

# Apprenticeship and Industry Training

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## Transport Refrigeration Technician Curriculum Guide

041 (2022)



Apprenticeship  
and Industry  
Training

**ALBERTA ADVANCED EDUCATION**

Transport refrigeration technician: apprenticeship education program curriculum guide

ISBN 978-1-4601-5222-5

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**Transport Refrigeration Technician  
Table of Contents**

**Apprenticeship .....2**  
**Apprenticeship and Industry Training System .....2**  
**Apprenticeship Safety .....3**  
**Technical Training.....3**  
**Procedures for Recommending Revisions to the Curriculum Guide .....3**  
**Apprenticeship Route toward Academic Credential .....4**  
**Transport Refrigeration Technician Training Profile .....5**

**CURRICULUM GUIDE**

**First Period Technical Training.....9**  
**Second Period Technical Training.....19**  
**Third Period Technical Training.....26**

## Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding a sponsor. Sponsors guide apprentices, and support on-the-job learning through provision of mentorship. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyman or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution (PSI) – usually a college or technical institute.

To receive their post-secondary credential, apprentices must learn theory and skills, and they must pass examinations. Criteria for the program—including the content and delivery of technical training—are developed and updated by the Registrar.

The graduate of the Transport Refrigeration Technician apprenticeship program is an individual who will be able:

- to diagnose repair, maintain and operate transport refrigeration equipment used to heat or cool the load as well as of diesel engines, APUs and other prime movers
- to use tools and equipment in order to carry out repairs according to manufacturer's
- to read and understand work orders, prepare estimates, interpret technical references and diagrams
- to download data from monitoring systems to diagnose problems and set parameters for proper operation
- to write work orders and update maintenance logs
- to be familiar with the work in related trades such as machinist, heavy equipment technician and welder
- to be familiar with and apply all regulations and legislation associated with the industry
- to perform assigned tasks in accordance with quality and production standards required by industry

### Apprenticeship and Industry Training System

Alberta's apprenticeship programs are supported by industry stakeholders that ensures a highly skilled, internationally competitive workforce in the province. The Registrar establishes the educational standards and provides direction to the system supported by industry and the PSI's. The Ministry of Advanced Education provides the legislative framework and administrative support for the apprenticeship and industry training system.

**Special thanks are offered to the following industry members who contributed to the development of the standard:**

Mr. R. Fleming	Calgary
Mr. J. Schmode	Calgary
Mr. D. Mueller	High River
Mr. L. Brugess	Ft. McMurray .
Mr. J. Winfield	Calgary
Mr. M. Purcell	Ft. McMurray

### Alberta Government

Alberta Advanced Education works with industry, sponsor and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and sponsors
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

## **Apprenticeship Safety**

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, sponsors, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

### **Occupational Health and Safety**

Persons engaged in, or supporting an individual in an experiential learning environment are often exposed to more worksite hazards than in other forms of traditional post-secondary education and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Occupational Health and Safety-OHS (a division of Alberta Labour and Immigration) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at [www.alberta.ca/occupational-health-safety.aspx](http://www.alberta.ca/occupational-health-safety.aspx)

### **Technical Training**

Apprenticeship technical training is delivered by the PSI's throughout Alberta. The PSI's are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All PSI's place a strong emphasis on safety that complements safe workplace practices towards the development of a culture of safety for all professions.

The PSI's work with industry and Alberta Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs across the province. They develop curriculum from the curriculum guides established by the Registrar in consultation with the PSI's and industry and provide the technical training to apprentices.

The following PSI's deliver Transport Refrigeration Technician trade apprenticeship technical training:

Southern Alberta Institute of Technology (Main Campus)  
Northern Alberta Institute of Technology (Main Campus)  
(periods one and three)

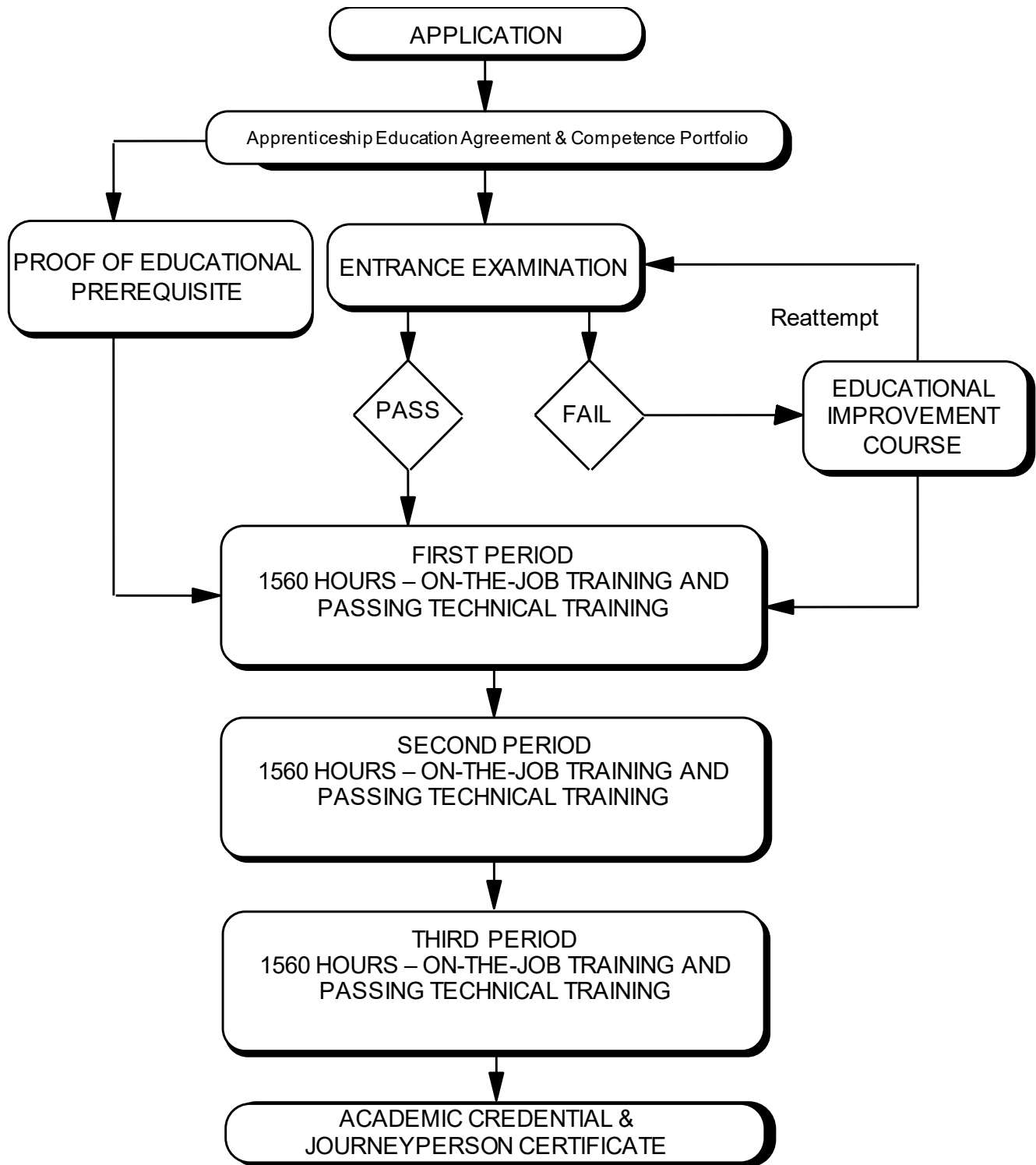
### **Procedures for Recommending Revisions to the Curriculum Guide**

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Registrar of Apprenticeship Programs  
c/o Apprenticeship Delivery and Industry Support Services  
Apprenticeship Delivery and Industry Support  
Advanced Education  
19th floor, Commerce Place  
10155 102 Street NW  
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used.

**Apprenticeship Route toward Academic Credential**



**Transport Refrigeration Technician Training Profile**  
**FIRST PERIOD**  
**(8 Weeks 30 Hours per Week – Total of 240 Hours)**

**SECTION ONE**

<b>OCCUPATIONAL SKILLS</b> 25%	<b>A</b> Safety Legislation, Regulations & Industry Policy in the Trades 3%	<b>B</b> Climbing, Lifting, Rigging and Hoisting 2%	<b>C</b> Hazardous Materials & Fire Protection 5%
	<b>D</b> Apprenticeship Training Program 3%	<b>E</b> Tools and Instruments 13%	<b>F</b> Ladders, Scaffolds and Lifts 3%
	<b>G</b> Rigging and Hoisting Equipment 10%	<b>H</b> Relevant Codes 3%	<b>I</b> Customer Relations 10%
	<b>J</b> Introduction to Drawing Interpretation 7%	<b>K</b> Pipe Working Skills Soldering and Brazing 34%	<b>L</b> Materials and Fastening Devices 7%

**SECTION TWO**

<b>INTRODUCTION TO REFRIGERATION, AIR CONDITIONING AND HEATING</b> 43%	<b>A</b> Refrigeration Principles 13%	<b>B</b> Vapour Compression Cycle 9%	<b>C</b> Introduction to Refrigeration Enthalpy and Gas Laws 19%
	<b>D</b> Air Properties and Air Flow Designs 10%	<b>E</b> Air Handling Systems and Accessories 10%	<b>F</b> Air Filtration 4%
	<b>G</b> Refrigeration and Air Conditioning Relevant Codes 4%	<b>H</b> Introduction to Valve Design and Functions 4%	<b>I</b> Refrigerant and Oil Handling 13%
	<b>J</b> Introduction Gasfitting Fundamentals 5%	<b>K</b> Properties of Gas and Principles of Combustion 4%	<b>L</b> Introduction Gasfitting Code and Regulations 5%

**SECTION THREE**

<b>INTRODUCTION TO ELECTRICAL THEORY</b> 19%	<b>A</b> Introduction to Electrical Safety, Connections and Meters 18%	<b>B</b> Current, Voltage, and Resistance 14%	<b>C</b> Series Resistive Circuits 9%
	<b>D</b> Parallel Resistive Circuits 9%	<b>E</b> Series-Parallel Resistive Circuits 14%	<b>F</b> Methods of Producing EMF and Magnetism 18%
	<b>G</b> Fundamentals of Alternating Current 14%	<b>H</b> Arc Flash and Electrical Safety 4%	

**SECTION FOUR**

**INTRODUCTIONS TO CONTROLS**  
13%



**A**

Introduction to Control Systems  
12%

**B**

Control Components  
13%

**C**

Refrigeration Controls Circuits  
31%

**D**

HVAC Controls Circuits  
25%

**E**

Building Systems Controls  
19%



**SECOND PERIOD**  
(8 Weeks 30 Hours per Week – Total of 240 Hours)

**SECTION ONE**

<b>ENGINE FUNDAMENTALS</b> 20%	<b>A</b>	<b>B</b>	<b>C</b>
	Engine Basics 19%	Blocks and Liners 8%	Pistons and Connecting Rods 9%
	<b>D</b>	<b>E</b>	<b>F</b>
	Crankshafts 6%	Camshafts 9%	Valve Trains 11%
	<b>G</b>		
	Cylinder Heads 38%		

**SECTION TWO**

<b>ENGINE SUPPORT SYSTEMS</b> 10%	<b>A</b>	<b>B</b>	<b>C</b>
	Induction Systems 24%	Exhaust Systems 24%	Emission Control Systems 28%
	<b>D</b>		
	Lubrication and Cooling Systems 24%		

**SECTION THREE**

<b>FUEL SYSTEMS</b> 16%	<b>A</b>	<b>B</b>	<b>C</b>
	Fuel Injection Components 77%	Engine Testing and Adjustments 15%	Electronic Fuel Systems 8%

**SECTION FOUR**

<b>DC FUNDAMENTALS</b> 20%	<b>A</b>	<b>B</b>	<b>C</b>
	Starting Systems 19%	Mechanical Generator Systems 19%	Battery Fundamentals 6%
	<b>D</b>	<b>E</b>	<b>F</b>
DC Electrical Circuits 25%	Wiring Diagrams 25%	Microprocessors 6%	

**SECTION FIVE**

<b>REFRIGERANT CONCEPTS</b> 20%	<b>A</b>	<b>B</b>	<b>C</b>
	Compressors 12%	Refrigeration Components 20%	System Specific Diagnostics 31%
	<b>D</b>	<b>E</b>	
Soldering and Brazing 25%	Factors Affecting System Performance 12%		

**SECTION SIX**

<b>SECONDARY SYSTEMS</b> 12%	<b>A</b>	<b>B</b>	<b>C</b>
	Liquid Propane Gas (LPG) Heating Systems 21%	Liquid Fuel Fired Heating Systems 64%	Auxiliary Power Systems 15%

**SECTION SEVEN**

<b>WORKPLACE COACHING</b> 2%	<b>A</b>
	Workplace Coaching Skills 100%

**THIRD PERIOD**  
**(8 Weeks 30 Hours per Week – Total of 240 Hours)**

**SECTION ONE**

**BASIC REFRIGERATION AND AIR CONDITIONING**  
 54%



<b>A</b>	<b>B</b>	<b>C</b>
Evaporator Feed Controls and Refrigeration Effect 12%	Automatic Flow Controls and Applications 8%	Refrigeration Accessories 3%
<b>D</b>	<b>E</b>	<b>F</b>
Compressors 11%	Evaporators and Condensers 5%	Evaporating Condensers and Cooling Towers 5%
<b>G</b>	<b>H</b>	<b>I</b>
System Install and Commissioning 28%	System Calculations and Analysis 19%	Retrofitting and Conversions 6%
<b>J</b>		
Split Systems 3%		

**SECTION TWO**

**BASIC HEATING**  
 13%



<b>A</b>	<b>B</b>	<b>C</b>
Natural Draft Burner Adjustments and Gas Consumption 18%	Pilots, Pilot Burners, Thermocouples and Thermopiles 19%	Pressure Regulators and Orifices 25%
<b>D</b>	<b>E</b>	<b>F</b>
Introduction to Flues, Draft Hoods and Vent Connections 19%	Single Line Drawings 13%	Heating with Alternative Methods 6%

**SECTION THREE**

**BASIC CONTROLS**  
 13%



<b>A</b>	<b>B</b>	<b>C</b>
Principles of Automatic Heating and Cooling Controls 18%	Temperature Sensing and Control Devices 13%	Basic Gas-Fired Forced-Air Heating Systems 19%
<b>D</b>	<b>E</b>	<b>F</b>
Mid/High-Efficiency/Gas-Fired/Forced-Air Heating Systems 19%	Basic Hot Water Heating Systems 6%	HVAC Units 25%

**SECTION FOUR**

**BASIC ELECTRICAL THEORY**  
 20%



<b>A</b>	<b>B</b>	<b>C</b>
Single Phase Transformers 8%	Single Phase Motors 29%	Compressor and Electrical Circuit Components 21%
<b>D</b>	<b>E</b>	<b>F</b>
Three Phase Fundamentals 13%	Troubleshooting Electrical Problems 21%	Introduction to Canadian Electrical Code 4%
<b>G</b>		
Class 1 and Class 2 Circuits 4%		

**FIRST PERIOD TECHNICAL TRAINING  
TRANSPORT REFRIGERATION TECHNICIAN TRADE  
CURRICULUM GUIDE**

*UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.*

**SECTION ONE:.....OCCUPATIONAL SKILLS .....25%**

**A. Safety Legislation, Regulations & Industry Policy in the Trades..... 3%**

**Outcome:**     ***Apply legislation, regulations and practices ensuring safe work in this trade.***

1. Demonstrate the application of the Occupational Health and Safety Act, Regulation and Code.
2. Describe the sponsor's and employee's role with Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations and related advisory bodies and agencies.
3. Describe industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of worker and sponsors to apply emergency procedures.
5. Describe tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of sponsors and employees with the selection and use of personal protective equipment (PPE).
7. Maintain required PPE for tasks.
8. Use required PPE for tasks.

**B. Climbing, Lifting, Rigging and Hoisting ..... 2%**

**Outcome:**     ***Use industry standard practices for climbing, lifting, rigging and hoisting in this trade.***

1. Describe manual lifting procedures.
2. Describe rigging hardware and associated safety factors.
3. Select equipment for rigging loads.
4. Describe hoisting and load moving procedures.
5. Maintain personal protective equipment (PPE) for climbing, lifting and load moving equipment.
6. Use PPE for climbing, lifting and load moving equipment.

**C. Hazardous Materials & Fire Protection ..... 5%**

**Outcome:**     ***Apply industry standard practices for hazardous materials and fire protection in this trade.***

1. Describe roles, responsibilities, features and practices related to the Workplace Hazardous Materials Information System (WHMIS) program.
2. Describe three key elements of WHMIS.
3. Describe handling, storing and transporting procedures for hazardous material.
4. Describe venting procedures when working with hazardous materials.
5. Describe hazards, classes, procedures and equipment related to fire protection.

- D. Apprenticeship Training Program..... 3%**
- Outcome:     *Manage an apprenticeship to earn journey person certification.***
1. Describe the contractual responsibilities of the apprentice, sponsor and Alberta Apprenticeship and Industry Training.
  2. Describe the purpose of the apprentice competency portfolio.
  3. Describe the procedure for changing sponsors during an active apprenticeship.
  4. Describe the purpose of the curriculum guide.
  5. Describe the procedure for advancing through apprenticeship.
  6. Describe advancement opportunities in this trade.
- E. Tools and Instruments..... 13%**
- Outcome:     *Use hand tools and power tools.***
1. Describe types, uses and care of hand, power tools and equipment.
  2. Demonstrate the use of hand tools and power tools used in the industry.
  3. Demonstrate proper connections of refrigeration gauges and operation of service valves.
  4. Perform calculations related to measurement using imperial and metric units.
- F. Ladders, Scaffolds and Lifts ..... 3%**
- Outcome:     *Use ladders, scaffolds and lifts.***
1. Describe the use of various types of ladders.
  2. Describe the use of various types of scaffolds.
  3. Describe the use of various types of lifts.
- G. Rigging and Hoisting Equipment ..... 10%**
- Outcome:     *Use rope and rigging components to hoist equipment.***
1. Describe the various types, parts, care and maintenance of natural and synthetic rope.
  2. Identify and describe the proper procedure for tying popular knots, and hitches.
  3. Describe types, parts and care and maintenance of wire ropes.
  4. Name differences between chain falls, come-a-longs, tiffors and snatch blocks.
  5. Describe characteristics of safe workloads of slings used for hoisting pipe, appliances and components.
  6. Describe hand signals when directing a crane.
  7. Demonstrate tying of knots and hitches.
- H. Relevant Codes ..... 3%**
- Outcome:     *Apply codes used in the refrigeration and air conditioning (RAC) industry.***
1. Describe the refrigeration codes that apply to RAC work.
  2. Describe the gas codes that apply to RAC work.
  3. Describe the plumbing codes that apply to RAC work.

4. Describe the electrical codes that apply to RAC work.
5. Describe the sheet metal codes that apply to RAC work.

**I. Customer Relations ..... 10%**

**Outcome:**     **Demonstrate effective customer relations.** 1. Describe effective communication techniques.

2. Describe methods used to determine customers' needs.
3. Describe customer reporting methods.
4. Describe job completion strategies.

**J. Introduction to Drawing Interpretation ..... 7%**

**Outcome:**     **Interpret basic drawing information.**

1. Use basic information found on drawings.
2. Interpret basic drawings.
3. Identify common symbols used in drawings and legends.
4. Identify abbreviations used in drawings.

**K. Pipe Working Skills, Soldering and Brazing ..... 34%**

**Outcome:**     **Apply pipe working skills on refrigeration, gas and plumbing pipe.**

1. Describe tools, equipment and material used for pipe work.
2. Describe tools and equipment used for soldering.
3. Describe tools and equipment used for brazing.
4. Describe oxyfuel equipment components, functions and maintenance.
5. Describe procedures of oxyfuel equipment use.
6. Demonstrate use of tools, equipment and material for pipe work.
7. Demonstrate use of tools and equipment for soldering.
8. Demonstrate use of tools and equipment for brazing.
9. Demonstrate oxyfuel leak detection, adjusting, operating, and shutdown procedures.

**L. Materials and Fastening Devices ..... 7%**

**Outcome:**     **Use materials and fasteners commonly used in the industry.**

1. Describe metallic and non-metallic materials' characteristics and applications.
2. Describe types of threaded fasteners and their applications.
3. Describe thread repair methods.
4. Describe types of non-threaded fasteners and their applications.
5. Demonstrate removal of seized and damaged fasteners.

**SECTION TWO: INTRODUCTION TO REFRIGERATION, AIR CONDITIONING AND HEATING.....43%****A. Refrigeration Principles..... 13%****Outcome: Explain the basic operation of a refrigeration system.**

1. Define the terms related to refrigeration principles.
2. Describe the basic concepts of heat transfer.
3. Describe methods of heat transfer.
4. Describe the laws of thermal dynamics.
5. Describe the units of measure pertaining to heat transfer.
6. Describe the function of refrigeration in transportation.
7. Perform calculations related to heat transfer.
8. Convert temperatures and pressures between various scales.

**B. Vapour Compression Cycle ..... 9%****Outcome: Explain the vapour compression cycle.**

1. Describe the basic concepts of the vapour compression cycle.
2. Describe the four essential components of a refrigeration system.
3. Describe the stages of the refrigeration cycle.
4. Describe the basic operating principles and applications of multiple evaporator systems.
5. Describe the basic difference between single and multiple evaporator systems.
6. Measure the refrigeration cycle on a working system.
7. Demonstrate the operation of a refrigeration system using a diagram.

**C. Introduction to Refrigeration Enthalpy and Gas Laws..... 19%****Outcome: Apply gas laws and pressure enthalpy charts to refrigeration systems.**

1. Define terms used in refrigeration and heating.
2. Describe gas laws and how they apply to thermal dynamics.
3. Describe fluids and fluid piping systems as it relates to refrigeration systems.
4. Describe the units of measurement used in refrigeration calculations.
5. Apply formulas used in calculating gas laws and pressure enthalpy.
6. Describe the components of a pressure enthalpy diagram.
7. Plot a basic cycle using a pressure enthalpy diagram.
8. Demonstrate use of formulas for calculating gas laws and pressure enthalpy.

**D. Air Properties and Air Flow Designs..... 10%****Outcome: Apply the properties of air as it relates to basic air flow design.**

1. Describe air properties as it relates to heat transfer.
2. Describe methods of heat transfer as they relate to air flow.
3. Describe units of measurement as it relates to air properties.

4. Describe methods used in calculating air flow design.
5. Calculate air flow required for a given heat transfer system.
6. Describe psychometrics.
7. Describe the meaning, function and uses of psychometric charts.
8. Plot and interpret a psychometric chart.

**E. Air Handling Systems and Accessories ..... 10%**

**Outcome:      *Service air handling systems and accessories.***

1. Describe air handling systems.
2. Describe air handling systems components.
3. Describe air handling accessories.
4. Describe air handling equipment maintenance requirements.
5. Define terms and components used in fans, belts and mechanical drives.
6. Demonstrate fan belt installation and mechanical drive alignment.

**F. Air Filtration ..... 4%**

**Outcome:      *Analyze efficiencies of air filtration systems.***

1. Define terms related to filtration.
2. Define filtration components and their application.
3. Describe the operation and efficiency of air filters.
4. Calculate velocities and pressure drops through filters.

**G. Refrigeration and Air Conditioning Relevant Codes ..... 4%**

**Outcome:      *Apply how the B52 Mechanical Refrigeration Code and the Canadian Code of Practice in the Refrigeration and Air Conditioning industry work in Alberta.***

1. Explain the scope and jurisdiction of the different codes.
2. Describe how the B52 relates to the Refrigeration and Air Conditioning industry.
3. Describe how the Canadian Code of Practice relates to the Refrigeration and Air Conditioning industry.
4. Demonstrate how the B52 is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work.
5. Demonstrate how the Canadian Code of Practice is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work.

**H. Introduction to Valve Design and Functions ..... 4%**

**Outcome:      *Maintain or repair valves in RAC systems.***

1. Describe general valve designs.
2. Describe applications of various valves.
3. Describe valve designs for various refrigeration system applications.
4. Describe the purpose, types and procedures for service valves.

5. Describe the purpose, types, construction, location and operation of suction-throttling valves.
6. Demonstrate operation of service valves.

**I. Refrigerant and Oil Handling ..... 13%**

**Outcome:      *Handle refrigerant and refrigeration oil safely.***

1. Describe the evolution and properties of refrigerants and their oils.
2. Describe the safe handling and storage of refrigerants and refrigeration oils.
3. Describe the safe recovery and disposal of refrigerants and refrigeration oils.
4. Describe leak testing methods and instruments used.
5. Describe the evacuation process of refrigeration systems.
6. Describe non OEM refrigerant products available in the industry.
7. Demonstrate the safe recovery and disposal of refrigerants.
8. Demonstrate the safe recovery and disposal of refrigeration oils.
9. Demonstrate leak testing methods and instruments used.
10. Demonstrate the evacuation process of refrigeration systems.
11. Demonstrate the proper maintenance procedures of recovery and evacuation equipment.
12. Demonstrate cleaning procedures for a contaminated system.
13. Complete Heating Refrigeration Air Conditioning Institute (HRAI) refrigerant handling training.

**J. Introduction to Gasfitting Fundamentals ..... 5%**

**Outcome:      *Explain and identify basic gas fundamentals and the purpose, legal status and organization of CAN/CSA Natural Gas and Propane Installation Codes B149.1, B149.2 and the Gas Bulletins.***

1. Describe historical foundations, career opportunities and trade regulatory structure.
2. Describe production, distribution and storage of natural gas.
3. Describe production, distribution and storage of propane gas.
4. State regulations pertaining to the general requirements of the gasfitter trade.
5. Interpret regulations pertaining to the gasfitter trade.

**K. Properties of Gas and Principles of Combustion ..... 4%**

**Outcome:      *Explain basic gas fundamentals.***

1. Identify chemical formulas used by the Refrigeration and Air Conditioning Mechanic trade.
2. Describe the relative densities, liquefaction ratios and heating value of gases.
3. Calculate appliance input values using properties of gases.
4. Identify definitions specific to combustion.
5. Explain the principles of combustion as a chemical change.



6. Describe the products of complete and incomplete combustion.
7. Describe the requirements for combustion air.
8. Describe flame adjustment techniques and correct safety practices when adjusting gas-fired equipment.

**L. Introduction to Gasfitting Code and Regulations..... 5%**

**Outcome:** *Apply standards pertaining to the installation of piping and tubing systems for various conditions of use in accordance with the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins.*

1. Describe the regulations contained in the scope section of the CAN/CSA B149.1 Natural Gas and Propane Installation Codes, amendments to the code and the regulations pertaining to installers responsibilities.
2. List the regulations contained in the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins pertaining to installation of piping and fittings.
3. List the regulations contained in the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins pertaining to testing of piping and fittings.
4. List the regulations contained in the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins pertaining to purging of piping and fittings.
5. Describe safety practices to be used pertaining to installation of piping and fittings.
6. Describe safety practices to be used pertaining to testing of piping and fittings.
7. Describe safety practices to be used pertaining to purging of piping and fittings.

**SECTION THREE: .....INTRODUCTION TO ELECTRICAL THEORY..... 19%**

**A. Introduction to Electrical Safety, Connections and Meters ..... 18%**

**Outcome:** *Use safe work practices on electrically energized equipment.*

1. Describe the hazards related to working with electrical circuits.
2. Describe safety precautions when working with electrical circuits.
3. Describe the physical properties of conductors, semiconductors and insulators.
4. Describe lockout tag out procedures related to working on electrical equipment.
5. Describe types of electrical connections.
6. State the applications of the various meters.
7. List the care and precautions associated with using meters.
8. Identify the connections for meters.
9. Demonstrate electrical connections.
10. Demonstrate range selection and connections of voltmeter, ammeter, ohmmeter and insulation testers.

- B. Current, Voltage, and Resistance ..... 14%**
- Outcome:** *Apply knowledge of voltage, current and resistance and determine how changing the value of any one of them affects the circuit.*
1. Describe an electric current.
  2. Describe voltage, current and power.
  3. Describe resistance and state and apply Ohm's Law.
  4. Connect and verify relationships between voltage, current and resistance according to Ohm's Law.
- C. Series Resistive Circuits..... 9%**
- Outcome:** *Connect a series resistive circuit and analyze the relationships between current, resistance and voltage.*
1. Define a series circuit.
  2. Apply the formula for total resistance in a series circuit.
  3. Apply Kirchhoff's voltage law to a series circuit.
  4. Determine the voltage drop across a closed-or-open-circuit component in a series circuit.
  5. Connect and verify Kirchhoff's current and voltage laws in a series resistive circuit.
- D. Parallel Resistive Circuits..... 9%**
- Outcome:** *Connect a parallel resistive circuit and analyze the relationships between current, resistance and voltage.*
1. Define a parallel circuit.
  2. Apply the formula for a total resistance in a parallel circuit.
  3. Apply Kirchhoff's current law to a parallel circuit.
  4. Describe the effects of open circuits on a parallel circuit.
  5. Connect and verify Kirchhoff's current law in a parallel resistive circuit.
- E. Series-Parallel Resistive Circuits ..... 14%**
- Outcome:** *Connect and analyze a series-parallel resistive circuit.*
1. Identify resistors that are in series.
  2. Identify resistors that are in parallel.
  3. Calculate the total resistance of a series-parallel circuit.
  4. Apply Kirchhoff's current law.
  5. Apply Kirchhoff's voltage law.
  6. Solve problems involving series-parallel circuits.
  7. Connect and verify the relationship of current, voltage and resistance in each part of a series/parallel circuit.

**F. Methods of Producing Electro Motive Force (EMF) and Magnetism ..... 18%****Outcome: Apply knowledge of EMF when servicing RAC equipment.**

1. Describe the production of EMF by using chemicals.
2. Describe the production of EMF by using heat.
3. Describe the production of EMF by using pressure.
4. Describe the production of EMF by using light.
5. Describe the production of EMF by using magnetism.
6. Describe the production of EMF by using electrostatics.
7. Describe the properties of magnetic materials.
8. Define the terminology related to magnetism.
9. Describe electromagnetism and basic design considerations for electromagnetic devices.
10. Describe how an induced voltage is generated.
11. Describe the process of electromagnetic induction.

**G. Fundamentals of Alternating Current..... 14%****Outcome: Apply knowledge of ac circuits when servicing RAC equipment.**

1. Describe the generation of an ac sine wave.
2. Determine the output frequency of an ac generator.
3. Calculate standard ac sine wave values.
4. Demonstrate the relationship between sine waves and phasor diagrams.
5. List the factors affecting impedance in an ac circuit.

**H. Arc Flash and Electrical Safety..... 4%****Outcome: Recognize arc flash hazards in electrical installations.**

1. Identify the hazards associated with arc flash.
2. Describe the personal protective equipment related to arc flash.
3. Describe lockout procedures related to energized systems.

**SECTION FOUR: .....INTRODUCTION TO CONTROLS ..... 13%****A. Introduction to Control Systems ..... 12%****Outcome: Service control systems used for heating and cooling.**

1. Describe terminology used in control systems.
2. Describe heating and cooling controls.
3. Describe heating and cooling control systems.
4. Interpret electrical diagrams used to show the function of a heating or cooling control system.

**B. Control Components..... 13%****Outcome: Service components used in control systems.**

1. Describe the components of heating and cooling systems.
2. Describe the construction of control system components.
3. Describe the application of control components for heating and cooling system.
4. Describe the operation of control system components.

**C. Refrigeration Control Circuits..... 31%****Outcome: Use control circuits for refrigeration systems.**

1. Describe components used in control circuits for refrigeration systems.
2. Describe the differences between medium and low temperature control circuits.
3. Describe the components of a medium temperature control circuit.
4. Describe the components of a low temperature control circuit.
5. Connect and verify operation of a medium temperature cooling control system.
6. Connect and verify operation of a low temperature cooling control system.

**D. Heating Ventilating Air Conditioning (HVAC) Control Circuits..... 25%****Outcome: Use control circuits for HVAC systems.**

1. Describe components used in HVAC control circuits.
2. Describe the construction of HVAC control system components.
3. Describe the application of control components for HVAC system.
4. Describe the operation of HVAC control system components.
5. Connect and verify operation of a HVAC control system.

**E. Building Systems Controls..... 19%****Outcome: Service building system control circuits.**

2. Describe components used in building control circuits.
3. Describe components and their applications of a pneumatic control system.
4. Describe the construction of building control system components.
5. Describe the application of control components for building system.
6. Describe the operation of building control systems.
7. Describe other systems that affect building control systems.

**SECOND PERIOD TECHNICAL TRAINING  
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UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

**SECTION ONE:.....ENGINE FUNDAMENTALS .....20%**

**A. Engine Basics..... 19%**

**Outcome:** *Explain the operating principles and design features of diesel engines.*

1. Describe engine terms and definitions.
2. Describe methods of classifying engines.
3. Describe the principles of operation for four stroke cycle engines.
4. Compare prime mover technologies.

**B. Blocks and Liners ..... 8%**

**Outcome:** *Describe the functions and design of cylinder block assemblies.*

1. Describe the functions, construction and design of engine cylinder blocks and liners.
2. Inspect engine block and liners for problems and wear.
3. Describe cylinder block repair and reconditioning procedures.

**C. Pistons and Connecting Rods ..... 9%**

**Outcome:** *Describe the functions and design of pistons, rings and connecting rods.*

1. Describe the function, construction and design features of piston and connecting rod assemblies.
2. Describe inspection and measurement of piston and connecting rod assemblies.

**D. Crankshafts ..... 6%**

**Outcome:** *Describe the functions and design of crankshafts and related components.*

1. Describe the function, lubrication, design features of crankshafts and related components.
2. Describe methods used to achieve engine balance.
3. Identify common crankshaft and bearing failures.
4. Measure a crankshaft to determine wear and serviceability.

**E. Camshafts ..... 9%**

**Outcome:** *Describe the functions and design of camshafts and related components.*

1. Explain the function and design features of camshaft assemblies.
2. Describe camshaft drive mechanisms and timing
3. Measure a camshaft to determine wear and serviceability.

**F. Valve Trains ..... 11%**

**Outcome: Service valve train components.**

1. Describe the design, construction and operation of valve trains and related components.
2. Describe the function and adjustment of the valves.
3. Measure valve train components to determine wear and serviceability.

**G. Cylinder Heads ..... 38%**

**Outcome: Service cylinder head components.**

1. Explain the function, construction and design features of cylinder heads.
2. Identify cylinder head sealing and retention devices.
3. Demonstrate cylinder head removal, inspection, installation procedures and precautions.
4. Diagnose cylinder head problems.

**SECTION TWO:..... ENGINE SUPPORT SYSTEMS ..... 10%**

**A. Induction Systems ..... 24%**

**Outcome: Service air induction systems and related components.**

1. Describe the functions of air induction system components.
2. Describe the service procedures for air induction systems.
3. Describe the use of test equipment to measure air inlet restriction.

**B. Exhaust Systems ..... 24%**

**Outcome: Service exhaust systems and related components.**

1. Describe the function and features of the exhaust system and components.
2. Demonstrate removal and installation procedures for exhaust components.
3. Describe the need for venting the exhaust system gases.

**C. Emission Control Systems..... 28%**

**Outcome: Service emission control systems and related components.**

1. Describe emission control systems, components, function and operation.
2. Diagnose and repair emission control systems.
3. Test engine exhaust temperature.

**D. Lubrication and Cooling Systems ..... 24%**

**Outcome: Diagnose lubrication and cooling systems faults.**

1. Describe function and operation of lubrication system components.
2. Demonstrate oil pressure test procedures.
3. Repair lubrication problems.
4. Describe functions and operations of cooling systems.

**SECTION THREE: .....FUEL SYSTEMS..... 16%**

**A. Fuel Injection Components ..... 77%**

**Outcome:      *Perform service and repair on fuel injection systems.***

1. Describe the types, design, and operation of transfer pumps.
2. Demonstrate diagnosis, removal and installation procedures for transfer pumps.
3. Describe the demand requirements of an injection system.
4. Describe the design, components, function and maintenance of fuel injection systems.
5. Describe timing advance functions and operations.
6. Demonstrate adjusting and timing procedures.
7. Describe the designs, principle of operation, characteristics, and application of metering systems.
8. Demonstrate removal and installation precautions.
9. Demonstrate inspection and diagnosis procedures for injection systems.
10. Demonstrate replacement and bleeding of injectors.
11. Describe the characteristics and operation of governors.
12. Diagnose problems of governors.

**B. Engine Testing and Adjustments ..... 15%**

**Outcome:      *Perform engine testing and adjustments.***

1. Demonstrate start up, run-up, test and shut down procedures.
2. Diagnose incorrect operating conditions.
3. Demonstrate repairs and adjustments.
4. Describe the effect of altitude change and severe weather conditions.

**C. Electronic Fuel Systems..... 8%**

**Outcome:      *Explain the operating principles and design features of an electronic fuel system.***

1. Describe various types of electronic fuel systems.
2. Identify the components of each type of electronic fuel systems.
3. Describe the operation of an electronic fuel system.

**SECTION FOUR: ..... DC FUNDAMENTALS ..... 20%**

**A. Starting Systems ..... 19%**

**Outcome:      *Demonstrate a working knowledge of a starting system.***

1. Describe components, designs and operating principles of starter systems.
2. Diagnose starting system problems utilizing a starter load test.
3. Repair starting system problems.

**B. Mechanical Generators Systems..... 19%**

**Outcome:      *Demonstrate a working knowledge of a dc charging system.***

1. Identify the parts and output of a 12 V dc alternator.
2. Explain the principle of operation and types of alternators.
3. Demonstrate diagnosis of alternator electrical and mechanical faults.
4. Describe common regulator types, function and factors impacting operation.
5. Demonstrate testing and precautions of regulators and circuits.
6. Trace circuits utilizing schematic diagrams and test equipment.
7. Define common charging system terminology.
8. Overhaul an alternator.

**C. Battery Fundamentals ..... 6%**

**Outcome:      *Perform battery maintenance, testing and storage.***

1. List safety precautions and procedures for boosting and charging batteries.
2. Describe multiple battery circuits in relation to connections and battery compatibility.

**D. DC Electrical Circuits..... 25%**

**Outcome:      *Demonstrate a working knowledge of dc theory.***

1. Explain the relationship between the structure of the atom and the flow of electrons.
2. Define quantity, express symbols and units of measurement.
3. Perform calculations using Ohm's Law.
4. Construct circuits and make voltage, current and resistance measurements.
5. Identify applications of series, parallel and series-parallel circuits.
6. Define Kirchoff's Laws.
7. Measure a circuit to demonstrate Kirchoff's current and voltage laws.
8. Define resistance and what factors impact it.
9. Define insulators.
10. Describe the components, purpose, location, operation and diagnosis of an electronic circuit.
11. Describe the loads controlled by the electronic circuits.
12. Diagnose problems using diagrams and test equipment.
13. Describe the importance of heat dissipation in electrical circuits.
14. Describe magnetic attraction and repulsion.
15. Describe electromagnetism and related terms.
16. Describe the methods used to generate ac and dc.
17. Describe the relationship between cycles, poles and frequency.
18. Identify the basic construction, operation and calculations for transformers.



**E. Wiring Diagrams..... 25%**

**Outcome: Demonstrate a working knowledge of electrical circuits in service work.**

1. Identify the components within transport systems heating and cooling circuits.
2. Demonstrate troubleshooting circuits using schematics, diagrams and testing procedures.
3. Demonstrate test procedures for low and high voltage systems.
4. Demonstrate test procedures for multi-voltage systems.

**F. Microprocessors ..... 6%**

**Outcome: Demonstrate a working knowledge of control circuits in service work.**

1. Identify the components and their location within microprocessors.
2. Describe the electrostatic discharge precautions for microprocessors service.
3. Demonstrate the procedures to access the operating screens from the microprocessor.
4. Explain the purpose of software revisions and the upgrade methods.
5. Interpret the alarm codes and clearing procedures.
6. Download data from onboard microprocessor to a computer.
7. Explain the security levels in microprocessors.

**SECTION FIVE.....REFRIGERANT CONCEPTS ..... 20%**

**A. Compressors ..... 12%**

**Outcome: Perform compressor diagnosis and repairs.**

1. Describe compressor's components and designs.
2. Describe refrigerant flow through a compressor.
3. Describe the lubrication of compressors.
4. Demonstrate diagnosis and reconditioning procedures.
5. Identify direction of rotation for lubrication.
6. Describe compressor shaft seals replacement.

**B. Refrigeration Components..... 20%**

**Outcome: Describe the purpose of refrigeration components.**

1. Describe the operation of a refrigeration system using a diagram.
2. Identify the components and their functions.
3. Describe the purpose, types, construction and air flow of an evaporator.
4. Explain how distributors avoid excessive pressure drops in a system.
5. Describe the purpose, types and procedures for service valves.
6. Identify the purpose, types, construction, location and operation of suction-throttling valves.
7. Explain the purpose of the pressure safety release valves.
8. Recognize the types of pressure release devices.
9. Describe the operating principles and applications of multiple evaporator systems.

10. Explain the difference between single and multiple evaporator systems.
11. Describe the operating principles and applications of multiple compressor systems.

**C. System Specific Diagnostics ..... 31%**

**Outcome: Diagnose and repair mobile refrigeration systems.**

1. Demonstrate master check procedures to evaluate unit condition.
2. Interpret manifold gauge readings for diagnostic purposes.
3. Test system operations to ensure superheating and sub-cooling conditions.
4. Describe the characteristics of a starving evaporator.
5. Describe the characteristics of a flooded evaporator.
6. Test 3-way valve operation and service.
7. Test flow control devices and service.
8. Replace faulty valves in a refrigeration system.
9. Diagnose a distributor tube.
10. Describe the heating method for accumulators.
11. Adjust suction pressure to specifications.
12. Verify optimal performance of system.
13. Identify components that can be replaced after a pump down versus an evacuation.

**D. Soldering and Brazing ..... 25%**

**Outcome: Perform soldering and brazing operations.**

1. Describe the characteristics, composition, and safe handling of welding gases and cylinders.
2. Identify the oxyfuel equipment parts, function and maintenance.
3. Demonstrate oxyfuel leak detection, adjusting, operating, and shutdown procedures.
4. Describe the problems and corrective procedures of oxyfuel equipment use.
5. Describe solder and brazing materials.
6. Describe repairs that can be achieved with brazing and soldering.
7. Demonstrate soldering and brazing.
8. Demonstrate tubing flaring, repairs, bending, swedging and pinching.
9. Describe the purpose and procedure for annealing copper tubing.

**E. Factors Affecting System Performance..... 12%**

**Outcome: Describe physical factors that impact refrigeration.**

1. Describe the purpose of insulation and seals within the industry.
2. Identify product temperature for loading, heat removal and temperature stabilization.
3. Describe the principles, methods, conditions and precautions for food and other cargo during loading, preservation and air circulation.
4. Calculate heat removal for the pre-cooling, heat removal, temperature stabilization and wall heat gain.
5. Fill out manufacturer's forms for load estimating.

6. Calculate product and total loads considering cargo safety.

**SECTION SIX:.....SECONDARY SYSTEMS..... 12%**

**A. Liquid Propane Gas (LPG) Heating Systems ..... 21%**

**Outcome: Perform service and maintenance on liquid propane gas heating systems.**

1. Describe construction and operating principles of catalytic heaters.
2. Describe safety precautions when lighting, servicing and installing heating systems.
3. Demonstrate handling, storage, testing procedures and precautions.
4. Describe insulators, isolators, and expansion devices.
5. Describe types and operation of mobile storage tanks.
6. Describe storage tank mounting and security precautions.
7. Describe the capacity and filling of L.P.G. tanks.
8. Demonstrate servicing, testing and adjustments of heating systems.

**B. Liquid Fuel Fired Heating Systems ..... 64%**

**Outcome: Perform service and maintenance on liquid fired heating systems.**

1. Describe construction and operating principles of fuel fired heaters.
2. Describe safety precautions for servicing and installing fuel fired heater systems.
3. Demonstrate testing procedures and precautions.
4. Demonstrate the servicing, testing and adjustment of fuel fired heater systems.

**C. Auxiliary Power Systems ..... 15%**

**Outcome: Demonstrate service and repair of auxiliary power systems.**

1. Describe purpose, construction and operating principles of auxiliary power units.
2. Describe the conditions and regulations that require auxiliary power units.
3. Describe the diagnosis and service of auxiliary power units.

**SECTION SEVEN: ..... WORKPLACE COACHING ..... 2%**

**A. Workplace Coaching Skills ..... 100%**

**Outcome: Use coaching skills when training an apprentice.**

1. Describe the process for coaching an apprentice.

**THIRD PERIOD TECHNICAL TRAINING  
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**SECTION ONE:..... BASIC REFRIGERATION AND AIR CONDITIONING.....54%**

**A. Evaporator Feed Controls and Refrigeration Effect ..... 12%**

**Outcome:     *Service evaporator feed controls on refrigeration equipment.***

1. Define terms related to evaporator feed control and refrigeration effect.
2. Describe types and operations of evaporator feed controls.
3. Describe components of evaporator feed control systems.
4. Describe control characteristics of expansion control devices.
5. Describe methods of producing the refrigeration effect.
6. Determine the proper metering device for various applications.
7. Demonstrate troubleshooting techniques of metering devices.
8. Measure superheat and adjust a thermal expansion valve (TXV).

**B. Automatic Flow Controls and Applications ..... 8%**

**Outcome:     *Use automatic flow controls in a refrigeration system.***

1. Define terms related automatic flow controls.
2. Describe components of automatic flow controls.
3. Describe the operation of automatic flow controls.
4. Describe the application of automatic flow controls.
5. Demonstrate service of automatic flow controls.

**C. Refrigeration Accessories ..... 3%**

**Outcome:     *Maintain and repair refrigeration accessories.***

1. Define terms related to refrigeration accessories.
2. Describe components related to refrigeration accessories.
3. Describe the operation of various refrigeration accessories.
4. Describe the application of various refrigeration accessories.

**D. Compressors ..... 11%**

**Outcome:     *Perform compressor diagnosis and repairs.***

1. Define terms related to compressors and refrigeration circuit components.
2. Describe types of compressors used in refrigeration and air conditioning systems.
3. Describe the components and operating characteristics of compressors.
4. Define terms related to compressor mechanical components.
5. Describe compressor components and their applications.

6. Describe the compression process and the flow of gas through the compressor.
7. Describe types of compressor lubrication.
8. Describe mechanical and electrical oil failure controls.
9. Describe capacity control systems.
10. Label a compressor circuit.
11. Disassemble and reassemble a small semi hermetic compressor.
12. Identify direction of rotation for lubrication.
13. Install, wire and check the operation of an oil failure control.

**E. Evaporators and Condensers ..... 5%**

**Outcome:** *Explain the operation and components of evaporators and condensers.*

1. Define terms related to evaporators and condensers.
2. Describe evaporator components and their applications.
3. Describe evaporator defrost methods.
4. Describe condenser components and their applications.
5. Describe service and repair of evaporators and condensers.
6. Describe how distributors avoid excessive pressure drops in a system.
7. Demonstrate evaporator and condenser sizing and balancing methods.

**F. Evaporative Condensers and Cooling Towers ..... 5%**

**Outcome:** *Explain the operation and components of evaporative condensers and cooling towers.*

1. Define terms related to evaporative condensers and cooling towers.
2. Describe evaporative condenser components and their applications.
3. Describe cooling tower components and their applications.
4. Describe water treatment procedures as it relates to cooling towers.
5. Describe seasonal operation of cooling towers.

**G. System Install and Commissioning ..... 28%**

**Outcome:** *Performs system install and commissioning of refrigeration and air conditioning (RAC) systems.*

1. Describe methods of selecting and locating system components.
2. Describe methods of mounting condensing units and evaporators.
3. Describe methods of connecting piping and accessories to an RAC system.
4. Compare the use of various piping materials.
5. Sketch an electrical wiring schematic for an RAC system.
6. Sketch a piping schematic for an RAC system.
7. Install and connect an RAC system.

8. Start-up an RAC system.
9. Complete a commissioning report for an RAC system.

**H. System Calculation and Analysis ..... 19%**

**Outcome:**     ***Troubleshoot, calculate and analyze refrigeration and air conditioning (RAC) systems.***

1. Define thermal dynamics as it pertains to service and troubleshooting of RAC systems.
2. Describe pressure enthalpy diagrams as they relate to various RAC system conditions.
3. Describe formulas used in analyzing system thermal dynamics.
4. Analyze and troubleshoot RAC systems using pressure enthalpy diagrams and system thermal dynamic formulas.
5. Use tools and charts to troubleshoot RAC systems under various conditions.

**I. Retrofitting and Conversions ..... 6%**

**Outcome:**     ***Perform retrofitting and conversions on RAC equipment.***

1. Describe steps used in designing and retrofitting or converting RAC systems.
2. Describe the hazards related to retrofitting or converting RAC systems.
3. Describe start-up and monitoring steps of a retrofitted or converted RAC system.

**J. Split Systems ..... 3%**

**Outcome:**     ***Service split cooling systems.***

1. Identify the components used in a typical cooling system.
2. Describe the operation of a typical cooling system.
3. Identify the requirements for combining a basic cooling system with an existing forced-air heating system.
4. Observe the operation of a combined heating and cooling system.

**SECTION TWO: ..... BASIC HEATING ..... 13%**

**A. Natural Draft Burner Adjustments and Gas Consumption ..... 18%**

**Outcome:**     ***Install and adjust pressure controls and gas-fired burners using ratings plates, gas meters, manometers and mechanical gauges to optimize consumption for gas-fired appliances.***

1. Determine appliance settings using rating plates, altitude designation and listed approval agencies.
2. Describe the requirements from the CAN/CSA B149.1 Natural Gas and Propane Installation Codes, CAN/CSA B149.2 Propane Storage and Handling Code and the Plumbing and Gas Safety Service Bulletin pertaining to gas appliance and adjustments and installer's responsibilities.
3. Define parts of a burner and burner terminology.
4. Measure manifold pressures to determine gas consumption of burners in both imperial and metric units.
5. Adjust orifices and manifold pressures to optimize gas consumption.
6. Identify meter dials and meter indexes in both metric and imperial units.

7. Explain principles of low pressure gas meter clocking.
8. Calculate gas consumption using timed meter readings.

**B. Pilots, Pilot Burners, Thermocouples and Thermopiles ..... 19%**

**Outcome: Service pilots, pilot burners, thermocouples and thermopiles.**

1. Describe pilot burner types and terminology.
2. Describe characteristics of pilot burners
3. Identify parts of aerated and non-aerated pilot burners.
4. State the primary purpose of a gas pilot
5. Describe burner ignition tests performed on all pilots.
6. Describe operating principles of thermocouples and thermopiles.
7. Describe the operation tests performed on proven pilots energizing a thermocouple.
8. Describe methods of installing thermocouples and thermopiles on standard circuits.
9. Describe operational tests performed on thermocouples and thermopiles.
8. Describe diagnostic tests for thermocouples
9. State causes for thermocouple failures.

**C. Pressure Regulators and Orifices ..... 25%**

**Outcome: Service gas pressure controls and burner orifices and adjust gas line pressure.**

1. Describe types, operating principles and applications of various gas pressure regulators.
2. Identify regulator sizing tables and list and describe correct installation procedures for various regulators.
3. Describe maintenance procedures for various regulators.
4. Describe pressure regulator problems and corrective procedures.
5. Identify types of orifices.
6. Use orifice sizing charts to determine orifice sizing for specific gas consumptions and pressure in both metric and imperial units.
7. Drill an orifice according to specific gas requirements
8. Demonstrate procedures for testing an orifice and adjust manifold pressure on HVAC equipment.

**D. Introduction to Flues, Draft Hoods and Vent Connections ..... 19%**

**Outcome: Service draft hoods and vent connectors.**

1. Define terminology pertaining to flues and draft control devices.
2. Describe flue collars and types of draft hoods including installation procedures.
3. Explain regulations pertaining to the sizing, installation and use of draft hoods on gas burning appliances as listed in the CAN/CSA B149.1 *Natural Gas and Propane Installation Code and STANDATA*.
4. Describe installation procedures for single and double acting barometric dampers.
5. Explain regulations pertaining to the selection, sizing, installation and use of draft control devices as specified in the CAN/CSA B149.1 *Natural Gas and Propane Installation Code and STANDATA*.
6. Describe vent connectors and installation techniques.

7. Explain regulations pertaining to vent connectors as listed in the CAN/CSA B149.1 *Natural Gas and Propane Installation Code and STANDATA*.
8. Size vent connectors using minimum size rules.

**E. Single Line Drawings ..... 13%**

**Outcome: Draw and interpret basic orthographic and isometric drawings.**

1. Draw and label the three views of orthographic drawings.
2. Draw sections of a simple object.
3. Draw and label orthographic single-line piping drawings with 90° elbows and tees and convert to isometric drawings.
4. Draw and label isometric single-line piping drawings containing 90° elbows and tees.

**F. Heating with Alternative Methods..... 6%**

**Outcome: Service alternative heating systems.**

1. Describe alternative heat sources.
2. Describe alternative heat source systems.

**SECTION THREE: ..... BASIC CONTROLS ..... 13%**

**A. Principles of Automatic Heating and Cooling Controls ..... 18%**

**Outcome: Explain the basic principles for automatic controls for heating and cooling systems.**

1. Describe the basic requirements of heating and cooling systems.
2. Describe the control components of a basic forced-air heating system.
3. Interpret basic electrical diagrams used to show the function of a heating or cooling control system.
4. Identify code requirements relating to the electrical installation of heating and cooling systems.

**B. Temperature Sensing and Control Devices ..... 13%**

**Outcome: Service temperature sensing and control devices.**

1. Identify operating characteristics of temperature-sensing devices.
2. Describe the application of temperature-sensing devices used in heating and cooling systems.
3. Describe the functions of thermostats in heating and cooling systems.

**C. Basic Gas-Fired Forced-Air Heating Systems ..... 19%**

**Outcome: Connect and troubleshoot basic 24 V and 120 V gas-fired, forced-air heating systems.**

1. Identify the components used in a basic gas-fired, forced-air heating system.
2. Describe the operation of a domestic heating system using a 24 V control circuit.
3. Describe the operation of a unit heater using a 120 V control circuit.
4. Describe the installation and operation of a fan interlock system on a residential forced air heating system.



5. Connect and verify a 24 V and 120 V control heating system.
6. Diagnose and repair 24 V and 120 V heating systems.

**D. Mid/High-Efficiency / Gas-Fired / Forced-Air Heating Systems..... 19%**

**Outcome:**     **Connect and troubleshoot mid and high-efficiency, gas-fired, forced-air heating systems.**

1. Identify the components of a mid-efficiency, gas-fired, forced-air heating system.
2. Troubleshoot a mid-efficiency, gas-fired, forced-air heating system.
3. Troubleshoot a high-efficiency, gas-fired, forced-air heating system.
4. Describe the purpose of and application of auxiliary equipment used with gas-fired, forced-air heating systems.
5. Connect and verify the operation of a direct spark ignition system in a high-efficiency gas-fired furnace.
6. Connect and verify the operation of a hot surface ignition system in a high-efficiency gas-fired furnace.

**E. Basic Hot Water Heating Systems..... 6%**

**Outcome:**     **Troubleshoot basic hot water heating systems.**

1. Describe the operation of a basic hot water heating system.
2. Identify the purpose and application of the components of a hot water heating system.
3. Analyze and troubleshoot the operation of a hot water heating system.

**F. HVAC Units ..... 25%**

**Outcome:**     **Troubleshoot a basic commercial heating and cooling control circuit for an HVAC unit.**

1. Describe the components of an HVAC unit.
2. Describe the operation of an HVAC unit.
3. Describe the applications of thermostats.
4. Describe procedures for troubleshooting a HVAC unit.
5. Troubleshoot the operation of a HVAC unit.

**SECTION FOUR: .....BASIC ELECTRICAL THEORY .....20%**

**A. Single-Phase Transformers..... 8%**

**Outcome:**     **Connect single-phase transformers on refrigeration RAC equipment.**

1. Describe the construction of a mutual induction transformer.
2. Describe the construction of a single winding transformer.
3. Determine the transformation ratio and volts-per-turn value of a transformer.
4. Describe transformer operation.
5. Describe the operation of current limiting (Class 2) transformers.
6. Describe the efficiencies of a transformer

7. Calculate the efficiency of a transformer.
8. Describe the connection options for a multiple winding transformer.
9. Identify, connect and perform tests on transformers.

**B. Single Phase Motors ..... 29%**

**Outcome: Connect and service split-phase, single phase motors.**

1. Describe the components, principles of operation and applications of a resistance split-phase motor.
2. Describe the components, principles of operation and applications of a capacitor-start motor.
3. Draw connection diagrams for single phase motors.
4. Describe the components, principle of operation and applications of a permanent-split-capacitor motor.
5. Describe the components, principle of operation and applications of a capacitor start/capacitor run motor.
6. Connect and analyze a dual voltage motor and reverse it.
7. Connect and analyze a multispeed single phase motor.

**C. Compressors and Electrical Circuit Components ..... 21%**

**Outcome: Connect and service compressors and circuit components.**

1. Describe motor starters and relays of compressors.
2. Describe motor protection used for compressors.
3. Sketch a motor starter circuit.
4. Sketch a compressor overload circuit.
5. Connect a single phase compressor circuit.
6. Troubleshoot motor failures and clean up procedures.

**D. Three Phase Fundamentals ..... 13%**

**Outcome: Service three phase electrical systems on RAC equipment**

1. Describe the difference between single phase power and three phase power.
2. Describe the generation of the phase voltages of a three phase system.
3. Describe the phase sequence of three phase sine waves.
4. Describe the advantages and disadvantages of three phase power over single phase power.

**E. Troubleshooting Electrical Problems ..... 21%**

**Outcome: Solve electrical related problems in refrigeration and HVAC circuits.**

1. Describe electrical problems common to refrigeration and HVAC circuits.
2. Describe methods used to test circuits in refrigeration and HVAC circuits.
3. Describe the possible effects of over voltage and under voltage on motors.
4. Describe the importance of full load amps, lock rotor amps and free running amps.
5. Use wiring diagrams to troubleshoot refrigeration and HVAC circuits.
6. Diagnose electrical motor problems using systematic test flowcharts.

7. Troubleshoot motors that are operating at higher than normal temperatures.
8. Perform tests on other electrical devices related to motor circuits.

**F. Introduction to Canadian Electrical Code..... 4%**

**Outcome:**      *Apply the Canadian Electrical Code (CEC) Part I, and the Alberta Electrical STANDATA to verify electrical installations in Alberta.*

1. Describe the purpose of the CEC Part 1.
2. Describe the procedures for the acceptance of the CEC by the provinces and the local authorities.
3. Describe the function of the electrical STANDATA.
4. Describe the organizational layout of the CEC.
5. Identify those responsible for an electrical installation.

**G. Class 1 and Class 2 Circuits..... 4%**

**Outcome:**      *Verify CEC requirements for Class 1 and Class 2 Circuits on RAC equipment.*

1. Define the terms from the CEC on Class 1 and Class 2 circuits.
2. Identify the requirements for Class 1 and Class 2 circuits.
3. Identify the Class 2 circuits as they apply to industry.



# **Apprenticeship and Industry Training**

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