control action of a controller and the three fundamental types of control action, which may be introduced into an automatic control system, are also described.

### **Module 18 - Pumps**

This module will discuss the types of pumps that may be installed in power stations. The construction, application, method of operation and protection devices on centrifugal pumps will also be discussed.

### **Module 19 - Lubrication and bearings**

In this module, the properties of oil and grease lubricants, the treatment of lubricating oils, lubrication systems and the main types of bearings found on power station plant, will be described.

### **Module 20 - Valves**

This module shall describe the types and operation of valves used in power stations. A large variety, both in regard to types and sizes and method of operation are used and it is important that they be operated correctly so that plant availability, safety and efficiency will not be impaired. It is desirable that operating staff know something of the construction of the more common valves so that they can operate them correctly and are knowledgeable enough to report accurately the position and nature of valve defects.

### **Week Five Assessment (Assessment No 5)**

A 3 hour written assessment covering all aspects of subjects covered in modules seventeen through twenty.

## ***Week Six Subjects:***

### **Module 21 - Fuel systems including coal handling plant**

This module will discuss the various fuels and fuel supply systems used in power station and fuel efficiencies including combustion of coal.

### **Module 22 - Boiler Draft System**

This module discusses the boiler draft system, its components and operation.

### **Module 23 - Boiler Steam & Feedwater Systems**

This module will discuss the components and operational methodology of the feedwater system including deaerators, feedwater pumps, feed heaters and flow control systems. Further, boiler water and steam systems, components and fittings will be discussed, as will basic boiler control methodology. This module is aimed at steam drum boilers.

### **Module 24 - Boiler Feedwater Treatment**

The development of modern boilers has resulted in the need for close control of boiler and feed water quality. This module is an overview of some of the important factors involved in achieving and maintaining high quality water and thus protecting the boiler water and steam components. It includes oxygen injection systems and an overview of measuring devices such as conductivity, silica and so on.

### **Week Six Assessment (Assessment No 6)**

A 3 hour written assessment covering all aspects of subjects covered in modules twenty one through twenty four.

## ***Week Seven Subjects:***

### **Module 25 - Turbine Systems**

This module shall discuss the various types of turbines used, steam path components including impulse and reaction blading, the Rankine cycle, and factors affecting turbine cycle efficiency. Further, the module shall discuss turbine sealing, extraction and drainage systems, turbine bypass systems, lube systems and control & monitoring systems.

### **Module 26 - Governors and Governor Control**

This module shall discuss governor theory and the various types of governor systems used in steam turbine control

### **Module 27 - Condenser and Condensate Systems**

This module shall discuss the various condensers, air extraction systems, condensate systems and control methodology from the exit of the turbine to the entry to the deaerator.

### **Week Seven Assessment (Assessment No 7)**

A 3 hour written assessment covering all aspects of subjects covered in modules twenty five through twenty seven.

## ***Week Eight Subjects:***

### **Module 28 - Compressed Air Systems**

This module will discuss the various compressed air systems used in power stations including station air, instrument air, fabric filter pulse air and so on.

### **Module 29 - Hydraulic Systems**

This module shall discuss the various hydraulic systems that may be used within the power station environment.

### **Module 30 - Water Treatment Plant**

This covers the theory of operation of raw water systems, clarifiers, chlorine dosing, sand filters, carbon filtration, demineralised water treatment systems, reverse osmosis systems, oily water treatment and discharge considerations.

### **Module 31 - Care of Plant**

One of the most important duties of an operator is to ensure that the various items of plant, for which he is responsible, are operated in a safe and efficient manner (including touch, smell, feel). Neglect in carrying out regular checks and inspections could lead to costly maintenance and even a reduction in station output. This module seeks to give the operator a basic understanding of these concepts.

### **Week Eight Assessment (Assessment No 8)**

A 2 hour written assessment covering all aspects of subjects covered in modules twenty eight through thirty one.