SKILLEDTRADES BC

PROGRAM OUTLINE

Gasfitter – Class A

SKILLED TRADES BC

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GASFITTER – CLASS A
PROGRAM OUTLINE

APPROVED BY INDUSTRY

OCTOBER 2020

BASED ON

NOA 2014

Developed by
SkilledTradesBC
Province of British Columbia

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Section 1

INTRODUCTION

Gasfitter – Class A

Foreword

The Gasfitter - Class 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 the Gasfitter – Class A National Occupational Analysis (2014) and British Columbia industry and instructor subject matter experts.

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

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

The Program Outline was prepared with the advice and assistance of British Columbia industry and instructor subject matter experts and will form the basis for further updating of the British Columbia Gasfitter – Class A 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 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.

Important Program Information:

Due to the high level of skill required in Math and Physics for the Gasfitter A 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. Members include:

- Michael Pizzolato, Cannepp Sales and Service
- Glen Ohs, Independent consultant
- Marty Old, Marty Old Consulting
- Brian Sweet, BCIT
- Jack Coutu, Teck – Highland Valley Copper

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

- Michael Pizzolato, Cannepp Sales and Service
- Glen Ohs, Independent consultant
- Marty Old, Marty Old Consulting
- Brian Sweet, BCIT
- Jack Coutu, Teck – Highland Valley Copper

Industry Subject Matter Experts retained as Program Outline reviewers:

- Michael Pizzolato, Cannepp Sales and Service
- Glen Ohs, Independent consultant
- Marty Old, Marty Old Consulting
- Brian Sweet, BCIT
- Jack Coutu, Teck – Highland Valley Copper
- Rick Vanier – Technical Safety BC

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 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	NA
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	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

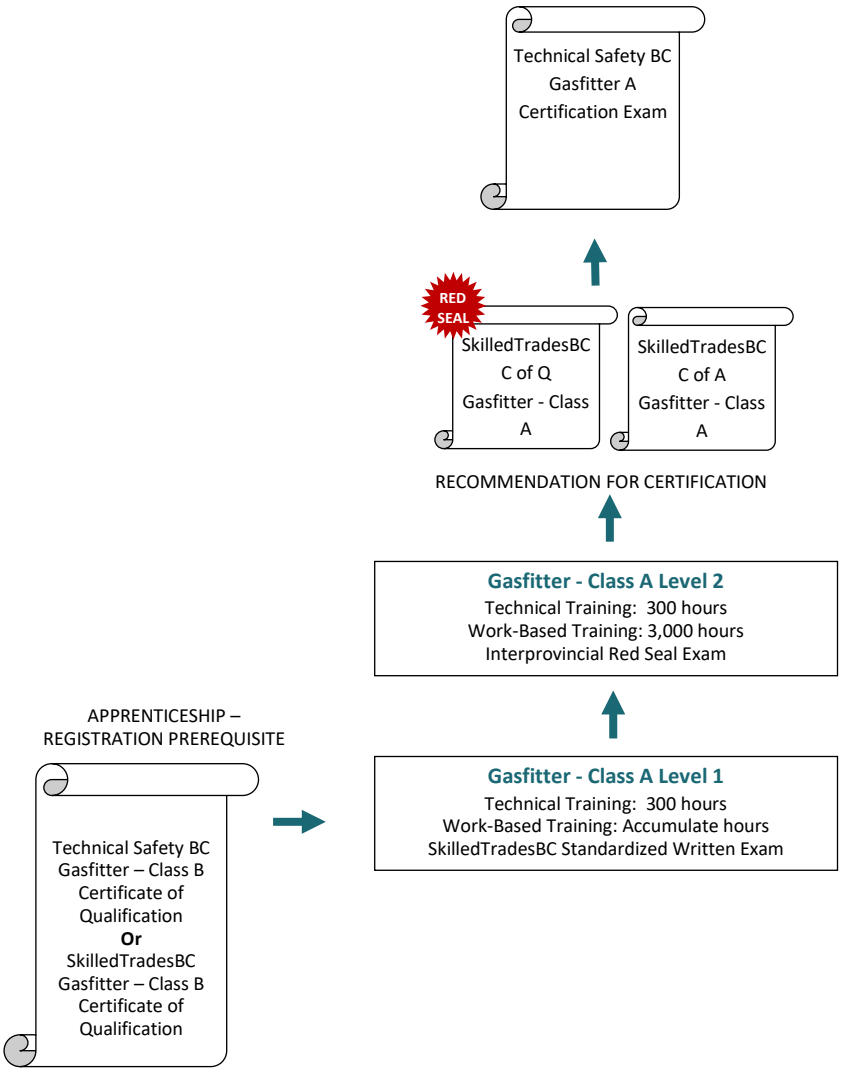
PROGRAM OVERVIEW

Gasfitter – Class A

Program Credentialing Model

Gasfitter – Class A

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



**Suggested duration based on 30-hour week*

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

- None

Occupational Analysis Chart

GASFITTER – CLASS A

Occupation Description: 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 andHydrogen and fuel oils. 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.

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

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.

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

	Apply wiring practices C7	Troubleshoot electrical circuits C8	Apply communication and networking technology C9		
	B-1 B-2 1	B-2 1	B-2 1 2		
PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS D	Size piping and tubing systems D1	Select regulators, valves, and valve train components D2	Plan propane system installations D3	Size venting systems D4	Size air supply systems D5	Select gas-fired appliances D6
	B-1 1	B-1 B-2 1 2	B-2 1	B-2 1	B-2 1	B-1 B-2 1
	Select burners D7	Select flame safeguards D8	Select combustion, safety and operating controls D9	Select electrical components D10	Select automation and instrumentation control systems D11	Plan a project D12
	B-1 B-2 1	B-1 B-2 1	B-2 1	B-1 1	B-2 2	B-1 B-2 1 2
INSTALL GAS-FIRED SYSTEMS E	Install piping and tubing systems E1	Install regulators, valves, and valve train components E2	Install LPG, LNG and CNG vaporizing and mixing systems E3	Install venting systems E4	Install air supply systems E5	Install draft control systems E6
	B-1	B-1 B-2 1	B-2 1	B-2 1	B-1 B-2 1	B-2 1
	Install burners E7	Install flame safeguards E8	Install combustion, safety and operating controls E9	Install automation and instrumentation control systems E10	Install boilers and ancillary equipment E11	Install air heating appliances and equipment E12
	2	1	1	B-2 2	B-2 1	B-2 2
COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT F	Commission fuel/air delivery systems F1	Perform appliance start-up procedures F2	Interpret gas metering devices F3	Perform combustion analysis F4	Commission boilers and ancillary equipment F5	Commission direct-fired make-up air heaters F6
	B-1 B-2 1 2	B-2 2	B-2 2	B-2 1 2	B-2 2	2
	Commission furnaces and ovens F7	Program temperature, pressure and operating controls F8	Program combustion control systems F9	Program PLCs F10	Commission draft control systems F11	Training and handover of gas-fired equipment F12
	B-2 2	B-2 2	2	2	B-2 2	B-2 2

MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT G	Service gas distribution systems G1	Service gas burners and ancillary equipment G2	Maintain boilers and ancillary equipment G3	Maintain gas-fired appliances G4	Maintain gas-fired refrigeration equipment G5	Service fuel/air delivery systems G6
	B-2 2	B-2 2	B-2 2	B-2 2	B-2 2	B-2 2

Service and repair control systems G7	Repair and replace furnace refractory G8	Decommission and disconnect gas-fired appliances and equipment G9
B-2 2	1	B-2 2

Level 1 - Training Topics and Suggested Time Allocation

GASFITTER – CLASS A

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**USE COMMON OCCUPATIONAL SKILLS**	**8%**	**90%**	**10%**	**100%**
A2	Use drawings and specifications		✓	✓	
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%**
B2	Apply combustion theory		✓		
B3	Apply draft theory		✓	✓	
B4	Interpret heating, cooling and process systems		✓		
B5	Apply knowledge of mechanical safety devices		✓		
B6	Apply alternate-fuel theory		✓	✓	
Line C	**APPLY ELECTRICAL CONCEPTS**	**32%**	**75%**	**25%**	**100%**
C1	Use the principles of electricity and electronics		✓		
C2	Use electrical wiring diagrams and schematics		✓	✓	
C3	Use the Canadian Electrical Code (CEC)		✓		
C5	Apply three phase motor theory		✓		
C6	Apply Variable Frequency Drive (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**	**26%**	**95%**	**5%**	**100%**
D1	Size piping and tubing systems		✓		
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		✓		
D10	Select electrical components		✓		
D12	Plan a project		✓	✓	

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line E	**INSTALL GAS-FIRED SYSTEMS**	**15%**	**90%**	**10%**	**100%**
E2	Install regulators, valves, and valve train components		✓		
E3	Install LPG, LNG and CNG vaporizing and mixing Systems		✓		
E4	Install venting systems		✓		
E5	Install air supply systems		✓		
E6	Install draft control systems		✓		
E8	Install flame safeguards		✓	✓	
E9	Install combustion, safety and operating controls		✓		
E11	Install boilers and ancillary equipment		✓		
Line F	**COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT**	**4%**	**100%**	**0%**	**100%**
F1	Commission fuel/air delivery systems		✓		
F4	Perform combustion analysis		✓		
Line G	**MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**	**1%**	**100%**	**0%**	**100%**
G8	Repair and replace furnace refractory		✓		
	Total Percentage for Gasfitter – Class A Level 1	**100%**			

Level 2 - Training Topics and Suggested Time Allocation

GASFITTER – CLASS A

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**USE COMMON OCCUPATIONAL SKILLS**	**2%**	**100%**	**0%**	**100%**
A4	Use technical instruments and testers		✓		
A5	Use codes, regulations and standards		✓		
Line B	**APPLY FUNDAMENTALS OF GAS UTILIZATION**	**2%**	**100%**	**0%**	**100%**
B2	Apply combustion theory		✓		
Line C	**APPLY ELECTRICAL CONCEPTS**	**6%**	**100%**	**0%**	**100%**
C2	Use electrical wiring diagrams and schematics		✓		
C9	Apply communication and networking technology		✓		
Line D	**PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS**	**11%**	**95%**	**5%**	**100%**
D2	Select regulators, valves, and valve train components		✓		
D11	Select automation and instrumentation control systems		✓		
D12	Plan a project		✓	✓	
Line E	**INSTALL GAS-FIRED SYSTEMS**	**8%**	**100%**	**0%**	**100%**
E7	Install burners		✓		
E10	Install automation and instrumentation control systems		✓		
E12	Install air heating appliances and equipment		✓		
Line F	**COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT**	**57%**	**75%**	**25%**	**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		✓	✓	
F6	Commission direct-fired make-up air heaters		✓	✓	
F7	Commission furnaces and ovens		✓		
F8	Program temperature, pressure and operating controls		✓		
F9	Program combustion control systems		✓		
F10	Program PLCs		✓		
F11	Commission draft control systems		✓		
F12	Training and handover of gas-fired equipment		✓		
Line G	**MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**	**14%**	**90%**	**10%**	**100%**
G1	Service gas distribution systems		✓		
G2	Service gas burners and ancillary equipment		✓		
G3	Maintain boilers and ancillary equipment		✓		

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
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 A Level 2	**100%**			

Section 3

PROGRAM CONTENT

Gasfitter – Class A

Level 1

Gasfitter – Class A

Line (GAC): A USE COMMON OCCUPATIONAL SKILLS

Competency: A2 Use drawings and specifications

Objectives

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

- Interpret process flow diagrams.
- Interpret piping and instrumentation diagrams.

LEARNING TASKS	CONTENT

1. Describe process flow diagrams	• Hydronic heating systems
	  ○ ICI (industrial/commercial/institutional)
	• Steam process systems
	• Process dryer and kiln systems
	• Air heating systems
	  ○ ICI (industrial/commercial/institutional)

2. Describe piping and instrumentation diagrams	• Hydronic heating systems
	  ○ ICI (industrial/commercial/institutional)
	• Steam process systems
	• Process dryer and kiln systems
	• Air heating systems
	  ○ ICI (industrial/commercial/institutional)

3. Interpret process flow, piping and instrumentation diagrams	• Hydronic heating systems
	  ○ ICI (industrial/commercial/institutional)
	• Steam process systems
	• Process dryer and kiln systems
	• Air heating systems
	  ○ ICI (industrial/commercial/institutional)

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 combustion analyzers.
- Use signal generators.

LEARNING TASKS	CONTENT

1. Describe combustion analyzers	• Types
	  ○ Certification
	• Sampling location
	• Combustion yield formula
	• Composition percentages
	  ○ CO_2
	  ○ O_2
	• CO ppm
	• NO_X ppm
	  ○ O_2 correction to 3%
	• Combustion efficiencies
	  ○ System temperatures
	• Stack temperatures
	• Draft
	• Appliance efficiencies
	• Burner type
	  ○ Mechanical
	  ○ Atmospheric
	• Application
	• Zeroing
	• Calibration
	• Smoke spot testing
	• Parts
	  ○ Desiccant
	  ○ Gas cells
	  ○ Water traps
	  ○ Filters/media
	  ○ Pump
	  ○ Probe

2. Describe signal generators	• Types
	  ○ 4-20 mA
	  ○ 0-10 V
	  ○ 4-20 V

LEARNING TASKS	CONTENT
	○ Flame signal • Application • Calibration
3. Describe electronic device integration	• Types of electronic hardware • Software ○ Proprietory ○ Apps
4. Use combustion analyzers	• Calibration • Fuel selection • Cell saturation • Composition percentages ○ CO_2 ○ O_2 • CO ppm • NO_X ppm ○ O_2 correction to 3% • Combustion efficiencies ○ System temperatures • Stack temperatures • Draft
5. Maintain combustion analyzers	• Annual calibration and re-certification • Storage and handling ○ Water trap/condenser maintenance ○ Desiccant/filter replacement ○ Manufacturer's documentation • Cell expiry dates/replacement
6. Use signal generators	• Simulate sensor signal to control input • Confirm signal output • Verification of operation • Troubleshooting

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 the B149.3 gas code.
- Interpret CSD-1 Code for Controls and Safety Devices for Automatically Fired Boilers.

LEARNING TASKS	CONTENT
1. Describe code implications	• Design • Planning • Installation • Maintenance • Decommissioning
2. Identify codes and standards	• B149.3 gas code • CSD-1 Code for Controls and Safety Devices for Automatically Fired Boilers

3. Interpret the B149.3 gas code	• Parts
	  ○ General requirements
	  ○ Additional requirements for process ovens, furnaces and atmosphere generators
	  ○ Valve train schematics
	  ○ Start-up procedures
	• Scope
	• Definitions
	• Contents
	• Tables

4. Interpret the B149.6 gas code	• Parts • Scope • Definitions • Contents
5. Interpret CSD-1 Code for Controls and Safety Devices for Automatically Fired Boilers	• Parts • Scope • Definitions • Contents

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 documentation responsibilities.

LEARNING TASKS	CONTENT

1. Describe documentation responsibilities	• Types of documents
	  ○ Commisisoning report
	  ○ Service reports
	  ○ Statements of completion
	  ○ Technical Safey BC documentation
	  ○ Permits
	  ○ Approvals
	  ○ Revised drawings
	• Regulatory responsibilities
	  ○ Safety Standards Act
	  ○ Safety Standards General Regulations
	  ○ Safety Standards Gas Regulations
	• Liability
	  ○ Contractor
	  ○ Fitter
	  ○ Owner

Line (GAC): B APPLY FUNDAMENTALS OF GAS UTILIZATION

Competency: B2 Apply combustion theory

Objectives

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

- Describe the combustion process.

LEARNING TASKS	CONTENT

1. Describe the chemistry of the combustion process	• Terms
	• Gas combustion phases
	• Stoichiometric combustion
	• Introduction and control of combustion air
	• Combustion air requirements
	  ○ Combustion
	  ○ Primary
	  ○ Secondary
	  ○ Tertiary
	  ○ Excess
	• Products of complete combustion
	  ○ Calculations
	• Products of incomplete combustion

2. Describe emissions	• NOx
	  ○ Nitric oxide
	  ○ Nitric dioxide
	  ○ Nitrous oxide
	• Thermal NOx
	• SOx
	  ○ Sulphur dioxide
	  ○ Sulphur trioxide
	• Particulate emissions
	• CO_2
	• CO

3. Describe the combustion of alternate fuels	• #2 oil/diesel • Waste oil

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 systems.
- Perform natural draft calculations.
- Describe draft control systems.
- Describe the effects of emission controls on draft.

LEARNING TASKS	CONTENT

1. Describe draft systems	• Natural draft systems
	• Mechanical draft systems
	  ○ Forced draft
	  ○ Induced draft

2. Perform natural draft calculations	• Theoretical draft • Actual draft • Temperature correction factors • Altitude correction factors • Velocities ○ Stack draft relative to economic stack velocity

3. Describe draft control systems	• Modulating dampers
	• Modulating draft fans
	• Draft control panels
	• Speed controls
	  ○ Triac drives
	  ○ Frequency drives
	• Pressure transducers
	• System interlocks

4. Describe the effects of emission controls on draft	• NOx control • Scrubbers • Economizers

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:

- Describe the parts and operation of gas fired heating/cooling systems.

LEARNING TASKS	CONTENT

1. Describe principles of refrigeration and cooling	• Sensible heat
	• Latent heat
	• Absorption
	• Pressures
	• Refrigerants
	  ○ Hazard recognition
	  ○ Safety practices

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

3. Describe ICI hydronic systems	• Boiler types
	• System pumps
	• Heat pumps
	• Controls
	• Ancillary equipment
	  ○ Heat exchangers
	  ○ Expansion tanks
	• Glycol
	• Heat emitters
	  ○ Variable air volume
	  ○ Radiant panels
	  ○ Baseboards
	• Water treatment
	  ○ Chemical pot feeder
	  ○ Side stream filters
	• Process Flow Diagrams (PFD)
	• Precommissioning system cleaning

4. Describe steam systems	• Boiler types

LEARNING TASKS	CONTENT

	• Deaerator
	• Hot well
	• Ancillary equipment
	  ○ Blow down systems
	  ○ Heat exchangers
	  ○ Economizers/feed water heaters
	• Controls
	  ○ Pumps
	  ○ Feedwater
	  ○ Operating
	  ○ Safety
	• Feed tank/pump
	• Supply/steam header
	• Condensate return
	• Steam traps
	• Low water cutoff
	• Water treatment
	  ○ Chemical injection systems
	  ○ Sample cooler
	  ○ Water softener
	• Codes
	• Process Flow Diagrams (PFD)
	• Boiler boil out
	• Precommissioning system cleaning

5. Describe other process systems	• Thermal fluid • CO_2 generation • Emmersion burner systems

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 the installation and testing mechnical safety devices.

LEARNING TASKS	CONTENT

1. Describe the applications of mechanical safety devices	• Codes and regulations
	• ASME standards
	• Types of valves
	  ○ Relief valves
	  ○ Safety valves
	  ○ Safety relief valves
	  ○ Temperature and pressure relief valves
	  ○ Rupture discs
	• Valve applications
	  ○ Types of valves
	  ○ Capacities
	  ○ Ratings
	• Hot Water Boiler
	• Steam Boiler
	• Hot Water Tank
	• Pressure vessels
	  ○ Propane tanks (LPG)
	  ○ Propane cylinders
	  ○ Accumulator tanks
	  ○ Liquified Natural Gas (LNG)
	• Compressed Natural Gas (CNG)

2. Describe the installation of mechanical safety devices	• Procedures
	• Discharge piping
	  ○ Pipe routing
	  ○ Termination
	  ○ Size
	  ○ Drip pan elbows
	• Location

3. Describe the testing of mechanical safety devices	• Recertification requirements
	  ○ Frequency
	  ○ ASME
	  ○ Technical Safety BC
	• Lift testing

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 over 400 MBH (120 kW).
- Describe the applications of alternate fuel appliances over 400 MBH (120 kW).
- Describe the installation of duel-fuel appliances over 400 MBH (120 kW).
- Perform propane-air mix calculations.

LEARNING TASKS	CONTENT
1. Describe types of alternate fuels	• #2 Oil/diesel • Waste oil • Digester gas • Landfill gas • Bio gas • Propane-air mixes • Manufactured gas
2. Describe digester gas, landfill gas and biogas generation and utilization	• B149.6 code requirements

3. Describe the applications of alternate-fuel appliances	• Appliances
	  ○ Boilers
	  ○ Industrial air heaters
	  ○ Burners
	• Facilities/applications
	• Filters
	• Fuel conditioning
	• Pumps
	• Blowers

4. Describe the installation of duel-fuel appliances	• Code requirements
	  ○ B149.1
	  ○ B149.6
	• Manufacturer's specifications
	• Job specifications
	  ○ Piping materials
	  ○ Valves
	  ○ Controls

5. Perform propane-air mix calculations	• Specific gravity • Calorific value

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 transformers.
- Describe proportional control operation.
- Describe power converters.
- Describe control point instrumentation.

LEARNING TASKS	CONTENT

1. Describe transformers	• Types
	  ○ Control
	  ○ Ignition
	  ○ Motor
	• Sizing
	  ○ Control
	  ○ Motor
	• Ratings
	• Fusing

2. Describe proportional control operation	• Electric
	  ○ Wheatstone bridge circuits
	• Electronic
	  ○ 4-20 mA current loops
	  ○ 0-10 V DC
	  ○ ModBus

3. Describe power converters	• Rectifiers • Inverters
4. Describe control point instrumentation	• Resistance temperature detectors (RTD) • Transducers • Thermocouples • Flow meters • O_2 sensors • Servo motors

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:

- Create a control narrative.
- Design a wiring diagram.

LEARNING TASKS	CONTENT
1. Describe circuit components	• Transformer • Limits • Safety devices • Controls • Permissives • Interlocks • OEM electronic devices ○ Principles of operation
2. Create a control narrative	• Components • Appliances • Wiring diagrams
3. Design a wiring diagram	• Control narrative • Electrical components • Integration of electronic components

Achievement Criteria 1

Performance	The learner will be able to design a wiring diagram for a steam boiler.
Conditions	To be assessed during technical training. The learner will be given: • Control narrative • List of electrical components
Criteria	The learner will be evaluated on: • Accuracy • Completeness • Use of symbols

Achievement Criteria 2

Performance	The learner will be able to create a control narrative for DFMA.
Conditions	To be assessed during technical training. The learner will be given: • Wiring diagram
Criteria	The learner will be evaluated on: • Accuracy • Completeness

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, section 28.

LEARNING TASKS

1. Describe CEC code requirements that apply to motors and generators

CONTENT

- Section 28
  - Overload protection
    - Mag starter heaters
    - Temperature sensors
  - Sizing motor conductors
  - Overcurrent protection
    - Fusing
    - Breakers
    - Relays
  - In rush current
    - Locked rotor
  - FLA
  - RLA
  - SFA
  - Disconnects/lockout
  - Clauses

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 operation and protection of three phase motors.

LEARNING TASKS	CONTENT

1. Describe characteristics and operation of three phase motors	• Three phase rotating field
	  ○ Delta connected
	  ○ Wye connected
	  – Reduced voltage
	• Characteristics
	  ○ Speed and torque
	  ○ Ratings
	  ○ Applications

2. Analyze causes of motor failure	• Design operating conditions
	  ○ Rating of motor
	  ○ Amperage and voltage
	  ○ Motor efficiency
	  ○ Motor heat
	  ○ Application
	• Bearings
	  ○ Lubrication
	  ○ Mechanical failure

3. Describe three phase motor starters	• Sizing
	  ○ NEMA ratings
	• Types of overloads
	  ○ Fuses
	  ○ Relays
	  ○ Heaters

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C6 Apply Variable Frequency Drive (VFD) and Electronically Commutated Motors (ECM) technology

Objectives

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

- Operate ECMs and VFDs.

LEARNING TASKS	CONTENT

1. Describe the operation of ECMs and VFDs	• Operation
	  ○ Tuning parameter identification
	  ○ Signal isolation DCS/VFD
	• Control of speed
	  ○ ECC (Eddy Current Coupling)
	  ○ Input signals (digital and analog)

2. Test the operation of a VFD	• Set up and test a ECM/VFD
3. Confirm the interaction of PID tuning and ECM configuration	• PID control in PLC/DCS with configuration parameters in ECM

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 cabling and components.

LEARNING TASKS	CONTENT
1. Install cables and conductors	• CEC • Supports • Colour coding • Class 2 circuits • Conduit • Wire labelling
2. Install junction and switch boxes	• CEC ○ Sizing • NEMA ratings • Intrinsically safe (explosion proof) • Voltage separation barriers • Conductor connections and terminations • Grounding/bonding
3. Install communication cable	• Shielding • Termination • Grounding/bonding • Cable lengths • Types

Line (GAC): C APPLY ELECTRICAL CONCEPTS

Competency: C8 Troubleshoot electrical circuits

Objectives

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

- Troubleshoot complex circuits.

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

2. Interpret electrical readings	• Manufacturer's literature
	• Predicted readings
	  ○ Voltage
	  ○ Current
	  ○ Resistance
	  ○ Continuity
	• Sequence of operation

3. Troubleshoot complex circuits	• Safety
	  ○ Arc flash
	• Modulating motor controls
	  ○ Components
	  ○ Balancing circuits
	  ○ Sensing devices
	• Complex systems
	  ○ Relationship of circuits
	  ○ Troubleshooting technique
	• Sequence of operation

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:

- Describe communication and networking technology.

LEARNING TASKS	CONTENT

1. Describe types of signal transmission systems	• Fibre optics
	  ○ Armoured cable
	  ○ Non armoured cable
	  ○ Multimode/single mode transmission
	• Wired
	  ○ Coax
	  ○ UTP (unshielded twisted pair)
	• Wireless
	  ○ Cellular
	  ○ Bluetooth
	  ○ WiFi
	  ○ IEEE standards

2. Describe communication protocols	• Types of protocols
	  ○ RS232
	  ○ RS422/485
	  ○ MODBUS
	  ○ BACnet MSTP
	  ○ BACnet IP
	  ○ Metasys N2
	  ○ Local Operation Network (LON)
	  ○ Device Net
	  ○ Highway Addressable Remote Transducer (HART)
	  ○ Spread spectrum
	  ○ Ethernet TCP/IP

3. Describe hardware layers	• Network switches (routers)
	  ○ Configurable
	  ○ Nonconfigurable
	  ○ Firewalls
	  ○ Hubs
	• Gateways
	  ○ Protocol interface
	  ○ Media interface
	  ○ Network isolation

4. Describe network connectors	• Types

LEARNING TASKS	CONTENT
	○ USB ○ Firewire ○ 9 pin, 25 pin serial port ○ RJ45 ○ M12 ○ M10

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:

- Size gas piping systems.

LEARNING TASKS	CONTENT
1. Describe ICI gas piping installations	• Pipe sizing tables • Code requirements • Piping practices
2. Size gas piping systems	• Sizing calculations/formulas • Piping material • Code requirements

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:

- Select valve train components.

LEARNING TASKS	CONTENT

1. Describe pressure regulators	• Types
	  ○ Direct operated
	  – Lever operated
	  ○ Pilot operated
	  ○ Zero governors
	  ○ Regulating safety shut-off valves
	• Operating principles
	  ○ Droop
	  ○ Lock-up
	  ○ Set point
	  ○ Critical flow
	• Applications

2. Select regulators	• Manufacturer's literature
	• Sizing tables
	  ○ Flow rate
	  ○ Pressure drop
	  ○ Orifice selection
	  ○ Spring selection
	• Body size
	• Body material
	• Types of fuel
	  ○ Natural gas
	  ○ Propane
	  ○ Digester gas
	• Code requirements

3. Describe over pressure protection (OPP)	• Code requirements
	• Types
	  ○ Relief
	  – Pop
	  – Modulating
	  ○ Isolation
	  ○ Monitor
	• Sizing
	• Terminations
	• Vent sizing

LEARNING TASKS	CONTENT

4. Describe valve train components	• Code requirements
	  ○ B149.3
	• Certification
	• Types
	  ○ Regulators
	  ○ Reliefs
	  ○ Safety shut-off valves
	  ○ Vent valves
	  ○ Firing valves
	  ○ Modulating valves
	  ○ FM valves
	  ○ Latch valves
	  ○ Pressure switches
	  ○ End/limit switches
	  ○ Actuators
	  ○ Solenoids
	• Ratings
	• Enclosures
	• Component parts
	• Component operation

5. Describe valve train operation	• Code requirements ○ B149.3 • Components of specific valve trains • Sequence of operation • Supervisory systems
6. Describe flow controllers	• Ratio regulators • Ratio controllers • Limiting orifices • Metering orifices

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

Competency: D3 Plan propane system installations

Objectives

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

- Describe propane storage.
- Describe propane installations.

LEARNING TASKS	CONTENT

1. Describe code requirements for propane storage	• B149.2
	• B149.5
	• Installer responsibility
	• Tank systems
	• Liquid service
	• Bulk tanks
	  ○ Location on the property
	  ○ Site security
	  ○ Valves
	  ○ Accessories
	  ○ Routine maintenance
	• Liquid withdrawal
	• Explosion proof devices
	  ○ Controls
	  ○ Motors
	  ○ Tools
	  ○ Switches

2. Describe the operation of LP vaporizers	• Code requirements
	  ○ B149.1
	  ○ B149.2
	• Types
	  ○ Direct fired
	  ○ Indirect fired
	  ○ Tank heaters
	• Sizing
	  ○ Applications
	  ○ Loads
	• Capacity
	• Location
	• Piping arrangements
	• Safety controls
	• Routine maintenance

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 special venting.
- Select mechanical draft control systems.

LEARNING TASKS	CONTENT

1. Describe venting systems	• Mechanical
	  ○ Induced
	  ○ Forced
	  ○ Appliance manufacturer's specifications
	  ○ Vent pressures
	• Natural draft
	  ○ Appliance manufacturer's specifications
	  ○ Vent pressures

2. Size special venting	• Engineering
	• Codes
	  ○ B149.1
	  ○ National Building Code
	• Design registry
	• Manufacturer's literature
	• Types
	  ○ Mechanical
	  ○ Natural draft
	  ○ Common venting

3. Select mechanical draft control systems	• Damper locations • Damper sizes • Damper types • Fan types • Fan locations • Control types • Control integration • Instrumentation • Design considerations

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 air supply systems for combined appliance inputs exceeding 400 MBH.

LEARNING TASKS	CONTENT

1. Describe combustion air supply	• Passive air supply
	• Mechanical air supply
	• Direct/indirect air supply
	• Code requirements
	• Openings
	• Ducts
	• Dampers
	• Louvres
	• Actuators
	• Combustion air heaters
	• Heat recovery systems
	• Controls
	  ○ Interlocks
	  ○ Pressure differential switches
	  ○ Permissives

2. Size passive air supply for combined appliance inputs exceeding 400 MBH	• Code requirements
	• Building envelope and construction
	• Category of the appliance
	• Draft control
	  ○ Dilution air requirements
	• Air requirement calculations
	  ○ Combustion
	  ○ Ventilation
	  ○ Flue gas dilution
	• Grills and louvers
	  ○ Types
	  ○ K factor
	  ○ Sizing
	  ○ Free area calculations
	  ○ Terminations
	• Air ducts
	  ○ Length
	  ○ Size

LEARNING TASKS

3. Size mechanical air supply for combined appliance inputs exceeding 400 MBH

CONTENT

- Code requirements
- Building envelope and construction
- Category of the appliance
- Grills and louvers
    - Types
    - K factor
    - Sizing
    - Free area calculations
    - Terminations
- Air ducts
    - Sizes
    - Location
    - Lengths
    - Fittings
- Fans
    - Types
    - Location
- Engineered systems
- Manufacturer's literature
- Psychometric characteristics and charts
- Air quality characteristics

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 ICI appliances.

LEARNING TASKS

1. Describe ICI gas-fired appliances

CONTENT

- Types
  - Air curtains
  - Hot water boosters
  - Boilers
- Fire tube
  - Vertical
  - Horizontal
- Water tube
  - Commercial
    - Flex tube
  - Industrial
    - A type
    - D type
    - O type
  - Commercial cooking equipment
  - Commercial clothes dryers
  - Industrial dryers
  - Construction heaters
  - Catalytic heaters
  - Carbon dioxide generators
  - Domestic service water heaters
  - Direct fired make-up air units
  - Indirect fired make-up air heaters
  - Incinerators
  - Vapourizers
  - Pressure boosters
  - Roof-top units
  - Thermal oxidizers
- Characteristics
  - Appliance design
  - Direct-fired
  - Indirect-fired
- Applications
- Approval agencies

LEARNING TASKS

2. Describe selection criteria for gas-fired appliances

CONTENT

- Project engineered specifications
- External static pressures
  - Air flow requirement
  - Duct resistance
- Code and Regulation requirements
- Manufacturers' specifications
  - Rating plate requirements
  - Clearances
  - Site preparation
  - Altitude rating
- Appliance sizing
  - Appliance input
  - Appliance output
  - Appliance efficiencies
  - Thermal efficiencies
- 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:

- Select mechanical ICI burners.

LEARNING TASKS	CONTENT

1. Select mechanical ICI burners	• Characteristics
	  ○ Flame retention
	  ○ Fuel-air ratio
	  ○ Flame profile
	• Types
	  ○ Pre-mix
	  ○ Diffusion
	  ○ Nozzle mix
	  ○ Chamber mix
	  ○ Forced draft
	  ○ Fan assisted
	  ○ Immersion
	• Parts
	• Operation
	  ○ Turn down ratio
	• Applications
	• Manufacturer's specifications
	• Control systems
	  ○ Fuel/air adjustments
	  ○ Linkage less

2. Describe proportional mixers	• Fuel-air ratios • Adjustments • Zero governors

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 safeguard systems.

LEARNING TASKS	CONTENT

1. Select flame detectors	• Flame rectification (flame rod)
	• Optical
	  ○ IR
	  ○ UV
	  ○ Self-checking
	• Pilot types
	  ○ Continuous
	  ○ Intermittent
	  ○ Interrupted
	• Applications
	  ○ Burner types
	  ○ Appliance types
	  ○ Effects of NOx control
	• Code requirements

2. Select ignition systems	• Pilot
	  ○ Continuous
	  ○ Intermittent
	  ○ Interrupted
	• Direct spark ignition (DSI)
	• Code requirements

3. Select flame safeguards	• Common manufacturers
	  ○ Honeywell
	  ○ Fireye
	  ○ Siemens
	• Wiring diagrams
	• Sequence of operation
	• Applications
	• Component compatibility
	• System compatibility
	• Conversions
	• Code requirements

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:

- Select combustion, safety and operating controls.

LEARNING TASKS	CONTENT
1. Describe permissives, limits and interlocks	• Permissives • Limits • Run interlock • Pre-ignition interlock • Pre-purge interlock • Low fire start interlock

2. Select permissives, limits and interlocks	• Types
	  ○ Temperature switches
	  ○ BAS contacts
	  ○ Pressure switches
	  ○ External interlocks
	  ○ Flow switches
	  ○ Liquid level switches
	  ○ End switches
	  ○ Temperature switches
	  ○ Flow switches
	  ○ PID loop controllers
	  ○ Air proving switches
	  ○ Proof of Closure (POC)
	• Applications
	• Code and regulations

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:

- Select electrical components.

LEARNING TASKS

1. Select electrical components

CONTENT

- Types
  - Transformers
  - Relays
    - Solid state
    - Electro-mechanical
  - Motor starters
  - Pumps
  - Solenoids
  - Solenoid valves
  - Actuators
  - Capacitors
  - Power supply
  - UPS
  - Overloads
  - Fuses
- Applications
- Code requirements
- Manufacturer's specifications

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:

- Design and source an ICI fuel supply system from meter set to appliance inlet.

LEARNING TASKS	CONTENT
1. Design piping system	• Layout • Pipe sizing
2. Select materials and equipment	• Pressure regulators • Tools • Piping components • Valves
3. Create documentation	• Piping drawing • Bill of materials • Component specifications • QA checklist • Permit requirements • Hazard assessment

Achievement Criteria

Performance

The learner will be able to:

- Design and source an ICI fuel supply system from meter set to appliance inlet.

Conditions

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

- Installation parameters
  - Gas meter pressure
  - Appliance input
  - Burner type
  - Architectural drawings

Criteria

The learner will be evaluated on:

- Code compliance
- Manufacturer's specification compliance
- Device selection
- Documentation
  - Permit requirements
  - Sized piping installation drawing
  - Materials list
  - Equipment list
  - Quality assurance (QA)
  - Hazard assessment
  - Labour allocation

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:

- Install gas pressure regulators and valve train components.

LEARNING TASKS	CONTENT
1. Describe the installation of regulator and valve train venting	• Vent attachments • Sizing • Orientation • Termination • Code requirements
2. Describe the installation of sensing lines for zero governors	• Materials • Connection locations • Operating principles

3. Describe the installation of valve actuators and modulated devices	• Butterfly valve overtravel linkage
	• Valve actuators
	  ○ Pneumatic
	  ○ Hydraulic
	  ○ Mechanical
	• Mounting
	• Code requirements
	• Manufacturer's specfications

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E3 Install LPG, LNG and CNG vaporizing and mixing systems

Objectives

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

- Describe the installation of LPG, LNG and CNG storage, vaporizing and mixing systems.

LEARNING TASKS	CONTENT

1. Describe requirements for bulk storage facilities	• Bulk tanks
	  ○ Location on the property
	  ○ Site security
	  ○ Valves
	  ○ Accessories
	• Filling
	  ○ Bulk tanks
	  ○ Pumps
	  ○ Meters
	• Liquefying procedures
	• Cryogenic principles
	• Code requirements
	  ○ B149.2
	  ○ B108

2. Describe the installation of vaporizers	• Code requirements
	• Types
	  ○ Direct fired
	  ○ Indirect fired
	  ○ Tank heaters
	• Sizing
	  ○ Applications
	  ○ Loads
	• Capacity
	• Location
	• Piping arrangements
	• Safety controls
	• Routine maintenance

3. Describe the installation of dispensing systems	• Code requirements • Components • Metering • Manufacturer's specifcations • Handling/safety procedures • Process flow diagrams • Over pressure protection • Excess flow protection

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:

- Install ICI venting systems.

LEARNING TASKS	CONTENT

1. Describe installation of type A venting materials	• Components
	  ○ Fittings
	  ○ Terminations
	  ○ Condensate collection
	  ○ Fire stopping
	  ○ Supports
	• Assembly
	  ○ Gaskets
	  ○ Mechanical fasteners and clamps
	  ○ Sealants
	• Code requirements
	• Grade/Slope

2. Describe the installation of mechanical venting systems	• Forced
	• Induced
	• Materials
	• Components
	  ○ Fittings
	  ○ Terminations
	  ○ Condensate collection
	  ○ Fire stopping
	  ○ Supports
	  ○ Wall and ceiling penatrations
	• Assembly
	  ○ Gaskets
	  ○ Mechanical fasteners and clamps
	  ○ Sealants and lubricants
	  ○ Glues and primers
	• Code requirements
	• Grade/Slope

3. Describe the installation of ancillary venting equipment	• Manufacturer's specfications
	• Heat reclaimers
	  ○ Economizers
	  ○ Feed water heaters
	  ○ Indirect on-demand heat recovery
	• CO_2 generation

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:

- Install combustion and ventilation air supply for ICI systems.

LEARNING TASKS	CONTENT

1. Install passive combustion and ventilation air supply for ICI systems	• Code requirements
	• Structural penetrations
	• Sealing
	• Opening and ducts
	  ○ Terminations
	  ○ Mechanical dampers
	  ○ Interlocks

2. Install mechanical combustion and ventilation air supply for ICI systems	• Code requirements
	• Structural penetrations
	• Sealing
	• Opening and ducts
	  ○ Terminations
	  ○ Mechanical dampers
	  ○ Interlocks
	• Fans/blowers
	• Controls

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:

- Install draft control systems.

LEARNING TASKS	CONTENT
1. Describe the installation of draft control dampers	• Types • Actuators • Linkages • Controls and instrumentation • Locations • Codes and regulations • Approvals
2. Describe the installation of draft control fans	• Types • Controls and instrumentation • Locations • Codes and regulations • Approvals

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E8 Install flame safeguards

Objectives

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

- Install ICI flame safeguards.

LEARNING TASKS	CONTENT

1. Describe the installation of ICI flame safeguards	• Manufacturer's specfications
	• Mounting
	• Wiring diagram updates
	• Wiring practices
	• Wire labelling
	• Operating conditions
	• Applications
	• Component compatibility
	• System compatibility
	• Conversions/upgrades
	• Code requirements
	• Static discharge
	• Regulatory requirements
	  ○ Approvals
	  ○ Design registry

Achievement Criteria

Performance	The learner will be able to: • Wire a flame safeguard
Conditions	To be assessed during technical training. The learner will be given conditions as noted from: • C2 – Use electrical wiring diagrams and schematics: wiring diagram • Flame safeguard • Tools and equipment
Criteria	The learner will be evaluated on: • Accuracy to the diagram • Wiring techniques • Neatness • Functionality

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E9 Install combustion, safety and operating controls

Objectives

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

- Install combustion, safety and operating controls.

LEARNING TASKS

1. Describe the installation of combustion, safety and operating controls

CONTENT

- Manufacturer's specfications
- Mounting
- Wiring diagram updates
- Wiring practices
- Wire labelling
- Operating conditions
- Applications
- Component compatibility
- System compatibility
- Conversions/upgrades
- Code requirements
- Static discharge
- Regulatory requirements
    - Approvals
    - Design registry

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 ICI boilers.

LEARNING TASKS	CONTENT

1. Install hot water boilers	• Seismic restraint
	• Expansion/contraction
	• Placement considerations
	  ○ Venting
	  ○ Air supply
	  ○ Access
	  ○ Electrical
	  – Clearance
	  – Isolation switches
	  ○ Clearance
	  ○ Manufacturer's specifications
	  ○ Codes
	  ○ Drainage
	  ○ Water supply
	• Materials
	• Ancillary equipment
	  ○ Valves
	  – Zone
	  – Mixing
	  – Diverting
	  – Isolation
	  – Dead boiler drain
	  – Flow control/balancing
	  – Vacuum reliefs
	  – Safety relief
	  ○ Circulators
	  ○ Expansion tanks
	  ○ Water treatment
	  – Pot feeder
	  – Filtration
	• Regulatory requirements
	  ○ Approvals
	  ○ Design registry
	• Inspect for shipping damage

2. Install steam boilers	• Seismic restraint • Expansion/contraction

LEARNING TASKS

CONTENT

- Placement considerations
  - Venting
  - Air supply
  - Access
  - Electrical
    - Clearance
    - Isolation switches
  - Clearance
  - Manufacturer's specifications
  - Codes
  - Drainage
  - Water supply
- Materials
- Ancillary equipment
  - Flow meters
  - Valves
    - Isolation
    - Dead boiler drain
    - Vacuum reliefs
    - Blow down
    - Safety relief
  - Condensate return system
    - Tanks
    - Traps
    - Pumps
    - Hot wells
  - Feed water system
    - Pumps
    - Economizers
    - Feed water heater
    - Controls
    - Valves
    - Deaerator/feed water tanks
  - Water treatment
    - Softeners
    - Chemicals
    - Conductivity
- Regulatory requirements
  - Approvals
  - Design registry
- Inspect for shipping damage

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 fuel and air delivery systems.

LEARNING TASKS	CONTENT
1. Pressure test piping systems	• Inert gas calculations

2. Purge gas pipe 4-inch diameter and larger	• Code requirements
	• Inert gases
	• Applications
	• Purpose
	• Engineered practices
	• Equipment
	  ○ Approved burners
	  ○ Gauges
	  ○ Regulators
	• Calculations
	  ○ Pressure
	  ○ Velocity
	  ○ Purge
	  ○ Volume
	• Gasification
	  ○ Flaring

3. Commission regulators	• Droop • Lock up pressure • Inlet pressure • Downstream set point pressure • Location of test gauges • Codes • Manufacturer's specifications of equipment • Commissioning report

4. Size burner orifices	• Types of fuel gases
	• Calculations
	  ○ Orifice flow formula
	  ○ Fuel gas conversions

5. Troubleshoot direct operated regulators	• Terminology • Operating principles • Applications • Freeze ups

LEARNING TASKS	CONTENT
	• Cycling • High lockup pressure • Venting • Creeping • Hunting

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

Competency: F4 Perform combustion analysis

Objectives

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

- Perform combustion analysis and adjustments.

LEARNING TASKS	CONTENT

1. Perform flue gas analysis	• Analyzer calibration
	• Fuel selection
	• Sampling locations
	• Manufacturer's documentation
	• Burner specifications
	  ○ Acceptable range
	  – CO_2
	  – O_2
	  – CO
	  – Temperature
	  – Stack draft
	  – Efficiency
	• Required adjustments
	• Data storage
	  ○ Printed results
	  ○ Electronic spreadsheet

2. Perform linkage adjustments	• Drive motors
	  ○ Stroke
	• Linkage hardware
	  ○ Jack shaft
	  ○ Drive levers
	  ○ Driven levers
	  ○ Over-travel linkage
	  ○ Ratios

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

Competency: G8 Repair and replace furnace refractory

Objectives

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

- Repair and replace furnace refractory.

LEARNING TASKS	CONTENT

1. Describe refractory	• Safety
	  ○ WHMIS
	  ○ PPE
	  ○ Exposure
	  ○ Health risks
	  ○ Hazard material testing
	  ○ Abatement
	• Types
	  ○ Castable
	  ○ Pre-cast
	  ○ Inswool moldable
	  ○ Blanket
	  – Refractory ceramic fibre (RCF)
	  – Super wool
	  ○ Board
	  ○ Bedding compounds
	  ○ 2-part liquid activated (Thermbond™)
	• Maintenance
	  ○ Wash coating compounds
	  ○ Patching compounds

2. Describe refractory installation	• Manufacturer's specifications
	• SDS
	• Handling
	  ○ PPE
	  ○ Mixing
	  ○ Cutting
	  ○ Placement
	  ○ Disposal
	• Curing

Level 2

Gasfitter – Class A

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:

- Describe the operation of Meggers.

LEARNING TASKS	CONTENT
1. Describe Meggers	• Operation • Application

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:

- Describe design registry.

LEARNING TASKS

1. Describe design registry

CONTENT

- Maintain design approvals
  - Manufacturer
  - Certifying bodies
    - CSA
    - ULC
- Regulatory requirements
  - Technical Safety BC
- Submittals
  - Drawings
  - Wiring diagrams
  - Control narratives
  - Programs

Line (GAC): B APPLY FUNDAMENTALS OF GAS UTILIZATION

Competency: B2 Apply combustion theory

Objectives

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

- Describe the control of combustion emissions.

LEARNING TASKS

1. Describe the control of combustion emissions

CONTENT

- Thermal NOx
  - Flue gas recirculation (FGR)
    - Internal
    - External
  - Flame quenching
  - Flame staging
  - Selective catalytic reduction
  - Selective non-catalytic reduction
- Photolysis of nitrogen oxide (Smog)
  - Ozone
  - VOC
- CO
  - Excess air
  - Refractory
  - Burner components

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:

- Describe PLC ladder logic.
- Describe SAMA drawings.

LEARNING TASKS	CONTENT

1. Describe PLC ladder logic	• Inputs
	• Outputs
	• Variables
	• PID loops
	• Scaling
	  ○ Zero
	  ○ Span

2. Describe SAMA drawings	• Symbols • PID controller • Process variables • Single loop control • Dual-element level control • Three-element drum level control • Logic diagram

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:

- Configure communication and networking devices.

LEARNING TASKS	CONTENT

1. Describe the features and limitations of communication protocols	• Types of protocols
	  ○ RS232
	  ○ RS422/485
	  ○ MODBUS
	  ○ BACnet MSTP
	  ○ BACnet IP
	  ○ Metasys N2
	  ○ Local Operation Network (LON)
	  ○ Device Net
	  ○ Highway Addressable Remote Transducer (HART)
	  ○ Spread spectrum
	  ○ Ethernet TCP/IP
	• Addressing methods and components
	• Potential sources of interference

2. Configure communication and networking devices	• Integration software • Pinging • IP addressing • Communication/transfer to BAS • WiFi

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:

- Select oil valve train components.

LEARNING TASKS	CONTENT

1. Describe oil pressure control	• Components
	  ○ Pressure reducing valves
	  ○ Bypass valves
	  ○ Orifices
	  ○ Pumps
	• Applications
	• Fuel supply system

2. Describe oil valve train components	• Certification
	• Types
	  ○ Safety shut-off valves
	  ○ Firing valves
	  ○ Modulating valves
	  ○ Latch valves
	  ○ Pressure switches
	  ○ End/limit switches
	  ○ Actuators
	  ○ Solenoids
	  ○ Bypass valves
	  ○ Relief valves
	  ○ Filters
	  ○ Air compressor
	  ○ Pumps
	  ○ Orifices
	  ○ Nozzles
	  ○ Metering orifices
	  ○ Fuel heaters
	• Ratings
	• Enclosures
	• Component parts
	• Component operation

3. Describe oil valve train operation	• Code requirements
	• Components of specific valve trains
	• Fuel atomization
	  ○ Pressure
	  ○ Air
	  ○ Steam
	• Sequence of operation
	• Supervisory systems

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:

- Select control point instrumentation.

LEARNING TASKS

1. Select control point instrumentation

CONTENT

- RTD
- Pressure transducers
- Flow meters
- Thermistors
- O_2 sensors
- PID controls
- Combustion control system
- BAS
- Lead lag
- Interface devices
- Actuators
- Communication interface
- Communication protocols
- BMS

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:

- Integrate automation and instrumentation controls.

LEARNING TASKS	CONTENT

1. Integrate automation and instrumentation controls	• Electrical diagrams
	• Component specifications
	  ○ Flame safeguards
	  ○ Draft control
	  ○ Communication
	  ○ Combustion control
	  ○ PID loop control

Achievement Criteria

Performance	The learner will be able to integrate automation and instrumentation controls.
Conditions	To be assessed during technical training. The learner will be given: • Wiring diagram • Control device specifications

Criteria	The learner will be evaluated on:
	• Updated wiring diagram
	  ○ Code compliance
	  ○ Completeness
	  ○ Accuracy
	  ○ Neatness

Line (GAC): E INSTALL GAS-FIRED SYSTEMS

Competency: E7 Install burners

Objectives

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

- Install ICI burners.

LEARNING TASKS

1. Describe the installation of ICI burners

CONTENT

- Sealing
- Support
- Manufacturer's specifications
- Refractory
- Wiring
- Mounting
- Approvals
    - Design registry
    - Permits

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:

- Install automation and instrumentation control systems.

LEARNING TASKS	CONTENT

1. Describe the installation of automation and instrumentation control systems	• Manufacturer's specfications
	• Mounting
	• Wiring diagram updates
	• Wiring practices
	• Wire labelling
	• Operating conditions
	• Applications
	• Component compatibility
	• System compatibility
	• Code requirements
	• Static discharge
	• Regulatory requirements
	  ○ Approvals
	  ○ Design registry

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 ICI air heating appliances.

LEARNING TASKS

1. Install ICI air heating appliances

CONTENT

- Types
  - Furnaces
  - Process burners
    - Air driers
    - Kilns
    - Paint driers
    - Food processing
  - Direct-fired make-up air heaters
  - Indirect make-up air heaters
  - Atmosphere generators
- Mounting
- Seismic restraint
- Placement considerations
  - Venting
  - Ducting
- Vibration isolation
- Zoning
- Air balancing systems
- Clearance
- Manufacturer's specifications
- Condensate management
  - Neutralizing tanks
  - Pumps
- Materials
- Ancillary equipment
  - Humidifiers
  - Heat exchangers
  - Filtration
  - Dampers
- Regulatory requirements
  - Approvals
  - Design registry
- Inspect for shipping damage

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 fuel/air delivery systems.

LEARNING TASKS	CONTENT

1. Commission appliance fuel valve train components	• Types
	  ○ Fuel gases
	  ○ Fuel oils
	• Valve actuators
	  ○ Pneumatic
	  ○ Hydraulic
	  ○ Mechanical
	• Safety shut-off valve (SSOV) tightness of closure
	• Vent valve operation
	• Test firing valve operation
	• Supervisory system operation
	• Valve proving systems (VPS)
	• Appliance gas regulators
	• Over pressure protection
	• Pressure switch adjustments
	• Instrumentation
	• Filters
	• Oil pressure regulators
	• Fuel supply
	  ○ Single pipe system
	  ○ Dual pipe system
	  – Bypass system

2. Commission pilot operated regulators	• Performance characteristics
	  ○ Pilot adjustments
	  ○ Droop
	  ○ Lock up pressure
	  ○ Inlet pressure
	  ○ Downstream set point pressure
	  ○ Reaction time
	• Codes
	• Manufacturer's specifications

3. Commission ICI gas burners	• Fuel flow adjustments
	  ○ Pressure regulator
	  ○ Flow valve

LEARNING TASKS

CONTENT

- Zero governor
- Air flow adjustments
  - Fan speeds
  - Dampers
  - Primary
  - Secondary
- Draft adjustments
  - Dampers
  - Controls
- Flue gas recirculation
  - Fan speeds
  - Dampers
- Regulatory requirements
  - Approvals
  - Design registry
  - Permits
- Start-up procedures
- Manufacturers' specifications
- Turn down ratio
- Confirmation of appliance input
- Combustion analysis
- Combustion adjustments
- Fuel conversions
- Troubleshooting
  - Burner pulsations
  - Limits and safeties
  - Stack temperatures
- Commissioning report

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 appliance start-up procedures.

LEARNING TASKS

1. Describe appliance start-up procedures

CONTENT

- Job hazard assessment
- Lock-out procedures
- Documentation
  - Commissioning reports
  - Service reports
  - Operation and maintenance manuals
  - Wiring diagrams
  - Flue gas analysis
  - Appliance approval
- Regulatory requirements
  - Permits
  - Product approval
  - Field inspections
- Pre-start-up inspection
  - Internals
  - Damage
  - Gaskets and seals
  - Panels
  - Wiring connections
  - Mechanical components
  - Code compliance
  - Safety relief valves
- System connections
  - Fuel piping
  - Venting
  - Ducting
  - Electrical
  - Controls
  - Water
  - Load piping
  - Steam
- Electrical ratings
- Tightness of electrical connections
- Belt/pulley alignment
- Valve tightness test

LEARNING TASKS	CONTENT

2. Commission flame safeguards	• Remove shipping materials
	• Energize system
	  ○ Electrical
	  ○ Pumps
	  ○ Fans
	  ○ Blowers
	  ○ Fuel
	• Motor rotation
	• Code compliance
	• Manufacturer's specifications
	• Site configurable settings and adjustments
	• Static check out
	• First cycle, test firing valves closed
	• Purge time
	• Spark interference test
	• Pilot trial for ignition
	• Flame signal
	• Flame failure response time
	• Lock-out (pilot)
	• Main trial for ignition
	• Pilot turn down test
	• Dynamic self check

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

Competency: F3 Interpret gas metering devices

Objectives

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

- Use gas metering devices.

LEARNING TASKS	CONTENT

1. Describe gas meters	• Types
	  ○ Positive displacement
	  – Bellows
	  – Rotary piston
	  – Rotary vane
	  ○ Inferential meter
	  – Ultrasonic
	  – Turbine
	  – Vortex shedding
	  – Pitot/pitot static tube
	  – Venturi
	• Principles of operation
	• Capacity
	• Pressure compensation
	• Reading
	  ○ Test dials
	  ○ Imperial
	  ○ Metric

2. Use gas metering devices	• Gas meters
	  ○ Clocking formula
	  – Temperature compensation
	  – Pressure compensation
	• Orifice plates
	  ○ Orifice flow formula

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

Competency: F4 Perform combustion analysis

Objectives

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

- Describe testing and emission requirements.

LEARNING TASKS	CONTENT

1. Describe smoke spot testing	• Equipment
	  ○ Manual pump
	  ○ Integrated into analyzer
	• Oil burner smoke scale

2. Describe environmental emissions requirements	• Fuels
	  ○ Fuel gases
	  – Methane
	  – Propane
	  – Digester gas
	  – Manufactured gas
	  – Syngas
	  ○ Fuel oils
	• Federal
	• Provincial
	• Regional
	• Permits
	• Monitoring

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

Competency: F5 Commission boilers and ancillary equipment

Objectives

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

- Commission boilers and ancillary equipment.

LEARNING TASKS	CONTENT

1. Commission boilers	• Boiler documentation
	  ○ Boil out procedures
	  ○ System flush
	  ○ Hydrostatic test
	• System connections
	  ○ Feed water
	  ○ Chemical
	  ○ Safety relief valves
	• Appliance start-up procedures
	• Commission fuel/air delivery system
	• Combustion analysis
	• Program/configure controls

2. Commission ancillary equipment	• Ancillary systems
	  ○ Feed water system
	  – Economizers
	  – Deaerator
	  – Hot well
	  ○ Pumps
	  ○ Condensate return system
	  ○ Heat recovery system
	  ○ Blow down system
	  ○ Heat exchangers
	• Inspection
	• Adjustments
	• Verification operation
	• Documentation

Achievement Criteria

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

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

Competency: F6 Commission direct-fired make-up air heaters

Objectives

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

- Commission direct-fired make-up air heaters.

LEARNING TASKS	CONTENT

1. Commission direct-fired make-up air heaters	• Documentation
	  ○ Engineering design
	  ○ Product approval
	  ○ Air balancing
	• System connections
	  ○ Ducting
	  ○ Exhaust systems
	• Appliance start-up procedures
	• Commission fuel/air delivery system
	• Combustion analysis
	• Program/configure controls
	  ○ Interlocks
	• Temperature rise
	• External static pressures

2. Perform DFMA calculations	• Input
	• Turn down ratio
	• Velocity
	• Volume
	• Area
	• Profile plates
	  ○ Gross opening
	  ○ Net opening
	• CO_2 ppm

Achievement Criteria

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

Line (GAC): 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 furnaces and ovens.

LEARNING TASKS

1. Commission furnaces and ovens

CONTENT

- Documentation
  - Engineering design
  - Product approval
- System connections
  - Ducting
  - Exhaust systems
- Appliance start-up procedures
- Commission fuel/air delivery system
- Combustion analysis
- Program/configure controls
- Temperature rise
- External static pressures
- Processes
  - Air heating
  - Curing
  - Drying
  - Atmospheric generation
    - Scrubbers

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 temperature, pressure and operating controls.

LEARNING TASKS	CONTENT

1. Program controls	• Configure devices
	• Set point adjustments
	  ○ PID loop tuning
	  ○ Auto tuning
	  ○ Manual adjustments
	• System demands
	  ○ Burner cycling
	  ○ Pressure requirements
	  ○ Temperature requirements
	  ○ Operating efficiency
	• Verify operating conditions
	  ○ Manufacturer's specifications
	  ○ Process design specifications
	  ○ Sensor calibration confirmation
	• Documentation
	  ○ Calibration certificates
	  ○ Record parameters

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

Competency: F9 Program combustion control systems

Objectives

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

- Program combustion control systems.

LEARNING TASKS

1. Program combustion controls

CONTENT

- Configure devices
- Configure servo-motors
- Confirm mechanical operation
  - Fuel valves
  - FGR dampers
  - Air dampers
  - Secondary fuel
- Plot combustion curve
  - Set light off position
  - Set and confirm low fire position
  - Set and confirm intermediate points
    - Set O_2 trim points
    - Set NOx points
  - Set and confirm high fire position
- Verify operating conditions
  - Manufacturer's specifications
  - Sensor calibration confirmation
- Documentation
  - Calibration certificates
  - Record parameters

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

Competency: F10 Program PLCs

Objectives

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

- Describe the operation of PLCs.

LEARNING TASKS	CONTENT
1. Describe PLCs	• CPU • Memory organization • Input interface • Output interface • Power supply • Programming/monitoring interface • Data table • Use program
2. Describe PLC ladder logic	• Types of programming languages • Relay ladder logic instructions • Output energize instruction • Examine if on instruction (XIC) • Examine if off instruction (XIO) • Latching and unlatching instructions • Internal relay instructions • Time and counter instructions
3. Describe the interaction of hardware and software	• Effects of input status on input image tables • Program logic scanning sequence • True-false instruction status • Control of program over output image tables • Effect of output image tables on output devices • Fail-safe wiring practices

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:

- Commission draft control systems.

LEARNING TASKS

1. Commission draft control systems

CONTENT

- Documentation
  - Engineering design
  - Product approval
  - Appliance design specifications
- Permits
- Code requirements
- Configure hardware
- Configure control points
- System integration

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:

- Describe training and handover of gas-fired equipment.

LEARNING TASKS	CONTENT

1. Transfer documentation	• Regulatory responsibilities
	• Operator manuals
	• As-built diagrams
	  ○ Wiring
	  ○ Mechanical
	  ○ P&ID

2. Describe appliance end user training	• Liability
	  ○ Contractor
	  ○ Fitter
	  ○ Owner
	  ○ Operator
	• Systems maintenance instructions
	  ○ Commissioning
	  ○ Owner's operation manual
	• Training
	  ○ Maintenance
	  – Daily
	  – Weekly
	  – Monthly
	  – Annually
	  ○ Features and functions
	  ○ Configuration
	  ○ Daily operation
	  ○ Operator interface
	  – Adjust set points
	  ○ System operation overview
	  ○ Documentation
	  – Maintenance records
	  – Log books
	  – Chemical reports
	  – Trend logs

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 maintenance of small gas utilities.

LEARNING TASKS	CONTENT

1. Describe the maintenance of small gas utilities	• Regulatory requirements
	• Changes
	  ○ Operating conditions
	  ○ Procedures
	  ○ Maps
	  ○ Drawings
	  ○ Plans
	• Cathodic protection system design and performance
	• Inspection, testing and monitoring records (corrosion control record, device control, leak detection)
	• Evaluation of testing and inspection
	• Repair and modification
	• Incidents and failure records and investigation
	• Records of deactivation

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

Competency: G2 Service gas burners and ancillary equipment

Objectives

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

- Describe servicing gas burners and ancillary equipment.

LEARNING TASKS

1. Describe the procedures for servicing gas burners

CONTENT

- Service schedule
- Inspection
  - Appearance
  - Performance
  - Signs of flame impingement
  - Sooting
  - Components
    - Distortion
    - Heat stress
    - Mechanical damage
    - Deterioration
    - Cracks
    - Water damage
    - Leaks
      - Water
      - Fuel oil
      - Fuel gas
- Ignition electrode
  - Inspection of ceramic
  - Gap to ground
  - Surface contaminants
  - Placement
- Flame rod
  - Inspection of ceramic
  - Placement
  - Surface contaminants
  - Short to ground check
- Flame signal reading
- Cleaning
- Reassembly
- Recommission
  - Firing
  - Clocking
  - Combustion analysis
- Documentation
  - Confirmation of operation
  - Manufacturer's specifications

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

Competency: G3 Maintain boilers and ancillary equipment

Objectives

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

- Escribe maintaining boilers and ancillary equipment.

LEARNING TASKS	CONTENT

1. Describe the maintenance of boilers	• Regulatory requirements
	• Boiler safety officer engagement
	• Pressure vessel integrity
	  ○ Hydrostatic test
	  ○ NDT testing (if required)
	• Safety relief valves
	  ○ Replace
	  ○ Recertify
	• Inspection
	  ○ Venting system
	  ○ Burner
	  ○ Refractory
	  ○ Heat exchanger
	  – Water side
	  ○ Engage water treatment specialist
	  – Fire side
	• Replace consumable OEM parts

2. Describe the maintenance of ancillary equipment	• Diagnostics
	  ○ Visual inspection
	  ○ Electrical parameters
	  ○ Temperatures
	  ○ Pressures
	  ○ Flow rates
	  ○ Manufacturer's specfications
	  ○ Vibration
	• Pumps
	• Expansion tank
	• Feed water supply systems
	• Blow down heat recovery
	• Fans
	• Valves/traps/strainers
	• Flue gas exhaust systems

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 maintaining gas-fired appliances.

LEARNING TASKS	CONTENT

1. Describe the maintenance of gas-fired appliances	• Regulatory requirements
	• Inspection
	  ○ Heat exchanger
	  ○ Venting system
	  ○ Burner
	  ○ Refractory
	  ○ Pumps
	  ○ Fans
	  ○ Valves
	  ○ Flue gas exhaust systems
	  ○ Combustion air fans
	• Replace consumable OEM parts
	• Diagnostics
	  ○ Visual inspection
	  ○ Electrical parameters
	  ○ Temperatures
	  ○ Pressures
	  ○ Flow rates
	  ○ Manufacturer's specfications
	  ○ Vibration

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 maintaining gas-fired refrigeration equipment.

LEARNING TASKS	CONTENT
1. Describe the refrigeration process of gas-fired appliances	• Terminology • Adsorption refrigeration • Safety
2. Describe troubleshooting procedures	• Heat input • Venting • Annual maintenance
3. Describe maintenance procedures	• Burner cleaning • Orifice cleaning • Manifold pressure • Heat exchanger cleaning • Flue gas passages • Ignition system • Load conditions • Condenser cleaning

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

Competency: G6 Service fuel/air delivery systems

Objectives

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

- Describe servicing fuel/air delivery systems.

LEARNING TASKS	CONTENT

1. Describe the servicing of fuel delivery systems	• Gas pressure regulators
	  ○ Soft seating components
	  ○ Over pressure protection
	  ○ OEM rebuild kits
	  ○ Levers and linkages
	  ○ Guides
	  ○ Strainers/filters
	• Lubricated plug valves
	  ○ OEM lubricant
	  ○ Lubrication procedures
	  ○ Rebuild procedures
	• Safety shut off valves
	  ○ Tightness of closure
	  ○ Rebuild kits
	  ○ Replacement
	  ○ Hydraulic oil
	• Cams and linkages
	  ○ Lubrication
	  ○ Cleaning
	  ○ Bearings
	  ○ Inspection
	• Motors
	  ○ Bearings
	  ○ Lubrication
	  ○ Electrical ratings

2. Describe the servicing of air delivery systems	• Blowers
	  ○ Bearings
	  ○ Lubrication
	• Valves
	  ○ OEM lubricant
	  ○ Lubrication procedures
	  ○ Rebuild procedures
	• Pressure switches
	  ○ Verify operation
	  ○ Clean

LEARNING TASKS	CONTENT

	• Motors
	  ○ Bearings
	  ○ Lubrication
	  ○ Electrical ratings
	• Linkages
	  ○ Lubrication
	  ○ Cleaning
	  ○ Bearings
	  ○ Inspection
	• Sensing line
	  ○ Clean

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:

- Troubleshoot and repair control systems.

LEARNING TASKS

1. Troubleshoot and repair control systems

CONTENT

- Motor control operation
  - Input power
  - Communication
  - Controller
  - Verify windings
  - Sequence of operation
  - Environmental conditions
- Relays/mag starters
  - Electrical operation
  - Mechanical operation
  - Contacts
- Wiring housekeeping
  - Terminal identification
  - Neatness
- Circuit boards
  - Inspections
    - Carbon
    - Over-temperature
    - Component distortion
    - Corrosion
    - Oxidization
  - Cleaning
  - Power supply
  - Inputs
  - Outputs
  - Operation
  - Wiring connections
  - Sequence of operation
  - Fault codes
  - Configuration

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 decommissioning and disconnecting gas-fired appliances and equipment.

LEARNING TASKS	CONTENT

1. Describe the decommissioning and disconnection of gas-fired appliances and equipment	• Code requirements
	• Lock-out/tag-out
	• Remove and cap venting
	• Remove and cap distribution system
	  ○ Isolate gas supply
	  ○ Purging procedures
	• Remove and cap ducting
	• Isolate and remove accessories
	• Disconnect and terminate wiring
	• Material disposal
	  ○ Hazards
	  ○ SDS
	  ○ Recyclables
	  ○ Environmental considerations

Section 4

ASSESSMENT GUIDELINES

Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	Gasfitter – Class A LEVEL 1		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	USE COMMON OCCUPATIONAL SKILLS	4%	0%
B	APPLY FUNDAMENTALS OF GAS UTILIZATION	10%	0%
C	APPLY ELECTRICAL CONCEPTS	35%	35%
D	PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS	35%	30%
E	INSTALL GAS-FIRED SYSTEMS	10%	35%
F	COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT	5%	0%
G	MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT	1%	0%
	Total	**100%**	**100%**
In-school theory / practical subject competency weighting		75%	25%
Final in-school percentage score		IN-SCHOOL %	

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

Assessment Guidelines – Level 2

Level 2 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	Gasfitter – Class A LEVEL 2		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	USE COMMON OCCUPATIONAL SKILLS	1%	0%
B	APPLY FUNDAMENTALS OF GAS UTILIZATION	4%	0%
C	APPLY ELECTRICAL CONCEPTS	5%	0%
D	PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS	30%	35%
E	INSTALL GAS-FIRED SYSTEMS	15%	0%
F	COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT	30%	65%
G	MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT	15%	0%
	Total	**100%**	**100%**
In-school theory / practical subject competency weighting		70%	30%
Final in-school percentage score Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal Examination.		IN-SCHOOL %	

All apprentices who complete Level 2 of the Gasfitter – Class A program with a FINAL level percentage score of 70% or greater will write Interprovincial Red Seal Examination.

SkilledTradesBC will enter the apprentices' Gasfitter – Class A Interprovincial Red Seal Examination percentage score into SkilledTradesBC Direct Access.

A minimum percentage score of 70% on each examination is required for a pass.

To obtain a Technical Safety BC Gasfitter – Class A license please see *Appendix A: Technical Safety BC Requirements.*

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

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

Cordless drills
Task lighting equipment

Testing and Measuring Equipment

Clamp-on ammeter
Computer
Electronic Flue gas analyzer
Electronic leak detector
Laser level
Magnahelic gauge
Manometers (incline and digital)
Measuring tape and markers
Multimeter
Megger
Nitrogen bottles and regulators
Signal generator
Spot smoke tester
Gas analyzer for PPM CO_2

Equipment

Direct-fired make-up air heater *(installation to include ability to alter external static pressure)*
ICI steam or hot water boiler *(complete with 1,000 MBH or larger fuller modulating burner. Energy load to permit performing boiler commissioning and combustion analysis with a minimum of burner cycling.)*

Personal Protective and Safety Equipment

Dust mask
Eye wash kit
Face shield
Fire extinguisher
First aid kit
Hearing protection
Lock-out devices

Standard Tools

Adjustable wrench
Ball-peen hammer
Combination wrench
Electrical knock out sets
Feeler gauges
Fuse puller
Files
Flashlight
Hacksaw
Hex Keys (set), metric and imperial
Knife
Levels
Nut drivers
Orifice drill sets
Pipe wrench
Pliers (lineman, needle nose, pump pliers)
Screwdrivers (complete set)
Socket set (imperial and metric)
Side cutters
Step drill bits
Tap and die sets
Wire crimpers
Wire brushes
Wire strippers

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 B149.3 current
- CAN/ CSA C22.1 current
- Safety Standards General Regulations
- Gas Safety Regulations

Recommended Resources

- 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
- CSA Gas Trade Training Modules, ISBN 978-1-4883-0127-8
- 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 B51 (current) Boiler Pressure Vessel and Pressure Piping Code
- CAN/ CSA B108 (current) Natural Gas Refuelling Stations Installation Code
- CSD-1(current) Controls and Safety Devices for Automatically Fired Boilers
- Design of Fluid Systems – Spirax Sarco, ISBN
- Electricity & Controls for HVAC/R – Herman/Sparkman, ISBN 978-1133-2782-07

Suggested Texts/Websites

- CT Johnson – Instrumentation and Controls www.ctjohnson.com/PDF/SAMA.pdf
- Technical Safety BC www.technicalsafetybc.ca
- TECA, Thermal Environmental Comfort Association, www.teca.ca
- SkilledTradesBC www.skilledtradesbc.ca
- CSA, www.csagroup.org
- Red Seal, www.red-seal.ca
- WorkSafeBC, www.worksafebc.com

NOTE:

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

Instructor Requirements

Occupation Qualification

The instructor must possess one of the following:

- Current BC Certificate of Competency/Qualification in Gasfitter - Class A (must obtain Red Seal Endorsement within 2 years of employment as an instructor)
- SkilledTradesBC Certificate of Qualification in Gasfitter – Class A with Red Seal Endorsement
- 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 Gasfitter – Class A. 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
Technical Safety BC Requirements

Gasfitter – Class A Exam administered by Technical Safety BC:

Technical Safety BC will issue the Gasfitter – Class A License once the following criteria have been met:

- *Technical Safety BC Certification Exam – Minimum 70%*
- *SkilledTradesBC Gasfitter – Class A, Certificate of Qualification with Red Seal Endorsement (includes completion of 3,000 work- based training hours)*

Tools and Equipment

(to be used in coordination with the program Tools and Equipment list beginning on page 107)

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
CNG	Compressed natural gas
CPU	Central processing unit
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
LNG	Liquefied natural gas
LON	Local operation network
LPG	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
NDT	Non-destructive testing
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSPS	New Source Performance Standards
NRR	Noise reduction rating number
OEM	Original equipment manufacturer
OH&S	Occupational Health and Safety
OS&Y	Outside stem and yoke (valve)
P&ID	Piping and instrumentation diagram
PLC	Programmable logic controller
PPE	Personal protective equipment
PRV	Pressure reducing valve
PTFI	Pilot trial for ignition
PVC	Programmable logic controller
QA	Quality assurance
RPM	Revolutions per minute
RTD	Resistance temperature detector
SCR	Selective catalytic reduction
SDS	Safety Data Sheet
TDG	Transportation of dangerous goods
TXV	Thermostatic expansion valve
UL	Underwriters Laboratories
ULC	Underwriters Laboratories of Canada
UST	Underground storage tank
VFD	Variable frequency drive
VSD	Variable speed drive
WHMIS	Workplace Hazardous Materials Information System

Appendix C
Previous Contributors

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

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