

# Refrigeration and Air Conditioning Mechanic (Commercial) Level 3

### **Refrigeration and Air Conditioning Mechanic (Commercial)**

**Unit:** C2 Refrigeration Load Calculations

**Level:** Three

**Duration:** 30 hours

Theory: 25 hours

Practical: 5 hours

**Overview:**

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of performing refrigeration load calculations.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
<b>1. Define terminology associated with refrigeration load calculations.</b>	<b>85%</b>
<b>2. Perform load calculations and determine total loads for refrigeration systems.</b>	<b>15%</b>
a. Transmission	
• K, C, U and R values	
• Solar load	
b. Air change	
• Infiltration	
• Ex-filtration	
• Usage	
c. Product	
• Sensible heat	
• Latent heat	
• Heat of respiration	
d. Miscellaneous	
• Fans	
• Lights	
• Motors	
• People	
• Equipment	
e. Defrost load	
• Air	
• Electric	
• Hot gas	
f. BTU/hr total	

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** C3 Refrigeration System Design

**Level:** Three

**Duration:** 25 hours

Theory: 20 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of refrigeration system design principles, refrigeration system components and their selection based on design criteria, refrigeration system capacity control, and knowledge of developing piping schematics and electrical schematics.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with refrigeration system design.	6%
2. Identify and interpret codes and regulations pertaining to refrigeration system design.	6%
3. Explain fundamental principles of refrigeration system design.	6%
4. Interpret graphs and tables for refrigeration system design.	6%
5. Identify capacity ratings of refrigeration system components.	6%
6. Perform calculations for refrigeration system design. a. Horsepower per ton <ul style="list-style-type: none"><li>• Low temperature system</li><li>• Medium temperature system</li><li>• High temperature system</li></ul>	6%
7. Describe the selection of components and ancillary devices for refrigeration systems based on design criteria.	6%
8. Describe the selection of refrigerant based on design criteria.	6%
9. Describe the factors to consider in the design and layout of refrigeration systems.	6%
10. Describe the importance of balancing system capacity with system load.	6%
11. Describe the factors to consider when sizing pipe for refrigeration piping systems.	5%
12. Describe the procedures used to size pipe for refrigeration piping systems.	5%

- |   |            |
|---|------------|
| <b>13. Develop piping schematics for refrigeration systems.</b>     | <b>15%</b> |
| <b>14. Develop electrical schematics for refrigeration systems.</b> | <b>15%</b> |

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** C4 Commercial Refrigeration Systems

**Level:** Three

**Duration:** 35 hours

Theory: 25 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of commercial refrigeration systems, their components and operation; the procedures used to install, maintain, and troubleshoot commercial refrigeration systems and their components, and demonstrate knowledge of specialty systems and their applications.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with commercial refrigeration systems.	8%
2. Identify and interpret codes and regulations pertaining to commercial refrigeration systems.	8%
3. Identify types of commercial refrigeration systems and describe their characteristics and applications.	8%
4. Identify types of specialty systems and describe their characteristics and applications. a. Ultra-low b. Cryogenic c. Cascade	8%
5. Identify commercial refrigeration system components and describe their purpose and operation.	8%
6. Identify factors that optimize storage of refrigerated and frozen products.	8%
7. Describe the procedures used to install commercial refrigeration systems and their components.	8%
8. Describe the procedures used to maintain and troubleshoot commercial refrigeration systems and their components.	7%
9. Describe the procedures used to start-up and shut-down commercial refrigeration systems.	7%
10. Demonstrate the procedures used to install, maintain, and troubleshoot commercial refrigeration systems and their components.	30%

### **Refrigeration and Air Conditioning Mechanic (Commercial)**

**Unit:** D2 Air Conditioning Systems

**Level:** Three

**Duration:** 25 hours

Theory: 15 hours

Practical: 10 hours

**Overview:**

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of residential and commercial air conditioning systems, their components and operation; the procedures used to install, maintain and troubleshoot residential and commercial air conditioning systems and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with residential and commercial air conditioning systems.	9%
2. Identify types of residential and commercial air conditioning systems and describe their characteristics and applications.	9%
3. Identify types of residential and commercial air conditioning system components and describe their purpose and operation.	9%
4. Describe the procedures used to install residential and commercial air conditioning equipment and their components.	9%
5. Describe the procedures used to maintain and troubleshoot residential and commercial air conditioning equipment and their components.	9%
6. Describe potential residential and commercial air conditioning problems and their causes and remedies.	9%
7. Describe the procedures used to calibrate and adjust air conditioning system components.	9%
8. Describe the procedures used to start-up and shut-down air conditioning systems.	7%
9. Perform the procedures to install, maintain and troubleshoot residential and commercial air conditioning systems and their components.	30%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** D3 Packaged Air Conditioning Units

**Level:** Three

**Duration:** 30 hours

Theory: 20 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of packaged air conditioning units, their components and operation, and of the procedures used to install, maintain and troubleshoot packaged air conditioning units and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with packaged air conditioning units.	7%
2. Identify hazards and describe safe work practices when working with packaged air conditioning units.	7%
3. Identify and interpret codes and regulations pertaining to packaged air conditioning units.	7%
4. Identify types of packaged air conditioning units and describe their characteristics and applications.	7%
5. Identify packaged air conditioning unit components and describe their purpose and operation.	7%
6. Perform calculations for packaged air conditioning units.	7%
7. Identify potential problems and describe their causes and remedies.	7%
8. Describe the procedures used to install packaged air conditioning units and their components.	7%
9. Describe the procedures used to maintain and troubleshoot packaged air conditioning units and their components.	7%
10. Describe the procedures used to start-up and shut-down packaged air conditioning units and their components.	7%
11. Demonstrate the procedures to install, maintain and troubleshoot packaged air conditioning units and their components.	30%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** D4 Heat Pump Systems

**Level:** Three

**Duration:** 30 hours

Theory: 20 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of heat pump systems, their components and operation, and of the procedures used to install, maintain, and troubleshoot heat pump systems and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with heat pump systems.	6%
2. Identify and interpret codes and regulations pertaining to heat pump systems.	6%
3. Describe the operating principles of heat pump systems.	6%
4. Identify types of heat pumps and describe their characteristics and applications.	6%
5. Identify heat pump components and describe their purpose and operation.	6%
6. Describe the operation of the defrost cycle as it relates to heat pumps.	6%
7. Describe the environmental considerations when installing heat pumps.	6%
8. Describe water quality as it relates to open loop systems.	6%
9. Perform calculations for heat pump systems.	6%
10. Describe control sequences for heat pumps.	6%
11. Describe the procedures used to install heat pumps and their components.	6%
12. Describe the procedures used to maintain and troubleshoot heat pumps and their components.	4%
13. Demonstrate the procedures to install, maintain and troubleshoot heat pumps and their components.	30%



## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** E4 Compressors III

**Level:** Three

**Duration:** 10 hours

Theory: 5 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of capacity control and of the procedures used to install, maintain and troubleshoot large commercial/industrial compressors and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with large commercial/industrial compressors.	2%
2. Identify hazards and describe safe work practices pertaining to large commercial/industrial compressors.	3%
3. Identify and interpret codes and regulations pertaining to large commercial/industrial compressors.	5%
4. Identify specialized tools and equipment and describe their applications and procedures for use.	5%
5. Identify methods used to cool compressors.	5%
6. Identify methods of forced compressor lubrication.	5%
7. Identify methods of compressor capacity control.	5%
8. Describe the procedures used to install large commercial/industrial compressors and their components.	5%
9. Describe procedures used to maintain and troubleshoot large commercial/industrial compressors and their components.	5%
10. Identify compressor failures and describe their causes and remedies. a. Mechanical b. Electrical	5%
11. Describe the procedures used to start-up and shut-down large commercial/industrial compressors.	5%
12. Demonstrate the procedures to install, maintain and troubleshoot large commercial/industrial compressors and their components.	50%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** E6 Motors II

**Level:** Three

**Duration:** 15 hours

Theory: 10 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of the procedures used to install, maintain, and troubleshoot single and multi-phase motors, their components, and motor controls.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with multi-phase motors and motor controls.	7%
2. Explain the principles of multi-phase motor operation.	7%
3. Identify types of starting devices for multi-phase motors and describe their characteristics, wiring configuration and operation.	7%
4. Identify single and multi-phase motor failures and describe their causes and remedies. a. Electrical b. Mechanical	7%
5. Describe methods used to change speed and rotation of multi-phase motors. a. Variable frequency drives (VFD)	7%
6. Describe the procedures used to install single and multi-phase motors and their components. a. Single-phase b. Three-phase c. Electrically-commutated motors (ECM)	7%
7. Describe the procedures used to maintain and troubleshoot single and multi-phase motors and their components.	7%
8. Describe the procedures used to install motor controls.	7%
9. Describe the procedures used to maintain and troubleshoot motor controls.	9%
10. Demonstrate installation, maintenance and troubleshooting single and multi-phase motors and their components.	20%
11. Demonstrate installation, maintenance and troubleshooting motor controls.	15%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** E11 Fluid Dynamics and Circulating Pumps

**Level:** Three

**Duration:** 15 hours

Theory: 15 hours

Practical: 0 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of fluid dynamics within piping systems and of circulating pumps, their components and operation.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with fluid dynamics and circulating pumps.	15%
2. Explain principles of fluid dynamics.	15%
3. Identify types of circulating pumps and describe their characteristics and applications.	15%
4. Identify circulating pump components and describe their purpose and operation.	15%
5. Describe the factors to consider when selecting a circulating pump. a. System parameters b. Pump curves c. Circuit configurations	15%
6. Identify potential problems of air in an open or closed system and their causes and remedies.	15%
7. Describe the procedures to purge air from an open or closed system.	10%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** E12 Refrigerant Flow Controls

**Level:** Three

**Duration:** 15 hours

Theory: 10 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of refrigerant flow controls and procedures for their operation, installation, maintenance and troubleshooting.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with refrigerant flow controls.	9%
2. Describe the purpose and operation of refrigerant flow controls.	9%
3. Identify types of refrigerant flow controls and describe their characteristics and applications. a. Direct acting b. Pilot operated	9%
4. Identify refrigerant flow control components and describe their purpose and operation.	9%
5. Describe the procedures used to install refrigerant flow controls.	9%
6. Describe the procedures used to maintain and troubleshoot refrigerant flow controls.	10%
7. Identify refrigerant flow control failures and describe their causes and remedies.	10%
8. Demonstrate operation, installation, maintenance and troubleshooting refrigerant flow controls.	35%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** E13 Evaporative Condensers and Cooling Towers

**Level:** Three

**Duration:** 10 hours

Theory: 8 hours

Practical: 2 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of evaporative condensers and cooling towers, their components and operation, and of the procedures used to install, maintain and troubleshoot evaporative condensers and cooling towers.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with evaporative condensers and cooling towers.	4%
2. Describe the purpose and operating principles of evaporative condensers.	4%
3. Identify types of evaporative condensers and describe their characteristics and applications.	4%
4. Identify evaporative condenser components and describe their purpose and operation.	4%
5. Describe the factors that influence the effectiveness of evaporative condensers.	4%
6. Describe and determine the capacity of an evaporative condenser using psychrometric processes.	4%
7. Identify methods to control head pressure and describe their associated procedures.	4%
8. Identify potential evaporative condenser problems and describe their causes and remedies.	4%
9. Describe the procedures used to install evaporative condensers.	4%
10. Describe the procedures used to maintain and troubleshoot evaporative condensers.	4%
11. Describe the procedures used to start-up, operate and shut-down evaporative condensers.	4%
12. Describe the purpose and operating principles of cooling towers.	4%

13. Identify types of cooling towers and describe their characteristics and applications. 4%
14. Identify cooling tower components and describe their purpose and operation. 4%
15. Describe the factors that influence the effectiveness of cooling towers. 4%
16. Describe and determine the capacity of a cooling tower using psychrometric processes. 4%
17. Identify potential water problems and describe their causes and remedies. 4%
18. Describe the procedures used to install cooling towers. 4%
19. Describe the procedures used to maintain and troubleshoot cooling towers. 4%
20. Describe the procedures used to start-up, operate and shut-down cooling towers. 4%
21. Perform the procedures to install, maintain and troubleshoot evaporative condensers, cooling towers and their components. 20%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** F3 Troubleshooting Refrigeration and Air Conditioning Electronics

**Level:** Three

**Duration:** 20 hours

Theory: 15 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of testing tools and equipment, their applications and procedures for use; and of the procedures used to troubleshoot electronic components and control boards.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with electronics.	20%
2. Identify electronic components and describe their purpose and operation.	20%
3. Identify tools and equipment used to test and troubleshoot electronic components and describe their applications and procedures for use.	20%
4. Describe the procedures used to troubleshoot electronic components and control boards.	15%
5. Perform the procedures to troubleshoot electronic components and control boards.	25%

## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** F4 Control Systems

**Level:** Three

**Duration:** 30 hours

Theory: 20 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of control systems, their components and operation, and of the procedures used to install, maintain and troubleshoot control systems and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
<b>1. Define terminology associated with control systems.</b>	<b>10%</b>
<b>2. Identify control principles and describe their operation.</b>	<b>10%</b>
a. Two position control	
b. Floating control	
c. Pulse width modulation	
d. Proportional (P)	
e. Proportional plus Integral (PI)	
f. Proportional plus Integral plus Derivative (PID)	
<b>3. Identify types of control systems and describe their characteristics and applications.</b>	<b>10%</b>
a. Electric	
b. Electronic	
c. Pneumatic	
d. Direct digital control (DDC)	
<b>4. Identify control system components and describe their purpose and applications.</b>	<b>10%</b>
<b>5. Describe the procedures used to install control systems and their components.</b>	<b>10%</b>
<b>6. Describe the procedures used to maintain and troubleshoot control systems and their components.</b>	<b>10%</b>
<b>7. Describe the procedures used to start-up and commission control systems.</b>	<b>10%</b>
<b>8. Perform the procedures to install, maintain and troubleshoot control systems and their components.</b>	<b>30%</b>



## Refrigeration and Air Conditioning Mechanic (Commercial)

**Unit:** G3 Gas Code III (includes Propane)

**Level:** Three

**Duration:** 25 hours

Theory: 20 hours

Practical: 5 hours

### Overview:

RACM (Commercial) apprentices require a good, practical grasp of the Gas Code, including Propane. This unit of instruction is the program gateway to further gas and propane learning skills.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Describe Liquid Petroleum (LP) liquid installation	10%
2. Describe LP pump, compressors and vaporizers	10%
3. Describe LP liquid meters, mixing equipment, transport units, trucks, rail, storage facilities, utility systems, pipeline and supply storage, natural gas utility systems, and high and low pressure natural gas and LP gas supply systems.	20%
4. Demonstrate the ability to install and maintain LP, handling equipment, pumps, compressors, vaporizers, meters.	30%
5. Demonstrate the ability to maintain LP transport equipment and storage facilities, maintain and repair LP utility systems, pipeline and supply storage LP transport equipment and storage facilities, to install, service and maintain high and low pressure natural gas and LP gas supply systems.	30%