

SKILLED**TRADES**^{BC}

PROGRAM OUTLINE

Gasfitter – Class B

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GASFITTER – CLASS B PROGRAM OUTLINE

**APPROVED BY INDUSTRY
SEPTEMBER 2017**

**Developed by
SkilledTradesBC
Province of British Columbia**

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Section 1

INTRODUCTION

Gasfitter – Class B

Foreword

The Gasfitter - Class B 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 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 Gasfitter – Class B 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 journey person. 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 Gasfitter B program, industry and instructors **strongly advise apprentices to upgrade their Math and Physics skills** prior to registration for technical training in this program.

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

This Program Outline was prepared with the advice and direction of an industry steering committee convened initially by SkilledTradesBC (SkilledTradesBC). Members include:

- Michael Pizzolato, Cannepp (Canadian Engineered Products & Sales)
- Richard Doerksen, Apex Steel and Gas
- Glen Ohs, Corix Utilities
- Rob Marchiori, Ram Mechanical
- Ray Bollinger, Just Mechanical
- Shane Richardson, Resilient Plumbing
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- Glen Ohs, Corix Utilities
- Rob Marchiori, Ram Mechanical
- Richard Doerksen, Apex Steel and Gas
- Michael Pizzolato, Cannepp (Canadian Engineered Products & Sales)
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- Marty Old, Marty Old Consulting
- Glen Ohs, Corix Utilities
- Brian Sweet, BCIT

Facilitators:

- Angela Caughy

SkilledTradesBC would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Gasfitter – Class B occupation.

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	NA
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
Assessment Guidelines	Understand the relative weightings of various competencies of the occupation on which assessment is based	Understand the relative weightings of various competencies of the occupation on which assessment is based	Understand the relative weightings of various competencies of the occupation on which assessment is based	Understand the relative weightings of various competencies of the occupation on which assessment is based
Appendix – Glossary of Terms	Defines program specific terms	Defines program specific terms	Defines program specific terms	Defines program specific terms

Section 2

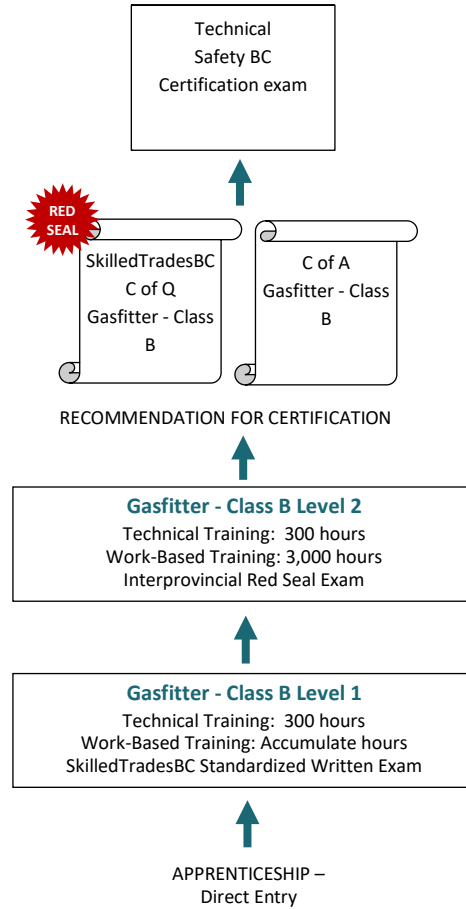
PROGRAM OVERVIEW

Gasfitter – Class B

Program Credentialing Model

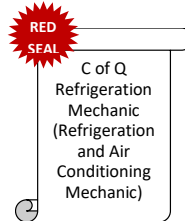
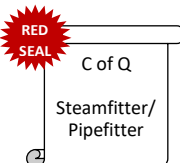
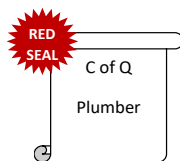
Gasfitter - Class B

C of Q = Certificate of Qualification
 C of A = Certificate of Apprenticeship
 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



*Individuals who are holders of more than one of these credentials will only be awarded credit for 1,500 hours total

Occupational Analysis Chart

GASFITTER – CLASS B

Gasfitters – Class B design, install, test, adjust, maintain and repair lines, appliances, equipment and accessories in various sectors. Fuels may include natural gas, manufactured gas, liquefied petroleum gas, digester gas, landfill gas, biogas or a mixture or dilution of any of these gases and Hydrogen. Appliances and equipment include those that do not exceed 400 000 Btuh (British Thermal Units per hour) or 120 kW (kilowatts) such as boilers, burners, makeup air units, furnaces, process burners, and various other gas-fired equipment.

Note: To work in this trade in BC, it is also necessary to pass the relevant Technical Safety BC (TSBC) Gasfitter – Class B certification exam to achieve the TSBC Gasfitter - Class B Certificate of Qualification or “license.” For more information, please visit the [TSBC website](#)

Gasfitters – Class A design, install, test, adjust, maintain and repair lines, appliances, equipment and accessories in various sectors. Fuels may include natural gas, manufactured gas, liquefied petroleum gas, digester gas, landfill gas, biogas or a mixture or dilution of any of these gases and Hydrogen. Appliances and equipment include those exceeding 400 000 Btuh (British Thermal Units per hour) or 120 kW (kilowatts) such as boilers, burners, makeup air units, furnaces, process burners, and various other gas-fired equipment.

Gas B = Level 1,2; Gas A= Level A-1, A-2

USE COMMON OCCUPATIONAL SKILLS A	Control workplace hazards A1	Use drawings and specifications A2	Use common tools and access equipment A3	Use technical instruments and testers A4	Use codes, regulations and standards A5	Organize work and maintain records A6
	1	1 A-1	1	1 2 A-1 A-2	1 2 A-1 A-2	1 2 A-1
APPLY FUNDAMENTALS OF GAS UTILIZATION B	Apply gas properties B1	Apply combustion theory B2	Apply draft theory B3	Interpret heating, cooling and process systems B4	Apply knowledge of mechanical safety devices B5	Apply alternate-fuel theory B6
	1	1 A-1 A-2	1 A-1	1 2 A-1	1 2 A-1	2 A-1
APPLY ELECTRICAL CONCEPTS C	Use the principles of electricity and electronics C1	Use electrical wiring diagrams and schematics C2	Use the Canadian Electrical Code (CEC) C3	Apply single phase motor theory C4	Apply three phase motor theory C5	Apply Variable Frequency Drive (VFD) and Electronically Commutated Motors (ECM) technology C6
	1 2 A-1	1 2 A-1 A-2	1 2 A-1	1 2	1 A-1	2 A-1

Program Overview

	Apply wiring practices C7 1 2 A-1	Troubleshoot electrical circuits C8 2 A-1	Apply communication and networking technology C9 2 A-1 A-2					
PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS D	Size piping and tubing systems D1 1 A-1	Select regulators, valves, and valve train components D2 1 2 A-1 A-2	Plan propane system installations D3 2 A-1	Size venting systems D4 2 A-1	Size air supply systems D5 2 A-1	Select gas-fired appliances D6 1 2 A-1		
	Select burners D7 1 2 A-1	Select flame safeguards D8 1 2 A-1	Select combustion, safety and operating controls D9 2 A-1	Select electrical components D10 1 A-1	Select automation and instrumentation control systems D11 2 A-2	Plan a project D12 1 2 A-1 A-2		
	INSTALL GAS-FIRED SYSTEMS E	Install piping and tubing systems E1 1	Install regulators, valves, and valve train components E2 1 2 A-1	Install LPG, LNG, CNG, vaporizing and mixing systems E3 2 A-1	Install venting systems E4 2 A-1	Install air supply systems E5 1 2 A-1	Install draft control systems E6 2 A-1	
		Install burners E7 A-2	Install flame safeguards E8 A-1	Install combustion, safety and operating controls E9 A-1	Install automation and instrumentation control systems E10 2 A-2	Install boilers and ancillary equipment E11 2 A-1	Install air heating appliances and equipment E12 2 A-2	
		COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT F	Commission fuel/air delivery systems F1 1 2 A-1 A-2	Perform appliance start-up procedures F2 2 A-2	Interpret gas metering devices F3 2 A-2	Perform combustion analysis F4 2 A-1 A-2	Commission boilers and ancillary equipment F5 2 A-2	Commission direct-fired make-up air heaters F6 A-2

Program Overview

**MAINTAIN AND
SERVICE GAS-FIRED
APPLIANCES AND
EQUIPMENT** **G**

Commission furnaces and ovens F7 2 A-2	Program temperature, pressure and operating controls F8 2 A-2	Program combustion control systems F9 A-2	Program PLCs F10 A-2	Commission draft control systems F11 2 A-2	Training and handover of gas-fired equipment F12 2 A-2
Service gas distribution systems G1 2 A-2	Service gas burners and ancillary equipment G2 2 A-2	Maintain boilers and ancillary equipment G3 2 A-2	Maintain gas-fired appliances G4 2 A-2	Maintain gas-fired refrigeration equipment G5 2 A-2	Service fuel/air delivery systems G6 2 A-2
Service and repair control systems G7 2 A-2	Repair and replace furnace refractory G8 A-1	Decommission and disconnect gas-fired appliances and equipment G9 2 A-2			

Training Topics and Suggested Time Allocation: Level 1

GASFITTER – CLASS B – LEVEL 1

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line A	Use Common Occupational Skills	20%	85%	15%	100%
A1	Control workplace hazards		✓		
A2	Use drawings and specifications		✓	✓	
A3	Use common tools and access equipment		✓	✓	
A4	Use technical instruments and testers		✓	✓	
A5	Use codes, regulations, and standards		✓	✓	
A6	Organize work and maintain records		✓	✓	
Line B	Apply Fundamentals of Gas Utilization	14%	90%	10%	100%
B1	Apply gas properties		✓		
B2	Apply combustion theory		✓		
B3	Apply draft theory		✓	✓	
B4	Interpret heating, cooling and process systems		✓		
B5	Apply knowledge of mechanical safety devices		✓	✓	
Line C	Apply Electrical Concepts	24%	85%	15%	100%
C1	Use the principles of electricity and electronics		✓		
C2	Use electrical wiring diagrams and schematics		✓	✓	
C3	Use the Canadian Electrical Code (CEC)		✓		
C4	Apply single phase motor theory		✓		
C5	Apply three phase motor theory		✓		
C7	Apply wiring practices		✓	✓	
Line D	Plan Gas-Fired Appliance System Installations	24%	80%	20%	100%
D1	Size piping and tubing systems		✓	✓	
D2	Select regulators, valves, and valve train components		✓		
D6	Select gas-fired appliances		✓		
D7	Select burners		✓		
D8	Select flame safeguards		✓		
D10	Select electrical components		✓	✓	
D12	Plan a project		✓	✓	
Line E	Install Gas-Fired Systems	14%	100%	0%	100%
E1	Install piping and tubing systems		✓		
E2	Install regulators, valves, and valve train components		✓		
E5	Install air supply systems		✓		
Line F	Commission Gas-Fired Appliances and Equipment	4%	90%	10%	100%
F1	Commission fuel/air delivery systems		✓	✓	
Total Percentage for Gasfitter – Class B Level 1		100%			

Training Topics and Suggested Time Allocation: Level 2

GASFITTER – CLASS B – LEVEL 2

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line A	Use Common Occupational Skills	8%	90%	10%	100%
A4	Use technical instruments and testers		✓		
A5	Use codes, regulations, and standards		✓		
A6	Organize work and maintain records		✓		
Line B	Apply Fundamentals of Gas Utilization	8%	85%	15%	100%
B4	Interpret heating, cooling and process systems		✓		
B5	Apply knowledge of mechanical safety devices		✓	✓	
B6	Apply alternate-fuel theory		✓	✓	
Line C	Apply Electrical Concepts	24%	80%	20%	100%
C1	Use the principles of electricity and electronics		✓		
C2	Use electrical wiring diagrams and schematics		✓	✓	
C3	Use the Canadian Electrical Code (CEC)		✓		
C4	Apply single phase motor theory		✓		
C6	Apply Variable Frequency (VFD) and Electronically Commutated Motors (ECM) technology		✓		
C7	Apply wiring practices		✓		
C8	Troubleshoot electrical circuits		✓		
C9	Apply communication and networking technology		✓		
Line D	Plan Gas-Fired Appliance System Installations	24%	100%	0%	100%
D2	Select regulators, valves, and valve train components		✓		
D3	Plan propane system installations		✓		
D4	Size venting systems		✓		
D5	Size air supply systems		✓		
D6	Select gas-fired appliances		✓		
D7	Select burners		✓		
D8	Select flame safeguards		✓		
D9	Select combustion, safety and operating controls		✓		
D11	Select automation and instrumentation control systems		✓		
D12	Plan a project		✓		
Line E	Install Gas-Fired Systems	16%	100%	0%	100%
E2	Install regulators, valves and valve train components		✓		
E3	Install LPG, LNG, CNG vaporizing and mixing systems		✓		
E4	Install venting systems		✓		
E5	Install air supply systems		✓		
E6	Install draft control systems		✓		
E10	Install automation and instrumentation control systems		✓		
E11	Install boilers and ancillary equipment		✓		
E12	Install air heating appliances and equipment		✓		

		% of Time Allocated to:			
		% of Time	Theory	Practical	Total
Line F	Commission Gas-Fired Appliances and Equipment	16%	50%	50%	100%
F1	Commission fuel/air delivery systems		✓		
F2	Perform appliance start-up procedures		✓	✓	
F3	Interpret gas metering devices		✓		
F4	Perform combustion analysis		✓		
F5	Commission boilers and ancillary equipment		✓	✓	
F7	Commission furnaces and ovens		✓	✓	
F8	Program temperature, pressure and operating controls		✓		
F11	Commission draft control systems		✓		
F12	Training and handover of gas-fired equipment		✓		
Line G	Maintain and Service Gas-Fired Appliances and Equipment	4%	100%	0%	100%
G1	Service gas distribution systems		✓		
G2	Service gas burners and ancillary equipment		✓		
G3	Maintain boilers and ancillary equipment		✓		
G4	Maintain gas-fired appliances		✓		
G5	Maintain gas-fired refrigeration equipment		✓		
G6	Service fuel/air delivery systems		✓		
G7	Service and repair control systems		✓		
G9	Decommission and disconnect gas-fired appliances and equipment		✓		
Total Percentage for Gasfitter – Class B Level 2		100%			

Section 3
PROGRAM CONTENT
Gasfitter – Class B

Level 1

Gasfitter – Class B

Line (GAC): A USE COMMON OCCUPATIONAL SKILLS

Competency: A1 Control workplace hazards

Objectives

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

- Assess and manage workplace hazards.
- Apply OHS regulations and WorkSafe BC standards.
- Use WHMIS.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>1. Describe common workplace hazards</p> | <ul style="list-style-type: none"> • Short term hazards <ul style="list-style-type: none"> ○ Confined space ○ Elevations ○ Electrical ○ Compressed gas ○ Explosive material (dust) ○ Air quality • Long term hazards <ul style="list-style-type: none"> ○ Respiratory disease ○ Repetitive strain injuries ○ Hearing loss ○ Chemical exposure • Constant awareness of surroundings <ul style="list-style-type: none"> ○ Safe attitude ○ Housekeeping ○ Site conditions |
| <p>2. Manage workplace hazards</p> | <ul style="list-style-type: none"> • WHMIS • TDG • OHS regulation • WorkSafe BC standards • Personal Protective Equipment (PPE) • Emergency shutoffs • Fire prevention • Chemical hazard response <ul style="list-style-type: none"> ○ Eye wash facilities ○ Emergency shower • Evacuation plan <ul style="list-style-type: none"> ○ Marshalling/mustering areas ○ Emergency exits ○ Emergency contact/phone numbers |
| <p>3. Describe lock-out and tag-out procedures</p> | <ul style="list-style-type: none"> • Understanding of system operation • Components requiring lock-out • Identification requirements |

LEARNING TASKS

CONTENT

- Situations where lock-out is required
- Lock-out equipment
 - Chains
 - Tags
 - Locks
 - Blind flanges
 - Spectacle

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 USE COMMON OCCUPATIONAL SKILLS

Competency: A3 Use common tools and access equipment

Objectives

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

- Use and maintain hand and power tools.
- Use cutting, soldering and brazing equipment.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Use and maintain hand and power tools
 2. Use access equipment
 3. Use cutting, soldering and brazing equipment
 4. Describe rigging and hoisting equipment | <ul style="list-style-type: none"> • Trade specific hand and power tools <ul style="list-style-type: none"> ○ See tools and equipment list in appendix
 • Ladders • Platforms • Lifts • Safety
 • Oxy-acetylene equipment • Air acetylene equipment • Maintenance/storage • Safety
 • Selection <ul style="list-style-type: none"> ○ Tirfors ○ Genie lift ○ Slings ○ Shackles • Ratings • Inspection • Storage and maintenance |
|--|---|

LEARNING TASKS

CONTENT

5. Describe temperature measuring instruments

6. Use temperature measuring instruments

7. Describe electrical testing meters

8. Use electrical test meters

9. Use combustible gas indicator (CGI)

- Manufacturer's specifications
- Diagnostics
 - Pressure tests
 - Leak detection
- Tightness of closure
- Thermometer
- Pyrometer
- Thermocouple
- Thermistor
- Scales
- Calibration
- Check readings
- Applications
- Types
 - Multi-meter
 - Ammeter
 - Ohm-meter
 - Volt-meter
 - Micro-ammeter
 - Milli-ammeter
- Check voltage
- Check current
- Check resistance
- Check for continuity
- Types
 - Electronic
 - Laser
 - Draeger
 - Flame ionization
- Applications

Line (GAC): A USE COMMON OCCUPATIONAL SKILLS

Competency: A5 Use codes, regulations, and standards

Objectives

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

- Interpret B149.1 sections 1, 2, 3, 4, 6, Annex A & B.
- Interpret the Safety Standards Act, Safety Standards General Regulation and Gas Safety Regulation.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <p>1. Describe code implications</p> | <ul style="list-style-type: none"> • Design • Planning • Installation • Maintenance • Decommissioning |
| <p>2. Describe the B149 Gas Code series</p> | <ul style="list-style-type: none"> • B149.1, B149.2, B149.3 • Layout • Sections • Contents • Index • Annexes • Tables • Definitions • Scope • Revisions |
| <p>3. Interpret Sections of the B149.1 Gas Code</p> | <ul style="list-style-type: none"> • Scope • Reference Publications • Definitions • General • Piping and Tubing Systems, Hose, and Fittings • Annexes A & B |
| <p>4. Use Gas Regulations</p> | <ul style="list-style-type: none"> • Role of Technical Safety BC (formally known as BC Safety Authority) • 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): A USE COMMON OCCUPATIONAL SKILLS

Competency: A6 Organize work and maintain records

Objectives

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

- Describe information contained in manufacturer and supplier documentation.
- Describe how to source manufacturer’s documentation.
- Describe record management.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Describe information contained in manufacturer and supplier documentation
 2. Describe how to source manufacturer’s documentation
 3. Describe record management | <ul style="list-style-type: none"> • Installation instructions and requirements • Operation and maintenance manuals • Product specifications <ul style="list-style-type: none"> ○ Certification agencies • Warranty information • Appliance rating plates • Manufacturer’s web-sites • Contact manufacturer • Local agencies • Paper based filing • Electronic filing • Service reports • Invoices • Time sheets • Purchase orders • Vehicle logs • Maintenance logs • Inventory • Permits • Statements of completion |
|---|--|

Line (GAC): B APPLY FUNDAMENTALS OF GAS UTILIZATION

Competency: B1 Apply gas properties

Objectives

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

- Describe the characteristics of hydrocarbon gases.
- Apply gas laws.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <p>1. Describe characteristics of hydrocarbon gases</p> | <ul style="list-style-type: none"> • Substances <ul style="list-style-type: none"> ○ Elements ○ Compounds ○ Mixtures • Density • Specific gravity • Buoyancy • Chemistry • Heat value • Flow characteristics • Ignition and flame temperatures • Flame speeds • Odourant • Limits of flammability |
| <p>2. Describe the factors that affect volumes and pressures and velocities</p> | <ul style="list-style-type: none"> • Boyle's Law • Charles Law • Gay-Lusac's Law • Combined Gas Law • Bernoulli's principle |
| <p>3. Apply gas laws</p> | <ul style="list-style-type: none"> • Boyle's Law • Charles Law • Gay-Lusac's Law • Combined Gas Law • Temperatures <ul style="list-style-type: none"> ○ Kelvin ○ Rankine • Pressures <ul style="list-style-type: none"> ○ Absolute |

Line (GAC): **B APPLY FUNDAMENTALS OF GAS UTILIZATION**

Competency: **B3 Apply draft theory**

Objectives

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

- Describe draft.
- Describe the building as a system.

LEARNING TASKS

1. Describe draft

2. Describe the building as a system

CONTENT

- Natural draft
 - Buoyancy
 - Temperature
 - Height
- Terms
 - Stack effect
 - Stack draft
 - Natural draft
 - Chimney effect
- Mechanical draft
- Negative air pressure
- Exhaust equipment
- Air supply equipment
- Building envelope
- Building ventilation
 - Air exchange equipment
- Regional location
- Type of building
- Code requirements
 - B149.1
 - Building Code

Line (GAC): B APPLY FUNDAMENTALS OF GAS UTILIZATION

Competency: B4 Interpret heating, cooling and process systems

Objectives

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

- Perform process heat load calculations.
- Describe the operation of hydronic heating systems.
- Describe the operation of residential forced air systems.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>1. Describe the properties of matter</p> | <ul style="list-style-type: none"> • States (Phases) <ul style="list-style-type: none"> ○ Solids ○ Liquids ○ Gases • Changes of state <ul style="list-style-type: none"> ○ Physical ○ Chemical |
| <p>2. Describe methods of heat transfer</p> | <ul style="list-style-type: none"> • Conduction • Convection • Radiation |
| <p>3. Describe process heat calculations</p> | <ul style="list-style-type: none"> • Sensible, latent & specific heat • British thermal unit (Btu) • KiloWatts (kW) |
| <p>4. Perform process heat load calculations for liquids, solids and air</p> | <ul style="list-style-type: none"> • Sensible, latent & specific heat • British thermal unit (Btu) • KiloWatts (kW) |
| <p>5. Calculate volumetric thermal expansion</p> | <ul style="list-style-type: none"> • Expansion coefficients • Temperature <ul style="list-style-type: none"> ○ ΔT • Volume |
| <p>6. Describe the operation of residential hydronic heating systems</p> | <ul style="list-style-type: none"> • Purpose • Volumetric thermal expansion <ul style="list-style-type: none"> ○ Expansion coefficients ○ Temperature <ul style="list-style-type: none"> – ΔT ○ Volume • Components <ul style="list-style-type: none"> ○ Expansion tank ○ Mixing valves ○ Air separator ○ Zone headers ○ Zone valves ○ Pumps |

LEARNING TASKS

CONTENT

7. Describe the operation of residential forced air systems

- Temperature indicators
- Air vents
- Feed water
- Water treatment
- Piping system configurations
 - Zoning
 - Supply water
 - Return water
 - Balancing
 - High-temperature
 - Low-temperature
 - Mixing
- 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
- Purpose
- Components
- Ducting configurations
 - Supply air
 - Return air
 - Zoning
- Controls
- Balancing

Line (GAC): **B APPLY FUNDAMENTALS OF GAS UTILIZATION**

Competency: **B5 Apply knowledge of mechanical safety devices**

Objectives

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

- Describe mechanical safety devices.

LEARNING TASKS

1. Describe Mechanical Safety Devices

CONTENT

- Pressure relief valves
- Temperature relief valves
- Safety valves
 - Pop Safety (PSV)
- Safety Relief valves (SRV)
- Ratings
- Vacuum relief

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C1 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.

LEARNING TASKS

1. Describe the fundamentals of electricity

2. Describe electrical circuits

CONTENT

- Basic principles
 - Atomic theory
 - Electron flow
 - Conductors - insulators
 - Kinds of electricity
 - AC current
 - DC current
 - Static electricity
 - Cathodic protection
 - Anode
 - Cathode
- Properties of wire
 - Resistance
 - Calculating resistance
 - Effect of temperature
 - Types of wires and cables
- Electrical sources
 - AC
 - Single phase
 - Three phase
 - DC
- Parts of a circuit
 - Source
 - Switch
 - Load
- DC circuits and measurements
 - Ohm's Law
 - Measurement of voltage and amperage
 - Resistors in parallel and series
 - Power and energy
 - Closing and opening DC circuits
- AC circuits and measurements
 - Inductance

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"> ○ AC amperage ○ Resistance ○ Impedance ○ Capacitance ○ Power factor ● 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 ● Primary winding ● Secondary winding ● Tappings |
|--|---|

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C2 Use electrical wiring diagrams and schematics

Objectives

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

- Identify electrical diagrams.
- Sketch a series and parallel circuit.
- Analyze simple circuits.
- Describe appliance circuits.

LEARNING TASKS

1. Identify electrical diagrams

2. Sketch a circuit

3. Analyze simple circuits

4. Describe appliance circuits

CONTENT

- Types of diagrams
 - Ladder
 - Schematic
 - Pictorial
 - Wiring
- Symbols used in schematic diagrams
- Read schematics
 - Identifying components
 - Determining function of circuit
 - Identifying control circuits
 - Parallel circuits
 - Series circuits
- Apply circuit diagrams
 - Troubleshooting techniques
- Parallel circuit
- Series circuit
- Safety
 - Lock out and fuse removal
 - First aid for electrical shock
- Test circuits
 - Voltage test
 - Amperage test
 - Resistance test
 - Continuity test
- Analyze readings
 - Compare to manufacturer's data
 - Compare to previous readings
 - Compare to expected data
 - Reasons for unexpected readings
- Transformer
- Limit/Safety
- Pump/fan
- Control

Line (GAC): C **APPLY ELECTRICAL CONCEPTS**
Competency: C3 **Use the Canadian Electrical Code (CEC)**

Objectives

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

- Interpret the Canadian Electrical Code Part 1.
- Interpret the Electrical Safety Regulations.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe the Canadian Electrical Code Part 1 2. Interpret the Electrical Safety Regulations 3. Size conductors 4. Describe wiring installation 5. Describe grounding and bonding techniques | <ul style="list-style-type: none"> • Section <ul style="list-style-type: none"> ○ 0,2,4,8,10,12 ○ Appendix B ○ Appendix D • Technical Safety BC (formerly BC Safety Authority (BCSA)) • Section 4 CEC • Section 12 CEC • Section 10 CEC |
|--|--|

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C4 Apply single phase motor theory

Objectives

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

- Describe single phase motors.

LEARNING TASKS

1. Identify motor components
2. Describe characteristics and operation of single phase motors

CONTENT

- Types of components
- AC theory
 - Electromagnetic theory
 - Induction motors

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C5 Apply three phase motor theory

Objectives

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

- Describe three phase motors.

LEARNING TASKS

1. Describe three phase motors

CONTENT

- Three phase supplies
 - Delta supply
 - Wye (Y) supply
- Characteristics
- Components
- Operation

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D1 Size piping and tubing systems

Objectives

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

- Describe piping, tubing and hoses.
- Size piping and tubing systems.

LEARNING TASKS

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

2. Describe natural gas fuel distribution systems

3. Describe piping, tubing and hoses

CONTENT

- Laminar flow
- Turbulent flow
- Specific gravity
- Pressure drop
- Velocity
- Size
- Piping material
- Fittings
- Utility provider
 - Gas well
 - Transmission line
 - Compressor station
 - City gate station
 - District regulator station
 - Distribution regulator
 - Gas main
 - Gas service
 - Service stop (valve)
 - Service regulator
 - Meter
- Consumer
 - Gas supply or building line
 - Branch line
 - Drop line
 - Riser
 - Drip or dirt pocket
 - Extension
- Gas pressures
 - High
 - Low
- Types
 - Black iron pipe
 - Copper tubing
 - PE piping
 - Tracer wire

LEARNING TASKS

CONTENT

4. Size piping and tubing systems

- Corrugated stainless steel tubing (CSST)
- Hoses
- Flexible connectors
- Schedules and grades
- Pressure ratings
- Nominal sizes
- Protective coatings
- Cathodic protection
- Identification markings
- Types
 - Black iron pipe
 - Copper tubing
 - Corrugated stainless steel tubing (CSST)
- Pressures
 - Low pressure
 - 2 psig (14 kPa)
 - High pressure
- Sizing factors
 - Appliance Rating
 - Distance
 - Allowable pressure drop
 - Piping or tubing type
 - Type of gas
 - Fittings
- Code requirements
- Procedures

LEARNING TASKS

4. Describe gas valve train for appliances 400 MBH or less

5. Describe the operation of a gas valve train

CONTENT

- Operating principles
- Applications
- Regulators
- Gas valves
- Manual valves
 - A-cock
 - B-cock
 - Test firing
- Flow control
- Electric valves
 - Solenoid
 - Diaphragm
 - Combination
- Non-electric valves
 - Rod and tube
 - Hydraulic
- Pilot safety valve
- Regulators

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D6 Select gas-fired appliances

Objectives

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

- Describe gas-fired appliances.

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): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D7 Select burners

Objectives

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

- Describe burners.
- Describe the operation of atmospheric burners.
- Describe burner orifices.

LEARNING TASKS

1. Describe burners

2. Describe atmospheric 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
 - Impingement
 - Flame retention
- High installations
- Pilot
 - Continuous
 - Intermittent
- Interrupted
- Types
 - Main burners
 - Pilot burners
- Parts
 - Burner port
 - Mixing tube

LEARNING TASKS

3. Describe burner orifices

CONTENT

- Burner head
- Operation
 - Venturi effect (Bernoulli's principle)
 - Primary air control
 - Fuel control
- Application
- Types
 - Plug
 - Cap
 - Adjustable
- Sizing
 - Tables
 - Calculations
 - Orifice flow formula
 - Drilling
- Drill index

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS**Competency: D8 Select flame safeguards****Objectives**

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

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

LEARNING TASKS

1. Describe flame detectors
2. Describe ignition systems
3. Describe standing pilot/thermocouple systems

CONTENT

- Thermocouple
- Thermopile
- Flame rectification (flame rod)
- Pilot types
 - Continuous
 - Intermittent
 - Interrupted
- Pilot
- Wiring circuit
- Sequence of operation
- Applications

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D10 Select electrical components

Objectives

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

- Describe switches.
- Install relays.

LEARNING TASKS

1. Describe switches

2. Describe relays

3. Select relays

4. Install relays

CONTENT

- Manual
- Temperature actuated
- Pressure actuated
- Liquid level actuated
- Flow
- Proximity/End
- Operation
- Ratings
- Contacts
 - Normally open
 - Normally closed
- 120 volt coils
- 24 volt coils
- Ratings
- 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
- Light bulbs
- Transformer

Criteria The learner will be evaluated on:

- Accuracy to the diagram
- Wiring techniques
- Neatness

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D12 Plan a project

Objectives

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

- Plan a residential piping installation.

LEARNING TASKS

1. Determine load

2. Layout the system

3. Size the system

4. Determine material take-off

CONTENT

- Appliance rating plates
- Manufacturer’s documentation
- Pressure
- System Regulators
- Regulator locations
- Hangers and supports
- Valve placement
- Drip legs
- Routing
- Piping material
- Pressure
 - 7-14 in WC
 - 2 psig
- Lengths
- Type of gas
- Pressure drop
- Fittings
- Valves
- Hangers and supports
- Regulators
- Pipe and tubing
- Consumables

Achievement Criteria

Performance	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • Plan a layout of a residential piping installation • Sketch an isometric piping drawing • Size the piping system • Generate a tool and material list.
Conditions	<p>To be assessed during technical training. The learner will be given:</p> <ul style="list-style-type: none"> • Residential floor plan with meter and appliance location • Appliance documentation • Sketching equipment • Delivery pressure.
Criteria	<p>The learner will be evaluated on:</p> <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.

LEARNING TASKS

CONTENT

- Code requirements
- Identification
- Procedures
- Fittings
- Valves
- Prohibited practice
- Location limitations
- Structural penetrations
 - Fire stopping
- Outlets
- Drip or dirt pockets
- Between buildings
- Concealment
 - Protection plates
- In concrete
- Protective coatings
- Underground
- Support
- Tools
- Connectors

Line (GAC): **E INSTALL GAS-FIRED SYSTEMS**
Competency: **E2 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.

LEARNING TASKS

1. Describe the installation of manual shut-off valves

2. Describe the installation of gas pressure regulators

CONTENT

- Code requirements
- Manufacturer's specifications
- Procedures
 - 2 piece ball valves

- Code requirements
- Manufacturer's specifications
- Procedures

Line (GAC): **E INSTALL GAS-FIRED SYSTEMS**

Competency: **E5 Install air supply systems**

Objectives

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

- Describe installation of passive air supply systems.

LEARNING TASKS

1. Describe installation of passive air supply

CONTENT

- Code requirements
- Structural penetrations
- Sealing
- Sheet metal assembly
 - Drive cleats
 - Esses
 - Tools
- Opening and ducts
 - Terminations
- Traps
- Weather
- Equivalent length of air supply

Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: F1 Commission fuel/air delivery systems

Objectives

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

- Describe testing and purging procedures for pipe under 4 inch diameter.

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 |

Level 2

Gasfitter – Class B

Line (GAC): A USE COMMON OCCUPATIONAL SKILLS

Competency: A4 Use technical instruments and testers

Objectives

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

- Use manometers and mechanical gauges and interpret pressure readings.
- Use electrical test meters and interpret readings.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Describe digital manometers and digital pressure gauges
 2. Use digital manometers and digital pressure gauges
 3. Use incline manometer
 4. Describe flue gas analyzers | <ul style="list-style-type: none"> • Types • Applications • Storage • Calibration • Zero • Connection <ul style="list-style-type: none"> ○ Positive pressure ○ Negative pressure ○ Pressure differential • Scale/range • Zero • Connection <ul style="list-style-type: none"> ○ Positive pressure ○ Negative pressure ○ Pressure differential • Sg of measuring fluid • Types • Sampling location • Combustion yield formula • Composition percentages <ul style="list-style-type: none"> ○ CO₂ ○ O₂ • CO ppm • Combustion efficiencies • Stack temperatures • Appliance efficiencies • Burner type <ul style="list-style-type: none"> ○ Mechanical ○ Atmospheric • Application • Zeroing • Parts <ul style="list-style-type: none"> ○ Desicant ○ Gas cells ○ Water traps ○ Filters ○ Pump ○ Probe |
|---|---|

Line (GAC): A USE COMMON OCCUPATIONAL SKILLS

Competency: A6 Organize work and maintain records

Objectives

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

- Apply records management.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe commissioning documentation
 2. Describe appliance handover
 3. Apply records management | <ul style="list-style-type: none"> • Commissioning report • Regulatory responsibilities • As-built drawings and operator manuals • Instructions to customer • Paper based filing • Electronic filing • Service reports • Invoices • Time sheets • Purchase orders • Vehicle logs • Maintenance logs • Inventory • Permits • Statements of completion |
|--|---|

Line (GAC): B APPLY FUNDAMENTALS OF GAS UTILIZATION

Competency: B6 Apply alternate-fuel theory

Objectives

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

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

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <p>1. Describe types of alternate fuels</p> | <ul style="list-style-type: none"> • Oil • Bio gas • Propane-air mixes • Methane (digester gas) • Manufactured gas |
| <p>2. Describe the applications of alternate fuel appliances</p> | <ul style="list-style-type: none"> • Appliances <ul style="list-style-type: none"> ○ Boilers ○ Furnaces ○ Burners • Facilities/applications • Filters • Fuel conditioning • Pumps • Blowers |
| <p>3. Describe the installation of dual-fuel appliances</p> | <ul style="list-style-type: none"> • Code requirements • Manufacturer’s specifications • Job specifications <ul style="list-style-type: none"> ○ Piping materials ○ Valves ○ Controls |

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C1 Use the principles of electricity and electronics

Objectives

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

- Describe and select single-phase transformers.
- Describe millivolt circuits.
- Identify resistors.
- Describe proportional control operation.
- Describe variable resistors.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Determine electrical loads
 2. Select single-phase transformers
 3. Describe the installation of single-phase transformers
 4. Describe millivolt circuits
 5. Identify resistors
 6. Describe proportional control operation
 7. Describe variable resistors | <ul style="list-style-type: none"> • Transformer secondary • Ratings <ul style="list-style-type: none"> ○ Amps • Sizing • Ratings <ul style="list-style-type: none"> ○ Watts ○ VA • Phasing <ul style="list-style-type: none"> ○ Grounding • Power generation <ul style="list-style-type: none"> ○ Thermocouple ○ Thermopiles • Switches • Loads • Application • Installation • Types • Colour coding • Types used by series • Method of control <ul style="list-style-type: none"> ○ Electric ○ Electronic • Thermistors <ul style="list-style-type: none"> ○ Effects of heat and resistance • Anticipators • Potentiometers |
|--|---|

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C2 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

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe circuit components
 2. Describe sequence of appliance operation
 3. Design wire diagram
 4. Create a control narrative from a wiring diagram for a hydronic heating system | <ul style="list-style-type: none"> • Transformer • Limits • Safety devices • Controls • Permissives • Interlocks
 • Control narratives • Components • Appliances • Wiring diagrams
 • Control narrative
 • 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): C **APPLY ELECTRICAL CONCEPTS**
Competency: C3 **Use the Canadian Electrical Code (CEC)**

Objectives

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

- Interpret the Canadian Electrical Code Part 1, sections 14, 16, 26 and 28.

LEARNING TASKS

CONTENT

- | | |
|--|--------------|
| 1. Describe CEC code requirements that apply to protection and control | • Section 14 |
| 2. Describe CEC code requirements that apply to class 1 and 2 circuits | • Section 16 |
| 3. Describe CEC code requirements for the installation of electrical equipment | • Section 26 |
| 4. Describe CEC code requirements that apply to motors and generators | • Section 28 |

Line (GAC): C **APPLY ELECTRICAL CONCEPTS**
Competency: C6 **Apply Variable Frequency (VFD) and Electronically Commutated Motors (ECM) technology**

Objectives

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

- Describe variable frequency drives (VFD).
- Describe electronically commutated motors (ECM).

LEARNING TASKS

1. Describe variable frequency drives (VFD)

2. Describe electronically commutated motors (ECM)

CONTENT

- Application
- Operation
- Protection
- Limitations

- Application
- Operation
 - DIP switch setting
 - External static pressure
- Troubleshooting

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C7 Apply wiring practices

Objectives

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

- Install electrical components.

LEARNING TASKS

CONTENT

1. Install cables and conductors

- CEC
- Supports
- Colour coding
- Class 2 circuits
- Conduit
- Wire labelling
- Tools

2. Install junction and switch boxes

- CEC
 - Sizing
- Conductor connections and terminations
- Grounding/bonding
- Tools

3. Install shielded cable

- Termination
- Grounding

4. Describe isolation switch installations

- CEC
 - Location
 - Type
 - Ratings

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C9 Apply communication and networking technology

Objectives

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

- Identify network protocols and cable connectors.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Identify network protocols
 2. Identify network cable connectors
 3. Describe wireless communication devices | <ul style="list-style-type: none"> • Modbus • BACnet • Local Operation Network (LON) • Types of connectors <ul style="list-style-type: none"> ○ USB ○ 9 pin, 25 pin serial port ○ RJ45 ○ RJ11 • WiFi • Bluetooth • Satellite • Cellular |
|---|--|

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D2 Select regulators, valves, and valve train components

Objectives

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

- Size regulators.

LEARNING TASKS

1. Describe pressure regulators

CONTENT

- Types
 - Direct operated
 - Lever operated
 - Zero governors
 - Propane
 - First stage
 - Second stage
- Operating elements
 - Loading
 - Measuring
 - Restricting
- Parts
 - Internal pressure relief
- Operating principles
 - Droop/offset
 - Lock-up
 - Set point
 - Critical flow
- Applications
- 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)

2. Size regulators

LEARNING TASKS

3. Describe the inspection of propane cylinders

CONTENT

- Maintenance
- Vehicle
- Security/fencing
- Containment
- Visual inspection
 - Damage
 - Corrosion
- Components
 - Valves
 - Reliefs
- Rating plates
 - Expiry/service dates
- Organize requalification

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D4 Size venting systems

Objectives

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

- Size venting.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Describe appliance categories
 2. Describe venting materials
 3. Describe types of venting systems
 4. Size Category 1 venting
 5. Size special venting | <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
 • Codes <ul style="list-style-type: none"> ○ B149.1 ○ National Building Code
 • Appliance type
 • Building type
 • Vent connector
 • Common vents
 • Engineering
 • Category
 • Codes <ul style="list-style-type: none"> ○ B149.1 ○ National Building Code
 • Design registry
 • Manufacturer’s documentation
 • Types <ul style="list-style-type: none"> ○ Classifications ○ Materials ○ Mechanical ○ Passive |
|--|--|

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D5 Size air supply systems

Objectives

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

- Size passive air supply systems.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Describe methods of combustion air supply
 2. Describe gas appliance air supply requirements
 3. Determine combustion air requirements for gas appliances installations | <ul style="list-style-type: none"> • Passive air supply • Mechanical air supply <ul style="list-style-type: none"> ○ Code requirements ○ Interlocks • 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 • 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 |
|--|---|

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D6 Select gas-fired appliances

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. Selection criteria for gas-fired appliances

CONTENT

- Impact of type of building construction on installation requirements
- Altitude rating requirement
- Code and Regulation requirements
- Manufacturer's requirements
 - Rating plate requirements
- Appliance sizing
 - Appliance input
 - Appliance output
 - Appliance efficiencies
 - Thermal efficiencies
- Site preparation
- Clearances
- Installer's responsibilities

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D7 Select burners

Objectives

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

- Describe the installation of mechanical burners.

LEARNING TASKS

1. Describe mechanical burners

2. Describe proportional mixers

3. Describe the installation of mechanical burners

CONTENT

- 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
- Fuel-air ratios
- Adjustments
- Zero governors
- Sealing
- Support
- Manufacturer's documentation
- Refractory
- Wiring
- Mounting

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D8 Select flame safeguards

Objectives

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

- Select flame safe guards.

LEARNING TASKS

1. Describe flame detectors

2. Describe ignition systems

3. 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)
- Common manufacturers
 - Honeywell
 - Fenwall
 - Siemens
 - Johnson Controls
- Wiring diagrams
- Sequence of operation
- Applications
- Component compatibility
- System compatibility
- Conversions

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D9 Select combustion, safety and operating controls

Objectives

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

- Describe limits, interlocks and operating controls.
- Describe the installation of programmable thermostats.

LEARNING TASKS

1. Describe limits and interlocks

2. Describe permissives

3. Describe the installation of programmable thermostats

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

- Types
 - Heating
 - Cooling
 - Heat pump
- Overrides
- Programming
 - Vacation mode
 - Freeze protection
 - Night set back
 - Heat anticipation
- Application
 - Single stage
 - 2 stage
- Wiring
- Manufacturer’s documentation
- Location

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS**Competency: D11 Select automation and instrumentation control systems****Objectives**

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

- Describe outdoor reset controls.
- Describe multi-boiler hydronic heating system components.

LEARNING TASKS

1. Describe outdoor reset controls
2. Describe multi-boiler hydronic heating system components

CONTENT

- Sensors
 - Types
- Thermistors
- Applications
- Cable types
- Inputs
- Outputs
 - 0-10 VDC
 - 4-20 mA
- Heating curves
 - System efficiencies
- Sequencing control
- Wiring techniques

Line (GAC): D PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS

Competency: D12 Plan a project

Objectives

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

- Create commissioning documentation for a high efficiency furnace and a condensing boiler.

LEARNING TASKS

1. Complete commissioning documentation for a high efficiency furnace and a condensing boiler

CONTENT

- Commissioning report
- Statement of completion
- Regulatory responsibilities
- As-built drawings and operator manuals
- Instructions to customer

Achievement Criteria

Performance The learner will be able to create post-commissioning paperwork 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:

- F5 – Commission boilers and ancillary equipment
- F7 – Commission furnaces and ovens

Criteria The learner will be evaluated on:

- Commissioning report
 - Report accuracy
 - Report Completeness
 - Operating according to manufacturer’s specifications

Line (GAC): **E INSTALL GAS-FIRED SYSTEMS**
Competency: **E2 Install regulators, valves, and valve trains**

Objectives

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

- Describe the installation of regulator venting.

LEARNING TASKS

1. Describe the installation of regulator venting

CONTENT

- Vent attachments
 - Lines
 - Limiting orifices
 - Surge arrestors
- Sizing
- Orientation
- Termination
- Code requirements

Line (GAC): E **INSTALL GAS-FIRED SYSTEMS**
Competency: E3 **Install LPG, LNG, CNG, vaporizing and mixing systems**

Objectives

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

- Describe propane cylinder/tank installation.

LEARNING TASKS

1. Describe propane cylinder/tank installation requirements

2. Describe the installation of propane cylinder/tank components

CONTENT

- Code requirements
- Describe cylinder/tank clearances from building
 - Openings
 - Air intakes
 - Doors
 - Windows
 - Flue termination
 - Dryer vents
- Location
- Placement
- Support
- Protection
- Access
 - Filling
 - Safety
 - Emergency procedures
 - Liquid handling
 - Maintenance
 - Vehicle
- Security/fencing
- Containment
- 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

LEARNING TASKS

CONTENT

- Operation
- Maintenance
- Valves and accessories for liquid withdrawal applications
 - Description
 - Operation
 - Maintenance
- Valves and accessories for filling applications
 - Description
 - Operation
 - Maintenance

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E4 Install venting systems

Objectives

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

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

LEARNING TASKS

1. Describe installation of venting materials

2.. Describe the installation of mechanical venting systems

CONTENT

- Components
 - Fittings
 - Terminations
 - Condensate collection
 - Fire stopping
 - Supports
 - Wall and ceiling penetrations
- Assembly
 - Gaskets
 - Mechanical fasteners and clamps
 - Sealants and lubricants
 - Glues and primers
- Code requirements
 - Directives
- Grade/Slope
- Forced
- Induced
- Components
 - Fittings
 - Terminations
 - Condensate collection
 - Fire stopping
 - Supports
 - Wall and ceiling penetrations
- Assembly
 - Gaskets
 - Mechanical fasteners and clamps
 - Sealants and lubricants
 - Glues and primers
- Code requirements
- Grade/Slope

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E5 Install air supply systems

Objectives

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

- Describe the installation of mechanical air supply systems.

LEARNING TASKS

CONTENT

1. Describe mechanical air supply systems

- Ducts
 - Sizes
 - Location
 - Lengths
 - Fittings

- Fans
 - Types
 - Location

- Engineered systems
- Manufacturer’s documentation
- Code requirements

2. Describe the installation of mechanical air supply systems

- Code requirements
- Structural penetrations
- Sealing
- Opening and ducts
 - Terminations
- Weather
- Interlocks

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E6 Install draft control systems

Objectives

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

- Describe the installation of draft control systems.

LEARNING TASKS

CONTENT

1. Describe draft control systems

- Types
 - Dampers
 - Mechanical
 - Thermal
 - Hoods
 - Diverters
 - Fans

2. Describe the installation of draft control systems

- Accessories
- Applications
- Vent height
- Location/building type
- Manufacturer's documentation
- Codes
- Supports
- Wiring
- Terminations

3. Describe commissioning of a barometric damper

- Types
 - Single acting
 - Double acting
- Code requirements
- Adjustments
- Tools and testing equipment
- Pressures
 - Effects on combustion chamber
 - Effects on vent

Line (GAC): **E INSTALL GAS-FIRED SYSTEMS**

Competency: **E10 Install automation and instrumentation control systems**

Objectives

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

- Describe the installation of outdoor reset controls.

LEARNING TASKS

1. Describe the installation of outdoor reset controls

CONTENT

- Sensors
 - Location
- Cabling termination and bonding
- Wiring connections
- Manufacturer's documentation

Line (GAC): E **INSTALL GAS-FIRED SYSTEMS**
Competency: E11 **Install boilers and ancillary equipment**

Objectives

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

- Install boilers.

LEARNING TASKS

1. Install boilers

CONTENT

- Seismic restraint
- Placement considerations
 - Venting
 - Air supply
 - Access
 - Electrical
 - Clearance
 - Isolation switches
 - Clearance
 - Manufacturer’s documentation
 - Codes
 - Drainage
 - Water supply
- Materials
- Ancillary equipment
 - Valves
 - Zone
 - Mixing
 - Diverting
 - Isolation
 - Dead boiler drain
 - Blow down
 - Flow control/balancing
 - Vacuum reliefs
 - Circulators
 - Expansion tanks
 - Feed water
 - Water treatment

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E12 Install air heating appliances and equipment

Objectives

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

- Install air heating appliances.

LEARNING TASKS

1. Install air heating appliances

CONTENT

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

Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: F1 Commission fuel/air delivery systems

Objectives

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

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

LEARNING TASKS

1. Describe purging procedures for pipe 4 inch diameter and larger

2. Commission regulators

3. Size burner orifices

4. Use gas metering devices

CONTENT

- Code requirements
- Inert gases
- Applications
- Purpose
- Equipment
 - Approved burners
 - Gauges
 - 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

Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: F2 Perform appliance start-up procedures

Objectives

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

- Describe factors to consider when starting up a system.

LEARNING TASKS

1. Describe start-up checklists

2. Describe factors to consider when starting up a system

CONTENT

- Appliance types
 - Boilers
 - Furnaces
 - Storage type water heaters
 - Tank less water heaters
 - Gas range
 - Gas dryer
 - Unit heater
 - Direct vent fire place
- Permits
- Electrical supply
- Water supply
- Load
- Gas supply
- Combustion air/venting
- Codes compliance
- Appliance approval
- Manufacturer’s documentation
- Appliance type
- Electrical supply
- Water supply
- Load
- Gas supply
- Combustion air/venting
- Codes compliance
 - B149.1
 - C22.1
- Manufacturer’s documentation
- Remove shipping materials
- Belt/pulley alignment
- Tightness of electrical connections
- Valve tightness test
- Leak test
- Hydrostatic test

LEARNING TASKS

CONTENT

- Feed water temperature
- Pressure set point
- Purging and flushing
- Water treatment
- Relief piping
- Draft
- Spillage
- Air inlet openings
- Water flow rates
 - Circulator speed
 - Balancing valves
- Condensate neutralization and disposal
- Combustion analysis

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to: <ul style="list-style-type: none"> ● 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 safety and efficiency ● Code compliance |

Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: F7 Commission furnaces and ovens

Objectives

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

- Commission a high efficiency furnace.

LEARNING TASKS

CONTENT

1. Verify electrical operating parameters

- Tightness of electrical connections
- Verify voltage
- Code compliance
- Verify electrical wiring diagram

2. Adjust burners

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

3. Verify safety devices, limits, and operating controls

- Flame failure response time
- Interlocks
- High limit
- Operating controls
- Thermostat
- Flame roll out switch
- Pressure switch
 - Air
- End switch
- Spill switch (vent safety)
- Heat exchanger temperature rise

4. Commission a high efficiency furnace

LEARNING TASKS

CONTENT

- External static pressure (ESP)
- Condensate trap
- Condensate pump
- Condensate neutralizing tank
- Air cleaners
- Temperature set points
- Flame safeguard
 - Sequence timing
 - Hot surface igniter (HSI amp draw)
 - Flame rod current
 - Flame failure response
- Blower speed and operation
- Check condition of heat exchanger
- Combustion analysis

Achievement Criteria

- | | |
|-------------|--|
| Performance | The learner will be able to: <ul style="list-style-type: none"> • 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 safety and efficiency • Code compliance |

Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: F8 Program temperature, pressure and operating controls

Objectives

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

- Program a programmable thermostat.

LEARNING TASKS

1. Describe programmable thermostats

2. Describe multi-purpose controls

3. Program a programmable thermostat

CONTENT

- Types
- Functions
- Applications
- Types
 - Burner modulating
 - Lead-lag
- Tekmar
- Honeywell
- Manufacturer's documentation
- Set point adjustment
- Night set back settings
- Home/away settings

Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: F11 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 barometric draft regulator
2. Adjust barometric draft regulator

CONTENT

- Purpose
- Principles of operation
- Burner's draft requirements
- Draft measurement
- Dilution air adjustment

Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: F12 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): G MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: G1 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

2. Describe the repair procedures for a gas distribution system

CONTENT

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

- Isolate system
 - Lockout procedures
- Inform customer
- Plan repair
- Purge piping
- Remove/replace components
- Pressure testing
- Purging and gasifying

LEARNING TASKS

4. Service condensing boilers and tank-less heaters

CONTENT

- Fans
 - Auxiliary fans
 - Exhaust fans
- Steam control valves
- Steam traps
- Pressure reducing valves
- Flue gas exhaust systems
- Inspect
 - Condensate trap
 - Condensate pump
 - Neutralize tank
 - Heat exchanger
 - Water flow rates
 - Flow balancing
 - Pumps
 - Primary
 - Secondary
- Verify
 - Water treatment
 - Temperature set points
 - Supply and return water temperatures
 - Make-up water
 - Expansion tank pressure

Line (GAC): G MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: G4 Maintain gas-fired appliances

Objectives

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

- Describe service requirements of gas-fired air heating appliances.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Verify electrical operating parameters
 2. Check safety devices, limits, and operating controls
 3. Service burners
 4. Verify flame safe guard system operation | <ul style="list-style-type: none"> • Tightness of electrical connections • Verify voltage • Code compliance • 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
 • 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
 • Primary control • Flame detector • Flame signal/rectification • Flame failure response time (FFRT) • Trial for ignition (PTFI/MTFI) |
|---|---|

Line (GAC): G MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: G5 Maintain gas-fired refrigeration equipment

Objectives

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

- Describe the maintenance of gas-fired refrigeration equipment.

LEARNING TASKS

CONTENT

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

Line (GAC): G MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT

Competency: G7 Service and repair 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): **G MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**

Competency: **G9 Decommission and disconnect gas-fired 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

Section 4

ASSESSMENT GUIDELINES

Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:		GASFITTER – CLASS B LEVEL 1	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	Use Common Occupational Skills	2%	0%
B	Apply Fundamentals of Gas Utilization	10%	0%
C	Apply Electrical Concepts	33%	0%
D	Plan Gas-Fired Appliance System Installations	27%	100%
E	Install Gas-Fired Systems	3%	0%
F	Commission Gas-Fired Appliances	25%	0%
	Total	100%	100%
In-school theory / practical subject competency weighting		85%	15%
Final in-school mark Apprentices must achieve a minimum 70% for the final in-school mark to be eligible to write the Gasfitter B Standardized Level exam		IN-SCHOOL %	

In-school Mark Combined theory and practical subject competency multiplied by	80%
Standard Level Exam Mark The exam score is multiplied by	20%
Final Level Mark	FINAL%

Assessment Guidelines – Level 2

Level 2 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:		GASFITTER – CLASS B LEVEL 2	
LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	Use Common Occupational Skills	2%	0%
B	Apply Fundamentals of Gas Utilization	30%	0%
C	Apply Electrical Concepts	20%	5%
D	Plan Gas-Fired Appliance System Installations	22%	5%
E	Install Gas-Fired Systems	8%	0%
F	Commission Gas-Fired Appliances	12%	90%
G	Maintain and Service Gas-Fired Appliances and Equipment	6%	0%
	Total	100%	100%
In-school theory / practical subject competency weighting		75%	25%
Final in-school mark		IN-SCHOOL %	

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
- Overhead and multimedia projectors with a projection screen
- 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

Shop Area

- Minimum 3000 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, ventilation (including make up air), drainage and water supply
- Refuse and recycling bins for used shop materials
- First-aid equipment
- Shops will support practical requirements as outlined in the program outline
- Shop facilities will support gas fitting practical training

Lab Requirements

- See shop area requirements

Student Facilities

- Adequate eating area as per WorkSafeBC requirements (4.84 OHS Regulation and Guidelines)
- Adequate washroom facilities as per WorkSafeBC requirements (4.84 OHS Regulation and Guidelines)

Instructor's Office Space

- Adequate office space for student consultation
- Desk and filing space
- Computer
- Internet access
- Printer
- Adequate storage facilities for material and training aids
- Access to photocopier
- Telephone

Tools and Equipment

Shop (Facility) Tools

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 roller
- Pipe stand
- Pipe threader
- Pipe vise
- Power vise
- Tube bender
- Tube cutter

Testing and Measuring Equipment

- Nitrogen bottles and regulators
- Computer
- Drafting equipment
- Electronic Flue gas analyzer
- Electronic leak detector
- Draft gauge
- Hand pump and accessories
- Hydrostatic pump and gauge (manual and power)
- Laser level
- Magnahelic gauge
- Manometers (incline, digital and U-tube)
- Measuring tape and markers
- Multimeter

Personal Protection 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

Standard Tools

- Adjustable wrench
- Ball-peen hammer
- Orifice drill sets
- Pipe wrench

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

Hoisting, Rigging and Access Tools and Equipment

- Come-a-longs and Tirsors
- 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

- CAN/ CSA B149.1 current
- CAN/ CSA B149.2 current
- CAN/ CSA C22.1 current
- Safety Standards General Regulation
- Gas Safety Regulation

Recommended Resources

- CSA Gas Trade Training Modules, ISBN 978-1-4883-0127-8
- 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
- Fundamentals of Gas Utilization – John Dutton, ISBN 978-0-9198-5235-8
- Design of Fluid Systems – Spirax Sarco, ISBN
- Electricity & Controls for HVAC/R – Herman/Sparkman, ISBN 978-1133-2782-07

Suggested Texts/Websites

- Technical Safety BC (formally known as BC Safety Authority), www.technicalsaftybc.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 one of the following:

- Current BC Certificate of Competency/Qualification in Gasfitting B
- Certificate must be equal or greater than the level of instruction

Work Experience

A minimum of 5 years' experience working in the industry as a Class B Gasfitter. This experience requirement may be varied based on:

- Type of experience and scope of exposure to the industry
- Other related credentials
- Specialized experience

Instructional Experience and Education

It is preferred that the instructor also possesses one of the following:

- Instructor Diploma or equivalent
- Bachelor's Degree in Education
- Master's Degree in Education

Appendices

Appendix A

Required Tools and Equipment

(to be used in coordination with the program Tools and Equipment list beginning on page 117)

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
Glossary of 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
BCSA	British Columbia Safety Authority
BHP	Boiler horse power
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	Mainflame Trial For Ignition
mV	millivolts
MSDS	Material safety data sheet
MSW	Municipal solid waste
NAAQS	National Ambient Air Quality Standards
NAPE	National Association of Power Engineers
NBC	National Building Code
NEMA	National Electrical Manufacturer's 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 reducing valve
PTFI	Pilot trial for ignition
PVC	Programmable logic controller
RPM	Revolutions per minute
RTD	Resistance temperature detector
SCR	Selective catalytic reduction
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

The Program Outline was prepared with the advice and direction of an industry steering committee convened initially by the Construction Industry Training Organization (CITO). Members included:

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