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PROGRAM OUTLINE

Gasfitter A

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GASFITTER A

PROGRAM OUTLINE

APPROVED BY INDUSTRY

DECEMBER 2012

Developed by
Industry Training Authority
Province of British Columbia

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Section 1

INTRODUCTION

Gasfitter A

Foreword

The revised Gasfitter A 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.

The Program Outline includes the minimum shop requirements needed to support instructors.

The Program Outline was prepared with the advice and assistance of the Gasfitter A Review Committee and will form the basis for further updating of the British Columbia Gasfitter A Program and learning resources by the Construction Industry Training Organization (CITO) on behalf of the Industry Training Authority (ITA).

Each competency is to be evaluated through the use of written examination. The individual must achieve a minimum final grade of 70% in order to be successful in each level. 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 measureable 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.

SAFETY ADVISORY

Be advised that references to the WorkSafeBC 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 Program Outline was prepared with the advice and direction of an industry steering committee convened initially by CITO. Members include:

- Rob Bradbury – Pacific Vocational College
- Jamie Good – Autogas Propane
- Satwant Sandhu – Century 21 Gas & Heating
- Gord Schlechtleipner – Fireplaces Unlimited
- Brian Sweet - BCIT
- Larry Wear – Canadian Utilities
- Brian Zinn – Technical Safety BC

Industry Subject Matter Experts retained to assist in the development of Program Outline content:

- Rick Vanier – Pacific Vocational College
- Rob Bradbury – Pacific Vocational College
- Brian Sweet - BCIT
- Gary Eamor – Technical Safety BC
- Jamie Good – Autogas Propane
- Dave Sales

The Industry Training Authority would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Gasfitter A 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	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, measureable 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 2

PROGRAM OVERVIEW

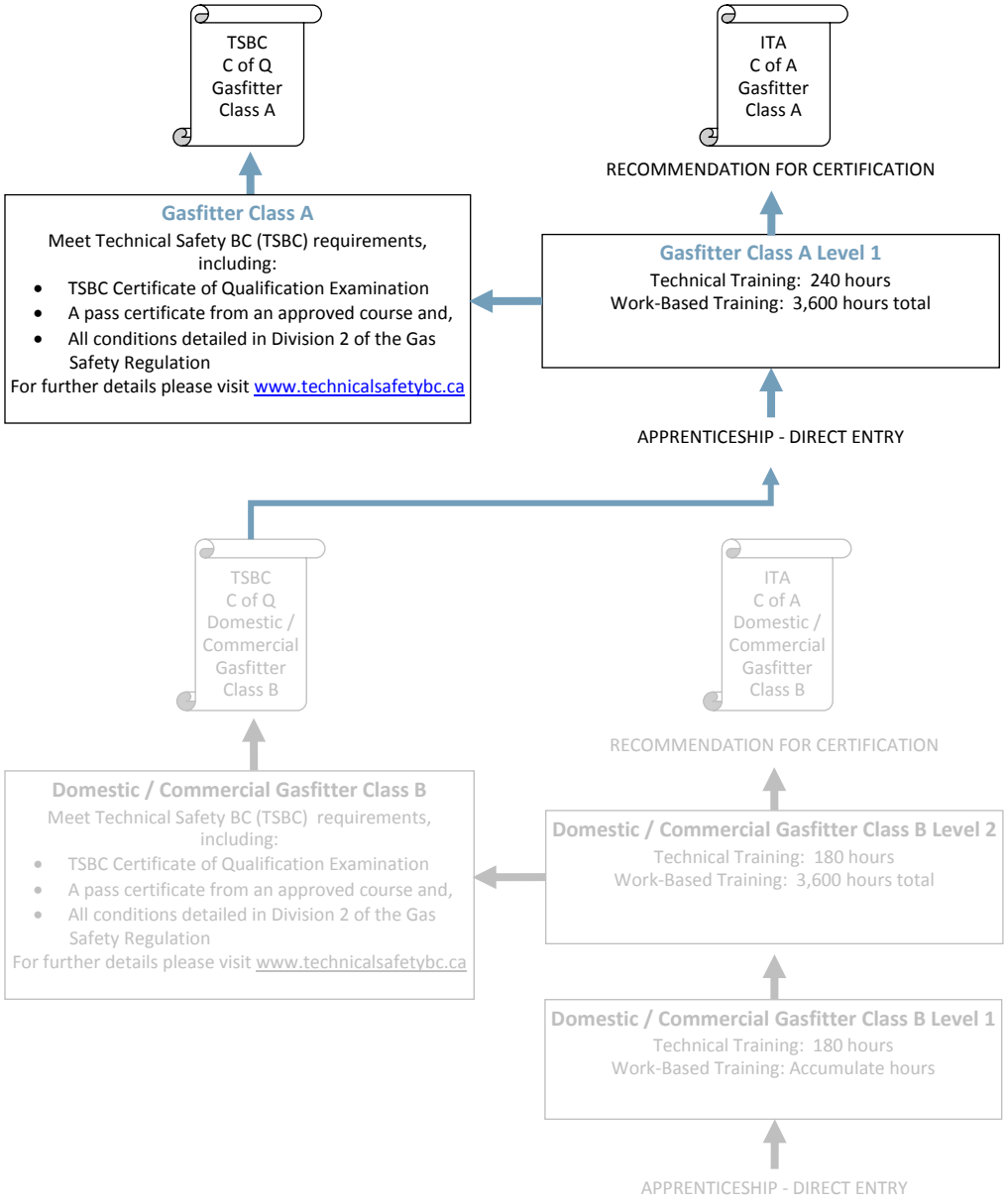
Gasfitter A

Program Credentialing Model

Apprenticeship Pathway

This graphic provides an overview of the Gasfitter A apprenticeship pathway.

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



CROSS-PROGRAM CREDITS

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

None

Challenge Pathway

Refer to the Technical Safety BC (TSBC) web site – www.technicalsafetybc.ca for information on the requirements for the completion of the Certificate of Qualification for (Class A) Gasfitter.

Occupational Analysis Chart

Gasfitter A

Occupation Description: "Gasfitter – (Class A)" means a person who installs, tests, maintains and repairs propane and/or natural gas lines, appliances, equipment and accessories in residential and commercial premises. The holder of a Gasfitter – (Class A) is involved in the installation or alteration of any gas system, except vehicle fuel systems, under an appropriate permit.

USE TOOLS AND EQUIPMENT **B**	Use Pressure Measuring Equipment B4	1																	
ORGANIZE WORK **C**	Use Mathematics and Science C1	1					Use Codes, Regulations and Standards C3	1											
INSTALL AND SERVICE FUEL SYSTEMS **D**	Install Piping and Tubing Systems D2	1					Use Meters D3	1					Install and Service Regulators D4	1					Install and Service Propane Systems D5	1				
INSTALL VENTING AND AIR SUPPLY **E**	Install Venting Systems E1	1					Install Air Supply Systems E2	1											

Program Overview

INSTALL AND SERVICE GAS EQUIPMENT **F**	Install and Service Burners F1	Install and Service Appliances F2	Perform Combustion Analysis F3	Describe Heating and Cooling Systems F4	
	1	1	1	1	
INSTALL AND SERVICE CONTROLS AND SAFEGUARDS **G**	Use the Principles of Electricity and Electronics G1	Use the Principles of Gas Controls G2	Install and Service Gas Controls G3	Install and Service Fuel Train Systems G4	
	1	1	1	1	

Training Topics and Suggested Time Allocation

Gasfitter A

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line B	**Use Tools and Equipment**	**2%**	**100%**	**0%**	**100%**
B4	Use Pressure Measuring Equipment	100	✓		
Line C	**Organize Work**	**8%**	**98%**	**2%**	**100%**
C1	Use Mathematics and Science	80	✓		
C3	Use Codes, Regulations and Standards	20	✓	✓	
Line D	**Install and Service Fuel Systems**	**17%**	**90%**	**10%**	**100%**
D2	Install Piping and Tubing Systems	35	✓	✓	
D3	Use Meters	5	✓		
D4	Install and Service Regulators	40	✓	✓	
D5	Install and Service Propane Systems	20	✓		
Line E	**Install Venting and Air Supply**	**5%**	**100%**	**0%**	**100%**
E1	Install Venting Systems	75	✓		
E2	Install Air Supply Systems	25	✓		
Line F	**Install and Service Gas Equipment**	**34%**	**80%**	**20%**	**100%**
F1	Install and Service Burners	25	✓		
F2	Install and Service Appliances	35	✓	✓	
F3	Perform Combustion Analysis	25	✓		
F4	Describe Heating and Cooling Systems	15	✓		
Line G	**Install and Service Controls and Safeguards**	**34%**	**80%**	**20%**	**100%**
G1	Use the Principles of Electricity and Electronics	5	✓		
G2	Use the Principles of Gas Controls	10	✓		
G3	Install and Service Gas Controls	55	✓	✓	
G4	Install and Service Fuel Train Systems	30	✓	✓	
	Total Percentage for Gasfitter A	**100%**			

The composite level mark is to consist of 80% theory and 20% practical.

Section 3

PROGRAM CONTENT

Gasfitter A

Gasfitter A

Level 1

Line (GAC): B USE TOOLS AND EQUIPMENT

Competency: B4 Use Pressure Measuring Equipment

Objectives

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

- Describe pressure measuring tools.
- Use pressure measuring tools.

LEARNING TASKS	CONTENT
1. Describe pressure measuring tools	• Review of manometers and mechanical gauges from level one Domestic/Commercial Gasfitter B • Add the following o Manometers – Incline – Digital o Mechanical gauges – Helical
2. Review the use of manometers and mechanical gauges	• Gas pressures o Standing line pressures o Operating line pressures o Gauge pressures o Absolute pressures o Conversion between different pressures

Line (GAC): C ORGANIZE WORK

Competency: C1 Use Mathematics and Science

Objectives

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

- Use mathematics and science to solve problems in the gas fitting trade.

LEARNING TASKS	CONTENT
1. Review Level 1 Gasfitter B	• Operations • Formulas • Conversions • Properties of matter • Pascal's Law • Archimedes Principles • Mechanical advantage as it relates to pressure and force • Flow factors • Universal Gas Law • Thermal expansion • Heat transfer • Heat load calculations • Characteristics of hydrocarbon gases • Galvanic corrosion
2. Apply math formulas to gas fitting problems	• Roots • Powers • Transposition
3. Perform complex heat load calculations	• Factors o Materials o States of matter o Temperature difference o Rate
4. Describe the absorption refrigeration cycle	• Boiling point versus pressure • Latent heat • Sensible heat

Line (GAC): C ORGANIZE WORK

Competency: C3 Use Codes, Regulations and Standards

Objectives

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

- Identify codes and standards encountered in the gas fitting trade.
- Identify various environmental agencies that affect the gas fitting trade.

LEARNING TASKS	CONTENT
1. Review Codes from Domestic/Commercial Gasfitter B	• B149.1 Gas Code • Gas Regulations • Canadian Electrical Code Part 1

2. Interpret the B149.3 Gas Code	• Layout
	• Parts
	  o General Requirements
	  o Additional Requirements for Process Ovens, Furnaces and Atmosphere Generators
	  o Valve Train Schematics
	  o Start-up Procedures
	• Scope
	• Definitions
	• Contents
	• Tables

3. Use the Gas Regulations	• Gas Safety Act • Gas Safety Regulations • Permits • Special Gas Permits • Notification of completion • Approvals • Variations to the National Gas Code • Bulletins and Directives

Achievement Criteria

Performance	The individual will use codes and standards in the application of shop projects.
Conditions	The individual will be given: • Projects • Codes and standards
Criteria	This would be reflected in the appropriate shop competencies.

Line (GAC): D INSTALL AND SERVICE FUEL SYSTEMS

Competency: D2 Install Piping and Tubing Systems

Objectives

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

- Select piping for gas appliances exceeding 400 MBH.
- Size piping for gas appliances exceeding 400 MBH.
- Install piping for gas appliances exceeding 400 MBH.

LEARNING TASKS	CONTENT
1. Review Codes from Domestic/Commercial Gasfitter B	• Residential and commercial installations • Pipe sizing • Code requirements • Piping practices
2. Size piping	• Sizing calculations/formulas • Piping material • Code requirements

3. Install piping systems	• Code requirements
	• Support
	• Terminations
	• Fittings
	• Valves
	• Welded piping systems
	  o Testing
	  o Certification requirements
	• Underground
	  o Cathodic protection
	  o Jeep test
	• Expansion
	• Pressure drops/calculations

4. Pressure test piping systems	• Code requirements
	• Inspections
	• Equipment
	• Calculations
	  o Temperature
	  o Volume
	  o Pressure
	• Cylinder calculations

LEARNING TASKS	CONTENT
	• Compressors • Gas law applications

5. Purge piping systems	• Code requirements
	• Equipment
	• Calculations
	  o Flow
	  o Velocity
	  o Volume
	  o Pressure
	  o Time
	• Purge point openings
	• Purging stacks
	• Inert gas

Achievement Criteria

Performance — The individual will pressure test and purge a piping system 4 inch or larger in size.

Conditions — The individual will be given:

- Piping system
- Tools and equipment

Criteria — The individual will score 70% or better on a rating sheet that reflects the following criteria:

- Application of formulas
- Sequence of operation

Line (GAC): D INSTALL AND SERVICE FUEL SYSTEMS

Competency: D3 Use Meters

Objectives:

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

- Describe the operation of gas meters.
- Calculate flow rates.
- Install gas meters.

LEARNING TASKS	CONTENT
1. Describe types of meters	• Positive displacement • Inferential meters • Capacity
2. Use meters	• Clocking o Pressure o Temperature o Flow rate • Orifice flow calculations
3. Install meters	• Installation criteria • Manufacturers' requirements • Applications

Line (GAC): D INSTALL AND SERVICE FUEL SYSTEMS

Competency: D4 Install and Service Regulators

Objectives

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

- Describe the installation requirements for gas pressure regulators.
- Install and service gas pressure regulators.

LEARNING TASKS	CONTENT

1. Review direct operated regulators	• Types
	• Terminology
	• Operating elements
	  o Loading
	  o Measuring
	  o Restricting
	• Parts
	• Operating principles
	• Applications
	• Vent attachments
	• Sizing tables
	  o Flow rate
	  o Pressure drop
	• Maintenance
	• Troubleshoot
	• Freeze ups

2. Describe types of pressure regulators	• Types
	  o Pilot operated
	  o Direct operated
	  o Lever operated
	  o Single ported balanced
	  o Double ported balanced
	  o Zero governors
	  o Proportional
	  o Two-stage regulator system (propane)
	• Parts
	• Operating principles
	• Applications

LEARNING TASKS	CONTENT

3. Describe methods of overpressure protection	• Code requirements
	• Applications
	• Relief
	  o Internal
	  o External
	  o Pop safety
	  o Modulating
	  o Capacity
	  o Termination
	• Safety shut-off
	• Monitor
	• Series regulation

4. Install pressure regulators	• Code requirements • Manufacturers' specifications • Selection • Applications • By-pass arrangements • Venting • Commissioning • Test points • Orientation • Sensing lines

5. Troubleshoot and repair pressure regulators	• Applications
	• Operation
	• Pressure testing
	• Procedures for adjusting
	• Verification of correct operation of all safety features
	• Manufacturer's recommendations
	• Code requirements
	• Location
	• Piping practices
	• Faults
	  o Obstructed vents
	  o Hunting
	  o Incorrect application/sizing
	  o Foreign material between seat and disc
	  o Corrosion
	  o Inlet pressure

LEARNING TASKS	CONTENT
	o Outlet gas pressure too high o Outlet gas pressure to low o Slow response o Not maintaining set point o Sensing lines o Excessive droop • Repair and replacement • Lockout procedures • Safety

Achievement Criteria

Performance — The individual will troubleshoot a zero governor regulator installation.

Conditions — The individual will be given:

- Zero governor regulator connected to a:
  - Nozzle mix burner
  - Pre-mix burner
  - Inserted faults
  - Tools and equipment

Criteria — The individual will score 70% or better on a rating sheet that reflects the following criteria:

- Procedure
- Correction
- Safety

Line (GAC): D INSTALL AND SERVICE FUEL SYSTEMS

Competency: D5 Install and Service Propane Systems

Objectives

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

- Describe requirements for delivery and storage of propane gas.
- Install and set-up systems used for the delivery of propane gas.

LEARNING TASKS	CONTENT
1. Review D5 Domestic/Commercial Gasfitter B	• Code requirements • Temperature effects on pressure • Filled capacity effect on vaporization rate • Cylinder/tank sizing • Describe cylinder/tank clearances from building • Installation procedures • Safety relief valves • Maintenance • Valves and accessories for vapour withdrawal applications • Valves and accessories for liquid applications • Valves and accessories for filling applications • Filling density at standard temperature • Filling capacity by mass • Vehicle impact protection • Vehicle access for filling storage tanks • Filling safety • Emergency procedures
2. Describe Code requirements for propane installations	• Installer responsibility • Tank systems • Filling plants • Refill centres • Installation of tank systems • Liquid service

LEARNING TASKS	CONTENT

3. Describe requirements for bulk storage facilities	• Bulk tanks
	  o Location on the property
	  o Site security
	  o Valves
	  o Accessories
	  o Routine maintenance
	• Filling
	  o Bulk tanks
	  o Pumps
	  o Meters
	• Liquefying procedures

4. Install LP vaporizers	• Code requirements
	• Types
	  o Direct fired
	  o Indirect fired
	  o Tank heaters
	• Sizing
	  o Applications
	  o Loads
	• Capacity
	• Location
	• Piping arrangements
	• Safety controls
	• Routine maintenance

5. Describe alternate fuels	• Types • Purpose • Multiple fuel mixtures • Fuel/air mixtures • Calculations • Equipment

Line (GAC): E INSTALL VENTING AND AIR SUPPLY

Competency: E1 Install Venting Systems

Objectives

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

- Describe the requirements for venting of appliances rated over 400 MBH.
- Size and install venting for appliances rated over 400 MBH.

LEARNING TASKS	CONTENT
1. Review E1 of Domestic/Commercial Gasfitter B	• Gas appliance venting • Mechanical draft appliances • Venting systems for gas appliances

2. Describe draft	• Theory
	• Calculations
	  o Theoretical draft
	  o Height
	  o Temperature
	  o Volume
	  o Velocity
	  o Pressure

3. Install venting systems	• Code requirements
	• Engineered systems
	• Non-engineered systems
	• Sizing
	• Materials used
	• Barometric draft controls
	• Types
	  o Induced
	  o Forced
	  o Balanced
	• Heat reclaimers
	• Flue dampers

Line (GAC): E INSTALL VENTING AND AIR SUPPLY

Competency: E2 Install Air Supply Systems

Objectives

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

- Describe air supply requirements for appliances rated over 400 MBH.
- Size and install air supplies for appliances rated over 400 MBH.

LEARNING TASKS	CONTENT

1. Review gas appliance air supply requirements	• Purpose
	  o Combustion air
	  – Primary air
	  – Secondary air
	  – Excess air
	  o Dilution air
	  o Ventilation air
	• Building as a system
	  o Negative air pressure
	• Openings and ducts
	  o Terminations

2. Review the determination of combustion air requirements for gas appliances installations with a combined input of up to and including 400 MBH	• Code requirements
	• Building envelope and construction
	• Category of the appliance
	• Draft control
	• Air requirement calculations
	  o Combustion
	  o Ventilation
	  o Flue gas dilution
	• Table selection
	• Grills and louvers
	  o Types
	  o Sizing
	  o Free area calculations
	• Air ducts
	  o Length
	  o Size

LEARNING TASKS	CONTENT

3. Review the determination of combustion air requirements for gas appliance installations with a combined input exceeding 400 MBH	• Code requirements
	• Dilution air requirements
	• Air requirement calculations
	  o Combustion
	  o Ventilation
	  o Flue gas dilution
	• Calculations
	• Grills and louvers
	  o Types
	  o Sizing
	  o Free area calculations
	• Air ducts
	  o Length
	  o Size

4. Review the installation of air supply	• Code requirements • Structural penetrations • Sealing • Openings and ducts o Terminations • Wind conditions • Length • Supply by mechanical means
5. Describe mechanical air supply	• Code requirements • Fan capacity • Calculations • Interlocks

Line (GAC): F INSTALL AND SERVICE GAS EQUIPMENT

Competency: F1 Install and Service Burners

Objectives

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

- Describe installation requirements for burners installed in commercial/industrial appliances.
- Install and commission burners on commercial/industrial appliances.

LEARNING TASKS	CONTENT
1. Review F1 Domestic/Commercial Gasfitter B	• Combustion requirements • Atmospheric burners • Mechanical burners • Burner orifices • Burner adjustment • Pilot installation

2. Describe commercial/industrial gas burners	• Design
	  o Low pressure, natural draft
	  o Low pressure, forced draft
	  o Induced draft
	  o High pressure natural draft
	  o Mechanical burners
	• Parts
	• Operation
	• Types
	  o Atmospheric
	  o Mechanical-draft
	  o Small port type (manifold)
	  o Large port burner (pressure)
	  o Tile-port burner (radiant)
	  o Premix
	  o Aspirator
	  o Fan mix
	  o Nozzle mixing
	  o Excess air burner
	  o Blast burner
	  o Conversion burners
	  o Immersion tube
	• Applications
	• Flame characteristics
	• Code requirements
	• Manufacturers' specifications

LEARNING TASKS	CONTENT

3. Commission commercial/industrial gas burners	• Fuel flow
	• Air flow
	• Draft
	• Flue gas recirculation
	• Turn down ratio
	• Code requirements
	• Start up procedures
	• Manufacturers' specifications
	• Mounting details
	• Flame characteristics and adjustment procedures
	• Maintenance procedures
	• Gas valve tightness testing
	• Fuel conversions
	• Troubleshooting
	  o Burner pulsations
	  o Limits and safeties
	  o Stack temperatures

Line (GAC): F INSTALL AND SERVICE GAS EQUIPMENT

Competency: F2 Install and Service Appliances

Objectives

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

- Describe installation requirements for commercial/industrial gas fired appliances.
- Install and adjust commercial/industrial gas fired appliances.

LEARNING TASKS	CONTENT
1. Review F2 of Domestic/Commercial Gasfitter B	• Types • Characteristics • Applications • Installation requirements • Commissioning • Code requirements

2. Describe commercial/industrial appliance installation	• Types
	  o Air wall
	  o Boilers/gas fired hot water boosters
	  o Commercial cooking equipment
	  o Commercial clothes dryers
	  o Industrial dryers
	  o Construction heaters
	  o Catalytic heaters
	  o Carbon dioxide generators
	  o Domestic service water heaters
	  o Direct fired make-up air units
	  o Indirect fired make-up air heaters
	  o Incinerators
	  o Industrial appliances
	  o Pressure boosters
	  o Roof-top units
	  o Stationary gas engines
	• Code requirements
	• Safety precautions
	• Approval agencies
	• Altitude rating requirements
	• Site preparation
	• Installation procedures
	• Venting requirements
	• Air supply requirements

LEARNING TASKS	CONTENT

3. Commission commercial/industrial appliances	• Types
	• Code requirements
	• Inspections
	• Boiler overview
	  o Types
	  o Ratings
	  o Start-up procedures
	• Direct fired make-up unit overview and start-up procedures
	  o Velocity/volume calculations
	  o Profile opening
	  o Temperature rise
	  o Static pressure
	  o Interlocks
	• Other appliance start-up procedures
	• Burner set-up
	  o Manifold pressure testing and adjustment
	  o Meter clocking and gas consumption
	  o Combustion gas analysis
	  o Efficiencies
	  o Pilot turndown test
	• Customer operating instructions
	• Installers responsibility
	• Routine maintenance
	• Testing and setting of operating controls, safety controls and interlocks
	• Describe common troubleshooting techniques

Achievement Criteria

Performance — The individual will commission an industrial boiler and direct fired make-up air unit.

Conditions — The individual will be given:

- Industrial boiler
- Direct fired make-up air unit
- Tools and equipment
- Manufacturers' specifications

Criteria — The individual will score 70% or better on a rating sheet that reflects the following criteria:

- To code
- To manufacturers' specifications
- Combustion analysis

Line (GAC): F INSTALL AND SERVICE GAS EQUIPMENT

Competency: F3 Perform Combustion Analysis

Objectives

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

- Describe the combustion process in burners installed in commercial/industrial appliances.
- Describe the combustion analysis process for commercial/industrial gas fired appliances.
- Perform combustion analysis and adjust equipment for maximum efficiency.

LEARNING TASKS	CONTENT
1. Review F3 of Domestic/Commercial Gasfitter B	• Chemical process of combustion • Combustion analysis for appliances up to and including 400 MBH
2. Describe combustion in commercial/industrial gas burners	• Terms • Primary and secondary air supply • Introduction and control of combustion air • Calculation and combustion air requirements • Products of complete combustion • Dangers of accumulation of products of combustion o NO_x o SO_x o CO_2 o CO • Products of incomplete combustion • Multi-fuel applications • Volumes of air for various proportions of excess air in the combustion chamber • Code requirements • Environmental requirements • Flue gas recirculation

LEARNING TASKS	CONTENT
3. Perform combustion analysis	• Percentage of carbon dioxide in the flue gas • Flue gas temperature • Calculation of excess air flowing through the combustion chamber • Appliance efficiency • Oxygen in the vent • Plotting combustion efficiency • Troubleshoot • Corrective measures to achieve maximum efficiency

Line (GAC): F INSTALL AND SERVICE GAS EQUIPMENT

Competency: F4 Describe Heating and Cooling Systems

Objectives

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

- Describe safety procedures when working around gas fired heating/cooling units.
- Describe the parts and operation of gas fired heating/cooling units.

LEARNING TASKS	CONTENT
1. Describe principles of refrigeration and cooling	• Sensible heat • Latent heat • Absorption • Pressures • Refrigerants

2. Describe types of gas fired air conditioning equipment	• Gas fired absorption systems
	  o Ammonia-water
	  o Water-lithium bromide systems
	• Gas fired absorption chiller/heat units
	  o Chilling cycle
	  o Heating cycle
	• Operation and installation considerations
	• Sequence of operation

3. Describe safety procedures when working around gas fired heating/cooling units	• Hazard recognition • OHS Regulations • Handling of refrigerants • Safety practices

Line (GAC): G INSTALL AND SERVICE CONTROLS AND SAFEGUARDS

Competency: G1 Use the Principles of Electricity and Electronics

Objectives

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

- Locate and apply Canadian Electrical Code rules pertaining to the installation electrical equipment on gas fired appliances.
- Install and wire single/three phase motors.

LEARNING TASKS	CONTENT
1. Review G1 of Domestic/Commercial Gasfitter B	• Describe principles of electricity • Describe principles of magnetism and magnetic induction
2. Describe Canadian Electrical Code Requirements	• Review C3 of Domestic/Commercial Gasfitter B • Three phase motors o Section 28
3. Describe electrical terminology	• Voltage • Lock-out procedures • Motor terminology • Nameplate data • Single-phase motors o Types – Split phase induction motor – Resistance start motor – Capacitor start motor – Permanent-split capacitor motor – Shaded pole induction motor – Dual voltage o Operation o Wiring o Control o Protection – Overload – Overcurrent • Three-phase motors o Types – Squirrel cage induction motors – Multispeed motors – Dual voltage o Operation o Wiring

LEARNING TASKS	CONTENT
	o Control o Protection – Overload – Overcurrent • Direct current motors • Effects of loading • Maintenance • Troubleshooting
5. Maintain motors	• Inspect • Troubleshoot

Line (GAC): G INSTALL AND SERVICE CONTROLS AND SAFEGUARDS

Competency: G2 Use the Principles of Gas Controls

Objectives

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

- Apply applications of control systems.

LEARNING TASKS	CONTENT

1. Describe power and control circuits found on commercial/industrial gas fired equipment	• Terminology
	• Diagrams
	  o One-line
	  o Schematic
	  o Ladder
	  o Wiring
	  o Symbols
	  o Timing
	  o Sequencing
	• Electronic controllers
	  o Types
	  o Operations
	  o Applications
	• Wheatstone bridge
	• Flame safeguards
	• Supervisory systems
	• Programmable Logic Controllers (PLCs)
	• Pre-Programmable Logic Controllers
	• Building management systems
	• Ignition
	• Lead lag

2. Describe commercial/industrial electro/mechanical controls	• Pressure controls • Temperature controls • Fluid controls • Combustion controls • Proportional controls • Supervisory systems • End switches and interlocks • Identification • Operation • Ratings

LEARNING TASKS	CONTENT

3. Describe flame safeguard controls	• Purpose
	• Flame characteristics
	  o Spectrum
	  o Flame ionization
	  o Flame rectification
	  o Flame flicker
	• Flame detector types
	• Flame safeguard terminology
	• Programmed controls and Interlocks terminology
	• Operating principles
	• Operating sequence
	• Parts
	• Code requirements
	• Safety

4. Apply applications of control systems	• Code requirements • Applications • Interfaces • Location • Wiring requirements

Line (GAC): G INSTALL AND SERVICE CONTROLS AND SAFEGUARDS

Competency: G3 Install and Service Gas Controls

Objectives

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

- Describe the installation requirements for controls used on commercial/industrial gas fired appliances.
- Install and adjust controls used on commercial/industrial gas fired appliances.
- Install a flame safeguard and supervisory system on a commercial/industrial gas fired appliance.

LEARNING TASKS	CONTENT
1. Install control systems for commercial/industrial appliances	• Supervisory systems • Pneumatic systems • Multi-stage systems • Modulating control systems • Programming control systems • Programmable control systems • On/off application • Dual fuel systems • Motor controls • Electrical diagrams • Sequence of operation • Maintenance • Troubleshooting • Safety

2. Install and service flame safeguards	• Flame detectors
	  o Types
	  o Sighting location
	  o Application
	  o Temperature
	  o Positioning
	• Programmed controls and interlocks
	• Operating sequence
	• Parts
	• Wiring practices
	• Commissioning
	• Manufacturer's specifications
	• Code requirements
	• Troubleshooting
	• Maintenance
	• Safety

Achievement Criteria

Performance	The individual will install a flame safeguard and supervisory system on a commercial/industrial gas appliance.
Conditions	The individual will be given: • Appliance • Flame safeguard • Supervisory system components • Tools and equipment
Criteria	The individual will score 70% or better on a rating sheet that reflects the following criteria: • Code • Safety • Verification of installation

Line (GAC): G INSTALL AND SERVICE CONTROLS AND SAFEGUARDS

Competency: G4 Install and Service Fuel Train Systems

Objectives

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

- Describe fuel train systems for inputs exceeding 400 MBH.
- Install and service fuel train systems for inputs exceeding 400 MBH.

LEARNING TASKS	CONTENT
1. Describe fuel train components	• Code requirements • Certification • Types • Purpose • Component parts • Component operation
2. Describe fuel train operation	• Code requirements • Components of specific fuel trains • Sequence of operation
3. Describe flow controllers	• Ratio regulators • Ratio controllers • Limiting orifices • Metering orifices
4. Install and service fuel train systems	• Code requirements • Inspections • Certification • Installation requirements • Manufacturers' specifications • Testing • Interlocking • Commissioning

Achievement Criteria

Performance	The individual will commission and troubleshoot fuel trains.
Conditions	The individual will be given: • Fuel train meeting code requirements of valve train diagrams of the B149.3 • Tools and equipment
Criteria	The individual will score 70% or better on a rating sheet that reflects the following criteria: • Meets Code requirements • Procedure • Fault corrected and verified • Safety

Section 4

TRAINING PROVIDER STANDARDS

Facility Requirements

Classroom Area

- Minimum 22 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 10 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

- N/A

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

Required Shop (Facility) Tools

Power Tools

Air compressor and accessories
Band saw
Bench grinder
Chop saw
Circular saw
Cordless drills
Drill press
Mini grinder
Portable band saw (hack saw)
Powder-actuated tools
Power drills
Power hole 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
Compressor
Computer
Drafting equipment
Electronic Flue gas analyzer
Electronic leak detector
Draft gauge
Scale ruler
Hand pump and accessories
Hydrostatic pump and gauge (manual and power)
Laser level
Manometers
Measuring tape and markers
Multimeter

Hoisting, Rigging and Access Tools and Equipment

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

Personal Protective and Safety Equipment

Eye wash kit
Face shield
Fire blanket
Fire extinguisher
First aid kit
Gloves (industrial rubber)
Hard hat
Hearing protection
Lock-out devices
Overalls
Rubber boots
Dust mask
Safety glasses/goggles
Safety harness, lanyard and life line

Standard Tools

Adjustable wrench
Ball-peen hammer
Broom
Caulking gun
Chalk line
Chisels
Claw hammer
Combination wrench
Drywall saw
Files
Flashlight
Hacksaw
Hand saw
Hex Keys (set)
Hole saw
Knife
Levels
Pick
Pipe wrench
Pin vice
Pliers (lineman, needle nose, water pump, channel lock)
Plumb bob
Pry bars
Punch
Ratchet
Rubber mallet
Scratch awl
Screwdrivers (complete set)
Shovel
Sledgehammer
Socket set (imperial and metric)
Square
Striker
T square
Tap and die sets
Threading hand dies
Tin snips (set)
Torque wrench
Tri-square
Utility brushes
Wire brushes
Orifice drills

Student Tools (supplied by student)

- Calculator
- Safety boots

Reference Materials

Required Reference Materials

- N/A

Recommended Resources

- CAN/ CSA B149.1 current
- CAN/ CSA B149.2 current
- CAN/ CSA B149.3 current
- CAN/ CSA C22.1 current

Suggested Texts

- N/A

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
- 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 A 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 be working towards one or more of the following:

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