



Power Station Operator Underpinning Knowledge Course

This is an eight-week (40 day) in class course designed to develop the trainee operator's underpinning knowledge to enable understanding of the operation of the various systems within a power station. Below is a list of the topics to be covered.

Week ONE Subjects:

Module 1 - 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 2 - 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 3 - 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.

Module 4 - 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 5 - 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.

Week TWO Subjects:

Assessment No 1

A 3 hour written assessment covering all aspects of subjects covered in modules 1 through 5.

Module 6 - 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 7 - 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.

Module 8 - 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 9 - 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 10 - 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 11 - 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 12 - 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.

Week THREE Subjects:

Assessment No 2

A 3 hour written assessment covering all aspects of subjects covered in modules 6 through 12.

Module 13 - 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 14 - 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.

Module 15 - 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 16 - 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.

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.

Week FOUR Subjects:

Assessment No 3

A 3 hour written assessment covering all aspects of subjects covered in modules 13 through 17.

Module 18 - 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 19 - Boiler Draft System

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

Module 20 – Boiler Firing Systems

This module discusses the oil and coal firing systems used in the modern steam drum boiler including an overview of the burner management system.

Module 21 - 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 22 – Unit Chemical Cycle

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 FIVE Subjects:

Assessment No 4

A 3 hour written assessment covering all aspects of subjects covered in modules 18 through 22.

Module 23 - 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, condenser and CW systems and control & monitoring systems.

Module 24 – Governors

This module shall discuss governor theory and the various types of governor systems used in steam turbine control including Digital Electro-Hydraulic Governors and delves in-depth into Turbine Supervisory Systems.

Module 25 - Condensate Systems

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

Module 26 - 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 SIX Subjects:

Assessment No 5

A 3 hour written assessment covering all aspects of subjects covered in modules 23 through 26.

Module 27 - 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 28 - 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 29 – Operational Considerations

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. The module then moves to an overview of unit operations including normal and emergency operations and operational issues that may be faced by operators of Boiler and Turbine plant. Finally, the module discusses the recording and reporting side of the power plant operator position.

Module 30 – Ash & Dust Systems

This module introduces the learner to the various ash and dust plant configurations used in power stations including electrostatic precipitators, fabric filter dust collecting plant, ash hoppers, ash conveyors, dense phase and wet ash handling and disposal plants.

Module 31 – Introduction to Data Acquisition Systems (SCADA, DCS, PLC's etc)

This module introduces the learner to SCADA, PLC and DCS systems used within modern power stations.



Week SEVEN Subjects:

Assessment No 6

A 3 hour written assessment covering all aspects of subjects covered in modules 27 through 31.

Module 32 – Heat exchangers

This module introduces the learner to heat exchange theory of operation and then works through operation of the various heat exchangers found within the power station environment.

Module 33 – Hydraulic Systems

This module introduces the learner to the various hydraulic components and systems used within the modern power station. It describes all components of common hydraulic systems and their operation.

Module 34 – Fault Finding Methods

This module introduces the learner to the various fault finding methods used to assist in the timely repair of faults within power stations.

Module 35 – High Voltage Equipment

This module introduces the learner to High Voltage switchyard power systems, switchgear, protection and interactions.

Week EIGHT Subjects:

Assessment No 7

A 3 hour written assessment covering all aspects of subjects covered in modules 32 through 35.

Module 36 – Boiler and turbine licensing

This module covers all the specifics required to be learned by the power station operator to prepare them for the High Risk Work Licenses BA and TO. This includes all study guides and evidence portfolios to be completed while on shift and under the tutelage of a licensed operator.

Assessment No 8

A 1 hour written assessment covering all aspects of subjects covered in modules 36.