SKILLEDTRADES BC

PROGRAM OUTLINE

Refrigeration and Air Conditioning Mechanic

The latest version of this document is available in PDF format on the SkilledTradesBC website
www.skilledtradesbc.ca

To order printed copies of Program Outlines
or learning resources (where available)
for BC trades contact:

Crown Publications, Queen's Printer
Web: www.crownpub.bc.ca
Email: crownpub@gov.bc.ca
Toll Free 1 800 663-6105

SKILLED TRADES BC

REFRIGERATION AND AIR CONDITIONING MECHANIC HARMONIZED PROGRAM OUTLINE

APPROVED BY INDUSTRY

DECEMBER 2018

BASED ON

RSOS 2019

Developed by
SkilledTradesBC
Province of British Columbia

TABLE OF CONTENTS

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 SkilledTradesBC.

SkilledTradesBC 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, SkilledTradesBC

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.

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Program Credentialing Model	Communicate program length and structure, and all pathways to completion	Understand the length and structure of the program	Understand the length and structure of the program, and pathway to completion	Understand challenger pathway to Certificate of Qualification
OAC	Communicate the competencies that industry has defined as representing the scope of the occupation	Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification	View the competencies they will achieve as a result of program completion	Understand the competencies they must demonstrate in order to challenge the program
Training Topics and Suggested Time Allocation	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	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	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	Understand the relative weightings of various competencies of the occupation on which assessment is based
Program Content	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	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	Provides detailed information on program content and performance expectations for demonstrating competency	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels
Training Provider Standards	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	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	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	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

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Appendix – Glossary of Acronyms			Defines program specific acronyms	

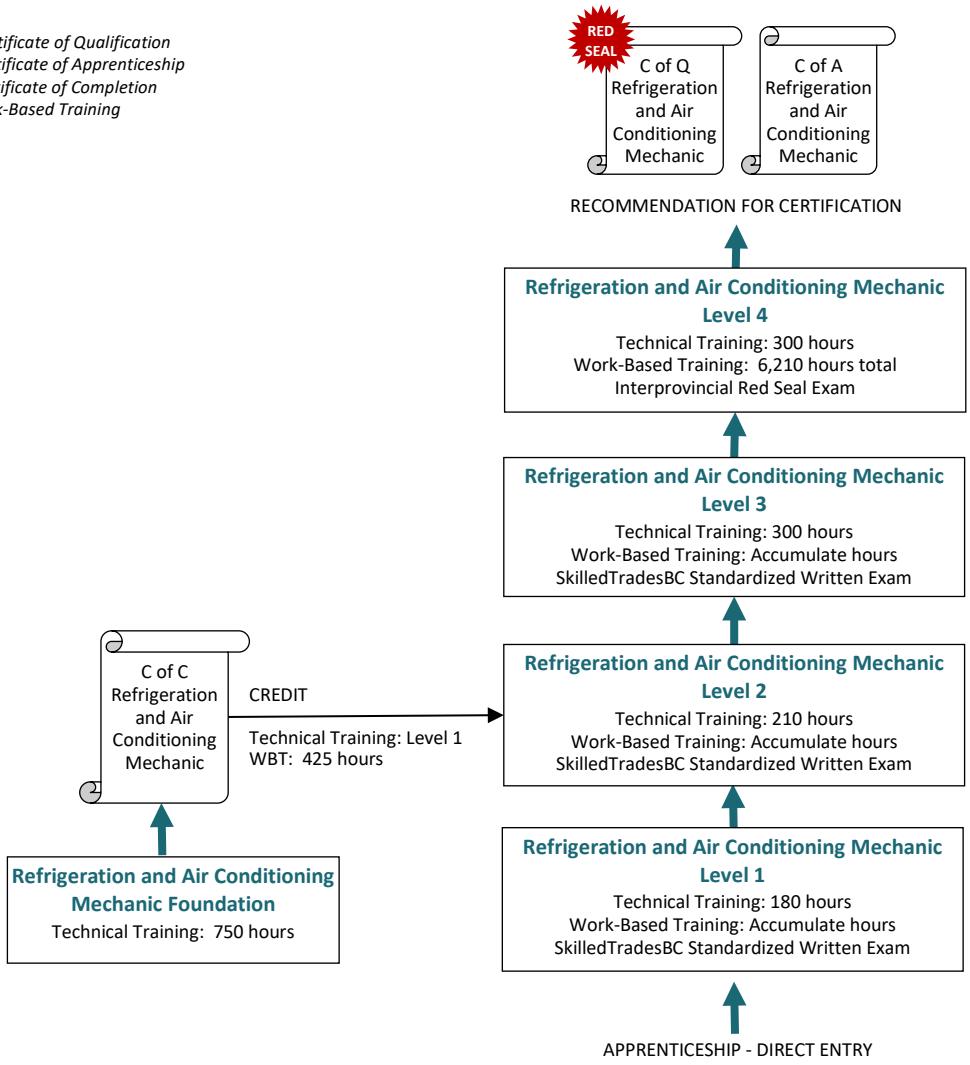
Section 2

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 Safety C of Q Gasfitter – Class B
Technical Training: None
Work-Based Training: 1,200 hours

C of Q Industrial Electrician
Technical Training: None
Work-Based Training: 1,800 hours

C of Q Construction Electrician
Technical Training: None
Work-Based Training: 900 hours

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.

PERFORM SAFETY RELATED FUNCTIONS **A**	Maintains Safe Work Environment A1	Use Personal Protective Equipment (PPE) and Safety Equipment A2	Perform Lock-Out and Tag-Out Procedures A3	Practice Fire Prevention A4		
	1	1	1	1		
USE TOOLS AND EQUIPMENT **B**	Use Hand Tools and Equipment B1	Use Portable and Stationary Power Tools B2	Use Brazing and Soldering Equipment B3	Use Charging, Evacuation and Recovery Tools B4	Use Diagnostic and Measuring Tools and Equipment B5	Use Access Equipment B6
	1	1	1	1	1 2	1
	Use Rigging, Hoisting, Lifting and Positioning Equipment B7	Use Digital Technology B8				
	1	1 2 3				
PERFORM ROUTINE TRADE ACTIVITIES **C**	Apply Mathematics and Science C1	Interpret Drawings and Specifications C2	Use Codes, Regulations and Standards C3	Use Manufacturer and Supplier Documentation C4	Organize Work and Maintain Records C5	Select Refrigerants, Compressed Gases and Oils C6
	1	1 2	1 2 3 4	1 2	1 2 3 4	1 2

HARMONIZED PROGRAM OUTLINE
Program Overview

	Apply Sealants and Adhesives C7	Select HVAC/R Components and Accessories C8	Select Fasteners, Brackets and Hangers C9	Install Valves C10	
	1	1 2 3	1	1 2	
USE COMMUNICATION TECHNIQUES D	Use Communication Techniques D1	Use Mentoring Techniques D2			
	1 4	4			
APPLY ELECTRICAL CONCEPTS E	Use the Principles of Electricity and Electronics E1	Use Electrical Wiring Diagrams and Schematics E2	Apply Motor and Motor Control Theory E3	Select Control Systems E4	Apply Wiring Practices E5
	1 2 3	1 2 3 4	1 2 3 4	1 2 3 4	1 2
APPLY REFRIGERATION AND AIR CONDITIONING THEORY F	Analyze Heat Pumps and Air Conditioning Systems F1	Analyze Refrigeration Systems F2	Apply Food Storage Theory F3	Analyze Hydronic Systems F4	
	1 2 3	1 2 3 4	2	3	
PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS G	Perform Work Site Preparation G1	Plan HVAC/R System Installation G2			
	1 2	1 2 3			
INSTALL REFRIGERATION AND AIR CONDITIONING SYSTEMS H	Install HVAC/R Piping and Tubing H1	Install HVAC/R Systems H2	Install Control Systems H3		
	1	1 2 3	1 2 3		
APPLY GAS UTILIZATION THEORY I	Apply Combustion Theory I1	Apply Draft Theory I2	Apply Alternate Fuel Theory I3	Apply Knowledge of Mechanical Safety Devices I4	
	2	2	3	2	

HARMONIZED PROGRAM OUTLINE
Program Overview

INSTALL GAS-FIRED SYSTEMS J	Identify Burners J1	Identify Flame Safeguards J2	Install Gas Piping and Tubing Systems J3	Install Gas Regulators, Valves and Valve Train Components J4	Install Gas Controls J5	Install Air Supply Systems J6
	3	3	2 4	3 4	3 4	4
	Install Gas Venting Systems J7	Install Draft Control Systems J8	Install Gas-Fired Appliances and Ancillary Equipment J9	Install LPG, LNG, CNG, Vaporizing and Mixing Systems J10	Plan Gas-Fired Appliance System Installations J11	
	3 4	4	2 3	4	4	
COMMISSION SYSTEMS K	Commission HVAC/R Systems K1	Commission Control Systems K2	Commission Fuel/Air Delivery Systems K3	Commission Gas-Fired Appliances and Ancillary Equipment	Perform Combustion Analysis K5	Commission Draft Control Systems K6
	3	3	4	4	4	4
	Training and Handover of Gas-Fired Equipment K7	Decommission and Disconnect Appliances and Equipment K8				
	4	4				
SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS L	Maintain HVAC/R Systems L1	Service HVAC/R Systems L2	Maintain Control Systems L3	Service Control Systems L4		
	1 2	2 3 4	2 3 4	2 3 4		
SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT M	Service Gas Distribution Systems M1	Service Gas Burners and Ancillary Equipment M2	Maintain Gas-Fired Appliances, Boilers and Ancillary Equipment M3	Service Fuel/Air Delivery Systems M4	Service and Repair Gas Control Systems M5	Maintain Gas-Fired Refrigeration Equipment M6
	3 4	3 4	3 4	4	3 4	4

Training Topics and Suggested Time Allocation – Level 1

REFRIGERATION AND AIR CONDITIONING MECHANIC

	Level 1	% of Time	% of Time Allocated to: Theory	Practical	Total
Line A	**PERFORM SAFETY RELATED FUNCTIONS**	**7%**	**80%**	**20%**	**100%**
A1	Maintains Safe Work Environment		✓		
A2	Use Personal Protective Equipment (PPE) and Safety Equipment		✓	✓	
A3	Perform Lock-Out and Tag-Out Procedures		✓	✓	
A4	Practice Fire Prevention		✓		
Line B	**USE TOOLS AND EQUIPMENT**	**7%**	**60%**	**40%**	**100%**
B1	Use Hand Tools and Equipment		✓		
B2	Use Portable and Stationary Power Tools		✓		
B3	Use Cutting, Brazing and Soldering Equipment		✓	✓	
B4	Use Charging, Evacuation and Recovery Tools		✓	✓	
B5	Use Diagnostic and Measuring Tools and Equipment		✓	✓	
B6	Use Access Equipment		✓		
B7	Use Rigging, Hoisting, Lifting and Positioning Equipment		✓		
B8	Use Digital Technology		✓		
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**28.5%**	**70%**	**30%**	**100%**
C1	Apply Mathematics and Science		✓		
C2	Interpret Drawings and Specifications		✓	✓	
C3	Use Codes, Regulations and Standards		✓	✓	
C4	Use Manufacturer and Supplier Documentation		✓		
C5	Organize Work and Maintain Records		✓		
C6	Select Refrigerants, Compressed Gases and Oils		✓		
C7	Apply Sealants and Adhesives		✓		
C8	Select HVAC/R Components and Accessories		✓		
C9	Select Fasteners, Brackets and Hangers		✓		
C10	Install Valves		✓		
Line D	**USE COMMUNICATION TECHNIQUES**	**1.5%**	**100%**	**0%**	**100%**
D1	Use Communication Techniques		✓		
Line E	**APPLY ELECTRICAL CONCEPTS**	**28.5%**	**70%**	**30%**	**100%**
E1	Use the Principles of Electricity and Electronics		✓	✓	
E2	Use Electrical Wiring Diagrams and Schematics		✓		
E3	Apply Motor and Motor Control Theory		✓	✓	
E4	Select Control Systems		✓		
E5	Apply Wiring Practices		✓		
Line F	**APPLY REFRIGERATION AND AIR CONDITIONING THEORY**	**3%**	**100%**	**0%**	**100%**
F1	Analyze Heat Pumps and Air Conditioning Systems		✓		
F2	Analyze Refrigeration Systems		✓		

	Level 1	% of Time	% of Time Allocated to: Theory	Practical	Total
Line G	**PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS**	**6%**	**100%**	**0%**	**100%**
G1	Perform Work Site Preparation		✓		
G2	Plan HVAC/R System Installation		✓		
Line H	**INSTALL REFRIGERATION AND AIR CONDITIONING SYSTEMS**	**14%**	**70%**	**30%**	**100%**
H1	Install HVAC/R Piping and Tubing		✓	✓	
H2	Install HVAC/R Systems		✓		
H3	Install Control Systems		✓		
Line L	**SERVICE REFRIGERATION AND AIR CONITIONING SYSTEMS**	**4.5%**	**100%**	**0%**	**100%**
L1	Maintain HVAC/R Systems		✓		
	Total Percentage for Refrigeration and Air Conditioning Mechanic Level 1	**100%**			

Training Topics and Suggested Time Allocation – Level 2

REFRIGERATION AND AIR CONDITIONING MECHANIC

	Level 2	% of Time	% of Time Allocated to: Theory	Practical	Total
Line B	**USE TOOLS AND EQUIPMENT**	**5%**	**80%**	**20%**	**100%**
B5	Use Diagnostic and Measuring Tools and Equipment		✓	✓	
B8	Use Digital Technology		✓		
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**12%**	**90%**	**10%**	**100%**
C2	Interpret Drawings and Specifications		✓	✓	
C3	Use Codes, Regulations and Standards		✓		
C4	Use Manufacturer and Supplier Documentation		✓		
C5	Organize Work and Maintain Records		✓		
C6	Select Refrigerants, Compressed Gases and Oils		✓		
C8	Select HVAC/R Components and Accessories		✓		
C10	Install Valves		✓		
Line E	**APPLY ELECTRICAL CONCEPTS**	**12%**	**100%**	**0%**	**100%**
E1	Use the Principles of Electricity and Electronics		✓		
E2	Use Electrical Wiring Diagrams and Schematics		✓		
E3	Apply Motor and Motor Control Theory		✓		
E4	Select Control Systems		✓		
E5	Apply Wiring Practices		✓		
Line F	**APPLY REFRIGERATION AND AIR CONDITIONING THEORY**	**12%**	**70%**	**30%**	**100%**
F1	Analyze Heat Pumps and Air Conditioning Systems		✓	✓	
F2	Analyze Refrigeration Systems		✓	✓	
F3	Apply Food Storage Theory		✓		
Line G	**PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS**	**12%**	**90%**	**10%**	**100%**
G1	Perform Work Site Preparation		✓		
G2	Plan HVAC/R System Installation		✓	✓	
Line H	**INSTALL REFRIGERATION AND AIR CONDITIONING SYSTEMS**	**24%**	**100%**	**0%**	**100%**
H2	Install HVAC/R Systems		✓		
H3	Install Control Systems		✓		
Line I	**APPLY GAS UTILIZATION THEORY**	**5%**	**100%**	**0%**	**100%**
I1	Apply Combustion Theory		✓		
I2	Apply Draft Theory		✓		
I4	Apply Knowledge of Mechanical Safety Devices		✓		
Line J	**INSTALL GAS-FIRED SYSTEMS**	**6%**	**80%**	**20%**	**100%**
J3	Install Gas Piping and Tubing Systems		✓	✓	
J9	Install Gas-Fired Appliances and Ancillary Equipment		✓		

	Level 2	% of Time	% of Time Allocated to: Theory	Practical	Total
Line L	**SERVICE REFRIGERATION AND AIR CONITIONING SYSTEMS**	**12%**	**100%**	**0%**	**100%**
L1	Maintain HVAC/R Systems		✓		
L2	Service HVAC/R Systems		✓		
L3	Maintain Control Systems		✓		
L4	Service Control Systems		✓		
	Total Percentage for Refrigeration and Air Conditioning Mechanic Level 2	**100%**			

Training Topics and Suggested Time Allocation – Level 3

REFRIGERATION AND AIR CONDITIONING MECHANIC

	Level 3	% of Time	% of Time Allocated to: Theory	Practical	Total
Line B	**USE TOOLS AND EQUIPMENT**	**4%**	**100%**	**0%**	**100%**
B8	Use Digital Technology		✓		
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**8%**	**100%**	**0%**	**100%**
C3	Use Codes, Regulations and Standards		✓		
C5	Organize Work and Maintain Records		✓		
C8	Select HVAC/R Components and Accessories		✓		
Line E	**APPLY ELECTRICAL CONCEPTS**	**19%**	**80%**	**20%**	**100%**
E1	Use the Principles of Electricity and Electronics		✓		
E2	Use Electrical Wiring Diagrams and Schematics		✓	✓	
E3	Apply Motor and Motor Control Theory		✓		
E4	Select Control Systems		✓		
Line F	**APPLY REFRIGERATION AND AIR CONDITIONING THEORY**	**10%**	**100%**	**0%**	**100%**
F1	Analyze Heat Pumps and Air Conditioning Systems		✓		
F2	Analyze Refrigeration Systems		✓		
F4	Analyze Hydronic Systems		✓		
Line G	**PLAN REFRIGERATION AND AIR CONDITIONING INSTALLATIONS**	**4%**	**100%**	**0%**	**100%**
G2	Plan HVAC/R System Installation		✓		
Line H	**INSTALL REFRIGERATION AND AIR CONDITIONING SYSTEMS**	**6%**	**100%**	**0%**	**100%**
H2	Install HVAC/R Systems		✓		
H3	Install Control Systems		✓		
Line I	**APPLY GAS UTILIZATION THEORY**	**2%**	**100%**	**0%**	**100%**
I3	Apply Alternate Fuel Theory		✓		
Line J	**INSTALL GAS-FIRED SYSTEMS**	**17%**	**100%**	**0%**	**100%**
J1	Identify Burners		✓		
J2	Identify Flame Safeguards		✓		
J4	Install Gas Regulators, Valves and Valve Train Components		✓		
J5	Install Gas Controls		✓		
J7	Install Gas Venting Systems		✓		
J9	Install Gas-Fired Appliances and Ancillary Equipment		✓		
Line K	**COMMISSION SYSTEMS**	**10%**	**100%**	**0%**	**100%**
K1	Commission HVAC/R Systems		✓		
K2	Commission Control Systems		✓		

	Level 3	% of Time	% of Time Allocated to: Theory	Practical	Total
Line L	**SERVICE REFRIGERATION AND AIR CONITIONING SYSTEMS**	**10%**	**80%**	**20%**	**100%**
L2	Service HVAC/R Systems		✓	✓	
L3	Maintain Control Systems		✓	✓	
L4	Service Control Systems		✓	✓	
Line M	**SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**	**10%**	**100%**	**0%**	**100%**
M1	Service Gas Distribution Systems		✓		
M2	Service Gas Burners and Ancillary Equipment		✓		
M3	Maintain Gas-Fired Appliances, Boilers and Ancillary Equipment		✓		
M5	Service and Repair Gas Control Systems		✓		
			✓		
	Total Percentage for Refrigeration and Air Conditioning Mechanic Level 3	**100%**			

Training Topics and Suggested Time Allocation – Level 4

REFRIGERATION AND AIR CONDITIONING MECHANIC

	Level 4	% of Time	% of Time Allocated to: Theory	Practical	Total
Line C	**PERFORM ROUTINE TRADE ACTIVITIES**	**21%**	**95%**	**5%**	**100%**
C3	Use Codes, Regulations and Standards		✓	✓	
C5	Organize Work and Maintain Records		✓		
Line D	**USE COMMUNICATION TECHNIQUES**	**2%**	**100%**	**0%**	**100%**
D1	Use Communication Techniques		✓		
D2	Use Mentoring Techniques		✓		
Line E	**APPLY ELECTRICAL CONCEPTS**	**21%**	**90%**	**10%**	**100%**
E2	Use Electrical Wiring Diagrams and Schematics		✓	✓	
E3	Apply Motor and Motor Control Theory		✓	✓	
E4	Select Control Systems		✓		
Line F	**APPLY REFRIGERATION AND AIR CONDITIONING THEORY**	**10%**	**100%**	**0%**	**100%**
F2	Analyze Refrigeration Systems		✓		
Line J	**INSTALL GAS-FIRED SYSTEMS**	**21%**	**80%**	**20%**	**100%**
J3	Install Gas Piping and Tubing Systems		✓		
J4	Install Gas Regulators, Valves and Valve Train Components		✓		
J5	Install Gas Controls		✓		
J6	Install Air Supply Systems		✓		
J7	Install Gas Venting Systems		✓		
J8	Install Draft Control Systems		✓		
J10	Install LPG, LNG, CNG, Vaporing and Mixing Systems		✓		
J11	Plan Gas-Fired Appliance System Installations		✓	✓	
Line K	**COMMISSION SYSTEMS**	**10%**	**80%**	**20%**	**100%**
K3	Commission Fuel/Air Delivery Systems		✓		
K4	Commission Gas-Fired Appliances and Ancillary Equipment		✓	✓	
K5	Perform Combustion Analysis		✓		
K6	Commission Draft Control Systems		✓		
K7	Training and Handover of Equipment		✓		
K8	Decommission and Disconnect Appliances and Equipment		✓		
Line L	**SERVICE REFRIGERATION AND AIR CONITIONING SYSTEMS**	**10%**	**90%**	**10%**	**100%**
L2	Service HVAC/R Systems		✓	✓	
L3	Maintain Control Systems		✓	✓	
L4	Service Control Systems		✓	✓	
Line M	**SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**	**5%**	**80%**	**20%**	**100%**

	Level 4	% of Time	% of Time Allocated to: Theory	Practical	Total
M1	Service Gas Distribution Systems		✓		
M2	Service Gas Burners and Ancillary Equipment		✓	✓	
M3	Maintain Gas-Fired Appliances, Boilers and Ancillary Equipment		✓	✓	
M4	Service Fuel/Air Delivery Systems		✓	✓	
M5	Service and Repair Gas Control Systems		✓	✓	
M6	Maintain Gas-Fired Refrigeration Equipment		✓		
	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	CONTENT

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

3. Describe safety precautions when working at elevations	• Fall restraint
	  ○ Guard rails
	  ○ Safety lines
	• Fall arrest
	• Personal Protective Equipment (PPE)

4. Manage workplace hazards	• Workplace Hazard Materials Identification System (WHMIS)
	  ○ Purpose
	  ○ Safety Data Sheets (SDS)
	  ○ Labels

LEARNING TASKS	CONTENT
	○ Symbols ○ Regulations • Transportation of Dangerous Goods (TDG) • Occupational Health and Safety (OHS) regulation ○ Rights and responsibilities ○ Inspections ○ General conditions • WorkSafeBC standards ○ Emergency shutoffs • Chemical hazard response ○ Eyewash facilities ○ Emergency shower • Evacuation plan ○ Marshalling/mustering areas ○ Emergency exits ○ Emergency contact/phone numbers
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	CONTENT

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

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

3. Use Personal Protective Equipment (PPE)	• Purpose
	• Selection
	• Operating procedures
	• Training requirements
	  ○ WorkSafeBC requirements
	  ○ Job site requirements
	• Inspection
	• Maintenance
	• Storage

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	CONTENT
1. Identify energy sources	• Electricity • Pressure • Kinetic

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

3. Use lock-out and tag-out procedures	• Zero energy state
	  ○ Disconnect
	  ○ Depressurize
	  ○ 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.

LEARNING TASKS	CONTENT
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
	  ○ Diesel
	  ○ Gasoline
	  ○ Propane
	  ○ Natural Gas
	  ○ Dust
	  ○ Insulation
	• Ventilation, including purging
	• Lubricants
	• Oily rags
	• Combustible metals
	• Aerosols
	• Fire extinguisher
	  ○ Expiry date
	  ○ 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

LEARNING TASKS	CONTENT

5. Describe the procedure for using a fire extinguisher	• Extinguisher selection
	• P.A.S.S.
	  ○ Pull
	  ○ Aim
	  ○ Squeeze
	  ○ 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.

LEARNING TASKS	CONTENT

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
	• Parts
	• Applications

2. Use hand tools	• Procedures • Safety • Adjustment • Inspection • Maintenance • Storage

3. Describe levelling tools	• Types
	  ○ Rules
	  ○ Plumbs
	  ○ Square
	  ○ Levels
	  – Laser
	  ○ Chalk line
	  ○ Tape measure
	• Applications

LEARNING TASKS	CONTENT
4. Use levelling tools	○ 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	CONTENT

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

2. Describe stationary power tools	• Types
	  ○ Cutting tools
	  ○ Grinding and abrasive tools
	  ○ Threading tools
	  ○ Drilling and boring tools
	  ○ Grooving tools
	  ○ Specialty tools
	• Accessories
	• Parts
	• Guards
	• Applications

3. Use power tools	• 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	CONTENT

1. Describe the brazing and soldering process	• Principles
	• Applications
	• Filler alloys
	• Equipment
	• Safety requirements
	  ○ Fire protection equipment
	  ○ Ventilation

2. Describe the procedures for brazing and soldering	• Joint preparation and design • Flux selection • Flame for brazing • Purging
3. Describe air-fuel and oxy-fuel equipment	• Cylinders • Regulators ○ Purging • Gauges • Flashback arrestors • Hoses • Spark arrestors • Torches • Torch attachments • Tips • Inspection • Maintenance • Storage • Transportation

4. Use air-fuel and oxy-fuel equipment to braze and solder	• Safety
	  ○ PPE
	  ○ Delivery systems
	  ○ Cylinder handling and storage
	  ○ Hazards
	  ○ Fire prevention equipment
	  ○ Hot work permit
	• Flammable material recognition

LEARNING TASKS

CONTENT

- Applications
- Procedures
  - Setup
  - Take down
  - Tip selection
  - Alloy selection
  - Flux selection
  - 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	CONTENT
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

LEARNING TASKS	CONTENT

	• Safety
	• Adjustment
	• Inspection/procedure
	• Maintenance
	  ○ Oil
	  – Clean
	  – Levels
	  ○ Clean and flush
	  ○ Inspect and replace components
	  – Gauges
	  – O-rings
	  – Seals
	  – Hoses
	• Verify and test
	  ○ Micron gauges
	• Storage
	  ○ Secure position
	  ○ Prevent oil spillage

5. Describe recovery/recycling equipment	• Types • Parts • Applications

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

LEARNING TASKS	CONTENT

- Temperature limits
- WHMIS

- Refrigerants
  - Mark and label
  - Condition
    - Clean and usable
    - Contaminated

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	CONTENT

1. Describe precision measuring tools	• Types
	  ○ Micrometers
	  ○ Manometers
	  – Accessories
	  ○ Indicators
	  ○ Vernier calipers
	  ○ Feeler gauges
	  ○ Tachometers
	  ○ Mechanical gauges
	  – Bourdon tube
	  – Compound
	  ▪ Magnehelic
	• Parts
	• Applications
	• Scales
	• Accuracy

2. Use precision measuring tools	• Procedures
	• Safety
	• Adjustment
	• Inspection
	• Maintenance
	  ○ Certification
	  ○ Calibration
	• Storage

3. Describe electrical test meters	• Types
	  ○ Voltmeter
	  ○ Ammeter
	  ○ Ohmmeter
	  ○ Megger
	  ○ 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

LEARNING TASKS	CONTENT

	• Maintenance
	  ○ Certification
	  ○ Calibration
	• Storage

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	CONTENT

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

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

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

LEARNING TASKS	CONTENT
	○ Platforms/planks ○ Tie backs • Certification
4. Use scaffolds	• 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	• Types ○ Scissor and vertical lifts ○ Boom lifts, straight mast and articulated boom • Training requirements • Standards, acts and regulations • Parts ○ Base section ○ Elevating section ○ Platform section • Fuel types and batteries • Safety ○ Fulcrum point ○ Load capacity rating ○ Centre of gravity ○ Side slope and grade ○ Fall arrest equipment ○ Fall restraint equipment ○ Hazard recognition • Site certification requirements ○ Equipment certifications ○ Employer responsibilities

LEARNING TASKS	CONTENT

6. Describe safe operation of aerial lifts	• 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

Line (GAC): B USE TOOLS AND EQUIPMENT

Competency: B7 Use Rigging, Hoisting, Lifting and Positioning Equipment

Objectives

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

- Use hoisting, lifting and rigging equipment.

LEARNING TASKS	CONTENT

1. Describe lifting and hoisting	• Principles
	  ○ Mechanical advantage
	  ○ Balance points
	  ○ Safety
	  ○ Estimation of weights
	  ○ Equipment capacities
	  ○ Equipment selection
	  ○ Lifting location
	  ○ Procedures
	  ○ Communication/hand signals
	  ○ 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

LEARNING TASKS	CONTENT
4. Describe lifting and hoisting communication	• Maintenance • Hand signals • Audible signals • Communication with the operator • Communication with others

5. Select slings	• Load
	  ○ Load factor labels
	• Application
	  ○ Sling angles
	  ○ Sling lengths

6. Tie knots, bends and hitches	• Types
	  ○ Bowline
	  ○ Rolling hitch
	  ○ Trucker's hitch
	• Purposes
	• Limitations

7. Use hoisting, lifting and rigging equipment	• 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
	  ○ Computers/laptops
	  ○ Smart phones
	  ○ Tablets
	  ○ User interface modules
	• Applications
	  ○ Monitoring
	  ○ Diagnostics
	  ○ System set-up
	  ○ System back-up

2. Use electronic devices	• Connection
	  ○ Manufacturer's specfications
	• System set-up
	  ○ Configuration
	• File back-up

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

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

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

6. Describe wireless communication devices	• WiFi • Bluetooth

LEARNING TASKS	CONTENT
	• Satellite • Cellular • 2-way radios

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	CONTENT
1. Apply calculator functions to trade related equations	• Whole numbers • Fractions • Decimals • Percentages
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	• Processes

6. Perform conversions	• Length
	• Volume
	• Capacity
	• Area
	• Mass
	• Weight
	• Heat energy
	  ○ Kilowatts
	  ○ BTUh
	  ○ Gigajoules
	• Temperature
	  ○ Fahrenheit
	  ○ Celsius
	  ○ Kelvin
	  ○ Rankine
	• Pressure
	  ○ Absolute
	  ○ Gauge

7. Calculate piping measurements	• Terms

LEARNING TASKS	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
8. Use the Pythagorean theorem of right angles	• Hypotenuse • Side opposite • Side adjacent
9. Calculate offsets using the applicable trigonometric function	• Calculator methods • Table-based methods
10. Calculate the required measurements for a parallel piping offset	• Unequal spread • Equal spread • Jumper
11. Describe the properties of matter	• Substances ○ Elements ○ Compounds ○ Mixtures • Adhesion • Cohesion • Conductivity ○ Dieletric • Density • Ductility • Elasticity • Malleability • Tensile strength • Heat properties ○ BTUs ○ Gigajoules ○ Specific Heat ○ Kilowatts
12. Use Pascal's theory of pressure and force	• Pressure

LEARNING TASKS	CONTENT
	○ Units of measure • Total Force ○ Pounds ○ Newtons
13. Use Archimedes' principles of displacement and floatation	• Specific weight/gravity • Buoyancy
14. Define mechanical advantage as it relates to fluid power	• Hydraulics • Hydrostatics
15. Describe factors that affect fluid flow in a piping system	• Viscosity • Laminar flow • Turbulent flow • Velocity • Piping material • Fittings
16. Describe factors that affect gas volumes and pressures	• Boyle's Law • Charles' Law • Gay-Lussac's Law • Dalton's Law • Combined Gas Law (General Gas Law) • Bernoulli's principle
17. Perform gas law calculations	• Boyle's Law • Charles' Law • Gay-Lussac's Law • Dalton's Law • Combined Gas Law (General Gas Law) • Temperature ○ Kelvin ○ Rankine • Pressures ○ Absolute ○ Gauge
18. Calculate the expansion and contraction of various piping materials due to heating and cooling	• Ferrous • Non-ferrous • Thermoplastic
19. Define methods of heat transfer	• Conduction • Convection • Radiation
20. Perform heat transfer calculations	• Sensible

LEARNING TASKS	CONTENT
	• Latent • 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 orothographic piping arrangement.

LEARNING TASKS	CONTENT

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

2. Use scale rulers	• Dimensions
	  ○ Imperial
	  ○ Metric

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

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

LEARNING TASKS	CONTENT

5. Describe drawing projections	• Title block
	• Views
	  ○ Elevation
	  ○ Plan
	  ○ Section
	  ○ Isometric
	  ○ Orthographic
	  ○ Oblique

6. Use drawing projections	• Isometric • Orthographic • Conversion from one to the other
7. Describe types of drawings	• Isometric • Orthographic • Process Flow Diagrams (PFD) • Piping and Instrumentation Diagrams (P & ID) • Sectional drawings • Detail drawings
8. Interpret mechanical 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.

LEARNING TASKS	CONTENT

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)
	  ○ B52 Code
	  ○ B149.1 Code
	  ○ 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
	  ○ Regulations
	  ○ Bulletins

2. Describe code implications	• Design • Planning • Installation

LEARNING TASKS	CONTENT

3. Interpret sections of the CSA B52 code	• 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.

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:

- Describe manufacturer and supplier documentation.
- Source manufacturer documentation.

LEARNING TASKS	CONTENT
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
  - Documentation
  - 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

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	CONTENT

1. Describe refrigerants	• Types
	  ○ Hydrocarbons
	  ○ CFC
	  ○ HFC
	  ○ HCFC
	  ○ Blends
	• Saturation properties
	  ○ Refrigerant tables
	• Solubility
	  ○ Crankcase
	  ○ Evaporator
	• Reactivity with metals
	  ○ Compatibility
	  ○ Combinations to avoid
	  ○ Moisture
	• Toxicity
	  ○ Physiological effect of halogenated refrigerants
	  ○ Effect of long term exposure
	  ○ Signs of over-exposure
	  ○ 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
	  ○ Use/purpose
	  ○ Construction of chart

LEARNING TASKS	CONTENT

	• Plotting cycle diagrams
	• Calculations
	• Performance characteristics
	  ○ Evaporator pressure
	  ○ Condenser pressure
	  ○ Compression ratio
	  ○ Displacement per ton
	  ○ Horsepower per ton
	  ○ Discharge temperature
	  ○ Applications
	• Migration

3. Describe compressed gases	• 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	CONTENT

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

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

3. Apply sealants and adhesives	• Safety
	  ○ SDS
	  ○ Flammability
	  ○ 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	CONTENT

1. Describe compressors	• Types
	  ○ Rotary
	  ○ Reciprocating
	  ○ Scroll
	  ○ Centrifugal
	  ○ Screw
	• Drives
	  ○ Open
	  ○ Semi-hermetic
	  ○ Hermetic
	• Applications
	  ○ Residential
	  ○ Commercial
	  ○ Industrial
	  ○ Institutional
	• Characterisitcs
	  ○ 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
	  ○ Blast

LEARNING TASKS	CONTENT

	• Requirements
	• Operation
	• Refrigerant management
	  ○ Flooded
	  ○ DX

3. Describe condensers	• Types
	  ○ Air cooled
	  – Static
	  – Fan-forced
	  ○ Water cooled
	  – Coaxial
	  – Shell and tube
	  – Brazed plate
	  – Waste water
	  – Closed loop
	  ○ Evaporative
	  ○ Split
	  ○ Coil and shell
	• Applications
	  ○ Ambient temperature
	  ○ Heat recovery
	  ○ Heat rejection
	• Requirements
	• Operation

4. Identify metering devices	• Types
	  ○ Fixed orifice
	  ○ Capillary tubes
	  ○ Hand expansion valve
	  ○ Automatic expansion valve
	  ○ Thermostatic expansion valve
	  ○ Electronic expansion valve
	  ○ Low side float
	  ○ High side float
	  ○ Subcooling control valve

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	CONTENT

1. Describe brackets, fasteners and hangers	• Hangers
	  ○ Clevis
	  ○ Split ring
	  ○ Riser clamp
	  ○ U-bolt
	  ○ U-hook
	  ○ U-channel strut
	  ○ Strap
	  ○ Threaded rod
	  ○ Cushion clamps
	  ○ Tear drop
	  ○ Spring isolation
	• Fasteners
	  ○ Screws
	  ○ Coach screw rods
	  ○ Lag screws
	  ○ Bolts
	  ○ Rod couplings
	  ○ Beam clamps
	• Anchors
	  ○ Wedge
	  ○ Undercut
	  ○ 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	CONTENT

1. Describe valves	• Types
	  ○ Butterfly
	  ○ Plug
	  ○ Ball
	  ○ Gate
	  ○ Globe
	  ○ Needle
	  ○ Check
	  ○ Pressure reducing
	  ○ Solenoid
	  ○ Regulating
	• Application
	• Materials
	• Limitations
	  ○ Pressure
	  ○ 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	CONTENT

1. Describe effective communication practices	• 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	CONTENT

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
	  ○ Power and energy

LEARNING TASKS	CONTENT
	○ Closing and opening DC circuits • AC circuits and measurements ○ Inductance ○ AC amperage ○ Resistance • Fundamentals of magnetism ○ Natural and artificial magnets ○ Magnetic fields ○ Strength of field ○ Force on two wires • Permeablility
3. Use laws and formulas	• Ohm's Law • Kirchoff's Law • Solve simple problems
4. Describe single phase power characteristics	• AC power distribution ○ Generation and transmission ○ Voltage drop ○ Step-down transformer • Power available • Single phase power supply ○ 3-wire, dual voltage • Circuit protection ○ Fuses ○ Circuit breakers
5. Describe three phase power characteristics	• AC power distribution ○ Generation and transmission ○ Voltage drop ○ Step-down transformer • Power available • Three phase power supply ○ Delta ○ Wye
6. Identify transformers	• Type of transformers ○ Step-up ○ Step-down ○ Isolation ○ Auto • Primary winding • Secondary winding • Tappings

LEARNING TASKS	CONTENT
7. Describe switches	• Manual • Temperature actuated • Pressure actuated • Liquid level actuated • Flow • Proximity/End • Auxiliary contacts

8. Select relays	• Operation
	• Ratings
	• Coil voltages
	• Contacts
	  ○ Normally open
	  ○ Normally closed
	  ○ Switching action

9. Install relays	• 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	CONTENT

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
	  ○ Manufacturer's specifications
	  ○ Previous readings
	  ○ Expected data
	  – Predicted readings
	  ○ 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	CONTENT

1. Describe single phase motors	• AC theory
	  ○ Electromagnetic theory
	  ○ Induction motors
	  ○ Voltage variations
	  ○ Frequency
	• Split phase motors
	• Capacitor start motors
	• Capacitor run motors
	• Shaded pole motors
	• Dual voltage motors
	• Motor starting relays
	  ○ Current
	  ○ Potential
	  ○ PTC
	  ○ Centrifugal
	• Components
	• Chracterisitcs

2. Describe three phase motors	• Three phase connections
	  ○ Delta
	  ○ Wye (Y)
	• Types
	  ○ Squirrel cage
	  ○ Wound rotor
	  ○ Synchronous
	• Motor components
	  ○ Windings
	  ○ Bearings
	  ○ Connections
	  ○ Cooling fans
	• Characteristics
	  ○ Speed and torque

LEARNING TASKS	CONTENT
	○ Ratings ○ Applications • Operation ○ Three phase rotating field – Delta connected – Wye connected ▪ Reduced voltage • Voltage imbalance • Current imbalance
3. Describe motor protection	• 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

1. Describe control systems

CONTENT

- Types
  - Thermostats
    - Line voltage
    - Low-voltage
  - Pressure switches
  - Flow switches
  - Temperature switches
    - Mechanical high limit
    - Electronic
    - Bi-metal switch
  - Interlocks
    - End switches
    - Air proving switches
    - Gas pressure switches
    - Float switches
  - Timers
- Terminology
- Applications
- Functions
- Characteristics
- Location

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	CONTENT

1. Describe wiring components	• Conductor types
	  ○ Solid
	  ○ Stranded
	  ○ Armoured
	  ○ Shielded
	• Connection types
	  ○ Wire nuts
	  ○ Crimp
	  ○ Solder
	  ○ Terminal strips/lug
	  ○ Heat shrink sleeve
	• Conduit types
	  ○ Metal conduit
	  – Rigid metal conduit
	  – Galvanized conduit
	  ○ Non-metallic conduit
	  ○ Flexible conduit
	• Fasteners
	• Junction box

2. Describe conductor installation	• Cutting of flexible conduit • Conductor insulation removal • Wire nuts
3. Describe conductor termination	• Wire nuts • Junction box • Terminal strips/lug • Mechanically secure • Heat shrink sleeve

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	CONTENT

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

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	CONTENT

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

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

LEARNING TASKS	CONTENT
2. Describe material handling	○ 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

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 piping design.
- Describe medium temperature refrigeration systems.
- Describe equipment placement.

LEARNING TASKS	CONTENT

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

2. Describe medium temperature systems	• Types
	  ○ Air cooled
	  ○ Water cooled

LEARNING TASKS	CONTENT

	• 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

3. Describe equipment placement	• Drawings and specifications
	  ○ Clearances
	• Location
	  ○ Access to service
	  ○ Indoors/outdoors
	• Site conditions
	  ○ Utilities
	• Foundation
	• Levelling
	• Codes and regulations

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.

LEARNING TASKS	CONTENT

1. Describe piping and tubing	• Codes and regulations
	• Manufacturer's specifications
	• Schedules
	• Characteristics
	• Types
	  ○ Steel
	  – Carbon
	  – Stainless
	  – Galvanized
	  ○ Copper
	  – Types
	  – Traps
	  – Compressor
	  – Minimum velocities
	  – Maximum velocities
	  – Slope
	  ○ Application specific
	  – Polypropylene
	  – PVC
	  – CPVC
	  – PEX

2. Describe methods of protecting piping and tubing	• Codes and regulations
	• Manufacturer's specifications
	• Water treatment
	  ○ Softener
	  ○ pH/neutralizer
	  ○ Iron filters
	• Frost protection
	  ○ Eutectic
	  ○ Insulation
	  ○ Heat trace
	  ○ Frost boxes
	  ○ Circulating pumps
	• Corrosion protection
	  ○ Coatings

LEARNING TASKS	CONTENT
	○ Inhibitors ○ Tape ○ Cathodic ○ Dielectric ○ Sleeving • Mechanical damage ○ Protective plates/shield ○ Sleeving ○ Bollards
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

LEARNING TASKS	CONTENT
6. Describe factors affecting structure penetrations	• Codes and regulations • Manufacturer's specfications • 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
- 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.

LEARNING TASKS	CONTENT

1. Describe the installation of medium temperature systems	• Codes and regulations
	• Drawings and specifications
	  ○ Placement
	• Equipment
	• Components
	• Accessories
	• Site requirements
	• Tools and equipment
	• Supports
	  ○ Seismic
	• Piping
	  ○ Types
	  ○ Design
	  ○ Insulation
	  ○ Traps
	  ○ Minimum velocities
	  ○ Maximum velocities
	  ○ Slope
	• Pipe identification
	• Assembly
	  ○ Equipment
	  ○ Components
	  ○ Accessories
	• Wiring
	• Testing
	  ○ Pressure
	  ○ Vacuum
	  ○ Electrical
	• Evacuation
	  ○ Manufacturer specifications
	  ○ B52 code requirements
	• Charging
	  ○ Zeotropic refrigerants
	  ○ 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.

LEARNING TASKS

1. Maintain system components

CONTENT

- Safety requirements
- Schedules
  - Seasonal conditions
- Visual inspection
  - Error codes
  - Contactor points
  - Coils
  - Heat exchangers
  - Fans
  - Blowers
  - Mechanical drives
  - Condensate drain
  - Supply and return diffusers
  - Dampers
  - Compressors
  - Crank case heater
- Tools and equipment
- System test
  - ΔT
- Manufacturer's specifications
- Isolate components
- Clean components
- Verification
  - Lubricants
  - Electrical connections
  - Safety devices
- Conditions for repair/replacement
  - Temperature
  - Pressure
  - Leaks
  - Corrosion
  - Control malfunction
  - Vibration
  - Irregular movement

LEARNING TASKS	CONTENT
	• Adjustments • Test • Return to service • Documentation

2. Maintain system consumables	• 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	CONTENT

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
    - Data entry
    - Accuracy
    - Verification
    - 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	CONTENT
1. Create a piping installation drawing for a refrigeration system	• 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	CONTENT
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	CONTENT
1. Apply manufacturer's and supplier documentation	• 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
  - Commissioning report
  - Service reports
  - Statements of completion
  - Technical Safey BC documentation
  - Permits
  - Approvals
  - Revised drawings
- Regulatory responsibilities
  - Safety Standards Act
  - Safety Standards General Regulations
  - Safety Standards Gas Regulations
- Liability
  - Contractor
  - 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	CONTENT

1. Describe lubrication systems	• Types
	• Applications
	• Operation
	  ○ Controlling oil
	  – Oil separators
	  – Piping for oil return
	• Components
	  ○ Oil heaters
	  ○ Oil coolers
	  ○ Regulators
	  ○ Oil traps
	  ○ Safeties
	  ○ Separators
	  ○ Reservoir
	  ○ 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 ○ 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
	  ○ Driers
	  ○ Moisture indicators
	  ○ Distributors
	  ○ Receivers
	  ○ Pressure regulators
	  – Evaporator
	  – Crankcase
	  – Condensing

LEARNING TASKS	CONTENT
	○ Accumulators ○ Valves – Solenoid – Service – Isolation – Check • Applications • Operation

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	CONTENT

1. Describe valves	• Normally open
	• Normally closed
	• Four-way valves
	  ○ Types
	• Three-way valves
	• Stop valves
	  ○ Check valves
	  ○ Solenoid valves
	• Pilot operated valves
	  ○ Two position
	  ○ 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	CONTENT

1. Select single-phase transformers	• Electrical load
	• Sizing
	• Ratings
	  ○ NEMA
	  ○ 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
	  ○ Thermocouple
	  ○ Thermopiles
	• Switches
	• Loads
	• Application

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

5. Identify resistors	• Types • Ratings • Application
6. Describe variable resistors	• Thermistors

LEARNING TASKS	CONTENT
	○ NTC ○ PTC ○ Resistant temperature device (RTD) • Pressure transducers • Anticipators • Potentiometers
7. Describe PLC ladder logic	• Inputs • Outputs ○ Actuators • Variables • PID loops • Scaling ○ Zero ○ Span

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	CONTENT

1. Interpret electrical diagrams	• Types
	  ○ Coolers
	  ○ Freezers
	  ○ HVAC
	• Symbols
	• Components
	• Functions

2. Draw a walk-in freezer circuit	• Components
	  ○ Oil safety switch
	  ○ Time clocks
	  ○ Defrost termination switch
	  ○ Fan delay
	  ○ Condensing unit
	  ○ Evaporator

3. Troubleshoot a walk-in freezer circuit	• Safety
	• Sequence of operation
	• Component location
	• Testing
	  ○ Voltage
	  ○ Amperage
	  ○ Resistance
	  ○ Continuity

4. Draw a multiple-voltage HVAC circuit	• Components
	  ○ Reversing valves
	  ○ Ambient thermostats
	  ○ Defrost control
	  ○ Outdoor unit
	  ○ Indoor unit
	  ○ Thermostat

5. Troubleshoot multiple-voltage HVAC circuit	• Safety • Sequence of operation

LEARNING TASKS	CONTENT

	• Component location
	• Testing
	  ○ Voltage
	  ○ Amperage
	  ○ Resistance
	  ○ Continuity

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:

- Identify causes of motor failure.
- Maintain semi and hermetic compressors.
- Verify motor starting and protection devices.
- Verify motor installation and operation.

LEARNING TASKS	CONTENT

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

2. Identify causes of semi and hermetic compressor motor failure	• 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	• Tools and equipment • Techniques for testing • Locked units • Test cords and instruments

4. Verify motor starting and protection devices	• Potential relays
	  ○ Principles of operation
	  ○ Wiring diagrams

LEARNING TASKS	CONTENT
	○ Applications • 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

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	CONTENT

1. Describe refrigeration control applications	• Pump down systems
	• Defrost
	  ○ Hot gas
	  ○ 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	CONTENT
1. Install cables and conductors	• CEC • Supports • Colour coding • Class 2 circuits • Conduit • Wire labelling • Tools
2. Install junction and switch boxes	• CEC ○ Sizing • Conductor connections and terminations • Grounding/bonding • Tools
3. Install shielded cable	• Termination • Grounding

4. Describe isolation switch installations	• CEC
	  ○ Location
	  ○ Type
	  ○ Ratings

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	CONTENT
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
	  ○ Axial
	  ○ Centrifugal
	  ○ Forward incline
	  ○ Backward incline
	  ○ Propeller
	• Fan laws and performance curves
	• Ducting
	  ○ Design
	  ○ Layout
	  ○ Sizing
	  ○ Low velocity
	  ○ Static regain
	  ○ Equal friction
	  ○ High velocity
	  ○ Noise control
	• Air intakes/outlets
	  ○ Types
	  ○ Room air distribution
	  ○ Balancing
	  ○ K-factor

LEARNING TASKS	CONTENT

4. Describe air filtration and purification	• 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	• Application
	• Operation
	• Types
	  ○ Fixed plate
	  ○ Heat wheel
	  ○ Heat pipe

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

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	CONTENT

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

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

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

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

5. Calculate cooler loads	• Heat loads
	  ○ Beer storage cooler
	  ○ Floral cooler

LEARNING TASKS	CONTENT
	○ 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
6. Calculate freezer loads	• Heat loads ○ Pull down freezer ○ Storage freezer • Product freezing load ○ Three components – Sensible heat – Latent heat ○ Run time ○ Equipment selection

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:

- Create a field level risk assessment (FLRA).

LEARNING TASKS	CONTENT

1. Create a field level risk assessment (FLRA)	• Safety equipment
	• Job specifications
	  ○ Coordination with other trades
	• Site conditions
	  ○ Access
	• Site/company policies
	• Jurisdictional regulations
	• WorkSafe BC compliance

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	CONTENT

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

2. Select low temperature refrigeration equipment	• Load calculation • Supplier documentation • Engineering documentation • Verify utilities • Placement
3. Describe equipment placement	• Drawings and specifications ○ Clearances

LEARNING TASKS	CONTENT

4. Create a material take-off for a freezer	• Location
	  ○ Access to service
	  ○ Indoors/outdoors
	• Site conditions
	  ○ Utilities
	• Foundation
	  ○ Insulated floor
	• Levelling
	• Codes and regulations
	• Terminology
	• Lists
	• Site considerations
	• Application
	• Service ability
	• Scheduling/time
	• Material selection
	• Customer specifications

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

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 low temperature systems.

LEARNING TASKS

1. Describe the installation of low temperature systems

CONTENT

- Codes and regulations
- Drawings and specifications
  - Placement
- Equipment
- Components
- Accessories
- Site requirements
- Tools and equipment
- Supports
  - Seismic
- Piping
  - Types
  - Design
  - Insulation
  - Traps
  - Minimum velocities
  - Maximum velocities
  - Slope
- Pipe identification
- Assembly
  - Equipment
  - Components
  - Accessories
- Wiring
- Testing
  - Pressure
  - Vacuum
  - Electrical
- Evacuation
  - Manufacturer specifications
  - B52 code requirements
- Charging
  - Zeotropic refrigerants
  - 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	CONTENT
1. Create a control system material take-off	• Terminology • Lists • Site considerations • Application • Service ability • Scheduling/time • Material selection ○ Codes • Engineered specifications • Customer specfications

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	CONTENT
1. Describe characteristics of hydrocarbon gases	• Chemistry • Heat value • Specific gravity • Flow characteristics • Ignition and flame temperature • Flame speeds • Odourant • Limits of flammability
2. Describe the chemistry of combustion	• Requirements for combustion • Products of combustion • Stoichiometric combustion • Complete combustion • Incomplete combustion • Combustion yield formula

3. Calculate air requirements and products of combustion	• Air requirements
	  ○ Combustion
	  ○ Primary
	  ○ Secondary
	  ○ Excess
	  ○ Dilution
	  ○ Total
	• Products of combustion
	  ○ CO_2
	  ○ H_2O
	  ○ O_2
	  ○ N_2

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.

LEARNING TASKS	CONTENT

1. Describe draft	• Natural draft
	  ○ Buoyancy
	  ○ Temperature
	  ○ Height
	• Terms
	  ○ Stack effect
	  ○ Stack draft
	  ○ Natural draft
	  ○ Chimney effect
	• Mechanical draft

2. Describe the building as a system	• Negative air pressure
	• Exhaust equipment
	• Air supply equipment
	• Building envelope
	• Building ventilation
	  ○ Air exchange equipment
	• Regional location
	• Type of building
	• Code requirements
	  ○ B149.1
	  ○ Building Code

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	CONTENT

1. Describe the applications of mechanical safety devices	• Mechanical safety devices
	  ○ Pressure relief
	  ○ Temperature and pressure relief
	  ○ Pop safety (PSV)
	  ○ Safety relief (SRV)
	  ○ Vacuum relief
	  ○ Fusible plug
	  ○ Ratings
	• Codes and regulations
	• ASME standards
	• Ratings
	• Hot Water Boiler
	• Steam Boiler
	• Hot Water Tank
	• Pressure vessels
	  ○ Propane tanks (LPG)
	  ○ Propane cylinders
	• Compressed Natural Gas (CNG)

2. Describe installation of mechanical safety devices	• Discharge piping
	  ○ Termination
	  ○ 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	CONTENT
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
	  ○ Gas well
	  ○ Transmission line
	  ○ Compressor station
	  ○ City gate station
	  ○ District regulator station
	  ○ Distribution regulator
	  ○ Gas main
	  ○ Gas service
	  ○ Service stop (valve)
	  ○ Service regulator
	  ○ Meter
	• Consumer
	  ○ Gas supply or building line
	  ○ Branch line
	  ○ Drop line
	  ○ Riser
	  ○ Drip or dirt pocket
	  ○ Extension
	• Gas pressures
	  ○ High
	  ○ Low

3. Describe piping, tubing and hoses	• Types
	  ○ Black iron pipe
	  ○ Copper tubing
	  ○ PE piping
	  – Tracer wire
	  ○ Corrugated stainless steel tubing

LEARNING TASKS	CONTENT
	(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
4. Calculate the linear thermal expansion and contraction of various materials	• Ferrous • Non-ferrous • Thermoplastic
5. Describe hangers and supports	• Types • Construction • Uses • Expansion • Seismic restraint • Protective materials ○ Electrolysis • Spacing • Inserts and fasteners • Installation procedures
6. Join pipe and tubing	• Safety • Methods ○ Welding ○ Threading ○ Flaring ○ Compression fittings ○ Brazing ○ Fusion (PE) • Procedure • Hot taps • Tools • Fittings
7. Perform tube bending	• 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
  - Boilers
    - Hot water
    - Steam
    - High mass
    - Low mass
  - Direct fired make-up air heaters
  - Direct vent appliances
  - Decorative appliances
    - Fireplace
    - Fire pit
  - Furnaces
  - Radiant heaters
    - Low intensity
    - High intensity
  - Ranges and/or Commercial cooking equipment
  - Rooftop units
  - Unit heaters
  - Water heaters
    - Tankless
    - Storage type
  - Gas-fired refrigerators
- Characteristics
  - Appliance design
  - Direct-fired
  - 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	CONTENT
1. Identify conditions requiring more than routine maintenance	• Metal fatigue (wear) • Vibration • Improper lubrication • Misalignment • Incorrect adjustments • Loose connections • Failed safety or operational controls • Incorrect operation • System cleanliness • Equipment lifecycle

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 refrigeration systems.

LEARNING TASKS	CONTENT
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
	  ○ Inadequate cooling
	  ○ Consult onsite personnel
	  ○ Observe conditions before servicing
	  ○ Service history
	• Inspection/testing
	  ○ Sensory
	  ○ Diagnostic
	  – Acid test
	  – Pressure drop test
	  ○ Monitoring
	• Tools and equipment
	• Isolate components
	• Conditions for repair/replacement
	  ○ Obtain approval

LEARNING TASKS	CONTENT
	– 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
  - Time clock
  - Defrost initiation/termination
- Inspection
  - Sensory
  - Diagnostic
  - Monitoring
  - Electrical connections
  - Set points
    - Differentials
    - Temperature
    - Pressure
  - Calibration
  - Cycling
    - Defrost
    - Pump down
    - Temperature
    - Pressure
- Tools and equipment
- Manufacturer's specifications
- Codes and regulations
- Verification
  - Sequence of operation
  - Operating and safety controls
- Diagnotic tests
- Adjustments
- Conditions for repair/replacement
- Documentation
  - Maintenance reports

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
  - Lock-out/tag-out
- Verify reported problem
  - Consult onsite personnel
  - Observe conditions before servicing
- Test sequence of operation
  - Normal operation
  - Time clock
  - Defrost initiation/termination
  - Pump down
  - Temperature control
  - Safety settings
- Inspection
  - Sensory
  - Diagnostic
  - Monitoring
  - Electrical connections
  - Set points
    - Differentials
    - Temperature
    - Pressure
  - Calibration
  - Cycling
    - Defrost
    - Pump down
    - Temperature
    - Pressure
- Tools and equipment
- Isolate components
- Conditions for repair/replacement
  - 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	CONTENT

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	CONTENT
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 Completetion • Approvals • Variations to the National Gas Code • Bulletins, Directives and Safety Orders

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 contractual documents.
- Describe quote preparation.

LEARNING TASKS	CONTENT

1. Describe contractual documents	• Purpose
	• Types
	  ○ Agreements
	  ○ General conditions
	  ○ Drawings
	  ○ Specifications
	  – Master format
	  – Divisions
	• General requirements
	• Responsibilites 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

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:

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

LEARNING TASKS	CONTENT

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
	  ○ Cooling

LEARNING TASKS	CONTENT
3. Service metering devices	○ 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 prinicples.
- Identify electronic devices.
- Identify electronic DC power supplies.
- Describe proportional control operation

LEARNING TASKS	CONTENT

1. Describe electronic principles	• Construction
	  ○ P-N junctions
	  ○ Impurities
	  ○ Depletion regions
	  ○ Forward and reverse bias
	• Characteristics
	  ○ Heat
	  ○ 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
	  ○ Components
	  ○ Operating principles
	• Full-wave rectifier
	  ○ Components
	  ○ Operating principles
	  ○ Applications
	• Filters
	• Regulators

4. Describe proportional control operation	• Electronic

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	CONTENT
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	CONTENT

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

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

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

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:

- 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	CONTENT

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	CONTENT

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

4. Describe heat pumps	• Types
	  ○ Air-to-air
	  ○ Air-to-water
	  ○ Water-to-water
	  ○ Geothermal
	• Characteristics

5. Describe system configurations	• Classifications
	  ○ Floor mounted
	  ○ Roof top
	  ○ Split systems
	  ○ Window units
	  ○ Conventional
	  ○ Dual fuel
	• System functions
	  ○ Single-stage cooling
	  ○ Multi-stage cooling
	  ○ Single and multi-stage heat
	  ○ Inverter drive
	  ○ Low ambient
	  ○ Features
	  ○ Heat sources
	  ○ Humidification
	• Roof top units
	  ○ Ratings

LEARNING TASKS	CONTENT
6. Describe variable refrigerant flow systems	○ Application ○ Components • Two pipe system • Three pipe system • Branch boxes • Y-pipes • Proprietary training

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	CONTENT

1. Describe defrost systems	• Supplementary heat defrost
	  ○ Water defrost
	  ○ Brine spray systems
	  ○ Electric defrost
	  ○ 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	CONTENT

1. Describe the operation of residential hydronic heating systems	• Purpose
	• Centrifugal force
	  ○ Principles
	  ○ Applications
	• Hydrostatics
	  ○ Pressure and heat
	  ○ Transmission of fluid pressure
	  ○ Properties of liquid
	  ○ Fluid flow in pipes
	• Properties of water/brine
	  ○ Fluid flow
	  ○ Pipe sizing
	  ○ System practices
	  ○ Specific gravity
	  ○ Specific heat
	• Volumetric thermal expansion
	  ○ Expansion coefficients
	  ○ Temperature
	  – ΔT
	  ○ Volume
	• Components
	  ○ Expansion tank
	  ○ Mixing valves
	  ○ Air separator
	  ○ Zone headers
	  ○ Zone valves
	  ○ Pumps
	  – Classification
	  – Components
	  – Operation

LEARNING TASKS	CONTENT
	– 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
2. Select pumps	• Design parameters • System configuration • Pump curve tables • Sizing
3. Describe multi-boiler hydronic heating system components	• Piping configuration ○ Primary ○ Primary/secondary ○ Low loss header
4. Calculate volumetric thermal expansion	• Codes • Expansion coefficients • Temperature

LEARNING TASKS	CONTENT
	○ ΔT • Volume • Operating pressure
5. Describe low pressure steam systems	• 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 paramenters and requirements.
- Create an HVAC material take-off.

LEARNING TASKS	CONTENT
1. Select HVAC equipment	• Load calculation ○ Site location • Supplier documentation • Engineering documentation • Verify utilities • Site requirements • Placement

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

3. Verify HVAC system parameters and requirements	• System capacity • Utilities • Condensate drainage ○ 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.

LEARNING TASKS

1. Describe the installation of HVAC systems

CONTENT

- Codes and regulations
- Drawings and specifications
  - Placement
- Equipment
- Components
- Accessories
- Site requirements
- Tools and equipment
- Supports
  - Seismic
- Piping
  - Types
  - Design
  - Insulation
  - Traps
  - Minimum velocities
  - Maximum velocities
  - Slope
- Pipe identification
- Assembly
  - Equipment
  - Components
  - Accessories
- Wiring
- Testing
  - Pressure
  - Vacuum
  - Electrical
- Evacuation
  - Manufacturer specifications
  - B52 code requirements
- Charging
  - Zeotropic refrigerants
  - 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	CONTENT
1. Create a control system material take-off	• Terminology • Lists • Site considerations • Application • Service ability • Scheduling/time • Material selection ○ Codes • Engineered specifications • Customer specfications

2. Install HVAC control systems	• Safety requirements
	• Drawings and specifications
	  ○ Placement
	  – Equipment
	  – Components
	  – Accessories
	• Codes and regulations
	• Manufacturer specifications
	• Tools and equipment
	• Assembly pre-check
	• Hardware configuration
	  ○ Wireless access
	• Assembly
	• Mounting
	• Field wiring
	  ○ Outdoor air sensors
	  ○ Room sensors
	  ○ Bonnet sensor
	• Load requirements
	• Terminations
	• Programming

LEARNING TASKS	CONTENT
	○ Vacation mode – Freeze protection ○ Night set back ○ Heat anticipation ○ Low ambient lock-out ○ Change over control ○ Defrost frequency ○ Equipment staging • Verification ○ Operating ranges • Documentation ○ Service reports ○ Start-up sheets ○ Customer manuals ○ Labelling ○ As-built control schematics

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	CONTENT
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
	  ○ Boilers
	  ○ Furnaces
	  ○ Burners
	• Facilities/applications
	• Filters
	• Fuel conditioning
	• Pumps
	• Blowers

3. Describe the installation of duel-fuel appliances	• Code requirements
	• Manufacturer's specifications
	• Job specifications
	  ○ Piping materials
	  ○ Valves
	  ○ Controls

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	CONTENT

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

2. Describe atmospheric burners	• Types
	  ○ Main burners
	  ○ Pilot burners

LEARNING TASKS	CONTENT

3. Describe mechanical burners	• Parts
	  ○ Burner port
	  ○ Mixing tube
	  ○ Burner head
	• Operation
	  ○ Venturi effect (Bernoulli's principle)
	  ○ Primary air control
	  ○ Fuel control
	• Application
	• Terminology
	  ○ Turndown
	  ○ High fire
	  ○ Low fire
	  ○ Modulation
	• Characteristics
	  ○ Flame retention
	  ○ Fuel-air ratio
	  ○ Impingement
	• Types
	  ○ Pre-mix
	  ○ Nozzle mix
	  ○ Chamber mix
	  ○ Forced draft
	  ○ Fan assisted
	• Parts
	• Fuel/air adjustments
	• Operation
	• Applications
	• Gas pressures
	• High altitude installations

4. Describe burner orifices	• Types
	  ○ Plug
	  ○ Cap
	  ○ Adjustable
	• Sizing
	  ○ Tables
	  ○ Calculations
	  – Orifice flow formula
	  ○ Drilling
	• Drill index

LEARNING TASKS	CONTENT
5. Describe proportional mixers	• Fuel-air ratios • Adjustments • Zero governors
6. Describe the installation of mechanical burners	• 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	CONTENT

1. Describe flame detectors	• Thermocouple
	• Thermopile
	• Flame rectification (flame rod)
	• UV/IR
	• Pilot types
	  ○ Continuous
	  ○ Intermittent
	  ○ 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
	  ○ Honeywell
	  ○ Fenwall
	  ○ Siemens
	  ○ 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	CONTENT

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

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

3. Describe pressure regulators	• Types
	  ○ Direct operated
	  ○ Lever operated
	  ○ Zero governors
	  ○ Propane
	  – First stage
	  – Second stage
	• Operating elements
	  ○ Loading
	  ○ Measuring

LEARNING TASKS	CONTENT
	○ Restricting • Parts ○ Internal pressure relief • Operating principles ○ Droop/offset ○ Lock-up ○ Set point ○ Critical flow • Applications
4. Describe gas valve train for appliances 400 MBH or less	• Regulators • Gas valves • Manual valves ○ A-cock ○ B-cock ○ Test firing • Flow control
5. Describe the operation of a gas valve train	• Electric valves ○ Solenoid ○ Diaphragm ○ Combination • Non-electric valves ○ Rod and tube ○ Hydraulic • Pilot safety valve • Regulators

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	CONTENT

1. Describe outdoor reset controls	• Sensors
	  ○ Types
	• Thermistors
	• Applications
	• Cable types
	• Inputs
	• Outputs
	  ○ 0-10 VDC
	  ○ 4-20 mA
	• Heating curves
	  ○ System efficiencies

2. Describe the installation of outdoor reset controls	• Sensors
	  ○ Types
	  ○ Location
	• Thermistors
	• Applications
	• Cable types
	• Inputs
	• Outputs
	  ○ 0-10 VDC
	  ○ 4-20 mA
	• Heating curves
	• System efficiencies
	• Cabling termination and bonding
	• Wiring connections
	• Manufacturer's documentation

3. Describe multi-boiler hydronic heating system components	• Sequencing control • Wiring techniques

LEARNING TASKS	CONTENT

4. Describe multi-purpose controls	• Types
	  ○ Burner modulating
	  ○ Lead-lag
	• Tekmar™
	• Honeywell™
	• Programming

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:

- Describe installation of venting materials.
- Describe the installation of mechanical venting systems.

LEARNING TASKS	CONTENT

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	• Forced

LEARNING TASKS	CONTENT

systems	• Induced
	• 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
	• Grade/Slope

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	CONTENT

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

LEARNING TASKS	CONTENT
	– Dead boiler drain – Blow down – Flow control/balancing – Vacuum reliefs ○ Circulators ○ Expansion tanks ○ Feed water ○ Water treatment
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

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	CONTENT

1. Describe pre-start-up checklists	• Apply test equipment
	• Supply voltage
	• Actual voltage vs. rated
	• Utilities and connections
	  ○ Electrical connections
	  ○ 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	• Energize unit • Check control voltage • Check voltage imbalance • Check current imbalance • Check rotation

LEARNING TASKS	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 ΔTs ○ Note ambient temperature • Set to minimum position for outdoor air • All panels and doors secured • Documentation ○ Record charge level
3. Set-up secondary system components	• 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

Line (GAC): K COMMISSION 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	CONTENT

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 specfications
	• 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
  - Insufficient heat
  - Inadequate cooling
  - Consult onsite personnel
  - Observe conditions before servicing
  - Service history
- Inspection/testing
  - Sensory
  - Diagnostic
    - Acid test
    - Pressure drop test
    - Electrical test
  - Monitoring
- Tools and equipment
- Isolate components
- Conditions for repair/replacement
  - Obtain approval
    - Cost estimating
  - Temperature
  - Leaks
  - Corrosion
  - Malfunction
  - Vibration
  - Irregular movement
- Procedures
  - Cleaning
  - Purging
  - 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 requirementts
- 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
- Diagnotic 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
- Diagnotic tests
- Adjustments
- Conditions for repair/replacement
- Return to service
- Documentation
  - Electronic
  - Paper
  - Maintenance reports

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 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
- Repair/replace components

LEARNING TASKS	CONTENT

	• 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.

LEARNING TASKS	CONTENT
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	CONTENT

1. Describe the inspection of ancillary equipment	• 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 insepcting ancillary equipment.

LEARNING TASKS	CONTENT

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	CONTENT
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
	  ○ Pilot
	  ○ 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	CONTENT
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	CONTENT
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	CONTENT
1. Describe effective communication practices	• 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	CONTENT

1. Describe learning strategies	• Coaching
	• Leadership
	• Practice
	• Assessing
	  ○ Contructive feedback
	  ○ Educating
	• Positive reinforcement
	• Proactive check-in

2. Describe outcomes of effective coaching	• Protocols • Responsibilities • Punctuality • Safety • Collaboration

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	CONTENT

1. Troubleshoot complex circuits	• 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	CONTENT

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	CONTENT

1. Describe electronic refrigerant monitoring	• Types
	• Applications
	  ○ Alarm
	  ○ Device interlocks
	  ○ Communications
	  ○ Locations
	• Operation
	• Code and regulations
	• Manufacturer's specfications

2. Describe other safety monitoring devices	• Gas detection devices
	  ○ Combustible gas detection
	  ○ CO_2

3. Select control point instrumentation	• Types
	  ○ Flow meters
	  ○ Communication interface devices
	• Applications
	• Operation

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 indirect systems.
- Describe ultra-low temp systems.
- Describe absorption systems.
- Describe ammonia systems.

LEARNING TASKS	CONTENT

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

3. Describe absorption systems	• Lithium-bromide absorption cycle ○ Identify components

LEARNING TASKS	CONTENT
4. Describe ammonia systems	○ 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 • Liquid recirculation systems ○ Basic system types

LEARNING TASKS	CONTENT
	○ 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 CO_2 systems	• Types ○ Subcritical system ○ Transcritical system – Plot PE chart • Tools and equipment • Applications ○ Multi-temperature • Operations • Limitations • Safety ○ Charging considerations

LEARNING TASKS	CONTENT
	○ Component ratings

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	CONTENT

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

2. Install piping, tubing and hoses	• Types
	• Methods
	• Code requirements
	• Identification
	• Procedures
	• Fittings
	• Valves
	• Prohibited practice
	• Location limitations
	• Structural penetrations
	  ○ Fire stopping
	• Outlets
	• Drip or dirt pockets
	• Between buildings
	• Concealment
	  ○ Protection plates

LEARNING TASKS	CONTENT
	• In concrete • Protective coatings • Underground • Support • Tools • Connectors

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	CONTENT
1. Describe the installation of manual shut-off valves	• Code requirements • Manufacturer's specifications • Procedures ○ 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
	  ○ Lines
	  ○ Limiting orifices
	  ○ Surge arrestors
	• Sizing
	• Orientation
	• Termination
	• Code requirements

4. Size regulators	• Types
	  ○ Level operated
	  ○ Direct operated
	  ○ Integrated/combination
	  ○ Zero governors
	• Application
	• Manufacturer's documentation
	• Sizing tables
	  ○ Flow rate
	  ○ Pressure drop
	  ○ Orifice selection
	  ○ 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	CONTENT

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	CONTENT

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

LEARNING TASKS	CONTENT
	– Size

4. Describe installation of passive air supply	• 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	CONTENT

1. Describe draft control systems	• Types
	  ○ Dampers
	  – Mechanical
	  – Thermal
	  ○ Hoods
	  ○ Diverters
	  ○ 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
	  ○ Single acting
	  ○ Double acting
	• Code requirements
	• Adjustments
	• Tools and testing equipment
	• Pressures
	  ○ Effects on combustion chamber
	  ○ 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.

LEARNING TASKS	CONTENT
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 vapourizaton rate
	• Describe cylinder/tank clearances from building
	  ○ Openings
	  ○ Air intakes
	  ○ Doors
	  ○ Windows
	  ○ Flue termination
	  ○ Dryer vents
	• Location
	• Placement
	• Support
	• Protection
	• Access

LEARNING TASKS	CONTENT
	○ Filling – Safety – Emergency procedures – Liquid handling ○ Maintenance ○ Vehicle • Security/fencing • Containment
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 withdrawl applications ○ Description ○ Operation ○ Maintenance • Valves and accessories for liquid withdrawal applications ○ Description ○ Operation ○ Maintenance • Valves and accessories for filling applications ○ Description ○ Operation

LEARNING TASKS	CONTENT
	○ Maintenance
5. Natural gas and propane appliance conversions	• High altitude • Pressure setting • Orifice sizing • Flame adjustment • Clocking • Codes

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	CONTENT
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
	  ○ 7-14 in WC
	  ○ 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	CONTENT
1. Describe piping and tubing testing requirements	• B149.1 • Pressure • Duration • Equipment

2. Describe piping and tubing pressure testing procedures	• Air
	  ○ Tools
	  ○ Equipment
	  ○ Spools
	  ○ System isolation
	  – Lockout
	• Inert gases
	  ○ Tools
	  ○ Equipment
	  ○ Spools
	  ○ System isolation
	  – Lockout
	  ○ Calculations
	• Leak (integrity) testing
	  ○ Soap test
	  ○ After appliance connection
	• Valve tightness of closure testing

3. Describe purging procedures for piping and tubing under 4-inch diameter	• Code requirements
	  ○ Locations
	  ○ Equipment
	• Duration

4. Describe purging procedures for pipe 4-inch diameter and larger	• Code requirements • Inert gases • Applications • Purpose • Equipment ○ Approved burners

LEARNING TASKS	CONTENT
	○ Gauges ○ Regulators • Pressures • Velocity
5. Commission regulators	• Droop • Lock up pressure • Inlet pressure • Downstream set point pressure • Location of test gauges • Codes
6. Size burner orifices	• Types of fuel gases • Tables • Calculations ○ Orifice flow formula ○ Fuel gas conversions • Drilling • Drill index
7. Use gas metering devices	• Low pressure clocking • High pressure clocking • High altitude appliance derating

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	CONTENT

1. Describe start-up checklists	• Appliance types
	  ○ Boilers
	  ○ Furnaces
	  ○ Storage type water heaters
	  ○ Tankless water heaters
	  ○ Gas range
	  ○ Gas dryer
	  ○ Unit heater
	  ○ 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
	  ○ B149.1
	  ○ C22.1
	• Manufacturer's documentation
	• Remove shipping materials
	• Belt/pulley alignment
	• Tightness of electrical connections

LEARNING TASKS	CONTENT
	• Valve tightness test • Leak test • Hydrostatic test
3. Verify electrical operating parameters	• Tightness of electrical connections • Verify voltage • Code compliance • Verify electrical wiring diagram

4. Adjust burners	• Types of burners
	  ○ Atmospheric
	  ○ Fan assisted
	  ○ Forced draft
	• Start-up procedure
	• Manifold pressure
	  ○ Measurement
	  ○ Adjustment
	• Burner input calculations
	  ○ Clocking
	• Altitude compensation
	  ○ High altitude de-rating
	• Flame characteristics
	• Air adjustments
	  ○ Air shutter
	  ○ Air damper
	  ○ Fan speeds
	• Pilot test
	  ○ Turn-down
	  ○ Drop-out
	• Flame failure response time

5. Commission boilers and water heaters	• Code requirements
	• Verify component specifications
	  ○ Appliance rating
	  ○ Relief valves
	  ○ Safety and limits
	  ○ Vacuum relief valve
	  ○ Expansion device
	  ○ Flame safeguard
	• Water temperature
	  ○ Operating set point
	  ○ Return water temperature
	  ○ Feed water temperature
	• Pressure set point

LEARNING TASKS	CONTENT

	• Purging and flushing
	• Water treatment
	• Relief piping
	• Draft
	• Spillage
	• Air inlet openings
	• Water flow rates
	  ○ Circulator speed
	  ○ Balancing valves
	• Condensate neutralization and disposal
	• Combustion analysis

6. Verify safety devices, limits, and operating controls	• Interlocks • High limit • Operating controls • Thermostat • Flame roll out switch • Pressure switch ○ Air • End switch • Spill switch (vent safety)

7. Commission a high efficiency furnace	• Heat exchanger temperature rise
	• External static pressure (ESP)
	• Condensate trap
	• Condensate pump
	• Condensate neutralizing tank
	• Air cleaners
	• Temperature set points
	• Flame safeguard
	  ○ Sequence timing
	  ○ Hot surface igniter (HSI amp draw)
	  ○ Flame rod current
	  ○ Flame failure response
	• Blower speed and operation
	• Check condition of heat exchanger
	• Combustion analysis

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 safey 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	CONTENT

1. Describe gas meters	• Types
	  ○ Positive displacement
	  – Bellows
	  – Rotary
	  ○ Inferential meter
	  – Ultrasonic
	  – Turbine
	• Protection
	  ○ Mechanical damage (bollards)
	  ○ Snow/ice accumulation
	• Principles of operation
	  ○ Positive displacement
	• Capacity
	• Pressure compensation
	• Reading
	  ○ Test dials
	  ○ Imperial
	  ○ Metric
	• Clocking

2. Describe the process used to determine the input of an appliance	• Calorific values • Clocked flow rates • Calculated inputs • Pressure correction factor • Temperature correction factor

3. Perform flue gas analysis	• Analyzer calibration
	• Fuel selection
	• Sampling locations
	• Manufacturer's documentation
	• Interpret readings
	  ○ Acceptable range
	  – CO_2
	  – O_2
	  – CO
	  – Temperature

LEARNING TASKS	CONTENT
	– Stack draft • Required adjustments • Data storage o Printed results o Electronic spreadsheet
4. Describe NOx	• Characteristics
5. Maintain combustion analyzer	• Annual calibration and re-certification • Storage and handling o Water trap maintenance o Manufacturer's documentation • Cell replacement

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	CONTENT
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 COMMISSION 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	CONTENT
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	CONTENT
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
  - Insufficient heat
  - Inadequate cooling
  - Consult onsite personnel
  - Observe conditions before servicing
  - Service history
- Inspection/testing
  - Sensory
  - 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
  - Monitoring
- Tools and equipment
- Isolate components
- Conditions for repair/replacement
  - Obtain approval
    - Cost estimating
  - Temperature
  - Leaks
  - Corrosion
  - 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
2. 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

LEARNING TASKS	CONTENT

treatment
  - Sediment
  - Scale accumulation
  - Condition of fill
  - Blow down
  - Δ T
  - Δ P
  - Air eliminators
  - Site conditions
  - Pumps
- Monitoring

- Tools and equipment
- Isolate components
- Conditions for repair/replacement
  - Obtain approval
    - Cost estimating
  - Temperature
  - Leaks
  - Corrosion
  - Malfunction
  - 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
  - Log books

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
  - Occupancy
  - Holiday
- Inspection
  - Diagnostic
  - Monitoring
  - Alarms
    - Acknowledge
    - Action
- Tools and equipment
- Manufacturer's specifications
- Codes and regulations
- Verification
  - Sequence of operation
  - Operating and safety controls
  - Communication protocols
- Diagnotic tests
- Adjustments
- Backup programming
- Conditions for repair/replacement
- Return to service
- Documentation
  - Electronic
  - Paper
  - 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
  - Lock-out/tag-out
- Verify reported problem
  - Consult onsite personnel
  - Observe conditions before servicing
- Test sequence of operation
  - Normal operation
- Inspection
  - Remote access
  - Local access
  - Internet connection
  - Direct connection
  - Diagnostic
  - Monitoring
  - Alarms
    - Acknowledge
    - Action
- Tools and equipment
- Isolate components
- Conditions for repair/replacement
  - Obtain approval
- Procedures
- Faults
- Causes
  - System readings
  - Data
- Codes and regulations
- Manufacturer's specifications
- Repair/replace components
- Return to service
  - Restore to normal operation
  - Verify correct operation
  - Check back with customer

LEARNING TASKS	CONTENT

	• 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.

LEARNING TASKS	CONTENT
1. Describe the repair procedures for a gas distribution system	• Isolate system ○ Lockout procedures • Inform customer • Plan repair • Purge piping • Remove/replace components • Pressure testing • Purging and gasifying

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	CONTENT

1. Describe the procedures for servicing gas burners	• Service schedule
	• Inspection
	  ○ Appearance
	  ○ Performance
	  ○ Signs of flame impingement
	  ○ Sooting
	• Cleaning
	• Reassembly
	• Recommission
	  ○ Firing
	  ○ Clocking
	  ○ 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	CONTENT

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

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

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

LEARNING TASKS	CONTENT

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 verifcation
	  ○ 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

LEARNING TASKS	CONTENT
	○ Furnaces ○ Radiant heaters – Low intensity – High intensity ○ Ranges and/or Commercial cooking equipment ○ Rooftop units ○ Unit heaters • Manufacturer's documentation • Technical Safety BC requirements • Contractor's check list/service report
8. Service high efficiency furnaces	• Verify ○ Heat exchanger temperature rise ○ External static pressure (ESP) ○ Temperature set points ○ Blower speed and operation • Inspect ○ Condensate trap ○ Condensate pump ○ Neutralize tank ○ Air cleaners ○ Heat exchanger
9. Service tankless heaters	• Inspect ○ Condensate trap ○ Condensate pump ○ Neutralize tank ○ Heat exchanger ○ Water flow rates – Flow balancing • Verify ○ Water treatment ○ Temperature set points ○ Supply and return water temperatures ○ Make-up water ○ Expansion tank pressure

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	CONTENT

1. Describe gas regulator troubleshooting procedures	• Manufacturer's documentation
	• Disconnect vent line connection
	• Verify regulator performance
	  ○ Setpoint
	  ○ Droop
	  ○ 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	CONTENT
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
	  ○ Pilot
	  ○ Main burner
	• Confirm pressure regulation
	• Tightness of closure

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

ASSESSEMENT GUIDELINES

Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	REFRIGERATION AND AIR CONDITIONING MECHANIC LEVEL 1		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	Perform Safety Related Functions	5%	15%
B	Use Tools and Equipment	12%	25%
C	Perform Routine Trade Activities	12%	15%
D	Use Communication Techniques	1%	0%
E	Apply Electrical Concepts	17%	15%
F	Apply Refrigeration and Air Conditioning Theory	12%	10%
G	Plan Refrigeration and Air Conditioning Installations	12%	0%
H	Install Refrigeration and Air Conditioning Systems	16%	20%
L	Service Refrigeration and Air Conditioning Systems	13%	0%
	Total	100%	100%
In-school theory / practical subject competency weighting		80%	20%
Final in-school percentage score		IN-SCHOOL %	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	100%

Assessment Guidelines – Level 2

Level 2 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	REFRIGERATION AND AIR CONDITIONING MECHANIC LEVEL 2		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
B	Use Tools and Equipment	11%	20%
C	Perform Routine Trade Activities	11%	40%
E	Apply Electrical Concepts	20%	0%
F	Apply Refrigeration and Air Conditioning Theory	11%	10%
G	Plan Refrigeration and Air Conditioning Installations	11%	30%
H	Install Refrigeration and Air Conditioning Systems	12%	0%
I	Apply Gas Utilization Theory	7%	0%
J	Install Gas-Fired Systems	7%	0%
L	Service Refrigeration and Air Conditioning Systems	10%	0%
	Total	100%	100%
In-school theory/practical subject competency weighting		80%	20%
Final in-school percentage score		IN-SCHOOL %	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	100%

Assessment Guidelines – Level 3

Level 3 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	REFRIGERATION AND AIR CONDITIONING MECHANIC LEVEL 3		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
B	Use Tools and Equipment	6%	0%
C	Perform Routine Trade Activities	9%	0%
E	Apply Electrical Concepts	12%	100%
F	Apply Refrigeration and Air Conditioning Theory	12%	0%
G	Plan Refrigeration and Air Conditioning Installations	8%	0%
H	Install Refrigeration and Air Conditioning Systems	8%	0%
I	Apply Gas Utilization Theory	6%	0%
J	Install Gas-Fired Systems	9%	0%
K	Commission Systems	12%	0%
L	Service Refrigeration and Air Conditioning Systems	10%	0%
M	Service Gas-Fired Appliances and Equipment	8%	0%
	Total	100%	100%
In-school theory / practical subject competency weighting		90%	10%
Final in-school percentage score		IN-SCHOOL %	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	100%

Assessment Guidelines – Level 4

Level 4 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	REFRIGERATION AND AIR CONDITIONING MECHANIC LEVEL 4		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
C	Perform Routine Trade Activities	17.5%	10%
D	Use Communication Techniques	2%	0%
E	Apply Electrical Concepts	17.5%	0%
F	Apply Refrigeration and Air Conditioning Theory	12.5%	0%
J	Install Gas-Fired Systems	12.5%	45%
K	Commission Systems	18%	45%
L	Service Refrigeration and Air Conditioning Systems	10%	0%
M	Service Gas-Fired Appliances and Equipment	10%	0%
	Total	100%	100%
In-school theory / practical subject competency weighting		70%	30%
Final in-school percentage score 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.

SkilledTradesBC will enter the apprentices' Refrigeration and Air Conditioning Mechanic Interprovincial Red Seal examination percentage score into SkilledTradesBC 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

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

Standard Equipment

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

Hoisting, Rigging and Access Tools and Equipment

- Come-a-longs and Tirfors
- Ladders
- Rope/cable
- Shackles
- Slings and chokers
- Snatch blocks

Student Tools (supplied by student)

Required

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

Recommended

- N/A

Reference Materials

Required Reference Materials

- Modern Refrigeration and Air Conditioning – Althouse, Turnquist, Bracciano, The Goodheart-Wilcox Company Inc., (19th or 20th edition), ISBN-13 978-1631263552
- 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
- Fundamentals of Gas Utilization – John Dutton, ISBN 978-0-9198-5235-8
- CSA, Gas Trade 3 Package, SKU: 2424179
- CSA, Gas Trade 2 Package, SKU: 2424187
- CSA, Gas Trade 1 Package, SKU: 2424604

Recommended Resources

- Principles of Refrigeration, Roy J. Dossatt, John Wiley & Sons, Inc., ISBN-13 978-0130272706
- Trane Reciprocating Refrigeration Manual, The Trane Company, ISBN - NA
- Trane Air Conditioning Manual, The Trane Company, ISBN - NA
- Low Pressure Boilers, Frederick M. Steingrass, Daryl R. Walker, American Technical Publishers, ISBN 978-0-8269-4365-1
- High Pressure Boilers, Frederick M. Steingrass,Harold J. Frost, Daryl R. Walker, American Technical Publishers, ISBN 978-0-8269-4315-6
- IPT's Pipe Trades Handbook, ISBN 978-0-920855-18-8
- IPT's Guide to Blueprint Interpretation, ISBN: 978-0-920855-42-3
- CAN/ CSA B.214 Installation of Hydronic Heating Systems
- Modern Hydronic Heating – John Seigenthaler, ISBN - NA
- Design of Fluid Systems – Spirax Sarco, ISBN - NA
- Electricity & Controls for HVAC/R – Herman/Sparkman, ISBN 978-1133-2782-07
- Electric Motors and Control Systems, Frank D. Petruzella, ISBN 978-0-07-434257-9

Suggested Texts/Websites

- Technical Safety BC www.technicalsafetybc.ca
- TECA, Thermal Environmental Comfort Association, www.teca.ca
- SkilledTradesBC www.skilledtradesbc.ca
- CSA, www.csagroup.org
- Red Seal, www.red-seal.ca
- WorkSafeBC, 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
- SkilledTradesBC 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 CO_2, CO, O_2, 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

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

OH&S	Occupational Health and Safety
OS&Y	Outside stem and yoke (valve)
PLC	Programmable logic controller
PPE	Personal protective equipment
PRV	Pressure relief valve
PTFI	Pilot trial for ignition
PLC	Programmable logic controller
RPM	Revolutions per minute
RTD	Resistance temperature detector
SCR	Selective catalytic reduction
SDS	Safety data sheet
TDG	Transportation of dangerous goods
TXV	Thermostatic expansion valve
UL	Underwriters Laboratories
ULC	Underwriters Laboratories of Canada
UST	Underground storage tank
VFD	Variable-frequency drive
VSD	Variable speed drive
WHMIS	Workplace Hazardous Materials Information System

Appendix C
Previous Contributors

This Program Outline was prepared with the advice and direction of an industry steering committee with funding support from SkilledTradesBC.

SkilledTradesBC 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