

SKILLED**TRADES**<sup>BC</sup>

## PROGRAM OUTLINE

Gasfitter – Class B

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# **GASFITTER – CLASS B PROGRAM OUTLINE**

**APPROVED BY INDUSTRY  
SEPTEMBER 2017**

**Developed by  
SkilledTradesBC  
Province of British Columbia**

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# **Section 1**

## **INTRODUCTION**

### **Gasfitter – Class B**

## Foreword

The Gasfitter - Class B Program Outline is intended as a guide for instructors, apprentices, and employers of apprentices as well as for the use of industry organizations, regulatory bodies, and provincial and federal governments. It reflects updated standards based on British Columbia industry and instructor subject matter experts.

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

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

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

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

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

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

### Important Program Information:

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

#### SAFETY ADVISORY

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

## Acknowledgements

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

- Michael Pizzolato, Cannepp (Canadian Engineered Products & Sales)
- Richard Doerksen, Apex Steel and Gas
- Glen Ohs, Corix Utilities
- Rob Marchiori, Ram Mechanical
- Ray Bollinger, Just Mechanical
- Shane Richardson, Resilient Plumbing
- Paul Bach, PJB Mechanical
- Kent O'Sullivan, Fortis BC
- Brad Wyatt, Technical Safety BC (formerly known as BC Safety Authority)

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

- Marty Old, TRU
- Brian Sweet, BCIT
- Rick Vanier, PVC
- Glen Ohs, Corix Utilities
- Rob Marchiori, Ram Mechanical
- Richard Doerksen, Apex Steel and Gas
- Michael Pizzolato, Cannepp (Canadian Engineered Products & Sales)
- Carl Kunic, Resilient Plumbing

Industry Subject Matter Experts and Instructors retained as outline reviewers:

- Marty Old, Marty Old Consulting
- Glen Ohs, Corix Utilities
- Brian Sweet, BCIT

Facilitators:

- Angela Caughy

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

## How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

| Section  | Training Providers  | Employers/ Sponsors  | Apprentices   | Challengers  |
|--|---|--|---|--|
| <b>Program Credentialing Model</b>                   | 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  |
| <b>OAC</b>   | 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  |
| <b>Training Topics and Suggested Time Allocation</b> | 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   |
| <b>Program Content</b>                               | Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measurable achievement criteria for objectives with a practical component          | Identifies detailed program content and performance expectations for competencies with a practical component; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice | Provides detailed information on program content and performance expectations for demonstrating competency  | Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels                     |
| <b>Training Provider Standards</b>                   | 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 |



| <b>Section</b>                      | <b>Training Providers</b>   | <b>Employers/ Sponsors</b>  | <b>Apprentices</b>  | <b>Challengers</b>  |
|-------------------------------------|---|---|---|---|
| <b>Assessment Guidelines</b>        | 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 |
| <b>Appendix – Glossary of Terms</b> | Defines program specific terms  | Defines program specific terms  | Defines program specific terms  | Defines program specific terms  |

# **Section 2**

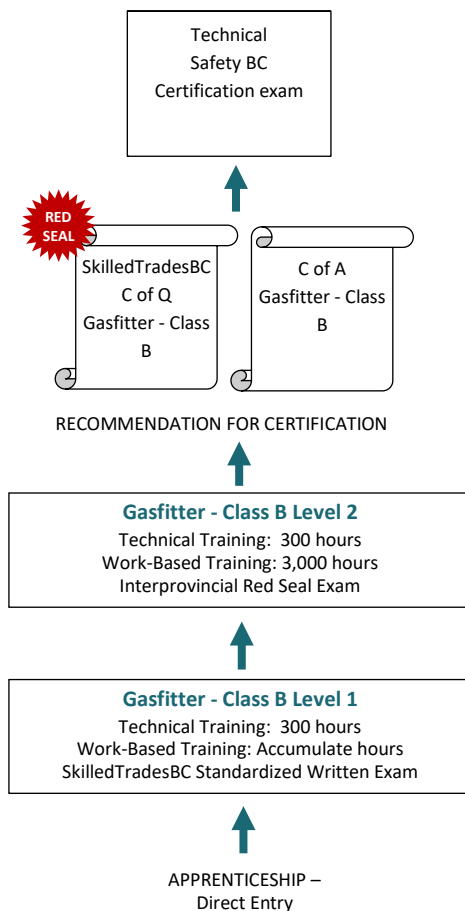
## **PROGRAM OVERVIEW**

### **Gasfitter – Class B**

## Program Credentialing Model

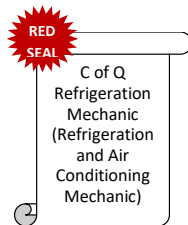
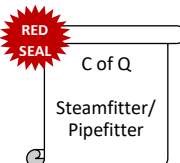
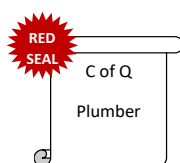
### Gasfitter - Class B

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



#### CROSS-PROGRAM CREDITS

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



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

## Occupational Analysis Chart

### GASFITTER – CLASS B

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

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

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

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

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

## Program Overview

|   |   |  |   |  |   |  |
|---|---|--|---|--|---|--|
|   | <div>Apply wiring practices</div> <div>C7</div> <div>12A-1</div>                  | <div>Troubleshoot electrical circuits</div> <div>C8</div> <div>2A-1</div>                          | <div>Apply communication and networking technology</div> <div>C9</div> <div>2A-1A-2</div>     |  |   |  |
| PLAN GAS-FIRED APPLIANCE SYSTEM INSTALLATIONS | <div>Size piping and tubing systems</div> <div>D1</div> <div>1A-1</div>           | <div>Select regulators, valves, and valve train components</div> <div>D2</div> <div>12A-1A-2</div> | <div>Plan propane system installations</div> <div>D3</div> <div>2A-1</div>                    | <div>Size venting systems</div> <div>D4</div> <div>2A-1</div>                                    | <div>Size air supply systems</div> <div>D5</div> <div>2A-1</div>                                | <div>Select gas-fired appliances</div> <div>D6</div> <div>12A-1</div>                  |
|   | <div>Select burners</div> <div>D7</div> <div>12A-1</div>                          | <div>Select flame safeguards</div> <div>D8</div> <div>12A-1</div>                                  | <div>Select combustion, safety and operating controls</div> <div>D9</div> <div>2A-1</div>     | <div>Select electrical components</div> <div>D10</div> <div>1A-1</div>                           | <div>Select automation and instrumentation control systems</div> <div>D11</div> <div>2A-2</div> | <div>Plan a project</div> <div>D12</div> <div>12A-1A-2</div>                           |
| INSTALL GAS-FIRED SYSTEMS                     | <div>Install piping and tubing systems</div> <div>E1</div> <div>1</div>           | <div>Install regulators, valves, and valve train components</div> <div>E2</div> <div>12A-1</div>   | <div>Install LPG, LNG, CNG, vaporizing and mixing systems</div> <div>E3</div> <div>2A-1</div> | <div>Install venting systems</div> <div>E4</div> <div>2A-1</div>                                 | <div>Install air supply systems</div> <div>E5</div> <div>12A-1</div>                            | <div>Install draft control systems</div> <div>E6</div> <div>2A-1</div>                 |
|   | <div>Install burners</div> <div>E7</div> <div>A-2</div>                           | <div>Install flame safeguards</div> <div>E8</div> <div>A-1</div>                                   | <div>Install combustion, safety and operating controls</div> <div>E9</div> <div>A-1</div>     | <div>Install automation and instrumentation control systems</div> <div>E10</div> <div>2A-2</div> | <div>Install boilers and ancillary equipment</div> <div>E11</div> <div>2A-1</div>               | <div>Install air heating appliances and equipment</div> <div>E12</div> <div>2A-2</div> |
| COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT | <div>Commission fuel/air delivery systems</div> <div>F1</div> <div>12A-1A-2</div> | <div>Perform appliance start-up procedures</div> <div>F2</div> <div>2A-2</div>                     | <div>Interpret gas metering devices</div> <div>F3</div> <div>2A-2</div>                       | <div>Perform combustion analysis</div> <div>F4</div> <div>2A-1A-2</div>                          | <div>Commission boilers and ancillary equipment</div> <div>F5</div> <div>2A-2</div>             | <div>Commission direct-fired make-up air heaters</div> <div>F6</div> <div>A-2</div>    |

|   |          |
|---|----------|
| <p><b>MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT</b></p> | <b>G</b> |
|---|----------|

## Training Topics and Suggested Time Allocation: Level 1

### GASFITTER – CLASS B – LEVEL 1

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

## Training Topics and Suggested Time Allocation: Level 2

### GASFITTER – CLASS B – LEVEL 2

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



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

# **Section 3**

## **PROGRAM CONTENT**

### **Gasfitter – Class B**

# **Level 1**

## **Gasfitter – Class B**

**Line (GAC):        A     USE COMMON OCCUPATIONAL SKILLS**
**Competency:        A1     Control workplace hazards**
**Objectives**

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

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

**LEARNING TASKS**

1. Describe common workplace hazards

**CONTENT**

- Short term hazards
  - Confined space
  - Elevations
  - Electrical
  - Compressed gas
  - Explosive material (dust)
  - Air quality
- Long term hazards
  - Respiratory disease
  - Repetitive strain injuries
  - Hearing loss
  - Chemical exposure
- Constant awareness of surroundings
  - Safe attitude
  - Housekeeping
  - Site conditions

2. Manage workplace hazards

- WHMIS
- TDG
- OHS regulation
- WorkSafe BC standards
- Personal Protective Equipment (PPE)
- Emergency shutoffs
- Fire prevention
- Chemical hazard response
  - Eye wash facilities
  - Emergency shower
- Evacuation plan
  - Marshalling/mustering areas
  - Emergency exits
  - Emergency contact/phone numbers

3. Describe lock-out and tag-out procedures

- Understanding of system operation
- Components requiring lock-out
- Identification requirements

**LEARNING TASKS****CONTENT**

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

**Achievement Criteria – (Workplace)**

|             |   |
|-------------|---|
| Performance | The learner is aware of WHMIS and that it is a required certification.                |
| Conditions  | To be assessed in the workplace.  |
| Criteria    | Tasks must be performed within specifications and time frames acceptable to industry. |

**Line (GAC):           A     USE COMMON OCCUPATIONAL SKILLS**

**Competency:           A2    Use drawings and specifications**

**Objectives**

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

- Interpret drawings and specifications.

**LEARNING TASKS**

1. Describe types of drawings

2. Read drawings

3. Interpret specifications

**CONTENT**

- Isometric
- Orthographic
- Process Flow Diagrams (PFD)
- Piping and Instrumentation Diagrams (P & ID)
- Sectional drawings
- Detail drawings
- Symbols
- Legends
- Scale
- Manufacturer's specifications
  - Appliance rating plates
  - Installation clearances

**Line (GAC):           A     USE COMMON OCCUPATIONAL SKILLS**

**Competency:         A3    Use common tools and access equipment**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

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

**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 pressure measuring tools.
- Interpret pressure readings.
- Use U-tube manometers.
- Use electrical testing meters to test voltage, amperage, resistance, and continuity.

**LEARNING TASKS**
**CONTENT**

- |   |  |
|---|--|
| 1.    Use Pascal's theory of pressure and force | <ul style="list-style-type: none"> <li>• Pounds</li> <li>• Pounds per square inch (psig)</li> <li>• Pascal (Pa)               <ul style="list-style-type: none"> <li>○ KiloPascal (kPa)</li> </ul> </li> <li>• Inches of water column (in WC)</li> <li>• Inches of mercury (in Hg)</li> <li>• Ounces per square inch (OSI)</li> <li>• Bar</li> <li>• Total force</li> </ul>  |
| 2.    Describe pressure measuring tools         | <ul style="list-style-type: none"> <li>• Manometers               <ul style="list-style-type: none"> <li>○ Types                   <ul style="list-style-type: none"> <li>– Digital</li> <li>– Slack tubed</li> <li>– Incline</li> </ul> </li> <li>○ Filing</li> <li>○ Fluids</li> <li>○ Calibration</li> <li>○ Differential</li> </ul> </li> <li>• Mechanical gauges               <ul style="list-style-type: none"> <li>○ Bourdon tube</li> <li>○ Compound                   <ul style="list-style-type: none"> <li>– Magnehelic gauge</li> </ul> </li> </ul> </li> </ul> |
| 3.    Use manometers and mechanical gauges      | <ul style="list-style-type: none"> <li>• Gas pressures               <ul style="list-style-type: none"> <li>○ Standing line pressures</li> <li>○ Operating line pressures</li> <li>○ Gauge pressures</li> <li>○ Absolute pressures</li> <li>○ Conversion between different pressures</li> </ul> </li> <li>• Diagnostics               <ul style="list-style-type: none"> <li>○ Pressure tests</li> <li>○ Leak detection</li> </ul> </li> </ul>   |
| 4.    Interpret pressure readings               | <ul style="list-style-type: none"> <li>• Code B149.1</li> </ul>  |



**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <p>5. Describe temperature measuring instruments</p> <p>6. Use temperature measuring instruments</p> <p>7. Describe electrical testing meters</p> <p>8. Use electrical test meters</p> <p>9. Use combustible gas indicator (CGI)</p> | <ul style="list-style-type: none"> <li>• Manufacturer's specifications</li> <li>• Diagnostics               <ul style="list-style-type: none"> <li>○ Pressure tests</li> <li>○ Leak detection</li> </ul> </li> <li>• Tightness of closure</li> <li>• Thermometer</li> <li>• Pyrometer</li> <li>• Thermocouple</li> <li>• Thermistor</li> <li>• Scales</li> <li>• Calibration</li> <li>• Check readings</li> <li>• Applications</li> <li>• Types               <ul style="list-style-type: none"> <li>○ Multi-meter</li> <li>○ Ammeter</li> <li>○ Ohm-meter</li> <li>○ Volt-meter</li> <li>○ Micro-ammeter</li> <li>○ Milli-ammeter</li> </ul> </li> <li>• Check voltage</li> <li>• Check current</li> <li>• Check resistance</li> <li>• Check for continuity</li> <li>• Types               <ul style="list-style-type: none"> <li>○ Electronic</li> <li>○ Laser</li> <li>○ Draeger</li> <li>○ Flame ionization</li> </ul> </li> <li>• Applications</li> </ul> |
|--|--|

**Line (GAC):           A     USE COMMON OCCUPATIONAL SKILLS**
**Competency:           A5    Use codes, regulations, and standards**
**Objectives**

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

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

**LEARNING TASKS**
**CONTENT**

- |  |   |
|--|---|
| 1. Describe code implications                | <ul style="list-style-type: none"> <li>• Design</li> <li>• Planning</li> <li>• Installation</li> <li>• Maintenance</li> <li>• Decommissioning</li> </ul>  |
| 2. Describe the B149 Gas Code series         | <ul style="list-style-type: none"> <li>• B149.1, B149.2, B149.3</li> <li>• Layout</li> <li>• Sections</li> <li>• Contents</li> <li>• Index</li> <li>• Annexes</li> <li>• Tables</li> <li>• Definitions</li> <li>• Scope</li> <li>• Revisions</li> </ul>   |
| 3. Interpret Sections of the B149.1 Gas Code | <ul style="list-style-type: none"> <li>• Scope</li> <li>• Reference Publications</li> <li>• Definitions</li> <li>• General</li> <li>• Piping and Tubing Systems, Hose, and Fittings</li> <li>• Annexes A &amp; B</li> </ul>   |
| 4. Use Gas Regulations                       | <ul style="list-style-type: none"> <li>• Role of Technical Safety BC (formally known as BC Safety Authority)</li> <li>• Safety Standards Act</li> <li>• Safety Standards General Regulation</li> <li>• Gas Safety Regulation</li> <li>• Permits</li> <li>• Notification of Completion</li> <li>• Approvals</li> <li>• Variations to the National Gas Code</li> <li>• Bulletins, Directives and Safety Orders</li> </ul> |

**Line (GAC):           A     USE COMMON OCCUPATIONAL SKILLS**

**Competency:           A6    Organize work and maintain records**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

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

**Line (GAC):        B    APPLY FUNDAMENTALS OF GAS UTILIZATION**
**Competency:        B1    Apply gas properties**
**Objectives**

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

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

**LEARNING TASKS**
**CONTENT**

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

**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 methods of combustion air supply.
- Calculate air requirements and products of combustion.

## LEARNING TASKS

1. Describe the chemistry of combustion
2. Calculate air requirements and products of combustion

## CONTENT

- Requirements for combustion
- Products of combustion
- Stoichiometric combustion
- Complete combustion
- Incomplete combustion
- Combustion yield formula
- Air requirements
  - Combustion
  - Primary
  - Secondary
  - Excess
  - Dilution
  - Total
- Products of combustion
  - CO<sub>2</sub>
  - H<sub>2</sub>O
  - O<sub>2</sub>
  - N<sub>2</sub>

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

**Competency: B3 Apply draft theory**

**Objectives**

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

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

**LEARNING TASKS**

1. Describe draft

2. Describe the building as a system

**CONTENT**

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

**Line (GAC):        B    APPLY FUNDAMENTALS OF GAS UTILIZATION**
**Competency:        B4    Interpret heating, cooling and process systems**
**Objectives**

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

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

**LEARNING TASKS**
**CONTENT**

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

**LEARNING TASKS**

**CONTENT**

7. Describe the operation of residential forced air systems

- Temperature indicators
- Air vents
- Feed water
- Water treatment
- Piping system configurations
  - Zoning
  - Supply water
  - Return water
  - Balancing
  - High-temperature
  - Low-temperature
  - Mixing
- Heating and cooling generating equipment
  - Boilers
    - High mass
    - Low mass
    - Fire tube
    - Water tube
  - Heat pumps
  - Heat exchangers
    - Plate
    - Tube and shell
  - Solar panels
- Process Flow Diagrams (PFD)
- Controls
- Heat transfer units
- Safety considerations
- Purpose
- Components
- Ducting configurations
  - Supply air
  - Return air
  - Zoning
- Controls
- Balancing



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

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

**Objectives**

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

- Describe mechanical safety devices.

**LEARNING TASKS**

1. Describe Mechanical Safety Devices

**CONTENT**

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

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C1 Use the principles of electricity and electronics**

**Objectives**

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

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

**LEARNING TASKS**

1. Describe the fundamentals of electricity

2. Describe electrical circuits

**CONTENT**

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

**LEARNING TASKS**

**CONTENT**

3. Use laws and formulas

4. Describe single phase power characteristics

5. Describe three phase power characteristics

6. Identify transformers

- AC amperage
- Resistance
- Impedance
- Capacitance
- Power factor
- Fundamentals of magnetism
  - Natural and artificial magnets
  - Magnetic fields
  - Strength of field
  - Force on two wires
- Permeability
- Ohm's Law
- Kirchoff's Law
- Solve simple problems
- AC power distribution
  - Generation and transmission
  - Voltage drop
  - Step-down transformer
- Power available
- Single phase power supply
  - 3-wire, dual voltage
- Circuit protection
  - Fuses
  - Circuit breakers
- AC power distribution
  - Generation and transmission
  - Voltage drop
  - Step-down transformer
- Power available
- Three phase power supply
  - Delta
  - Wye
- Type of transformers
  - Step-up
  - Step-down
  - Isolation
- Primary winding
- Secondary winding
- Tappings

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C2 Use electrical wiring diagrams and schematics**

**Objectives**

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

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

**LEARNING TASKS**

1. Identify electrical diagrams

2. Sketch a circuit

3. Analyze simple circuits

4. Describe appliance circuits

**CONTENT**

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

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C3 Use the Canadian Electrical Code (CEC)**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

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

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C4 Apply single phase motor theory**

**Objectives**

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

- Describe single phase motors.

**LEARNING TASKS**

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

**CONTENT**

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

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C5 Apply three phase motor theory**

**Objectives**

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

- Describe three phase motors.

**LEARNING TASKS**

1. Describe three phase motors

**CONTENT**

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

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C7 Apply wiring practices**

**Objectives**

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

- Describe wiring components.
- Describe conductor installation.
- Describe wire termination.

**LEARNING TASKS**

1. Describe wiring components

**CONTENT**

- Wire types
  - Solid
  - Stranded
- Connection types
  - Wire nuts
  - Crimp
  - Solder
  - Terminal strips/lug
  - Heat shrink sleeve
- Conduit types
  - Metal conduit
    - Rigid metal conduit
    - Galvanized conduit
  - Non-metallic conduit
  - Flexible conduit
- Fasteners
- Junction box
- Cutting of flexible conduit
- Wire insulation removal
- Wire nuts
- Wire nuts
- Junction box
- Terminal strips/lug
- Mechanically secure
- Heat shrink sleeve

2. Describe conductor installation

3. Describe wire termination



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

**Competency: D1 Size piping and tubing systems**

**Objectives**

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

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

**LEARNING TASKS**

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

2. Describe natural gas fuel distribution systems

3. Describe piping, tubing and hoses

**CONTENT**

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

**LEARNING TASKS**

**CONTENT**

4. Size piping and tubing systems

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

**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 valves.
- Describe the operation of gas valve trains for appliances rated at 400 MBH or less.
- Describe the purpose and operation of gas pressure regulators.

## LEARNING TASKS

1. Describe manual valves
2. Describe automatic gas valves
3. Describe pressure regulators

## CONTENT

- Types
  - Plug valves
  - Butterfly
  - Ball valves
  - Needle valves
- Construction
- Operation
- Pressure markings and ratings
- Maintenance
- Electric
  - Solenoid
  - Diaphragm
  - Combination
  - Single stage
  - Two stage
  - Modulating
  - Pilot safety
    - Safety shut off
- Non-electric
  - Rod and tube
  - Hydraulic
- Types
  - Appliances
  - Line pressure
  - Service
  - Direct operated
- Operating elements
  - Loading
  - Measuring
  - Restricting
- Pressure adjustment
  - Gas line
  - Manifold
- Parts

**LEARNING TASKS**

4. Describe gas valve train for appliances 400 MBH or less
  
5. Describe the operation of a gas valve train

**CONTENT**

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

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

**Competency: D6 Select gas-fired appliances**

**Objectives**

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

- Describe gas-fired appliances.

**LEARNING TASKS**

1. Describe gas-fired appliances

**CONTENT**

- Types
  - Boilers
    - Hot water
    - Steam
    - High mass
    - Low mass
  - Direct fired make-up air heaters
  - Direct vent appliances
  - Decorative appliances
    - Fireplace
    - Fire pit
  - Furnaces
  - Radiant heaters
    - Low intensity
    - High intensity
  - Ranges and/or Commercial cooking equipment
  - Rooftop units
  - Unit heaters
  - Water heaters
    - Tankless
    - Storage type
  - Gas fired refrigerators
- Characteristics
  - Appliance design
  - Direct-fired
  - Indirect-fired
- Applications
- Approval agencies

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

**Competency: D7 Select burners**

**Objectives**

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

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

**LEARNING TASKS**

1. Describe burners

**CONTENT**

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

2. Describe atmospheric burners

**LEARNING TASKS**

3. Describe burner orifices

**CONTENT**

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

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

**Competency: D8 Select flame safeguards**

**Objectives**

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

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

**LEARNING TASKS**

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

**CONTENT**

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



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

**Competency: D10 Select electrical components**

**Objectives**

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

- Describe switches.
- Install relays.

**LEARNING TASKS**

1. Describe switches

2. Describe relays

3. Select relays

4. Install relays

**CONTENT**

- Manual
- Temperature actuated
- Pressure actuated
- Liquid level actuated
- Flow
- Proximity/End
- Operation
- Ratings
- Contacts
  - Normally open
  - Normally closed
- 120 volt coils
- 24 volt coils
- Ratings
- Wiring base connections
- Symbols
- Terminal identification on wiring diagram
- Enclosures

**Achievement Criteria**

**Performance** The learner will be able to install/wire a relay.

**Conditions** To be assessed during technical training.

The learner will be given:

- Ladder diagram
- Double pole, single throw relay
- Power supply
- Switch
- Light bulbs
- Transformer

**Criteria** The learner will be evaluated on:

- Accuracy to the diagram
- Wiring techniques
- Neatness

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

**Competency: D12 Plan a project**

**Objectives**

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

- Plan a residential piping installation.

**LEARNING TASKS**

1. Determine load

2. Layout the system

3. Size the system

4. Determine material take-off

**CONTENT**

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

**Achievement Criteria**

|             |   |
|-------------|---|
| Performance | <p>The learner will be able to:</p> <ul style="list-style-type: none"> <li>• Plan a layout of a residential piping installation</li> <li>• Sketch an isometric piping drawing</li> <li>• Size the piping system</li> <li>• Generate a tool and material list.</li> </ul>  |
| Conditions  | <p>To be assessed during technical training.<br/>The learner will be given:</p> <ul style="list-style-type: none"> <li>• Residential floor plan with meter and appliance location</li> <li>• Appliance documentation</li> <li>• Sketching equipment</li> <li>• Delivery pressure.</li> </ul>  |
| Criteria    | <p>The learner will be evaluated on:</p> <ul style="list-style-type: none"> <li>• Material take-off <ul style="list-style-type: none"> <li>○ Accuracy</li> </ul> </li> <li>• Isometric drawing <ul style="list-style-type: none"> <li>○ Neatness</li> <li>○ Accuracy</li> </ul> </li> <li>• Code compliance <ul style="list-style-type: none"> <li>○ Sizing</li> <li>○ Hanger spacing</li> <li>○ Valves</li> <li>○ Drip legs</li> <li>○ Swing joints</li> <li>○ Pipe identification.</li> </ul> </li> </ul> |

**Line (GAC): E INSTALL GAS-FIRED SYSTEMS**
**Competency: E1 Install piping and tubing systems**
**Objectives**

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

- Join pipe and tubing using threading and flaring.
- Perform tube bending.
- Size piping and tubing systems, low pressure and 2 psig (14 kPa).

**LEARNING TASKS**
**CONTENT**

- |  |  |
|--|--|
| 1. Properties of piping materials  | <ul style="list-style-type: none"> <li>• Tensile strength</li> <li>• Malleability</li> <li>• Elasticity</li> </ul>   |
| 2. Calculate the linear thermal expansion and contraction of various materials | <ul style="list-style-type: none"> <li>• Ferrous</li> <li>• Non-ferrous</li> <li>• Thermoplastic</li> </ul>  |
| 3. Describe hangers and supports   | <ul style="list-style-type: none"> <li>• Types</li> <li>• Construction</li> <li>• Uses</li> <li>• Expansion</li> <li>• Seismic restraint</li> <li>• Protective materials                             <ul style="list-style-type: none"> <li>○ Electrolysis</li> </ul> </li> <li>• Spacing</li> <li>• Inserts and fasteners</li> <li>• Installation procedures</li> </ul> |
| 4. Join pipe and tubing  | <ul style="list-style-type: none"> <li>• Safety</li> <li>• Methods                             <ul style="list-style-type: none"> <li>○ Welding</li> <li>○ Threading</li> <li>○ Flaring</li> <li>○ Compression fittings</li> <li>○ Brazing</li> <li>○ Fusion (PE)</li> </ul> </li> <li>• Procedure</li> <li>• Hot taps</li> <li>• Tools</li> <li>• Fittings</li> </ul>   |
| 5. Perform tube bending  | <ul style="list-style-type: none"> <li>• Tools</li> <li>• Technique</li> </ul>   |
| 6. Install piping, tubing and hoses  | <ul style="list-style-type: none"> <li>• Types</li> <li>• Methods</li> </ul>   |

**LEARNING TASKS**

**CONTENT**

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

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

**Competency:**        **E2    Install regulators, valves, and valve train components**

**Objectives**

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

- Describe manual shut-off valves installation.
- Describe gas pressure regulator installation.

**LEARNING TASKS**

1. Describe the installation of manual shut-off valves
  
2. Describe the installation of gas pressure regulators

**CONTENT**

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

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

**Competency: E5 Install air supply systems**

**Objectives**

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

- Describe installation of passive air supply systems.

**LEARNING TASKS**

1. Describe installation of passive air supply

**CONTENT**

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

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

**Competency: F1 Commission fuel/air delivery systems**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

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



# **Level 2**

## **Gasfitter – Class B**

**Line (GAC):        A     USE COMMON OCCUPATIONAL SKILLS**
**Competency:        A4     Use technical instruments and testers**
**Objectives**

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

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

**LEARNING TASKS**
**CONTENT**

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

**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 code rules and regulations applicable to the Gasfitter B certification.
- Apply Section 7 of the B149.1 Gas Code.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| 1. Interpret Sections 4, 5, 6, 7, 8 and Annex C of the B149.1 Gas Code                | <ul style="list-style-type: none"> <li>• General</li> <li>• Pressure Controls</li> <li>• Piping and Tubing Systems, Hose, and Fittings</li> <li>• Installation of Specific Types of Appliances</li> <li>• Venting Systems and Air Supply for Appliances</li> <li>• Vent Sizing Tables for Category 1 Appliances</li> </ul> |
| 2. Interpret the B149.2 Gas Code  | <ul style="list-style-type: none"> <li>• Layout</li> <li>• Sections</li> <li>• Contents</li> <li>• Index</li> <li>• Annexes</li> <li>• Tables</li> <li>• Definitions</li> <li>• Scope</li> <li>• Revisions</li> </ul>  |
| 3. Apply Section 7 of the B149.1 Gas Code to appliance installation and commissioning | <ul style="list-style-type: none"> <li>• Design</li> <li>• Planning</li> <li>• Installation</li> <li>• Commissioning</li> <li>• Maintenance</li> <li>• Decommissioning</li> </ul>  |

**Line (GAC):           A     USE COMMON OCCUPATIONAL SKILLS**

**Competency:         A6     Organize work and maintain records**

**Objectives**

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

- Apply records management.

**LEARNING TASKS**

**CONTENT**

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

**Competency:** B4 Interpret heating, cooling and process systems

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

- ## LEARNING TASKS

1. Describe low pressure steam systems

2. Describe the operation of a propane refrigerator

**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 applications and installation of mechanical safety devices.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| <p>1. Describe the applications of mechanical safety devices</p> | <ul style="list-style-type: none"> <li>• Codes and regulations</li> <li>• ASME standards</li> <li>• Ratings</li> <li>• Hot Water Boiler</li> <li>• Steam Boiler</li> <li>• Hot Water Tank</li> <li>• Pressure vessels               <ul style="list-style-type: none"> <li>○ Propane tanks (LPG)</li> <li>○ Propane cylinders</li> </ul> </li> <li>• Compressed Natural Gas (CNG)</li> </ul> |
| <p>2. Describe installation of mechanical safety devices</p>     | <ul style="list-style-type: none"> <li>• Discharge piping               <ul style="list-style-type: none"> <li>○ Termination</li> <li>○ Size</li> </ul> </li> <li>• Location</li> </ul>  |

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

**Competency:           B6    Apply alternate-fuel theory**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

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

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**
**Competency: C1 Use the principles of electricity and electronics**
**Objectives**

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

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

**LEARNING TASKS**

1. Determine electrical loads
2. Select single-phase transformers
3. Describe the installation of single-phase transformers
4. Describe millivolt circuits
5. Identify resistors
6. Describe proportional control operation
7. Describe variable resistors

**CONTENT**

- Transformer secondary
- Ratings
  - Amps
- Sizing
- Ratings
  - Watts
  - VA
- Phasing
  - Grounding
- Power generation
  - Thermocouple
  - Thermopiles
- Switches
- Loads
- Application
- Installation
- Types
- Colour coding
- Types used by series
- Method of control
  - Electric
  - Electronic
- Thermistors
  - Effects of heat and resistance
- Anticipators
- Potentiometers



**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C2 Use electrical wiring diagrams and schematics**

**Objectives**

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

- Design a wire diagram for a hydronic heating system.
- Describe the sequence of operation for a furnace and hydronic heating system.
- Create a control narrative from a wiring diagram for a hydronic system.

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| 1. Describe circuit components  | <ul style="list-style-type: none"> <li>• Transformer</li> <li>• Limits</li> <li>• Safety devices</li> <li>• Controls</li> <li>• Permissives</li> <li>• Interlocks</li> </ul>                     |
| 2. Describe sequence of appliance operation                                       | <ul style="list-style-type: none"> <li>• Control narratives</li> <li>• Components</li> <li>• Appliances</li> <li>• Wiring diagrams</li> </ul>  |
| 3. Design wire diagram  | <ul style="list-style-type: none"> <li>• Control narrative</li> </ul>  |
| 4. Create a control narrative from a wiring diagram for a hydronic heating system | <ul style="list-style-type: none"> <li>• Diagram types               <ul style="list-style-type: none"> <li>○ Schematic</li> <li>○ Ladder</li> <li>○ Process flow diagram</li> </ul> </li> </ul> |

**Achievement Criteria 1**

- |             |   |
|-------------|---|
| Performance | The learner will be able to design a wire diagram for a high-temp 4 zone hydronic heating system.   |
| Conditions  | To be assessed during technical training.<br>The learner will be given: <ul style="list-style-type: none"> <li>• Electrical data</li> <li>• Sketching materials</li> <li>• System component requirements</li> </ul> |
| Criteria    | The learner will be evaluated on: <ul style="list-style-type: none"> <li>• Accuracy</li> <li>• Completeness</li> <li>• Use of symbols</li> <li>• Sequence of operation</li> </ul>                                   |

**Achievement Criteria 2**

|             |  |
|-------------|--|
| Performance | The learner will be able to create a control narrative from wiring diagrams.   |
| Conditions  | <p>To be assessed during technical training.</p> <p>The learner will be given:</p> <ul style="list-style-type: none"> <li>• Ladder diagram</li> <li>• Schematic diagram</li> </ul> |
| Criteria    | <p>The learner will be evaluated on:</p> <ul style="list-style-type: none"> <li>• Accuracy</li> <li>• Completeness</li> <li>• Sequence of operation</li> </ul>                     |

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C3 Use the Canadian Electrical Code (CEC)**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

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

**Line (GAC):** C APPLY ELECTRICAL CONCEPTS

**Competency:** C4 Apply single phase motor theory

## Objectives

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

- Describe characteristics and operation of single phase motors.
- Describe motor protection.

## LEARNING TASKS

## CONTENT

1. Describe characteristics and operation of single phase motors
  - Split phase motors
  - Capacitor start motors
  - Capacitor run motors
  - Shaded pole motors
  - Dual voltage motors
  - Motor starting relays
    - Current
    - Potent
2. Describe motor protection
  - Motor protection
    - Inherent protectors
    - Line overloads
    - Heaters
    - Circuit breakers
    - Effects of ambient temperature
  - Magnetic contactors
    - Types
    - Operation
    - Application and ratings
    - Starters
    - Line voltage control
      - Start-stop control
      - Hand-off-auto control
  - Line voltage control
    - 115 volt

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

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

- ## LEARNING TASKS

## CONTENT

- 67

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C7 Apply wiring practices**

**Objectives**

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

- Install electrical components.

**LEARNING TASKS**

1. Install cables and conductors

2. Install junction and switch boxes

3. Install shielded cable

4. Describe isolation switch installations

**CONTENT**

- CEC
- Supports
- Colour coding
- Class 2 circuits
- Conduit
- Wire labelling
- Tools
- CEC
  - Sizing
- Conductor connections and terminations
- Grounding/bonding
- Tools
- Termination
- Grounding
- CEC
  - Location
  - Type
  - Ratings

**Line (GAC): C APPLY ELECTRICAL CONCEPTS**

**Competency: C8 Troubleshoot electrical circuits**

**Objectives**

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

- Interpret electrical readings.

**LEARNING TASKS**

1. Describe common electrical faults

2. Interpret electrical readings

**CONTENT**

- Power surge
- Insufficient voltage
- Short circuits
- Blown fuses
- Damaged conductors
- Corrosion
- Dirty contacts
- Loose termination
- Incorrect wiring
- Open switches
- Closed switches
- Manufacturer's documentation
- Ohm's law
- Predicted readings
  - Voltage
  - Current
  - Resistance
  - Continuity
- 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:

- Identify network protocols and cable connectors.

**LEARNING TASKS**

**CONTENT**

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



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

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

**Objectives**

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

- Size regulators.

**LEARNING TASKS**

1. Describe pressure regulators

**CONTENT**

- Types
  - Direct operated
  - Lever operated
  - Zero governors
  - Propane
    - First stage
    - Second stage
- Operating elements
  - Loading
  - Measuring
  - Restricting
- Parts
  - Internal pressure relief
- Operating principles
  - Droop/offset
  - Lock-up
  - Set point
  - Critical flow
- Applications
- Types
  - Level operated
  - Direct operated
  - Integrated/combination
  - Zero governors
- Application
- Manufacturer's documentation
- Sizing tables
  - Flow rate
  - Pressure drop
  - Orifice selection
  - Spring selection
- Pipe size
- Types of fuel
- Code
- Over pressure protection (OPP)

2. Size regulators

**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 systems.
- Describe the requirements for the installation of propane cylinder/tank storage systems.
- Describe the inspection of propane cylinder/tanks.

## LEARNING TASKS

1. Describe propane storage systems
2. Describe propane cylinder/tank installation requirements

## CONTENT

- Cylinders
- Tanks
- Liquid services
- Gaseous services
- Piping components
- Rating plates
- Transportation
- Code requirements
- Sizing
  - Load factors
  - Fill level
  - Fill density
- Temperature effects on pressure
- Temperature effects on vapourization rate
- Filled capacity effect on vapourization rate
- Describe cylinder/tank clearances from building
  - Openings
  - Air intakes
  - Doors
  - Windows
  - Flue termination
  - Dryer vents
- Location
- Placement
- Support
- Protection
- Access
  - Filling
    - Safety
    - Emergency procedures
    - Liquid handling

**LEARNING TASKS**

**CONTENT**

3. Describe the inspection of propane cylinders

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

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

**Competency:** D4 Size venting systems

## Objectives

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

- Size venting.

## LEARNING TASKS

## CONTENT

1. Describe appliance categories
  - Category 1, 2, 3 and 4
    - Vent pressure
    - Appliance efficiencies
2. Describe venting materials
  - Types
    - Single wall venting (C vent)
    - A vent
    - B vent
    - L vent
    - BH vent
      - Class 1, 2, 3 and 4
    - BW vent
3. Describe types of venting systems
  - Mechanical
    - Forced
    - Induced
  - Passive
  - Vent pressures
4. Size Category 1 venting
  - Codes
    - B149.1
    - National Building Code
  - Appliance type
  - Building type
  - Vent connector
  - Common vents
5. Size special venting
  - Engineering
  - Category
  - Codes
    - B149.1
    - National Building Code
  - Design registry
  - Manufacturer's documentation
  - Types
    - Classifications
    - Materials
    - Mechanical
    - Passive

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

**Competency: D5 Size air supply systems**

**Objectives**

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

- Size passive air supply systems.

**LEARNING TASKS**

**CONTENT**

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

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

**Competency: D6 Select gas-fired appliances**

**Objectives**

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

- Select gas fired appliances rated at 400 MBH or less.

**LEARNING TASKS**

1. Selection criteria for gas-fired appliances

**CONTENT**

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

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

**Competency: D7 Select burners**

**Objectives**

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

- Describe the installation of mechanical burners.

**LEARNING TASKS**

1. Describe mechanical burners

2. Describe proportional mixers

3. Describe the installation of mechanical burners

**CONTENT**

- Terminology
  - Turndown
  - High fire
  - Low fire
  - Modulation
- Characteristics
  - Flame retention
  - Fuel-air ratio
  - Impingement
- Types
  - Pre-mix
  - Nozzle mix
  - Chamber mix
  - Forced draft
  - Fan assisted
- Parts
- Fuel/air adjustments
- Operation
- Applications
- Gas pressures
- High altitude installations
- Fuel-air ratios
- Adjustments
- Zero governors
- Sealing
- Support
- Manufacturer's documentation
- Refractory
- Wiring
- Mounting

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

**Competency:** D8 **Select flame safeguards**

## Objectives

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

- Select flame safe guards.

## LEARNING TASKS

1. Describe flame detectors
2. Describe ignition systems
3. Describe flame safe guards

## CONTENT

- Thermocouple
- Thermopile
- Flame rectification (flame rod)
- UV/IR
- Pilot types
  - Continuous
  - Intermittent
  - Interrupted
- Pilot
- Direct spark ignition (DSI)
- Hot surface ignition (HSI)
- Common manufacturers
  - Honeywell
  - Fenwall
  - Siemens
  - Johnson Controls
- Wiring diagrams
- Sequence of operation
- Applications
- Component compatibility
- System compatibility
- Conversions



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

**Competency:** D9 Select combustion, safety and operating controls

## Objectives

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

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

## LEARNING TASKS

## CONTENT

- Describe limits and interlocks
  - Pressure switches
  - Flow switches
  - Temperature switches
    - Mechanical high limit
    - Aquastat
    - Electronic
    - Flame rollout switch
    - Spill switch
  - Interlocks
    - End switches
    - Air proving switches
    - Gas pressure switches
- Describe permissives
- Describe the installation of programmable thermostats
  - Thermostat
  - Aquastat
  - DDC contacts
  - Timer
  - Types
    - Heating
    - Cooling
    - Heat pump
  - Overrides
  - Programming
    - Vacation mode
      - Freeze protection
    - Night set back
    - Heat anticipation
  - Application
    - Single stage
    - 2 stage
  - Wiring
  - Manufacturer's documentation
  - Location

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

**Competency:** D11 Select automation and instrumentation control systems

## Objectives

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

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

## LEARNING TASKS

## CONTENT

1. Describe outdoor reset controls
  - Sensors
    - Types
  - Thermistors
  - Applications
  - Cable types
  - Inputs
  - Outputs
    - 0-10 VDC
    - 4-20 mA
  - Heating curves
    - System efficiencies
2. Describe multi-boiler hydronic heating system components
  - Sequencing control
  - Wiring techniques

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

**Competency: D12 Plan a project**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Complete commissioning documentation for a high efficiency furnace and a condensing boiler</li> </ol> | <ul style="list-style-type: none"> <li>• Commissioning report</li> <li>• Statement of completion</li> <li>• Regulatory responsibilities</li> <li>• As-built drawings and operator manuals</li> <li>• Instructions to customer</li> </ul> |
|---|--|

**Achievement Criteria**

- |             |   |
|-------------|---|
| Performance | The learner will be able to create post-commissioning paperwork for a high efficiency furnace and a condensing boiler.  |
| Conditions  | <p>To be assessed during technical training.</p> <p>The learner will be given conditions as noted from:</p> <ul style="list-style-type: none"> <li>• F5 – Commission boilers and ancillary equipment</li> <li>• F7 – Commission furnaces and ovens</li> </ul>                                       |
| Criteria    | <p>The learner will be evaluated on:</p> <ul style="list-style-type: none"> <li>• Commissioning report               <ul style="list-style-type: none"> <li>○ Report accuracy</li> <li>○ Report Completeness</li> <li>○ Operating according to manufacturer's specifications</li> </ul> </li> </ul> |

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

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

- Describe the installation of regulator venting.

**LEARNING TASKS**

1. Describe the installation of regulator venting

**CONTENT**

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

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

**Objectives**

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

- Describe propane cylinder/tank installation.

**LEARNING TASKS**

1. Describe propane cylinder/tank installation requirements

**CONTENT**

- Code requirements
- Describe cylinder/tank clearances from building
  - Openings
  - Air intakes
  - Doors
  - Windows
  - Flue termination
  - Dryer vents
- Location
- Placement
- Support
- Protection
- Access
  - Filling
    - Safety
    - Emergency procedures
    - Liquid handling
  - Maintenance
  - Vehicle
- Security/fencing
- Containment
- Procedures
- Regulator placements
- Safety shut-off valves
  - Excess flow valves
  - Pneumatic actuator
- Safety relief valves
  - Pressures
  - Location of discharge outlets
  - Calculations of rate of discharge
- Maintenance
  - Code B149.2
- Valves and accessories for vapour withdrawal applications
  - Description

2. Describe the installation of propane cylinder/tank components

**LEARNING TASKS**

**CONTENT**

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

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

**Competency: E4 Install venting systems**

**Objectives**

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

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

**LEARNING TASKS**

**CONTENT**

1. Describe installation of venting materials

- Components
  - Fittings
  - Terminations
  - Condensate collection
  - Fire stopping
  - Supports
  - Wall and ceiling penetrations

- Assembly
  - Gaskets
  - Mechanical fasteners and clamps
  - Sealants and lubricants
  - Glues and primers

- Code requirements
  - Directives

- Grade/Slope

2.. Describe the installation of mechanical venting systems

- Forced

- Induced

- Components
  - Fittings
  - Terminations
  - Condensate collection
  - Fire stopping
  - Supports
  - Wall and ceiling penetrations

- Assembly
  - Gaskets
  - Mechanical fasteners and clamps
  - Sealants and lubricants
  - Glues and primers

- Code requirements

- Grade/Slope

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

**Competency: E5 Install air supply systems**

**Objectives**

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

- Describe the installation of mechanical air supply systems.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| 1. Describe mechanical air supply systems                     | <ul style="list-style-type: none"> <li>• Ducts                             <ul style="list-style-type: none"> <li>○ Sizes</li> <li>○ Location</li> <li>○ Lengths</li> <li>○ Fittings</li> </ul> </li> <li>• Fans                             <ul style="list-style-type: none"> <li>○ Types</li> <li>○ Location</li> </ul> </li> <li>• Engineered systems</li> <li>• Manufacturer's documentation</li> <li>• Code requirements</li> </ul> |
| 2. Describe the installation of mechanical air supply systems | <ul style="list-style-type: none"> <li>• Code requirements</li> <li>• Structural penetrations</li> <li>• Sealing</li> <li>• Opening and ducts                             <ul style="list-style-type: none"> <li>○ Terminations</li> </ul> </li> <li>• Weather</li> <li>• Interlocks</li> </ul>   |



**Line (GAC): E INSTALL GAS-FIRED SYSTEMS**
**Competency: E6 Install draft control systems**
**Objectives**

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

- Describe the installation of draft control systems.

**LEARNING TASKS**
**CONTENT**

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

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

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

**Objectives**

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

- Describe the installation of outdoor reset controls.

**LEARNING TASKS**

**CONTENT**

- |  |  |
|--|--|
| 1. Describe the installation of outdoor reset controls | <ul style="list-style-type: none"> <li>• Sensors                             <ul style="list-style-type: none"> <li>○ Location</li> </ul> </li> <li>• Cabling termination and bonding</li> <li>• Wiring connections</li> <li>• Manufacturer's documentation</li> </ul> |
|--|--|

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

### Objectives

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

- Install boilers.

### LEARNING TASKS

1. Install boilers

### CONTENT

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

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

**Competency: E12 Install air heating appliances and equipment**

**Objectives**

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

- Install air heating appliances.

**LEARNING TASKS**

1. Install air heating appliances

**CONTENT**

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

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

**Competency:** F1 Commission fuel/air delivery systems

## Objectives

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

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

## LEARNING TASKS

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

## CONTENT

1. Describe purging procedures for pipe 4 inch diameter and larger
  - Code requirements
  - Inert gases
  - Applications
  - Purpose
  - Equipment
    - Approved burners
    - Gauges
    - Regulators
  - Pressures
  - Velocity
2. Commission regulators
  - Droop
  - Lock up pressure
  - Inlet pressure
  - Downstream set point pressure
  - Location of test gauges
  - Codes
3. Size burner orifices
  - Types of fuel gases
  - Tables
  - Calculations
    - Orifice flow formula
    - Fuel gas conversions
  - Drilling
  - Drill index
4. Use gas metering devices
  - Low pressure clocking
  - High pressure clocking
  - High altitude appliance derating

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

**Competency: F2 Perform appliance start-up procedures**

**Objectives**

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

- Describe factors to consider when starting up a system.

**LEARNING TASKS**

**CONTENT**

1. Describe start-up checklists

- Appliance types
  - Boilers
  - Furnaces
  - Storage type water heaters
  - Tank less water heaters
  - Gas range
  - Gas dryer
  - Unit heater
  - Direct vent fire place

- Permits
- Electrical supply
- Water supply
- Load
- Gas supply
- Combustion air/venting
- Codes compliance
- Appliance approval
- Manufacturer's documentation

2. Describe factors to consider when starting up a system

- Appliance type
- Electrical supply
- Water supply
- Load
- Gas supply
- Combustion air/venting
- Codes compliance
  - B149.1
  - C22.1
- Manufacturer's documentation
- Remove shipping materials
- Belt/pulley alignment
- Tightness of electrical connections
- Valve tightness test
- Leak test
- Hydrostatic test

**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:

- Describe the operation of gas meters.
- Interpret gas meters.
- Identify types of gas meters.

**LEARNING TASKS**

1. Describe gas meters

**CONTENT**

- Types
  - Positive displacement
    - Bellows
    - Rotary
  - Inferential meter
    - Ultrasonic
    - Turbine
- Protection
  - Mechanical damage (bollards)
  - Snow/ice accumulation
- Principles of operation
  - Positive displacement
- Capacity
- Pressure compensation
- Reading
  - Test dials
  - Imperial
  - Metric
- Clocking
- Calorific values
- Clocked flow rates
- Calculated inputs
- Pressure correction factor
- Temperature correction factor

2. Describe the process used to determine the firing input of an appliance

**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 flue gas analysis.
- Describe NO<sub>x</sub>.

## LEARNING TASKS

1. Perform flue gas analysis
2. Describe NOx
3. Maintain combustion analyzer

## CONTENT

- Analyzer calibration
- Fuel selection
- Sampling locations
- Manufacturer's documentation
- Interpret readings
  - Acceptable range
    - CO<sub>2</sub>
    - O<sub>2</sub>
    - CO
    - Temperature
    - Stack draft
- Required adjustments
- Data storage
  - Printed results
  - Electronic spreadsheet
- Characteristics
- Annual calibration and re-certification
- Storage and handling
  - Water trap maintenance
  - Manufacturer's documentation
- Cell replacement



**Line (GAC):        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 a storage type water heater with a standing pilot and atmospheric burner.

## LEARNING TASKS

## CONTENT

1. Verify electrical operating parameters
  - Tightness of electrical connections
  - Verify voltage
  - Code compliance
  - Verify electrical wiring diagram
2. Adjust burners
  - Types of burners
    - Atmospheric
    - Fan assisted
    - Forced draft
  - Start up procedure
  - Manifold pressure
    - Measurement
    - Adjustment
  - Burner input calculations
    - Clocking
  - Altitude compensation
    - High altitude de-rating
  - Flame characteristics
  - Air adjustments
    - Air shutter
    - Air damper
    - Fan speeds
  - Pilot test
    - Turn-down
    - Drop-out
    - Flame failure response time
3. Commission boilers and water heaters
  - Code requirements
  - Verify component specifications
    - Appliance rating
    - Relief valves
    - Safety and limits
    - Vacuum relief valve
    - Expansion device
    - Flame safeguard
  - Water temperature
    - Operating set point
    - Return water temperature

**LEARNING TASKS**

**CONTENT**

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

**Achievement Criteria**

- |             |  |
|-------------|--|
| Performance | The learner will be able to: <ul style="list-style-type: none"> <li>• Commission a condensing boiler</li> </ul>  |
| Conditions  | To be assessed during technical training.<br>The learner will be given: <ul style="list-style-type: none"> <li>• Condensing boiler</li> <li>• Manufacturer's documentation</li> <li>• Tools and testing equipment</li> <li>• Applicable equipment</li> </ul> |
| Criteria    | The learner will be evaluated on: <ul style="list-style-type: none"> <li>• Appliance meeting manufacturer's specifications</li> <li>• Appliance operating safety and efficiency</li> <li>• Code compliance</li> </ul>  |

**Line (GAC): F COMMISSION GAS-FIRED APPLIANCES AND EQUIPMENT**
**Competency: F7 Commission furnaces and ovens**
**Objectives**

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

- Commission a high efficiency furnace.

**LEARNING TASKS**

1. Verify electrical operating parameters
2. Adjust burners
3. Verify safety devices, limits, and operating controls
4. Commission a high efficiency furnace

**CONTENT**

- Tightness of electrical connections
- Verify voltage
- Code compliance
- Verify electrical wiring diagram
- Types of burners
  - Atmospheric
  - Fan assisted
  - Forced draft
- Start up procedure
- Manifold pressure
  - Measurement
  - Adjustment
- Burner input calculations
  - Clocking
- Altitude compensation
  - High altitude de-rating
- Flame characteristics
- Air adjustments
  - Air shutter
  - Air damper
  - Fan speeds
- Pilot test
  - Turn-down
  - Drop-out
- Flame failure response time
- Interlocks
- High limit
- Operating controls
- Thermostat
- Flame roll out switch
- Pressure switch
  - Air
- End switch
- Spill switch (vent safety)
- Heat exchanger temperature rise

**LEARNING TASKS**

**CONTENT**

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

**Achievement Criteria**

|             |   |
|-------------|---|
| Performance | <p>The learner will be able to:</p> <ul style="list-style-type: none"> <li>• Commission a high efficiency furnace</li> </ul>  |
| Conditions  | <p>To be assessed during technical training.</p> <p>The learner will be given:</p> <ul style="list-style-type: none"> <li>• High efficiency furnace</li> <li>• Manufacturer's documentation</li> <li>• Tools and testing equipment</li> <li>• Applicable equipment</li> </ul> |
| Criteria    | <p>The learner will be evaluated on:</p> <ul style="list-style-type: none"> <li>• Appliance meeting manufacturer's specifications</li> <li>• Appliance operating safety and efficiency</li> <li>• Code compliance</li> </ul>  |

**Competency:** F8 Program temperature, pressure and operating controls

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

- Program a programmable thermostat.

## CONTENT

1. Describe programmable thermostats
  - Types
  - Functions
  - Applications
2. Describe multi-purpose controls
  - Types
    - Burner modulating
    - Lead-lag
  - Tekmar
  - Honeywell
3. Program a programmable thermostat
  - Manufacturer's documentation
  - Set point adjustment
  - Night set back settings
  - Home/away settings

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

**Competency: F11 Commission draft control systems**

**Objectives**

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

- Adjust a barometric draft regulator.

**LEARNING TASKS**

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

**CONTENT**

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

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

**Competency:** F12 Training and handover of gas-fired equipment

## Objectives

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

- Transfer appliance operation to end user.

## LEARNING TASKS

1. Transfer documentation
2. Describe appliance end user training

## CONTENT

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

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

**Competency:           G1    Service gas distribution systems**

**Objectives**

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

- Describe the service procedures for distribution piping.

**LEARNING TASKS**

**CONTENT**

1. Describe the inspection of a gas distribution system
  
2. Describe the repair procedures for a gas distribution system

- Leak detection
- Pressure testing
- Cathodic protection
- Identify damage or defect
  
- Isolate system
  - Lockout procedures
- Inform customer
- Plan repair
- Purge piping
- Remove/replace components
- Pressure testing
- Purging and gasifying



**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 the procedures for servicing gas burners.

## LEARNING TASKS

## CONTENT

- Describe the procedures for servicing gas burners.
  - Service schedule
  - Inspection
    - Appearance
    - Performance
    - Signs of flame impingement
    - Sooting
  - Cleaning
  - Reassembly
  - Recommission
    - Firing
    - Clocking
    - Combustion analysis
- Describe the inspection of ancillary equipment
  - HSI
    - Amperage check
    - Resistance check
    - Placement
  - Ignition electrode
    - Inspection of ceramic
    - Gap to ground
    - Surface contaminants
    - Placement
  - Flame rod
    - Inspection of ceramic
    - Placement
    - Surface contaminants
    - Short to ground check
    - Flame signal reading
- Describe replacement procedures for ancillary equipment
  - Identify faulty component
  - Source correct replacement component
  - Replace component
  - Confirm component operation

**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:

- Describe boiler maintenance procedures.

## LEARNING TASKS

## CONTENT

1. Describe the inspection of boilers
  - Pressure vessel integrity
  - Heat exchanger condition
    - Water side
    - Fire side
  - Venting system condition
  - Burner condition
  - Refractory condition
2. Describe the inspection of ancillary equipment
  - Types
    - Pumps
    - Zone valve
    - Mixing valve
    - Expansion tank
    - Feed water supply systems
    - Fans
      - Auxiliary fans
      - Exhaust fans
    - Steam control valves
    - Steam traps
    - Pressure reducing valves
    - Flue gas exhaust systems
  - Visual inspection
  - Verify electrical parameters
  - Water temperatures
  - Pressures
  - Flow
  - Combustion air
  - Manufacturer's documentation
  - Client requirements
3. Describe ancillary equipment repair/replacement
  - Pumps
  - Zone valve
  - Mixing valve
  - Expansion tank
  - Feed water supply systems
  - Water treatment systems

**LEARNING TASKS**

**CONTENT**

4. Service condensing boilers and tank-less heaters

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

**Line (GAC):            G    MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**
**Competency:            G4    Maintain gas-fired appliances**
**Objectives**

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

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

**LEARNING TASKS**
**CONTENT**

- |  |   |
|--|---|
| 1.    Verify electrical operating parameters               | <ul style="list-style-type: none"> <li>• Tightness of electrical connections</li> <li>• Verify voltage</li> <li>• Code compliance</li> <li>• Verify electrical wiring diagram</li> </ul>  |
| 2.    Check safety devices, limits, and operating controls | <ul style="list-style-type: none"> <li>• Interlocks</li> <li>• High limit</li> <li>• Operating controls               <ul style="list-style-type: none"> <li>○ Thermostat</li> </ul> </li> <li>• Flow switch</li> <li>• Flame roll out switch</li> <li>• Pressure switch               <ul style="list-style-type: none"> <li>○ Air</li> <li>○ Gas</li> </ul> </li> <li>• End switch</li> <li>• Vent safety switch</li> <li>• Spill switch</li> </ul>   |
| 3.    Service burners                                      | <ul style="list-style-type: none"> <li>• Manufacturer's documentation</li> <li>• Client requirements</li> <li>• Pilot verification</li> <li>• Pre-ignition check</li> <li>• Main burner light off</li> <li>• Combustion verification               <ul style="list-style-type: none"> <li>○ Flue gas analysis</li> </ul> </li> <li>• Verify gas pressures               <ul style="list-style-type: none"> <li>○ Manifold</li> <li>○ Supply</li> </ul> </li> <li>• Clocking</li> <li>• Clean components               <ul style="list-style-type: none"> <li>○ Burner ports</li> <li>○ Air intakes</li> <li>○ Ignition systems</li> </ul> </li> </ul> |
| 4.    Verify flame safe guard system operation             | <ul style="list-style-type: none"> <li>• Primary control</li> <li>• Flame detector</li> <li>• Flame signal/rectification</li> <li>• Flame failure response time (FFRT)</li> <li>• Trial for ignition (PTFI/MTFI)</li> </ul>   |

**LEARNING TASKS**

5. Describe servicing requirements for gas-fired appliances

6. Service high efficiency furnaces

7. Service tank-less heaters

**CONTENT**

- Pilot turn down test
- Pilot drop out test
- Types
  - Direct vent appliances
  - Decorative appliances
    - Fireplace
    - Fire pit
  - Furnaces
  - Radiant heaters
    - Low intensity
    - High intensity
  - Ranges and/or Commercial cooking equipment
  - Rooftop units
  - Unit heaters
- Manufacturer's documentation
- Technical Safety BC (formerly BCSA) requirements
- Contractor's check list/service report
- Verify
  - Heat exchanger temperature rise
  - External static pressure (ESP)
  - Temperature set points
  - Blower speed and operation
- Inspect
  - Condensate trap
  - Condensate pump
  - Neutralize tank
  - Air cleaners
  - Heat exchanger
- Inspect
  - Condensate trap
  - Condensate pump
  - Neutralize tank
  - Heat exchanger
  - Water flow rates
    - Flow balancing
- Verify
  - Water treatment
  - Temperature set points
  - Supply and return water temperatures
  - Make-up water
  - Expansion tank pressure

**Line (GAC):            G    MAINTAIN AND SERVICE GAS-FIRED APPLIANCES AND EQUIPMENT**
**Competency:           G5    Maintain gas-fired refrigeration equipment**
**Objectives**

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

- Describe the maintenance of gas-fired refrigeration equipment.

**LEARNING TASKS**
**CONTENT**

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

**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 the servicing procedures for fuel/air delivery systems.

**LEARNING TASKS**

**CONTENT**

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Describe gas regulator troubleshooting procedures</li> </ol> | <ul style="list-style-type: none"> <li>• Manufacturer's documentation</li> <li>• Disconnect vent line connection</li> <li>• Verify regulator performance               <ul style="list-style-type: none"> <li>○ Setpoint</li> <li>○ Droop</li> <li>○ Lock up</li> </ul> </li> <li>• Confirm orifice size</li> <li>• Confirm regulator application</li> <li>• Confirm internal relief operation</li> </ul> |
| <ol style="list-style-type: none"> <li>2. Describe gas regulator repair procedures</li> </ol>          | <ul style="list-style-type: none"> <li>• Manufacturer's documentation</li> <li>• Testing</li> <li>• Adjustments</li> <li>• Vent line sizing</li> <li>• Parts replacement</li> </ul>   |

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

**Competency:           G7    Service and repair control systems**

**Objectives**

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

- Describe service and repair procedures for control systems.

**LEARNING TASKS**

**CONTENT**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Describe troubleshooting procedures for flame safe guards</li> </ol>      | <ul style="list-style-type: none"> <li>• Cycle appliance</li> <li>• Confirm control sequence</li> <li>• Confirm control terminal voltage</li> </ul>   |
| <ol style="list-style-type: none"> <li>2. Describe troubleshooting procedures for combination gas valves</li> </ol> | <ul style="list-style-type: none"> <li>• Cycle appliance</li> <li>• Confirm operation               <ul style="list-style-type: none"> <li>○ Pilot</li> <li>○ Main burner</li> </ul> </li> <li>• Confirm pressure regulation</li> <li>• Tightness of closure</li> </ul> |



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

**Competency:           G9   Decommission and disconnect gas-fired appliances and equipment**

**Objectives**

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

- Describe the removal of gas-fired appliances.

**LEARNING TASKS**

**CONTENT**

1. Describe the disconnection of appliances and accessories

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

2. Describe the removal of gas-fired appliances

- Regulations
- Disposal
- Recycling

## **Section 4**

# **ASSESSMENT GUIDELINES**

## Assessment Guidelines – Level 1

### Level 1 Grading Sheet: Subject Competency and Weightings

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

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

## Assessment Guidelines – Level 2

### Level 2 Grading Sheet: Subject Competency and Weightings

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

## **Section 5**

# **TRAINING PROVIDER STANDARDS**

## **Facility Requirements**

### **Classroom Area**

- Minimum 10 square feet per student
- Comfortable seating and tables suitable for learning
- Compliance with the local and national fire code and occupational safety requirements
- Meets applicable municipal zoning bylaws for technical instruction and education facilities
- Overhead and multimedia projectors with a projection screen
- Whiteboard with marking pens and erasers
- Lighting controls to allow easy visibility of the projection screen while allowing students to take notes
- Windows must have shades or blinds to adjust sunlight
- Heating/Air conditioning for comfort all year round
- The acoustics in the room must allow the students to be able to hear the instructor

### **Shop Area**

- Minimum 3000 square feet of shop area including a tool crib and work stations
- Minimum 8 foot ceiling height in shop areas
- Minimum 8 foot ceiling in lab areas
- Adequate heating, lighting, ventilation (including make up air), drainage and water supply
- Refuse and recycling bins for used shop materials
- First-aid equipment
- Shops will support practical requirements as outlined in the program outline
- Shop facilities will support gas fitting practical training

### **Lab Requirements**

- See shop area requirements

### **Student Facilities**

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

### **Instructor's Office Space**

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

## Tools and Equipment

### Shop (Facility) Tools

#### *Power Tools*

- Air compressor
- Cordless drills
- Mini grinder
- Power drills
- Portable band saw (hack saw)
- Power threading machine
- Reciprocating saw
- Rotary hammer
- Task lighting equipment

#### *Cutting and Joining Equipment*

- Half round file
- Flaring tools
- Hand operated oiler
- Oxy-acetylene equipment
- Pipe cutter
- Pipe reamer
- Pipe roller
- Pipe stand
- Pipe threader
- Pipe vise
- Power vise
- Tube bender
- Tube cutter

#### *Testing and Measuring Equipment*

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

#### *Personal Protectice and Safety Equipment*

- Eye wash kit
- Face shield
- Fire extinguisher
- First aid kit
- Gloves (leather)
- Hearing protection
- Lock-out devices
- Overalls
- Safety harness, lanyard and life line

#### *Standard Tools*

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

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

***Hoisting, Rigging and Access Tools and Equipment***

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

**Student Tools (supplied by student)**

***Required***

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

***Recommended***

- N/A



## Reference Materials

### Required Reference Materials

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

### Recommended Resources

- CSA Gas Trade Training Modules, ISBN 978-1-4883-0127-8
- Low Pressure Boilers, Frederick M. Steingrass, Daryl R. Walker, American Technical Publishers, ISBN 978-0-8269-4365-1
- High Pressure Boilers, Frederick M. Steingrass, Harold J. Frost, Daryl R. Walker, American Technical Publishers, ISBN 978-0-8269-4315-6
- IPT's Pipe Trades Handbook, ISBN 978-0-920855-18-8
- IPT's Guide to Blueprint Interpretation, ISBN: 978-0-920855-42-3
- CAN/ CSA B.214 Installation of Hydronic Heating Systems
- Modern Hydronic Heating – John Seigenthaler, ISBN
- Fundamentals of Gas Utilization – John Dutton, ISBN 978-0-9198-5235-8
- Design of Fluid Systems – Spirax Sarco, ISBN
- Electricity & Controls for HVAC/R – Herman/Sparkman, ISBN 978-1133-2782-07

### Suggested Texts/Websites

- Technical Safety BC (formally known as BC Safety Authority), [www.technicalsaftybc.ca](http://www.technicalsaftybc.ca)
- TECA, Thermal Environmental Comfort Association, [www.teca.ca](http://www.teca.ca)
- SkilledTradesBC [www.skilledtradesbc.ca](http://www.skilledtradesbc.ca)
- CSA, [www.csagroup.org](http://www.csagroup.org)
- Red Seal, [www.red-seal.ca](http://www.red-seal.ca)
- WorkSafeBC, [www.worksafebc.com](http://www.worksafebc.com)

**NOTE:**

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

## **Instructor Requirements**

### **Occupation Qualification**

The instructor must possess one of the following:

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

### **Work Experience**

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

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

### **Instructional Experience and Education**

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

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

# Appendices

## Appendix A

### Required Tools and Equipment

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

#### Level One (Class B) Apprenticeship

- 1 threading machine (power drive with threading attachment) for every 4 students
- 1 oxy/acetylene cutting outfit for every 8 students
- 1 fuel/air brazing unit for every 4 students
- 1 flaring tool for every 8 students
- 1 tubing bender for every 8 students

#### Level Two (Class B) Apprenticeship

- 1 multimeter for every 2 students
- 1 flue gas analyzer capable of measuring CO<sub>2</sub>, CO, O<sub>2</sub>, stack temperature and excess air for every 8 students
- 1 liquid filled manometer for every 4 students
- 1 digital manometer for every 4 students
- 1 incline manometer for every 16 students
- Necessary hand and power tools to service furnaces, boilers and domestic water heaters
- 1 forced-air furnace for every 4 students
- 1 hot water boiler for every 4 students
- 1 tankless water heater for every 8 students
- 1 storage type water heater for every 8 students 1 residential range for every 16 students
- 1 residential dryer for every 16 students
- 1 unit heater for every 16 students
- All appliances to have an input of 120 kW or less

## Appendix B Glossary of Acronyms

|               |  |
|---------------|--|
| <b>AHJ</b>    | Authority having jurisdiction                  |
| <b>ANSI</b>   | American National Standards Institute          |
| <b>ASME</b>   | American Society of Mechanical Engineers       |
| <b>ASOPE</b>  | American Society of Power Engineers            |
| <b>AST</b>    | Aboveground storage tank                       |
| <b>ASTM</b>   | American Society of Testing and Materials      |
| <b>BCSA</b>   | British Columbia Safety Authority              |
| <b>BHP</b>    | Boiler horse power                             |
| <b>Btuh</b>   | British thermal units per hour                 |
| <b>CAPS</b>   | Combustion Air Proving Switch                  |
| <b>CEC</b>    | Canadian Electrical Code                       |
| <b>CEMS</b>   | Continuous emissions monitoring system         |
| <b>CPVC</b>   | Chlorinated polyvinyl chloride                 |
| <b>CSA</b>    | Canadian Standards Association                 |
| <b>CSST</b>   | Corrugated Stainless Steel Tubing              |
| <b>DFMA</b>   | Direct-Fired Make-up Air                       |
| <b>ECM</b>    | Electronically commutated motors               |
| <b>ESP</b>    | External static pressure                       |
| <b>EXV</b>    | Electronic expansion valve                     |
| <b>FGR</b>    | Flue gas recirculation                         |
| <b>HGPS</b>   | High gas pressure switch                       |
| <b>HMI</b>    | Human-machine interface                        |
| <b>HRT</b>    | Horizontal return tubular (boiler)             |
| <b>ICI</b>    | Industrial, commercial and institutional       |
| <b>IR</b>     | Infrared                                       |
| <b>ISO</b>    | International Organization for Standardization |
| <b>kW</b>     | kilowatts                                      |
| <b>LAER</b>   | Lowest achievable emission rate                |
| <b>LEED</b>   | Leadership in Energy and Environmental Design  |
| <b>LGPS</b>   | Low gas pressure switch                        |
| <b>LON</b>    | Local operation network                        |
| <b>LP Gas</b> | Liquified Petroleum Gas                        |
| <b>mA</b>     | milliamps                                      |
| <b>MAWP</b>   | Maximum allowable working pressure             |
| <b>MCC</b>    | Motor control centre                           |
| <b>MTFI</b>   | Mainflame Trial For Ignition                   |
| <b>mV</b>     | millivolts                                     |
| <b>MSDS</b>   | Material safety data sheet                     |
| <b>MSW</b>    | Municipal solid waste                          |
| <b>NAAQS</b>  | National Ambient Air Quality Standards         |
| <b>NAPE</b>   | National Association of Power Engineers        |
| <b>NBC</b>    | National Building Code                         |
| <b>NEMA</b>   | National Electrical Manufacturer's Association |

|                 |  |
|-----------------|--|
| <b>NFPA</b>     | National Fire Protection Association             |
| <b>NSPS</b>     | New Source Performance Standards                 |
| <b>NRR</b>      | Noise reduction rating number                    |
| <b>OH&amp;S</b> | Occupational Health and Safety                   |
| <b>OS&amp;Y</b> | Outside stem and yoke (valve)                    |
| <b>PLC</b>      | Programmable logic controller                    |
| <b>PPE</b>      | Personal protective equipment                    |
| <b>PRV</b>      | Pressure reducing valve                          |
| <b>PTFI</b>     | Pilot trial for ignition                         |
| <b>PVC</b>      | Programmable logic controller                    |
| <b>RPM</b>      | Revolutions per minute                           |
| <b>RTD</b>      | Resistance temperature detector                  |
| <b>SCR</b>      | Selective catalytic reduction                    |
| <b>TDG</b>      | Transportation of dangerous goods                |
| <b>TXV</b>      | Thermostatic expansion valve                     |
| <b>UL</b>       | Underwriters Laboratories                        |
| <b>ULC</b>      | Underwriters Laboratories of Canada              |
| <b>UST</b>      | Underground storage tank                         |
| <b>VFD</b>      | Variable frequency drive                         |
| <b>VSD</b>      | Variable speed drive                             |
| <b>WHMIS</b>    | Workplace Hazardous Materials Information System |

## Appendix C

### Previous Contributors

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