

SKILLED**TRADES**^{BC}

PROGRAM OUTLINE

Refrigeration and Air Conditioning
Mechanic

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REFRIGERATION AND AIR CONDITIONING MECHANIC HARMONIZED PROGRAM OUTLINE

**APPROVED BY INDUSTRY
DECEMBER 2018**

**BASED ON
RSOS 2019**

**Developed by
SkilledTradesBC
Province of British Columbia**

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Section 1

INTRODUCTION

**Refrigeration and Air Conditioning
Mechanic**

Foreword

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

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

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

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

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

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

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

Important Program Information:

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

SAFETY ADVISORY

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

Acknowledgements

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

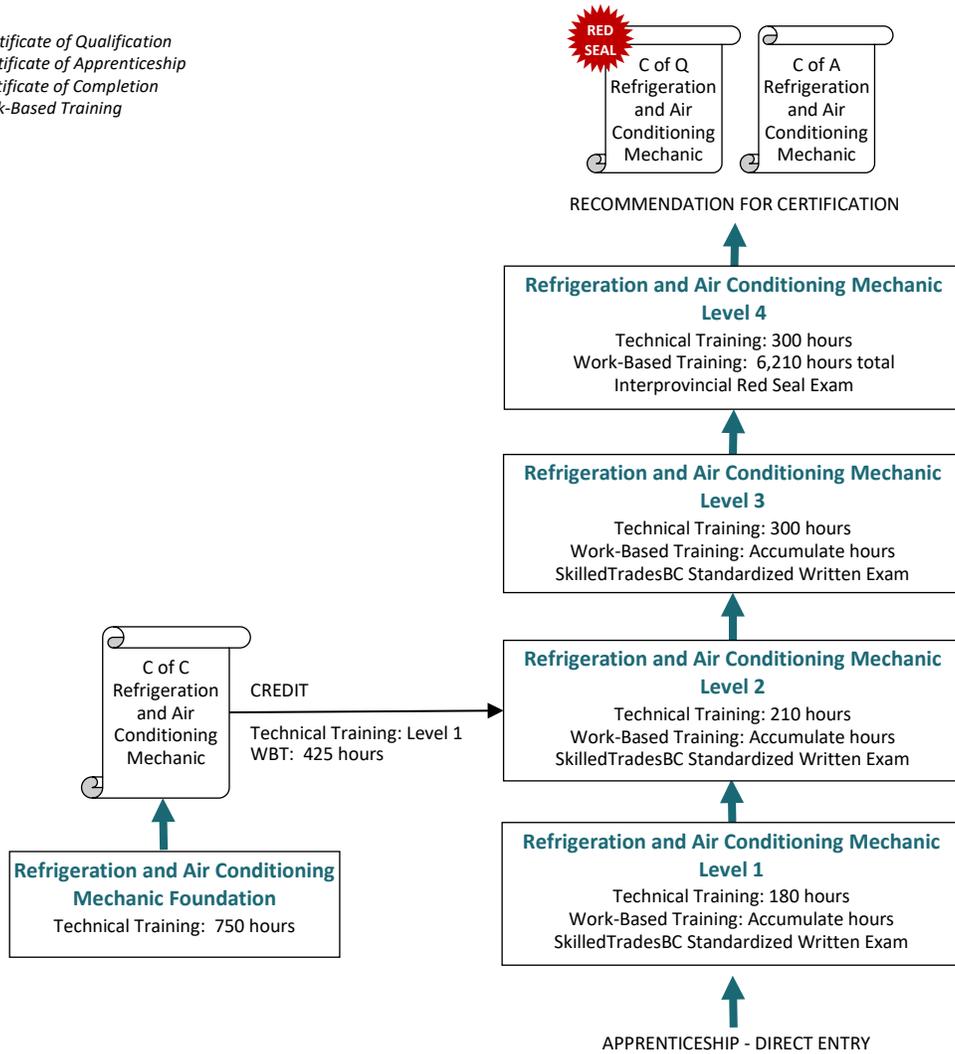
Section 2

PROGRAM OVERVIEW

**Refrigeration and Air Conditioning
Mechanic**

Program Credentialing Model

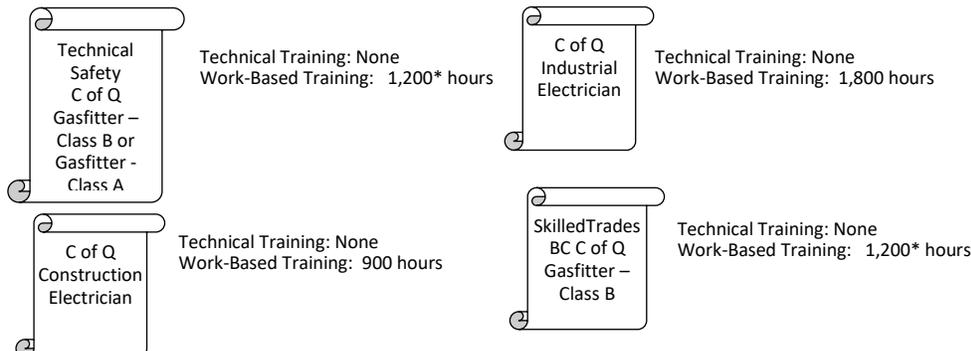
C of Q = Certificate of Qualification
 C of A = Certificate of Apprenticeship
 C of C = Certificate of Completion
 WBT = Work-Based Training



CROSS-PROGRAM CREDITS

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

Please note: Certifications obtained outside of British Columbia may not be eligible for the same credit towards certification in this trade. Please contact SkilledTradesBC to verify the Cross-Program Credits applicable to out-of-province certifications.



** Individuals who are holders of more than one of these credentials will only be awarded credit for up to 1,200 hours total*

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

**HARMONIZED PROGRAM OUTLINE
Program Overview**

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

HARMONIZED PROGRAM OUTLINE
Program Overview

INSTALL GAS-FIRED SYSTEMS J	Identify Burners J1 3	Identify Flame Safeguards J2 3	Install Gas Piping and Tubing Systems J3 2 4	Install Gas Regulators, Valves and Valve Train Components J4 3 4	Install Gas Controls J5 3 4	Install Air Supply Systems J6 4
	Install Gas Venting Systems J7 3 4	Install Draft Control Systems J8 4	Install Gas-Fired Appliances and Ancillary Equipment J9 2 3	Install LPG, LNG, CNG, Vaporizing and Mixing Systems J10 4	Plan Gas-Fired Appliance System Installations J11 4	
COMMISSION SYSTEMS K	Commission HVAC/R Systems K1 3	Commission Control Systems K2 3	Commission Fuel/Air Delivery Systems K3 4	Commission Gas-Fired Appliances and Ancillary Equipment K4 4	Perform Combustion Analysis K5 4	Commission Draft Control Systems K6 4
	Training and Handover of Gas-Fired Equipment K7 4	Decommission and Disconnect Appliances and Equipment K8 4				
SERVICE REFRIGERATION AND AIR CONDITIONING SYSTEMS L	Maintain HVAC/R Systems L1 1 2	Service HVAC/R Systems L2 2 3 4	Maintain Control Systems L3 2 3 4	Service Control Systems L4 2 3 4		
	Service Gas Distribution Systems M1 3 4	Service Gas Burners and Ancillary Equipment M2 3 4	Maintain Gas-Fired Appliances, Boilers and Ancillary Equipment M3 3 4	Service Fuel/Air Delivery Systems M4 4	Service and Repair Gas Control Systems M5 3 4	Maintain Gas-Fired Refrigeration Equipment M6 4

Training Topics and Suggested Time Allocation – Level 1

REFRIGERATION AND AIR CONDITIONING MECHANIC

		% of Time Allocated to:			
Level 1		% of Time	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

		% of Time Allocated to:			
Level 2		% of Time	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		✓		

		% of Time Allocated to:			
Level 2		% of Time	Theory	Practical	Total
Line L	SERVICE REFRIGERATION AND AIR CONTIONING 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

		% of Time Allocated to:			
Level 3		% of Time	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		✓		

		% of Time Allocated to:			
Level 3		% of Time	Theory	Practical	Total
Line L	SERVICE REFRIGERATION AND AIR CONDITIONING 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

		% of Time Allocated to:			
Level 4		% of Time	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, Vaporizing 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 CONDITIONING SYSTEMS	10%	90%	10%	100%
L2	Service HVAC/R Systems		✓	✓	
L3	Maintain Control Systems		✓	✓	
L4	Service Control Systems		✓	✓	

		% of Time Allocated to:			
Level 4		% of Time	Theory	Practical	Total
Line M	SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT	5%	80%	20%	100%
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

LEARNING TASKS

CONTENT

- | | |
|--|--|
| <p>5. Describe how site-specific safety policies are established</p> | <ul style="list-style-type: none"> ○ Regulations ● Transportation of Dangerous Goods (TDG) ● Occupational Health and Safety (OHS) regulation <ul style="list-style-type: none"> ○ Rights and responsibilities ○ Inspections ○ General conditions ● WorkSafeBC standards <ul style="list-style-type: none"> ○ Emergency shutoffs ● Chemical hazard response <ul style="list-style-type: none"> ○ Eyewash facilities ○ Emergency shower ● Evacuation plan <ul style="list-style-type: none"> ○ Marshalling/mustering areas ○ Emergency exits ○ Emergency contact/phone numbers ● Standards, acts and regulations ● Hazard assessment <ul style="list-style-type: none"> ○ Safety policy ○ Site conditions ○ Working in isolation ● Types of meetings <ul style="list-style-type: none"> ○ 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

- | | |
|--|--|
| <p>1. Describe Personal Protective Equipment (PPE)</p> | <ul style="list-style-type: none"> • Safety footwear • Eye protection • Ear protection • Head protection • Arc flash protection • Respiratory protection <ul style="list-style-type: none"> ○ Positive pressure ○ Negative pressure • Clothing <ul style="list-style-type: none"> ○ High visibility workwear ○ Sun protection factor (SPF) ○ Gloves ○ Fall protection |
| <p>2. Describe safety equipment</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Fire extinguishers ○ First aid ○ Ventilation ○ Screens ○ Spill kits • Procedures • Storage • Limitations • Standards, acts and regulations |
| <p>3. Use Personal Protective Equipment (PPE)</p> | <ul style="list-style-type: none"> • Purpose • Selection • Operating procedures • Training requirements <ul style="list-style-type: none"> ○ 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

1. Identify energy sources

2. Describe lock-out and tag-out

3. Use lock-out and tag-out procedures

CONTENT

- Electricity
- Pressure
- Kinetic

- System operation
- Components
- Lock-out condition requirements
- Lock-out equipment
 - Locks
 - Tags
 - Identification requirements
 - Chains
 - Support blocks
 - Blind flanges
 - Spades
 - Spectacle blinds
- 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: <ul style="list-style-type: none">• Safety• Completion and verification of:<ul style="list-style-type: none">○ 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

- | | |
|--|---|
| <p>1. Describe the conditions necessary to support a fire</p> | <ul style="list-style-type: none"> • Air • Fuel • Heat |
| <p>2. Describe the classes of fires according to the materials being burned</p> | <ul style="list-style-type: none"> • Class A • Class B • Class C • Class D • Symbols and colours |
| <p>3. Apply preventative fire safety precautions</p> | <ul style="list-style-type: none"> • Hot work permit (site specific) • Handling and storage of flammable materials • Symbols • Fuels <ul style="list-style-type: none"> ○ Diesel ○ Gasoline ○ Propane ○ Natural Gas ○ Dust ○ Insulation • Ventilation, including purging • Lubricants • Oily rags • Combustible metals • Aerosols • Fire extinguisher <ul style="list-style-type: none"> ○ Expiry date ○ Fill level |
| <p>4. Describe the considerations and steps to be taken prior to fighting a fire</p> | <ul style="list-style-type: none"> • 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

1. Describe hand tools

CONTENT

- Types
 - Files
 - Metal saws
 - Taps and dies
 - Chisels, drifts, punches
 - Hammers
 - Woodworking tools
 - Gasket forming tools
 - Wrenches
 - Wheel and gear pullers
 - Pliers
 - Shears and snips
 - Screwdrivers
 - Tube benders
 - Flaring/swaging tools
 - Tube cutters
 - Hand pipe threader

2. Use hand tools

- Parts
- Applications
- Procedures
- Safety
- Adjustment
- Inspection
- Maintenance
- Storage

3. Describe levelling tools

- Types
 - Rules
 - Plumbs
 - Square
 - Levels
 - Laser
 - Chalk line
 - Tape measure
- Applications
 - Levelling

LEARNING TASKS

4. Use levelling tools

CONTENT

○ Alignment

- Procedures
- Inspection
- Maintenance
- Storage

Line (GAC): **B USE TOOLS AND EQUIPMENT**
Competency: **B2 Use Portable and Stationary Power Tools**

Objectives

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

- Use power tools.

LEARNING TASKS

1. Describe portable power tools

2. Describe stationary power tools

3. Use power tools

CONTENT

- 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
- Types
 - Cutting tools
 - Grinding and abrasive tools
 - Threading tools
 - Drilling and boring tools
 - Grooving tools
 - Specialty tools
- Accessories
- Parts
- Guards
- Applications
- Procedures
- Capacities
- Safety
- Adjustment
- Inspection
- Maintenance
- Storage

Line (GAC): **B USE TOOLS AND EQUIPMENT**
Competency: **B3 Use Brazing and Soldering Equipment**

Objectives

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

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

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe the brazing and soldering process
 2. Describe the procedures for brazing and soldering
 3. Describe air-fuel and oxy-fuel equipment
 4. Use air-fuel and oxy-fuel equipment to braze and solder | <ul style="list-style-type: none"> • Principles • Applications • Filler alloys • Equipment • Safety requirements <ul style="list-style-type: none"> ○ Fire protection equipment ○ Ventilation
 • Joint preparation and design • Flux selection • Flame for brazing • Purging
 • Cylinders • Regulators <ul style="list-style-type: none"> ○ Purging • Gauges • Flashback arrestors • Hoses • Spark arrestors • Torches • Torch attachments • Tips • Inspection • Maintenance • Storage • Transportation
 • Safety <ul style="list-style-type: none"> ○ 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

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <ul style="list-style-type: none"> 5. Describe recovery/recycling equipment
 6. Use recovery/recycling equipment | <ul style="list-style-type: none"> • Safety • Adjustment • Inspection/procedure • Maintenance <ul style="list-style-type: none"> ○ Oil <ul style="list-style-type: none"> – Clean – Levels ○ Clean and flush ○ Inspect and replace components <ul style="list-style-type: none"> – Gauges – O-rings – Seals – Hoses • Verify and test <ul style="list-style-type: none"> ○ Micron gauges • Storage <ul style="list-style-type: none"> ○ Secure position ○ Prevent oil spillage • Types • Parts • Applications • Manufacturer’s specifications • Procedures <ul style="list-style-type: none"> ○ Push/pull ○ Liquid and vapour recovery ○ Efficient recovery ○ Contaminated system recovery <ul style="list-style-type: none"> – Filter driers • Safety • Inspection • Maintenance <ul style="list-style-type: none"> ○ Clean and test <ul style="list-style-type: none"> – Recovery units – Hoses – Screens and filters <ul style="list-style-type: none"> ▪ Blockage ▪ Proper refrigerant filtration ○ Refrigerant cylinders <ul style="list-style-type: none"> – Certification – Storage <ul style="list-style-type: none"> ▪ Secure |
|---|---|

LEARNING TASKS

CONTENT

- Upright
- 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

- | | |
|--|---|
| <p>1. Describe precision measuring tools</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Micrometers ○ Manometers <ul style="list-style-type: none"> – Accessories ○ Indicators ○ Vernier calipers ○ Feeler gauges ○ Tachometers ○ Mechanical gauges <ul style="list-style-type: none"> – Bourdon tube – Compound <ul style="list-style-type: none"> ▪ Magnehelic • Parts • Applications • Scales • Accuracy |
| <p>2. Use precision measuring tools</p> | <ul style="list-style-type: none"> • Procedures • Safety • Adjustment • Inspection • Maintenance <ul style="list-style-type: none"> ○ Certification ○ Calibration • Storage |
| <p>3. Describe electrical test meters</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Voltmeter ○ Ammeter ○ Ohmmeter ○ Megger ○ Capacitor tester • Ranges |

LEARNING TASKS

CONTENT

4. Use electrical test meters	<ul style="list-style-type: none"> • Rated for applications • Accessories • Applications • Procedures • Safety • Adjustment • Inspection • Maintenance <ul style="list-style-type: none"> ○ Certification ○ Calibration • Storage
5. Describe temperature measuring instruments	<ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Thermometer ○ Pyrometer ○ Thermocouple ○ Thermistor • Parts • Ranges and scales • Applications
6. Use temperature measuring instruments	<ul style="list-style-type: none"> • Procedures • Safety • Adjustment • Readings • Inspection • Maintenance <ul style="list-style-type: none"> ○ Certification ○ Calibration • Storage
7. Describe leak detectors	<ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Electronic ○ Refrigerant dye and UV light ○ Bubble solution ○ Ultrasonic • Parts • Ranges and scales • Applications
8. Use leak detectors	<ul style="list-style-type: none"> • Procedures • Safety • Adjustment • Inspection

LEARNING TASKS

CONTENT

- Maintenance
 - Certification
 - Calibration
- Storage

LEARNING TASKS

CONTENT

4. Use scaffolds

- Platforms/planks
- Tie backs
- Certification
- Hazard recognition
- Selection
- Inspection
- Safety regulations
- Erecting and dismantling
- Access
- Fall arrest equipment
- Operating procedures
- Limitations
- Securing
- Maintenance
- Manufacturer's specifications
- Selection
- Limitations
- Care and storage
- 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

5. Describe aerial lifts

LEARNING TASKS

6. Describe safe operation of aerial lifts

CONTENT

- Limitations
- Pre-shift inspection
 - Log book/check off sheet
 - Manual
 - Machine certification
- Loading the platform
- Operating the lift
- Working on the platform
- Energized power lines
- Care and storage

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

7. Use hoisting, lifting and rigging equipment

- Purposes
- Limitations
- Safety
- Working load limit (WLL)
- Lift plan
- Communication/hand signals
- Securing of loads
 - Pre lift
 - Post lift
- Inspection
- Maintenance
- Storage
- Disposal

Line (GAC): **B** **USE TOOLS AND EQUIPMENT**
Competency: **B8** **Use Digital Technology**

Objectives

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

- Use electronic devices.
- Describe digital technology.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>1. Describe electronic devices</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Computers/laptops ○ Smart phones ○ Tablets ○ User interface modules • Applications <ul style="list-style-type: none"> ○ Monitoring ○ Diagnostics ○ System set-up ○ System back-up |
| <p>2. Use electronic devices</p> | <ul style="list-style-type: none"> • Connection <ul style="list-style-type: none"> ○ Manufacturer’s specifications • System set-up <ul style="list-style-type: none"> ○ Configuration • File back-up |
| <p>3. Describe digital technology</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Direct digital control ○ Programmable logic controller (PLC) ○ Micro processor • Applications <ul style="list-style-type: none"> ○ System set-up ○ Diagnostics |
| <p>4. Identify network protocols</p> | <ul style="list-style-type: none"> • Modbus • BACnet • Local Operation Network (LON) |
| <p>5. Identify network cable connectors</p> | <ul style="list-style-type: none"> • Types of connectors <ul style="list-style-type: none"> ○ USB ○ 9 pin, 25 pin serial port ○ RJ45 ○ RJ11 |
| <p>6. Describe wireless communication devices</p> | <ul style="list-style-type: none"> • 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

1. Apply calculator functions to trade related equations
2. Use formulas to calculate area
3. Use formulas to calculate volumes
4. Use formulas to calculate capacity
5. Transpose formulas
6. Perform conversions
7. Calculate piping measurements

CONTENT

- Whole numbers
- Fractions
- Decimals
- Percentages
- Cross sectional area of pipe
- Cylinders
- Rectangular tanks
- Imperial gallons
- US gallons
- Litres
- Processes
- Length
- Volume
- Capacity
- Area
- Mass
- Weight
- Heat energy
 - Kilowatts
 - BTUh
 - Gigajoules
- Temperature
 - Fahrenheit
 - Celsius
 - Kelvin
 - Rankine
- Pressure
 - Absolute
 - Gauge
- Terms
 - Thread allowance

LEARNING TASKS

CONTENT

- | | |
|--|--|
| <p>8. Use the Pythagorean theorem of right angles</p> <p>9. Calculate offsets using the applicable trigonometric function</p> <p>10. Calculate the required measurements for a parallel piping offset</p> <p>11. Describe the properties of matter</p> | <ul style="list-style-type: none"> ○ Fitting allowance ○ End to end ○ End to centre ○ Centre to centre ○ Face to face ○ End to back ○ Back to back ○ Socket depth ● Calculations ● Grades ● Elevations ● Benchmarks ● Hypotenuse ● Side opposite ● Side adjacent ● Calculator methods ● Table-based methods ● Unequal spread ● Equal spread ● Jumper ● Substances <ul style="list-style-type: none"> ○ Elements ○ Compounds ○ Mixtures ● Adhesion ● Cohesion ● Conductivity <ul style="list-style-type: none"> ○ Dielectric ● Density ● Ductility ● Elasticity ● Malleability ● Tensile strength ● Heat properties <ul style="list-style-type: none"> ○ BTUs ○ Gigajoules ○ Specific Heat ○ Kilowatts ● Pressure <ul style="list-style-type: none"> ○ Units of measure |
| <p>12. Use Pascal's theory of pressure and force</p> | |

LEARNING TASKS	CONTENT
	<ul style="list-style-type: none"> • Total Force <ul style="list-style-type: none"> ○ Pounds ○ Newtons
13. Use Archimedes' principles of displacement and floatation	<ul style="list-style-type: none"> • Specific weight/gravity • Buoyancy
14. Define mechanical advantage as it relates to fluid power	<ul style="list-style-type: none"> • Hydraulics • Hydrostatics
15. Describe factors that affect fluid flow in a piping system	<ul style="list-style-type: none"> • Viscosity • Laminar flow • Turbulent flow • Velocity • Piping material • Fittings
16. Describe factors that affect gas volumes and pressures	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Boyle's Law • Charles' Law • Gay-Lussac's Law • Dalton's Law • Combined Gas Law (General Gas Law) • Temperature <ul style="list-style-type: none"> ○ Kelvin ○ Rankine • Pressures <ul style="list-style-type: none"> ○ Absolute ○ Gauge
18. Calculate the expansion and contraction of various piping materials due to heating and cooling	<ul style="list-style-type: none"> • Ferrous • Non-ferrous • Thermoplastic
19. Define methods of heat transfer	<ul style="list-style-type: none"> • Conduction • Convection • Radiation
20. Perform heat transfer calculations	<ul style="list-style-type: none"> • Sensible • Latent

LEARNING TASKS

CONTENT

- Specific heat

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

Objectives

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

- Interpret information found on a set of drawings.
- Use drafting symbols, lettering and line conventions.
- Convert between orthographic and isometric projections.
- Create an isometric drawing of a basic orthographic piping arrangement.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Describe drafting tools and materials | <ul style="list-style-type: none"> • Tools <ul style="list-style-type: none"> ○ Compasses ○ Dividers ○ Protractors ○ Scale rulers ○ Triangles • Erasers and shields • Pencils • Templates |
| 2. Use scale rulers | <ul style="list-style-type: none"> • Dimensions <ul style="list-style-type: none"> ○ Imperial ○ Metric |
| 3. Describe symbols | <ul style="list-style-type: none"> • Pipe fittings • Components • Accessories • Electrical • Sheet metal • Architectural • Coordinates |
| 4. Describe lettering and dimensioning in drawings | <ul style="list-style-type: none"> • Lines <ul style="list-style-type: none"> ○ Border ○ Center ○ Dimension ○ Extension ○ Hidden ○ Object ○ Phantom • Lettering <ul style="list-style-type: none"> ○ Hierarchy • Legend • Title block |

LEARNING TASKS

CONTENT

- | | |
|----------------------------------|---|
| 5. Describe drawing projections | <ul style="list-style-type: none"> • Views <ul style="list-style-type: none"> ○ Elevation ○ Plan ○ Section ○ Isometric ○ Orthographic ○ Oblique |
| 6. Use drawing projections | <ul style="list-style-type: none"> • Isometric • Orthographic • Conversion from one to the other |
| 7. Describe types of drawings | <ul style="list-style-type: none"> • Isometric • Orthographic • Process Flow Diagrams (PFD) • Piping and Instrumentation Diagrams (P & ID) • Sectional drawings • Detail drawings |
| 8. Interpret mechanical drawings | <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Orthographic drawing • Sketching tools and paper |
| Criteria | The learner will be evaluated on: <ul style="list-style-type: none"> • 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

1. Identify codes, standards and organizations

CONTENT

- 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
- Design
- Planning
- Installation

2. Describe code implications

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

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

- Liquid receivers
 - Section 6
 - Section 9
 - Sizing
- Pressure testing requirements
 - Field installed systems
 - Pressure relief devices
- 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: 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

1. Describe refrigerants

2. Use pressure enthalpy (PE) charts

CONTENT

- 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
- Pressure enthalpy charts
 - Use/purpose
 - Construction of chart

LEARNING TASKS

3. Describe compressed gases

CONTENT

- Plotting cycle diagrams
- Calculations
- Performance characteristics
 - Evaporator pressure
 - Condenser pressure
 - Compression ratio
 - Displacement per ton
 - Horsepower per ton
 - Discharge temperature
 - Applications
- Migration
- Types
- Properties
- Compatibility
- Pressures
- Storage
- Handling
- Codes
- Transportation
 - Transport Canada approved straps
- Pressure/temperature relief devices
- Toxicity
- Safety

Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C7 Apply Sealants and Adhesives

Objectives

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

- Apply sealants.
- Apply adhesives.

LEARNING TASKS

1. Select sealants

2. Select adhesives

3. Apply sealants and adhesives

CONTENT

- Types
 - Silicone
 - Spray foam
 - Thread seal
 - Fire stop
 - Putties
 - Cork tape
 - Splicing tape
- Applications
- Manufacturer’s specifications
- Codes and regulations
- Types
 - Insulation glues
 - Primers
 - Pipe adhesives
- Applications
- Manufacturer’s specifications
- Code and regulations
- 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

1. Describe compressors

CONTENT

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

2. Describe evaporators

- Types
 - Bare tube
 - Plate
 - Finned
 - Shell and tube
 - Coax
 - Brazed plate
- Applications
 - High temp
 - Medium temp
 - Low temp
 - Blast

LEARNING TASKS

CONTENT

3. Describe condensers

- Requirements
- Operation
- Refrigerant management
 - Flooded
 - DX
- 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
- 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

4. Identify metering devices

Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C9 Select Fasteners, Brackets and Hangers

Objectives

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

- Select brackets, fasteners and hangers.

LEARNING TASKS

1. Describe brackets, fasteners and hangers

CONTENT

- Hangers
 - 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
- Application
- Spacing
- Seismic requirements
- Compatibility with piping
- Weight ratings
- Codes and regulations
- Manufacturer’s specifications

2. Select brackets, fasteners and hangers

Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C10 Install Valves

Objectives

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

- Describe valves.
- Describe the installation of valves.

LEARNING TASKS

1. Describe valves

CONTENT

- Types
 - Butterfly
 - Plug
 - Ball
 - Gate
 - Globe
 - Needle
 - Check
 - Pressure reducing
 - Solenoid
 - Regulating
- Application
- Materials
- Limitations
 - Pressure
 - Temperature
- Seat design
- Code and regulations
- Manufacturer’s specifications
- Orientation
- Relative placement

2. Describe the installation of valves

Line (GAC): D USE COMMUNICATION TECHNIQUES
Competency: D1 Use Communication Techniques

Objectives

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

- Describe effective communication practices.

LEARNING TASKS

1. Describe effective communication practices

CONTENT

- Verbal
- Non-verbal
 - Body language
 - Signals
- Active listening
 - Hearing
 - Interpreting
 - Reflecting
 - Responding
 - Paraphrasing
- Learning styles
 - See
 - Hear
 - Attempt
- Workplace responsibilities
 - Personal
 - Attitude
 - Harassment
 - Discrimination
 - Supervisor
 - Human Resources (HR)
- Toolbox meetings
 - Field Level Risk Assessment (FLRA)
 - Site specific safety requirements

Line (GAC): E **APPLY ELECTRICAL CONCEPTS**
Competency: E1 **Use the Principles of Electricity and Electronics**

Objectives

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

- Describe electrical concepts.
- Solve simple problems using Ohm’s and Kirchhoff’s Laws.
- Describe single phase and three phase power supplies.
- Identify transformers.
- Describe switches and relays.
- Install relays.

LEARNING TASKS

1. Describe the fundamentals of electricity

2. Describe electrical circuits

CONTENT

- 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
- 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

- | | |
|--|--|
| <p>3. Use laws and formulas</p> <p>4. Describe single phase power characteristics</p> <p>5. Describe three phase power characteristics</p> <p>6. Identify transformers</p> | <ul style="list-style-type: none"> ○ Closing and opening DC circuits ● AC circuits and measurements <ul style="list-style-type: none"> ○ Inductance ○ AC amperage ○ Resistance ● Fundamentals of magnetism <ul style="list-style-type: none"> ○ Natural and artificial magnets ○ Magnetic fields ○ Strength of field ○ Force on two wires ● Permeability ● Ohm's Law ● Kirchoff's Law ● Solve simple problems ● AC power distribution <ul style="list-style-type: none"> ○ Generation and transmission ○ Voltage drop ○ Step-down transformer ● Power available ● Single phase power supply <ul style="list-style-type: none"> ○ 3-wire, dual voltage ● Circuit protection <ul style="list-style-type: none"> ○ Fuses ○ Circuit breakers ● AC power distribution <ul style="list-style-type: none"> ○ Generation and transmission ○ Voltage drop ○ Step-down transformer ● Power available ● Three phase power supply <ul style="list-style-type: none"> ○ Delta ○ Wye ● Type of transformers <ul style="list-style-type: none"> ○ 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

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

2. Describe three phase motors

- Components
- Characteristics
- 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

3. Describe motor protection

- Ratings
- Applications
- Operation
 - Three phase rotating field
 - Delta connected
 - Wye connected
 - Reduced voltage
- Voltage imbalance
- Current imbalance
- Motor protection
 - Inherent protectors
 - Line overloads
 - Heaters
 - Circuit breakers
 - Effects of ambient temperature
- Magnetic contactors
 - Types
 - Operation
 - Application and ratings
 - Starters
 - Line voltage control
 - Start-stop control
 - Hand-off-auto control
- Line voltage control
 - 115 volt
 - 230 volt
 - Voltage variations

Achievement Criteria

Performance	The learner will be able to disassemble, reassemble and test windings for a single phase and a three phase motor.
Conditions	To be assessed during technical training. The learner will be given: <ul style="list-style-type: none"> ● Specifications ● Tools and materials ● Equipment
Criteria	The learner will be evaluated on: <ul style="list-style-type: none"> ● 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

1. Describe wiring components

2. Describe conductor installation

3. Describe conductor termination

CONTENT

- 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
- Cutting of flexible conduit
- Conductor insulation removal
- Wire nuts
- Wire nuts
- Junction box
- Terminal strips/lug
- Mechanically secure
- Heat shrink sleeve

**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
 - Silica

LEARNING TASKS

CONTENT

2. Describe material handling

- 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

1. Describe piping design

CONTENT

- 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
- Types
 - Air cooled
 - Water cooled

2. Describe medium temperature systems

LEARNING TASKS

3. Describe equipment placement

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
- Drawings and specifications
 - Clearances
- Location
 - Access to service
 - Indoors/outdoors
- Site conditions
 - Utilities
- Foundation
- Levelling
- Codes and regulations

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>3. Prepare piping and tubing</p> | <ul style="list-style-type: none"> ○ Inhibitors ○ Tape ○ Cathodic ○ Dielectric ○ Sleeving ● Mechanical damage <ul style="list-style-type: none"> ○ Protective plates/shield ○ Sleeving ○ Bollards |
| <p>4. Describe piping and tubing jointing methods</p> | <ul style="list-style-type: none"> ● Measurements ● Cutting ● Bending ● Burr removal ● Reaming ● Threading ● Sealant ● Priming ● Flaring ● Sanding/filing ● Flux ● Beveling ● Grooving ● Press-fit ● Soldered ● Brazed ● Flanged ● Compression ● Swaged ● Push-fit ● Threaded ● Crimped ● Expanded |
| <p>5. Join piping and tubing</p> | <ul style="list-style-type: none"> ● Safe work practices ● Codes and regulations ● Manufacturer's specifications ● Fittings ● Accessories ● Tools and Equipment ● Assembly |

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 6. Describe factors affecting structure penetrations | <ul style="list-style-type: none"> • Codes and regulations • Manufacturer’s specifications • Structural integrity • Fire separation • Interference with other building components and systems • Hidden components • Sleeve installation • Sealing |
| 7. Describe methods of structure penetrations | <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • Potential defects <ul style="list-style-type: none"> ○ 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 | <ul style="list-style-type: none"> • 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:	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

2. Maintain system consumables

CONTENT

- Adjustments
- Test
- Return to service
- Documentation

- Types
 - Filters
 - Belts
 - Condensate treatment tablets
 - Grease
 - Lubricants
- Inspection
 - Sensory
 - Diagnostic
 - Monitoring
- Tools and equipment
- Manufacturer's specifications
- Isolation
- Clean/repair/replace
- Adjustments
- Test
- Return to service
- Documentation

Level 2

Refrigeration and Air Conditioning Mechanic

Line (GAC): **B USE TOOLS AND EQUIPMENT**
Competency: **B5 Use Diagnostic and Measuring Tools and Equipment**

Objectives

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

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

LEARNING TASKS

CONTENT

1. Describe tools used for air measurement

- Types
 - U-tube manometer
 - Digital manometer
 - Inclined manometer
 - Anemometer
 - Velometer
 - Balometer
 - Magnehelic
 - Tachometer

2. Use air measuring tools

- Accessories
- Ranges
- Applications
- Procedures
- Safety
- Adjustment
- Inspection
- Maintenance
 - Certification
 - Calibration

3. Use a combustible gas detector

- Storage
- Types
 - Electronic
 - Laser
 - Draeger
 - Flame ionization
- Applications
- Inspection
- Maintenance
 - Certification
 - Calibration
- Storage

Achievement Criteria

Performance	The learner will be able to: <ul style="list-style-type: none">• 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: <ul style="list-style-type: none">• Specifications• Tools and materials
Criteria	The learner will be evaluated on: <ul style="list-style-type: none">• 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

1. Create a piping installation drawing for a refrigeration system

CONTENT

- Codes
- Sizing
- Components
- Supports
- Equipment location
- Dimensions
- Symbols
- Legends
- Scale

Achievement Criteria

Performance	The learner will be able to create a piping installation drawing for a refrigeration system.
Conditions	To be assessed during technical training. The learner will be given: <ul style="list-style-type: none"> • Specifications • Sketching tools and paper
Criteria	The learner will be evaluated on: <ul style="list-style-type: none"> • Neatness • Accuracy • Completeness

Line (GAC): C **PERFORM ROUTINE TRADE ACTIVITIES**
Competency: C3 **Use Codes, Regulations and Standards**

Objectives

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

- Identify environmental agencies associated with system drainage.
- Interpret B52 code requirements for field assembly and testing.
- Interpret B52 code requirements for Class T machinery rooms.

LEARNING TASKS

1. Identify environmental agencies associated with system drainage
2. Interpret sections of the CSA B52 code

CONTENT

- Provincial Regulations
- WorkSafe BC
- Authority Having Jurisdiction (AHJ)
- Field assembly and testing
- Class T machinery rooms
 - Ammonia
 - Safe work practices
 - Emergency discharge systems

Line (GAC): C **PERFORM ROUTINE TRADE ACTIVITIES**
Competency: C4 **Use Manufacturer and Supplier Documentation**

Objectives

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

- Apply manufacturer's and supplier documentation .

LEARNING TASKS

1. Apply manufacturer's and supplier documentation

CONTENT

- Proprietary data sheets
- Installation literature
- Operation literature
- Maintenance literature
- Parts list

Line (GAC): C **PERFORM ROUTINE TRADE ACTIVITIES**
Competency: C5 **Organize Work and Maintain Records**

Objectives

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

- Describe documentation responsibilities.

LEARNING TASKS

1. Describe documentation responsibilities

CONTENT

- Types of documents
 - Commissioning report
 - Service reports
 - Statements of completion
 - Technical Safety 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

1. Describe lubrication systems

CONTENT

- 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 | <ul style="list-style-type: none"> • Applications • Components • Operation • Lubrication • Sizing |
| 2. Select evaporators | <ul style="list-style-type: none"> • Applications • Components • Requirements <ul style="list-style-type: none"> ○ Defrost type • Operation • Sizing |
| 3. Select condensers | <ul style="list-style-type: none"> • Applications • Components • Requirements • Condensing medium • Operation • Sizing |
| 4. Select metering devices | <ul style="list-style-type: none"> • Types • Operation • Applications • Limitations • Sizing |
| 5. Select accessories | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Driers ○ Moisture indicators ○ Distributors ○ Receivers ○ Pressure regulators <ul style="list-style-type: none"> – 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

1. Describe valves

2. Describe the installation of valves

CONTENT

- Normally open
- Normally closed
- Four-way valves
 - Types
- Three-way valves
- Stop valves
 - Check valves
 - Solenoid valves
- Pilot operated valves
 - Two position
 - Modulating
- 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

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Select single-phase transformers
 2. Describe the installation of single-phase transformers
 3. Describe millivolt circuits
 4. Describe proportional control operation
 5. Identify resistors
 6. Describe variable resistors | <ul style="list-style-type: none"> • Electrical load • Sizing • Ratings <ul style="list-style-type: none"> ○ NEMA ○ VA • Safety • Codes • Manufacturer’s documentation • Phasing • Grounding • Wiring • Terminations • Testing • Power generation <ul style="list-style-type: none"> ○ Thermocouple ○ Thermopiles • Switches • Loads • Application • Types used by series • Method of control <ul style="list-style-type: none"> ○ Pneumatic ○ Electric • Types • Ratings • Application • Thermistors |
|---|---|

LEARNING TASKS

CONTENT

7. Describe PLC ladder logic

- NTC
- PTC
- Resistant temperature device (RTD)
- Pressure transducers
- Anticipators
- Potentiometers
- Inputs
- Outputs
 - Actuators
- Variables
- PID loops
- Scaling
 - Zero
 - Span

LEARNING TASKS

CONTENT

- Testing
 - Voltage
 - Amperage
 - Resistance
 - Continuity

LEARNING TASKS

CONTENT

5. Verify motor installation and operation

- 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
- 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: E5 **Apply Wiring Practices**

Objectives

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

- Install electrical components.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Install cables and conductors
 2. Install junction and switch boxes
 3. Install shielded cable
 4. Describe isolation switch installations | <ul style="list-style-type: none"> • CEC • Supports • Colour coding • Class 2 circuits • Conduit • Wire labelling • Tools
 • CEC <ul style="list-style-type: none"> ○ Sizing • Conductor connections and terminations • Grounding/bonding • Tools
 • Termination • Grounding
 • CEC <ul style="list-style-type: none"> ○ Location ○ Type ○ Ratings |
|---|---|

LEARNING TASKS

CONTENT

5. Describe air-to-air heat exchangers

- 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
- 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

- | | |
|--|---|
| <p>1. Analyze mechanical refrigeration systems</p> <p>2. Describe multi-temperature systems</p> <p>3. Describe water chilled systems</p> | <ul style="list-style-type: none"> • Component balancing <ul style="list-style-type: none"> ○ Load factors ○ Performance diagrams ○ Evaporator performance ○ Compressor performance ○ Condenser performance ○ Plot pressure enthalpy (PE) chart • Single temperature systems • Multi-temperature systems • Flow control valves • System control • Characteristics • Applications • Operation |
|--|---|

Achievement Criteria

- | | |
|--|---|
| <p>Performance</p> <p>Conditions</p> <p>Criteria</p> | <p>The learner will be able to read values and plot points using a PE chart.</p> <p>To be assessed during technical training.
The learner will be given:</p> <ul style="list-style-type: none"> • Operational parameters • PE charts • Tools and equipment <p>The learner will be evaluated on:</p> <ul style="list-style-type: none"> • Accuracy • Completeness |
|--|---|

Line (GAC): F **APPLY REFRIGERATION AND AIR CONDITIONING THEORY**
Competency: F3 **Apply Food Storage Theory**

Objectives

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

- Describe food preservation and storage.
- Describe insulation requirements.
- Calculate cooler and freezer loads.

LEARNING TASKS

1. Describe principles of food preservation

2. Describe medium (fresh) temperature storage

3. Describe low (frozen) temperature storage

4. Describe insulation requirements

5. Calculate cooler loads

CONTENT

- Applications
- Causes of spoilage
- Spoilage prevention
- Storage life
- Product safety
- Fresh food
 - Classification by storage requirements
 - Properties of food products
- Fresh meat
 - Storage requirements
 - Display storage
- Methods of freezing
 - Quick freezing
 - Sharp freezing
 - Immersion freezing
 - Contact freezing
- Properties of food products
 - Freezing temperatures
 - Storage temperatures
 - Life of frozen foods
- Types
 - Insulated walls
 - Vapour barrier
- Application
- Insulating values
 - R-values
 - U-values
 - Calculations
- Heat loads
 - Beer storage cooler
 - Floral cooler

LEARNING TASKS

CONTENT

6. Calculate freezer loads

- Meat storage room
- Fresh vegetable cooler
- Components of heat loads
 - Wall transmission
 - Air change load
 - Product load
 - Miscellaneous loads
- Equipment selection
 - Total load
 - Hours run time
 - Selecting evaporator coil for correct TD
- Heat loads
 - Pull down freezer
 - Storage freezer
- Product freezing load
 - Three components
 - Sensible heat
 - Latent heat
 - Run time
 - Equipment selection

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

1. Create a field level risk assessment (FLRA)

CONTENT

- Safety equipment
- Job specifications
 - Coordination with other trades
- Site conditions
 - Access
- Site/company policies
- Jurisdictional regulations
- WorkSafe BC compliance

**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

- | | |
|--|--|
| <p>1. Describe low temperature refrigeration systems</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Air cooled ○ Water cooled • Applications <ul style="list-style-type: none"> ○ Low temp • Refrigerants • Components <ul style="list-style-type: none"> ○ Evaporator ○ Condenser ○ Metering device ○ Compressor ○ Defrost controls • Accessories <ul style="list-style-type: none"> ○ Service valves ○ Regulating valves ○ Receiver ○ Filter drier ○ Sight glass ○ Pressure switches ○ Liquid line solenoid valve ○ Temperature control ○ Accumulator • Operation |
| <p>2. Select low temperature refrigeration equipment</p> | <ul style="list-style-type: none"> • Load calculation • Supplier documentation • Engineering documentation • Verify utilities • Placement |
| <p>3. Describe equipment placement</p> | <ul style="list-style-type: none"> • Drawings and specifications <ul style="list-style-type: none"> ○ Clearances |

LEARNING TASKS

4. Create a material take-off for a freezer

CONTENT

- 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

LEARNING TASKS

CONTENT

- Load requirements
- Terminations
- Verification
 - Operating ranges
- Documentation
 - Service report
 - Plot cycle

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

- | | |
|---|--|
| <p>1. Describe factors that affect fluid flow in a piping system</p> <p>2. Describe natural gas fuel distribution systems</p> <p>3. Describe piping, tubing and hoses</p> | <ul style="list-style-type: none"> • Laminar flow • Turbulent flow • Specific gravity • Pressure drop • Velocity • Size • Piping material • Fittings • Utility provider <ul style="list-style-type: none"> ○ 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 <ul style="list-style-type: none"> ○ Gas supply or building line ○ Branch line ○ Drop line ○ Riser ○ Drip or dirt pocket ○ Extension • Gas pressures <ul style="list-style-type: none"> ○ High ○ Low • Types <ul style="list-style-type: none"> ○ Black iron pipe ○ Copper tubing ○ PE piping <ul style="list-style-type: none"> – Tracer wire |
|---|--|

LEARNING TASKS

CONTENT

<p>4. Calculate the linear thermal expansion and contraction of various materials</p> <p>5. Describe hangers and supports</p> <p>6. Join pipe and tubing</p> <p>7. Perform tube bending</p>	<ul style="list-style-type: none"> ○ Corrugated stainless steel tubing (CSST) ○ Hoses ○ Flexible connectors ● Properties of piping materials <ul style="list-style-type: none"> ○ Tensile strength ○ Malleability ○ Elasticity ● Schedules and grades ● Pressure ratings ● Nominal sizes ● Protective coatings ● Cathodic protection ● Identification markings ● Ferrous ● Non-ferrous ● Thermoplastic ● Types ● Construction ● Uses ● Expansion ● Seismic restraint ● Protective materials <ul style="list-style-type: none"> ○ Electrolysis ● Spacing ● Inserts and fasteners ● Installation procedures ● Safety ● Methods <ul style="list-style-type: none"> ○ Welding ○ Threading ○ Flaring ○ Compression fittings ○ Brazing ○ Fusion (PE) ● Procedure ● Hot taps ● Tools ● Fittings ● Tools
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LEARNING TASKS

CONTENT

- 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

1. Identify conditions requiring more than routine maintenance

CONTENT

- Metal fatigue (wear)
- Vibration
- Improper lubrication
- Misalignment
- Incorrect adjustments
- Loose connections
- Failed safety or operational controls
- Incorrect operation
- System cleanliness
- Equipment lifecycle

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
- Diagnostic 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
- Causes

LEARNING TASKS

CONTENT

- System readings
- Data
 - Mechanical
 - Electrical
- Codes and regulations
- Manufacturer's specifications
- Repair/replace components
- Return to service
 - Verify correct operation
 - Cycle all modes
 - Check back with customer
- Documentation
 - Electronic
 - Paper
 - Service report

Level 3

Refrigeration and Air Conditioning Mechanic

Line (GAC): **B** **USE TOOLS AND EQUIPMENT**
Competency: **B8** **Use Digital Technology**

Objectives

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

- Perform air conditioning load calculations.
- Perform psychrometric calculations.
- Describe remote monitoring.

LEARNING TASKS

1. Use software for design and analytics

2. Analyze remote monitoring

CONTENT

- Simulators
- Apps
- Manufacturer's software
- Heat loss/gain calculations
 - Peak load
 - Average load
 - 1% and 5% design
- Psychrometric calculations
 - Mixtures
 - Processes
- Purpose
- Data
- Hardware/software requirements
- Access authority
- Sample system

Line (GAC): C PERFORM ROUTINE TRADE ACTIVITIES
Competency: C3 Use Codes, Regulations and Standards

Objectives

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

- Describe the purpose of the B149.1 gas code.
- Use gas regulations.

LEARNING TASKS

1. Describe the purpose of the B149.1 gas code

2. Use gas regulations

CONTENT

- Scope
- Reference Publications
- Definitions
- General

- Role of Technical Safety BC
- Role of the Gasfitter
- Safety Standards Act
- Safety Standards General Regulation
- Gas Safety Regulation
- Permits
- Notification of Completion
- Approvals
- Variations to the National Gas Code
- Bulletins, Directives and Safety Orders

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

1. Describe contractual documents

2. Describe quote preparation

CONTENT

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

1. Explain capacity control

2. Select heat exchangers

CONTENT

- 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
- 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

3. Service metering devices

CONTENT

- Subcooling
- Dehumidifying
- Operation
- Adjustments and settings
- Troubleshooting
- Repair

Line (GAC): E **APPLY ELECTRICAL CONCEPTS**
Competency: E1 **Use the Principles of Electricity and Electronics**

Objectives

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

- Describe electronic principles.
- Identify electronic devices.
- Identify electronic DC power supplies.
- Describe proportional control operation

LEARNING TASKS

1. Describe electronic principles

2. Identify electronic devices

3. Identify electronic DC power supplies

4. Describe proportional control operation

CONTENT

- Construction
 - P-N junctions
 - Impurities
 - Depletion regions
 - Forward and reverse bias
- Characteristics
 - Heat
 - Over-current
- Diodes
- Silicon Controlled Rectifiers (SCRs)
- Triacs
- Solid state relays
- Transducers
- Half-wave rectifier
 - Components
 - Operating principles
- Full-wave rectifier
 - Components
 - Operating principles
 - Applications
- Filters
- Regulators
- 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

- | | |
|--|---|
| <p>1. Describe circuit components</p> | <ul style="list-style-type: none"> • Transformer <ul style="list-style-type: none"> ○ Phasing • Limits • Safety devices • Controls • Permissives • Interlocks |
| <p>2. Describe sequence of appliance operation</p> | <ul style="list-style-type: none"> • Control narratives • Components • Appliances • Wiring diagrams |
| <p>3. Design wire diagram</p> | <ul style="list-style-type: none"> • Control narrative |
| <p>4. Create a control narrative from a wiring diagram for a hydronic heating system</p> | <ul style="list-style-type: none"> • Diagram types <ul style="list-style-type: none"> ○ 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: <ul style="list-style-type: none"> • Electrical data • Sketching materials • System component requirements |
| Criteria | The learner will be evaluated on: <ul style="list-style-type: none"> • 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): 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

1. Plot psychrometric processes

2. Analyze fan systems

3. Calculate heat gain and heat loss

CONTENT

- 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
- Central fan systems
 - Basic layout
 - Variations in systems
 - Component operation
 - Control of components
 - Pressures
- Conditions

LEARNING TASKS

CONTENT

- | | |
|-----------------------------------|---|
| | <ul style="list-style-type: none"> ○ Comfort ○ Environmental ○ Standard ○ Air distribution ● Calculate total load <ul style="list-style-type: none"> ○ Types <ul style="list-style-type: none"> – Sensible – Latent ○ Sources <ul style="list-style-type: none"> – Internal – External – Factors – Conductivity – Wall gain – Body heat – Ducting gains/losses – Ventilation – Lights and appliances |
| 4. Describe heat pumps | <ul style="list-style-type: none"> ● Types <ul style="list-style-type: none"> ○ Air-to-air ○ Air-to-water ○ Water-to-water ○ Geothermal ● Characteristics ● Classifications <ul style="list-style-type: none"> ○ Floor mounted ○ Roof top ○ Split systems ○ Window units ○ Conventional ○ Dual fuel ● System functions <ul style="list-style-type: none"> ○ Single-stage cooling ○ Multi-stage cooling ○ Single and multi-stage heat ○ Inverter drive ○ Low ambient ○ Features ○ Heat sources ○ Humidification ● Roof top units <ul style="list-style-type: none"> ○ Ratings ○ Application |
| 5. Describe system configurations | |

LEARNING TASKS

CONTENT

6. Describe variable refrigerant flow systems

- 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

1. Describe defrost systems

CONTENT

- 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

1. Describe the operation of residential hydronic heating systems

CONTENT

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

LEARNING TASKS

CONTENT

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

Objectives

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

- Describe various burners.
- Describe the operation of atmospheric burners.
- Describe burner orifices.
- Describe the installation of mechanical burners.

LEARNING TASKS

1. Describe burners

CONTENT

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

2. Describe atmospheric burners

LEARNING TASKS

CONTENT

3. Describe mechanical burners

- 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
- Types
 - Plug
 - Cap
 - Adjustable
- Sizing
 - Tables
 - Calculations
 - Orifice flow formula
 - Drilling
- Drill index

4. Describe burner orifices

LEARNING TASKS

5. Describe proportional mixers

6. Describe the installation of mechanical burners

CONTENT

- Fuel-air ratios
- Adjustments
- Zero governors

- Sealing
- Support
- Manufacturer's documentation
- Refractory
- Wiring
- Mounting

Line (GAC): J **INSTALL GAS-FIRED SYSTEMS**
Competency: J2 **Identify Flame Safeguards**

Objectives

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

- Describe flame detectors.
- Describe ignition systems.
- Describe the operation of standing pilot/thermocouple systems.

LEARNING TASKS

1. Describe flame detectors

2. Describe ignition systems

3. Describe standing pilot/thermocouple systems

4. Describe flame safe guards

CONTENT

- Thermocouple
- Thermopile
- Flame rectification (flame rod)
- UV/IR
- Pilot types
 - Continuous
 - Intermittent
 - Interrupted

- Pilot
- Direct spark ignition (DSI)
- Hot surface ignition (HSI)

- Wiring circuit
- Sequence of operation
- Applications

- 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

<p>1. Describe manual valves</p>	<ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Plug valves ○ Butterfly ○ Ball valves ○ Needle valves • Construction • Operation • Pressure markings and ratings • Maintenance
<p>2. Describe automatic gas valves</p>	<ul style="list-style-type: none"> • Electric <ul style="list-style-type: none"> ○ Solenoid ○ Diaphragm ○ Combination ○ Single stage ○ Two stage ○ Modulating ○ Pilot safety <ul style="list-style-type: none"> – Safety shut off • Non-electric <ul style="list-style-type: none"> ○ Rod and tube ○ Hydraulic
<p>3. Describe pressure regulators</p>	<ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Direct operated ○ Lever operated ○ Zero governors ○ Propane <ul style="list-style-type: none"> – First stage – Second stage • Operating elements <ul style="list-style-type: none"> ○ Loading ○ Measuring

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>4. Describe gas valve train for appliances 400 MBH or less</p> <p>5. Describe the operation of a gas valve train</p> | <ul style="list-style-type: none"> ○ Restricting • Parts <ul style="list-style-type: none"> ○ Internal pressure relief • Operating principles <ul style="list-style-type: none"> ○ Droop/offset ○ Lock-up ○ Set point ○ Critical flow • Applications • Regulators • Gas valves • Manual valves <ul style="list-style-type: none"> ○ A-cock ○ B-cock ○ Test firing • Flow control • Electric valves <ul style="list-style-type: none"> ○ Solenoid ○ Diaphragm ○ Combination • Non-electric valves <ul style="list-style-type: none"> ○ 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

- | | |
|--|--|
| <p>1. Describe outdoor reset controls</p> | <ul style="list-style-type: none"> • Sensors <ul style="list-style-type: none"> ○ Types • Thermistors • Applications • Cable types • Inputs • Outputs <ul style="list-style-type: none"> ○ 0-10 VDC ○ 4-20 mA • Heating curves <ul style="list-style-type: none"> ○ System efficiencies |
| <p>2. Describe the installation of outdoor reset controls</p> | <ul style="list-style-type: none"> • Sensors <ul style="list-style-type: none"> ○ Types ○ Location • Thermistors • Applications • Cable types • Inputs • Outputs <ul style="list-style-type: none"> ○ 0-10 VDC ○ 4-20 mA • Heating curves • System efficiencies • Cabling termination and bonding • Wiring connections • Manufacturer’s documentation |
| <p>3. Describe multi-boiler hydronic heating system components</p> | <ul style="list-style-type: none"> • Sequencing control • Wiring techniques |

LEARNING TASKS

4. Describe multi-purpose controls

CONTENT

- 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe appliance categories
 2. Describe venting materials
 3. Describe types of venting systems
 4. Describe the installation of venting materials

 5. Describe the installation of mechanical venting systems | <ul style="list-style-type: none"> • Category 1, 2, 3 and 4 <ul style="list-style-type: none"> ○ Vent pressure ○ Appliance efficiencies
 • Types <ul style="list-style-type: none"> ○ Single wall venting (C vent) ○ A vent ○ B vent ○ L vent ○ BH vent <ul style="list-style-type: none"> – Class 1, 2, 3 and 4 ○ BW vent
 • Mechanical <ul style="list-style-type: none"> ○ Forced ○ Induced
 • Passive
 • Vent pressures
 • Components <ul style="list-style-type: none"> ○ Fittings ○ Terminations ○ Condensate collection ○ Fire stopping ○ Supports ○ Wall and ceiling penetrations
 • Assembly <ul style="list-style-type: none"> ○ Gaskets ○ Mechanical fasteners and clamps ○ Sealants and lubricants ○ Glues and primers
 • Code requirements <ul style="list-style-type: none"> ○ Directives
 • Grade/Slope
 • Forced |
|--|--|

LEARNING TASKS

CONTENT

- 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

LEARNING TASKS

CONTENT

3. Install air heating appliances

- Dead boiler drain
- Blow down
- Flow control/balancing
- Vacuum reliefs
- o Circulators
- o Expansion tanks
- o Feed water
- o Water treatment
- Mounting
- Seismic restraint
- Placement considerations
 - o Venting
 - o Ducting
 - Assembly
 - Installation
 - Vibration isolation
 - Zoning
 - External static pressures
 - o Air supply
 - o Access
 - o Electrical
 - Clearance
 - Isolation switches
 - o Clearance
 - o Manufacturer's documentation
 - o Drainage
- Materials
- Ancillary equipment
 - o Electronic air cleaners
 - o Pumps
 - o Humidifiers
 - o 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

1. Describe pre-start-up checklists

CONTENT

- 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
- Energize unit
- Check control voltage
- Check voltage imbalance
- Check current imbalance
- Check rotation

2. Perform system start-up

LEARNING TASKS

CONTENT

3. Set-up secondary system components

- 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 ΔT s
 - Note ambient temperature
- Set to minimum position for outdoor air
- All panels and doors secured
- Documentation
 - Record charge level
- Tools and equipment
- Controls, valves and regulators adjustments
- System readings
- Component adjustments/balancing
- Secondary
 - Balancing valves
 - Pumps
 - Fans
 - Flow controls
 - Temperature controls
- Eutectic test
 - Concentration
 - Level
 - Freeze point
 - Specific gravity
 - Refractometer

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

LEARNING TASKS

2. Maintain pneumatic control systems

CONTENT

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

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

1. Describe the inspection of a gas distribution system

CONTENT

- Leak detection
- Pressure testing
- Cathodic protection
- Identify damage or defect

Line (GAC): M **SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**
Competency: M2 **Service Gas Burners and Ancillary Equipment**

Objectives

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

- Describe the procedures for inspecting ancillary equipment.

LEARNING TASKS

1. Describe the inspection of ancillary equipment

CONTENT

- HSI
 - Amperage check
 - Resistance check
 - Placement
- Ignition electrode
 - Inspection of ceramic
 - Gap to ground
 - Surface contaminants
 - Placement
- Flame rod
 - Inspection of ceramic
 - Placement
 - Surface contaminants
 - Short to ground check
 - Flame signal reading

Line (GAC): M **SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**
Competency: 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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe troubleshooting procedures for flame safe guards
 2. Describe troubleshooting procedures for combination gas valves | <ul style="list-style-type: none"> • Cycle appliance • Confirm control sequence • Confirm control terminal voltage
 • Cycle appliance • Confirm operation <ul style="list-style-type: none"> ○ 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

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

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

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

4. Apply the Canadian Electrical Code (CEC)

CONTENT

- 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

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

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

- 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: <ul style="list-style-type: none">• Tables from the Canadian Electrical Code (CEC)• Set of problems to solve
Criteria	The learner will be evaluated on: <ul style="list-style-type: none">• Accuracy• Completeness

Line (GAC): C **PERFORM ROUTINE TRADE ACTIVITIES**
Competency: C5 **Organize Work and Maintain Records**

Objectives

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

- Describe commissioning documentation.
- Describe equipment handover.

LEARNING TASKS

1. Describe commissioning documentation
2. Describe equipment handover

CONTENT

- Commissioning report
- Regulatory responsibilities
- As built drawings and operator manuals
- Instructions to customer
- Warranty information
- Job completion
- Maintenance schedule log

Line (GAC): D USE COMMUNICATION TECHNIQUES
Competency: D1 Use Communication Techniques

Objectives

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

- Describe effective communication practices.

LEARNING TASKS

1. Describe effective communication practices

CONTENT

- Customer relations
- Sales skills
- Coordination with other trades
- Project handover

Line (GAC): D USE COMMUNICATION TECHNIQUES
Competency: D2 Use Mentoring Techniques

Objectives

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

- Use mentoring techniques.

LEARNING TASKS

1. Describe learning strategies

2. Describe outcomes of effective coaching

CONTENT

- Coaching
- Leadership
- Practice
- Assessing
 - Constructive feedback
 - Educating
- Positive reinforcement
- Proactive check-in
- 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

1. Troubleshoot complex circuits

CONTENT

- Electrical duct heaters
 - Components
 - Power circuits
 - Control circuits
- Condensing units
 - Components
 - Power circuits
 - Control circuits
- Indoor fan coil units
 - Components
 - Power circuits
 - Control circuits
- Damper motor controls
 - Components
 - Balancing circuits
 - Sensing devices
- Complex systems
 - Basic schematic building blocks
 - Relationship of circuits
- Systematic procedure for troubleshooting

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

Objectives

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

- Describe three phase motor starters.
- Perform ECM motor testing.
- Perform voltage and current imbalance testing.

LEARNING TASKS

1. Describe three phase motor starters

CONTENT

- 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
- Safety requirements
- Tools and equipment
- Communication verification
- Windings
- OEM specifications
- Safety requirements
- Tools and equipment
- Measurements
 - Phase voltage imbalance percentage
 - Current imbalance percentage

2. Perform ECM motor testing

3. Perform voltage and current imbalance testing

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

Objectives

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

- Describe electronic refrigerant monitoring.
- Describe other safety monitoring devices.
- Select control point instrumentation.

LEARNING TASKS

1. Describe electronic refrigerant monitoring

2. Describe other safety monitoring devices

3. Select control point instrumentation

CONTENT

- Types
- Applications
 - Alarm
 - Device interlocks
 - Communications
 - Locations
- Operation
- Code and regulations
- Manufacturer’s specifications
- Gas detection devices
 - Combustible gas detection
 - CO₂
- 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

1. Describe indirect systems

2. Describe ultra-low temp systems

3. Describe absorption systems

CONTENT

- 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
- 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
- Lithium-bromide absorption cycle

LEARNING TASKS

CONTENT

4. Describe ammonia systems

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

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>5. Describe CO₂ systems</p> | <ul style="list-style-type: none"> ○ Basic system types ○ System components ○ Accumulator ○ Valves ○ Operation ● Ammonia plant operation <ul style="list-style-type: none"> ○ Start-up and shut-down procedures ○ System components <ul style="list-style-type: none"> – Discharge procedures – Cold traps ○ Lubrication system <ul style="list-style-type: none"> – Oil drainage procedures – Oil handling and disposal – Cold traps ○ Maintenance and preventative maintenance <ul style="list-style-type: none"> – Procedures for de-pressurization – Brine analysis review <ul style="list-style-type: none"> ▪ Ammonia ▪ pH ▪ Iron ▪ Dissolved solids ▪ Scheduled analysis – Non-destructive testing ○ Safety precautions <ul style="list-style-type: none"> – WorkSafe BC regulations – Technical Safety BC <ul style="list-style-type: none"> ▪ Pressure vessels act – Procedures for ammonia isolation <ul style="list-style-type: none"> ▪ Pressure relief purpose – Procedures for brine isolation ● Types <ul style="list-style-type: none"> ○ Subcritical system ○ Transcritical system <ul style="list-style-type: none"> – Plot PE chart ● Tools and equipment ● Applications |
|---|---|

LEARNING TASKS

CONTENT

- Multi-temperature
- Operations
- Limitations
- Safety
 - Charging considerations
 - 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

2. Install piping, tubing and hoses

- Code requirements
- Procedures
- 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

1. Describe the installation of manual shut-off valves
2. Describe the installation of gas pressure regulators
3. Describe the installation of regulator venting
4. Size regulators

CONTENT

- Code requirements
- Manufacturer’s specifications
- Procedures
 - 2 piece ball valves
- Code requirements
- Manufacturer’s specifications
- Procedures
- Vent attachments
 - Lines
 - Limiting orifices
 - Surge arrestors
- Sizing
- Orientation
- Termination
- Code requirements
- 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
- Over pressure protection (OPP)

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

Objectives

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

- Describe limits, interlocks and operating controls.

LEARNING TASKS

1. Describe limits and interlocks

2. Describe permissives

CONTENT

- 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
- 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

- | | |
|---|--|
| <p>1. Describe methods of combustion air supply</p> | <ul style="list-style-type: none"> • Passive air supply • Mechanical air supply <ul style="list-style-type: none"> ○ Code requirements ○ Interlocks |
| <p>2. Describe gas appliance air supply requirements</p> | <ul style="list-style-type: none"> • Purpose <ul style="list-style-type: none"> ○ Combustion air <ul style="list-style-type: none"> – Primary air – Secondary air – Excess air ○ Dilution air ○ Ventilation air • Openings and ducts <ul style="list-style-type: none"> ○ Terminations • Code requirements |
| <p>3. Determine combustion air requirements for gas appliance installations</p> | <ul style="list-style-type: none"> • Sizing procedures for combined input of up to and including 400 MBH and exceeding 400 MBH <ul style="list-style-type: none"> ○ Code requirements ○ Building envelope and construction ○ Category of the appliance ○ Draft control <ul style="list-style-type: none"> – Dilution air requirements ○ Air requirement calculations <ul style="list-style-type: none"> – Combustion – Ventilation – Flue gas dilution ○ Table selection ○ Grills and louvers <ul style="list-style-type: none"> – Types – Sizing – Free area calculations ○ Air ducts <ul style="list-style-type: none"> – Length – Size |

LEARNING TASKS

4. Describe installation of passive air supply

5. Describe mechanical air supply systems

6. Describe the installation of mechanical air supply systems

CONTENT

- Code requirements
- Structural penetrations
- Sealing
- Sheet metal assembly
 - Drive cleats
 - Esses
 - Tools
- Opening and ducts
 - Terminations
- Traps
- Weather
- Equivalent length of air supply
- Ducts
 - Sizes
 - Location
 - Lengths
 - Fittings
- Fans
 - Types
 - Location
- Engineered systems
- Manufacturer's documentation
- Code requirements
- Code requirements
- Structural penetrations
- Sealing
- Opening and ducts
 - Terminations
- Weather
- Interlocks

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

- | | |
|--|---|
| <p>1. Describe draft control systems</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Dampers <ul style="list-style-type: none"> – Mechanical – Thermal ○ Hoods ○ Diverters ○ Fans • Accessories • Applications • Vent height |
| <p>2. Describe the installation of draft control systems</p> | <ul style="list-style-type: none"> • Location/building type • Manufacturer’s documentation • Codes • Supports • Wiring • Terminations |
| <p>3. Describe commissioning of a barometric damper</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Single acting ○ Double acting • Code requirements • Adjustments • Tools and testing equipment • Pressures <ul style="list-style-type: none"> ○ Effects on combustion chamber ○ Effects on vent |

LEARNING TASKS

CONTENT

3. Describe the inspection of propane cylinders

4. Describe the installation of propane cylinder/tank components

- Filling
 - Safety
 - Emergency procedures
 - Liquid handling
- Maintenance
- Vehicle
- Security/fencing
- Containment
- Visual inspection
 - Damage
 - Corrosion
- Components
 - Valves
 - Reliefs
- Rating plates
 - Expiry/service dates
- Organize requalification
- Procedures
- Regulator placements
- Safety shut-off valves
 - Excess flow valves
 - Pneumatic actuator
- Safety relief valves
 - Pressures
 - Location of discharge outlets
 - Calculations of rate of discharge
- Maintenance
 - Code B149.2
- Valves and accessories for vapour withdrawal applications
 - Description
 - Operation
 - Maintenance
- Valves and accessories for liquid withdrawal applications
 - Description
 - Operation
 - Maintenance
- Valves and accessories for filling applications
 - Description
 - Operation

LEARNING TASKS

CONTENT

5. Natural gas and propane appliance conversions

- Maintenance
 - 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Determine load
 2. Layout the system
 3. Size the system
 4. Determine material take-off
 5. Complete commissioning documentation for a high efficiency furnace and a condensing boiler | <ul style="list-style-type: none"> • Appliance rating plates • Manufacturer’s documentation
 • Pressure • System Regulators • Regulator locations • Hangers and supports • Valve placement • Drip legs • Routing
 • Piping material • Pressure <ul style="list-style-type: none"> ○ 7-14 in WC ○ 2 psig • Lengths • Type of gas • Pressure drop
 • Fittings • Valves • Hangers and supports • Regulators • Pipe and tubing • Consumables
 • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Residential floor plan with meter and appliance location • Appliance documentation • Sketching equipment • Delivery pressure.
Criteria	The learner will be evaluated on: <ul style="list-style-type: none"> • Material take-off <ul style="list-style-type: none"> ○ Accuracy • Isometric drawing <ul style="list-style-type: none"> ○ Neatness ○ Accuracy • Code compliance <ul style="list-style-type: none"> ○ 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: <ul style="list-style-type: none"> • K4 – Commission Gas-Fired Appliances and Ancillary Equipment
Criteria	The learner will be evaluated on: <ul style="list-style-type: none"> • Commissioning report <ul style="list-style-type: none"> ○ 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

- | | |
|---|---|
| <p>1. Describe piping and tubing testing requirements</p> | <ul style="list-style-type: none"> • B149.1 • Pressure • Duration • Equipment |
| <p>2. Describe piping and tubing pressure testing procedures</p> | <ul style="list-style-type: none"> • Air <ul style="list-style-type: none"> ○ Tools ○ Equipment ○ Spools ○ System isolation <ul style="list-style-type: none"> – Lockout • Inert gases <ul style="list-style-type: none"> ○ Tools ○ Equipment ○ Spools ○ System isolation <ul style="list-style-type: none"> – Lockout ○ Calculations • Leak (integrity) testing <ul style="list-style-type: none"> ○ Soap test ○ After appliance connection • Valve tightness of closure testing |
| <p>3. Describe purging procedures for piping and tubing under 4-inch diameter</p> | <ul style="list-style-type: none"> • Code requirements <ul style="list-style-type: none"> ○ Locations ○ Equipment • Duration |
| <p>4. Describe purging procedures for pipe 4-inch diameter and larger</p> | <ul style="list-style-type: none"> • Code requirements • Inert gases • Applications • Purpose • Equipment <ul style="list-style-type: none"> ○ Approved burners ○ Gauges |

LEARNING TASKS**CONTENT**

5. Commission regulators

6. Size burner orifices

7. Use gas metering devices

- Regulators
 - Pressures
 - Velocity
 - Droop
 - Lock up pressure
 - Inlet pressure
 - Downstream set point pressure
 - Location of test gauges
 - Codes
- Types of fuel gases
- Tables
- Calculations
 - Orifice flow formula
 - Fuel gas conversions
- Drilling
- Drill index
- Low pressure clocking
- High pressure clocking
- High altitude appliance derating

LEARNING TASKS

CONTENT

3. Verify electrical operating parameters

4. Adjust burners

5. Commission boilers and water heaters

- Valve tightness test
- Leak test
- Hydrostatic test
- Tightness of electrical connections
- Verify voltage
- Code compliance
- Verify electrical wiring diagram
- 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
- 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

- | | |
|--|---|
| <p>6. Verify safety devices, limits, and operating controls</p> <p>7. Commission a high efficiency furnace</p> | <ul style="list-style-type: none"> • Purging and flushing • Water treatment • Relief piping • Draft • Spillage • Air inlet openings • Water flow rates <ul style="list-style-type: none"> ○ Circulator speed ○ Balancing valves • Condensate neutralization and disposal • Combustion analysis • Interlocks • High limit • Operating controls • Thermostat • Flame roll out switch • Pressure switch <ul style="list-style-type: none"> ○ Air • End switch • Spill switch (vent safety) • Heat exchanger temperature rise • External static pressure (ESP) • Condensate trap • Condensate pump • Condensate neutralizing tank • Air cleaners • Temperature set points • Flame safeguard <ul style="list-style-type: none"> ○ 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: <ul style="list-style-type: none">• Condensing boiler• Manufacturer's documentation• Tools and testing equipment• Applicable equipment
Criteria	The learner will be evaluated on: <ul style="list-style-type: none">• Appliance meeting manufacturer's specifications• Appliance operating safely 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: <ul style="list-style-type: none">• High efficiency furnace• Manufacturer's documentation• Tools and testing equipment• Applicable equipment
Criteria	The learner will be evaluated on: <ul style="list-style-type: none">• Appliance meeting manufacturer's specifications• Appliance operating safely and efficiency• Code compliance

LEARNING TASKS

4. Describe NOx
5. Maintain combustion analyzer

CONTENT

- Stack draft
- Required adjustments
- Data storage
 - Printed results
 - Electronic spreadsheet
- Characteristics
- Annual calibration and re-certification
- Storage and handling
 - Water trap maintenance
 - 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

1. Describe a barometric draft regulator
2. Adjust a barometric draft regulator

CONTENT

- Purpose
- Principles of operation
- 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

1. Transfer documentation
2. Describe appliance end user training

CONTENT

- Regulatory responsibilities
- Operator manuals
- Instructions to customer
- Light up instructions
- Systems maintenance instructions

Line (GAC): K **COMMISSION SYSTEMS**
Competency: K8 **Decommission and Disconnect Appliances and Equipment**

Objectives

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

- Describe the removal of gas-fired appliances.

LEARNING TASKS

1. Describe the disconnection of appliances and accessories

2. Describe the removal of gas-fired appliances

CONTENT

- Tools
- Lock out/isolation
- Termination
- Purge
- Check for leaks

- 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

2. Troubleshoot and repair cooling towers

- 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
- 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

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
- Diagnostic 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

1. Describe the repair procedures for a gas distribution system

CONTENT

- 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

- | | |
|---|---|
| <p>1. Describe the procedures for servicing gas burners</p> | <ul style="list-style-type: none"> • Service schedule • Inspection <ul style="list-style-type: none"> ○ Appearance ○ Performance ○ Signs of flame impingement ○ Sooting • Cleaning • Reassembly • Recommission <ul style="list-style-type: none"> ○ Firing ○ Clocking ○ Combustion analysis |
| <p>2. Describe replacement procedures for ancillary equipment</p> | <ul style="list-style-type: none"> • Identify faulty component • Source correct replacement component • Replace component • Confirm component operation |

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>4. Check safety devices, limits, and operating controls</p> | <ul style="list-style-type: none"> • Verify electrical wiring diagram • Interlocks • High limit • Operating controls <ul style="list-style-type: none"> ○ Thermostat • Flow switch • Flame roll out switch • Pressure switch <ul style="list-style-type: none"> ○ Air ○ Gas • End switch • Vent safety switch • Spill switch |
| <p>5. Service burners</p> | <ul style="list-style-type: none"> • Manufacturer's documentation • Client requirements • Pilot verification • Pre-ignition check • Main burner light off • Combustion verification <ul style="list-style-type: none"> ○ Flue gas analysis • Verify gas pressures <ul style="list-style-type: none"> ○ Manifold ○ Supply • Clocking • Clean components <ul style="list-style-type: none"> ○ Burner ports ○ Air intakes ○ Ignition systems |
| <p>6. Verify flame safe guard system operation</p> | <ul style="list-style-type: none"> • 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 |
| <p>7. Describe servicing requirements for gas-fired appliances</p> | <ul style="list-style-type: none"> • Types <ul style="list-style-type: none"> ○ Direct vent appliances ○ Decorative appliances <ul style="list-style-type: none"> – Fireplace – Fire pit |

LEARNING TASKS

CONTENT

- | | | |
|----|----------------------------------|--|
| 8. | Service high efficiency furnaces | <ul style="list-style-type: none"> ○ Furnaces ○ Radiant heaters <ul style="list-style-type: none"> – 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 ● Verify <ul style="list-style-type: none"> ○ Heat exchanger temperature rise ○ External static pressure (ESP) ○ Temperature set points ○ Blower speed and operation ● Inspect <ul style="list-style-type: none"> ○ Condensate trap ○ Condensate pump ○ Neutralize tank ○ Air cleaners ○ Heat exchanger |
| 9. | Service tankless heaters | <ul style="list-style-type: none"> ● Inspect <ul style="list-style-type: none"> ○ Condensate trap ○ Condensate pump ○ Neutralize tank ○ Heat exchanger ○ Water flow rates <ul style="list-style-type: none"> – Flow balancing ● Verify <ul style="list-style-type: none"> ○ 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: 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

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe troubleshooting procedures for flame safe guards
 2. Describe troubleshooting procedures for combination gas valves | <ul style="list-style-type: none"> • Cycle appliance • Confirm control sequence • Confirm control terminal voltage
 • Cycle appliance • Confirm operation <ul style="list-style-type: none"> ○ 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe the refrigeration process of gas-fired appliances 2. Describe the installation requirements of gas-fired refrigeration equipment 3. Describe troubleshooting procedures 4. Describe burner maintenance procedures | <ul style="list-style-type: none"> • Terminology • Absorption refrigeration • B.149.1 code requirements • Manufacturer’s documentation • Leveling • Air circulation • Clearances • Venting requirements • Heat input • Air circulation • Leveling • Annual maintenance • Burner cleaning • Orifice cleaning • Manifold pressure • Gas supply tube cleaning • Chimney and boiler tube cleaning |
|--|--|

Section 4

ASSESSMENT GUIDELINES

Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

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 Talfors
- 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.technicalssafetybc.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

Additionally, all Refrigeration and Air Conditioning Mechanic instructors delivering Red Seal Gasfitter - Class B content must possess **one** of the following:

- SkilledTradesBC Gasfitter - Class B Certificate of Qualification (C of Q) with Interprovincial Red Seal endorsement

OR

- SkilledTradesBC Gasfitter – Class A Certificate of Qualification (C of Q) with Interprovincial Red Seal endorsement

The following are recommended but *not required*:

- Electrical FSR Class RE.

Work Experience

A minimum of 5 years' experience working in the industry as a Refrigeration and Air Conditioning Mechanic journey person 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 CO₂, CO, O₂, stack temperature and excess air for every 8 students
- 1 liquid filled manometer for every 4 students
- 1 digital manometer for every 4 students
- 1 incline manometer for every 16 students
- Necessary hand and power tools to service furnaces, boilers and domestic water heaters
- 1 forced-air furnace for every 4 students
- 1 hot water boiler for every 4 students
- 1 tankless water heater for every 8 students
- 1 storage type water heater for every 8 students
- 1 residential range for every 16 students
- 1 residential dryer for every 16 students
- 1 unit heater for every 16 students
- All appliances to have an input of 120 kW or less

**Appendix B
Acronyms**

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 Mazsatar
- Jason Rockson