

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 1 of 15
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1. Act, Regulations and Codes (6.7%): To locate information relating to the staffing, operation, maintenance, inspection, and testing of the refrigeration plant and its equipment using reference material such as....

Competencies:	Learning Objectives:
<p>1.1. Relevant Provincial Jurisdictional legislation.</p> <p>Reference: Text: Book 1: Ch. 1 Boiler & Pressure Vessels Act Book 1: Ch. 2 Introduction to CSA & ASME Codes CSA-B52 Mechanical Refrigeration Code</p>	<p>Discuss the purpose of the Jurisdictional Acts/Regulations</p> <ol style="list-style-type: none"> 1. Explain purpose and scope of Manitoba Act/Regulations 2. Discuss regulations relating to Power Engineering Qualifications
<p>1.2. CSA B52 (current edition) Mechanical Refrigeration Code</p> <p>Reference: Text: Book 1: Ch. 1 Boiler & Pressure Vessels Act Book 1: Ch. 2 Introduction to CSA & ASME Codes CSA-B52 Mechanical Refrigeration Code</p>	<p>Demonstrate a working knowledge of CSA codes as they relate to the Refrigeration Class Power Engineer:</p> <ol style="list-style-type: none"> 1. Identify and locate information from CSA-B52 Mechanical Refrigeration Code. 2. Intro to CSA B52-05 Code
<p>1.3. CSA Z94.4 Selection, Care and Use of Respirators</p> <p>Reference: Text: Book 1: Ch. 2 Introduction to CSA & ASME Codes CSA- CSA Z94.4 Selection, Care and Use of Respirators</p>	<p>Demonstrate a working knowledge of CSA codes as they relate to the Refrigeration Class Power Engineer:</p> <ol style="list-style-type: none"> 1. Identify and locate information from CSA- CSA Z94.4 Selection, Care and Use of Respirators 2. Identify selection, use and care of respirators
<p>1.4. CEPA E2 Regulations</p> <p>Reference: Text: Book 1: Ch. 1 Boiler & Pressure Vessels Act Book 1: Ch. 2 Introduction to CSA & ASME Codes CSA-B52 Mechanical Refrigeration Code CEPA E2 Regulations</p>	<p>Demonstrate a working knowledge of CEPA codes as they relate to the Refrigeration Class Power Engineer:</p> <ol style="list-style-type: none"> 1. Identify and locate information from CSA-B52 Mechanical Refrigeration Code. 2. Describe CEPA E2 and its purpose

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 2 of 15
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2. Safety (6.7%): To fully **understand the dangers** associated with the operation of a refrigeration plant and the **precautions** to be taken to minimize or prevent such dangers:

Competencies:	Learning Objectives:
<p>2.1. Gas Detection And Monitoring</p> <p>Reference: Text: Book 1: Ch. 19 Refrigerants</p>	<p>Describe how the Building Operator can prevent accidental situations to protect the occupants of their facility</p> <ol style="list-style-type: none"> 1. Explain gas detection and monitoring devices 2. Describe refrigerant characteristics related to gas detection and monitoring
<p>2.2. Gas Exposure Limits</p> <p>Reference: Text: Book 1: Ch. 19 Refrigerants CSA B52</p>	<p>Describe the general safety precautions required in the maintenance and operation of buildings</p> <ol style="list-style-type: none"> 1. Identify various exposure limits and their effects
<p>2.3. Personal Protective Equipment (PPE)</p> <p>Reference: Text: Book 1: Ch. 16 Building Safety</p>	<p>Explain the personal safety responsibilities and precautions that must be applied by the Building Operator</p> <ol style="list-style-type: none"> 1. Explain PPE responsibilities of the Building Operator 2. Identify required PPE for worksite 3. Describe purpose and use of PPE
<p>2.4. Basic WHIMIS</p> <p>Reference: Text: Book 1: Ch. 16 Building Safety Material Safety Data Sheets (MSDS)</p>	<p>Describe the importance and structure of WHIMIS</p> <ol style="list-style-type: none"> 1. Explain meaning, enforcement and importance of WHIMIS 2. Explain responsibility for maintaining WHIMIS records 3. Review rights and responsibilities under WHIMIS 4. Describe use of Material Safety Data Sheet (MSDS)
<p>2.5. Isolation, Confined Space And Fall Protection</p> <p>Reference: Text: Book 1: Ch. 16 Building Safety Workplace, Safety and Health Regulations</p>	<p>Describe procedures needed to enter into, or work safely in confined spaces</p> <ol style="list-style-type: none"> 1. Define isolation, confined space and fall protection 2. Outline provincial regulations/procedure to be followed when performing a confined space entry
<p>2.6. Basic First Aid and CPR</p> <p>Reference: Text: Ch. 17 First Aid & CPR for Adult Casualties</p>	<p>Describe how the Building Operator can protect the occupants of their facility</p> <ol style="list-style-type: none"> 1. Describe the purpose of First Aid, CPR 2. Recognize the need for CPR

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 3 of 15
---	-----------------------------	-----------------------------------

<p>2.7. Plant Fire Protection</p> <p>Reference: Text: Book 1: Ch. 14 Fires & Extinguishing Media Book 1: Ch. 15 Portable Fire Extinguishers</p>	<p>Discuss acceptable methods of extinguishing various classifications of fire and describe fire extinguishers and fire detection systems.</p> <ol style="list-style-type: none"> 1. Explain the different fire classifications and describe the extinguishing methods for each 2. Explain applications and operation of standpipes, hoses and sprinklers in buildings. 3. Explain various types of fire and smoke detectors 4. Describe operation and maintenance (inspection) of common types of portable fire extinguishers. 5. Discuss the need and use of a fire-pump
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3. Administration (6.7%):	
Competencies:	Learning Objectives:
<p>3.1. Mechanical Drawing</p> <p>Reference: Text: Book 1: Ch. 16 Building Safety</p>	<p>Describe how equipment is interconnected by using a mechanical drawing</p>
<p>3.2. Maintenance Planning</p> <p>Reference: Text: Book 1: Ch. 16 Building Safety CSA B52 section 8.4, on maintenance planning</p>	<p>Describe the requirements of the Building Operator in regards to the maintenance and operation of buildings</p> <ol style="list-style-type: none"> 1. Identify the purpose of maintenance planning
<p>3.3. Materials And Welding</p> <p>Reference: Text: Book 1: Ch. 6 Welding Methods and Inspection Book 1: Ch. 7 Welding Terms, Forge and Fusion Processes Book 1: Ch. 10 Intro to Piping and Pipe Fittings</p>	<p>Define welding terms and describe methods of weld inspection</p> <ol style="list-style-type: none"> 1. Define the common terms used in welding 2. Identify arc welding and braze welding processes <p>Discuss the various construction materials, size classification and connections methods for piping in a plant</p> <ol style="list-style-type: none"> 1. State the applications and compatibilities for the most common materials in refrigeration plants 2. Identify screwed, flanged and welded pipe connections
<p>3.4. Basic Communications</p> <p>Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operations (p. 169)</p>	<p>Describe the routine operation and associated log sheets used by Building Operators</p> <ol style="list-style-type: none"> 1. Describe the legal and operational requirements for logbooks

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 4 of 15
---	-----------------------------	-----------------------------------

4. Fundamentals (16.7%): Candidates must demonstrate an understanding of refrigeration fundamentals including.	
Competencies:	Learning Objectives:
4.1. Identifying Basic Thermodynamic Principles Reference: Text: Book 1: Ch. 3 Introduction to Thermodynamics	Discuss the design and application of basic thermoil systems. 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.
4.2. A Basic Understanding Of Gas Behaviour Reference: Text: Book 1: Ch. 3 Introduction to Thermodynamics	Describe the expansion of solids and liquids 1. Give different temperature and pressure conditions 2. Describe the behaviour of gas
4.3. Differentiating Between CFC S, HCFC S, And HFC Refrigerants Reference: Text: Book 1: Ch. 19 Refrigerants Book 1: Ch. 20 Environmental Impact of Chlorinated Hydrocarbons	Describe the different refrigerants used and explain the various properties of these refrigerants 1. Describe and differentiate halogen refrigerants 2. Describe the characteristics and thermodynamic properties of refrigerants 3. Describe the physical properties of refrigerants
4.4. An Awareness of the Environmental Impact That Each Type of Refrigerant Can Pose Reference: Text: Book 1: Ch. 20 Environmental Impact of Chlorinated Hydrocarbons	Describe the nature and impact of chlorinated hydrocarbons on the environment 1. Explain importance of organic materials 2. Describe hazards and impacts and steps taken to reduce damage to our environment.
4.5. A Thorough Understanding of the Purpose of the Components of Vapour Compression Refrigeration Cycle Reference: Text: Book 1: Ch. 4 Thermodynamics of Refrigeration	Explain the theory and terms associated with refrigeration 1. Explain the fundamentals of refrigeration 2. Describe the actual cycle of operations in a vapour compression refrigeration system 3. Explain how the capacity of a refrigeration system is described and how refrigeration table are used to calculate system performance.
4.6. A Thorough Understanding of the Compression Refrigeration Cycle Including the Function of the: 4.6.1. Compressor 4.6.2. Condenser 4.6.3. Metering Device 4.6.4. Evaporator Reference: Text: Book 2: Ch. 21 Compression Refrigeration Systems	Describe the operating principle of compression refrigeration system 1. Describe basic layout of compression refrigeration systems 2. Explain how compression refrigeration system temperatures and pressures are related 3. Describe layout of packaged refrigeration systems and role of a refrigeration economizer

<p>4.7. Basic Operating Principle of an Absorption Refrigeration System</p> <p>Reference: Text: Book 2: Ch. 22 Absorption Refrigeration System Book 2: Ch. 31 Absorption Refrigeration System Operation and Maintenance</p>	<p>Describe the theory and operation of an absorption refrigeration system</p> <ol style="list-style-type: none"> 1. Describe basic layout and operation of an ammonia absorption refrigeration system 2. Describe basic layout and operation of a lithium bromide absorption refrigeration system 3. Compare advantages and disadvantages of absorption and compression systems
<p>4.8. Direct, and Indirect Refrigeration Systems</p> <p>Reference: Text: Book 2: Ch. 21 Compression Refrigeration Systems</p>	<p>Distinguish between direct and indirect refrigeration systems</p> <ol style="list-style-type: none"> 1. Describe direct and indirect refrigeration systems
<p>4.9. The Use Of Secondary Refrigerants, the Mediums Used, and the Applications Of Such Coolants as used in The Commercial and the Industrial Sector</p> <p>Reference: Text: Book 1: Ch. 19 Refrigerants</p>	<p>Describe the properties and applications of secondary refrigerants</p>
<p>4.10. The Essential Qualities of a Good Refrigerant such as the Main Properties of:</p> <ol style="list-style-type: none"> 4.10.1. R-134a 4.10.2. R-22 4.10.3. R-717 <p>Reference: Text: Book 1: Ch. 19 Refrigerants</p>	<p>Describe the different refrigerants used and explain the various properties of these refrigerants:</p> <ol style="list-style-type: none"> 1. Describe the identification and classification of refrigerants 2. Describe the characteristics and thermodynamic properties of refrigerants 3. Describe the properties of the following refrigerants: <ul style="list-style-type: none"> • R-134a • R-22 • R-717
<p>4.11. Types Of Refrigeration Systems and Their Associated Equipment</p> <ol style="list-style-type: none"> 4.11.1. Direct Expansion 4.11.2. Flooded 4.11.3. Liquid Overfeed <ol style="list-style-type: none"> 4.11.3.1. Low Pressure Receivers 4.11.3.2. Liquid Recirculation Pumps <p>Reference: Text: Book 1: Ch. 8 Types of Pumps Book 2: Ch. 21 Compression Refrigeration Systems Book 2: Ch. 22 Absorption Refrigeration System</p>	<p>Describe the theory and operation of refrigeration systems</p> <ol style="list-style-type: none"> 1. Describe the following refrigeration systems and associated equipment: <ul style="list-style-type: none"> • direct expansion • flooded • liquid overfeed (low pressure receives, liquid recirculation pumps)

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 6 of 15
---	-----------------------------	-----------------------------------

5. Compressors (6.7%): Candidates must demonstrate an understanding of compressors including the:	
Competencies:	Learning Objectives:
5.1. Main Types Of Refrigeration Compressors and Have a Basic Understanding Of Each Type Including Packaged Types Reference: Text: Book 2: Ch. 23 Refrigeration Compressors	Describe the operating principles and the components of refrigeration compressors 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
5.2. Application and the Types Of Booster Compressors Used Within a Two Stage or Compound Refrigeration System Reference: Text: Book 2: Ch. 23 Refrigeration Compressors	Describe the construction and operation of booster compressors 1. Describe the application of booster compressors in two stage and compound systems. 2. Identify the types of booster compressors.
5.3. Main Types Of Prime Movers Used To Drive Refrigeration Compressors Reference: Text: Book 2: Ch. 23 Refrigeration Compressors	Identify and describe the main types of prime movers used to drive refrigeration compressors.
5.4. Difference Between <i>Hermetic</i>, <i>Semi-Hermetic</i>, and <i>Open-Type</i> Compressors Reference: Text: Book 2: Ch. 23 Refrigeration Compressors	Explain the difference between hermetic, semi-hermetic and open-type compressors.
5.5. Methods Used To Prevent Leakage Of Refrigerant At The Compressor Shaft, and Prevent Liquid Refrigerant From Entering The Compressor Reference: Text: Book 2: Ch. 23 Refrigeration Compressors	Discuss methods used to prevent leakage of refrigerant at the compressor shaft, and prevent liquid refrigerant from entering the compressor. 1. Describe the construction and operation of seals for refrigeration compressors
5.6. Different Methods Employed To Control The Capacity of the Various Types of Refrigeration Compressors Including: Stop Start, Slide Valves (Variable Clearance Volume), Variable Frequency Drives, etc. Reference: Text: Book 2: Ch. 26 Refrigeration Metering Devices	Describe the operating principles of refrigeration metering devices and capacity controls 1. Describe the different methods used to control the capacity of refrigeration compressors
5.7. Two-Stage Centrifugal Chiller Reference: Text: Book 2: Ch. 24 Heat Exchangers for Refrigeration Systems	Describe the designs and construction of refrigeration system evaporators 1. Describe the construction and operation of a centrifugal refrigeration compressor

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 7 of 15
---	-----------------------------	-----------------------------------

5.8. Compressor Cooling Reference: Text: Book 2: Ch. 24 Heat Exchangers for Refrigeration Systems	Describe the designs and construction of refrigeration system condensers 1. Identify various methods for compressor cooling
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6. Controls and Instrumentation (13.3%): Candidates must demonstrate an **understanding** of the controls and accessories including:

Competencies:	Learning Objectives:
6.1. Basic Computer Control and Instrumentation Reference: Text: Book 2: Ch. 28 Refrigeration Cycle Controls	Describe the purposes and operating principles of the operational and safety controls on a refrigeration system 1. Identify types of computer controls used in refrigeration plants (Programmable Logic Controller - PLC, Direct Digital Controller - DDC & Human Machine Interface - HMI) 2. Describe the instrumentation used in refrigeration plants.
6.2. Six Commonly Used Types of Refrigerant Flow Metering Devices Used To Control The Flow Of Refrigerants Reference: Text: Book 2: Ch. 26 Refrigeration Metering Devices	Describe the operating principles of refrigeration metering devices and capacity controls 1. Describe the construction and operation of compression refrigeration cycle expansion valves.
6.3. The Operation of a Thermostatic Expansion Valve Reference: Text: Book 1: Ch. 11 Introduction to Valves Book 2: Ch. 26 Refrigeration Metering Devices (p. 91)	Describe the operating principles of refrigeration metering devices and capacity controls 1. Describe the construction and operation of a thermostatic expansion valve.
6.4. The Function, Principle Of Operation, and the Location(s) of the Following Operational Controllers: 6.4.1. Temperature and/or Pressure Actuated 6.4.2. Humidity Actuated 6.4.3. Evaporator Pressure Regulator 6.4.4. Cooling Water Regulating Valve Reference: Text: Book 1: Ch. 11 Introduction to Valves Book 2: Ch. 28 Refrigeration Cycle Controls	Describe the operating principles of refrigeration metering devices and capacity controls 1. Describe the operation of temperature, pressure and humidity controls for refrigeration systems 2. Describe the actuators used in refrigeration control systems
6.5. The Safety Controls Used in a Refrigeration System, and the Operation Of Each Type such as: 6.5.1. High Pressure Cut-Out 6.5.2. Low Pressure Cut-Out 6.5.3. Oil Failure Protection Devices 6.5.4. High Discharge Cut-Outs 6.5.5. High Oil Cut-Outs 6.5.6. Motor Overload Devices Reference:	Describe the purposes and operating principles of the operational and safety controls on a refrigeration system. 1. List and describe the typical refrigeration system safety shutdown devices

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 8 of 15
---	-----------------------------	-----------------------------------

Text: Book 2: Ch. 30 Refrigeration Metering Devices	
<p>6.6. The Function and the Location of the Following Components in a System:</p> <p>6.6.1. Oil Separators as applied to:</p> <p> 6.6.1.1. Reciprocating Compressors</p> <p> 6.1.2. Screw Compressors</p> <p>6.6.2. Suction Strainers and Scale Traps</p> <p>6.6.3. Filter-Driers</p> <p>6.6.4. Moisture Indicators</p> <p>6.6.5. Crankcase Heaters in Reciprocating Compressors and Oil Heaters in Screw Compressors</p> <p>6.6.6. Oil Stills</p> <p>6.6.7. Purge, Charging Valves</p> <p>6.6.8. Pressure Relief Devices</p> <p>Reference: Text: Book 2: Ch. 27 Refrigeration Accessories Book 2: Ch. 28 Refrigeration Cycle Controls</p>	<p>Describe the purposes and operating principles of the operational and safety controls on a refrigeration system.</p> <p>1. Identify the location of the following components:</p> <ul style="list-style-type: none"> • oil separators as applied to: <ul style="list-style-type: none"> ▪ reciprocating compressors ▪ screw compressors. • suction strainers and scale traps • filter-driers • moisture indicators • crankcase heaters in reciprocating compressors and oil heaters in screw compressors • oil stills • purge, charging valves • pressure relief devices
<p>6.7. The Type of Piping/Tubing Allowed for the Different Types of Refrigerants</p> <p>Reference: Text: Book 1: Ch. 10 Introduction to Piping & Pipe Fittings (pp. 141-149) Book 1: Ch. 11 Introduction to Valves Book 2: Ch. 27 Refrigeration Accessories (p. 116)</p>	<p>Discuss the basic types of piping, piping connections, supports and drainage devices used in industry</p> <p>1. Identify the types of piping/tubing allowed for the different types of refrigerants.</p> <p>2. State the applications for most common materials and identify the sizes of commercial pipe</p> <p>3. Describe methods of connection for screwed, flanged and welded pipe and identify fittings and their markings.</p>
<p>6.8. The Use Of Receivers in a Refrigeration System, Their Location, and the Code Required Safety Fittings Attached Including:</p> <p>6.8.1. High Pressure Receivers</p> <p>6.8.2. Low Pressure Receivers</p> <p>6.8.3. Intermediate or Controlled Pressure Receivers</p>	<p>Describe the use and locations of receivers in a refrigeration system.</p> <p>1. Identify the safety fittings required by the code for:</p> <ul style="list-style-type: none"> • High pressure receivers • Low pressure receivers • Intermediate or controlled pressure receivers.
<p>6.9. The Methods Employed to Control Humidity</p> <p>Reference: Text: Book 2: Ch. 35 Ventilation & Air Filters</p>	<p>Describe and explain the various ventilation systems found in buildings</p> <p>1. Explain the difference between natural and mechanical ventilation</p> <p>2. Describe the following methods employed to control humidity:</p> <ul style="list-style-type: none"> • Desiccant • Mechanical • Ventilation

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 9 of 15
---	-----------------------------	-----------------------------------

7. Condensers and Cooling Towers (6.7%): Candidates must demonstrate an understanding of condensers and cooling towers including the:	
Competencies:	Learning Objectives:
7.1. Different Types Of Air-Cooled and Water-Cooled Condensers Reference: Text: Book 2: Ch. 24 Heat Exchangers for Refrigeration Systems	Describe the design and construction of refrigeration system condensers. 1. Describe the different types of condensers including: <ul style="list-style-type: none"> • air-cooled, • water-cooled, and • evaporative
7.2. Evaporative Type Condenser and the Effects Of Humidity on this Type of Condenser's Operation Reference: Text: Book 2: Ch. 24 Heat Exchangers for Refrigeration Systems	Describe the design and construction of an evaporative type condenser 1. Explain the effects of humidity on condenser operation.
7.3. Main Factors on which the Rate Of Heat Transfer Is Dependent On in a Cooling Tower Reference: Text: Book 2: Ch. 25 Cooling Towers	Describe the operation of cooling towers 1. List the basic components of a cooling tower 2. List the factors that determine rate of cooling in a cooling tower
7.4. Evaporative Cooling Effect and Its Consequences Reference: Text: Book 2: Ch. 25 Cooling Towers (p. 76-81)	Describe the operation of cooling towers 1. Explain the effects and consequences of evaporative cooling on condensers and cooling towers
7.5. Need For Water Treatment and the Water Tests Required Reference: Text: Book 2: Ch. 25 Cooling Towers (p. 76-81)	Describe the water treatment necessary for cooling water 1. Explain the need for water treatment 2. Identify required water testing for condensers and cooling towers
7.6. Ability To Recognize Bacteria Concerns Associated With Water Sumps and What Can Be Done To Prevent Associated Risks Reference: Text: Book 2: Ch. 25 Cooling Towers (p. 80)	Describe the water treatment necessary for cooling water 1. Identify concerns associated with bacteria and water sumps 2. Describe measures to prevent associated risks.

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 10 of 15
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8. Evaporators and Cooling Coils (6.7%): Candidates must demonstrate an understanding of evaporators and cooling coils including the:	
Competencies:	Learning Objectives:
<p>8.1. Construction and Application For Each Of The Following:</p> <ul style="list-style-type: none"> 8.1.1. Bare Tube Construction 8.1.2. Fin And Tube Construction 8.1.3. Plate Type Construction 8.1.4. Chillers Including: <ul style="list-style-type: none"> 8.1.4.1. Shell & Tube Construction 8.1.4.2. Plate & Frame Construction <p>Reference: Text: Book 2: Ch. 24 Heat Exchangers for Refrigeration Systems</p>	<p>Describe the different types of heat exchangers used in refrigeration systems</p> <ol style="list-style-type: none"> 1. Describe the designs and construction of refrigeration system evaporators
<p>8.2. Differences Between A Dry Expansion (also called direct expansion) and a Flooded Expansion and Liquid Overfeed Evaporators</p> <p>Reference: Text: Book 2: Ch. 24 Heat Exchangers for Refrigeration Systems</p>	<p>Describe the different types of heat exchangers used in refrigeration systems</p> <ol style="list-style-type: none"> 1. Describe the designs and construction of refrigeration system evaporators
<p>8.3. Thermal Storage Systems</p> <p>Reference: Text: Book 2: Ch. 24 Heat Exchangers for Refrigeration Systems</p>	<p>Describe thermal storage systems</p> <ol style="list-style-type: none"> 1. Describe the design and construction of thermal storage systems

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 11 of 15
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9. Operation and Maintenance (6.7%): Candidates must demonstrate an understanding of operation and maintenance including:	
Competencies:	Learning Objectives:
9.1. The Refrigeration Leak Test Methods Used To Find Refrigerant Leaks Reference: Text: Book 2: Ch. 29 Compression Refrigeration System Pre-Startup Procedures	Describe the various pre-startup procedures used on compression refrigeration systems 1. Describe how to perform refrigeration system leak tests
9.2. How You Would Start-Up and Shut Down A Single-Stage Refrigeration System Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operations	Describe the various operation and maintenance procedures used on compression refrigeration systems 1. Describe the steps in the start-up and shutdown of a compression refrigeration system
9.3. How Air Is Removed From An Operating System and Including Both Manual and Automatic Purging Reference: Text: Book 2: Ch. 29 Compression Refrigeration System Pre-Startup Procedures	Describe the various operation and maintenance procedures used on compression refrigeration systems 1. Describe how a refrigeration system is purged of non-condensable gases prior to start-up
9.4. How To Add Oil To A Running Compressor and An Understanding Of Basic Refrigerant Charging Reference: Text: Book 2: Ch. 29 Compression Refrigeration System Pre-Startup Procedures	Describe the various operation and maintenance procedures used on compression refrigeration systems 1. List the steps for adding oil to a refrigeration compressor when it is in service
9.5. Some Common Reasons For The Following Conditions: 9.5.1. Failure Of A Compressor To Start 9.5.2. Causes For Compressor Short Cycling 9.5.3. Causes Of Continuous Operation Of The Compressor Under Light Loads and While System Cooling Is Not Required 9.5.4. Discharge Pressure Too High, or Too Low; Suction Pressure Too High, or Too Low Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operations	Describe the various operation and maintenance procedures used on compression refrigeration systems 1. Apply a compression refrigeration system troubleshooting guide

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 12 of 15
---	-----------------------------	------------------------------------

<p>9.6. The Maintenance Requirements for Compressors, System Pumps, Valves, Metering Devices, Evaporators, and Condensers to Ensure Safe and Continuous Operation</p> <p>Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operations</p>	<p>Describe the various operation and maintenance procedures used on compression refrigeration systems</p> <ol style="list-style-type: none"> 1. List and describe the standard preventive maintenance procedures for compression refrigeration systems
<p>9.7. The Precautions to be Taken When Draining Oil Separators to Prevent Unsafe Conditions</p> <p>Reference: Text: Book 2: Ch. 29 Compression Refrigeration System Operation & Maintenance</p>	<p>Describe the various operation and maintenance procedures used on compression refrigeration systems</p> <ol style="list-style-type: none"> 1. Describe how to safely remove oil from refrigeration systems.
<p>9.8. The Methods Used To Defrost Evaporators. Emphasis Will Be On Industrial/Commercial Refrigeration Defrost Methods</p> <p>Reference: Text: Book 2: Ch. 31 Compression Refrigeration System Operation & Maintenance</p>	<p>Describe the various operation and maintenance procedures used on compression refrigeration systems</p> <ol style="list-style-type: none"> 1. Explain the methods used to defrost evaporators such as: <ul style="list-style-type: none"> • Air, • Water • Hot gas
<p>9.9. An Understanding of What Crystallization is With Respect to Absorption Refrigeration Systems</p> <p>Reference: Text: Book 2: Ch. 31 Absorption Refrigeration System Operation & Maintenance</p>	<p>Describe the various operation and maintenance procedures used on absorption refrigeration systems</p> <ol style="list-style-type: none"> 1. Apply an absorption refrigeration system-troubleshooting guide
<p>9.10. Defrosting Evaporators</p> <p>Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operation & Maintenance</p>	<p>See 9.8</p>
<p>9.11. Oil Removal From Systems</p> <p>Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operation & Maintenance</p>	<p>See 9.7</p>
<p>9.12. Pumping Down Systems</p> <p>Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operation & Maintenance</p>	<p>Describe the steps required to pump down a system.</p>

MANITOBA REFRIGERATION OPERATOR FOR RECREATION FACILITIES COURSE OUTLINE	SOPEEC SYLLABUS DESCRIPTION	Curriculum Matrix Page 13 of 15
---	-----------------------------	------------------------------------

9.13. Equipment Isolation Reference: Text: Book 2: Ch. 30 Compression Refrigeration System Operation & Maintenance	Describe the steps required to isolate equipment.
9.14. Low Temperature Receivers	
9.15. Low Temperature Liquid Recirculation (Liquid Overfeed)	
9.16. Chemical Treatment for Condensers and Cooling Towers Reference: Text: Book 2: Ch. 25 Cooling Towers	Describe the operation and maintenance of cooling towers 1. Describe the water treatment necessary for cooling water

10. Electrical (3.3%): Candidates must demonstrate a basic understanding of electricity including:	
Competencies:	Learning Objectives:
10.1. The Use and Function of the Following Electrical Components: Circuit Breakers, Relays, Rheostats, Fuses, Electrical Switches, and Cut-Outs Reference: Text: Book 1: Ch. 18 Introduction to Electricity	Discuss the design and accessories of an electrical circuit 1. Describe circuit accessories, including switches, fuses, breakers and receptacles 2. Explain the danger of electric shock
10.2. The Dangers and Maintenance Requirements of Electric Motors Reference: Text: Book 1: Ch. 8 Types of Pumps Book 1: Ch. 18 Introduction to Electricity	Identify the dangers and maintenance requirements of electric motors 1. Describe transformers and electric motors 2. Explain motor types, bearing care and troubleshooting of motors 3. Describe simple electrical system problems, including short circuits, grounds and bad connections.
10.3. The Basic Differences with Motor Starters and the Application of Different Types Reference: Text: Book 1: Ch. 18 Introduction to Electricity	Discuss the basic differences with motor starts and the application of different types 1. Differentiate between types of motor starters and their application 2. Explain CSA approval and marking for electrical applications

11. Air Conditioning (3.3%): Candidates must demonstrate an **understanding** of air conditioning including:

Competencies:	Learning Objectives:
<p>11.1. The Psychrometrics Of Air, And The Air Conditioning Factors That Affect Comfort</p> <p>Reference: Text: Book 2: Ch. 33 Application of the Psychrometric Chart</p>	<p>Describe the operation of various air conditioning systems</p> <ol style="list-style-type: none"> 1. Discuss what is meant by 'comfort conditions' with respect to the Psychrometric chart
<p>11.2. The Ability to Analyze/Demonstrate on a Psychrometric Chart the Behaviour of Air when Subjected to Cooling, Humidification and Dehumidification</p> <p>Reference: Text: Book 2: Ch. 33 Application of the Psychrometric Chart</p>	<p>Solve problems using a psychrometric chart</p> <ol style="list-style-type: none"> 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
<p>11.3. The Different Categories of Air Conditioning Systems</p> <p>Reference: Text: Book 2: Ch. 40 Air Conditioning Systems I Book 2: Ch. 41 Air Conditioning Systems II</p>	<p>Describe the operation of various air conditioning systems</p> <ol style="list-style-type: none"> 1. List the functions and categories of air conditioning systems
<p>11.4. How Legionnaires Disease Can Be Drawn Into Ventilation Systems and Recognize the Effects Thereof</p> <p>Reference: Text: Book 2: Ch. 35 Ventilation & Air Filters Book 2: Ch. 25 Cooling Towers (p. 74)</p>	<p>Describe the operation of air handling units</p> <ol style="list-style-type: none"> 1. Describe how Legionnaires Disease can be drawn into ventilation systems and the resulting effects

12. Mathematic and Science (6.7%) :The candidate should be able to **perform** basic refrigeration calculations:

Competencies:	Learning Objectives:
12.1 Elementary Mathematics Reference: Text: Book 1: Ch. 5 Introduction to Basic Mechanics	Perform basic arithmetic operations <ol style="list-style-type: none"> 1. Perform basic calculations (add, subtract, divide, multiply) 2. Perform basic calculations on decimal numbers 3. Perform basic calculations on fractions 4. Evaluate percentage problems 5. Given a ratio, determine the correct quantity of a substance
12.2 Elementary Mechanics And Dynamics Reference: Text: Book 1: Ch. 5 Introduction to Basic Mechanics	Define basic terms used in the study of mechanics <ol style="list-style-type: none"> 1. Define pressure, work, power and energy 2. Explain application of levers, pulleys and inclined planes 3. Identify where simple machines are used in plant
12.3 Elementary Thermodynamics Reference: Text: Book 1: Ch. 4 Thermodynamics of Refrigeration	Explain the terms and principles associated with the thermodynamics of refrigeration <ol style="list-style-type: none"> 1. State how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance 2. Apply basic formulas to refrigeration calculations

13. Practical Experience (10%) : The candidate is expected to be **able to answer examination questions** as they relate to the **equipment** they have gained refrigeration plant **experience on** including:

Competencies:	Learning Objectives:
13.1. Schematic Flow Diagrams Of Systems Including: <ol style="list-style-type: none"> 13.1.1. Types of Compressors Used 13.1.2. Compressor Size 13.1.3. Compressor Capacities 13.1.4. Pressures and Temperatures 13.1.5. Methods of Capacity Control 	To be met by the 900 practical hours
13.2. Safety Devices and Operational Controls Installed on Systems to Ensure Safe and Efficient Operation	To be met by the 900 practical hours
13.3. The Compressor and Refrigeration System Maintenance Procedures to be in place to Ensure Safe Refrigeration Plant Operation as well as Ensuring Compliance With The Required Act, Regulations and Codes	To be met by the 900 practical hours