



REFRIGERATION PLANT OPERATOR (EDITION 3)

COURSE OUTLINE WITH OUTCOMES

2 Part Set

Part 1 (572 pages)

Unit 1: Introductory Information for Refrigeration Plant Operators

Chapter 1 Introduction to Basic Mechanics

Learning Outcome

Apply basic terms and calculations used in the study of mechanics.

Learning Objectives

1. Define mass, force, acceleration, velocity, and weight.
2. Perform simple calculations involving force, pressure, work, power, and energy.

Chapter 2 Force, Work, Pressure, Power and Energy

Learning Outcome

Perform calculations involving force, work, pressure, power, and energy.

Learning Objectives

1. Perform calculations involving force and work.
2. Perform calculations involving gauge, atmospheric, and absolute pressure.
3. Perform calculations involving power and different forms of mechanical energy.

Chapter 3 Introduction to Thermodynamics

Learning Outcome

Explain the principles and laws of thermodynamics.

Learning Objectives

1. Define the first two laws of thermodynamics.
2. Define heat and specific heat, and perform sensible heat calculations.
3. Describe the expansion of solids and liquids.

Chapter 4 Introduction to Heat Transfer and Heat Exchangers

Learning Outcome

Explain the modes of heat transfer and the theory of heat exchanger operation.

Learning Objectives

1. Describe the three modes of heat transfer with reference to heat exchangers.
2. Discuss the general design and construction of typical heat exchangers.
3. Describe heat transfer fluids and how they affect the operation of a heat exchanger, including fouling, leakage, and vapour locking.
4. Describe heat exchanger inspection, maintenance, and operation, including placing them in service and removing them from service.



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Chapter 5 Jurisdictional Legislation for Power Engineers

Learning Outcome

Describe the application of Jurisdictional Acts and Regulations with respect to boilers and pressure vessels.

Learning Objectives

1. Describe how the Power Engineering profession is regulated in Canada.
2. Explain the purpose and scope of your Jurisdictional Act and Regulations pertaining to Power Engineering and Pressure Equipment.
3. Explain the purpose and intent of the Regulations governing Power Engineers and Pressure Welders.

Chapter 6 Codes and Standards for Refrigeration Plant Operators and Pressure Vessels

Learning Outcome

Describe the purpose of boiler and pressure vessel Codes and Standards.

Learning Objectives

1. Discuss the history of how codes and standards became necessary in the pressure equipment field.
2. Explain the content and use of the CSA B52 Mechanical Refrigeration Code.

Unit 2: Safety

Chapter 1 Introduction to 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 be in an energy plant, and the basic Personal Protective Equipment that may be required.
3. Define, give examples of, and describe common power house hazards.
4. Describe Industrial health and safety management systems.
5. Describe Hazard Assessment and Control programs.

Chapter 2 Plant Safety Programs

Learning Outcome

Describe common safety programs generally applied in plants.

Learning Objectives

1. Describe common occupational health and safety (OH&S) programs found in most plants.
2. Describe industrial safety programs in which Power Engineers may require additional training.
3. Discuss safe work permits.
4. Describe methods of equipment isolation and lock out.



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Chapter 3 Handling of Dangerous Materials

Learning Outcome

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

Learning Objectives

1. Discuss the WHMIS system.
2. Discuss the essential components required in the WHMIS systems.
3. Describe the safe handling and use of gas cylinders in an energy plant (power plant).
4. Discuss the safe handling of Hydrocarbons.

Chapter 4 Plant Fire Safety

Learning Outcome

Explain fire safety in an industrial plant.

Learning Objectives

1. Discuss the theory, terminology, and the life safety issues associated with fires.
2. Explain the five classes of fires, and describe the types of fire extinguishing media and how they act on these fires.
3. Explain fire prevention.
4. Discuss fire prevention methods for the five types of fires.

Chapter 5 Fire Extinguishing Methods and Equipment

Learning Outcome

Describe typical fire extinguishing equipment and its operation in plant environments.

Learning Objectives

1. Describe the construction and operation of various types of portable fire extinguishers.
2. Discuss the inspection and maintenance requirements of portable fire extinguishers.
3. Describe the types, layout, and operation of standpipe and sprinkler systems.
4. Discuss the maintenance requirements of standpipe and sprinkler system components.
5. Describe the purpose, operation, and maintenance of fire pumps.



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Unit 3: Introductory Fluid Handling Technology

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.

Unit 4: Communications and Maintenance

Chapter 1 Energy Plant Sketching

Learning Outcome

Create engineering equipment sketches.

Learning Objectives

1. Create sketches using centre lines and dimensioning.
2. Recognize standard views of an object.
3. Recognize cross-hatching methods in sectional drawings.
4. Identify common symbols and lines used in plant system trace drawings.



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Chapter 2 Plant Communications

Learning Outcome

Describe the types and proper usage of plant communication systems.

Learning Objectives

1. Discuss effective written and verbal communication skills, including the use of two-way radios.
2. Discuss the elements of Maintenance Management Systems, including work requests and work orders.
3. Discuss the purpose, revision, and control of Standard Operating Procedures.

Chapter 3 Plant Maintenance and Administration

Learning Outcome

Explain typical components of maintenance and administration programs for utilities and process facilities.

Learning Objectives

1. Describe the typical components and responsibilities of scheduled and preventive maintenance management programs.
2. Explain the importance and extent of record keeping, and describe the quality and content requirements for operating logbooks and records.
3. Explain the importance of procedures in the operation of a facility, and describe the application of well-written procedures to personnel training and daily operation.

Unit 5: Welding

Chapter 1 Introduction to Welding

Learning Outcome

Describe welding processes relevant to the plant and Power Engineering.

Learning Objectives

1. Describe non-fusion welding process, equipment used, and methods.
2. Describe forge and oxy-fuel fusion welding processes and cutting processes.
3. Describe metal arc welding processes.
4. Describe heat treatment of welds.

Chapter 2 Boiler and Pressure Vessel Weld Inspection

Learning Outcome

Describe inspection processes and testing methods for welds and materials.

Learning Objectives

1. Describe common weld defects.
2. Describe the process of Visual Testing of welds.
3. Describe the process of Penetrant Testing for detecting weld or material defects.
4. Describe the process of radiographic weld testing.
5. Describe the process of ultrasonic weld testing.



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Unit 6: Electricity

Chapter 1 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. Describe simple electrical system problems, including short circuits, grounds, and bad connections. Describe static electricity.
5. Describe transformers and electric motors. Explain motor types, bearing care, and troubleshooting of motors.
6. Explain the CSA approval and markings for electrical appliances.

Chapter 2 DC Motor Torque Characteristics and Starting

Learning Outcome

Explain basic concepts in the production of electricity and the design, characteristics and operation of DC generators and motors.

Learning Objectives

1. Describe the design and operating principles of a DC generator or motor, clearly stating the purpose of the armature, brushes, windings, and poles.
2. Explain the speed/load characteristics of shunt, series, and compound DC motors; define and calculate percent speed regulation, and explain how speed is controlled in DC motors.
3. Explain DC motor torque characteristics and describe the starting mechanisms for DC motors.

Chapter 3 AC Motor Speed Control and Starting

Learning Outcome

Explain the formation and characteristics of AC power, and describe the design, construction, and operating principles of AC generators, motors, and transformers.

Learning Objectives

1. Describe the design, applications, and operating principles for large three-phase squirrel cage and wound rotor induction motors.
2. Explain variable speed control, variable speed starting, and step starting for large induction motors.



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Unit 7: Pumps and Compressors

Chapter 1 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 2 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 3 Introduction to Compressors

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.

Chapter 4 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.



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Part 2 (536 pages)

Unit 1: Lubrication and Water Treatment

Chapter 1 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.

Chapter 2 Types of Bearings and Lubrication

Learning Outcome

Describe bearing types, methods for care and maintenance of bearings, and bearing lubrication systems.

Learning Objectives

1. Define boundary and full fluid film lubrication.
2. Describe shell (sleeve) bearings.
3. Explain the causes of bearing failure.

Chapter 3 Cooling Tower and Condenser Water Treatment

Learning Outcome

Discuss the general principles, methods, and equipment used for the treatment of condenser water, and their effects on the cooling tower.

Learning Objectives

1. Describe the effects of water on condensers and cooling tower materials.
2. Describe condenser and cooling tower water treatment.
3. Describe cooling tower and condenser water tests for common treatment methods.

Chapter 4 Recirculating System Water Treatment

Learning Outcome

Describe recirculating water systems, their effects, treatment, and tests.

Learning Objectives

1. Describe recirculating water system corrosion and deposition.
2. Describe the use of sacrificial anodes, and measurement techniques to determine corrosion.
3. Describe glycol system testing requirements.
4. Discuss the monitoring tools, procedures, and tests used in recirculating water systems.



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Chapter 5 Condensers and 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.

Unit 2: Refrigeration

Chapter 1 Refrigeration Basics

Learning Outcome

Explain the basic concept of refrigeration and refrigerants.

Learning Objectives

1. Explain the fundamentals of refrigeration.
2. Describe the cycle of operations in a vapour compression refrigeration system.
3. Explain how the 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.
5. Describe how refrigerants are classified.
6. Describe the thermodynamic properties of refrigerants.
7. Describe the properties of refrigerants relating to miscibility, leakage tendency, odour, moisture reaction, toxicity, and flammability.

Chapter 2 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. Describe the layout of packaged refrigeration systems and the role of a refrigeration economizer.
4. Describe the special types of refrigeration compressors, including how they are similar to and different from air compressors.
5. Describe the special designs of refrigeration system evaporators and condensers.



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Chapter 3 Refrigeration System Control and Operation

Learning Outcome

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

Learning Objectives

1. Describe refrigeration system controls.
2. List the safety shutdown devices specific to centrifugal compressor water chillers.
3. Describe typical refrigeration system safety shutdown devices.
4. Describe the construction and operation of refrigerant metering devices.
5. Describe the different methods used to control evaporator capacity.
6. Describe the different methods used to control the capacity of refrigeration compressors.

Chapter 4 Refrigeration System Operation and Maintenance

Learning Outcome

Describe the operating principles and maintenance of refrigeration systems.

Learning Objectives

1. Discuss refrigeration auxiliaries.
2. Describe refrigeration system leak test procedures.
3. Describe how a refrigeration system is dried and charged prior to startup.
4. List the steps for adding oil to an in-service refrigeration compressor.
5. Describe the startup and shutdown procedure for a compression refrigeration system.
6. Describe operational log sheets and preventative maintenance procedures for refrigeration systems.
7. Describe how a refrigeration system is purged of non-condensable gases.
8. Discuss refrigeration condenser operation and maintenance requirements.
9. Explain typical problems and resolutions related to refrigeration systems.

Chapter 5 Absorption Refrigeration Systems

Learning Outcome

Describe the operating principle, maintenance, and operation of absorption refrigeration systems.

Learning Objectives

1. Describe the basic absorption system, comparing the differences to the compression system.
2. Describe the theory and operation of an ammonia absorption refrigeration system.
3. Describe the theory and operation of a lithium bromide absorption refrigeration system.
4. Explain the operation of absorption refrigeration systems with respect to crystallization and dilution.
5. Describe the major parts and systems of an absorption system including the heat exchanger bypass system; pump motor lubrication and cooling system; and purging system.
6. Describe the startup and shutdown procedures for an absorption refrigeration system.
7. Describe the preventive maintenance to perform on an absorption refrigeration system.
8. Explain typical problems and resolutions related to an absorption refrigeration system.



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Chapter 6 Refrigeration Plant Safety

Learning Outcome

Outline the potential hazards inherent to refrigeration plants, the CSA requirements intended to mitigate hazards, and typical responses taken in the case of a significant leak.

Learning Objectives

1. Identify and provide a basic explanation of the CSA B52 Code requirements for refrigeration plant machinery rooms.
2. Identify safe practices for refrigeration plant operation and maintenance.
3. Describe the appropriate emergency response to a significant refrigerant leak.
4. Describe the Canadian Environmental Emergency Regulations and how they relate to refrigeration plants.

Chapter 7 Ammonia Refrigeration Safety

Learning Outcome

Apply safety procedures to ammonia refrigeration systems.

Learning Objectives

1. Discuss the basic guidelines for oil removal from piping or vessels on ammonia refrigeration systems.
2. Discuss the properties and testing of secondary refrigeration systems.
3. Describe the steps and precautions to take when pumping down a compression refrigeration system.
4. Explain the specific points to isolate and lock out for various maintenance on specific refrigeration plant equipment.

Unit 3: HVAC

Chapter 1 Conditioning the Air

Learning Outcome

Explain the methods and techniques for conditioning air in plants and buildings.

Learning Objectives

1. Discuss the process to condition air for human comfort and health.
2. List the categories and functions of HVAC systems.
3. Describe the operation of air-handling units.



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Chapter 2 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.

Chapter 3 Fans for Air Distribution Systems

Learning Outcome

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

Learning Objectives

1. Discuss the theory of airflow 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.

Chapter 4 Ventilation and Air Filters

Learning Outcome

Describe the various ventilation systems, including 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.

Chapter 5 HVAC Duct Systems

Learning Outcome

Describe the designs and components of duct systems used in HVAC applications.

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.



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Unit 4: Environmental Systems

Chapter 1 Psychrometric Properties of Air

Learning Outcome

Describe the psychrometric properties of air.

Learning Objectives

1. Explain the composition of air and define the terms humidity, relative humidity, and dew point.
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.

Chapter 2 Application of the Psychrometric Chart

Learning Outcome

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.

Chapter 3 Cooling Systems and Combination Systems

Learning Outcome

Describe central, unitary, and combined HVAC systems.

Learning Objectives

1. Describe the general layout and operation of unitary air conditioning systems.
2. Describe the general layout and operation of central air conditioning systems.
3. Describe the general layout and operation of combined air conditioning systems.
4. Discuss how HVAC systems should be operated under different situations.



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Chapter 4 Heat Gains and Losses, and Heat Recovery Methods

Learning Outcome

Describe heat gains and losses, and common methods for energy recovery.

Learning Objectives

1. Define heat transmission terminology.
2. Describe heat gain and heat loss analysis in a building or plant.
3. Describe the general principles of HVAC heat recovery.

Chapter 5 HVAC Control Strategy

Learning Outcome

Describe the control systems strategies used in HVAC systems.

Learning Objectives

1. Describe a basic ventilation control strategy for HVAC systems.
2. Describe heating control strategies for HVAC systems.
3. Describe humidification, dehumidification, and cooling control strategies for HVAC systems.
4. Describe volume control with static pressure regulation for HVAC systems.