PROGRAM OUTLINE
Refrigeration and Air Conditioning Mechanic
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Section 1

INTRODUCTION

Refrigeration and Air Conditioning Mechanic
Foreword

The Refrigeration and Air Conditioning Mechanic Program Outline is intended as a guide for instructors, apprentices, and employers of apprentices as well as for the use of industry organizations, regulatory bodies, and provincial and federal governments. It reflects updated standards based on the Red Seal Occupational Standard, and British Columbia industry and instructor subject matter experts.

Practical instruction by demonstration and student participation should be integrated with classroom sessions. Safe working practices, even though not always specified in each operation or topic, are an implied part of the program and should be stressed throughout the apprenticeship.

This Program Outline includes a list of recommended reference textbooks that are available to support the learning objectives and the minimum shop requirements needed to support instruction.

The Program Outline was prepared with the advice and assistance of British Columbia industry and instructor subject matter experts and will form the basis for further updating of the British Columbia Refrigeration and Air Conditioning Mechanic Program and learning resources.

Each competency is to be evaluated through the use of written examination in which the learner must achieve a minimum of 70% in order to receive a passing grade. The types of questions used on these exams must reflect the cognitive level indicated by the learning objectives and the learning tasks listed in the related competencies.

Achievement Criteria are included for those competencies that require a practical component. The intent of including Achievement Criteria in the Program Outline is to ensure consistency in training across training institutions in British Columbia. Their purpose is to reinforce the theory and to provide a mechanism for evaluation of the individual’s ability to apply the theory to practice. It is important that these performances be observable and measurable and that they reflect the skills spelled out in the competency as those required as competent journeyperson. The conditions under which these performances will be observed and measured must be clear to the individual as well as the criteria by which the individual will be evaluated. The individual must also be given the level of expectation of success.

The performance spelled out in the Achievement Criteria is a suggested performance and is not meant to stifle flexibility of delivery. Training providers are welcome to substitute other practical performances that measure skills and attainment of the competency. Multiple performances may also be used to replace individual performances where appropriate.

Important Program Information:
Due to the high level of skill required in Math and Physics for the this program, industry and instructors strongly advise apprentices to upgrade their Math and Physics skills prior to registration for technical training.

SAFETY ADVISORY
Be advised that references to the WorkSafe BC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation. The current Standards and Regulation in BC can be obtained on the following website: http://www.worksafebc.com. Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.
Acknowledgements

The Occupational Analysis Chart (OAC) and Program Outline was prepared with the advice and direction of industry and training provider subject matter experts from the Refrigeration and Air Conditioning Mechanic trade convened by the Industry Training Authority.

The Industry Training Authority would like to acknowledge the dedication and hard work of the industry representatives appointed to identify the training requirements of the Refrigeration and Air Conditioning Mechanic trade:

- Ray Bollinger, Just Mechanical
- Matt Buss, UA 516
- Robin Gibson, BC Institute of Technology
- Ray Koepke, Okanagan College
- Ryan Wegwitz, Island Temperature Controls
- Peter Whiten, Custom Air

Facilitators:

- Angela Caughy, ITA
# How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

<table>
<thead>
<tr>
<th>Section</th>
<th>Training Providers</th>
<th>Employers/ Sponsors</th>
<th>Apprentices</th>
<th>Challengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Credentialing Model</td>
<td>Communicate program length and structure, and all pathways to completion</td>
<td>Understand the length and structure of the program</td>
<td>Understand the length and structure of the program, and pathway to completion</td>
<td>Understand challenger pathway to Certificate of Qualification</td>
</tr>
<tr>
<td>OAC</td>
<td>Communicate the competencies that industry has defined as representing the scope of the occupation</td>
<td>Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification</td>
<td>View the competencies they will achieve as a result of program completion</td>
<td>Understand the competencies they must demonstrate in order to challenge the program</td>
</tr>
<tr>
<td>Training Topics and Suggested Time Allocation</td>
<td>Shows proportionate representation of general areas of competency (GACs) at each program level, the suggested proportion of time spent on each GAC, and percentage of time spent on theory versus practical application</td>
<td>Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application</td>
<td>Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application</td>
<td>Understand the relative weightings of various competencies of the occupation on which assessment is based</td>
</tr>
<tr>
<td>Program Content</td>
<td>Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measurable achievement criteria for objectives with a practical component</td>
<td>Identifies detailed program content and performance expectations for competencies with a practical component; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice</td>
<td>Provides detailed information on program content and performance expectations for demonstrating competency</td>
<td>Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels</td>
</tr>
<tr>
<td>Section</td>
<td>Training Providers</td>
<td>Employers/ Sponsors</td>
<td>Apprentices</td>
<td>Challengers</td>
</tr>
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</tr>
<tr>
<td>Training Provider Standards</td>
<td>Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program</td>
<td>Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own</td>
<td>Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors</td>
<td>Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment</td>
</tr>
</tbody>
</table>

**Appendix – Glossary of Acronyms**

Defines program specific acronyms
Section 2

PROGRAM OVERVIEW

Refrigeration and Air Conditioning Mechanic
Program Credentialing Model

C of Q = Certificate of Qualification
C of A = Certificate of Apprenticeship
C of C = Certificate of Completion
WBT = Work-Based Training

CROSS-PROGRAM CREDITS
Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program

Technical Training: None
C of Q Gasfitter – Class B
Technical Training: None
C of Q Industrial Electrician
Technical Training: None
C of Q Construction Electrician

Refrigeration and Air Conditioning Mechanic Foundation
Technical Training: 750 hours

Refrigeration and Air Conditioning Mechanic
Level 1
Technical Training: 180 hours
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Refrigeration and Air Conditioning Mechanic
Level 2
Technical Training: 210 hours
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Refrigeration and Air Conditioning Mechanic
Level 3
Technical Training: 300 hours
Work-Based Training: Accumulate hours
ITA Standardized Written Exam

Refrigeration and Air Conditioning Mechanic
Level 4
Technical Training: 300 hours
Work-Based Training: 6,210 hours total
Interprovincial Red Seal Exam

APPRENTICESHIP - DIRECT ENTRY
### Occupational Analysis Chart

**Occupation Description:** Refrigeration and air conditioning mechanics install, maintain and service residential, commercial, industrial and institutional heating, ventilation, air conditioning and refrigeration units and systems. They also connect to air delivery systems, install and service hydronic and secondary refrigerant systems and associated controls. Their duties include laying out reference points for installation, assembling and installing components, installing wiring to connect components to an electric power supply and calibrating related controls. They also measure, cut, bend, thread and connect pipe to functional components and utilities. They maintain and service systems by inspecting and testing components, brazing and soldering parts to repair defective joints, adjusting and replacing worn or defective components and reassembling repaired components and systems. As part of service and commissioning, refrigeration and air conditioning mechanics start-up, test, charge, adjust, calibrate, balance, measure, verify, maintain and document systems.

Additional certification may be required in some jurisdictions to allow Refrigeration and Air Conditioning Mechanics to plan and perform the work described above.

<table>
<thead>
<tr>
<th>PERFORM SAFETY RELATED FUNCTIONS</th>
<th>A</th>
<th>Maintains Safe Work Environment</th>
<th>A1</th>
<th>Use Personal Protective Equipment (PPE) and Safety Equipment</th>
<th>A2</th>
<th>Perform Lock-Out and Tag-Out Procedures</th>
<th>A3</th>
<th>Practice Fire Prevention</th>
<th>A4</th>
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</thead>
<tbody>
<tr>
<td>USE TOOLS AND EQUIPMENT</td>
<td>B</td>
<td>Use Hand Tools and Equipment</td>
<td>B1</td>
<td>Use Portable and Stationary Power Tools</td>
<td>B2</td>
<td>Use Brazing and Soldering Equipment</td>
<td>B3</td>
<td>Use Charging, Evacuation and Recovery Tools</td>
<td>B4</td>
</tr>
<tr>
<td>PERFORM ROUTINE TRADE ACTIVITIES</td>
<td>C</td>
<td>Apply Mathematics and Science</td>
<td>C1</td>
<td>Interpret Drawings and Specifications</td>
<td>C2</td>
<td>Use Codes, Regulations and Standards</td>
<td>C3</td>
<td>Use Manufacturer and Supplier Documentation</td>
<td>C4</td>
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</table>
**HARMONIZED PROGRAM OUTLINE**

**Program Overview**

<table>
<thead>
<tr>
<th>USE COMMUNICATION TECHNIQUES</th>
<th>D</th>
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<tbody>
<tr>
<td>Use Communication Techniques</td>
<td>D1</td>
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<tr>
<td>Use Mentoring Techniques</td>
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<th>APPLY ELECTRICAL CONCEPTS</th>
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<tbody>
<tr>
<td>Use the Principles of Electricity and Electronics</td>
<td>E1</td>
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<tr>
<td>Use Electrical Wiring Diagrams and Schematics</td>
<td>E2</td>
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<tr>
<td>Apply Motor and Motor Control Theory</td>
<td>E3</td>
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<td>Select Control Systems</td>
<td>E4</td>
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<tr>
<td>Apply Wiring Practices</td>
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<tr>
<th>APPLY REFRIGERATION AND AIR CONDITIONING THEORY</th>
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<td>Analyze Heat Pumps and Air Conditioning Systems</td>
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<td>Analyze Refrigeration Systems</td>
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<tr>
<td>Apply Food Storage Theory</td>
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<td>Analyze Hydronic Systems</td>
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<tr>
<th>PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS</th>
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<tbody>
<tr>
<td>Perform Work Site Preparation</td>
<td>G1</td>
</tr>
<tr>
<td>Plan HVAC/R System Installation</td>
<td>G2</td>
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<tr>
<th>INSTALL REFRIGERATION AND AIR CONDITIONING SYSTEMS</th>
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<tbody>
<tr>
<td>Install HVAC/R Piping and Tubing</td>
<td>H1</td>
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<tr>
<td>Install HVAC/R Systems</td>
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<tr>
<td>Install Control Systems</td>
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### HARMONIZED PROGRAM OUTLINE

#### Program Overview

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<th>APPLY GAS UTILIZATION THEORY</th>
<th>Apply Combustion Theory</th>
<th>Apply Draft Theory</th>
<th>Apply Alternate Fuel Theory</th>
<th>Apply Knowledge of Mechanical Safety Devices</th>
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<th>INSTALL GAS-FIRED SYSTEMS</th>
<th>Identify Burners</th>
<th>Identify Flame Safeguards</th>
<th>Install Gas Piping and Tubing Systems</th>
<th>Install Gas Regulators, Valves and Valve Train Components</th>
<th>Install Gas Controls</th>
<th>Install Air Supply Systems</th>
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<tr>
<th>SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS</th>
<th>Maintain HVAC/R Systems</th>
<th>Service HVAC/R Systems</th>
<th>Maintain Control Systems</th>
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Refrigeration and Air Conditioning Mechanic Harmonized Program Outline

Industry Training Authority 06/19
## Training Topics and Suggested Time Allocation – Level 1

### REFRIGERATION AND AIR CONDITIONING MECHANIC

<table>
<thead>
<tr>
<th>Line</th>
<th>Training Topic</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<tbody>
<tr>
<td>Line A</td>
<td><strong>PERFORM SAFETY RELATED FUNCTIONS</strong></td>
<td>7%</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>A1</td>
<td>Maintains Safe Work Environment</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>Use Personal Protective Equipment (PPE) and Safety Equipment</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>Perform Lock-Out and Tag-Out Procedures</td>
<td></td>
<td>✓</td>
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<tr>
<td>A4</td>
<td>Practice Fire Prevention</td>
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<td>✓</td>
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<tr>
<td>Line B</td>
<td><strong>USE TOOLS AND EQUIPMENT</strong></td>
<td>7%</td>
<td>60%</td>
<td>40%</td>
<td>100%</td>
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<tr>
<td>B1</td>
<td>Use Hand Tools and Equipment</td>
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<tr>
<td>B2</td>
<td>Use Portable and Stationary Power Tools</td>
<td></td>
<td>✓</td>
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</tr>
<tr>
<td>B3</td>
<td>Use Cutting, Brazing and Soldering Equipment</td>
<td></td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>B4</td>
<td>Use Charging, Evacuation and Recovery Tools</td>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>B5</td>
<td>Use Diagnostic and Measuring Tools and Equipment</td>
<td></td>
<td>✓</td>
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<tr>
<td>B6</td>
<td>Use Access Equipment</td>
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<tr>
<td>B7</td>
<td>Use Rigging, Hoisting, Lifting and Positioning Equipment</td>
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<td>✓</td>
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</tr>
<tr>
<td>B8</td>
<td>Use Digital Technology</td>
<td></td>
<td>✓</td>
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<tr>
<td>Line C</td>
<td><strong>PERFORM ROUTINE TRADE ACTIVITIES</strong></td>
<td>28.5%</td>
<td>70%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>C1</td>
<td>Apply Mathematics and Science</td>
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<td>✓</td>
<td></td>
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<tr>
<td>C2</td>
<td>Interpret Drawings and Specifications</td>
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<td>✓</td>
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<tr>
<td>C3</td>
<td>Use Codes, Regulations and Standards</td>
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<td>✓</td>
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<tr>
<td>C4</td>
<td>Use Manufacturer and Supplier Documentation</td>
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<td>✓</td>
<td></td>
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<tr>
<td>C5</td>
<td>Organize Work and Maintain Records</td>
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<td>✓</td>
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<td>C6</td>
<td>Select Refrigerants, Compressed Gases and Oils</td>
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<tr>
<td>C7</td>
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Total Percentage for Refrigeration and Air Conditioning Mechanic Level 1: 100%
# Training Topics and Suggested Time Allocation – Level 2

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## Training Topics and Suggested Time Allocation – Level 3

### REFRIGERATION AND AIR CONDITIONING MECHANIC

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**Total Percentage for Refrigeration and Air Conditioning Mechanic Level 3**

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<td>K4</td>
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<td>K5</td>
<td>Perform Combustion Analysis</td>
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<td>K6</td>
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<td>K7</td>
<td>Training and Handover of Equipment</td>
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<td>K8</td>
<td>Decommission and Disconnect Appliances and Equipment</td>
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<td>L3</td>
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### HARMONIZED PROGRAM OUTLINE

#### Program Overview

<table>
<thead>
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<th>% of Time Allocated to:</th>
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<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<td>M6 Maintain Gas-Fired Refrigeration Equipment</td>
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**Total Percentage for Refrigeration and Air Conditioning Mechanic Level 4**

| Total Percentage for Refrigeration and Air Conditioning Mechanic Level 4 | 100% |
Section 3
PROGRAM CONTENT

Refrigeration and Air Conditioning Mechanic
Level 1
Refrigeration and Air Conditioning Mechanic
Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS
Competency: A1 Maintains Safe Work Environment

Objectives
To be competent in this area, the individual must be able to:
- Manage workplace hazards.
- Use WHMIS.

LEARNING TASKS

1. Identify workplace hazards
- Short term hazards
  - Confined space
  - Elevations
  - Electrical
  - Compressed gas
  - Explosive/flammable material
  - Air quality
- Long term hazards
  - Respiratory disease
  - Repetitive strain injuries
  - Hearing loss
  - Chemical exposure
- Constant awareness of surroundings
  - Safe attitude
  - Housekeeping
  - Site conditions

2. Describe safety hazards when working at elevations
- Floor openings
- Weather
  - Wind
  - Snow
  - Lightning
  - Rain
- Access equipment
- Fall restraint
  - Guard rails
  - Safety lines
- Fall arrest
- Personal Protective Equipment (PPE)

3. Describe safety precautions when working at elevations
- Workplace Hazard Materials Identification System (WHMIS)
  - Purpose
  - Safety Data Sheets (SDS)
  - Labels

4. Manage workplace hazards
5. Describe how site-specific safety policies are established

- Standards, acts and regulations
- Hazard assessment
  - Safety policy
  - Site conditions
  - Working in isolation
- Types of meetings
  - Tool box
  - Safety committee

Achievement Criteria (Workplace)

Performance: The learner is aware of WHMIS and that it is a required certification.

Conditions: To be assessed in the workplace.

Criteria: Tasks must be performed within specifications and time frames acceptable to industry.
Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS
Competency: A2 Use Personal Protective Equipment (PPE) and Safety Equipment

Objectives
To be competent in this area, the individual must be able to:
• Use (and maintain) Personal Protective Equipment (PPE) and safety equipment.

LEARNING TASKS

1. Describe Personal Protective Equipment (PPE)
   • Safety footwear
   • Eye protection
   • Ear protection
   • Head protection
   • Arc flash protection
   • Respiratory protection
     o Positive pressure
     o Negative pressure
   • Clothing
     o High visibility workwear
     o Sun protection factor (SPF)
     o Gloves
     o Fall protection

2. Describe safety equipment
   • Types
     o Fire extinguishers
     o First aid
     o Ventilation
     o Screens
     o Spill kits
   • Procedures
   • Storage
   • Limitations
   • Standards, acts and regulations

3. Use Personal Protective Equipment (PPE)
   • Purpose
   • Selection
   • Operating procedures
   • Training requirements
     o WorkSafeBC requirements
     o Job site requirements
   • Inspection
   • Maintenance
   • Storage
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS
Competency: A3 Perform Lock-out and Tag-out Procedures

Objectives
To be competent in this area, the individual must be able to:
• Use lock-out and tag-out procedures.

LEARNING TASKS

1. Identify energy sources
   • Electricity
   • Pressure
   • Kinetic

2. Describe lock-out and tag-out
   • System operation
   • Components
   • Lock-out condition requirements
   • Lock-out equipment
     o Locks
     o Tags
       – Identification requirements
     o Chains
     o Support blocks
     o Blind flanges
     o Spades
     o Spectacle blinds
   • Procedures

3. Use lock-out and tag-out procedures
   • Zero energy state
     o Disconnect
     o Depressurize
     o Isolate
   • Lock-out
   • Tag-out
   • Test

Achievement Criteria
Performance
The learner will be able to perform electrical, mechanical and pressure lock-out with verification.

Conditions
To be assessed during technical training.
The learner will be given:
• Lock-out equipment
• Isolation devices
• Multi-meter
• Lock and key
• Tag
Criteria

The learner will be evaluated on:

- Safety
- Completion and verification of:
  - Electrical lock-out procedures
  - Mechanical lock-out procedures
  - Pressure lock-out procedures
Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS
Competency: A4 Practice Fire Prevention

Objectives
To be competent in this area, the individual must be able to:
• Identify classes of fires.
• Select fire extinguishers for class of fire and relevant condition.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe the conditions necessary to support a fire | • Air  
• Fuel  
• Heat |
| 2. Describe the classes of fires according to the materials being burned | • Class A  
• Class B  
• Class C  
• Class D  
• Symbols and colours |
| 3. Apply preventative fire safety precautions | • Hot work permit (site specific)  
• Handling and storage of flammable materials  
• Symbols  
• Fuels  
  o Diesel  
  o Gasoline  
  o Propane  
  o Natural Gas  
  o Dust  
  o Insulation  
• Ventilation, including purging  
• Lubricants  
• Oily rags  
• Combustible metals  
• Aerosols  
• Fire extinguisher  
  o Expiry date  
  o Fill level |
| 4. Describe the considerations and steps to be taken prior to fighting a fire | • Warning others and fire department  
• Evacuation of others  
• Fire contained and not spreading  
• Personal method of egress  
• Training |
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 5. Describe the procedure for using a fire extinguisher | • Extinguisher selection  
• P.A.S.S.  
  o Pull  
  o Aim  
  o Squeeze  
  o Sweep |
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B1 Use Hand Tools and Equipment

Objectives
To be competent in this area, the individual must be able to:
• Use hand and levelling tools.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe hand tools | • Types  
  ○ Files  
  ○ Metal saws  
  ○ Taps and dies  
  ○ Chisels, drifts, punches  
  ○ Hammers  
  ○ Woodworking tools  
  ○ Gasket forming tools  
  ○ Wrenches  
  ○ Wheel and gear pullers  
  ○ Pliers  
  ○ Shears and snips  
  ○ Screwdrivers  
  ○ Tube benders  
  ○ Flaring/swaging tools  
  ○ Tube cutters  
  ○ Hand pipe threader |
| 2. Use hand tools | • Parts  
  • Applications  
  • Procedures  
  • Safety  
  • Adjustment  
  • Inspection  
  • Maintenance  
  • Storage |
| 3. Describe levelling tools | • Types  
  ○ Rules  
  ○ Plumbs  
  ○ Square  
  ○ Levels  
  - Laser  
  ○ Chalk line  
  ○ Tape measure |
  • Applications
LEARNING TASKS

4. Use levelling tools

CONTENT

- Levelling
- Alignment

- Procedures
- Inspection
- Maintenance
- Storage
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B2 Use Portable and Stationary Power Tools

Objectives
To be competent in this area, the individual must be able to:
• Use power tools.

LEARNING TASKS

1. Describe portable power tools
   • Types
     o Electric
     o Pneumatic
   • Cutting tools
   • Grinding and abrasive tools
   • Threading tools
   • Drilling, boring and coring tools
   • Grooving tools
   • Specialty tools
     o Fusion tools
     o Pressing tool (Pro press™)
     o Extruded T (T-Drill™)
   • Accessories
     o Power cords
     o GFIs
     o Dust extraction

2. Describe stationary power tools
   • Types
     o Cutting tools
     o Grinding and abrasive tools
     o Threading tools
     o Drilling and boring tools
     o Grooving tools
     o Specialty tools
   • Accessories
   • Parts
   • Guards
   • Applications
   • Procedures
   • Capacities
   • Safety
   • Adjustment
   • Inspection
   • Maintenance
   • Storage
**Line (GAC):** B    **USE TOOLS AND EQUIPMENT**

**Competency:** B3 Use Brazing and Soldering Equipment

### Objectives

To be competent in this area, the individual must be able to:

- Use air-fuel and oxy-fuel equipment to braze and solder.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>LEARNING TASKS</th>
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<tbody>
<tr>
<td></td>
<td>1. Describe the brazing and soldering process</td>
</tr>
<tr>
<td></td>
<td>2. Describe the procedures for brazing and soldering</td>
</tr>
<tr>
<td></td>
<td>3. Describe air-fuel and oxy-fuel equipment</td>
</tr>
<tr>
<td></td>
<td>4. Use air-fuel and oxy-fuel equipment to braze and solder</td>
</tr>
<tr>
<td>Principles</td>
<td>• Joint preparation and design</td>
</tr>
<tr>
<td>Applications</td>
<td>• Flux selection</td>
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<td>Filler alloys</td>
<td>• Flame for brazing</td>
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<tr>
<td>Equipment</td>
<td>• Purging</td>
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<td>Safety requirements</td>
<td>• Cylinders</td>
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<tr>
<td>o Fire protection equipment</td>
<td>• Regulators</td>
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<tr>
<td>o Ventilation</td>
<td>o Purging</td>
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<tr>
<td>Equipment</td>
<td>• Gauges</td>
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<td>• Flashback arrestors</td>
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<td>• Hoses</td>
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<td>• Spark arrestors</td>
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<td>PPE</td>
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<td>Delivery systems</td>
<td>• Torch attachments</td>
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<tr>
<td>o Cylinder handling and storage</td>
<td>• Tips</td>
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<tr>
<td>Hazards</td>
<td>• Inspection</td>
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<tr>
<td>Fire prevention equipment</td>
<td>• Maintenance</td>
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<td>o Hot work permit</td>
<td>• Storage</td>
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<tr>
<td>Flammable material recognition</td>
<td>• Transportation</td>
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<td>o Cylinder handling and storage</td>
<td>• Flammable material recognition</td>
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<tr>
<td>o Hazards</td>
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</tbody>
</table>
LEARNING TASKS

CONTENT

• Applications

• Procedures
  o Setup
  o Take down
  o Tip selection
  o Alloy selection
  o Flux selection
  o Flux removal

Achievement Criteria

Performance
The learner will be able to braze and solder.

Conditions
To be assessed during technical training.
The learner will be given:

• Materials
• Tools and equipment
• Specifications/drawings

Criteria
The learner will be evaluated on:

• Set-up/shut down
• Technique
• Accuracy
• Penetration
• Appearance
• Pressure test
• Bend test
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B4 Use Charging, Evacuation and Recovery Tools

Objectives
To be competent in this area, the individual must be able to:
- Use charging, evacuation and recovery tools.
- Inspect and maintain charging, evacuation and recovery tools.

LEARNING TASKS

1. Describe gauge manifold
   - Types
   - Parts
   - Fittings
     - Schrader
   - Applications
   - Colour coding

2. Use gauge manifold
   - Procedures
   - Safety
   - Adjustment
     - Zeroing gauges
   - Inspection
     - Cracked hoses and seals
     - Broken glasses and dials
   - Maintenance
   - Storage

3. Describe vacuum pumps
   - Types
   - Parts
     - Ballast valves
       - Gauge manifold
       - Micron gauge
   - Fittings
   - Applications

4. Use vacuum pumps
   - Procedures
     - Dehydration techniques
       - Deep vacuum pumps
       - Measure deep vacuum
       - Triple evacuation
       - Pump performance
         - Capacities
     - Limiting factors
     - High-dry nitrogen
     - CFC code of practice
     - Schrader removal tool
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<tr>
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<td>• Safety</td>
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<td>• Inspection/procedure</td>
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<td>• Maintenance</td>
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<td></td>
<td>o Oil</td>
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<td>o Clean and flush</td>
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<td>o Inspect and replace components</td>
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<td>− Gauges</td>
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<td>− O-rings</td>
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<td>− Seals</td>
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<td>− Hoses</td>
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<td>• Verify and test</td>
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<td>o Micron gauges</td>
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<td>• Storage</td>
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<td>o Secure position</td>
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<td>o Prevent oil spillage</td>
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5. Describe recovery/recycling equipment
   • Types
   • Parts
   • Applications

6. Use recovery/recycling equipment
   • Manufacturer’s specifications
   • Procedures
     o Push/pull
     o Liquid and vapour recovery
     o Efficient recovery
     o Contaminated system recovery
       − Filter driers
   • Safety
   • Inspection
   • Maintenance
     o Clean and test
       − Recovery units
       − Hoses
       − Screens and filters
         ▪ Blockage
         ▪ Proper refrigerant filtration
     o Refrigerant cylinders
       − Certification
       − Storage
         ▪ Secure
         ▪ Upright
### LEARNING TASKS

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<tbody>
<tr>
<td>• Temperature limits</td>
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<td>• WHMIS</td>
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<tr>
<td>o Refrigerants</td>
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<tr>
<td>- Mark and label</td>
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<tr>
<td>- Condition</td>
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<tr>
<td>• Clean and usable</td>
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<tr>
<td>• Contaminated</td>
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</table>

### Achievement Criteria

- **Performance**: The learner will be able to perform evacuation and refrigerant recovery.
- **Conditions**: To be assessed during technical training.
  - The learner will be given:
    - Vacuum pump
    - Recovery machine
    - Gauge manifold
    - Micron gauge
    - Recovery cylinder
    - Refrigerant scale
    - Tools and equipment
      - Schrader removal tool
- **Criteria**: The learner will be evaluated on:
  - Proper equipment set-up and use
  - Safety
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B5 Use Diagnostic and Measuring Tools and Equipment

Objectives
To be competent in this area, the individual must be able to:
• Use precision measuring tools.
• Use temperature measuring instruments.
• Use leak detectors.
• Use electrical test meters.

LEARNING TASKS

1. Describe precision measuring tools

   CONTENT
   • Types
     o Micrometers
     o Manometers
     – Accessories
     o Indicators
     o Vernier calipers
     o Feeler gauges
     o Tachometers
     o Mechanical gauges
     – Bourdon tube
     – Compound
       ▪ Magnehelic
     • Parts
     • Applications
     • Scales
     • Accuracy

2. Use precision measuring tools

   • Procedures
   • Safety
   • Adjustment
   • Inspection
   • Maintenance
     o Certification
     o Calibration
     • Storage

3. Describe electrical test meters

   • Types
     o Voltmeter
     o Ammeter
     o Ohmmeter
     o Megger
     o Capacitor tester
     • Ranges
### LEARNING TASKS

### CONTENT

#### 4. Use electrical test meters
- Rated for applications
- Accessories
- Applications
- Procedures
- Safety
- Adjustment
- Inspection
- Maintenance
  - Certification
  - Calibration
- Storage

#### 5. Describe temperature measuring instruments
- Types
  - Thermometer
  - Pyrometer
  - Thermocouple
  - Thermistor
- Parts
- Ranges and scales
- Applications

#### 6. Use temperature measuring instruments
- Procedures
- Safety
- Adjustment
- Readings
- Inspection
- Maintenance
  - Certification
  - Calibration
- Storage

#### 7. Describe leak detectors
- Types
  - Electronic
  - Refrigerant dye and UV light
  - Bubble solution
  - Ultrasonic
- Parts
- Ranges and scales
- Applications

#### 8. Use leak detectors
- Procedures
- Safety
- Adjustment
- Inspection
<table>
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<td>o Certification</td>
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<tr>
<td></td>
<td>o Calibration</td>
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<td></td>
<td>• Storage</td>
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</table>
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B6 Use Access Equipment

Objectives
To be competent in this area, the individual must be able to:
• Use ladders.
• Describe the use of elevated platforms.

LEARNING TASKS

1. Describe ladders and elevated platforms
   • Types
     o Ladders
     o Platforms
     o Lifts
   • Applications
   • Safety
     o Fall arrest equipment
     o Fall restraint equipment
     o Hazard recognition
   • Standards, acts and regulations
   • Site certification requirements
     o Equipment certifications
     o Employer responsibilities

2. Use ladders and elevated platforms
   • Selections
   • Procedures
   • Limitations
   • Securing
   • Inspection
   • Maintenance
   • Storage

3. Describe scaffolds
   • Types
     o Tube and coupler
     o End frame
     o Baker’s
   • Parts
     o Outriggers
     o Guardrails
     o Wheels
     o Feet
     o Toe boards
     o Clips and locking devices
     o Coupling pins
     o Jacks
LEARNING TASKS

4. Use scaffolds

 CONTENT

   • Certification
   • Hazard recognition
   • Selection
   • Inspection
   • Safety regulations
   • Erecting and dismantling
   • Access
   • Fall arrest equipment
   • Operating procedures
   • Limitations
   • Securing
   • Maintenance
   • Manufacturer’s specifications
   • Selection
   • Limitations
   • Care and storage

5. Describe aerial lifts

 CONTENT

   • Types
     o Scissor and vertical lifts
     o Boom lifts, straight mast and articulated boom
   • Training requirements
   • Standards, acts and regulations
   • Parts
     o Base section
     o Elevating section
     o Platform section
   • Fuel types and batteries
   • Safety
     o Fulcrum point
     o Load capacity rating
     o Centre of gravity
     o Side slope and grade
     o Fall arrest equipment
     o Fall restraint equipment
     o Hazard recognition
   • Site certification requirements
     o Equipment certifications
     o Employer responsibilities
LEARNING TASKS
6. Describe safe operation of aerial lifts

CONTENT
- Limitations
- Pre-shift inspection
  - Log book/check off sheet
  - Manual
  - Machine certification
- Loading the platform
- Operating the lift
- Working on the platform
- Energized power lines
- Care and storage
Objectives
To be competent in this area, the individual must be able to:
• Use hoisting, lifting and rigging equipment.

LEARNING TASKS
1. Describe lifting and hoisting

   • Principles
     o Mechanical advantage
     o Balance points
     o Safety
     o Estimation of weights
     o Equipment capacities
     o Equipment selection
     o Lifting location
     o Procedures
     o Communication/hand signals
     o Securing of loads

   • Certification requirements
   • Lift plan

2. Describe lifting and hoisting equipment

   • Boom trucks
   • Chain falls
   • Come-alongs
   • Cranes
   • Loaders
   • Tirfors
   • Winches
   • Inspection
   • Maintenance

3. Describe rigging equipment

   • Chains
   • Shackles
   • Slings/chokes
   • Snatch blocks
   • Softeners
   • Spreader bars
   • Tag lines
   • Turnbuckles
   • Storage
   • Inspection
   • Disposal
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

LEARNING TASKS

4. Describe lifting and hoisting communication

5. Select slings

6. Tie knots, bends and hitches

7. Use hoisting, lifting and rigging equipment

CONTENT

- Maintenance
- Hand signals
- Audible signals
- Communication with the operator
- Communication with others
- Load
  - Load factor labels
- Application
  - Sling angles
  - Sling lengths
- Types
  - Bowline
  - Rolling hitch
  - Trucker’s hitch
- Purposes
- Limitations
- Safety
- Working load limit (WLL)
- Lift plan
- Communication/hand signals
- Securing of loads
  - Pre lift
  - Post lift
- Inspection
- Maintenance
- Storage
- Disposal
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B8 Use Digital Technology

Objectives
To be competent in this area, the individual must be able to:
• Use electronic devices.
• Describe digital technology.

LEARNING TASKS CONTENT
1. Describe electronic devices
   • Types
     o Computers/laptops
     o Smart phones
     o Tablets
     o User interface modules
   • Applications
     o Monitoring
     o Diagnostics
     o System set-up
     o System back-up

2. Use electronic devices
   • Connection
     o Manufacturer’s specifications
   • System set-up
     o Configuration
   • File back-up

3. Describe digital technology
   • Types
     o Direct digital control
     o Programmable logic controller (PLC)
     o Micro processor
   • Applications
     o System set-up
     o Diagnostics

4. Identify network protocols
   • Modbus
   • BACnet
   • Local Operation Network (LON)

5. Identify network cable connectors
   • Types of connectors
     o USB
     o 9 pin, 25 pin serial port
     o RJ45
     o RJ11

6. Describe wireless communication devices
   • WiFi
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<td>2-way radios</td>
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</table>
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C1 Apply Mathematics and Science

Objectives
To be competent in this area, the individual must be able to:
• Apply formulas.
• Calculate piping measurements and offsets.
• Perform conversions and heat transfer calculations.

LEARNING TASKS
1. Apply calculator functions to trade related equations
2. Use formulas to calculate area
   • Cross sectional area of pipe
3. Use formulas to calculate volumes
   • Cylinders
   • Rectangular tanks
4. Use formulas to calculate capacity
   • Imperial gallons
   • US gallons
   • Litres
5. Transpose formulas
6. Perform conversions
   • Whole numbers
   • Fractions
   • Decimals
   • Percentages
   • Length
   • Volume
   • Capacity
   • Area
   • Mass
   • Weight
   • Heat energy
     o Kilowatts
     o BTUh
     o Gigajoules
   • Temperature
     o Fahrenheit
     o Celsius
     o Kelvin
     o Rankine
   • Pressure
     o Absolute
     o Gauge
7. Calculate piping measurements
   • Terms
**LEARNING TASKS**

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<tr>
<th>No.</th>
<th>Task Description</th>
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<tr>
<td>8.</td>
<td>Use the Pythagorean theorem of right angles</td>
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<td>9.</td>
<td>Calculate offsets using the applicable trigonometric function</td>
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<tr>
<td>10.</td>
<td>Calculate the required measurements for a parallel piping offset</td>
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<tr>
<td>11.</td>
<td>Describe the properties of matter</td>
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<td>12.</td>
<td>Use Pascal’s theory of pressure and force</td>
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</table>

**CONTENT**

- Thread allowance
- Fitting allowance
- End to end
- End to centre
- Centre to centre
- Face to face
- End to back
- Back to back
- Socket depth
- Calculations
- Grades
- Elevations
- Benchmarks
- Hypotenuse
- Side opposite
- Side adjacent
- Calculator methods
- Table-based methods
- Unequal spread
- Equal spread
- Jumper
- Substances
  - Elements
  - Compounds
  - Mixtures
- Adhesion
- Cohesion
- Conductivity
  - Dieletric
- Density
- Ductility
- Elasticity
- Malleability
- Tensile strength
- Heat properties
  - BTUs
  - Gigajoules
  - Specific Heat
  - Kilowatts
- Pressure
LEARNING TASKS

13. Use Archimedes’ principles of displacement and floatation

14. Define mechanical advantage as it relates to fluid power

15. Describe factors that affect fluid flow in a piping system

16. Describe factors that affect gas volumes and pressures

17. Perform gas law calculations

18. Calculate the expansion and contraction of various piping materials due to heating and cooling

19. Define methods of heat transfer

20. Perform heat transfer calculations

CONTENT

- Units of measure
  - Total Force
    - Pounds
    - Newtons
  - Specific weight/gravity
  - Buoyancy
  - Hydraulics
  - Hydrostatics
  - Viscosity
  - Laminar flow
  - Turbulent flow
  - Velocity
  - Piping material
  - Fittings
  - Boyle’s Law
  - Charles’ Law
  - Gay-Lussac’s Law
  - Dalton’s Law
  - Combined Gas Law (General Gas Law)
  - Bernoulli’s principle
  - Temperature
    - Kelvin
    - Rankine
  - Pressures
    - Absolute
    - Gauge
  - Ferrous
  - Non-ferrous
  - Thermoplastic
  - Conduction
  - Convection
  - Radiation
  - Sensible
  - Latent
LEARNING TASKS

CONTENT

• Specific heat
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C2 Interpret Drawings and Specifications

Objectives
To be competent in this area, the individual must be able to:
• Interpret information found on a set of drawings.
• Use drafting symbols, lettering and line conventions.
• Convert between orthographic and isometric projections.
• Create an isometric drawing of a basic orthographic piping arrangement.

LEARNING TASKS

1. Describe drafting tools and materials
   • Tools
     o Compasses
     o Dividers
     o Protractors
     o Scale rulers
     o Triangles
   • Erasers and shields
   • Pencils
   • Templates

2. Use scale rulers
   • Dimensions
     o Imperial
     o Metric

3. Describe symbols
   • Pipe fittings
   • Components
   • Accessories
   • Electrical
   • Sheet metal
   • Architectural
   • Coordinates

4. Describe lettering and dimensioning in drawings
   • Lines
     o Border
     o Center
     o Dimension
     o Extension
     o Hidden
     o Object
     o Phantom
   • Lettering
     o Hierarchy
   • Legend
LEARNING TASKS

5. Describe drawing projections

6. Use drawing projections

7. Describe types of drawings

8. Interpret mechanical drawings

CONTENT

- Title block
- Views
  - Elevation
  - Plan
  - Section
  - Isometric
  - Orthographic
  - Oblique
- Isometric
- Orthographic
- Conversion from one to the other
- Isometric
- Orthographic
- Process Flow Diagrams (PFD)
- Piping and Instrumentation Diagrams (P & ID)
- Sectional drawings
- Detail drawings
- Specifications
- Architectural prints

Achievement Criteria

Performance  The learner will be able to create an isometric drawing from a set of orthographic drawings.

Conditions  To be assessed during technical training.

The learner will be given:
- Orthographic drawing
- Sketching tools and paper

Criteria  The learner will be evaluated on:
- Interpretation of drawings
- Neatness
- Accuracy
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C3 Use Codes, Regulations and Standards

Objectives
To be competent in this area, the individual must be able to:
• Identify codes, standards and organizations.
• Describe code implications.
• Interpret CSA B52 code requirements for refrigerants, receivers and pressure testing.
• Complete the CFC/HCFC/HFC Control Training Program.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Identify codes, standards and organizations | • American Society of Mechanical Engineers (ASME)  
• American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)  
• National Standard of Canada (NSC)  
• Canadian Commission on Building and Fire Codes (CCBFC)  
• Canadian Gas Association (CGA)  
• Canadian Standards Association (CSA)  
  o B52 Code  
  o B149.1 Code  
  o Amendments/bulletins  
• Canadian Electrical Code  
• National Building Code of Canada (NBC)  
• Underwriters Laboratories of Canada (ULC)  
• Municipal bylaws  
• Permits  
• Health Act  
• Safety Standards Act  
• Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA)  
• Leadership in Energy and Environmental Design (LEED)  
• Technical Safety BC  
  o Regulations  
  o Bulletins |
| 2. Describe code implications | • Design  
• Planning |
LEARNING TASKS

3. Interpret sections of the CSA B52 code

CONTENT

- Installation
- Maintenance
- Decommissioning
- Refrigerants
  - Classifications
    - Group 1
    - Group 2
    - Group 3
  - Characteristics
    - Maximum quantities
    - Occupancies
    - Formula and number
- Liquid receivers
  - Section 6
  - Section 9
  - Sizing
- Pressure testing requirements
  - Field installed systems
  - Pressure relief devices

4. Describe the CFC/HCFC/HFC Control Training Program

- Provincial requirements
- Environment Canada requirements
- Federal requirements

Achievement Criteria

Performance
The learner will complete the CFC/HCFC/HFC Control Training Program.

Conditions
To be assessed during technical training.
The learner will be:
- Scheduled to take the CFC/HCFC/HFC Control Training Program Exam

Criteria
The learner will be evaluated according to CFC/HCFC/HFC Control Training Program testing requirements.
Objectives
To be competent in this area, the individual must be able to:
- Describe manufacturer and supplier documentation.
- Source manufacturer documentation.

LEARNING TASKS
1. Describe manufacturer and supplier documentation
   - Installation instructions and requirements
   - Operation and maintenance manuals
   - Product specifications
     - Certification agencies
   - Warranty information
   - Appliance rating plates
   - Electrical diagrams and schematics
   - Field wiring diagram

2. Source manufacturer documentation
   - Manufacturer websites
   - Contact manufacturer
   - Local agencies
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C5 Organize Work and Maintain Records

Objectives
To be competent in this area, the individual must be able to:
• Describe record management.

LEARNING TASKS
1. Describe record management

CONTENT
• Technical training plan
  o Documentation
  o Scheduling
• Job site documentation
• Paper based filing
• Electronic filing
• Service reports
• Invoices
• Time sheets
• Repair orders
• Technical bulletins
• Inspection forms
• Purchase orders
• Vehicle logs
• Maintenance logs
• Refrigerant logs
• Inventory
• Permits
• Statements of completion
• File backup
HARMONIZED PROGRAM OUTLINE
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Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C6 Select Refrigerants, Compressed Gases and Oils

Objectives
To be competent in this area, the individual must be able to:
• Describe refrigerants.
• Use pressure enthalpy (PE) charts.
• Describe compressed gases.

LEARNING TASKS
1. Describe refrigerants

   • Types
     o Hydrocarbons
     o CFC
     o HFC
     o HCFC
     o Blends
   • Saturation properties
     o Refrigerant tables
   • Solubility
     o Crankcase
     o Evaporator
   • Reactivity with metals
     o Compatibility
     o Combinations to avoid
     o Moisture
   • Toxicity
     o Physiological effect of halogenated refrigerants
     o Effect of long term exposure
     o Signs of over-exposure
     o Exposure to heat
       – Flammability
       – Decomposition
       – Phosgene and chlorine
       – Acids
   • Environmental regulations
   • Codes
   • Storage
   • Handling
   • Tools and equipment

2. Use pressure enthalpy (PE) charts

   • Pressure enthalpy charts
     o Use/purpose
     o Construction of chart
LEARNING TASKS

3. Describe compressed gases

CONTENT

- Plotting cycle diagrams
- Calculations
- Performance characteristics
  - Evaporator pressure
  - Condenser pressure
  - Compression ratio
  - Displacement per ton
  - Horsepower per ton
  - Discharge temperature
  - Applications
- Migration
- Types
- Properties
- Compatibility
- Pressures
- Storage
- Handling
- Codes
- Transportation
  - Transport Canada approved straps
- Pressure/temperature relief devices
- Toxicity
- Safety
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C7 Apply Sealants and Adhesives

Objectives
To be competent in this area, the individual must be able to:
• Apply sealants.
• Apply adhesives.

LEARNING TASKS

1. Select sealants
   • Types
     o Silicone
     o Spray foam
     o Thread seal
     o Fire stop
     o Putties
     o Cork tape
     o Splicing tape
   • Applications
   • Manufacturer’s specifications
   • Codes and regulations

2. Select adhesives
   • Types
     o Insulation glues
     o Primers
     o Pipe adhesives
   • Applications
   • Manufacturer’s specifications
   • Code and regulations

3. Apply sealants and adhesives
   • Safety
     o SDS
     o Flammability
     o Ventilation
   • Tools and equipment
   • Surface preparation
   • Procedures
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C8 Select HVAC/R Components and Accessories

Objectives
To be competent in this area, the individual must be able to:
• Describe compressors, evaporators and condensers.
• Identify metering devices.

LEARNING TASKS

1. Describe compressors
   - Types
     - Rotary
     - Reciprocating
     - Scroll
     - Centrifugal
     - Screw
   - Drives
     - Open
     - Semi-hermetic
     - Hermetic
   - Applications
     - Residential
     - Commercial
     - Industrial
     - Institutional
   - Characteristics
     - Performance
     - Capacity
     - Displacement
     - Limiting factors
   - Operation

2. Describe evaporators
   - Types
     - Bare tube
     - Plate
     - Finned
     - Shell and tube
     - Coax
     - Brazed plate
   - Applications
     - High temp
     - Medium temp
     - Low temp
LEARNING TASKS

3. Describe condensers

4. Identify metering devices
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C9  Select Fasteners, Brackets and Hangers

Objectives
To be competent in this area, the individual must be able to:
• Select brackets, fasteners and hangers.

LEARNING TASKS

1. Describe brackets, fasteners and hangers

CONTENT
• Hangers
  o Clevis
  o Split ring
  o Riser clamp
  o U-bolt
  o U-hook
  o U-channel strut
  o Strap
  o Threaded rod
  o Cushion clamps
  o Tear drop
  o Spring isolation
• Fasteners
  o Screws
  o Coach screw rods
  o Lag screws
  o Bolts
  o Rod couplings
  o Beam clamps
• Anchors
  o Wedge
  o Undercut
  o Drop-in
• Seismic restraints

2. Select brackets, fasteners and hangers

• Application
• Spacing
• Seismic requirements
• Compatibility with piping
• Weight ratings
• Codes and regulations
• Manufacturer’s specifications
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C10 Install Valves

Objectives
To be competent in this area, the individual must be able to:
• Describe valves.
• Describe the installation of valves.

LEARNING TASKS

1. Describe valves
   - Types
     o Butterfly
     o Plug
     o Ball
     o Gate
     o Globe
     o Needle
     o Check
     o Pressure reducing
     o Solenoid
     o Regulating
   - Application
   - Materials
   - Limitations
     o Pressure
     o Temperature
   - Seat design

2. Describe the installation of valves
   - Code and regulations
   - Manufacturer’s specifications
   - Orientation
   - Relative placement
Line (GAC): D USE COMMUNICATION TECHNIQUES

Competency: D1 Use Communication Techniques

Objectives
To be competent in this area, the individual must be able to:
- Describe effective communication practices.

LEARNING TASKS
1. Describe effective communication practices

CONTENT
- Verbal
- Non-verbal
  - Body language
  - Signals
- Active listening
  - Hearing
  - Interpreting
  - Reflecting
  - Responding
  - Paraphrasing
- Learning styles
  - See
  - Hear
  - Attempt
- Workplace responsibilities
  - Personal
    - Attitude
    - Harassment
    - Discrimination
  - Supervisor
  - Human Resources (HR)
- Toolbox meetings
  - Field Level Risk Assessment (FLRA)
    - Site specific safety requirements
Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E1 Use the Principles of Electricity and Electronics

Objectives
To be competent in this area, the individual must be able to:
- Describe electrical concepts.
- Solve simple problems using Ohm’s and Kirchhoff’s Laws.
- Describe single phase and three phase power supplies.
- Identify transformers.
- Describe switches and relays.
- Install relays.

LEARNING TASKS

1. Describe the fundamentals of electricity
   - Safety
   - Basic principles
     - Atomic theory
     - Electron flow
     - Conductors - insulators
     - Kinds of electricity
       - AC current
       - DC current
       - Static electricity
   - Properties of conductors
     - Resistance
     - Calculating resistance
     - Effect of temperature
     - Types of conductors and cables
   - Electrical sources
     - AC
       - Single phase
       - Three phase
     - DC

2. Describe electrical circuits
   - Parts of a circuit
     - Source
     - Switch/disconnect
     - Load
     - Conductor
   - DC circuits and measurements
     - Ohm’s Law
     - Measurement of voltage and amperage
     - Resistors in parallel and series
### LEARNING TASKS

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<td>o 3-wire, dual voltage</td>
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<td>• Describe three phase power characteristics</td>
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<td>• Primary winding</td>
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<tr>
<td>• Identify transformers</td>
</tr>
</tbody>
</table>
LEARNING TASKS

7. Describe switches

8. Select relays

9. Install relays

CONTENT

- Tappings
- Manual
- Temperature actuated
- Pressure actuated
- Liquid level actuated
- Flow
- Proximity/End
- Auxiliary contacts

- Operation
- Ratings
- Coil voltages
- Contacts
  - Normally open
  - Normally closed
  - Switching action

- Wiring base connections
- Symbols
- Terminal identification on wiring diagram
- Enclosures

Achievement Criteria

Performance The learner will be able to install/wire a relay.
Conditions To be assessed during technical training.
The learner will be given:
- Ladder diagram
- Double pole, single throw relay
- Power supply
- Switch
- Load
- Transformer

Criteria The learner will be evaluated on:
- Accuracy to the diagram
- Wiring techniques
- Neatness
Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E2 Use Electrical Wiring Diagrams and Schematics

Objectives
To be competent in this area, the individual must be able to:
• Interpret electrical diagrams.
• Sketch a series and parallel circuit.
• Describe common faults.
• Troubleshoot simple circuits.

LEARNING TASKS
1. Interpret electrical diagrams
   • Types of diagrams
     - Ladder
     - Schematic
     - Pictorial
     - Wiring
   • Symbols
   • Components
   • Function of circuit
     - Identify control circuits
       - Parallel circuits
       - Series circuits

2. Sketch a circuit
   • Parallel circuit
   • Series circuit

3. Describe common electrical faults
   • Power surge
   • Insufficient voltage
   • Short circuits
   • Blown fuses
   • Damaged conductors
   • Corrosion
   • Dirty contacts
   • Loose termination
   • Incorrect wiring

4. Troubleshoot simple circuits
   • Safety
   • Sequence of operation
   • Component location
   • Testing
     - Voltage
     - Amperage
     - Resistance
     - Continuity
LEARNING TASKS

CONTENT

• Readings
  o Manufacturer’s specifications
  o Previous readings
  o Expected data
    - Predicted readings
  o Unexpected data
Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E3 Apply Motor and Motor Control Theory

Objectives
To be competent in this area, the individual must be able to:
• Describe single phase motors.
• Describe three phase motors.
• Describe motor protection.
• Disassemble and reassemble single and three phase motors.

LEARNING TASKS
1. Describe single phase motors

   CONTENT
   • AC theory
     o Electromagnetic theory
     o Induction motors
     o Voltage variations
     o Frequency
   • Split phase motors
   • Capacitor start motors
   • Capacitor run motors
   • Shaded pole motors
   • Dual voltage motors
   • Motor starting relays
     o Current
     o Potential
     o PTC
     o Centrifugal
   • Components
   • Characteristics

2. Describe three phase motors

   CONTENT
   • Three phase connections
     o Delta
     o Wye (Y)
   • Types
     o Squirrel cage
     o Wound rotor
     o Synchronous
   • Motor components
     o Windings
     o Bearings
     o Connections
     o Cooling fans
   • Characteristics
     o Speed and torque
### LEARNING TASKS

**3. Describe motor protection**

### CONTENT

- **Ratings**
- **Applications**

- **Operation**
  - Three phase rotating field
    - Delta connected
    - Wye connected
    - Reduced voltage

- **Voltage imbalance**
- **Current imbalance**

- **Motor protection**
  - Inherent protectors
  - Line overloads
  - Heaters
  - Circuit breakers
  - Effects of ambient temperature

- **Magnetic contactors**
  - Types
  - Operation
  - Application and ratings
  - Starters
  - Line voltage control
    - Start-stop control
    - Hand-off-auto control

- **Line voltage control**
  - 115 volt
  - 230 volt
  - Voltage variations

### Achievement Criteria

**Performance**

The learner will be able to disassemble, reassemble and test windings for a single phase and a three phase motor.

**Conditions**

To be assessed during technical training.

The learner will be given:

- Specifications
- Tools and materials
- Equipment

**Criteria**

The learner will be evaluated on:

- Safety
- Accuracy
- Completeness
## Line (GAC): E  APPLY ELECTRICAL CONCEPTS

### Competency: E4 Select Control Systems

**Objectives**

To be competent in this area, the individual must be able to:

- Describe control systems.

### LEARNING TASKS

<table>
<thead>
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<th>CONTENT</th>
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<td><strong>1. Describe control systems</strong></td>
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</tbody>
</table>
## Line (GAC): E  APPLY ELECTRICAL CONCEPTS

### Competency: E5  Apply Wiring Practices

#### Objectives

To be competent in this area, the individual must be able to:

- Describe wiring components.
- Describe conductor installation.
- Describe wire termination.

#### LEARNING TASKS

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<tr>
<th>1. Describe wiring components</th>
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<td>- Crimp</td>
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<td>- Solder</td>
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<td>- Terminal strips/lug</td>
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<td>- Heat shrink sleeve</td>
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<td>- Conduit types</td>
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<td>- Metal conduit</td>
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<td>- Rigid metal conduit</td>
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<td>- Non-metallic conduit</td>
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<td>- Flexible conduit</td>
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<th>3. Describe conductor termination</th>
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<td>- Wire nuts</td>
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<td>- Junction box</td>
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<td>- Terminal strips/lug</td>
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<td>- Mechanically secure</td>
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<td>- Heat shrink sleeve</td>
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</table>
Line (GAC): F APPLY REFRIGERATION AND AIR CONDITIONING THEORY

Competency: F1 Analyze Heat Pumps and Air Conditioning Systems

Objectives
To be competent in this area, the individual must be able to:
- Describe heat pumps.
- Create a flow diagram for a heat pump.

LEARNING TASKS
1. Describe heat pumps
   - Terminology
   - Reverse-cycle operation
     - 4-way reversing valves
       - Fails to cool
       - Fails to heat
     - Check valves
     - Construction and operation
     - Applications
   - Heat pump operating cycles
     - Cooling cycle
     - Heating cycle
     - Defrost cycle
   - Air to air heat pumps
     - Basic theory
     - Performance

2. Create a flow diagram for a heat pump
   - Operating in heating mode
   - Operating in cooling mode
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

Line (GAC): F APPLY REFRIGERATION AND AIR CONDITIONING THEORY
Competency: F2 Analyze Refrigeration Systems

Objectives
To be competent in this area, the individual must be able to:
- Describe basic refrigeration systems.
- Describe the PE chart in relation to refrigeration cycles.
- Describe factors that limit performance.

LEARNING TASKS

1. Describe basic refrigeration systems
   - Definition of refrigeration
   - Open cycle
     - Evaporative cooling
     - Expendable refrigerants
   - Closed cycle
     - Basic system components
       - Compressor
       - Metering device
       - Evaporator
       - Condenser
     - Refrigerant tables
     - Evaporation
     - Vapour compression
     - Condensing
     - Coefficient of performance

2. Describe mechanical refrigeration cycles
   - Simple saturated cycle
     - R-134a cycle on PE chart
   - Variations in cycle using a PE chart
     - Superheating suction vapour
     - Subcooling the liquid
     - Using heat exchanger
     - Pressure drops
     - Change in suction pressure
     - Change in discharge pressure
     - Change in volumetric efficiency of compressor

CONTENT
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

Line (GAC): G PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency: G1 Perform Work Site Preparation

Objectives
To be competent in this area, the individual must be able to:
• Describe work site preparation.
• Describe material handling.

LEARNING TASKS
1. Describe work site preparation

CONTENT
• Safety requirements
  o Access equipment safety
    − Certification
    − WorkSafe BC
    • Right to refuse unsafe work
    − Height safety
  o Working in isolation
    − Check in
    − Check out
  o Fire watch
• Verify work requirements
• Toolbox meetings
• Determine site layout and conditions
  o Coordination with other trades
  o Escape routes
• Locate
  o Tool crib
  o On site hazards
  o First aid station
  o Eye wash stations
  o Fire extinguishers
  o Deluge shower
  o Access equipment
  o Isolation points
    − Water
    − Gas
    − Electrical
    − Utilities
• Identify field level risk assessment (FLRA)
  o Machinery rooms
  o Asbestos
  o Lead
LEARNING TASKS

2. Describe material handling

CONTENT

- Silica
- Refrigerants
- Oxygen levels
- Confined space protocols
- Pressure vessels
- Site/company policy compliance
- Verify and inspect
  - Packing slips
  - Documentation
  - Damages to materials
  - Completeness of order
- Labelling
  - WHMIS
- Secure
- Storage
- Waste disposal
- Codes and regulations
- Environmental awareness
Objectives
To be competent in this area, the individual must be able to:
• Describe piping design.
• Describe medium temperature refrigeration systems.
• Describe equipment placement.

LEARNING TASKS
1. Describe piping design
   • Basic principles
     o Design factors
     o Use of tables
   • Common problems
     o Under-sized lines
     o Over-sized lines
   • Size suction lines
     o Evaporator piping
     o Risers and traps
     o Piping to compressor
   • Interconnecting multiple compressors
     o Equalizer lines
     o Oil level control
   • Size discharge piping
     o Single and multiple compressors
     o Risers and traps
   • Size liquid piping
     o Condenser return
     o Liquid line
   • Size condenser to receiver piping
     o Single condenser
     o Multiple condensers
     o Equalizer line applications
   • Head pressure control
     o Reasons for control
     o Flooded coil
     o Bypass circuits

2. Describe medium temperature systems
   • Types
     o Air cooled
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

LEARNING TASKS

CONTENT

- Water cooled
  - Applications
    - Medium temp
  - Components
    - Evaporator
    - Condenser
    - Metering device
    - Compressor
  - Accessories
    - Service valves
    - Receiver
    - Filter drier
    - Sight glass
    - Pressure switches
    - Liquid line solenoid valve
    - Temperature control
  - Operation
  - Drawings and specifications
    - Clearances
  - Location
    - Access to service
    - Indoors/outdoors
  - Site conditions
    - Utilities
  - Foundation
  - Levelling
  - Codes and regulations

3. Describe equipment placement
Line (GAC): H  INSTALL REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency: H1  Install HVAC/R Piping and Tubing

Objectives
To be competent in this area, the individual must be able to:
• Prepare, join and install piping and tubing.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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<td>2. Describe methods of protecting piping and tubing</td>
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<td>• Manufacturer’s specifications</td>
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<td>• Frost protection</td>
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<td>o Circulating pumps</td>
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<td>• Corrosion protection</td>
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<td>o Coatings</td>
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</tbody>
</table>
LEARNING TASKS

3. Prepare piping and tubing
   - Measurements
   - Cutting
   - Bending
   - Burr removal
   - Reaming
   - Threading
   - Sealant
   - Priming
   - Flaring
   - Sanding/filing
   - Flux
   - Beveling
   - Grooving

4. Describe piping and tubing jointing methods
   - Press-fit
   - Soldered
   - Brazed
   - Flanged
   - Compression
   - Swaged
   - Push-fit
   - Threaded
   - Crimped
   - Expanded

5. Join piping and tubing
   - Safe work practices
   - Codes and regulations
   - Manufacturer’s specifications
   - Fittings
   - Accessories
   - Tools and Equipment
   - Assembly

6. Describe factors affecting structure penetrations
   - Codes and regulations
### LEARNING TASKS

#### CONTENT
- Manufacturer’s specifications
- Structural integrity
- Fire separation
- Interference with other building components and systems
- Hidden components
- Sleeve installation
- Sealing

7. Describe methods of structure penetrations

- Codes and regulations
- Manufacturer’s specifications
- Fire stopping
- Fire rating requirements
- Required gaps
- Fastening and wrapping
- Sealing

8. Describe pre-installation inspection of piping and tubing

- Potential defects
  - Pin holes
  - Cracked fittings
  - Bent ends
  - Uneven casting
  - Damaged pipe and coatings
- Environmental effects
- Visual inspection
- Interpretation of marking
- Codes, regulations
- Manufacturer’s specifications

9. Install piping and tubing

- Codes and regulations
- Manufacturer’s specifications
- Safe work practices
- Application
- Tools and equipment
- Layout
- Supports
- Penetrations

### Achievement Criteria

**Performance**
The learner will be able to prepare, join and install pipe.

**Conditions**
To be assessed during technical training.
The learner will be given:
- Drawings and specifications
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

- Tools and equipment
- Materials

Criteria

The learner will be evaluated on:

- Accuracy
- Neatness
- Inclusions
Line (GAC): H  INSTALL REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency:  H2  Install HVAC/R Systems

Objectives
To be competent in this area, the individual must be able to:
- Describe the installation of medium temperature systems.

<table>
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<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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<tbody>
<tr>
<td>1. Describe the installation of medium temperature systems</td>
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LEARNING TASKS

CONTENT

- Azeotropic refrigerants
Line (GAC): H INSTALL REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency: H3 Install Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Install control systems.

LEARNING TASKS
1. Install control systems

CONTENT
• Safety requirements
• Drawings and specifications
  • Placement
    – Equipment
    – Components
    – Accessories
• Codes and regulations
• Manufacturer specifications
• Tools and equipment
• Assembly pre-check
• Hardware configuration
• Assembly
• Mounting
• Field wiring
  • Line voltage
  • Extra-low voltage
  • Thermostat connections
  • Cooler
  • Freezer
  • Residential
• Termination designation
  • Wire nuts
  • Crimp connectors
  • Terminal strips
  • Lug connectors
• Verification
  • Operating ranges
Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS
Competency: L1 Maintain HVAC/R Systems

Objectives
To be competent in this area, the individual must be able to:
• Maintain system components and consumables.

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<tr>
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LEARNING TASKS

2. Maintain system consumables

CONTENT

- Irregular movement
  - Adjustments
  - Test
  - Return to service
  - Documentation

- Types
  - Filters
  - Belts
  - Condensate treatment tablets
  - Grease
  - Lubricants

- Inspection
  - Sensory
  - Diagnostic
  - Monitoring

- Tools and equipment
- Manufacturer’s specifications
- Isolation
- Clean/repair/replace
- Adjustments
- Test
- Return to service
- Documentation
Level 2
Refrigeration and Air Conditioning Mechanic
Line (GAC): B  USE TOOLS AND EQUIPMENT
Competency: B5  Use Diagnostic and Measuring Tools and Equipment

Objectives
To be competent in this area, the individual must be able to:

- Use air measuring tools.
- Use a combustible gas detector.

LEARNING TASKS

1. Describe tools used for air measurement
   - Types
     - U-tube manometer
     - Digital manometer
     - Inclined manometer
     - Anemometer
     - Velometer
     - Balometer
     - Magnehelic
     - Tachometer
   - Accessories
   - Ranges
   - Applications

2. Use air measuring tools
   - Procedures
   - Safety
   - Adjustment
   - Inspection
   - Maintenance
     - Certification
     - Calibration
   - Storage

3. Use a combustible gas detector
   - Types
     - Electronic
     - Laser
     - Draeger
     - Flame ionization
   - Applications
   - Inspection
   - Maintenance
     - Certification
     - Calibration
   - Storage
Achievement Criteria

Performance  The learner will be able to:
  • Measure and calculate velocity.
  • Measure and calculate volume.
  • Measure and calculate pressure.
  • Measure and calculate RPM.
  • Measure and calculate temperature rise/drop.

Conditions  To be assessed during technical training.
  The learner will be given:
  • Specifications
  • Tools and materials

Criteria  The learner will be evaluated on:
  • Accuracy
  • Efficiency
  • Completeness
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B8 Use Digital Technology

Objectives
To be competent in this area, the individual must be able to:
• Use software for design and analytics.

LEARNING TASKS
1. Use software for design and analytics

CONTENT
• Simulators
• Apps
• Manufacturer’s software
• Load calculations
  o Data entry
  o Accuracy
  o Verification
  o Input/output schedules
• Manual check
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C2 Interpret Drawings and Specifications

Objectives
To be competent in this area, the individual must be able to:
• Create a piping installation drawing for a refrigeration system.

LEARNING TASKS
1. Create a piping installation drawing for a refrigeration system

CONTENT
• Codes
• Sizing
• Components
• Supports
• Equipment location
• Dimensions
• Symbols
• Legends
• Scale

Achievement Criteria
Performance The learner will be able to create a piping installation drawing for a refrigeration system.
Conditions To be assessed during technical training.
The learner will be given:
• Specifications
• Sketching tools and paper
Criteria The learner will be evaluated on:
• Neatness
• Accuracy
• Completeness
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C3 Use Codes, Regulations and Standards

Objectives
To be competent in this area, the individual must be able to:
- Identify environmental agencies associated with system drainage.
- Interpret B52 code requirements for field assembly and testing.
- Interpret B52 code requirements for Class T machinery rooms.

LEARNING TASKS
1. Identify environmental agencies associated with system drainage
   - Provincial Regulations
   - WorkSafe BC
   - Authority Having Jurisdiction (AHJ)

2. Interpret sections of the CSA B52 code
   - Field assembly and testing
   - Class T machinery rooms
     - Ammonia
     - Safe work practices
     - Emergency discharge systems
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C4  Use Manufacturer and Supplier Documentation

Objectives
To be competent in this area, the individual must be able to:
• Apply manufacturer’s and supplier documentation.

LEARNING TASKS
1. Apply manufacturer’s and supplier documentation

CONTENT
• Proprietary data sheets
• Installation literature
• Operation literature
• Maintenance literature
• Parts list
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES

Competency: C5 Organize Work and Maintain Records

Objectives
To be competent in this area, the individual must be able to:

• Describe documentation responsibilities.

LEARNING TASKS
1. Describe documentation responsibilities

CONTENT
• Types of documents
  o Commissioning report
  o Service reports
  o Statements of completion
  o Technical Safety BC documentation
  o Permits
  o Approvals
  o Revised drawings

• Regulatory responsibilities
  o Safety Standards Act
  o Safety Standards General Regulations
  o Safety Standards Gas Regulations

• Liability
  o Contractor
  o Fitter

• Owner
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C6  Select Refrigerants, Compressed Gases and Oils

Objectives
To be competent in this area, the individual must be able to:
• Describe lubrication systems.
• Analyze lubricants.

LEARNING TASKS
1. Describe lubrication systems
   • Types
   • Applications
   • Operation
     o Controlling oil
       – Oil separators
       – Piping for oil return
   • Components
     o Oil heaters
     o Oil coolers
     o Regulators
     o Oil traps
     o Safeties
     o Separators
     o Reservoir
     o Pumps

2. Analyze lubricants
   • Types
   • Properties
   • Application
   • Oil retrofit
   • Oil and refrigerant mixtures
   • Sources of contamination
   • Remediation for contamination
   • Acid testing
   • Environmental regulations/requirements
   • Codes
   • Storage
   • Handling
Line (GAC): C  PERFORM ROUTINE TRADE ACTIVITIES
Competency: C8  Select HVAC/R Components and Accessories

Objectives
To be competent in this area, the individual must be able to:
• Select compressors, evaporators, and condensers.
• Select metering devices.
• Select accessories.

LEARNING TASKS  CONTENT
1. Select compressors
   • Applications
   • Components
   • Operation
   • Lubrication
   • Sizing

2. Select evaporators
   • Applications
   • Components
   • Requirements
     o Defrost type
   • Operation
   • Sizing

3. Select condensers
   • Applications
   • Components
   • Requirements
   • Condensing medium
   • Operation
   • Sizing

4. Select metering devices
   • Types
   • Operation
   • Applications
   • Limitations
   • Sizing

5. Select accessories
   • Types
     o Driers
     o Moisture indicators
     o Distributors
     o Receivers
     o Pressure regulators
       - Evaporator
       - Crankcase
       - Condensing
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<td>• Operation</td>
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</table>
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C10 Install Valves

Objectives
To be competent in this area, the individual must be able to:
• Describe the installation of valves.

LEARNING TASKS
1. Describe valves
   • Normally open
   • Normally closed
   • Four-way valves
     o Types
   • Three-way valves
   • Stop valves
     o Check valves
     o Solenoid valves
   • Pilot operated valves
     o Two position
     o Modulating

2. Describe the installation of valves
   • Code and regulations
   • Manufacturer’s specifications
   • Orientation
   • Relative placement
Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E1 Use the Principles of Electricity and Electronics

Objectives
To be competent in this area, the individual must be able to:
• Select single-phase transformers.
• Describe millivolt circuits.
• Describe proportional control operation.
• Identify resistors.
• Describe variable resistors.
• Describe PLC ladder logic.

LEARNING TASKS
1. Select single-phase transformers
   • Electrical load
   • Sizing
   • Ratings
     o NEMA
     o VA

2. Describe the installation of single-phase transformers
   • Safety
   • Codes
   • Manufacturer’s documentation
   • Phasing
   • Grounding
   • Wiring
   • Terminations
   • Testing

3. Describe millivolt circuits
   • Power generation
     o Thermocouple
     o Thermopiles
   • Switches
   • Loads
   • Application

4. Describe proportional control operation
   • Types used by series
   • Method of control
     o Pneumatic
     o Electric

5. Identify resistors
   • Types
   • Ratings
   • Application

6. Describe variable resistors
   • Thermistors
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<td>• Span</td>
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</table>
**Line (GAC):** E  APPLY ELECTRICAL CONCEPTS  
**Competency:** E2  Use Electrical Wiring Diagrams and Schematics

### Objectives

To be competent in this area, the individual must be able to:

- Interpret electrical diagrams.
- Troubleshoot walk-in freezer circuits.
- Troubleshoot multiple-voltage HVAC/R circuits.

### LEARNING TASKS

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<td>- Time clocks</td>
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<td>- Indoor unit</td>
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<td>- Thermostat</td>
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<tr>
<td>5. Troubleshoot multiple-voltage HVAC circuit</td>
<td>- Safety</td>
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<td>- Sequence of operation</td>
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### LEARNING TASKS

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<td>o Amperage</td>
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<td>o Resistance</td>
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<td>o Continuity</td>
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HARMONIZED PROGRAM OUTLINE  
Program Content  
Level 2

**Line (GAC):** E  
**Competency:** E3  
**Apply Motor and Motor Control Theory**

### Objectives
To be competent in this area, the individual must be able to:
- Identify causes of motor failure.
- Maintain semi and hermetic compressors.
- Verify motor starting and protection devices.
- Verify motor installation and operation.

### LEARNING TASKS

#### 1. Identify causes of single and three phase motor failure
- **CONTENT**
  - Design operating conditions
    - Rating of motor
    - Amperage and voltage
      - Imbalance (three phase)
    - Motor efficiency
    - Motor heat
    - Application
  - Symptoms
    - Fails to start
    - Fails to run continuously
    - Trips protector
    - Short cycles
  - Common causes
    - Relay failures
    - Capacitor failures

#### 2. Identify causes of semi and hermetic compressor motor failure
- **CONTENT**
  - Examine system
  - Oil testing
  - Correct replacement
  - System clean up
  - Rating of semi and hermetic compressor BTU
  - Horsepower
  - Amperage and voltage

#### 3. Maintain semi and hermetic compressors
- **CONTENT**
  - Tools and equipment
  - Techniques for testing
  - Locked units
  - Test cords and instruments

#### 4. Verify motor starting and protection devices
- **CONTENT**
  - Potential relays
    - Principles of operation
    - Wiring diagrams
LEARNING TASKS

CONTENT

- Current relays
  - Principles of operation
  - Wiring diagrams
  - Applications

- PTC device
  - Principles of operation
  - Wiring diagrams
  - Applications

- Capacitors
  - Run capacitors
  - Start capacitors

- Motor protectors
  - Thermal
  - Magnetic
  - Inherent
  - External

5. Verify motor installation and operation

- Mechanical checks
  - Belts
    - Types
    - Tension
    - Alignment
    - Replacement
  - Bearings
  - Noise
  - Changing rotation
  - Motor sheave
    - Types
    - Alignment
    - Speed
    - Amperage
    - Adjustment

- Electrical checks
  - Amperage
  - Voltage
  - Power and starting
  - Check windings
HARMONIZED PROGRAM OUTLINE
Program Content
Level 2

Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E4 Select Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe refrigeration control applications.
• Select refrigeration controls.

LEARNING TASKS

1. Describe refrigeration control applications
   • Pump down systems
   • Defrost
     o Hot gas
     o Electric
   • Air-side capacity
   • Compressor staging
   • Lock-out relay
   • Latching circuit
   • Hand off-auto

2. Select refrigeration controls
   • Safeties/controls
     ○ Pressure
     – Oil safety
     – High/low
     – Fan cycling
     – Loss of charge
     ○ Temperature
     – Discharge
     – Anti-ice
     – Low ambient
     – Box
   • Location
   • Line duty
   • Pilot duty
   • Codes
   • Manufacturer specifications
   • Engineering specifications
   • Limitations
### Line (GAC): E APPLY ELECTRICAL CONCEPTS

**Competency:** E5 Apply Wiring Practices

#### Objectives

To be competent in this area, the individual must be able to:
- Install electrical components.

#### LEARNING TASKS

<table>
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<tr>
<th>CONTENT</th>
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</thead>
<tbody>
<tr>
<td>1. Install cables and conductors</td>
<td><strong>Objective</strong>: To be competent in this area, the individual must be able to:</td>
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<tr>
<td><strong>CEC</strong></td>
<td>• Install electrical components.</td>
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<tr>
<td><strong>Supports</strong></td>
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<td><strong>Colour coding</strong></td>
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<td><strong>Class 2 circuits</strong></td>
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<td><strong>Conduit</strong></td>
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<td><strong>Wire labelling</strong></td>
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<tr>
<td><strong>Tools</strong></td>
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<tr>
<td>2. Install junction and switch boxes</td>
<td><strong>Objective</strong>: To be competent in this area, the individual must be able to:</td>
</tr>
<tr>
<td><strong>CEC</strong></td>
<td>• Sizing</td>
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<td><strong>Sizing</strong></td>
<td>• Conductor connections and terminations</td>
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<td><strong>Conductor connections and terminations</strong></td>
<td>• Grounding/bonding</td>
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<td><strong>Grounding/bonding</strong></td>
<td>• Tools</td>
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<td><strong>Tools</strong></td>
<td>• Termination</td>
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HARMONIZED PROGRAM OUTLINE
Program Content
Level 2

Line (GAC): F APPLY REFRIGERATION AND AIR CONDITIONING THEORY
Competency: F1 Analyze Heat Pumps and Air Conditioning Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the properties of air.
• Interpret a psychrometric chart.
• Describe fan laws and performance curves.
• Describe air filtration and purification systems.
• Describe air-to-air heat exchangers.

LEARNING TASKS

1. Describe properties of air

   • Composition of air
   • Air quantities
   • Water vapour content
   • Heat content

2. Describe the psychrometric chart

   • Structure
   • Reading values
   • Plotting points
   • Comfort zone

3. Describe fan systems

   • Types
     o Axial
     o Centrifugal
     o Forward incline
     o Backward incline
     o Propeller
   • Fan laws and performance curves
   • Ducting
     o Design
     o Layout
     o Sizing
     o Low velocity
     o Static regain
     o Equal friction
     o High velocity
     o Noise control
   • Air intakes/outlets
     o Types
     o Room air distribution
     o Balancing
     o K-factor
LEARNING TASKS
4. Describe air filtration and purification

CONTENT
- Purpose
- Contaminants
- Filters
  - Types
  - Degrees of filtration
  - Sizes of particles
  - Maintenance
  - Principles of operation
- Electronic air cleaners
  - Operation
  - Maintenance
  - Troubleshooting
- UV air purifiers
  - Operation
  - Maintenance
  - Troubleshooting

5. Describe air-to-air heat exchangers

Achievement Criteria
Performance The learner will be able to read values and plot points using a psychrometric chart.
Conditions To be assessed during technical training.
The learner will be given:
  - Project specifications
  - Tools and materials
Criteria The learner will be evaluated on:
  - Accuracy
  - Completeness
HARMONIZED PROGRAM OUTLINE
Program Content
Level 2

Line (GAC): F APPLY REFRIGERATION AND AIR CONDITIONING THEORY

Competency: F2 Analyze Refrigeration Systems

Objectives

To be competent in this area, the individual must be able to:

- Use a pressure enthalpy (PE) chart to balance components.
- Describe multi-temperature systems.
- Describe water chilled systems.

LEARNING TASKS

1. Analyze mechanical refrigeration systems
   - Component balancing
     - Load factors
     - Performance diagrams
     - Evaporator performance
     - Compressor performance
     - Condenser performance
     - Plot pressure enthalpy (PE) chart

2. Describe multi-temperature systems
   - Single temperature systems
   - Multi-temperature systems
   - Flow control valves
   - System control

3. Describe water chilled systems
   - Characteristics
   - Applications
   - Operation

Achievement Criteria

Performance
The learner will be able to read values and plot points using a PE chart.

Conditions
To be assessed during technical training.
The learner will be given:

- Operational parameters
- PE charts
- Tools and equipment

Criteria
The learner will be evaluated on:

- Accuracy
- Completeness
Line (GAC): F APPLY REFRIGERATION AND AIR CONDITIONING THEORY

Competency: F3 Apply Food Storage Theory

Objectives
To be competent in this area, the individual must be able to:
• Describe food preservation and storage.
• Describe insulation requirements.
• Calculate cooler and freezer loads.

LEARNING TASKS
1. Describe principles of food preservation
   • Applications
   • Causes of spoilage
   • Spoilage prevention
   • Storage life
   • Product safety

2. Describe medium (fresh) temperature storage
   • Fresh food
     o Classification by storage requirements
     o Properties of food products
   • Fresh meat
     o Storage requirements
     o Display storage

3. Describe low (frozen) temperature storage
   • Methods of freezing
     o Quick freezing
     o Sharp freezing
     o Immersion freezing
     o Contact freezing
   • Properties of food products
     o Freezing temperatures
     o Storage temperatures
     o Life of frozen foods

4. Describe insulation requirements
   • Types
     o Insulated walls
     o Vapour barrier
   • Application
   • Insulating values
     o R-values
     o U-values
     o Calculations

5. Calculate cooler loads
   • Heat loads
LEARNING TASKS

6. Calculate freezer loads

CONTENT

- Beer storage cooler
- Floral cooler
- Meat storage room
- Fresh vegetable cooler

- Components of heat loads
  - Wall transmission
  - Air change load
  - Product load
  - Miscellaneous loads

- Equipment selection
  - Total load
  - Hours run time
  - Selecting evaporator coil for correct TD

- Heat loads
  - Pull down freezer
  - Storage freezer

- Product freezing load
  - Three components
    - Sensible heat
    - Latent heat
  - Run time
  - Equipment selection
Objectives
To be competent in this area, the individual must be able to:
- Create a field level risk assessment (FLRA).

LEARNING TASKS
1. Create a field level risk assessment (FLRA)

CONTENT
- Safety equipment
- Job specifications
  - Coordination with other trades
- Site conditions
  - Access
- Site/company policies
- Jurisdictional regulations
- WorkSafe BC compliance
HARMONIZED PROGRAM OUTLINE
Program Content
Level 2

Line (GAC): G PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency: G2 Plan HVAC/R System Installation

Objectives
To be competent in this area, the individual must be able to:
• Describe low temp refrigeration systems.
• Select low temp refrigeration equipment.
• Describe equipment placement.
• Create a material take-off.

LEARNING TASKS

1. Describe low temperature refrigeration systems
   • Types
     o Air cooled
     o Water cooled
   • Applications
     o Low temp
   • Refrigerants
   • Components
     o Evaporator
     o Condenser
     o Metering device
     o Compressor
     o Defrost controls
   • Accessories
     o Service valves
     o Regulating valves
     o Receiver
     o Filter drier
     o Sight glass
     o Pressure switches
     o Liquid line solenoid valve
     o Temperature control
     o Accumulator
   • Operation

2. Select low temperature refrigeration equipment
   • Load calculation
   • Supplier documentation
   • Engineering documentation
   • Verify utilities
   • Placement

3. Describe equipment placement
   • Drawings and specifications
     o Clearances
LEARNING TASKS

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4. Create a material take-off for a freezer

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<td>• Customer specifications</td>
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Achievement Criteria

Performance  The learner will be able to plan a material take-off.

Conditions  To be assessed during technical training.

The learner will use the drawing from C2 – Interpret Drawings and Specifications and will be given:

- Specifications

Criteria  The learner will be evaluated on:

- Accuracy
- Completeness
- Neatness
**Objectives**

To be competent in this area, the individual must be able to:

- Describe the installation of low temperature systems.

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>1. Describe the installation of low temperature systems</th>
<th>CONTENT</th>
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<tbody>
<tr>
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<td>- Codes and regulations</td>
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<td>- Evacuation</td>
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<td>- Manufacturer specifications</td>
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<td>- B52 code requirements</td>
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<td>- Charging</td>
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<td>- Zeotropic refrigerants</td>
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</table>
LEARNING TASKS

CONTENT

- Azeotropic refrigerants
Line (GAC): H

INSTALL REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency: H3 Install Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Create a control system material take-off.
• Install control systems.

LEARNING TASKS
1. Create a control system material take-off
   - Terminology
   - Lists
   - Site considerations
   - Application
   - Service ability
   - Scheduling/time
   - Material selection
     - Codes
   - Engineered specifications
   - Customer specifications

2. Install control systems
   - Safety requirements
   - Drawings and specifications
     - Placement
       - Equipment
       - Components
       - Accessories
   - Codes and regulations
   - Manufacturer specifications
   - Tools and equipment
   - Assembly pre-check
   - Hardware configuration
   - Assembly
   - Mounting
   - Field wiring
     - Temperature control
     - Defrost
     - Defrost termination/fan delay
     - Liquid line solenoid
     - Hot gas solenoid
     - Electrical heat
     - Heat traces
     - Pressure controls
LEARNING TASKS

CONTENT

- Load requirements
- Terminations
- Verification
  - Operating ranges
- Documentation
  - Service report
  - Plot cycle
# Line (GAC): I APPLY GAS UTILIZATION THEORY

## Competency: I1 Apply Combustion Theory

### Objectives

To be competent in this area, the individual must be able to:
- Describe methods of combustion air supply.
- Calculate air requirements and products of combustion.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>1. Describe characteristics of hydrocarbon gases</td>
<td>- Chemistry</td>
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<td>- Heat value</td>
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<td></td>
<td>- Specific gravity</td>
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<td>- Flame speeds</td>
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<td>- Limits of flammability</td>
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<td>2. Describe the chemistry of combustion</td>
<td>- Requirements for combustion</td>
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<td>- Products of combustion</td>
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<td>- Stoichiometric combustion</td>
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<td>- Incomplete combustion</td>
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<td>3. Calculate air requirements and products of</td>
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<td>o N₂</td>
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</tbody>
</table>
Line (GAC):  I  APPLY GAS UTILIZATION THEORY
Competency:  I2  Apply Draft Theory

Objectives
To be competent in this area, the individual must be able to:
- Describe draft.
- Describe the building as a system.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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</thead>
<tbody>
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<td>1. Describe draft</td>
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<td>o Chimney effect</td>
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<td>• Mechanical draft</td>
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<td>2. Describe the building as a system</td>
<td>• Negative air pressure</td>
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<td>• Exhaust equipment</td>
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<td>• Building envelope</td>
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<td>• Building ventilation</td>
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<td>• Regional location</td>
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<td>• Type of building</td>
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<td>o Building Code</td>
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</table>
Line (GAC): I APPLY GAS UTILIZATION THEORY
Competency: I4 Apply Knowledge of Mechanical Safety Devices

Objectives
To be competent in this area, the individual must be able to:
• Describe the applications and installation of mechanical safety devices.

LEARNING TASKS
1. Describe the applications of mechanical safety devices
   • Mechanical safety devices
     o Pressure relief
     o Temperature and pressure relief
     o Pop safety (PSV)
     o Safety relief (SRV)
     o Vacuum relief
     o Fusible plug
     o Ratings
     • Codes and regulations
     • ASME standards
     • Ratings
     • Hot Water Boiler
     • Steam Boiler
     • Hot Water Tank
     • Pressure vessels
       o Propane tanks (LPG)
       o Propane cylinders
     • Compressed Natural Gas (CNG)
 2. Describe installation of mechanical safety devices
   • Discharge piping
     o Termination
     o Size
   • Location
Line (GAC): J INSTALL GAS-FIRED SYSTEMS
Competency: J3 Install Gas Piping and Tubing Systems

To be competent in this area, the individual must be able to:

• Describe piping, tubing and hoses for gas applications.

LEARNING TASKS

1. Describe factors that affect fluid flow in a piping system
   • Laminar flow
   • Turbulent flow
   • Specific gravity
   • Pressure drop
   • Velocity
   • Size
   • Piping material
   • Fittings

2. Describe natural gas fuel distribution systems
   • Utility provider
     o Gas well
     o Transmission line
     o Compressor station
     o City gate station
     o District regulator station
     o Distribution regulator
     o Gas main
     o Gas service
     o Service stop (valve)
     o Service regulator
     o Meter
   • Consumer
     o Gas supply or building line
     o Branch line
     o Drop line
     o Riser
     o Drip or dirt pocket
     o Extension
   • Gas pressures
     o High
     o Low
   • Types
     o Black iron pipe
     o Copper tubing
     o PE piping
     − Tracer wire

3. Describe piping, tubing and hoses
   • Types
LEARNING TASKS

4. Calculate the linear thermal expansion and contraction of various materials

5. Describe hangers and supports

6. Join pipe and tubing

7. Perform tube bending

CONTENT

- Corrugated stainless steel tubing (CSST)
- Hoses
- Flexible connectors
- Properties of piping materials
  - Tensile strength
  - Malleability
  - Elasticity
- Schedules and grades
- Pressure ratings
- Nominal sizes
- Protective coatings
- Cathodic protection
- Identification markings
- Ferrous
- Non-ferrous
- Thermoplastic
- Types
- Construction
- Uses
- Expansion
- Seismic restraint
- Protective materials
  - Electrolysis
- Spacing
- Inserts and fasteners
- Installation procedures
- Safety
- Methods
  - Welding
  - Threading
  - Flaring
  - Compression fittings
  - Brazing
  - Fusion (PE)
- Procedure
- Hot taps
- Tools
- Fittings
- Tools
- Technique
LINE (GAC): J  INSTALL GAS-FIRED SYSTEMS
Competency: J9  Install Gas-Fired Appliances and Ancillary Equipment

Objectives
To be competent in this area, the individual must be able to:
• Select gas-fired appliances rated at 400 MBH or less.

LEARNING TASKS
1. Describe gas-fired appliances

CONTENT
• Types
  o Boilers
    – Hot water
    – Steam
    – High mass
    – Low mass
  o Direct fired make-up air heaters
  o Direct vent appliances
  o Decorative appliances
    – Fireplace
    – Fire pit
  o Furnaces
  o Radiant heaters
    – Low intensity
    – High intensity
  o Ranges and/or Commercial cooking equipment
  o Rooftop units
  o Unit heaters
  o Water heaters
    – Tankless
    – Storage type
  o Gas-fired refrigerators
• Characteristics
  o Appliance design
  o Direct-fired
  o Indirect-fired
• Applications
• Approval agencies
Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L1 Maintain HVAC/R Systems

Objectives
To be competent in this area, the individual must be able to:
• Identify conditions requiring more than routine maintenance.

LEARNING TASKS
1. Identify conditions requiring more than routine maintenance

CONTENT
• Metal fatigue (wear)
• Vibration
• Improper lubrication
• Misalignment
• Incorrect adjustments
• Loose connections
• Failed safety or operational controls
• Incorrect operation
• System cleanliness
• Equipment lifecycle
Objectives
To be competent in this area, the individual must be able to:
• Service refrigeration systems.

LEARNING TASKS
1. Describe system operating conditions
   • Suction pressure
   • Discharge pressure
   • Relationships of pressure
   • Condensing temperatures
   • Evaporating temperatures
   • High pressure safety
   • Condenser efficiency
   • Liquid sub-cooling
   • Evaporator efficiency
   • Air handling deficiencies
   • Electrical voltages and amperages
   • Sight glass conditions
   • Pressure/temperature drop across filter drier
   • Site conditions

2. Troubleshoot and repair refrigeration systems
   • Safe work practices
   • Lock-out/tag-out
   • Verify reported problem
     o Inadequate cooling
     o Consult onsite personnel
     o Observe conditions before servicing
     o Service history
   • Inspection/testing
     o Sensory
     o Diagnostic
       - Acid test
       - Pressure drop test
     o Monitoring
   • Tools and equipment
   • Isolate components
   • Conditions for repair/replacement
     o Obtain approval
LEARNING TASKS

CONTENTS

- Cost estimating
  - Temperature
  - Leaks
  - Corrosion
  - Malfunction
  - Vibration
  - Irregular movement

- Procedures
  - Cleaning
  - Purging
  - Isolating

- Faults
- Causes
- Repair/replace components
- Return to service
- Documentation
  - Electronic
  - Paper
  - Service report
Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L3 Maintain Control Systems

Objectives

To be competent in this area, the individual must be able to:
• Maintain refrigeration control systems.

LEARNING TASKS

1. Maintain refrigeration control systems

CONTENT

• Safety requirements
• Schedules
  o Time clock
  o Defrost initiation/termination
• Inspection
  o Sensory
  o Diagnostic
  o Monitoring
  o Electrical connections
  o Set points
    − Differentials
    − Temperature
    − Pressure
  o Calibration
  o Cycling
    − Defrost
    − Pump down
    − Temperature
    − Pressure
• Tools and equipment
• Manufacturer’s specifications
• Codes and regulations
• Verification
  o Sequence of operation
  o Operating and safety controls
• Diagnostic tests
• Adjustments
• Conditions for repair/replacement
• Documentation
  o Maintenance reports
HARMONIZED PROGRAM OUTLINE
Program Content
Level 2

Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L4 Service Control Systems

Objectives

To be competent in this area, the individual must be able to:

• Service refrigeration control systems.

LEARNING TASKS

1. Troubleshoot and repair refrigeration control systems

CONTENT

• Safety requirements
  o Lock-out/tag-out

• Verify reported problem
  o Consult onsite personnel
  o Observe conditions before servicing

• Test sequence of operation
  o Normal operation
  o Time clock
  o Defrost initiation/termination
  o Pump down
  o Temperature control
  o Safety settings

• Inspection
  o Sensory
  o Diagnostic
  o Monitoring
  o Electrical connections
  o Set points
    − Differentials
    − Temperature
    − Pressure
  o Calibration
  o Cycling
    − Defrost
    − Pump down
    − Temperature
    − Pressure

• Tools and equipment
• Isolate components
• Conditions for repair/replacement
  o Obtain approval
• Procedures
• Faults
LEARNING TASKS

CONTENT

- Causes
  - System readings
  - Data
    - Mechanical
    - Electrical
- Codes and regulations
- Manufacturer’s specifications
- Repair/replace components
- Return to service
  - Verify correct operation
    - Cycle all modes
  - Check back with customer
- Documentation
  - Electronic
  - Paper
  - Service report
Level 3
Refrigeration and Air Conditioning Mechanic
Line (GAC): B USE TOOLS AND EQUIPMENT
Competency: B8 Use Digital Technology

Objectives
To be competent in this area, the individual must be able to:
- Perform air conditioning load calculations.
- Perform psychrometric calculations.
- Describe remote monitoring.

LEARNING TASKS
1. Use software for design and analytics
   - Simulators
   - Apps
   - Manufacturer’s software
   - Heat loss/gain calculations
     - Peak load
     - Average load
     - 1% and 5% design
   - Psychrometric calculations
     - Mixtures
     - Processes

2. Analyze remote monitoring
   - Purpose
   - Data
   - Hardware/software requirements
   - Access authority
   - Sample system
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C3 Use Codes, Regulations and Standards

Objectives
To be competent in this area, the individual must be able to:
• Describe the purpose of the B149.1 gas code.
• Use gas regulations.

LEARNING TASKS
1. Describe the purpose of the B149.1 gas code
   • Scope
   • Reference Publications
   • Definitions
   • General

2. Use gas regulations
   • Role of Technical Safety BC
   • Role of the Gasfitter
   • Safety Standards Act
   • Safety Standards General Regulation
   • Gas Safety Regulation
   • Permits
   • Notification of Completion
   • Approvals
   • Variations to the National Gas Code
   • Bulletins, Directives and Safety Orders
Objectives
To be competent in this area, the individual must be able to:
- Describe contractual documents.
- Describe quote preparation.

LEARNING TASKS

1. Describe contractual documents
   - Purpose
   - Types
     - Agreements
     - General conditions
     - Drawings
     - Specifications
       - Master format
       - Divisions
   - General requirements
   - Responsibilities and obligations
     - Permits and requirements
     - Guarantees/warranties
     - Liability
     - Tests and inspections
     - Workmanship
   - Change orders
   - Request for information (RFI)

2. Describe quote preparation
   - Design criteria
   - Specifications
   - Sequence of operation
   - Permits
   - Inspections
   - Crew requirements
     - Hours of labour
   - Materials/inventory
   - Estimation of total work hours
   - Site specific requirements
   - Margins
Objectives

To be competent in this area, the individual must be able to:

- Explain capacity control.
- Select heat exchangers.
- Service metering devices.

LEARNING TASKS

1. Explain capacity control

   - Load variations
     - Factors
     - Low load effects
   - Basic on/off
   - Condensers
     - Air side
     - Refrigerant side
     - Splitting
   - Evaporators
     - Multiple evaporators
     - Split circuits
     - Hot-gas bypass systems
   - Compressors
     - Balance load with evaporator
     - Variable speed
     - Multiple compressors
     - Mechanical unloaders
     - Hot-gas bypass systems

2. Select heat exchangers

   - Types
     - Tube
     - Plate
     - Brazed plate
     - Shell and tube
     - Regenerative
     - Plate fin
     - Fin tube
     - Adiabatic wheel
     - Coax
   - Applications
     - Liquid suction
     - Desuperheating
     - Heat recovery
LEARNING TASKS

3. Service metering devices

CONTENT

- Cooling
- Subcooling
- Dehumidifying
- Operation
- Adjustments and settings
- Troubleshooting
- Repair
Line (GAC): E  APPLY ELECTRICAL CONCEPTS
Competency:  E1  Use the Principles of Electricity and Electronics

Objectives
To be competent in this area, the individual must be able to:
• Describe electronic principles.
• Identify electronic devices.
• Identify electronic DC power supplies.
• Describe proportional control operation

LEARNING TASKS
CONTENT
1. Describe electronic principles
   • Construction
     o P-N junctions
     o Impurities
     o Depletion regions
     o Forward and reverse bias
   • Characteristics
     o Heat
     o Over-current

2. Identify electronic devices
   • Diodes
   • Silicon Controlled Rectifiers (SCRs)
   • Triacs
   • Solid state relays
   • Transducers

3. Identify electronic DC power supplies
   • Half-wave rectifier
     o Components
     o Operating principles
   • Full-wave rectifier
     o Components
     o Operating principles
     o Applications
   • Filters
   • Regulators
   • Electronic

4. Describe proportional control operation
Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E2 Use Electrical Wiring Diagrams and Schematics

Objectives
To be competent in this area, the individual must be able to:
- Design a wire diagram for a hydronic heating system.
- Describe the sequence of operation for a furnace and hydronic heating system.
- Create a control narrative from a wiring diagram for a hydronic system.

LEARNING TASKS
1. Describe circuit components
   - Transformer
     - Phasing
   - Limits
   - Safety devices
   - Controls
   - Permissives
   - Interlocks

2. Describe sequence of appliance operation
   - Control narratives
   - Components
   - Appliances
   - Wiring diagrams

3. Design wire diagram
   - Control narrative

4. Create a control narrative from a wiring diagram for a hydronic heating system
   - Diagram types
     - Schematic
     - Ladder
     - Process flow diagram

Achievement Criteria 1
Performance
The learner will be able to design a wire diagram for a high-temp 4 zone hydronic heating system.

Conditions
To be assessed during technical training.
The learner will be given:
- Electrical data
- Sketching materials
- System component requirements

Criteria
The learner will be evaluated on:
- Accuracy
- Completeness
- Use of symbols
- Sequence of operation
Achievement Criteria 2

Performance  The learner will be able to create a control narrative from wiring diagrams.
Conditions  To be assessed during technical training.
            The learner will be given:
            • Ladder diagram
            • Schematic diagram
Criteria  The learner will be evaluated on:
            • Accuracy
            • Completeness
            • Sequence of operation
Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E3 Apply Motor and Motor Control Theory

Objectives
To be competent in this area, the individual must be able to:
- Describe electronically commutated motors (ECM).
- Describe variable frequency drives (VFDs).

LEARNING TASKS
1. Describe electronically commutated motors (ECM)
   - Safety
   - Types
     - Communicating
     - Wired
     - Multi-tap
   - Application
   - Characteristics
     - CFM/static pressure
     - Constant torque
   - Operation
     - DIP switch setting
     - External static pressure
   - Troubleshooting
     - Mechanical
     - Electronic

2. Describe variable frequency drives (VFDs)
   - Safety
   - Types
   - Application
   - Characteristics
     - AC Conversion
     - DC Bus filter
     - DC Inversion
     - PW modulation
     - Line/load reactors
   - Operation
   - Configuration
   - Protection
   - Limitations
   - Accessories
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E4 Select Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Select programmable logic controls (PLCs).
• Describe building automation systems.

LEARNING TASKS

1. Select programmable logic controls (PLCs)
   • Components
   • Applications
   • Function
   • Integration
   • Codes
   • Manufacturer’s specifications
   • Engineered specifications
   • Limitations
   • Location

2. Describe building automation systems
   • Purpose
   • Systems
     o Lighting
     o Fire
     o Security
     o HVAC
     o Irrigation
     o Sound
     o Load shedding
     o Window coverings
     o Distributed control systems
     o Computer interface
     o Occupancy
     o Ventilation
   • Operation
     o Industry standard signals
     o Data logging
     o Trend logging
     o Hardware and software requirements
       − Input devices
       − Output devices
     o Access levels of authority

CONTENT
Objectives
To be competent in this area, the individual must be able to:
- Plot psychrometric processes.
- Analyze fan systems.
- Calculate heat gain and heat loss.
- Describe heat pumps.
- Describe system configurations.
- Describe variable refrigerant flow systems.

LEARNING TASKS
1. Plot psychrometric processes
   - Structure of psychrometric chart
     - Lines and scales
     - Finding a state point
     - Plotting system parameters
   - Relationship of air and water
     - Heat exchange between air and water
     - Action of air in contact with water
   - Air conditioning processes
     - Heating
     - Cooling
     - Heat and humidification
     - Cooling and dehumidification
   - Air mixtures
     - Indoor and outside air
       - Percentage of mixture
       - Bypass air
   - Calculate unit capacities
     - Determining load from chart
     - Coil selection
     - Condensing unit selection
2. Analyze fan systems
   - Central fan systems
     - Basic layout
     - Variations in systems
     - Component operation
     - Control of components
     - Pressures
LEARNING TASKS

3. Calculate heat gain and heat loss

   • Conditions
     o Comfort
     o Environmental
     o Standard
     o Air distribution
   • Calculate total load
     o Types
       - Sensible
       - Latent
     o Sources
       - Internal
       - External
       - Factors
       - Conductivity
       - Wall gain
       - Body heat
       - Ducting gains/losses
       - Ventilation
       - Lights and appliances

4. Describe heat pumps

   • Types
     o Air-to-air
     o Air-to-water
     o Water-to-water
     o Geothermal
   • Characteristics

5. Describe system configurations

   • Classifications
     o Floor mounted
     o Roof top
     o Split systems
     o Window units
     o Conventional
     o Dual fuel
   • System functions
     o Single-stage cooling
     o Multi-stage cooling
     o Single and multi-stage heat
     o Inverter drive
     o Low ambient
     o Features
     o Heat sources
     o Humidification
   • Roof top units
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<td>• Two pipe system</td>
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<td>• Three pipe system</td>
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<td>• Branch boxes</td>
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<td>• Y-pipes</td>
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<td>• Proprietary training</td>
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</tbody>
</table>
Line (GAC): F APPLY REFRIGERATION AND AIR CONDITIONING THEORY

Competency: F2 Analyze Refrigeration Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe defrost systems.

LEARNING TASKS
1. Describe defrost systems

CONTENT
• Supplementary heat defrost
  o Water defrost
  o Brine spray systems
  o Electric defrost
  o Gas defrost
    – Reverse-cycle defrost
    – Three pipe system
Line (GAC): F APPLY REFRIGERATION AND AIR CONDITIONING THEORY

Competency: F4 Analyze Hydronic Systems

Objectives
To be competent in this area, the individual must be able to:
• Select pumps.
• Describe the operation of hydronic heating systems.
• Describe multi-boiler hydronic heating system components.
• Calculate volumetric thermal expansion.
• Describe low pressure steam systems.
• Describe the installation of a propane refrigerator.

LEARNING TASKS
1. Describe the operation of residential hydronic heating systems

CONTENT
• Purpose
• Centrifugal force
  o Principles
  o Applications
• Hydrostatics
  o Pressure and heat
  o Transmission of fluid pressure
  o Properties of liquid
  o Fluid flow in pipes
• Properties of water/brine
  o Fluid flow
  o Pipe sizing
  o System practices
  o Specific gravity
  o Specific heat
• Volumetric thermal expansion
  o Expansion coefficients
  o Temperature
    – \( \Delta T \)
  o Volume
• Components
  o Expansion tank
  o Mixing valves
  o Air separator
  o Zone headers
  o Zone valves
  o Pumps
    – Classification
    – Components
LEARNING TASKS

2. Select pumps

3. Describe multi-boiler hydronic heating system components

4. Calculate volumetric thermal expansion

CONTENT

− Operation
− Performance characteristics
  − Temperature indicators
  − Air vents
  − Feed water
  − Water treatment
  − Strainer

• Piping system configurations
  − Zoning
  − Supply water
  − Return water
  − Balancing
  − High-temperature
  − Low-temperature
  − Mixing/diverting
  − Reverse-return

• Heating and cooling generating equipment
  − Boilers
    − High mass
    − Low mass
    − Fire tube
    − Water tube
  − Heat pumps
  − Heat exchangers
    − Plate
    − Tube and shell
  − Solar panels

• Process Flow Diagrams (PFD)
• Controls
• Heat transfer units
• Safety considerations
• Design parameters
• System configuration
• Pump curve tables
• Sizing

• Piping configuration
  − Primary
  − Primary/secondary
  − Low loss header

• Codes
• Expansion coefficients
• Temperature
LEARNING TASKS | CONTENT
--- | ---
5. Describe low pressure steam systems | • \( \Delta T \)
   • Volume
   • Operating pressure
   • Boiler
   • Ancillary equipment
   • Feed tank/pump
   • Supply/steam header
   • Condensate return
   • Steam traps
   • Low water cutoff
   • Water treatment
   • Codes
   • Process Flow Diagrams (PFD)

6. Describe the installation of a propane refrigerator | • Manufacturer's documentation
   • Codes
Line (GAC): G PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency: G2 Plan HVAC/R System Installation

Objectives
To be competent in this area, the individual must be able to:
- Select HVAC equipment.
- Describe HVAC equipment placement.
- Verify HVAC system parameters and requirements.
- Create an HVAC material take-off.

LEARNING TASKS

1. Select HVAC equipment
   - Load calculation
     o Site location
   - Supplier documentation
   - Engineering documentation
   - Verify utilities
   - Site requirements
   - Placement

2. Describe HVAC equipment placement
   - Drawings and specifications
   - Equipment location
   - Site conditions
     o Seismic considerations
     o Structural considerations
   - Levelling
   - Scheduling/time
   - Codes and regulations

3. Verify HVAC system parameters and requirements
   - System capacity
   - Utilities
   - Condensate drainage
     o Pumps

4. Create an HVAC material take-off
   - Terminology
   - Lists
   - Site considerations
   - Application
   - Service ability
   - Material selection
   - Customer specifications
Line (GAC): H INSTALL REFRIGERATION AND AIR CONDITIONING INSTALLATIONS
Competency: H2 Install HVAC/R Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the installation of HVAC systems.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Describe the installation of HVAC systems | • Codes and regulations  
• Drawings and specifications  
  o Placement  
• Equipment  
• Components  
• Accessories  
• Site requirements  
• Tools and equipment  
• Supports  
  o Seismic  
• Piping  
  o Types  
  o Design  
  o Insulation  
  o Traps  
  o Minimum velocities  
  o Maximum velocities  
  o Slope  
• Pipe identification  
• Assembly  
  o Equipment  
  o Components  
  o Accessories  
• Wiring  
• Testing  
  o Pressure  
  o Vacuum  
  o Electrical  
• Evacuation  
  o Manufacturer specifications  
  o B52 code requirements  
• Charging  
  o Zeotropic refrigerants |
LEARNING TASKS

CONTENT

- Azeotropic refrigerants
Line (GAC): H INSTALL REFRIGERATION AND AIR CONDITIONING INSTALLATIONS

Competency: H3 Install Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Create a control system material take-off.
• Install HVAC control systems.

LEARNING TASKS

1. Create a control system material take-off
   • Terminology
   • Lists
   • Site considerations
   • Application
   • Service ability
   • Scheduling/time
   • Material selection
     o Codes
   • Engineered specifications
   • Customer specifications

2. Install HVAC control systems
   • Safety requirements
   • Drawings and specifications
     o Placement
       – Equipment
       – Components
       – Accessories
   • Codes and regulations
   • Manufacturer specifications
   • Tools and equipment
   • Assembly pre-check
   • Hardware configuration
     o Wireless access
   • Assembly
   • Mounting
   • Field wiring
     o Outdoor air sensors
     o Room sensors
     o Bonnet sensor
   • Load requirements
   • Terminations
   • Programming
     o Vacation mode
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<td>o As-built control schematics</td>
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HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

Line (GAC): I APPLY GAS UTILIZATION THEORY
Competency: I3 Apply Alternate Fuel Theory

Objectives
To be competent in this area, the individual must be able to:

- Describe types of alternate fuels for appliances under 400MBH (120kW).
- Describe the applications of alternate fuel appliances under 400MBH (120kW).
- Describe the installation of duel-fuel appliances under 400MBH (120kW).

LEARNING TASKS

1. Describe types of alternate fuels
   - Oil
   - Bio gas
   - Propane-air mixes
   - Methane (digester gas)
   - Manufactured gas

2. Describe the applications of alternate fuel appliances
   - Appliances
     o Boilers
     o Furnaces
     o Burners
   - Facilities/applications
   - Filters
   - Fuel conditioning
   - Pumps
   - Blowers

3. Describe the installation of duel-fuel appliances
   - Code requirements
   - Manufacturer’s specifications
   - Job specifications
     o Piping materials
     o Valves
     o Controls
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

Line (GAC): J INSTALL GAS-FIRED SYSTEMS
Competency: J1 Identify Burners

Objectives
To be competent in this area, the individual must be able to:
• Describe various burners.
• Describe the operation of atmospheric burners.
• Describe burner orifices.
• Describe the installation of mechanical burners.

LEARNING TASKS
1. Describe burners

   CONTENT
   • Terminology
     o Turndown
     o High fire
     o Low fire
     o Modulation
     o Port loading
   • Types
     o Forced draft
     o Fan assisted
     o Atmospheric
     o Inspérating
     o Asperating
   • Gas Properties
   • Flame Characteristics
     o Aerated
       – Oxidizing
       – Carbonizing
       – Neutral
     o Non-aerated
     o Bunsen
     o Luminous
     o Impingment
     o Flame retention
   • High installations
   • Pilot
     o Continuous
     o Intermittent
   • Interrupted
   • Types
     o Main burners
     o Pilot burners

2. Describe atmospheric burners
LEARNING TASKS

3. Describe mechanical burners

4. Describe burner orifices
**LEARNING TASKS**

5. Describe proportional mixers

6. Describe the installation of mechanical burners

**CONTENT**

- Fuel-air ratios
- Adjustments
- Zero governors
- Sealing
- Support
- Manufacturer’s documentation
- Refractory
- Wiring
- Mounting
Line (GAC): J  INSTALL GAS-FIRED SYSTEMS
Competency: J2 Identify Flame Safeguards

Objectives
To be competent in this area, the individual must be able to:
• Describe flame detectors.
• Describe ignition systems.
• Describe the operation of standing pilot/thermocouple systems.

LEARNING TASKS
1. Describe flame detectors
   • Thermocouple
   • Thermopile
   • Flame rectification (flame rod)
   • UV/IR
   • Pilot types
     o Continuous
     o Intermittent
     o Interrupted

2. Describe ignition systems
   • Pilot
   • Direct spark ignition (DSI)
   • Hot surface ignition (HSI)

3. Describe standing pilot/thermocouple systems
   • Wiring circuit
   • Sequence of operation
   • Applications

4. Describe flame safe guards
   • Common manufacturers
     o Honeywell
     o Fenwall
     o Siemens
     o Johnson Controls
   • Wiring diagrams
   • Sequence of operation
   • Applications
   • Component compatibility
   • System compatibility
   • Conversions
Line (GAC): J INSTALL GAS-FIRED SYSTEMS
Competency: J4 Install Regulators, Valves and Valve Train Components

Objectives
To be competent in this area, the individual must be able to:
• Select valves.
• Describe regulators.
• Describe the operation of gas valve trains for appliances rated at 400 MBH or less.
• Describe the purpose and operation of gas pressure regulators.

LEARNING TASKS

1. Describe manual valves
   • Types
     o Plug valves
     o Butterfly
     o Ball valves
     o Needle valves
   • Construction
   • Operation
   • Pressure markings and ratings
   • Maintenance

2. Describe automatic gas valves
   • Electric
     o Solenoid
     o Diaphragm
     o Combination
     o Single stage
     o Two stage
     o Modulating
     o Pilot safety
       − Safety shut off
   • Non-electric
     o Rod and tube
     o Hydraulic

3. Describe pressure regulators
   • Types
     o Direct operated
     o Lever operated
     o Zero governors
     o Propane
       − First stage
       − Second stage
   • Operating elements
     o Loading
     o Measuring
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<td>• Pilot safety valve</td>
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<td>• Regulators</td>
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5. Describe the operation of a gas valve train
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

Line (GAC): J INSTALL GAS-FIRED SYSTEMS
Competency: J5 Install Gas Controls

Objectives
To be competent in this area, the individual must be able to:
- Describe the installation of outdoor reset controls.
- Describe multi-boiler hydronic heating system components.

### LEARNING TASKS

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<td>2. Describe the installation of outdoor reset controls</td>
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<td>3. Describe multi-boiler hydronic heating system components</td>
<td>- Sequencing control</td>
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<td>- Wiring techniques</td>
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</tbody>
</table>
4. Describe multi-purpose controls

**CONTENT**

- Types
  - Burner modulating
  - Lead-lag
- Tekmar™
- Honeywell™
- Programming
Line (GAC): J
Competency: J7 Install Gas Venting Systems

Objectives
To be competent in this area, the individual must be able to:
- Describe installation of venting materials.
- Describe the installation of mechanical venting systems.

LEARNING TASKS

1. Describe appliance categories
   - Category 1, 2, 3 and 4
     - Vent pressure
     - Appliance efficiencies

2. Describe venting materials
   - Types
     - Single wall venting (C vent)
     - A vent
     - B vent
     - L vent
     - BH vent
     - Class 1, 2, 3 and 4
     - BW vent

3. Describe types of venting systems
   - Mechanical
     - Forced
     - Induced
   - Passive
   - Vent pressures

4. Describe the installation of venting materials
   - Components
     - Fittings
     - Terminations
     - Condensate collection
     - Fire stopping
     - Supports
     - Wall and ceiling penetrations
   - Assembly
     - Gaskets
     - Mechanical fasteners and clamps
     - Sealants and lubricants
     - Glues and primers
   - Code requirements
     - Directives
   - Grade/Slope
5. Describe the installation of mechanical venting systems

<table>
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</table>
Line (GAC): J  INSTALL GAS-FIRED SYSTEMS
Competency: J9 Install Gas-Fired Appliances and Ancillary Equipment

Objectives
To be competent in this area, the individual must be able to:
- Install boilers.
- Install air heating appliances.

LEARNING TASKS
1. Selection criteria for gas-fired appliances
   - Impact of type of building construction on installation requirements
   - Altitude rating requirement
   - Code and Regulation requirements
   - Manufacturer’s requirements
     - Rating plate requirements
   - Appliance sizing
     - Appliance input
     - Appliance output
     - Appliance efficiencies
     - Thermal efficiencies
   - Site preparation
   - Clearances
   - Installer’s responsibilities

2. Install boilers
   - Seismic restraint
   - Placement considerations
     - Venting
     - Air supply
     - Access
     - Electrical
       - Clearance
       - Isolation switches
     - Clearance
     - Manufacturer’s documentation
     - Codes
     - Drainage
     - Water supply
   - Materials
   - Ancillary equipment
     - Valves
       - Zone
       - Mixing
       - Diverting
       - Isolation
3. Install air heating appliances

- Mounting
- Seismic restraint
- Placement considerations
  - Venting
  - Ducting
    - Assembly
    - Installation
    - Vibration isolation
    - Zoning
    - External static pressures
  - Air supply
  - Access
  - Electrical
    - Clearance
    - Isolation switches
  - Clearance
  - Manufacturer’s documentation
  - Drainage
- Materials
- Ancillary equipment
  - Electronic air cleaners
  - Pumps
  - Humidifiers
  - Water treatment
    - Neutralizing tanks

- Dead boiler drain
- Blow down
- Flow control/balancing
- Vacuum reliefs
  - Circulators
  - Expansion tanks
  - Feed water
  - Water treatment
Line (GAC): K  COMMISSION SYSTEMS
Competency: K1 Commission HVAC/R Systems

Objectives
To be competent in this area, the individual must be able to:
• Commission HVAC/R systems.

LEARNING TASKS
1. Describe pre-start-up checklists

CONTENT
• Apply test equipment
• Supply voltage
• Actual voltage vs. rated
• Utilities and connections
  o Electrical connections
  o Water connections
• Condensate drain line slope
• Condensate trap primed
• Air filter
• Belts
• Pulleys
• Alignment
• Oil levels
• Confirm unit evacuated and has holding charge
• Compressor hold down bolts relaxed
• Shipping packaging
• Transformer primary tap
• Shipping manuals removed
• Damper pre-check
• Dipswitch settings
• Battery in thermostat
• Apply correct schematics and labels
• Permits
• Codes and regulations
• System approval
• Manufacturer’s documentation
• Sequence of operation

2. Perform system start-up

CONTENT
• Energize unit
• Check control voltage
• Check voltage imbalance
• Check current imbalance
• Check rotation
LEARNING TASKS

3. Set-up secondary system components

CONTENT

- Compressor
- Fans
  - Install unit covers
  - Confirm fan amperage draw
    - Name plate specifications
  - Check suction pressure
  - Check discharge pressure
  - Check superheat
  - Check sub-cooling
  - Adjust charge level to meet manufacturer's specifications
  - Verify condenser fan operation
    - Amperage draw
  - Check $\Delta T$s
    - Note ambient temperature
  - Set to minimum position for outdoor air
  - All panels and doors secured
  - Documentation
    - Record charge level
  - Tools and equipment
  - Controls, valves and regulators adjustments
  - System readings
  - Component adjustments/balancing
  - Secondary
    - Balancing valves
    - Pumps
    - Fans
    - Flow controls
    - Temperature controls
  - Eutectic test
    - Concentration
    - Level
    - Freeze point
    - Specific gravity
    - Refractometer
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

Line (GAC): K COCOMMISSION SYSTEMS
Competency: K2 Commission Control Systems

Objectives
To be competent in this area, the individual must be able to:
- Perform start-up checks.
- Verify operating parameters.

LEARNING TASKS

1. Perform start-up checks
   - Tools and equipment
   - Electrical connections
     - Tightness
     - Voltage
     - Codes
     - Wiring diagrams
   - Pneumatic connections
   - Electronic connections
   - Energize system
   - Transformer output
   - Transformer primary taps
   - Voltage and current imbalance

2. Verify operating parameters
   - Tools and equipment
   - Manufacturer’s specifications
   - Parameters
     - Alarm
     - Humidity
     - Temperature
     - Pressures
     - Flow
     - Levels
   - Programming
   - Set point adjustments
   - Load requirements
   - Operating controls adjustments
   - Calibrate controls
   - Test safety controls
   - Documentation
Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L2 Service HVAC/R Systems

Objectives
To be competent in this area, the individual must be able to:
• Service HVAC systems.

LEARNING TASKS
1. Troubleshoot and repair HVAC systems

CONTENT
• Safe work practices
• Lock-out/tag-out
• Verify reported problem
  o Insufficient heat
  o Inadequate cooling
  o Consult onsite personnel
  o Observe conditions before servicing
  o Service history
• Inspection/testing
  o Sensory
  o Diagnostic
    − Acid test
    − Pressure drop test
    − Electrical test
  o Monitoring
• Tools and equipment
• Isolate components
• Conditions for repair/replacement
  o Obtain approval
    − Cost estimating
  o Temperature
  o Leaks
  o Corrosion
  o Malfunction
  o Vibration
  o Irregular movement
• Procedures
  o Cleaning
  o Purging
  o Isolating
• Faults
• Causes
• Repair/replace components
LEARNING TASKS

CONTENT
- Electrically failed
- Mechanically failed
- Operator error
- Return to service
  - Confirm correct operation
  - Contributing causes of failure
- Documentation
  - Electronic
  - Paper
  - Service report
Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L3 Maintain Control Systems

Objectives
To be competent in this area, the individual must be able to:
- Maintain HVAC control systems.
- Maintain pneumatic control systems.

LEARNING TASKS
1. Maintain HVAC control systems

CONTENT
- Safety requirements
- Schedules
  - Set backs
  - Holiday
  - Cycle defrost
  - Day light savings time/zones
- Inspection
  - Mode cycle
  - Contacts
  - Electrical connections
  - Sensors
  - Calibration
  - Cycle back-up heat
  - Installer program
  - Sequence of operation
- Tools and equipment
- Manufacturer’s specifications
- Codes and regulations
- Verification
  - Operating and safety controls
  - Communication
- Diagnostic tests
- Error codes
- Adjustments
- Conditions for repair/replacement
- Return to service
- Documentation
  - Electronic
  - Paper
  - Maintenance report
LEARNING TASKS
2. Maintain pneumatic control systems

CONTENT
- Safety requirements
- Inspection
  - Compressor
    - Auto blow down
    - Pressure setting
    - Belts
    - Oil
    - Air filter
  - Air drier
  - Pressure reducing valve
    - Branch pressure
    - Line pressure
  - Condensate drain
  - Actuator
    - Linkage
  - Pneumatic air leaks
- Tools and equipment
- Manufacturer’s specifications
- Codes and regulations
  - Tank certification
- Verification
  - Sequence of operation
  - Operating and safety controls
- Diagnostic tests
- Adjustments
- Conditions for repair/replacement
- Return to service
- Documentation
  - Electronic
  - Paper
  - Maintenance reports
Objectives

To be competent in this area, the individual must be able to:

- Service HVAC control systems.

LEARNING TASKS

1. Troubleshoot and repair HVAC control systems

CONTENT

- Safety requirements
  - Lock-out/tag-out

- Verify reported problem
  - Consult onsite personnel
  - Observe conditions before servicing

- Test sequence of operation
  - Normal operation
  - Defrost initiation/termination
  - Auxiliary heat
  - Pump down
  - Temperature control
  - Safety settings

- Inspection
  - Mode cycle
  - Contacts
  - Electrical connections
  - Sensors
  - Calibration
  - Cycle back-up heat
  - Installer program
  - User program

- Tools and equipment
- Isolate components
- Conditions for repair/replacement
- Procedures
- Faults
  - Error codes
- Causes
  - System readings
  - Data
- Codes and regulations
- Manufacturer’s specifications
LEARNING TASKS

CONTENT

- Repair/replace components
- Return to service
  - Verify correct operation
  - Cycle all modes
  - Check back with customer
- Documentation
  - Electronic
  - Paper
  - Service reports
Line (GAC): M SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M1 Service Gas Distribution Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the service procedures for distribution piping.

<table>
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<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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</thead>
</table>
| 1. Describe the inspection of a gas distribution system | • Leak detection  
• Pressure testing  
• Cathodic protection  
• Identify damage or defect |
Line (GAC): M  SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M2  Service Gas Burners and Ancillary Equipment

Objectives
To be competent in this area, the individual must be able to:
- Describe the procedures for inspecting ancillary equipment.

LEARNING TASKS
1. Describe the inspection of ancillary equipment

CONTENT
- HSI
  - Amperage check
  - Resistance check
  - Placement
- Ignition electrode
  - Inspection of ceramic
  - Gap to ground
  - Surface contaminants
  - Placement
- Flame rod
  - Inspection of ceramic
  - Placement
  - Surface contaminants
  - Short to ground check
  - Flame signal reading
Line (GAC): M  SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M3  Maintain Gas-Fired Appliances, Boilers and Ancillary Equipment

Objectives
To be competent in this area, the individual must be able to:
• Describe the procedures for inspecting boilers.
• Describe the procedures for inspecting ancillary equipment.

LEARNING TASKS

1. Describe the inspection of boilers
   - Pressure vessel integrity
   - Heat exchanger condition
     - Water side
     - Fire side
   - Venting system condition
   - Burner condition
   - Refractory condition

2. Describe the inspection of ancillary equipment
   - Types
     - Pumps
     - Zone valve
     - Mixing valve
     - Expansion tank
     - Feed water supply systems
     - Fans
       - Auxiliary fans
       - Exhaust fans
     - Steam control valves
     - Steam traps
     - Pressure reducing valves
     - Flue gas exhaust systems
   - Visual inspection
   - Verify electrical parameters
   - Water temperatures
   - Pressures
   - Flow
   - Combustion air
   - Manufacturer’s documentation
   - Client requirements
Line (GAC): M  SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M5  Service and Repair Gas Control Systems

Objectives
To be competent in this area, the individual must be able to:
- Describe troubleshooting procedures for flame safe guards.
- Describe troubleshooting procedures for combination gas valves.

LEARNING TASKS
1. Describe troubleshooting procedures for flame safe guards
   • Cycle appliance
   • Confirm control sequence
   • Confirm control terminal voltage

2. Describe troubleshooting procedures for combination gas valves
   • Cycle appliance
   • Confirm operation
     o Pilot
     o Main burner
   • Confirm pressure regulation
   • Tightness of closure
Level 4
Refrigeration and Air Conditioning Mechanic
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C3 Use Codes, Regulations and Standards

Objectives
To be competent in this area, the individual must be able to:
- Interpret codes, rules and regulations applicable to the Gasfitter B certification.
- Apply Section 7 of the B149.1 Gas Code.
- Interpret and apply the Canadian Electrical Code.

LEARNING TASKS

1. Interpret sections 4, 5, 6, 7, 8 and Annex C of the B149.1 Gas Code

   - General
   - Pressure Controls
   - Piping and Tubing Systems, Hose, and Fittings
   - Installation of Specific Types of Appliances
   - Venting Systems and Air Supply for Appliances
   - Vent Sizing Tables for Category 1 Appliances

2. Interpret the B149.1 and B149.2 Gas Code

   - Layout
   - Sections
   - Contents
   - Index
   - Annexes
   - Tables
   - Definitions
   - Scope
   - Revisions

3. Apply Section 7 of the B149.1 Gas Code to appliance installation and commissioning

   - Design
   - Planning
   - Installation
   - Commissioning
   - Maintenance
   - Decommissioning

4. Apply the Canadian Electrical Code (CEC)

   - Sections and tables
   - Motor protection
   - Motor compressors
   - Conductor selection, sizing and protection
Achievement Criteria

Performance  The learner will be able to solve problems using the tables from the Canadian Electrical Code (CEC).

Conditions  To be assessed during technical training.
   The learner will be given:
   • Tables from the Canadian Electrical Code (CEC)
   • Set of problems to solve

Criteria  The learner will be evaluated on:
   • Accuracy
   • Completeness
Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C5 Organize Work and Maintain Records

Objectives
To be competent in this area, the individual must be able to:
• Describe commissioning documentation.
• Describe equipment handover.

LEARNING TASKS
1. Describe commissioning documentation
   • Commissioning report
   • Regulatory responsibilities

2. Describe equipment handover
   • As built drawings and operator manuals
   • Instructions to customer
   • Warranty information
   • Job completion
   • Maintenance schedule log
Line (GAC): D USE COMMUNICATION TECHNIQUES
Competency: D1 Use Communication Techniques

Objectives
To be competent in this area, the individual must be able to:
• Describe effective communication practices.

LEARNING TASKS
1. Describe effective communication practices

CONTENT
• Customer relations
• Sales skills
• Coordination with other trades
• Project handover
Line (GAC): D USE COMMUNICATION TECHNIQUES
Competency: D2 Use Mentoring Techniques

Objectives
To be competent in this area, the individual must be able to:
• Use mentoring techniques.

LEARNING TASKS
1. Describe learning strategies
   • Coaching
   • Leadership
   • Practice
   • Assessing
     o Constructive feedback
     o Educating
   • Positive reinforcement
   • Proactive check-in

2. Describe outcomes of effective coaching
   • Protocols
   • Responsibilities
   • Punctuality
   • Safety
   • Collaboration
HARMONIZED PROGRAM OUTLINE
Program Content
Level 4

Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E2 Use Electrical Wiring Diagrams and Schematics

Objectives
To be competent in this area, the individual must be able to:
- Troubleshoot complex circuits.

LEARNING TASKS

1. Troubleshoot complex circuits

CONTENT
- Electrical duct heaters
  - Components
  - Power circuits
  - Control circuits
- Condensing units
  - Components
  - Power circuits
  - Control circuits
- Indoor fan coil units
  - Components
  - Power circuits
  - Control circuits
- Damper motor controls
  - Components
  - Balancing circuits
  - Sensing devices
- Complex systems
  - Basic schematic building blocks
  - Relationship of circuits
- Systematic procedure for troubleshooting
Line (GAC): E APPLY ELECTRICAL CONCEPTS

Competency: E3 Apply Motor and Motor Control Theory

Objectives
To be competent in this area, the individual must be able to:
- Describe three phase motor starters.
- Perform ECM motor testing.
- Perform voltage and current imbalance testing.

LEARNING TASKS

1. Describe three phase motor starters
   - Part-winding starters
     - Purpose
     - Operation
     - Motor requirements
     - Types of starters
     - Motor protection
   - Reduced voltage starters
     - Primary resistor
     - Auto-transformer
   - Wye/Delta starters
     - Purpose
     - Operation
     - Motor requirements
   - Interlocked circuits
     - Multiple motor control
     - Types of control

2. Perform ECM motor testing
   - Safety requirements
   - Tools and equipment
   - Communication verification
   - Windings
   - OEM specifications

3. Perform voltage and current imbalance testing
   - Safety requirements
   - Tools and equipment
   - Measurements
     - Phase voltage imbalance percentage
     - Current imbalance percentage
Line (GAC): E APPLY ELECTRICAL CONCEPTS
Competency: E4 Select Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe electronic refrigerant monitoring.
• Describe other safety monitoring devices.
• Select control point instrumentation.

LEARNING TASKS
1. Describe electronic refrigerant monitoring
   • Types
   • Applications
     o Alarm
     o Device interlocks
     o Communications
     o Locations
   • Operation
   • Code and regulations
   • Manufacturer’s specifications

2. Describe other safety monitoring devices
   • Gas detection devices
     o Combustible gas detection
     o CO₂

3. Select control point instrumentation
   • Types
     o Flow meters
     o Communication interface devices
   • Applications
   • Operation
Compeency: F2 Analyze Refrigeration Systems

Objectives
To be competent in this area, the individual must be able to:
- Describe indirect systems.
- Describe ultra-low temp systems.
- Describe absorption systems.
- Describe ammonia systems.

LEARNING TASKS

1. Describe indirect systems
   - Secondary heat transfer medium
     - Types
       - Salt based
       - Glycol based
       - Alcohol based
     - Selection of medium
     - Indirect systems
       - Refer to B-52 Code for types
     - Applications
     - Chemistry
     - System corrosion
     - Preparing mediums
     - Maintaining mediums

2. Describe ultra-low temp systems
   - Cascade systems
     - Identify components
     - Plot cycle on PE charts
     - Applications
     - Sequence of operation
     - Service precautions
   - Compound systems
     - Identify components
     - Plot cycle on PE chart
     - Applications
     - Service precautions
   - Auto cascade systems
     - Identify components
     - Plot cycle on PE chart
     - Applications
     - Sequence of operation
     - Service precautions
LEARNING TASKS

3. Describe absorption systems
   - Lithium-bromide absorption cycle
     - Identify components
     - Examine cycle on Li-Br chart
     - Explain crystallization
     - Examine purges
     - Applications
   - Ammonia cycle
     - Identify components
     - Applications
   - System valves
     - Stop valves
       - Application
       - Location
       - Function
   - Refrigerant control
     - Flow control
     - Surge protection
       - Traps and accumulators
   - Control of oil
     - Oil and Ammonia mixtures
     - Oil separators and receivers
     - Oil return to compressor
     - Oil accumulations
     - Oil recovery
     - Contaminant disposal
       - AHJ
   - Purging and purgers
     - Manual
     - Automatic
   - Surge drum
     - Purpose
   - Safety valves
     - Code requirements
     - Fire valve
   - Distillers
     - Purpose
     - Principles of operation
     - System connections
   - Compressor cooling
     - Water jackets
     - Oil coolers
     - Desuperheaters

4. Describe ammonia systems
   - System valves
     - Stop valves
   - Refrigerant control
     - Flow control
     - Surge protection
       - Traps and accumulators
   - Control of oil
     - Oil and Ammonia mixtures
     - Oil separators and receivers
     - Oil return to compressor
     - Oil accumulations
     - Oil recovery
     - Contaminant disposal
       - AHJ
   - Purging and purgers
     - Manual
     - Automatic
   - Distillers
     - Purpose
   - Safety valves
     - Code requirements
     - Fire valve
   - Compressor cooling
     - Water jackets
     - Oil coolers
     - Desuperheaters
LEARNING TASKS

CONTENT

- Liquid recirculation systems
  - Basic system types
  - System components
  - Accumulator
  - Valves
  - Operation

- Ammonia plant operation
  - Start-up and shut-down procedures
  - System components
    - Discharge procedures
    - Cold traps
  - Lubrication system
    - Oil drainage procedures
    - Oil handling and disposal
    - Cold traps
  - Maintenance and preventative maintenance
    - Procedures for de-pressurization
    - Brine analysis review
      - Ammonia
      - pH
      - Iron
      - Dissolved solids
      - Scheduled analysis
    - Non-destructive testing
  - Safety precautions
    - WorkSafe BC regulations
    - Technical Safety BC
      - Pressure vessels act
    - Procedures for ammonia isolation
      - Pressure relief purpose
    - Procedures for brine isolation

5. Describe CO₂ systems

- Types
  - Subcritical system
  - Transcritical system
    - Plot PE chart

- Tools and equipment
- Applications
  - Multi-temperature
### LEARNING TASKS

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</table>
Line (GAC): J INSTALL GAS-FIRED SYSTEMS
Competency: J3 Install Gas Piping and Tubing Systems

Objectives
To be competent in this area, the individual must be able to:
• Size piping and tubing systems, low pressure and 2 psig (14 kPa).

LEARNING TASKS
1. Size piping and tubing systems

CONTENT
• Types
  o Black iron pipe
  o Copper tubing
  o Corrugated stainless steel tubing (CSST)
• Pressures
  o Low pressure
  o 2 psig (14 kPa)
  o High pressure
• Sizing factors
  o Appliance Rating
  o Distance
  o Allowable pressure drop
  o Piping or tubing type
  o Type of gas
  o Fittings
• Code requirements
• Procedures

2. Install piping, tubing and hoses

• Types
• Methods
• Code requirements
• Identification
• Procedures
• Fittings
• Valves
• Prohibited practice
• Location limitations
• Structural penetrations
  o Fire stopping
• Outlets
• Drip or dirt pockets
• Between buildings
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<td>• Connectors</td>
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</tbody>
</table>
Line (GAC): J  INSTALL GAS-FIRED SYSTEMS
Competency: J4  Install Regulators, Valves and Valve Train Components

Objectives
To be competent in this area, the individual must be able to:
• Describe manual shut-off valves installation.
• Describe gas pressure regulator installation.
• Describe the installation of regulator venting.
• Size regulators.

LEARNING TASKS

1. Describe the installation of manual shut-off valves
   • Code requirements
   • Manufacturer’s specifications
   • Procedures
     o 2 piece ball valves

2. Describe the installation of gas pressure regulators
   • Code requirements
   • Manufacturer’s specifications
   • Procedures

3. Describe the installation of regulator venting
   • Vent attachments
     o Lines
     o Limiting orifices
     o Surge arrestors
   • Sizing
   • Orientation
   • Termination
   • Code requirements

4. Size regulators
   • Types
     o Level operated
     o Direct operated
     o Integrated/combination
     o Zero governors
   • Application
   • Manufacturer’s documentation
   • Sizing tables
     o Flow rate
     o Pressure drop
     o Orifice selection
     o Spring selection
   • Pipe size
   • Types of fuel
   • Code
LEARNING TASKS

CONTENT

• Over pressure protection (OPP)
# Line (GAC): J INSTALL GAS-FIRED SYSTEMS

**Competency:** J5 Install Gas Controls

## Objectives

To be competent in this area, the individual must be able to:
- Describe limits, interlocks and operating controls.

## LEARNING TASKS

1. Describe limits and interlocks
   - Pressure switches
   - Flow switches
   - Temperature switches
     - Mechanical high limit
     - Aquastat
     - Electronic
     - Flame rollout switch
     - Spill switch
   - Interlocks
     - End switches
     - Air proving switches
     - Gas pressure switches

2. Describe permissives
   - Thermostat
   - Aquastat
   - DDC contacts
   - Timer
### Line (GAC): J  INSTALL GAS-FIRED SYSTEMS

#### Competency: J6  Install Air Supply Systems

#### Objectives

To be competent in this area, the individual must be able to:

- Size passive air supply systems.
- Describe installation of passive air supply systems.
- Describe the installation of mechanical air supply systems.

#### LEARNING TASKS

1. Describe methods of combustion air supply
   - Passive air supply
   - Mechanical air supply
     - Code requirements
     - Interlocks

2. Describe gas appliance air supply requirements
   - Purpose
     - Combustion air
       - Primary air
       - Secondary air
       - Excess air
     - Dilution air
     - Ventilation air
     - Openings and ducts
       - Terminations
     - Code requirements

3. Determine combustion air requirements for gas appliance installations
   - Sizing procedures for combined input of up to and including 400 MBH and exceeding 400 MBH
     - Code requirements
     - Building envelope and construction
     - Category of the appliance
     - Draft control
       - Dilution air requirements
     - Air requirement calculations
       - Combustion
       - Ventilation
       - Flue gas dilution
     - Table selection
     - Grills and louvers
       - Types
       - Sizing
       - Free area calculations
     - Air ducts
       - Length
<table>
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<th>LEARNING TASKS</th>
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</table>
| 4. Describe installation of passive air supply | - Size  
  - Code requirements  
  - Structural penetrations  
  - Sealing  
  - Sheet metal assembly  
    - Drive cleats  
    - Esses  
    - Tools  
  - Opening and ducts  
    - Terminations  
  - Traps  
  - Weather  
  - Equivalent length of air supply |
| 5. Describe mechanical air supply systems | - Ducts  
  - Sizes  
  - Location  
  - Lengths  
  - Fittings  
  - Fans  
    - Types  
    - Location  
  - Engineered systems  
  - Manufacturer’s documentation  
  - Code requirements |
| 6. Describe the installation of mechanical air supply systems | - Code requirements  
  - Structural penetrations  
  - Sealing  
  - Opening and ducts  
    - Terminations  
  - Weather  
  - Interlocks |
**Line (GAC):** J  **INSTALL GAS-FIRED SYSTEMS**  
**Competency:** J7  **Install Gas Venting Systems**

**Objectives**
To be competent in this area, the individual must be able to:

- Size venting.

**LEARNING TASKS**

**CONTENT**

1. Size Category 1 venting
   - Codes
     - B149.1
     - National Building Code
   - Appliance type
   - Building type
   - Vent connector
   - Common vents

2. Size special venting
   - Engineering
   - Category
   - Codes
     - B149.1
     - National Building Code
   - Design registry
   - Manufacturer’s documentation
   - Types
     - Classifications
     - Materials
     - Mechanical
     - Passive
Line (GAC): J INSTALL GAS-FIRED SYSTEMS
Competency: J8 Install Draft Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the installation of draft control systems.

LEARNING TASKS
1. Describe draft control systems
   • Types
     o Dampers
       – Mechanical
       – Thermal
     o Hoods
     o Diverters
     o Fans
   • Accessories
   • Applications
   • Vent height

2. Describe the installation of draft control systems
   • Location/building type
   • Manufacturer’s documentation
   • Codes
   • Supports
   • Wiring
   • Terminations

3. Describe commissioning of a barometric damper
   • Types
     o Single acting
     o Double acting
   • Code requirements
   • Adjustments
   • Tools and testing equipment
   • Pressures
     o Effects on combustion chamber
     o Effects on vent
Line (GAC): J INSTALL GAS-FIRED SYSTEMS  
Competency: J10 Install LPG, LNG, CNG, Vaporizing and Mixing Systems

Objectives
To be competent in this area, the individual must be able to:

- Describe propane storage systems.
- Describe the requirements for the installation of propane cylinder/tank storage systems.
- Describe the inspection of propane cylinder/tanks.
- Describe propane cylinder/tank installation.
- Appliance natural gas and propane conversion.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
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</table>
| 1. Describe propane storage systems | • Cylinders  
• Tanks  
• Liquid services  
• Gaseous services  
• Piping components  
• Rating plates  
• Transportation |
| 2. Describe propane cylinder/tank installation requirements | • Code requirements  
• Sizing  
  - Load factors  
  - Fill level  
  - Fill density  
• Temperature effects on pressure  
• Temperature effects on vapourization rate  
• Filled capacity effect on vapourization rate  
• Describe cylinder/tank clearances from building  
  - Openings  
  - Air intakes  
  - Doors  
  - Windows  
  - Flue termination  
  - Dryer vents  
• Location  
• Placement  
• Support  
• Protection  
• Access |
LEARNING TASKS

3. Describe the inspection of propane cylinders

- Visual inspection
  - Damage
  - Corrosion
- Components
  - Valves
  - Reliefs
- Rating plates
  - Expiry/service dates
- Organize requalification

4. Describe the installation of propane cylinder/tank components

- Procedures
- Regulator placements
- Safety shut-off valves
  - Excess flow valves
  - Pneumatic actuator
- Safety relief valves
  - Pressures
  - Location of discharge outlets
  - Calculations of rate of discharge
- Maintenance
  - Code B149.2
- Valves and accessories for vapour withdrawal applications
  - Description
  - Operation
  - Maintenance
- Valves and accessories for liquid withdrawal applications
  - Description
  - Operation
  - Maintenance
- Valves and accessories for filling applications
  - Description
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</table>
Line (GAC): J  INSTALL GAS-FIRED SYSTEMS
Competency: J11  Plan Gas-Fired Appliance System Installations

Objectives
To be competent in this area, the individual must be able to:

• Plan a residential gas piping installation.
• Create commissioning documentation for a high efficiency furnace and a condensing boiler.

LEARNING TASKS

1. Determine load
   • Appliance rating plates
   • Manufacturer’s documentation

2. Layout the system
   • Pressure
   • System Regulators
   • Regulator locations
   • Hangers and supports
   • Valve placement
   • Drip legs
   • Routing

3. Size the system
   • Piping material
   • Pressure
     o 7-14 in WC
     o 2 psig
   • Lengths
   • Type of gas
   • Pressure drop

4. Determine material take-off
   • Fittings
   • Valves
   • Hangers and supports
   • Regulators
   • Pipe and tubing
   • Consumables

5. Complete commissioning documentation for a high efficiency furnace and a condensing boiler
   • Commissioning report
   • Statement of completion
   • Regulatory responsibilities
   • As built drawings and operator manuals
   • Instructions to customer
Achievement Criteria 1

Performance  The learner will be able to:
- Plan a layout of a residential gas piping installation.
- Sketch an isometric piping drawing.
- Size the piping system.
- Generate a tool and material list.

Conditions  To be assessed during technical training.
The learner will be given:
- Residential floor plan with meter and appliance location
- Appliance documentation
- Sketching equipment
- Delivery pressure.

Criteria  The learner will be evaluated on:
- Material take-off
  - Accuracy
- Isometric drawing
  - Neatness
  - Accuracy
- Code compliance
  - Sizing
  - Hanger spacing
  - Valves
  - Drip legs
  - Swing joints
  - Pipe identification.

Achievement Criteria 2

Performance  The learner will be able to create post-commissioning paper work for a high efficiency furnace and a condensing boiler.

Conditions  To be assessed during technical training.
The learner will be given conditions as noted from:
- K4 – Commission Gas-Fired Appliances and Ancillary Equipment

Criteria  The learner will be evaluated on:
- Commissioning report
  - Report accuracy
  - Report Completeness
  - Operating according to manufacturer’s specifications
Line (GAC): K

COMMISSION SYSTEMS

Competency: K3 Commission Fuel/Air Delivery Systems

Objectives
To be competent in this area, the individual must be able to:

• Commission regulators.
• Describe purging procedures for pipe 4 inch diameter and larger.
• Use gas metering devices.

LEARNING TASKS

1. Describe piping and tubing testing requirements
   - B149.1
   - Pressure
   - Duration
   - Equipment
   - Air
     - Tools
     - Equipment
     - Spools
     - System isolation
       - Lockout

2. Describe piping and tubing pressure testing procedures
   - Inert gases
     - Tools
     - Equipment
     - Spools
     - System isolation
       - Lockout
     - Calculations
   - Leak (integrity) testing
     - Soap test
     - After appliance connection
   - Valve tightness of closure testing
   - Code requirements
     - Locations
     - Equipment
   - Duration

3. Describe purging procedures for piping and tubing under 4-inch diameter
   - Code requirements
   - Inert gases
   - Applications
   - Purpose
   - Equipment
     - Approved burners

4. Describe purging procedures for pipe 4-inch diameter and larger
   - Code requirements
   - Inert gases
   - Applications
   - Purpose
   - Equipment
## LEARNING TASKS

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5. Commission regulators

6. Size burner orifices

7. Use gas metering devices

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HARMONIZED PROGRAM OUTLINE
Program Content
Level 4

Line (GAC): K  COMMISSION SYSTEMS
Competency: K4  Commission Gas-Fired Appliances and Ancillary Equipment

Objectives
To be competent in this area, the individual must be able to:
• Describe factors to consider when starting up a system.
• Commission a storage type water heater with a standing pilot and atmospheric burner.
• Commission a high efficiency furnace.

LEARNING TASKS
1. Describe start-up checklists
   • Appliance types
     o Boilers
     o Furnaces
     o Storage type water heaters
     o Tankless water heaters
     o Gas range
     o Gas dryer
     o Unit heater
     o Direct vent fire place
   • Permits
   • Electrical supply
   • Water supply
   • Load
   • Gas supply
   • Combustion air/venting
   • Codes compliance
   • Appliance approval
   • Manufacturer’s documentation

2. Describe factors to consider when starting up a system
   • Appliance type
   • Electrical supply
   • Water supply
   • Load
   • Gas supply
   • Combustion air/venting
   • Codes compliance
     o B149.1
     o C22.1
   • Manufacturer’s documentation
   • Remove shipping materials
   • Belt/pulley alignment
   • Tightness of electrical connections
### Learning Tasks

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<td>• Combustion analysis</td>
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</table>
Achievement Criteria 1

Performance  The learner will be able to commission a condensing boiler.
Conditions  To be assessed during technical training.
The learner will be given:
  • Condensing boiler
  • Manufacturer’s documentation
  • Tools and testing equipment
  • Applicable equipment
Criteria  The learner will be evaluated on:
  • Appliance meeting manufacturer’s specifications
  • Appliance operating safety and efficiency
  • Code compliance

Achievement Criteria 2

Performance  The learner will be able to commission a high efficiency furnace.
Conditions  To be assessed during technical training.
The learner will be given:
  • High efficiency furnace
  • Manufacturer’s documentation
  • Tools and testing equipment
  • Applicable equipment
Criteria  The learner will be evaluated on:
  • Appliance meeting manufacturer’s specifications
  • Appliance operating safety and efficiency
  • Code compliance
Line (GAC): K  COMMISSION SYSTEMS

Competency: K5  Perform Combustion Analysis

Objectives
To be competent in this area, the individual must be able to:
• Perform flue gas analysis.
• Describe NOx.

LEARNING TASKS

1. Describe gas meters

   CONTENT
   • Types
     o Positive displacement
       - Bellows
       - Rotary
     o Inferential meter
       - Ultrasonic
       - Turbine
   • Protection
     o Mechanical damage (bollards)
     o Snow/ice accumulation
   • Principles of operation
     o Positive displacement
   • Capacity
   • Pressure compensation
   • Reading
     o Test dials
     o Imperial
     o Metric
   • Clocking

2. Describe the process used to determine the input of an appliance

   CONTENT
   • Calorific values
   • Clocked flow rates
   • Calculated inputs
   • Pressure correction factor
   • Temperature correction factor

3. Perform flue gas analysis

   CONTENT
   • Analyzer calibration
   • Fuel selection
   • Sampling locations
   • Manufacturer’s documentation
   • Interpret readings
     o Acceptable range
       - CO₂
       - O₂
       - CO
       - Temperature
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<td>• Annual calibration and re-certification</td>
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Line (GAC): K  COMMISSION SYSTEMS
Competency: K6  Commission Draft Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Adjust a barometric draft regulator.

LEARNING TASKS
1. Describe a barometric draft regulator
   • Purpose
   • Principles of operation
2. Adjust a barometric draft regulator
   • Burner’s draft requirements
   • Draft measurement
   • Dilution air adjustment
Line (GAC): K COMMISION SYSTEMS
Competency: K7 Training and Handover of Gas-Fired Equipment

Objectives
To be competent in this area, the individual must be able to:
- Transfer appliance operation to end user.

LEARNING TASKS
1. Transfer documentation
   - Regulatory responsibilities
   - Operator manuals
   - Instructions to customer
2. Describe appliance end user training
   - Light up instructions
   - Systems maintenance instructions
Line (GAC): K COMMISSION SYSTEMS
Competency: K8 Decommission and Disconnect Appliances and Equipment

Objectives
To be competent in this area, the individual must be able to:
• Describe the removal of gas-fired appliances.

LEARNING TASKS
1. Describe the disconnection of appliances and accessories
   • Tools
   • Lock out/isolation
   • Termination
   • Purge
   • Check for leaks

2. Describe the removal of gas-fired appliances
   • Regulations
   • Disposal
   • Recycling
Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L2 Service HVAC/R Systems

Objectives
To be competent in this area, the individual must be able to:
• Service hydronic systems.
• Service cooling towers.

LEARNING TASKS
1. Troubleshoot and repair hydronic systems

CONTENT
• Safe work practices
• Lock-out/tag-out
• Verify reported problem
  o Insufficient heat
  o Inadequate cooling
  o Consult onsite personnel
  o Observe conditions before servicing
  o Service history
• Inspection/testing
  o Sensory
  o Diagnostic
    - Acid test
    - Pressure drop test
    - Electrical test
    - Corrosion test
    - Pressure spikes
    - Leaking PRV
    - Backflow prevention
    - Expansion tank condition
    - Make-up water feed valve
    - Water test
      ▪ pH test
      ▪ Chemical treatment
    o Monitoring
• Tools and equipment
• Isolate components
• Conditions for repair/replacement
  o Obtain approval
    - Cost estimating
  o Temperature
  o Leaks
  o Corrosion
  o Malfunction
LEARNING TASKS

CONTENT

- Vibration
  - Irregular movement
- Procedures
  - Cleaning
  - Purging
  - Isolating
- Faults
- Causes
- Repair/replace components
  - Electrically failed
  - Mechanically failed
  - Operator error
- Return to service
  - Confirm correct operation
  - Contributing causes of failure
- Documentation
  - Electronic
  - Paper
- Service report
- Troubleshoot and repair cooling towers
  - Safe work practices
  - Lock-out/tag-out
  - Verify reported problem
    - Insufficient heat
    - Inadequate cooling
    - Consult onsite personnel
    - Observe conditions before servicing
    - Service history
  - Inspection/testing
    - Sensory
    - Diagnostic
      - Freeze protection
      - Water leaks
      - Strainers
      - Electrical test
      - Corrosion test
      - Pressure spikes
      - Leaking PRV
      - Backflow prevention
      - Expansion tank condition
      - Make-up water feed valve
      - Water test
        - pH test
        - Chemical

2. Troubleshoot and repair cooling towers
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Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L3 Maintain Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Maintain DDC control systems.

LEARNING TASKS
1. Maintain DDC control systems

CONTENT
• Safety requirements
• Schedules
  o Occupancy
  o Holiday
• Inspection
  o Diagnostic
  o Monitoring
  o Alarms
    – Acknowledge
    – Action
• Tools and equipment
• Manufacturer’s specifications
• Codes and regulations
• Verification
  o Sequence of operation
  o Operating and safety controls
  o Communication protocols
• Diagnostic tests
• Adjustments
• Backup programming
• Conditions for repair/replacement
• Return to service
• Documentation
  o Electronic
  o Paper
  o Maintenance report
Line (GAC): L SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS

Competency: L4 Service Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Service DDC control systems.

LEARNING TASKS
1. Troubleshoot and repair DDC control systems

CONTENT
• Safety requirements
  o Lock-out/tag-out
• Verify reported problem
  o Consult onsite personnel
  o Observe conditions before servicing
• Test sequence of operation
  o Normal operation
• Inspection
  o Remote access
  o Local access
  o Internet connection
  o Direct connection
  o Diagnostic
  o Monitoring
  o Alarms
    − Acknowledge
    − Action
• Tools and equipment
• Isolate components
• Conditions for repair/replacement
  o Obtain approval
• Procedures
• Faults
• Causes
  o System readings
  o Data
• Codes and regulations
• Manufacturer’s specifications
• Repair/replace components
• Return to service
  o Restore to normal operation
  o Verify correct operation
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Check back with customer</td>
</tr>
<tr>
<td></td>
<td>• Documentation</td>
</tr>
<tr>
<td></td>
<td>• Electronic</td>
</tr>
<tr>
<td></td>
<td>• Paper</td>
</tr>
<tr>
<td></td>
<td>• Service reports</td>
</tr>
</tbody>
</table>
**Line (GAC):** M  SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT  
**Competency:** M1  Service Gas Distribution Systems

### Objectives

To be competent in this area, the individual must be able to:

- Describe the service procedures for distribution piping.

### LEARNING TASKS

<table>
<thead>
<tr>
<th>1. Describe the repair procedures for a gas distribution system</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
Line (GAC): M SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M2 Service Gas Burners and Ancillary Equipment

Objectives
To be competent in this area, the individual must be able to:
• Describe the procedures for servicing gas burners.

LEARNING TASKS
1. Describe the procedures for servicing gas burners
   • Service schedule
   • Inspection
     o Appearance
     o Performance
     o Signs of flame impingement
     o Sooting
   • Cleaning
   • Reassembly
   • Recommission
     o Firing
     o Clocking
     o Combustion analysis

2. Describe replacement procedures for ancillary equipment
   • Identify faulty component
   • Source correct replacement component
   • Replace component
   • Confirm component operation
Line (GAC): M SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M3 Maintain Gas-Fired Appliances, Boilers and Ancillary Equipment

Objectives
To be competent in this area, the individual must be able to:
- Describe boiler maintenance procedures.
- Describe service requirements of gas-fired air heating appliances.

LEARNING TASKS
1. Describe ancillary equipment repair/replacement
   • Pumps
   • Zone valve
   • Mixing valve
   • Expansion tank
   • Feed water supply systems
   • Water treatment systems
   • Fans
     o Auxiliary fans
     o Exhaust fans
   • Steam control valves
   • Steam traps
   • Pressure reducing valves
   • Flue gas exhaust systems

2. Service condensing boilers and tankless heaters
   • Inspect
     o Condensate trap
     o Condensate pump
     o Neutralize tank
     o Heat exchanger
     o Water flow rates
       - Flow balancing
       - Pumps
         ▪ Primary
         ▪ Secondary
   • Verify
     o Water treatment
     o Temperature set points
     o Supply and return water temperatures
     o Make-up water
     o Expansion tank pressure

3. Verify electrical operating parameters
   • Tightness of electrical connections
   • Verify voltage
   • Code compliance
LEARNING TASKS

4. Check safety devices, limits, and operating controls
   - Verify electrical wiring diagram
   - Interlocks
   - High limit
   - Operating controls
     - Thermostat
   - Flow switch
   - Flame roll out switch
   - Pressure switch
     - Air
     - Gas
   - End switch
   - Vent safety switch
   - Spill switch

5. Service burners
   - Manufacturer's documentation
   - Client requirements
   - Pilot verification
   - Pre-ignition check
   - Main burner light off
   - Combustion verification
     - Flue gas analysis
   - Verify gas pressures
     - Manifold
     - Supply
   - Clocking
   - Clean components
     - Burner ports
     - Air intakes
     - Ignition systems

6. Verify flame safe guard system operation
   - Primary control
   - Flame detector
   - Flame signal/rectification
   - Flame failure response time (FFRT)
   - Trial for ignition (PTFI/MTFI)
   - Pilot turn down test
   - Pilot drop out test

7. Describe servicing requirements for gas-fired appliances
   - Types
     - Direct vent appliances
     - Decorative appliances
       - Fireplace
       - Fire pit
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Service high efficiency furnaces</td>
<td>• Verify</td>
</tr>
<tr>
<td></td>
<td>o Heat exchanger temperature rise</td>
</tr>
<tr>
<td></td>
<td>o External static pressure (ESP)</td>
</tr>
<tr>
<td></td>
<td>o Temperature set points</td>
</tr>
<tr>
<td></td>
<td>o Blower speed and operation</td>
</tr>
<tr>
<td></td>
<td>• Inspect</td>
</tr>
<tr>
<td></td>
<td>o Condensate trap</td>
</tr>
<tr>
<td></td>
<td>o Condensate pump</td>
</tr>
<tr>
<td></td>
<td>o Neutralize tank</td>
</tr>
<tr>
<td></td>
<td>o Air cleaners</td>
</tr>
<tr>
<td></td>
<td>o Heat exchanger</td>
</tr>
<tr>
<td>9. Service tankless heaters</td>
<td>• Inspect</td>
</tr>
<tr>
<td></td>
<td>o Condensate trap</td>
</tr>
<tr>
<td></td>
<td>o Condensate pump</td>
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<tr>
<td></td>
<td>o Neutralize tank</td>
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<td></td>
<td>o Heat exchanger</td>
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<td></td>
<td>o Water flow rates</td>
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<td></td>
<td>− Flow balancing</td>
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<td></td>
<td>• Verify</td>
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<td></td>
<td>o Water treatment</td>
</tr>
<tr>
<td></td>
<td>o Temperature set points</td>
</tr>
<tr>
<td></td>
<td>o Supply and return water temperatures</td>
</tr>
<tr>
<td></td>
<td>o Make-up water</td>
</tr>
<tr>
<td></td>
<td>o Expansion tank pressure</td>
</tr>
</tbody>
</table>
Line (GAC): M SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M4 Service Fuel/Air Delivery Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe the servicing procedures for fuel/air delivery systems.

LEARNING TASKS

1. Describe gas regulator troubleshooting procedures
   • Manufacturer’s documentation
   • Disconnect vent line connection
   • Verify regulator performance
     o Setpoint
     o Droop
     o Lock up
   • Confirm orifice size
   • Confirm regulator application
   • Confirm internal relief operation

2. Describe gas regulator repair procedures
   • Manufacturer’s documentation
   • Testing
   • Adjustments
   • Vent line sizing
   • Parts replacement
Line (GAC): M SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M5 Service and Repair Gas Control Systems

Objectives
To be competent in this area, the individual must be able to:
• Describe service and repair procedures for control systems.

LEARNING TASKS
1. Describe troubleshooting procedures for flame safe guards
   • Cycle appliance
   • Confirm control sequence
   • Confirm control terminal voltage

2. Describe troubleshooting procedures for combination gas valves
   • Cycle appliance
   • Confirm operation
     o Pilot
     o Main burner
   • Confirm pressure regulation
   • Tightness of closure
HARMONIZED PROGRAM OUTLINE
Program Content
Level 4

Line (GAC): M SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT
Competency: M6 Maintain Gas-Fired Refrigeration Equipment

Objectives
To be competent in this area, the individual must be able to:
• Describe the maintenance of gas-fired refrigeration equipment.

LEARNING TASKS | CONTENT
--- | ---
1. Describe the refrigeration process of gas-fired appliances | • Terminology
• Absorption refrigeration

2. Describe the installation requirements of gas-fired refrigeration equipment | • B.149.1 code requirements
• Manufacturer's documentation
• Leveling
• Air circulation
• Clearances
• Venting requirements

3. Describe troubleshooting procedures | • Heat input
• Air circulation
• Leveling
• Annual maintenance

4. Describe burner maintenance procedures | • Burner cleaning
• Orifice cleaning
• Manifold pressure
• Gas supply tube cleaning
• Chimney and boiler tube cleaning
Section 4

ASSESSMENT GUIDELINES
Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Perform Safety Related Functions</td>
<td>5%</td>
<td>15%</td>
</tr>
<tr>
<td>B Use Tools and Equipment</td>
<td>12%</td>
<td>25%</td>
</tr>
<tr>
<td>C Perform Routine Trade Activities</td>
<td>12%</td>
<td>15%</td>
</tr>
<tr>
<td>D Use Communication Techniques</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>E Apply Electrical Concepts</td>
<td>17%</td>
<td>15%</td>
</tr>
<tr>
<td>F Apply Refrigeration and Air Conditioning Theory</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td>G Plan Refrigeration and Air Conditioning Installations</td>
<td>12%</td>
<td>0%</td>
</tr>
<tr>
<td>H Install Refrigeration and Air Conditioning Systems</td>
<td>16%</td>
<td>20%</td>
</tr>
<tr>
<td>L Service Refrigeration and Air Conditioning Systems</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

In-school theory / practical subject competency weighting

| IN-SCHOOL % | 80% | 20% |

Final in-school mark
Apprentices must achieve a minimum 70% for the final in-school mark to be eligible to write the Refrigeration and Air Conditioning Mechanic Standardized Level exam.

| Final Level Mark | 100% |
Level 2 Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>LINE</th>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Use Tools and Equipment</td>
<td>11%</td>
<td>20%</td>
</tr>
<tr>
<td>C</td>
<td>Perform Routine Trade Activities</td>
<td>11%</td>
<td>40%</td>
</tr>
<tr>
<td>E</td>
<td>Apply Electrical Concepts</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>F</td>
<td>Apply Refrigeration and Air Conditioning Theory</td>
<td>11%</td>
<td>10%</td>
</tr>
<tr>
<td>G</td>
<td>Plan Refrigeration and Air Conditioning Installations</td>
<td>11%</td>
<td>30%</td>
</tr>
<tr>
<td>H</td>
<td>Install Refrigeration and Air Conditioning Systems</td>
<td>12%</td>
<td>0%</td>
</tr>
<tr>
<td>I</td>
<td>Apply Gas Utilization Theory</td>
<td>7%</td>
<td>0%</td>
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<tr>
<td>J</td>
<td>Install Gas-Fired Systems</td>
<td>7%</td>
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</tr>
<tr>
<td>L</td>
<td>Service Refrigeration and Air Conditioning Systems</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Final in-school mark**
Apprentices must achieve a minimum 70% for the final in-school mark to be eligible to write the Refrigeration and Air Conditioning Mechanic Standardized Level exam.

**Final in-school percentage score**

<table>
<thead>
<tr>
<th>In-school Mark</th>
<th>Standardized Level Exam Mark</th>
<th>Final Level Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined theory and practical subject competency</td>
<td>The exam score is multiplied by</td>
<td>100%</td>
</tr>
<tr>
<td>80%</td>
<td>20%</td>
<td></td>
</tr>
</tbody>
</table>
# Assessment Guidelines – Level 3

## Level 3 Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>PROGRAM: IN-SCHOOL TRAINING:</th>
<th>REFRIGERATION AND AIR CONDITIONING MECHANIC LEVEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LINE</strong></td>
<td><strong>SUBJECT COMPETENCIES</strong></td>
</tr>
<tr>
<td>B</td>
<td>Use Tools and Equipment</td>
</tr>
<tr>
<td>C</td>
<td>Perform Routine Trade Activities</td>
</tr>
<tr>
<td>E</td>
<td>Apply Electrical Concepts</td>
</tr>
<tr>
<td>F</td>
<td>Apply Refrigeration and Air Conditioning Theory</td>
</tr>
<tr>
<td>G</td>
<td>Plan Refrigeration and Air Conditioning Installations</td>
</tr>
<tr>
<td>H</td>
<td>Install Refrigeration and Air Conditioning Systems</td>
</tr>
<tr>
<td>I</td>
<td>Apply Gas Utilization Theory</td>
</tr>
<tr>
<td>J</td>
<td>Install Gas-Fired Systems</td>
</tr>
<tr>
<td>K</td>
<td>Commission Systems</td>
</tr>
<tr>
<td>L</td>
<td>Service Refrigeration and Air Conditioning Systems</td>
</tr>
<tr>
<td>M</td>
<td>Service Gas-Fired Appliances and Equipment</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

**In-school theory / practical subject competency weighting**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>In-school theory / practical subject competency weighting</strong></td>
<td>90%</td>
</tr>
</tbody>
</table>

### Final in-school mark

Apprentices must achieve a minimum 70% for the final in-school mark to be eligible to write the Refrigeration and Air Conditioning Mechanic Standardized Level exam.

### In-school Mark

Combined theory and practical subject competency

| **In-school Mark** | **80%** |

### Standardized Level Exam Mark

The exam score is multiplied by

| **Standardized Level Exam Mark** | **20%** |

### Final Level Mark

| **Final Level Mark** | **100%** |
Assessment Guidelines – Level 4

Level 4 Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>LINE</th>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>Perform Routine Trade Activities</td>
<td>17.5%</td>
<td>10%</td>
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<td>D</td>
<td>Use Communication Techniques</td>
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<tr>
<td>E</td>
<td>Apply Electrical Concepts</td>
<td>17.5%</td>
<td>0%</td>
</tr>
<tr>
<td>F</td>
<td>Apply Refrigeration and Air Conditioning Theory</td>
<td>12.5%</td>
<td>0%</td>
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<tr>
<td>J</td>
<td>Install Gas-Fired Systems</td>
<td>12.5%</td>
<td>45%</td>
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<tr>
<td>K</td>
<td>Commission Systems</td>
<td>18%</td>
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<tr>
<td>L</td>
<td>Service Refrigeration and Air Conditioning Systems</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>M</td>
<td>Service Gas-Fired Appliances and Equipment</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

In-school theory / practical subject competency weighting

<table>
<thead>
<tr>
<th></th>
<th>70%</th>
<th>30%</th>
</tr>
</thead>
</table>

**Final in-school mark**

Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal exam.

**In-school %**

All apprentices who complete Level 4 of the Refrigeration and Air Conditioning Mechanic program with a FINAL level percentage score of 70% or greater will write the Interprovincial Red Seal examination as their final assessment.

ITA will enter the apprentices’ Refrigeration and Air Conditioning Mechanic Interprovincial Red Seal examination percentage score into ITA Direct Access.

A minimum percentage score of 70% on the examination is required for a pass.
Section 5

TRAINING PROVIDER STANDARDS
Facility Requirements

Classroom Area
- Minimum 10 square feet per student
- Comfortable seating and tables suitable for learning
- Compliance with the local and national fire code and occupational safety requirements
- Meets applicable municipal zoning bylaws for technical instruction and education facilities
- Multimedia projectors with a projection screen
- Document camera
- Whiteboard with marking pens and erasers
- Lighting controls to allow easy visibility of the projection screen while allowing students to take notes
- Windows must have shades or blinds to adjust sunlight
- Heating/Air conditioning for comfort all year round
- The acoustics in the room must allow the students to be able to hear the instructor
- Computer lab complete with 16 computers and internet access

Shop Area
- Minimum 3,000 square feet of shop area including a tool crib and work stations
- Minimum 8 foot ceiling height in shop areas
- Minimum 8 foot ceiling in lab areas
- Adequate heating, lighting and lighting control
- Ventilation as per WorkSafeBC standards
- Refuse and recycling bins for used shop materials
- First aid facilities
- Shops/labs will support practical requirements as outlined in the program outline

Lab Requirements
- Shops/labs will support practical requirements as outlined in the program outline

Student Facilities
- Adequate lunch room as per WorkSafeBC requirements (4.84 OHS Regulation and Guidelines)
- Adequate washroom facilities as per WorkSafeBC requirements (4.84 OHS Regulation and Guidelines)
- Personal Storage lockers

Instructor’s Office Space
- Adequate space for student consultation
- Desk and filing space
- Computer
- Internet access
• Printer
• Adequate storage facilities for material and training aids
• Access to photocopier
• Telephone

Other
• N/A
Tools and Equipment

(See Appendix A for Technical Safety BC Tools and Equipment Requirements)

Shop Equipment

Power Tools

- Air compressor
- Cordless drills
- Mini grinder
- Power drills
- Portable band saw (hack saw)
- Power threading machine
- Reciprocating saw
- Rotary hammer
- Task lighting equipment

Cutting and Joining Equipment

- Half round file
- Flaring tools
- Hand operated oiler
- Oxy-acetylene equipment
- Pipe cutter
- Pipe reamer
- Pipe roll groover
- Pipe stand
- Hand pipe threader
- Pipe vise
- Power vise
- Tube bender
- Tube cutter

Testing and Measuring Equipment

- Nitrogen cylinders and regulators
- Computer and load calculation software
- Drafting equipment
- Electronic Flue gas analyzer
- Electronic leak detector
- Draft gauge
- Refrigeration gauge manifold
- Refrigerant recovery unit
- Refrigerant recovery cylinder
- Refrigerant scale
- Anemometer
- Leak detectors
- Megohmmeter
- Psychrometers
- Compressor oil charging pump and accessories
- Laser level
- Magnehelic gauge
- Manometers (incline, digital and U-tube)
- Measuring tape and markers
- Multimeter
- Balometer
- Tachometer
- Vacuum pump
- Vacuum gauge
- Printer/scanner
- Eddy current testers
- Test kits (oil, pH)
- Thermometers
HARMONIZED PROGRAM OUTLINE
Training Provider Standards
Section 5

Personal Protective and Safety Equipment
- Eye wash kit
- Face shield
- Fire extinguisher
- First aid kit
- Gloves (leather)
- Hearing protection
- Lock-out devices
- Overalls
- Safety harness, lanyard and life line
- Self-contained breathing apparatus

Standard Tools
- Adjustable wrench
- Ball-peen hammer
- Combination wrench
- Orifice drill sets
- Pipe wrench
- Pliers (lineman, needle nose, water pump, channel lock)
- Fuse puller
- Files
- Flashlight
- Hacksaw
- Screwdrivers (complete set)
- Striker
- Threading hand dies
- Electrical knock out sets
- Hex Keys (set)(metric and imperial)
- Tin snips (set)
- Step drill bits
- Wire strippers
- Tri-square
- Knife
- Wire cutters
- Levels
- Wire crimpers
- Nut drivers
- Wire brushes

Standard Equipment
- Electrical components
- Evaporators
- Refrigeration units
- Condensers
- Air conditioning units
- Metering devices
- Transformers
- DDC controls
- Fan systems
- Single phase motors
- Air conditioning units
- Three phase motors
- Heat pumps
- Hydronic components

Hoisting, Rigging and Access Tools and Equipment
- Come-a-longs and Tirfors
- Shackles
- Ladders
- Slings and chokers
- Rope/cable
- Snatch blocks
Student Tools (supplied by student)

**Required**
- Calculator
- Hard hat
- Safety boots
- Safety goggles/glasses

**Recommended**
- N/A
Reference Materials

Required Reference Materials
- B52 Mechanical Refrigeration Code, CSA, current
- CAN/ CSA B149.1 current
- CAN/ CSA B149.2 current
- CAN/ CSA C22.1 current
- Safety Standards General Regulation
- Gas Safety Regulation
- CSA, Gas Trade 3 Package, SKU: 2424179
- CSA, Gas Trade 2 Package, SKU: 2424187
- CSA, Gas Trade 1 Package, SKU: 2424604

Recommended Resources
- CAN/ CSA B.214 Installation of Hydronic Heating Systems

Suggested Texts/Websites
- Technical Safety BC [www.technicalsafetybc.ca](http://www.technicalsafetybc.ca)
- TECA, Thermal Environmental Comfort Association, [www.teca.ca](http://www.teca.ca)
- ITA, Industry Training Authority [www.itabc.ca](http://www.itabc.ca)
- CSA, [www.csagroup.org](http://www.csagroup.org)
- Red Seal, [www.red-seal.ca](http://www.red-seal.ca)
- WorkSafeBC, [www.worksafebc.com](http://www.worksafebc.com)

**NOTE:**
This list of Reference Materials is for training providers. Apprentices should contact their preferred training provider for a list of recommended or required texts for this program.
Instructor Requirements

Occupation Qualification
The instructor must possess:
- Refrigeration and Air Conditioning Mechanic – Certificate of Qualification with Red Seal Endorsement;
- Current Certificate of Competency/Qualification in Gasfitter – Class B (if teaching the Gasfitter – Class B content)
- Certificate must be equal or greater than the level of instruction
- Electrical FSR Class RE (recommended, but not required)

Work Experience
A minimum of 5 years’ experience working in the industry as a Refrigeration and Air Conditioning Mechanic journeyperson after Red Seal certification.

Instructional Experience and Education
It is preferred that the instructor also possesses one of the following:
- Provincial (BC) Instructor Diploma or equivalent
- Bachelor’s Degree in Education
- Master’s Degree in Education
  AND
- 2 years supervisory or administrative experience
- Experienced user of relevant software
  - Word processing
  - Spreadsheets
  - Presentations
- CAD
Appendices
Appendix A
Technical Safety BC Requirements

Gasfitter – Class B Exam administered by Technical Safety BC:

- Successful completion of Refrigeration and Air Conditioning Mechanic Levels 1 - 3
- ITA transcript demonstrating a minimum 75% work based training hours 4,657 (6,210 total); and
- Be registered on an official class list provided by an approved training institution for their final level (Refrigeration and Air Conditioning Mechanic - Level 4) technical training

Tools and Equipment
(to be used in coordination with the program Tools and Equipment list beginning on page 236)

Level One (Class B) Apprenticeship

- 1 threading machine (power drive with threading attachment) for every 4 students
- 1 oxy/acetylene cutting outfit for every 8 students
- 1 fuel/air brazing unit for every 4 students
- 1 flaring tool for every 8 students
- 1 tubing bender for every 8 students

Level Two (Class B) Apprenticeship

- 1 multimeter for every 2 students
- 1 flue gas analyzer capable of measuring CO₂, CO, O₂, stack temperature and excess air for every 8 students
- 1 liquid filled manometer for every 4 students
- 1 digital manometer for every 4 students
- 1 incline manometer for every 16 students
- Necessary hand and power tools to service furnaces, boilers and domestic water heaters
- 1 forced-air furnace for every 4 students
- 1 hot water boiler for every 4 students
- 1 tankless water heater for every 8 students
- 1 storage type water heater for every 8 students
- 1 residential range for every 16 students
- 1 residential dryer for every 16 students
- 1 unit heater for every 16 students
- All appliances to have an input of 120 kW or less
## Appendix B
### Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHJ</td>
<td>Authority having jurisdiction</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASOPE</td>
<td>American Society of Power Engineers</td>
</tr>
<tr>
<td>AST</td>
<td>Aboveground storage tank</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society of Testing and Materials</td>
</tr>
<tr>
<td>BTU/h</td>
<td>British Thermal Units per hour</td>
</tr>
<tr>
<td>CAPS</td>
<td>Combustion Air Proving Switch</td>
</tr>
<tr>
<td>CEC</td>
<td>Canadian Electrical Code</td>
</tr>
<tr>
<td>CEMS</td>
<td>Continuous emissions monitoring system</td>
</tr>
<tr>
<td>CPVC</td>
<td>Chlorinated polyvinyl chloride</td>
</tr>
<tr>
<td>CSA</td>
<td>Canadian Standards Association</td>
</tr>
<tr>
<td>CSST</td>
<td>Corrugated Stainless Steel Tubing</td>
</tr>
<tr>
<td>DFMA</td>
<td>Direct-Fired Make-up Air</td>
</tr>
<tr>
<td>ECM</td>
<td>Electronically commutated motors</td>
</tr>
<tr>
<td>ESP</td>
<td>External static pressure</td>
</tr>
<tr>
<td>EXV</td>
<td>Electronic expansion valve</td>
</tr>
<tr>
<td>FGR</td>
<td>Flue gas recirculation</td>
</tr>
<tr>
<td>HGPS</td>
<td>High gas pressure switch</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-machine interface</td>
</tr>
<tr>
<td>HRT</td>
<td>Horizontal return tubular (boiler)</td>
</tr>
<tr>
<td>ICI</td>
<td>Industrial, commercial and institutional</td>
</tr>
<tr>
<td>IR</td>
<td>Infrared</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>kW</td>
<td>kilowatts</td>
</tr>
<tr>
<td>LAER</td>
<td>Lowest achievable emission rate</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
</tr>
<tr>
<td>LGPS</td>
<td>Low gas pressure switch</td>
</tr>
<tr>
<td>LON</td>
<td>Local operation network</td>
</tr>
<tr>
<td>LP Gas</td>
<td>Liquified Petroleum Gas</td>
</tr>
<tr>
<td>mA</td>
<td>milliamps</td>
</tr>
<tr>
<td>MAWP</td>
<td>Maximum allowable working pressure</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor control centre</td>
</tr>
<tr>
<td>MTFI</td>
<td>Main Flame Trial For Ignition</td>
</tr>
<tr>
<td>mV</td>
<td>millivolts</td>
</tr>
<tr>
<td>NAAQS</td>
<td>National Ambient Air Quality Standards</td>
</tr>
<tr>
<td>N.A.P.E.</td>
<td>National Association of Power Engineers</td>
</tr>
<tr>
<td>NBC</td>
<td>National Building Code</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
</tbody>
</table>
## HARMONIZED PROGRAM OUTLINE

### Appendices

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSPS</td>
<td>New Source Performance Standards</td>
</tr>
<tr>
<td>NRR</td>
<td>Noise reduction rating number</td>
</tr>
<tr>
<td>OH&amp;S</td>
<td>Occupational Health and Safety</td>
</tr>
<tr>
<td>OS&amp;Y</td>
<td>Outside stem and yoke (valve)</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable logic controller</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal protective equipment</td>
</tr>
<tr>
<td>PRV</td>
<td>Pressure relief valve</td>
</tr>
<tr>
<td>PTFI</td>
<td>Pilot trial for ignition</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable logic controller</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolutions per minute</td>
</tr>
<tr>
<td>RTD</td>
<td>Resistance temperature detector</td>
</tr>
<tr>
<td>SCR</td>
<td>Selective catalytic reduction</td>
</tr>
<tr>
<td>SDS</td>
<td>Safety data sheet</td>
</tr>
<tr>
<td>TDG</td>
<td>Transportation of dangerous goods</td>
</tr>
<tr>
<td>TXV</td>
<td>Thermostatic expansion valve</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories</td>
</tr>
<tr>
<td>ULC</td>
<td>Underwriters Laboratories of Canada</td>
</tr>
<tr>
<td>UST</td>
<td>Underground storage tank</td>
</tr>
<tr>
<td>VFD</td>
<td>Variable-frequency drive</td>
</tr>
<tr>
<td>VSD</td>
<td>Variable speed drive</td>
</tr>
<tr>
<td>WHMIS</td>
<td>Workplace Hazardous Materials Information System</td>
</tr>
</tbody>
</table>
Appendix C
Previous Contributors

This Program Outline was prepared with the advice and direction of an industry steering committee with funding support from the Industry Training Authority (ITA).

The Industry Training Authority (ITA) would like to acknowledge the dedication and hard work of the industry representatives appointed to identify the training requirements of the Refrigeration and Air Conditioning Mechanic trade. Members included:

- Matt Buss
- Dean Gabriele
- Sylvain Girard
- Blaire Mazsatalar
- Jason Rockson