



**PanGlobal**

Partner in Education

**Process Operator Series**

**Book I**

Book Outline



# Process Operator Series Book I

## Course Outline

### Process Operator Series: Part A

## Unit 1: Piping and Valves

### Chapter 1 Introduction to Energy Plant Piping Systems

#### Learning Outcome

Discuss the basic types of piping, piping connections, supports, and drainage devices used in industry.

#### Learning Objectives

1. State the applications for the most common materials and identify the sizes of commercial pipe.
2. Describe methods of connection for screwed, flanged, and welded pipe; identify fittings and their markings.
3. Describe methods and devices used to allow for pipe expansion and support.
4. Explain the methods used to promote good drainage of steam pipes, including the installation and maintenance of steam traps, to reduce the effects of water hammer.
5. Explain the requirements, materials, and methods for insulating pipe.

### Chapter 2 Introduction to Energy Plant Valves

#### Learning Outcome

Discuss the design and uses of the valve designs most commonly used in industry and on boilers.

#### Learning Objectives

1. Describe standard valve designs.
2. Describe design and operation of specialized boiler valves.
3. Describe a typical steam pressure reducing station, and the design and operation of steam system pressure-reducing valves.
4. Discuss valve details, including materials of construction and identification markings.
5. Describe typical valve maintenance requirements.

### Chapter 3 Steam Traps

#### Learning Outcome

Explain the purpose of steam traps and describe the installation and operating principles of the various steam traps found on piping systems.

#### Learning Objectives

1. Describe the designs and operating principles of mechanical traps.
2. Describe the designs and operating principles of thermostatic steam traps.
3. Describe the correct piping arrangement and procedures for a steam trap. Explain the purpose and design of a strainer.
4. Explain the causes, effects, and prevention of water hammer.



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### **Unit 2: Pumps and Compressors**

#### **Chapter 4 Types of Pumps**

##### **Learning Outcome**

Describe the construction and operating principles of various types of pumps used in plants.

##### **Learning Objectives**

1. List common pump applications.
2. Define the terms associated with pump performance.
3. Describe the common pumps found in plants.

#### **Chapter 5 Pump Operation and Maintenance**

##### **Learning Outcome**

Describe the major considerations and procedures for pump operation and maintenance.

##### **Learning Objectives**

1. Discuss the components of a driver and pump assembly.
2. Discuss pump shaft sealing, compression packing, and the replacement of compression packing.
3. Describe the standard types of mechanical seals.
4. Describe pump bearings, shaft alignment procedures, and the equipment used to align shafts.
5. Describe centrifugal pump startup and priming procedures.
6. Describe positive displacement pump operating characteristics, priming, startup, and routine checks.

#### **Chapter 6 Air Compression**

##### **Learning Outcome**

Describe the operating principles of the different types of compressors.

##### **Learning Objectives**

1. Describe the main classifications and types of compressors.
2. Describe gaseous compression systems.



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### **Chapter 7 Compressor Operation and Maintenance**

#### **Learning Outcome**

Describe the major considerations and general procedures for compressor operation and maintenance.

#### **Learning Objectives**

1. Describe compressor parts and auxiliary equipment.
2. Describe the construction and operation of seals for compressors.
3. Describe the capacity control of compressors.
4. Describe preventative maintenance and routine procedures for compressors.

### **Unit 3: Lubrication**

#### **Chapter 8 Lubrication**

#### **Learning Outcome**

Describe the importance and the principles of lubrication.

#### **Learning Objectives**

1. Discuss the concept of lubrication and list the purposes of a lubricant.
2. List the various classes and types of lubricants and describe their respective properties and applications.
3. List the properties of lubricating oils and the additives used.

### **Unit 4: Prime Movers and Heat Engines**

#### **Chapter 9 Heat Engines and Prime Movers**

#### **Learning Outcome**

Discuss the historical conversion of heat energy into mechanical energy.

#### **Learning Objectives**

1. Differentiate between the terms “heat engine” and “prime mover.”
2. Discuss the history of the steam engine and the expansive power of steam.

#### **Chapter 10 Steam Turbines**

#### **Learning Outcome**

Describe the construction and operation of steam turbines.

#### **Learning Objectives**

1. Describe the principle of operation and major components of a steam turbine.
2. Describe the lubrication and sealing of steam turbine shafts.
3. Describe how the rotational speed of a steam turbine is governed and controlled.
4. List the steps to follow in a typical steam turbine start-up and shut-down.



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### **Chapter 11 Gas Turbines**

#### **Learning Outcome**

Describe the application, startup, operation, and maintenance required for gas turbines.

#### **Learning Objectives**

1. Describe the principle of construction and operation of gas turbines.
2. Identify the operational characteristics of gas turbines.
3. Describe regeneration and combined steam-gas turbine operating cycles.
4. Describe the key elements of gas turbine startup, operation, and auxiliaries.

### **Chapter 12 Internal Combustion Engines**

#### **Learning Outcome**

Describe the application, construction, and operation of internal combustion engines.

#### **Learning Objectives**

1. Discuss the fuels used in internal combustion engines.
2. Describe the working cycles of the 4-stroke and 2-stroke spark ignition engines.
3. Describe the working cycle of the 4-stroke compression ignition (diesel) cycle.
4. Describe the construction of basic spark and compression engines.
5. Explain the basic operating considerations for diesel engines.

## **Unit 5: Heat Exchangers**

### **Chapter 13 Cooling Towers**

#### **Learning Outcome**

Describe the operation and maintenance of condensers and cooling towers.

#### **Learning Objectives**

1. Explain the construction and operation of condensers, and how they relate to the operation of cooling towers.
2. Explain the principle of operation, the purpose, and the major components of cooling towers.
3. Describe the construction and operation of natural draft cooling towers.
4. Describe the construction and operation of mechanical draft cooling towers.
5. Discuss cold climate operation for cooling towers.
6. Explain typical problems and resolutions required within the operation of cooling towers.

### **Answer Guide**



### Process Operator Series: Part B

## Unit 6: Electrotechnology

### Chapter 14 Basic Electricity

#### Learning Outcome

Apply the concepts of basic electricity while performing simple calculations using voltage, current, resistance, and power.

#### Learning Objectives

1. Describe the atomic structure of matter and its relationship to electricity.
2. Describe basic electrical circuits.
3. State Ohm's Law and apply it to single-resistor circuits.
4. Apply Ohm's Law to series resistance circuits.
5. Apply Ohm's Law to parallel resistance circuits.
6. Explain electrical conductors and insulators using examples.
7. Explain the factors that affect resistance mathematically.
8. Calculate the power developed in an electrical circuit.

### Chapter 15 Magnetism and Electromagnetism

#### Learning Outcome

Describe the basic principles of magnetism.

#### Learning Objectives

1. Describe magnetism and the relationship between magnetism and electricity.
2. Describe the relationship between electricity and magnetism in an electrical generator.
3. Describe the relationship between electricity and magnetism in an electric motor.

### Chapter 16 Electrical Metering Devices

#### Learning Outcome

Describe the design and application of electrical metering devices.

#### Learning Objectives

1. Describe electrical meters and their uses.
2. Describe how voltage, current, and resistance are measured in an electric circuit.
3. Describe the construction and operation of a kilowatt hour meter.



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### **Chapter 17 Motors and Generators**

#### **Learning Outcome**

Describe the operating principles of the various types of AC and DC motors and generators.

#### **Learning Objectives**

1. Describe the construction and operation of DC generators and motors.
2. Describe the construction and operation of AC generators (alternators) and motors.
3. Interpret the information on a motor nameplate.
4. Perform basic calculations relating to power factor and power factor correction.

## **Unit 7: Instrumentation and Controls**

### **Chapter 18 Introduction to Energy Plant Controls and Instrumentations**

#### **Learning Outcome**

Describe the overall purpose and function of plant instrumentation systems.

#### **Learning Objectives**

1. Describe the concept and basic components of a control loop.
2. Describe the various means by which control signals are transmitted, and the function of transducers.
3. List and describe the types of instruments that are not control loop components.

### **Chapter 19 Introduction to Process Measurement**

#### **Learning Outcome**

Describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity, and composition.

#### **Learning Objectives**

1. Describe the types of pressure sensing and measuring devices.
2. Describe the types of level sensing and measuring devices.
3. Describe the types of flow sensing and measuring devices.
4. Describe the types of temperature sensing and measuring devices.
5. Describe the types of humidity sensing and measuring devices.
6. Describe the types of gas sensing and measuring devices.



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### **Chapter 20 Basic Control and Instrumentation Components**

#### **Learning Outcome**

Describe the basic types and functions of transmitters, recorders, controllers, and control actuators.

#### **Learning Objectives**

1. Describe the construction and operational principles of instrumentation transmitters.
2. Describe the construction and operational principles of instrumentation indicators and recorders.
3. Describe the construction and operational principles of instrumentation controllers.
4. Describe the construction and operational principles of final control elements.

### **Chapter 21 Introduction to Programmable Controllers**

#### **Learning Outcome**

Describe the operation of programming controls for boilers, including applicable testing and maintenance procedures.

#### **Learning Objectives**

1. Discuss how programmable controllers work and how they act as sequencers for equipment.
2. Describe applications of programmable controllers.
3. Explain the HMI (human machine interface) and purpose of touchscreen displays, functions, and alarm handling.

## **Unit 8: Plant Maintenance and Processes**

### **Chapter 22 Powerhouse Maintenance I**

#### **Learning Outcome**

Describe the safe use of common hand tools in the powerhouse.

#### **Learning Objectives**

1. Describe the types and proper use of hacksaws, files, chisels, hammers, screwdrivers, and wrenches.
2. Describe the types and proper use of hand threading tools.
3. Describe the types and proper use of measuring tools.
4. Describe the proper layout of work and the use of layout tools.
5. Describe the types and proper use of portable and fixed grinders, hand drills, drill presses, and the care of drill bits.





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### **Chapter 23 Common Plant Configurations in Hydrocarbon Centric Industries**

#### **Learning Outcome**

Identify steam-related processes employed in common types of plants.

#### **Learning Objectives**

1. Identify standard thermal system pathways and segments commonly used in plants.
2. Identify equipment and processes in heat transfer fluid (HTF) heating systems.
3. Identify the main thermal processes used in oil refining industries.
4. Describe the main processes used in steam assisted gravity drainage (SAGD) and cyclic steam stimulation (CSS).
5. Identify thermal processes used in gas separation and compression plants.

#### **Answer Guide**