



# REFRIGERATION PLANT OPERATOR

## COURSE OUTLINE WITH OUTCOMES

### Content

#### Part 1

##### 1. Boiler & 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.

##### 2. Introduction to CSA & 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 – Power Boilers.
4. Explain the purpose of ASME Boiler and Pressure Vessel Code, Section VII – Recommended Rules for the Care and Operation of Power Boilers.
5. Explain the purpose of ASME Boiler and Pressure Vessel Code, Section IV – 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.

##### 3. Introduction to Thermodynamics

###### Learning Outcome

Explain the principles of thermodynamics, including the laws of thermodynamics and the modes of heat transfer.

###### Learning Objectives

1. Define various terms associated with the study of thermodynamics.
2. Describe the laws and the different temperature scales used in thermodynamics.
3. Define heat and specific heat and perform sensible heat calculations.
4. Describe the expansion of solids and liquids.
5. Describe the three modes of heat transfer.

##### 4. Thermodynamics of Refrigeration

###### Learning Outcome

Explain the terms and principles associated with the thermodynamics of refrigeration.

###### Learning Objectives

1. Explain the fundamentals of refrigeration.
2. Describe the cycle of operations in a vapour compression refrigeration system.
3. Explain how operating temperatures and pressures are selected and related for a vapour compression refrigeration system.
4. State how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance.



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### 5. Introduction to Basic Mechanics

#### Learning Outcome

Define basic terms used in the study of mechanics.

#### Learning Objectives

1. Define mass, force, acceleration, velocity and weight.
2. Define force, pressure, work, power and energy.

### 6. Welding Methods & Inspection

#### Learning Outcome

Describe oxyacetylene welding and electric arc welding and the applications of each.

#### Learning Objectives

1. Describe metal arc and brazing welding processes.
2. Discuss commonly used methods of weld inspection and testing.

### 7. Welding Terms, Forge & Fusion Welding Processes

#### Learning Outcome

Describe welding terms and methods of weld inspection.

#### Learning Objectives

1. Describe the common terms used in welding.
2. Describe forge and oxyacetylene fusion welding processes.

### 8. Types of Pumps

#### Learning Outcome

Describe the design and operating principles of various types of pumps used 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 industry.

### 9. Pump Operation & Maintenance

#### Learning Outcome

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

#### Learning Objectives

1. Describe the construction and function of pump wearing rings.
2. Discuss pump shaft sealing and describe the process that is followed when replacing compression type packing.
3. Describe the standard types of mechanical seals.
4. Describe pump bearing and shaft alignment equipment and procedures.
5. Describe pump start-up and priming procedures.
6. Apply pump troubleshooting steps.



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### 10. Introduction to Piping & Pipe Fittings

#### 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 and 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 piping, including the installation and maintenance of steam traps. Explain water hammer.
5. Explain the need for piping insulation and describe materials and methods of insulation.

### 11. Introduction to Valves

#### Learning Outcome

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

#### Learning Objectives

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

### 12. Lubrication Principles

#### Learning Outcome

Describe the importance of lubrication and the principles concerned with 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 application.
3. List the properties of lubricating oils, the additives used and their selection criteria.

### 13. 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 preventative maintenance for reciprocating air compressors.

### 14. Fires & Extinguishing Media

#### Learning Outcome

Describe the fire classifications and the types of extinguishing media suitable for each classification.

#### Learning Objectives

1. Discuss the theory, terminology and the life safety issues associated with fires.
2. Explain the four classes of fires and describe the types of fire extinguishing media and how they act on these fires.
3. Describe the design and operation of standpipe and sprinkler systems.



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### 15. Portable Fire Extinguishers

#### Learning Outcome

Describe the types of portable fire extinguishers, and their application for each fire classification.

#### Learning Objectives

1. Describe the applicability, types, construction and operation of various types of portable fire extinguishers.
2. Discuss the inspection and maintenance of portable fire extinguishers.

### 16. Building Safety

#### Learning Outcome

Describe how the Power Engineer 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 Power Engineer.
2. Describe the general safety precautions required in the maintenance and operation of buildings.
3. Identify common scenarios where the Power Engineer can prevent accidents and explain the importance of first aid and CPR training.

### 17. First Aid & CPR for Adult Casualties

#### Learning Outcome

Identify possible or potential medical difficulties in a person, and provide assistance until professional medical aid can be obtained.

#### Learning Objectives

1. Identify and discuss the steps in the assessment process.
2. Describe the ABC's of first aid.
3. Describe the first aid procedures associated with heart attack and stroke.
4. Describe standard emergency assistance procedures.

**Note: This chapter is not intended to replace training in first aid or CPR provided by organizations such as the Canadian Red Cross and Saint John's Ambulance. It is strongly recommended that people take proper practical training in first aid or CPR given by those organizations.**

### 18. 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.



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### 19. Refrigerants

#### Learning Outcome

Describe the different refrigerants and explain the classification and various properties of each refrigerant.

#### Learning Objectives

1. Describe how refrigerants are classified.
2. Describe the thermodynamic properties of refrigerants.
3. Describe the properties of refrigerants relating to miscibility, leakage tendency, odour, moisture reaction, toxicity and flammability.

### 20. Environmental Impact of Chlorinated Hydrocarbons

#### Learning Outcome

Describe the nature and impact of chlorinated hydrocarbons on the environment.

#### Learning Objectives

1. Explain the importance of organic materials to our livelihood.
2. Describe the benefit and harm of pesticides and herbicides to our environment.
3. Describe the hazards of PCBs (polychlorinated biphenyls) and what actions have been taken to reduce them.
4. Describe dioxins, furans, and phenols, their sources, and their impact on the environment.
5. Explain the impact of CFCs (chlorofluorocarbons) on the ozone shield and describe actions undertaken to reduce damage.



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### Part 2

#### 21. Compression Refrigeration Systems

##### Learning Outcome

Describe the operating principles 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.

#### 22. Absorption Refrigeration Systems

##### Learning Outcome

Describe the operating principle of the absorption refrigeration systems.

##### Learning Objectives

1. Describe the theory and operation of an ammonia absorption refrigeration system.
2. Describe the theory and operation of a lithium bromide absorption refrigeration system.
3. Compare the advantages and disadvantages of absorption and compression refrigeration systems.

#### 23. Refrigeration Compressors

##### Learning Outcome

Describe the operating principles and the components of refrigeration compressors.

##### 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, volumetric efficiency and compression ratio of a refrigeration compressor.

#### 24. 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.

#### 25. 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. Describe the water treatment necessary for cooling water.
6. Apply a cooling tower troubleshooting guide.



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### 26. Refrigeration Metering Devices

#### 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 different methods used to control the capacity of evaporators.
3. Describe the different methods used to control the capacity of refrigeration compressors.

### 27. Refrigeration Accessories

#### Learning Outcome

Describe the various accessories used in refrigeration systems.

#### Learning Objective

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

### 28. 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 temperature, pressure and humidity controls for refrigeration systems.
2. Describe the actuators used in refrigeration control systems.
3. List and describe the typical refrigeration system safety shutdown devices.

### 29. 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 start-up.
3. Describe how a refrigeration system is purged of noncondensable gases prior to start-up.
4. List the steps for adding oil to a refrigeration compressor when it is in service.

### 30. 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 start-up and shutdown of a compression refrigeration system.
2. List the safety shutdown devices specific to centrifugal compressor water chillers.
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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### 31. Absorption Refrigeration System Operation & Maintenance

#### Learning Outcome

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

#### Learning Objectives

1. Explain crystallization, equilibrium concentration and dilution.
2. Describe how to purge the system.
3. Explain the operation and purpose of the controls found on the system.
4. Describe how to start and stop the system.

### 32. Psychrometric Properties of Air

#### Learning Outcomes

Describe the psychrometric properties of air.

#### Learning Objectives

1. Explain the composition of air and define the terms humidity, relative humidity and dewpoint.
2. Define the terms: dry bulb temperature, wet bulb temperature, wet bulb depression and psychrometer, and state the relationship between these terms and relative humidity.
3. Define the specific volume and enthalpy of air.
4. Identify and interpret the psychrometric properties of air on a psychrometric chart.

### 33. Application of the Psychrometric Chart

#### Learning Outcomes

Solve problems using a psychrometric chart.

#### Learning Objectives

1. Interpret the psychrometric chart to find values of specific properties.
2. Apply the psychrometric chart to the heating and cooling of air, and calculate heat added or removed.
3. Apply the psychrometric chart to the humidification and dehumidification of air and calculate moisture added or removed.
4. Apply the psychrometric chart to combined heating/cooling and humidification problems.
5. Discuss what is meant by "comfort conditions" with respect to the psychrometric chart.

### 34. Fans for Air Distribution Systems

#### Learning Outcome

Describe the air flow behaviour and movement of air through distribution systems.

#### Learning Objectives

1. Discuss the theory of air flow and pressure conversions.
2. Describe the major types of air handling fans, their construction and operation.
3. Interpret fan performance curves.
4. Describe fan motors, drives and belt guards.
5. Describe fan volume controls.

### 35. Ventilation & 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 various contaminants found in air.
3. Describe the types of air cleaning devices used in industrial/commercial buildings.





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### 36. Air Conditioning Duct Systems

#### Learning Outcome

Describe the designs and components of duct systems used in air conditioning.

#### Learning Objectives

1. Explain how air duct systems are classified.
2. Describe air duct materials, system layout, fabrication and installation.
3. Describe air duct leakage.
4. List and describe the types of liners, dampers, and louvres used in air duct systems.
5. Discuss terminal air distribution devices and the principles of diffusion, induction, entrainment and aspiration.

### 37. 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 warm air types of humidifiers.
3. Describe industrial and commercial types of humidifiers.

### 38. Coil Types

#### Learning Outcome

Describe the various types of coils used in air conditioning systems.

#### Learning Objectives

1. Describe the general construction of finned type heat exchanger coils.
2. Describe the detailed construction and operational principles of water coils.
3. Describe the detailed construction and operational principles of steam coils.

### 39. Coil Operation

#### Learning Outcome

Describe the operation of the various types of coils used in air conditioning systems.

#### Learning Objectives

1. Explain the operational and equipment sizing issues and freezing problems associated with steam coils.
2. Explain the operational and equipment sizing issues and freezing problems associated with water coils.
3. Explain the operational and equipment sizing issues associated with glycol coils.
4. Describe the installation recommendations for coils, piping, steam traps, control valves, air vents and vacuum relief devices.

### 40. Air Conditioning Systems I

#### Learning Outcome

Describe the operation of various air conditioning systems.

#### Learning Objectives

1. List the functions 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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### 41. Air Conditioning Systems II

#### Learning Outcome

Describe the design and operation of combined air conditioning systems and explain the factors to consider when selecting an air conditioning system.

#### Learning Objectives

1. Describe the general layout and operation of combined air conditioning systems.
2. Discuss the alternative arrangements of equipment for air conditioning systems.
3. Discuss the selection criteria for air conditioning systems.

### 42. Air Conditioning Heat Recovery Systems

#### Learning Outcome

Explain the purpose, design and operation of heat recovery in air conditioning systems.

#### Learning Objectives

1. Describe the general principles of air conditioning heat recovery and the operation of “run-around” systems.
2. Describe the thermal wheel air conditioning heat recovery system.
3. Describe the heat pipe air conditioning heat recovery system.
4. Describe the heat pump system.

### 43. Air Conditioning System Controls

#### Learning Outcome

Describe the control systems used in air conditioning.

#### Learning Objectives

1. Describe various ventilation control strategies for air conditioning systems.
2. Describe preheat coil control strategies for air conditioning systems.
3. Describe heating coil control strategies for air conditioning systems.
4. Describe humidification control strategies for air conditioning systems.
5. Describe dehumidification and cooling control strategies for air conditioning systems.
6. Describe volume control with static pressure regulation for air conditioning systems.
7. Describe complete air conditioning control systems.