

# Refrigeration and Air Conditioning Mechanic Level 4

## **Refrigeration and Air Conditioning Mechanic**

**Unit:** D1 Refrigeration Estimation and Coordination

**Level:** Four

**Duration:** 14 hours

Theory: 7 hours

Practical: 7 hours

### **Overview:**

This unit is designed to provide the apprentice with the knowledge and skills of refrigeration estimation and coordination. Beginning with terminology, apprentices will interpret codes and specifications pertaining to refrigeration estimation & coordination. Apprentices will review technical and working documents. Apprentices will also demonstrate and perform a refrigeration job estimate using technical and working documents. Finally, apprentices will develop a plan to coordinate the performance of a refrigeration project.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with refrigeration estimation and coordination.	10%
2. Identify safety documentation and describe safe work practices associated with refrigeration estimation and coordination.	5%
3. Interpret codes and specifications pertaining to refrigeration estimation and coordination.	10%
4. Review technical and working documents. a. Equipment and service documents b. Drawings, blueprints and specifications	25%
5. Demonstrate and perform a refrigeration job estimate using technical and working documents.	30%
6. Interpret technical and working drawings and develop a plan to coordinate the performance of a refrigeration project. a. Materials b. Equipment c. Site considerations d. Installation e. Commissioning f. Labour	20%

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## **Refrigeration and Air Conditioning Mechanic**

**Unit: D2 Refrigeration Systems Installation**

**Level:** Four

**Duration:** 35 hours

Theory: 25 hours

Practical: 10 hours

### **Overview:**

This unit is designed to provide the apprentice with knowledge and skills of refrigeration systems installation. Beginning with terminology, hazards, and safe work practices, the unit will include jurisdictional codes and manufactures' specifications pertaining to refrigeration systems installation. Topics include: a review of compressor motors, their characteristics, and application to refrigeration systems. Apprentices will describe the procedures to determine system parameters. Apprentices will also calculate loads and heat/loss gain for refrigeration systems. Finally, apprentices will describe and demonstrate the procedures to install various types of refrigeration systems and components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Review terminology associated with refrigeration systems installation.	5%
2. Identify hazards and describe safe work practices and equipment pertaining to refrigeration systems installation.	5%
3. Interpret jurisdictional codes and manufacturers' specifications pertaining to refrigeration systems installation.	5%
4. Review compressor motors, their characteristics, and application to refrigeration systems. a. Types <ul style="list-style-type: none"><li>• Reciprocating</li><li>• Scroll</li><li>• Rotary</li><li>• Screw</li><li>• Centrifugal</li><li>• Swing</li><li>• Linear</li></ul>	15%
5. Describe the procedures to determine system parameters.	20%
6. Calculate loads and heat/loss gain for refrigeration systems.	25%

7. **Describe and demonstrate the procedures to install various types of refrigeration systems and components.** 25%
- a. Compressors
  - b. Accessories
  - c. Equipment placement
  - d. Hangers

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## Refrigeration and Air Conditioning Mechanic

**Unit:** D3 Control Systems Installation III

**Level:** Four

**Duration:** 35 hours

Theory: 25 hours

Practical: 10 hours

### Overview:

This unit is designed to provide the apprentice with knowledge and skills of control systems installation. Beginning with terminology, hazards, and safe work practices, the unit will include jurisdictional codes and regulations pertaining to the installation of control systems. Topics include a review of control systems and their characteristics and applications. Apprentices will review the procedures to incorporate control strategies into control systems. Apprentices will also describe and demonstrate the installation of control systems and their components. Finally, apprentices will demonstrate and perform commissioning of control systems and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with control systems and their components.	10%
2. Identify hazards and safe work practices pertaining to control systems installation.	10%
3. Interpret codes and regulations pertaining to control systems installation.	10%
4. Review control systems and describe their characteristics and applications. a. Control systems <ul style="list-style-type: none"><li>• Electrical</li><li>• Mechanical</li><li>• Electronic</li><li>• Integrated control circuits</li></ul>	10%
5. Review the procedures to incorporate control strategies into control systems. a. Two position control b. Floating control c. Pulse width modulation (Pwm) d. Proportional (P) e. Proportional integral (Pi) f. Proportional integral derivative (Pid) g. Building Automation System (Bas) h. Direct digital control (Ddc)	10%
6. Describe and demonstrate installation of control systems and their components. a. Control section	30%

b. Control placement

**7. Demonstrate and perform commissioning of control systems and their components.**

**20%**

- a. Verify control order of operations
- b. Verify control operation

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## Refrigeration and Air Conditioning Mechanic

**Unit:** D4 Refrigeration Systems Service

**Level:** Four

**Duration:** 63 hours

Theory: 35 hours

Practical: 28 hours

### Overview:

This unit is designed to provide the apprentice with knowledge and skills of refrigeration systems service. Beginning with terminology, hazards and safe work practices, the unit will interpret information and sequence of operation pertaining to refrigeration systems service. Topics include: a review of refrigeration systems, components, accessories and their characteristics and applications. Apprentices will identify and describe tools and equipment used for checking and completing refrigeration system charge, their applications and procedures for use. Apprentices will also describe and demonstrate refrigeration systems service procedures. Finally, apprentices will perform refrigeration systems service on various types of refrigeration equipment.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. <b>Define terminology associated with refrigeration systems service.</b>	<b>5%</b>
2. <b>Identify hazards and safe work practices pertaining to refrigeration systems service.</b>	<b>5%</b>
3. <b>Interpret information and sequence of operation pertaining to refrigeration systems service.</b> a. Drawings b. Wiring diagrams c. Manufacturers' literature d. Schematic diagrams	<b>10%</b>
4. <b>Review refrigeration systems, components, accessories and describe their characteristics and applications.</b> a. Electrical components	<b>10%</b>
5. <b>Identify and describe tools and equipment used for checking and completing refrigeration system charge, their applications and procedures for use.</b> a. Refrigeration system equipment b. Refrigeration components c. Refrigeration accessories	<b>20%</b>
6. <b>Describe and demonstrate refrigeration systems service procedures.</b> a. Pre-start-up checks • Sequence of operation b. Start-up	<b>30%</b>

- Phasing
- Voltage imbalance and amperage
- Refrigerant charge adjustments
- Oil levels
- Operating pressures and temperatures
- System control adjustments
- Manufacturers' recommendations
- Liquid or air requirements
- c. Complete system charge
  - Measuring superheat and sub-cooling
  - Weighing critical charge
  - Interpreting charge charts
  - Checking sight glass
- d. Set up, test and adjust system components
  - Blowers
  - Fans
  - Pumps
  - Compressors
  - Motors
  - Dampers
  - Temperature/pressure controls
  - Valves
- e. Commission/documentation
- f. Troubleshoot
- g. Repair
- h. Maintenance

**7. Perform refrigeration systems service on various types of refrigeration equipment. 20%**

- a. Pre-start-up check
- b. Start-up
- c. Primary and secondary component set up
- d. Commission
- e. Troubleshoot
- f. Repair

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## Refrigeration and Air Conditioning Mechanic

**Unit:** D5 Control Systems Service III

**Level:** Four

**Duration:** 28 hours

Theory: 20 hours

Practical: 8 hours

### Overview:

This unit is designed to provide the apprentice with knowledge and skills of control systems service. Beginning with terminology, hazards and safe work practices, the unit will interpret codes and regulations pertaining to control systems service. Topics include: tools and equipment used to troubleshoot, perform maintenance and repair on control systems and their components. Apprentices will interpret heating, ventilation, air conditioning and refrigeration (HVAC/R) control information sourced from drawings, specifications and service manuals. Apprentices will also describe and demonstrate the procedures to service control systems and their components. Finally, apprentices will demonstrate and perform procedures used to maintain and troubleshoot control systems.

<b>Objectives and Content:</b>	<b>Percent of <u>Unit Mark (%)</u></b>
<b>1. Define terminology associated with control systems service.</b> a. Control systems b. Components	<b>5%</b>
<b>2. Identify hazards and safe work practices pertaining to control systems service.</b> a. Control systems	<b>5%</b>
<b>3. Interpret codes and regulations pertaining to control systems service.</b> a. Control systems b. Components	<b>10%</b>
<b>4. Identify and describe tools and equipment used to troubleshoot and perform maintenance and repair on control systems and their components.</b>	<b>10%</b>
<b>5. Interpret HVAC/R control information sourced from drawings, specifications and service manuals.</b> a. Wiring diagrams <ul style="list-style-type: none"> <li>• Terminology</li> <li>• Symbols</li> <li>• Interpretation</li> </ul>	<b>10%</b>
<b>6. Describe and demonstrate the procedures to service control systems and their components.</b> a. Control circuit systems and components <ul style="list-style-type: none"> <li>• Verify basic electrical using schematic wiring diagrams</li> </ul>	<b>30%</b>

- b. Control systems
  - Sequence of operation
  - Start up with digital technology
  - Verify and set operating parameters
  - Commission
- c. Calibrate components and adjust parameter set points
  - Electronic controls
  - Control systems
  - Operating and safety controls
- d. Maintenance
- e. Basic diagnosis
  - Electronic controls
  - Inspection
- f. Control system failures
  - Causes
  - Sources
- g. Lock out
  - Isolate
  - De-energize
- h. Repair
  - Control systems
  - Components

**7. Demonstrate and perform procedures used to maintain and troubleshoot control systems. 30%**

- a. Lock out, tag out and verify systems are de-energized
- b. Trace out electrical sequence of operation on refrigeration systems
- c. Verify and calibrate controls or set points as required

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## Refrigeration and Air Conditioning Mechanic

**Unit:** D6 Industrial Refrigeration Systems

**Level:** Four

**Duration:** 63 hours

Theory: 56 hours

Practical: 7 hours

### Overview:

This unit is designed to provide the apprentice with knowledge and skills of industrial refrigeration systems. Beginning with terminology, hazards, and safe work practices, the unit will interpret codes and regulations pertaining to industrial refrigeration systems. Apprentices will identify and describe industrial refrigeration systems. Apprentices will also describe the operating principles of chillers, chiller systems, evaporative condensers, cooling towers and their components. Finally, apprentices will describe the procedures associated with industrial refrigeration systems.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with industrial refrigeration systems.	5%
2. Identify hazards and safe work practices pertaining to industrial refrigeration systems.	5%
3. Identify and interpret codes and regulations pertaining to industrial refrigeration systems. a. Chillers b. Chiller systems	10%
4. Identify and describe industrial refrigeration systems. a. Types <ul style="list-style-type: none"><li>• Chillers</li><li>• Chiller systems</li><li>• Evaporative condensers</li><li>• Cooling towers</li></ul> b. Characteristics c. Applications <ul style="list-style-type: none"><li>• Air conditioning</li><li>• Ice rink/surface</li><li>• Process</li><li>• Supermarket</li></ul>	20%
5. Describe the operating principles of chillers, chiller systems, evaporative condensers, cooling towers and their components. a. Schematic diagrams	20%

- b. Capacity controls
- c. Factors that influence effectiveness
- d. Potential problems
  - Causes
  - Remedies

**6. Describe the procedures associated with industrial refrigeration systems. 40%**

- a. Systems
  - Chillers
  - Chiller systems
  - Evaporative condensers
  - Cooling towers
- b. Procedures
  - Install
  - Start-up
  - Shut-down
  - Maintenance
  - Troubleshoot

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## Refrigeration and Air Conditioning Mechanic

**Unit:** D7 Journeyperson Trainer

**Level:** Four

**Duration:** 7 hours

Theory: 7 hours

Practical: 0 hours

### Overview:

Level 1 in-school technical training offers an entry-level orientation to the challenges of apprenticeship training as it relates to the development of core tasks, skill requirements, and social competencies. This unit introduces senior apprentices to the responsibilities of workplace training that they will assume as supervising journeypersons. Most trades have a rich tradition of refreshing and sharing their trade skills from one generation of trade practitioner to the next. This unit orients senior apprentices to some of the practical and conceptual tools that can enable them to contribute to this trade heritage when they become certified journeypersons and, ultimately, journeyperson trainers.

The journeyperson's obligation to assist entry-level apprentices to develop skills and knowledge is complex and challenging. It involves safety considerations, employer expectations, provincial regulations, as well as the tradition of skills stewardship that links modern practice with the long history of workplace teaching and learning that defines the apprenticeable trades. The ability to offer timely and appropriate support to apprentices is itself an important area of trade learning. This unit presents material intended to help refine this ability through reflection and discussion by senior apprentices, and discussion with their in-school instructor and journeyperson trainer.

This content reflects Manitoba and Canadian standards prescribed for journeyperson-level supervisory capabilities, as well as key topics in current research on the importance of workplace training in apprenticeship systems. These detailed descriptors represent suggested focal points or guidelines for potentially worthwhile exploration, and are neither mandatory nor exhaustive.

### Objectives and Content:

**Percent of  
Unit Mark (%)**

- |   |            |
|---|------------|
| <b>1. Compare/contrast role-options and responsibilities of the supervising journeyperson.</b>  | <b>50%</b> |
| a. Implicit vs. explicit standards and content: training goals are/are not codified; assessment measures are/are not used   |            |
| b. Accountability for results: e.g., journeyperson is/is not required to prepare performance evaluation that could affect apprentice's employability or wage-rate, etc.   |            |
| c. Long-term vs. short-term supervision assignments – e.g., considerable latitude/little latitude for apprentice to learn from mistakes   |            |
| d. Formally vs. informally structured – e.g., supervision assignment is part of a prescribed cycle of assignments involving coordination among multiple journeypersons; apprentice is trained according to an individual training plan negotiated with employer |            |
| e. Types of supervisory role options and what is implied by each:   |            |
| • Journeyperson Trainer (JT) role: often initiated by someone other than apprentice, and limited to a particular skill set, task, or production requirement   |            |
| • Mentor role: often initiated by apprentice, and relatively open-ended regarding   |            |

content, duration, etc.

- Peer role: typically involves individual upgrading or cross-training of one journeyperson by another; can include senior apprentice assisting less-experienced trade learner
- Coordinator role: often a senior-level journeyperson appointed by an organization to assume responsibilities for monitoring progression of groups of apprentices
- Other roles: may be improvised by journeyperson, such as combination or multiple roles of the above

**2. Describe and demonstrate common requirements about providing journeyperson level supervision. 50%**

- a. Apprenticeship learning adapted to journeyperson supervision assignments and a journeyperson perspective
  - Application of adult education concepts to trades teaching and learning (e.g., responsibilities and expectations of senior-level apprentices)
  - Practical significance of 'styles' of adult learning and teaching
  - Helping senior-level apprentices integrate in-school technical training and on-the-job practical training experiences
  - Providing help and guidance for new tasks and skills
  - Providing help and guidance for fixing mistakes
  - Learning and teaching "the ropes" – socialization of apprentice within a community of trade practice (e.g., how to borrow a tool, interrupt a journeyperson, and seek advice of experienced co-workers)
  - Coverage and documentation of prescribed tasks and subtasks where applicable
  - Discuss the limits of the journeyperson trainers' own responsibilities and competence (e.g., scope, willingness to train, etc.)
  - Benefits of maintaining a personal record of achievements, ideas, and needs as a journeyperson trainer (e.g., resume, portfolio, training credentials, logbook, etc.)
- b. Individual reflection and guided group discussion about personal experiences of workplace learning as an apprentice
  - Identification of best and worst practices of journeyperson trainer
  - Identification of workplace and other factors that can contribute to good and bad trades teaching/learning experiences
  - Development of professional standards and work ethic regarding one's responsibility to share one's knowledge and skills with others in the workplace (e.g., use/misuse of humour, rigour, discretion, craft-pride, etc.)
  - Qualities of a good journeyperson trainer
  - Components of workplace journeyperson training
  - Processes and recommended practices re: journeyperson training
  - Troubleshooting problems re: supervision assignments
- c. Role of assessment in supervising, coaching, or guiding other people to learn or improve their skills (e.g., formative and summative evaluation), and how this might contribute to how the journeyperson-level supervision task is approached in future
- d. Compare and contrast discussion results with current knowledge and resources about workplace training methods as they apply to journeyperson-level supervision assignments
- e. Other (as may be specified by instructor)

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## Refrigeration and Air Conditioning Mechanic

**Unit:** D8 Pre-Interprovincial Exam Review

**Level:** Four

**Duration:** 70 hours

Theory: 70 hours

Practical: 0 hours

### Overview:

This unit offers senior apprentices a systematic review of skills and knowledge required to pass the Interprovincial Examination. It promotes a purposeful personal synthesis between on-the-job learning and the content of in-school technical training. The unit includes information about the significance of Interprovincial (Red Seal) certification and the features of the Interprovincial Examination.

**Note: No percentage-weightings for test purposes are prescribed for this unit's objectives. Instead, a 'Pass/Fail' grade will be recorded for the unit in its entirety.**

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
<p><b>1. Describe the significance, format and general content of Inter-Provincial (IP) Examinations for the trade of Refrigeration and Air Conditioning Mechanic (RACM).</b></p> <ul style="list-style-type: none"> <li>a. Scope and aims of Interprovincial (Red Seal) certification; value of certifications</li> <li>b. Obligations of candidates for Interprovincial certification               <ul style="list-style-type: none"> <li>• Relevance of Interprovincial Examinations to current, accepted trade practices; industry-based provincial and national validation of test items</li> <li>• Supplemental Policy (retesting)</li> <li>• Confidentiality of examination content</li> </ul> </li> <li>c. Multiple-choice format (four-option) item format, Red Seal standards for acceptable test items</li> <li>d. Government materials relevant to the Interprovincial Examinations for apprentice Refrigeration and Air Conditioning Mechanics               <ul style="list-style-type: none"> <li>• Red Seal Occupational Standard (RSOS) – for RACM; prescribed scope of the skills and knowledge which comprise the trade</li> <li>• RSOS “Pie-chart” and its relationship to content distribution of Interprovincial Examination items</li> <li>• Red Seal Examination Breakdown</li> <li>• Red Seal Self-Assessment Guide</li> <li>• Apprenticeship Manitoba Technical Training package</li> </ul> </li> </ul>	n/a
<p><b>2. Identify resources, strategies and other considerations for maximizing successful completion of written examinations.</b></p> <ul style="list-style-type: none"> <li>a. Personal preparedness               <ul style="list-style-type: none"> <li>• Rest</li> <li>• Nutrition</li> <li>• Personal study regimen</li> </ul> </li> </ul>	n/a

- Prior experience in test situations (e.g., Unit Tests)
- b. Self-assessment, consultation and personal study plan
    - Self-assessment of individual strengths/weaknesses in trade related skills and knowledge
    - Approved textbooks
    - Study groups
3. **Review program content regarding the major work activity of performs common occupational skills.** n/a
  4. **Review program content regarding the major work activity of performs routine trade activities.** n/a
  5. **Review program content regarding the major work activity of plans installation.** n/a
  6. **Review program content regarding the major work activity of performs installation.** n/a
  7. **Review program content regarding the major work activity of performs commissioning.** n/a
  8. **Review program content regarding the major work activity of performs maintenance and service.** n/a

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