



FIFTH CLASS (EDITION 3.5)

COURSE OUTLINE WITH OUTCOMES

The material in this series is aligned with the SOPEEC Fifth Class Syllabus, dated October 2012.

Book 1: Low Pressure Boiler Components and Operation (368 pages)

Unit 1: Boiler Details

Chapter 1 Watertube Boilers (Heating, Power, and Tubular)

Learning Outcome

Describe the various types of watertube boilers used in small industrial and heating systems.

Learning Objectives

1. Describe the construction of watertube and copper-tubular boilers.
2. Describe the water circulation in a longitudinal drum straight tube boiler.
3. Describe two-drum bent tube boilers, and the advantages of a bent tube boiler compared to a straight tube boiler.
4. Describe the construction of the “A” type, “D” type, and “O” type and the advantages of packaged watertube boilers.

Chapter 2 Cast-Iron Sectional and Modular Boilers

Learning Outcome

Describe and explain the uses of cast-iron boilers.

Learning Objectives

1. Describe the general construction of cast-iron sectional boilers.
2. List the advantages of cast-iron sectional boilers over watertube and firetube boilers.
3. Describe the arrangement of equipment in a multiple cast-iron sectional boiler heating plant.
4. Describe the construction and operation of cast-iron modular boilers.

Chapter 3 Firetube Boilers (Heating and Power)

Learning Outcome

Describe the various types of firetube boilers used in power and heating systems.

Learning Objectives

1. Explain the difference between power and heating boilers.
2. Describe the historical significance, the construction, and application of the early types of firetube boilers: the HRT, or horizontal return tubular, locomotive, and firebox boilers.
3. Describe the construction and application of wetback and dryback Scotch boilers.
4. Describe the construction and application of vertical firetube boilers and tubeless boilers used in heating plant service.
5. Describe the construction of packaged firetube boilers.



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Chapter 4 Electric Boilers

Learning Outcome

Describe electric boilers with regard to their use and general design.

Learning Objectives

1. Compare electric boilers to fuel-fired boilers.
2. Describe the construction and operating principle of electrode-type electric boilers.
3. Describe the construction and operating principle of immersion-type electric boilers.

Unit 2: Boiler Fittings and Controls

Chapter 5 Basic Fittings for Steam Boilers

Learning Outcome

Name, identify, and explain the operating principles and the differences, if any, between the following low and high pressure boiler fittings: pressure gauges, gauge siphons, safety valves, gauge glasses and water columns, safety shutoff valves, quick opening valves, stop valves, check valves, and vent valves.

Learning Objectives

1. Describe the construction, purpose, and operation of pressure gauges and gauge siphons (pigtailed).
2. Describe the testing of pressure gauges.
3. Describe the construction, operation, installation, and testing of low-pressure (safety relief) and high-pressure (safety or pop) valves.
4. Describe the purpose, function, and testing of gauge glasses and water columns.
5. Explain how to change a gauge glass.
6. Describe the construction, operation, and purpose of the following valves: gauge glass safety shutoff valves, gauge glass quick closing valves, stop valves, check valves, blowoff (blowdown) valves, and vent valves.

Chapter 6 Basic Fittings for Hot Water Boilers

Learning Outcome

Name, identify and explain the operating principles of the following hot water boiler fittings and equipment: pressure, altitude or combination gauges, thermometers, safety relief valves, temperature relief devices, stop valves or drain valves, backflow preventers, and expansion tanks.

Learning Objectives

1. Identify the required instruments, fittings, and controls on a hot water boiler system.
2. Explain how to change a gauge glass on an expansion tank.
3. Describe the construction and operation of the “auto fill valve.”
4. List the usual devices and fittings that are used in hot water heating boiler systems.



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Chapter 7 Low Water Fuel Cut-Offs and Feedwater Controls

Learning Outcome

Discuss the design, operation and testing of low-water fuel cutoffs and describe feedwater control methods and devices used on low-pressure boilers.

Learning Objectives

1. Describe the construction and operation of float and electrode low water level fuel cut-off equipment.
2. Describe the testing and maintenance of float and electrode low water level fuel cut-offs.
3. Describe the operation of a feedwater float switch operating a valve and a float switch operating a pump.
4. Explain the purpose and function of heating boiler feedwater and condensate piping connections.

Chapter 8 Heating Boiler Operating Controls

Learning Outcome

Name and describe the various operating controls found on low-pressure boilers.

Learning Objectives

1. Describe the operation of the on-off control, the high-low fire control, the modulating control, and the high limit control found on low-pressure steam boilers and hot water heating boilers.
2. Explain the operation of the common control switches found on a low-pressure heating boiler.
3. Describe the operation of the safety switches or interlocks found on the fuel supplies of low-pressure heating boilers.
4. Explain the required testing and maintenance of heating boiler controls.

Chapter 9 Boiler Combustion Controls

Learning Outcome

Explain the design and operation of various combustion controls on heating boilers.

Learning Objectives

1. List and discuss the various types of boiler flame failure detectors.
2. Describe the testing of boiler flame failure safety devices.

Chapter 10 Boiler Programming Controls

Learning Outcome

Describe the basic operation of boiler programming controls.

Learning Objectives

1. Describe the operation of equipment that is used to automatically start up and shut down boilers.
2. List a typical sequence of startup and shutdown events.
3. Describe common 5th Class Power Engineer responses to a boiler programmer startup or shutdown.



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Unit 3: Boiler Operation and Maintenance

Chapter 11 Basic Boiler Operation

Learning Outcome

Describe the preparation, start-up and shutdown, abnormal conditions, and routine operational checks in the operation of steam and hot water boilers.

Learning Objectives

1. Explain the preparation required before starting a steam or hot water boiler.
2. Explain the startup steps once the boiler has been prepared.
3. State possible abnormal conditions during startup and the cautions required to avoid uneven expansion and thermal shock.
4. Describe the procedure required when “cutting in” an additional boiler.
5. Describe the operating conditions for hot water and steam boilers that must be checked daily, and state the required monthly checks.
6. Explain the procedure for removing a hot water boiler from service.
7. Describe the procedure for removing a steam boiler from service.
8. Explain the emergency conditions that can occur during the operation of a steam boiler. Explain the causes and prevention of furnace and pressure explosions.
9. Explain the reasons for boiler accidents, and describe the role and design of operating logs in the safe operation of a boiler.
10. Operator traits, good operating practice, curiosity, using your senses, (sense-interpret-analyze-perform = SIAP), trusting your instincts, experience and due diligence.

Chapter 12 Routine Boiler Maintenance and Inspection

Learning Outcome

Describe the service and maintenance required for boilers. Discuss the procedure for preparing a boiler for inspection and cleaning, and describe mechanical boiler cleaning methods.

Learning Objectives

1. Describe the general servicing and routine maintenance of packaged firetube and cast-iron sectional boilers.
2. Explain the importance of layups and state the procedures to be followed for wet and dry boiler layups.
3. Describe the symptoms of a leaking firetube.
4. List the steps and precautions to be taken to prepare a boiler for inspection.
5. Describe the inspection of a boiler.
6. Describe the methods and tools used for mechanical and chemical cleaning of a boiler.
7. Discuss the standard procedure for a hydrostatic test and the reason for doing the test.



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Unit 4: Fuels and Combustion

Chapter 13 Combustion and Draft

Learning Outcome

Discuss the characteristics of common fuels used in heating boilers, conditions for complete and incomplete combustion, draft methods, and the application of flue gas analysis.

Learning Objectives

1. Explain natural and mechanical draft arrangements.
2. Describe draft measurement using U-tube and inclined draft gauges.
3. Describe the use, advantages, and characteristics of common boiler fuels.
4. State the requirements and reactions for complete and incomplete combustion.
5. Explain the difference between a pressure explosion and a furnace explosion.

Chapter 14 Burners for Boilers

Learning Outcome

Describe the operation of the various types of gas and oil burners used on boilers.

Learning Objectives

1. Describe the operation of atmospheric and ring gas burners.
2. Describe the construction and operation of automatic valves.
3. Describe the principle of oil atomizing burners for boilers.
4. List and describe the auxiliary equipment needed for an oil combustion system.
5. Describe the overall components and operation of fuel oil systems.

Unit 5: Piping and Valves

Chapter 15 Piping Materials and Connections

Learning Outcome

Discuss the various construction materials, size classification, and connection methods for the piping in a plant.

Learning Objectives

1. Explain the characteristics and applications of the various materials used to manufacture piping and fittings.
2. Explain pipe size, schedules, and classifications.
3. Identify screwed, flanged, and welded pipe connections.



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Chapter 16 Piping Expansion, Support, and Insulation

Learning Outcome

Discuss piping expansion, support, and insulation.

Learning Objectives

1. Explain pipe expansion and the principle of expansion bends and joints.
2. Explain the purpose of pipe supports and describe various pipe support designs.
3. Explain the purposes for pipe insulation and describe the use of the common insulation materials.

Chapter 17 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.
4. Explain the purpose and design of a strainer.
5. Explain the causes, effects, and prevention of water hammer.

Chapter 18 Introduction to Valves

Learning Outcome

Discuss the design, application, and maintenance of common types of valves used in piping systems.

Learning Objectives

1. Describe five standard valve designs: gate, globe, butterfly, ball, and plug.
2. Describe the design and operation of check and non-return valves.
3. Describe the function of a pressure-reducing valve.
4. Describe valve identification markings.
5. Describe typical valve maintenance requirements.

Unit 6: Thermoil Systems

Chapter 19 Introduction to Thermoil Heaters and Systems

Learning Outcome

Discuss the design and application of basic thermoil systems.

Learning Objectives

1. Describe the principle of thermoil heating.
2. Describe a direct heating thermoil system.
3. Describe the design and operation of unfired steam generating systems.



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Book 2: Elements of Human Comfort in Facility Operation (552 pages)

Unit 1: Heating Systems and Human Comfort

Chapter 1 Heat Gains and Losses

Learning Outcome

Describe the various ways a building gains and loses heat.

Learning Objectives

1. Define heat transmission terminology and identify conversions or related units.
2. Describe the heat gains that occur in a building due to conduction, infiltration, ventilation, and radiation.
3. Describe the heat gains that occur in a building due to people, lighting, electric motors, appliances, and cooking.
4. Describe the heat losses that occur in a building due to conduction, convection, radiation, infiltration, and ventilation.

Chapter 2 Steam Heating Equipment

Learning Outcome

Describe the operating principles of steam heating equipment and components.

Learning Objectives

1. Describe the construction and operation of steam heating system devices used to transfer heat from the steam to a heated space.
2. List and describe the auxiliary equipment used in a steam heating system, including air vents, radiator valves and traps, and condensate return equipment.

Chapter 3 Steam Heating Systems

Learning Outcome

Describe the operating principles and maintenance procedures of steam heating systems and the components of these systems.

Learning Objectives

1. Describe standard types of piping and equipment layout for steam heating systems.
2. Describe the general operation and maintenance of steam heating systems.
3. Apply a steam heating system troubleshooting guide.



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Chapter 4 Hot Water Heating Systems

Learning Outcome

Describe the various designs of hot water heating systems.

Learning Objectives

1. Describe the standard piping and circulation layouts of hot water heating systems.
2. Compare the advantages and disadvantages of hot water and steam heating systems.
3. Describe radiant panel and snow melting hot water systems.

Chapter 5 Hot Water Heating System Equipment and Operation

Learning Outcome

Describe accessories, operation and troubleshooting of a hot water heating system.

Learning Objectives

1. Describe the purpose and function of standard hot water heating system components such as diverter fittings, air vents, air separators, flow control valves, balancing valves and fittings, riser stop valves, pressure reducing valves, circulating pumps, expansion tanks, and steam to hot water converters.
2. Explain how the location of the hot water circulating pump and the expansion tank are determined.
3. Describe the cleaning, filling, starting, routine operation, and troubleshooting of hot water heating systems.
4. Apply a hot water heating system troubleshooting guide.

Chapter 6 Warm Air Heating System Equipment

Learning Outcome

Describe the operating principles of warm air heating sources.

Learning Objectives

1. Compare the advantages and disadvantages of forced air and gravity warm air systems.
2. List and describe the common sources of warm air heat.
3. List and describe the operational characteristics of directly fired space heaters.

Chapter 7 Warm Air Furnace Components and Maintenance

Learning Outcome

Describe the components and maintenance requirements of typical warm air heating and ventilating systems.

Learning Objectives

1. Describe the operation of furnace components.
2. Describe and discuss the relative merits of three types of air distribution and duct systems.
3. Describe the recommended maintenance procedures for warm air heating and ventilating systems.
4. Apply a troubleshooting guide for forced warm air systems and components.



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Chapter 8 Ventilation and Air Filters

Learning Outcome

Describe the various ventilation systems found in buildings, as well as describe the various types of air filters used in these systems.

Learning Objectives

1. Explain the difference between natural and mechanical ventilation.
2. Describe the types of contaminants found in air.
3. Describe the types of air cleaning devices used in buildings.

Chapter 9 Infrared and Electric Heating

Learning Outcome

Describe infrared and electric heating systems.

Learning Objectives

1. Discuss the concept and application of infrared heating.
2. Describe the construction and operation of gas-fired and electric infrared heaters.
3. List the advantages of electric heating systems compared to other types of heating systems.
4. Describe the different methods of electric heating.

Chapter 10 Humidification

Learning Outcome

Explain the equipment and principles of humidification.

Learning Objectives

1. Describe the general purpose and principles of humidification.
2. Describe residential and commercial types of humidifiers.
3. Describe industrial types of humidifiers.

Chapter 11 Electric Controls for Heating Systems

Learning Outcome

Describe and explain the function of the various components of an electric control circuit.

Learning Objectives

1. Discuss the various terms associated with electric control systems.
2. Describe the basic construction and operation of electric thermostats, humidity controllers, and pressure controllers.
3. Describe the function and operation of the controlled devices in electric control systems.
4. Explain the operating sequence of a basic electric control circuit.



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Unit 2: Plumbing and Auxiliaries

Chapter 12 Building Water Supply Systems

Learning Outcome

Explain the various water supply systems in a building.

Learning Objectives

1. Describe the cold water distribution system in a building.
2. Describe the hot water distribution system in a building.
3. Describe the construction and operation of building system hot water heaters.
4. Explain what is meant by “backflow prevention” and describe the common methods used.
5. List and describe the construction and operation of water system protective devices in buildings.

Chapter 13 Sanitary Drainage Systems

Learning Outcome

Describe various sanitary drainage systems employed in buildings.

Learning Objectives

1. Describe the overall layout of building drainage systems.
2. Describe storm water drainage systems for buildings.
3. List the steps to take in the routine maintenance of building sanitary drainage system devices.
4. Apply a troubleshooting guide for sanitary drainage systems.

Unit 3: Lighting

Chapter 14 Lighting Systems

Learning Outcome

Explain the various lighting systems and some of the basic design considerations for lighting a space.

Learning Objectives

1. Describe the common types of lighting equipment and systems.
2. Explain the various methods of lighting control.
3. Describe the general requirements and criteria for emergency lighting in buildings.
4. Discuss the interrelationship between lighting, air conditioning, and energy conservation in buildings.



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Unit 4: Refrigeration

Chapter 15 Refrigeration Theory

Learning Outcome

Explain the theory and terms associated with refrigeration.

Learning Objectives

1. Explain the fundamentals of refrigeration.
2. Describe the practical cycle of operations in a vapour compression refrigeration system.
3. State how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance.

Chapter 16 Refrigerants

Learning Outcome

Describe the different refrigerants used and explain the various properties of these refrigerants.

Learning Objectives

1. Describe the identification and classification of refrigerants.
2. Describe the characteristics and thermodynamic properties of refrigerants.
3. Describe the physical properties of refrigerants.

Chapter 17 Compression Refrigeration Systems

Learning Outcome

Describe the operating principle of compression refrigeration systems.

Learning Objectives

1. Describe the basic layout of compression refrigeration systems.
2. Distinguish between direct and indirect refrigeration systems.
3. Explain how compression refrigeration system temperatures and pressures are related.
4. Describe the layout of packaged refrigeration systems and the role of a refrigeration economizer.

Chapter 18 Refrigeration Compressors

Learning Outcome

Describe the operating principles and the components of refrigeration compressors and perform simple compressor calculations.

Learning Objectives

1. Describe the construction and operation of a reciprocating refrigeration compressor.
2. Describe the construction and operation of a rotary refrigeration compressor.
3. Describe the construction and operation of a centrifugal refrigeration compressor.
4. Describe the construction and operation of seals for refrigeration compressors.
5. Calculate the capacity, efficiency, and ratio of a refrigeration compressor.



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Chapter 19 Heat Exchangers for Refrigeration Systems

Learning Outcome

Describe the different types of heat exchangers used in refrigeration systems.

Learning Objectives

1. Describe the designs and construction of refrigeration system evaporators.
2. Describe the designs and construction of refrigeration system condensers.
3. Discuss refrigeration condenser operation and maintenance.

Chapter 20 Refrigeration Accessories

Learning Outcome

Describe the various accessories used in refrigeration systems.

Learning Objectives

1. List and describe the operation of the gauges, separators, strainers, and indicators that are used as accessories in refrigeration systems.

Chapter 21 Cooling Towers

Learning Outcome

Describe the operation and maintenance of cooling towers.

Learning Objectives

1. List the factors that determine rate of cooling in a cooling tower and the basic components of a cooling tower.
2. Describe the construction and operation of a natural draft cooling tower.
3. Describe the construction and operation of a mechanical draft cooling tower.
4. Discuss cold climate operation for cooling towers.
5. Apply a cooling tower troubleshooting guide.

Chapter 22 Air Conditioning Systems

Learning Outcome

Describe the operation of various air conditioning systems.

Learning Objectives

1. List the functional components and categories of air conditioning systems.
2. Describe the operation of air handling units.
3. Describe the general layout and operation of unitary air conditioning systems.
4. Describe the general layout and operation of central air conditioning systems.



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Unit 5: Refrigeration and AC System Controls

Chapter 23 Refrigeration Metering Devices and Capacity Controls

Learning Outcome

Describe the operating principles of refrigeration metering devices and capacity controls.

Learning Objectives

1. Describe the construction and operation of compression refrigeration cycle expansion valves.
2. Describe the types of evaporator and compressor capacity controls.

Chapter 24 Refrigeration Cycle Controls

Learning Outcome

Describe the purposes and operating principles of the operational and safety controls on a refrigeration system.

Learning Objectives

1. Describe the operation of the various operating controls for refrigeration systems.
2. Describe the actuators used in refrigeration control systems.
3. Describe the typical refrigeration system safety shutdown devices.

Chapter 25 Compression Refrigeration System Pre-Startup Procedures

Learning Outcome

Describe the various pre-startup procedures used on compression refrigeration systems.

Learning Objectives

1. Describe how to perform refrigeration system leak tests.
2. Describe how a refrigeration system is dried and charged prior to startup.
3. Describe how a refrigeration system is purged of noncondensable gases prior to startup.
4. List the steps for adding oil to a refrigeration compressor when it is in service.

Chapter 26 Compression Refrigeration System Operations

Learning Outcome

Describe the various operation and maintenance procedures used on compression refrigeration systems.

Learning Objectives

1. Describe the steps in the startup and shutdown of a compression refrigeration system.
2. List the safety shutdown devices that are specific to centrifugal compressors.
3. Describe the routine operation and associated log sheets for compression refrigeration systems.
4. List and describe the standard preventive maintenance procedures for compression refrigeration systems.
5. Apply a compression refrigeration system troubleshooting guide.



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Unit 6: Pumps and Air Compressors

Chapter 27 Air Compression

Learning Outcome

Describe the operating principles of the different types of air compressors.

Learning Objectives

1. Describe the main classifications and types of air compressors.
2. Describe air compressor auxiliary equipment, including capacity control systems.
3. Discuss preventive maintenance for reciprocating air compressors.

Chapter 28 Types of Pumps

Learning Outcome

Describe the various types of pumps found in buildings and industrial plants.

Learning Objectives

1. List the common applications of pumps in the power industry.
2. Define the terms associated with pump performance.
3. Describe the common types of pumps used in the power industry.

Chapter 29 Pump Operation and Maintenance

Learning Outcome

Describe all details pertaining to pump operation and various maintenance procedures performed on pumps.

Learning Objectives

1. Describe the construction and function of pump wear rings.
2. Discuss pump shaft sealing and describe the process that is followed when replacing compression type packing.
3. Sketch and describe the standard types of mechanical seals.
4. Describe pump bearing and shaft alignment equipment and procedures.
5. Describe pump startup and priming procedures.
6. Identify pump troubles and their possible causes.

Chapter 30 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.



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Chapter 31 Types of Bearing Lubrication

Learning Outcome

Describe the methods for simple care and maintenance of bearings and their related lubrication systems.

Learning Objectives

1. Define boundary and fluid film lubrication.
2. Describe shell (sleeve) bearings.
3. Describe the construction and operation of thrust bearings.
4. Describe how to clean and replace roller and ball bearings.
5. List the causes of bearing failure.

Unit 7: Distributed Generation

Chapter 32 Microturbines

Learning Outcome

Describe the application and operation of microturbines.

Learning Objectives

1. Explain the application of microturbines in the generation of electricity and heat.

Chapter 33 Internal Combustion (IC) Engine Gen-Sets

Learning Outcome

Describe the application and operation of IC gen-sets.

Learning Objectives

1. Explain startup and shutdown procedures.
2. Explain the proper routine pre-start and operational checks.
3. Identify the three main methods of starting gen-sets.



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Book 3: Basic Physical Science, Safety, and Regulation for Facility Operations (360 pages)

Unit 1: Provincial Acts, Regulations, and Adopted Codes

Chapter 1 Boiler and Pressure Vessels Act

Learning Outcome

Discuss the purpose of the jurisdictional acts/regulations pertaining to the operation of boilers and pressure equipment.

Learning Objectives

1. Explain the purpose and scope of your jurisdictional act and regulations.
2. Explain the purpose and intent of the regulations governing the operation of boilers and pressure equipment.
3. Discuss the regulations relating to Power Engineering qualifications.

Chapter 2 Introduction to CSA and ASME Codes for Boilers

Learning Outcome

Demonstrate a working knowledge of the CSA codes, and the ASME codes of concern to the 5th Class Power Engineer.

Learning Objectives

1. Explain the content and use of the CSA-B51: Boiler, Pressure Vessel, and Pressure Piping Code.
2. Explain the content and use of the CSA-B52: Mechanical Refrigeration Code.
3. Explain the purpose of ASME Boiler and Pressure Vessel Code, Section I - Rules for Construction of Power Boilers.
4. Explain the purpose of ASME Boiler and Pressure Vessel Code, Section VII - Recommended Guidelines for the Care of Power Boilers.
5. Explain the purpose of ASME Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers.
6. Explain the purpose of ASME Boiler and Pressure Vessel Code, Section VI - Recommended Rules for the Care and Operation of Heating Boilers.

Unit 2: Basic Math

Chapter 3 SI Units

Learning Outcome

Perform simple calculations involving SI units.

Learning Objectives

1. List SI units for length, mass, temperature, speed, and their symbols.
2. Identify and list symbols for unit prefixes.
3. Perform conversions between basic SI, imperial, and U.S. customary system (USCS) units.



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Chapter 4 Basic Arithmetic Operations

Learning Outcome

Perform basic arithmetic operations.

Learning Objectives

1. Perform basic arithmetic operations (addition, subtraction, multiplication, and division) on whole numbers without the use of a calculator.
2. Perform basic arithmetic operations on decimal numbers.
3. Perform basic arithmetic operations on fractions.
4. Reduce fractions to lowest terms.
5. Convert fractions to decimals and decimals to fractions.
6. Solve percentage problems.
7. Given a ratio, determine the correct quantity of a substance.

Chapter 5 Transposition

Learning Outcome

Transpose equations in order to find values for different variables in a formula.

Learning Objectives

1. Transpose commonly used equations involving up to two variables and all basic mathematical operations.
2. Insert values into common equations and solve them.

Chapter 6 Areas and Volumes of Solids

Learning Outcome

Calculate the volumes of rectangular objects, cylinders, and spheres and the surface areas of cylinders and spheres.

Learning Objectives

1. State the SI units for area and volume.
2. Calculate the surface area and volume of a rectangular tank.
3. Calculate the surface area and volume of a cylinder.

Unit 3: Applied Science

Chapter 7 Application of Basic Mechanics

Learning Outcome

Define basic terms used in the study of mechanics.

Learning Objectives

1. Define the terms force, velocity, mass, pressure, energy, work and power.
2. Explain the application of levers, pulleys, and inclined planes.
3. Identify where simple machines are used in the plant.
4. Define mechanical advantage.



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Chapter 8 Introduction to Thermodynamics

Learning Outcome

Explain the principles of thermodynamics and the modes of heat transfer.

Learning Objectives

1. Describe the three states of matter.
2. Describe the expansion of solids and liquids.
3. Explain the different temperature scales used in thermodynamics (Celsius and Fahrenheit).
4. Explain sensible and latent heat, and the thermodynamic transformation of ice to steam.
5. Describe the three modes of heat transfer.
6. Explain the energy in the expansion of water to steam.

Unit 4: Safety

Chapter 9 Fire Safety and Site Hazards

Learning Outcome

Discuss acceptable methods of extinguishing various classifications of fire. Briefly describe site hazards awareness.

Learning Objectives

1. Explain the overall need for and the intent of fire protection standards, laws, and regulations.
2. Explain the different fire classifications and describe the extinguishing methods for each.
3. Explain the application and operation of standpipes, hoses, and sprinklers in buildings.
4. Explain the various types of fire and smoke detectors.
5. Describe the operation, placement, and maintenance of the common types of portable extinguishers.
6. Discuss the need for and use of a fire pump.
7. Briefly describe safety aspects of common site hazards.
8. Explain how to perform a pre-job hazard assessment.

Chapter 10 Building Safety

Learning Outcome

Describe how the building operator can prevent accidental situations to protect the occupants of their facility.

Learning Objectives

1. Explain the personal safety responsibilities and precautions that must be applied by the building operator.
2. Describe the general safety precautions required in the maintenance and operation of buildings.
3. Identify common scenarios where the building operator can prevent accidents, and explain the importance of first aid and CPR training.



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Chapter 11 Confined Space Entry

Learning Outcome

Describe procedures needed to enter into, or work safely in confined spaces.

Learning Objectives

1. Define confined space, list some confined spaces, and describe the hazards of being in a confined space.
2. Refer to local jurisdictional regulations and describe procedures to be followed when performing a confined space entry, including completion of an entry checklist.

Chapter 12 Introduction to Occupational Health and Safety Legislation

Learning Outcome

Discuss the provincial legislation addressing occupational health and safety.

Learning Objectives

1. Explain the general intent of occupational health and safety standards.
2. Discuss some of the responsibilities, according to the Act, of workers, employers, and others in relation to health and safety.
3. Describe the conditions that must exist before a worker can refuse to work.
4. Identify jurisdictional regulations related to health and safety.
5. List the two different types of logs kept in boiler plants and the importance of each.

Chapter 13 Introduction to Heating Plant Safety

Learning Outcome

Describe general plant safety as it relates to Power Engineers.

Learning Objectives

1. Discuss the cost and effects of workplace accidents.
2. Describe the basic hazards that may exist in an energy plant, and the basic personal protective equipment that may be required.
3. Define, give examples of, and describe common workplace hazards. (Note that additional training will be required beyond this course material.)
4. Describe equipment isolation and lockout procedures.



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Chapter 14 Handling of Dangerous Materials

Learning Outcome

Describe the policies and procedures for safe storage and handling of dangerous goods and materials.

Learning Objectives

1. Discuss the WHMIS.
2. Describe the Safety Data Sheets (SDS) and Material Safety Data Sheets (MSDS) required in the WHMIS.
3. Identify the labels required in the WHMIS.
4. Describe the safe handling and use of gas cylinders in an energy plant (power plant).
5. Discuss the safe handling of hydrocarbons.

Unit 5: Electricity

Chapter 15 Introduction to Electricity

Learning Outcome

Discuss the design and accessories of an electrical circuit; describe the design and troubleshooting of lighting systems and electric motors.

Learning Objectives

1. Explain electricity, electric circuits, and voltage drop.
2. Calculate current and power in an electric circuit, estimate the cost of electrical power for a facility, and describe how to read a power meter.
3. Describe circuit accessories, including switches, fuses, breakers, and receptacles. Explain the danger of electric shock.
4. Explain what constitutes a good lighting system. Explain maintenance of a lighting system and troubleshooting of incandescent and fluorescent systems.
5. Describe simple electrical system problems, including short circuits, grounds, and bad connections. Describe static electricity.
6. Describe transformers and electric motors. Explain motor types, bearing care, and troubleshooting of motors.
7. Explain the CSA approval and markings for electrical appliances.

Unit 6: Welding

Chapter 16 Welding Terms and Inspection

Learning Outcome

Define welding terms and describe methods of weld inspection.

Learning Objectives

1. Define the common terms used in welding.
2. Describe the jurisdictional requirements for a weld repair.
3. Explain the role of the 5th Class Power Engineer in preparing for a welder.
4. Discuss the commonly used methods of weld inspection and testing.



FIFTH CLASS (EDITION 3.5)

COURSE OUTLINE WITH OUTCOMES

Unit 7: Water Treatment

Chapter 17 Water Treatment

Learning Outcome

Explain the purpose of the common external and internal water treatment methods.

Learning Objectives

1. Explain the four general sources of impurities and the three general treatment methods.
2. Explain the purpose of external filtration and describe the design of pressure, filter-aid, and cartridge filters.
3. Explain boiler blowoff/blowdown.
4. Describe the operating principles of a sodium zeolite water softener.
5. Explain troubleshooting and common operating problems associated with water softeners.
6. Describe methods of feeding treatment chemicals into a boiler.
7. Define potable water and explain the importance of backflow prevention.
8. Describe the testing of potable water.

Chapter 18 Monitoring and Testing

Learning Outcome

Explain general sampling and testing procedures and equipment, and describe specific testing procedures, plus interpret test results for a boiler water treatment monitoring and testing program.

Learning Objectives

1. List the four classes of impurities and three general treatment methods.
2. Explain how to obtain a representative water sample.
3. Discuss testing methods.
4. Describe the principles and procedures for testing for hardness, dissolved solids, phosphate, molybdate, pH, sodium sulfite, and alkalinity.

Unit 8: Communications

Chapter 19 Technical Communications

Learning Outcome

Utilize some of the best practices on various types of communication techniques. Identify the key elements of an SOP with document control and update methods. Identify the key components of a Maintenance Management System.

Learning Objectives

1. Discuss effective communication in written, verbal, and radio techniques.
2. Discuss the importance of standard operating procedures (SOPs), how they are written, and how to have them updated.
3. Explain a maintenance management system and the essential information and requirements in this system.



FIFTH CLASS (EDITION 3.5)

COURSE OUTLINE WITH OUTCOMES

Chapter 20 Plant Diagrams

Learning Outcome

Use basic engineering diagrams to learn the processes within the specific workplace.

Learning Objectives

1. Discuss the different types of plant (or building) diagrams (drawings) that the Power Engineer may encounter, including the basic symbols and lines used.
2. Explain how to trace out lines in a plant and make a sketch using basic drawing symbols of multiple systems.