Apprenticeship and Industry Training

Refrigeration and Air Conditioning Mechanic Apprenticeship Course Outline

014.1 (2016)

Alberta

Apprenticeship and Industry Training

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Apprenticeship and Industry Training:
Refrigeration and Air Conditioning Mechanic Apprenticeship Course Outline

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Refrigeration and Air Conditioning Mechanic

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Course Outlines

Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Refrigeration and Air Conditioning Mechanic Technician Provincial Apprenticeship Committee.

The graduate of the Refrigeration and Air Conditioning Mechanic apprenticeship training is a journeyman who will:

- supervise, train and coach apprentices
- use and maintain hand and power tools to the standards of competency and safety required in the trade
- have a thorough knowledge of the principle components of refrigeration systems, heat/cool units and air conditioning
- have a thorough knowledge of the electrical and automatic controls used in all aspects of the refrigeration and air conditioning industry
- be capable of assembling, installing or over hauling all components
- have an intimate knowledge of other mechanical trades, which contribute to refrigeration and air conditioning systems
- be proficient in the use of test instruments
- exercise good judgment and resourcefulness in construction, maintenance and workplace health and safety
- know, and be able to apply their knowledge of the installation, and service of HVAC systems in accordance with local, provincial and national standards for the industry
- do all Refrigeration and Air Conditioning Mechanic tasks expected of a journeyman.

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
    - standards and requirements for training and certification in their trade
    - courses and examinations in their trade
    - apprenticeship and certification
    - designation of trades and occupations
    - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board.

Refrigeration and Air Conditioning Mechanic PAC Members at the Time of Publication

Mr. Aaron Mathes	Fort McMurray	Presiding Officer
Mr. George Bird	Calgary	Employer
Mr. David Malay	Edmonton	Employer
Mr. Aubrey Hilman	Calgary	Employer
Mr. David Rice	St. Albert	Employee
Mr. Rene Lauenstein	Calgary	Employee
Mr. Michael Whiting	Lethbridge	Employee
Mr. Koi Sim Wong	Calgary	Employee

Alberta Government

Alberta Advanced Education works with industry, employer 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 employers
- 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, employers, 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.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board (board) fully supports safe learning and working environments and emphasizes the importance of safety awareness and education throughout apprenticeship training- in both on-the- job training and technical training. The board also recognizes that safety awareness and education begins on the first day of on-the-job training and thereby is the initial and ongoing responsibility of the employer and the apprentice as required under workplace health and safety training. However the board encourages that safe workplace behaviour is modeled not only during on-the-job training but also during all aspects of technical training, in particular, shop or lab instruction. Therefore the board recognizes that safety awareness and training in apprenticeship technical training reinforces, but does not replace, employer safety training that is required under workplace health and safety legislation.

The board has established a policy with respect to safety awareness and training:

> **The board promotes and supports safe workplaces, which embody a culture of safety for all apprentices, employers and employees. Employer required safety training is the responsibility of the employer and the apprentice, as required under legislation other than the *Apprenticeship and Industry Training Act.***

The board's complete document on its 'Apprenticeship Safety Training Policy' is available at www.tradesecrets.alberta.ca; access the website and conduct a search for 'safety training policy'.

Implementation of the policy includes three common safety learning outcomes and objectives for all trade course outlines. These common learning outcomes ensure that each course outline utilizes common language consistent with workplace health and safety terminology. Under the title of 'Standard Workplace Safety', this first section of each trade course outline enables the delivery of generic safety training; technical training providers will provide trade specific examples related to the content delivery of course outline safety training.

Occupational Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force 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 (a division of Alberta Human Services) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.humanservices.alberta.ca

Technical Training

Apprenticeship technical training is delivered by the technical institutes and colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place a strong emphasis on safety that complements safe workplace practices towards the development of a culture of safety for all trades.

The technical institutes and colleges work with Alberta's Apprenticeship and Industry Training Board, industry committees 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 course outlines established by industry and provide technical training to apprentices.

The following institutions deliver Refrigeration and Air Conditioning Mechanic apprenticeship technical training:

Northern Alberta Institute of Technology
Southern Alberta Institute of Technology

Procedures for Recommending Revisions to the Course Outline

Advanced Education has prepared this course outline in partnership with the Refrigeration and Air Conditioning Mechanic Provincial Apprenticeship Committee.

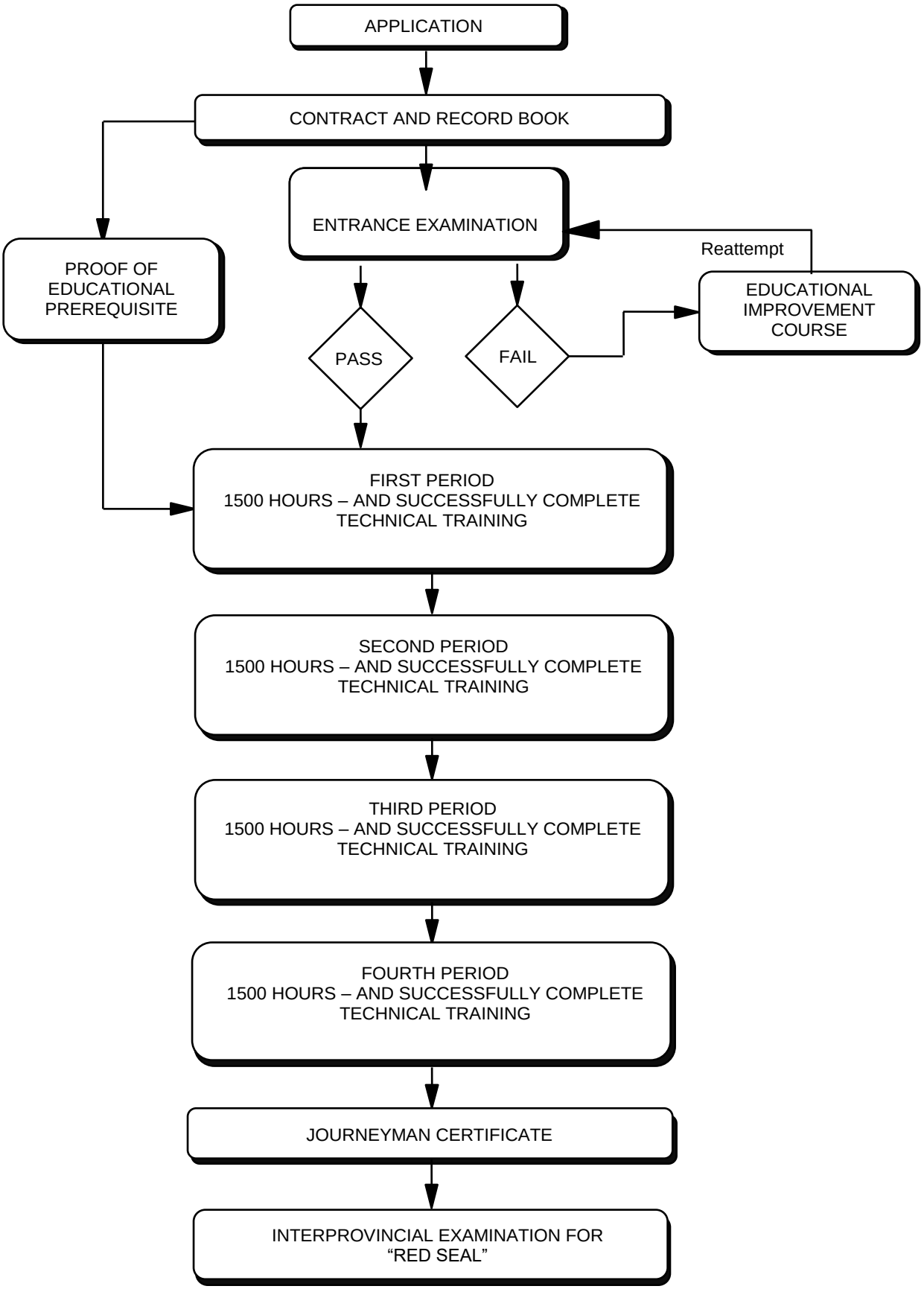
This course outline was approved on December 18, 2015 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

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

Refrigeration and Air Conditioning Mechanic Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education
10th 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. Recommendations for change will be placed on the agenda for regular meetings of the Refrigeration and Air Conditioning Mechanic Provincial Apprenticeship Committee.

Apprenticeship Route Toward Certification



Refrigeration and Air Conditioning Mechanic Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

OCCUPATIONAL SKILLS
60 HOURS

A	B	C
Safety Legislation, Regulations & Industry Policy in the Trades 2 Hours	Climbing, Lifting, Rigging and Hoisting 1 Hour	Hazardous Materials & Fire Protection 3 Hours
D	**E**	**F**
Apprenticeship Training Program 2 Hours	Tools and Instruments 8 Hours	Ladders, Scaffolds and Lifts 2 Hours
G	**H**	**I**
Rigging and Hoisting Equipment 6 Hours	Relevant Codes 2 Hours	Customer Relations 6 Hours
J	**K**	**L**
Introduction to Drawing Interpretation 4 Hours	Pipe Working Skills Soldering and Brazing 20 Hours	Materials and Fastening Devices 4 Hours

SECTION TWO

INTRODUCTION TO REFRIGERATION, AIR CONDITIONING AND HEATING
104 HOURS

A	B	C
Refrigeration Principles 14 Hours	Vapour Compression Cycle 10 Hours	Introduction to Refrigeration Enthalpy and Gas Laws 20 Hours
D	**E**	**F**
Air Properties and Air Flow Designs 10 Hours	Air Handling Systems and Accessories 10 Hours	Air Filtration 4 Hours
G	**H**	**I**
Refrigeration and Air Conditioning Relevant Codes 4 Hours	Introduction to Valve Design and Functions 4 Hours	Refrigerant and Oil Handling 14 Hours
J	**K**	**L**
Introduction to Gasfitting Fundamentals 5 Hours	Properties of Gas and Principles of Combustion 4 Hours	Introduction to Gasfitting Code and Regulations 5 Hours

SECTION THREE

INTRODUCTION TO ELECTRICAL THEORY
44 HOURS

A	B	C
Introduction to Electrical Safety, Connections and Meters 8 Hours	Current, Voltage, and Resistance 6 Hours	Series Resistive Circuits 4 Hours
D	**E**	**F**
Parallel Resistive Circuits 4 Hours	Series-Parallel Resistive Circuits 6 Hours	Methods of Producing EMF and Magnetism 8 Hours
G	**H**	
Fundamentals of Alternating Current 6 Hours	Arc Flash and Electrical Safety 2 Hours	

SECTION FOUR

INTRODUCTIONS TO CONTROLS
32 HOURS

A	B	C
Introduction to Control Systems 4 Hours	Control Components 4 Hours	Refrigeration Controls Circuits 10 Hours
D	**E**	
HVAC Controls Circuits 8 Hours	Building Systems Controls 6 Hours	

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

SECTION ONE

BASIC REFRIGERATION AND AIR CONDITIONING
128 HOURS

A	B	C
Evaporator Feed Controls and Refrigeration Effect 16 Hours	Automatic Flow Controls and Applications 10 Hours	Refrigeration Accessories 4 Hours
D	**E**	**F**
Compressors 14 Hours	Evaporators and Condensers 6 Hours	Evaporating Condensers and Cooling Towers 6 Hours
G	**H**	**I**
System Install and Commissioning 36 Hours	System Calculations and Analysis 24 Hours	Retrofitting and Conversions 8 Hours
J		
Split Systems 4 Hours		

SECTION TWO

BASIC HEATING
32 HOURS

A	B	C
Natural Draft Burner Adjustments and Gas Consumption 6 Hours	Pilots, Pilot Burners, Thermocouples and Thermopiles 6 Hours	Pressure Regulators and Orifices 8 Hours
D	**E**	**F**
Introduction to Flues, Draft Hoods and Vent Connections 6 Hours	Single Line Drawings 4 Hours	Heating with Alternative Methods 2 Hours

SECTION THREE

BASIC CONTROLS
32 HOURS

A	B	C
Principles of Automatic Heating and Cooling Controls 6 Hours	Temperature Sensing and Control Devices 4 Hours	Basic Gas-Fired Forced-Air Heating Systems 6 Hours
D	**E**	**F**
Mid/High-Efficiency / Gas-Fired / Forced-Air Heating Systems 6 Hours	Basic Hot Water Heating Systems 2 Hours	HVAC Units 8 Hours

SECTION FOUR

BASIC ELECTRICAL THEORY
48 HOURS

A	B	C
Single Phase Transformers 4 Hours	Single Phase Motors 14 Hours	Compressor and Electrical Circuit Components 10 Hours
D	**E**	**F**
Three Phase Fundamentals 6 Hours	Troubleshooting Electrical Problems 10 Hours	Introduction to Canadian Electrical Code 2 Hours
G		
Class 1 and Class 2 Circuits 2 Hours		

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

SECTION ONE

INTERMEDIATE REFRIGERATION AND AIR CONDITIONING
112 HOURS

A	B	C
Refrigeration Load Calculations and Design 24 Hours	Piping Design and Installation Practices 36 Hours	Defrosting Methods Circuits and Controls 10 Hours

D	E	F
Troubleshooting of Refrigeration and HVAC Systems 26 Hours	Ice Machines 4 Hours	Industrial Refrigeration Systems 8 Hours

G
Codes Related to Refrigeration and Air Conditioning Installations 4 Hours

SECTION TWO

INTERMEDIATE HEATING THEORY
32 HOURS

A	B	C
Electronic Ignition Systems 12 Hours	Natural and Fan Assisted Draft Appliances 12 Hours	Introduction to Make Up Air 8 Hours

SECTION THREE

INTERMEDIATE ELECTRICAL THEORY
34 HOURS

A	B	C
Three Phase Motors 6 Hours	Motor Installations 14 Hours	Variable Speed Drives 8 Hours

D
Diagrams 6 Hours

SECTION FOUR

AIR HANDLING THEORY
62 HOURS

A	B	C
HVAC Load Calculations and Design 14 Hours	Advanced Air Properties 10 Hours	Air Conditioning Systems 32 Hours

D
Air Instruments and System Balancing 6 Hours

FOURTH PERIOD
(8 Weeks/30 Hours per Week – Total of 240 Hours)

SECTION ONE

ADVANCED REFRIGERATION THEORY
80 HOURS

A	B	C
Chillers 14 Hours	Ultra Low Compression Systems 10 Hours	Multiplex Systems 16 Hours
D	**E**	**F**
Industrial Refrigeration Systems 20 Hours	Circulating Pumps 8 Hours	B52 Piping Codes and Canadian Code of Practice 4 Hours
G		
Advanced Drawing Interpretation 8 Hours		

SECTION TWO

ADVANCED HEATING THEORY
48 HOURS

A	B	C
Troubleshooting Gas Fired Equipment 10 Hours	Combustion Analysis 8 Hours	Advanced Make-up Air Systems 16 Hours
D	**E**	
Troubleshooting Make-up Air Systems 10 Hours	Workplace Coaching Skills 4 Hours	

SECTION THREE

COMPLEX AIR SYSTEM THEORY
40 HOURS

A	B	C
Complex HVAC Systems 10 Hours	Troubleshooting Complex HVAC Systems 12 Hours	Advanced Mechanical Drives for Fan Systems 4 Hours
D	**E**	**F**
Installation of HVAC Equipment 8 Hours	Energy Management Systems (EMS) and Indoor Air Quality 4 Hours	Alberta's Industry Network 2 Hours

SECTION FOUR

ADVANCED CONTROL SYSTEMS
72 HOURS

A	B	C
Specialized Electronic Control Systems 16 Hours	Electromechanical Control Systems 12 Hours	Advanced Electrical Troubleshooting 10 Hours
D	**E**	**F**
Schematic Diagrams 10 Hours	Economizer Controls and Accessories 14 Hours	New Environmental Technology 8 Hours
G		
Interprovincial Standards Red Seal Program 2 Hours		

NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training

FIRST PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

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

SECTION ONE: ..... OCCUPATIONAL SKILLS ..... 60 HOURS

A. Safety Legislation, Regulations & Industry Policy in the Trades ..... 2 Hours

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 employer'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 employers 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 employers 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 ..... 1 Hour

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 ..... 3 Hours

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..... 2 Hours

Outcome: Manage an apprenticeship to earn journeyman certification.

1. Describe the contractual responsibilities of the apprentice, employer and Alberta Apprenticeship and Industry Training.
2. Describe the purpose of the apprentice record book.
3. Describe the procedure for changing employers during an active apprenticeship.
4. Describe the purpose of the course outline.
5. Describe the procedure for progressing through an apprenticeship.
6. Describe advancement opportunities in this trade.

E. Tools and Instruments..... 8 Hours

Outcome: Use hand tools and power tools.

1. Describe types, uses and care of hand, power tools and instruments.
2. Demonstrate the use of hand tools and power tools used in the industry.
3. Demonstrate 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..... 2 Hours

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..... 6 Hours

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, tirfors 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..... 2 Hours

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.....6 Hours

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.....4 Hours

Outcome: Interpret basic drawings 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.....20 Hours

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.....4 Hours

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..... 104 HOURS

A. Refrigeration Principles ..... 14 Hours

Outcome: Explain the basic operation of a refrigeration system.

1. Define terms related to refrigeration principles.
2. Describe 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 ..... 10 Hours

Outcome: Explain the vapour compression cycle.

1. Describe 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 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 ..... 20 Hours

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 Hours

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 psychrometrics.
7. Describe the meaning, function and uses of psychrometric charts.
8. Plot and interpret a psychrometric chart.

E. Air Handling Systems and Accessories.....10 Hours

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 Hours

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 Hours

Outcome: Apply 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 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 Hours

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 RAC system applications.
4. Describe the purpose, types and procedures for service valves.
5. Describe the purpose, types, construction, location and operation of RAC valves.
6. Demonstrate operation of service valves.

I. Refrigerant and Oil Handling.....14 Hours

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 Hours

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 Hours

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 safety practices when adjusting gas-fired equipment.

L. Introduction to Gasfitting Code and Regulations ..... 5 Hours

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 installer's responsibilities.
2. List the regulations contained in the CAN/CSA B149.1 Natural Gas and Propane Installation Codes 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 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 and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins pertaining to purging of piping and fittings.
5. Describe safety practices pertaining to installation of piping and fittings.
6. Describe safety practices pertaining to testing of piping and fittings.
7. Describe safety practices pertaining to purging of piping and fittings.

SECTION THREE: .....INTRODUCTION TO ELECTRICAL THEORY..... 44 HOURS

A. Introduction to Electrical Safety, Connections and Meters ..... 8 Hours

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 ..... 6 Hours

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.....4 Hours

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.....4 Hours

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 .....6 Hours

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 .....8 Hours

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.....6 Hours

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.....2 Hours

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..... 32 HOURS

A. Introduction to Control Systems .....4 Hours

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.....4 Hours

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.....10 Hours

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.....8 Hours

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.....6 Hours

Outcome: Service building system control circuits.

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

SECOND PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

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

SECTION ONE: ..... BASIC REFRIGERATION AND AIR CONDITIONING..... .128 HOURS

A. Evaporator Feed Controls and Refrigeration Effect ..... 16 Hours

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 ..... 10 Hours

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 ..... 4 Hours

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 ..... 14 Hours

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 ..... 6 Hours

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 ..... 6 Hours

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 ..... 36 Hours

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 ..... 24 Hours

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 ..... 8 Hours

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 ..... 4 Hours

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 ..... 32 HOURS

A. Natural Draft Burner Adjustments and Gas Consumption ..... 6 Hours

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 ..... 6 Hours

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.
10. Describe diagnostic tests for thermocouples.
11. State causes for thermocouple failures.

C. Pressure Regulators and Orifices ..... 8 Hours

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

1. Describe types, operating principles and applications or 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 ..... 6 Hours

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 ..... 4 Hours

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 ..... 2 Hours

Outcome: Service alternative heating systems.

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

SECTION THREE: ..... BASIC CONTROLS ..... 32 HOURS

A. Principles of Automatic Heating and Cooling Controls ..... 6 Hours

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 ..... 4 Hours

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 ..... 6 Hours

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 ..... 6 Hours

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 ..... 2 Hours

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 ..... 8 Hours

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 ..... 48 HOURS

A. Single-Phase Transformers ..... 4 Hours

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 ..... 14 Hours

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 ..... 10 Hours

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 ..... 6 Hours

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 ..... 10 Hours

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.....2 Hours

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.....2 Hours

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.

THIRD PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

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

SECTION ONE: ..... INTERMEDIATE REFRIGERATION AND AIR CONDITIONING ..... 112 HOURS

A. Refrigeration Load Calculations, Designs and Equipment Selection ..... 24 Hours

Outcome: Calculate loads for refrigeration systems and select equipment.

1. Describe terminology and formulas used in refrigeration load calculations.
2. Describe refrigeration loads.
3. Describe short and long methods of load calculating.
4. Describe infiltration loads and food preservation.
5. Calculate refrigeration load requirements.
6. Describe terminology and formulas used in system design and equipment selection.
7. Describe refrigeration systems and equipment.
8. Describe equipment applications and limitations.
9. Select refrigeration equipment components.

B. Piping Design and Installation Practices ..... 36 Hours

Outcome: Design and install refrigeration and HVAC systems.

1. Describe terminology and formulas used in piping design.
2. Describe refrigeration and HVAC piping systems.
3. Describe piping applications and limitations.
4. Describe gas defrosting piping methods.
5. Calculate requirements for refrigeration and HVAC piping systems.
6. Connect and analyze a low temperature refrigeration system and components.
7. Analyze the design and installation of a medium temperature refrigeration system and components.
8. Analyze the design and installation of a split HVAC system and components.

C. Defrosting Methods Circuits and Controls ..... 10 Hours

Outcome: Service defrosting circuits and controls.

1. Describe terminology and formulas used in defrosting circuits and controls.
2. Describe methods of defrosting.
3. Describe defrosting components and their applications.
4. Install, connect and analyze defrosting components.

D. Troubleshooting of Refrigeration and HVAC Systems ..... 26 Hours

Outcome: Solve problems in refrigeration and HVAC systems.

1. Describe electrical problems with refrigeration and HVAC systems.

2. Describe oil problems with refrigeration and HVAC systems.
3. Describe refrigerant problems with refrigeration and HVAC systems.
4. Describe compressor problems with refrigeration and HVAC systems.
5. Describe piping problems with refrigeration and HVAC systems.
6. Describe air flow problems with refrigeration and HVAC systems.
7. Describe methods used to test circuits in refrigeration and HVAC systems.
8. Use test equipment to troubleshoot refrigeration and HVAC system problems.

E. Ice Machines ..... 4 Hours

Outcome: Install and maintain ice machines.

1. Describe the operation of ice machines.
2. Describe the harvest methods of ice machines.
3. Describe the maintenance of ice machines.
4. Describe the cleaning of ice machines.
5. Connect and analyze ice machines.

F. Industrial Refrigeration Systems ..... 8 Hours

Outcome: Service industrial refrigeration systems.

1. Describe terminology used in industrial refrigeration systems.
2. Describe components of industrial refrigeration systems.
3. Describe applications and limitations of industrial refrigeration components.
4. Describe designs of industrial refrigeration systems.
5. Observe an industrial refrigeration system in operation.

G. Codes Related to Refrigeration and Air Conditioning Installations ..... 4 Hours

Outcome: Apply the B52 Mechanical Refrigeration Code and the Canadian Code of Practice to install Refrigeration and Air Conditioning equipment in Alberta.

1. Describe how the B52 relates to the refrigeration and air conditioning installations.
2. Describe how the Canadian Code of Practice relates to the refrigeration and air conditioning installations.
3. Demonstrate how the B52 is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work in industrial applications.
4. Demonstrate how the Canadian Code of Practice is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work in industrial applications.

SECTION TWO: ..... INTERMEDIATE HEATING THEORY ..... 32 HOURS

A. Electronic Ignition Systems ..... 12 Hours

Outcome: Troubleshoot electronic ignitions and components found in HVAC equipment.

1. Describe the operation of basic ignition systems used in mid and high-efficiency furnaces.
2. Describe the application and sequence of operation of electronic controls.

3. Interpret electrical schematic drawings.
4. Describe diagnostic techniques and routine maintenance requirements for electrical controls.

B. Natural and Fan Assisted Draft Appliances.....12 Hours

Outcome: Install and service gas fired appliances, and conversion burners.

1. Describe requirements of the types of burners used in natural and power assisted draft appliances.
2. Describe the operation and function of each type of burner.
3. Explain the relationship between fan speed and volume delivered.
4. Explain the relationship between volume delivered and static pressure.
5. Explain the selection requirements for fan units.
6. Describe the differences in fan location between natural, induced and forced.
7. Describe procedures for converting an appliance from one gas to another.
8. Describe regulations, applicable Gas Codes and as they apply to natural and fan-assisted draft appliances.
9. List and explain the safe light-up requirements for burners.

C. Introduction to Make-Up Air .....8 Hours

Outcome: Service make-up air units.

1. Describe terminology used in make-up air units.
2. Describe components used in make-up air units.
3. Describe applications and limitations of make-up air components.
4. Describe designs of make-up air systems.

SECTION THREE: .....INTERMEDIATE ELECTRICAL THEORY ..... 34 HOURS

A. Three Phase Motors .....6 Hours

Outcome: Service three phase motors on RAC equipment.

1. Identify terms related to three-phase induction motor.
2. Describe the characteristics of mechanical loads.
3. Describe the construction of a three-phase induction motor.
4. Describe the principle of operation of a squirrel-cage induction motor.
5. Describe information located on a motor nameplate and calculate horsepower, motor efficiency and speed regulation.
6. Calculate rotor parameters including synchronous speed, slip and breakdown torque, and determine the effect that the percent slip has on rotor parameters.
7. Describe NEMA rotor designs A, B, C and D, and their electrical and mechanical characteristics.
8. Describe the wound-rotor motor and its electrical and mechanical characteristics.
9. Describe the relationship between torque and rotor electrical characteristics in a squirrel-cage induction motor.

B. Motor Installations ..... 14 Hours

Outcome: Install motors in RAC systems.

1. Describe motor installation methods.
2. Describe three phase motor connections.
3. Describe three phase motor starting methods.
4. Describe methods of reversing three phase motors.
5. Describe three phase motor protection.
6. Connect and analyze a three phase dual voltage motor connection.
7. Connect and analyze a three phase two speed motor connection.
8. Connect and analyze a three phase part winding motor connection.
9. Connect and analyze a three phase wye motor connection.
10. Connect and analyze a three phase delta motor connection.

C. Variable Speed Drives (VSD) ..... 8 Hours

Outcome: Program, adjust and troubleshoot variable speed drives in RAC applications.

1. Describe the principles of operation of ac induction in VSD motors.
2. Compare methods of speed control of ac induction motors.
3. Describe the principles of operation and application of a typical VSD.
4. Describe the principles of operation and application of a dc motor used with VSD.
5. Connect, program and troubleshoot a VSD.

D. Diagrams ..... 6 Hours

Outcome: Interpret electrical diagrams used in refrigeration and HVAC systems.

1. Describe electrical diagrams used in refrigeration and HVAC systems.
2. Describe symbols and terminology used in refrigeration and HVAC systems.
3. Interpret diagrams for refrigeration and HVAC systems.
4. Draw electrical diagrams for a refrigeration and HVAC system.

SECTION FOUR: ..... AIR HANDLING THEORY ..... 62 HOURS

A. HVAC Load Calculations, Design and Equipment Selection ..... 14 Hours

Outcome: Calculate loads for HVAC systems, design and select equipment.

1. Describe terminology and formulas used in HVAC load calculations.
2. Describe HVAC loads.
3. Describe short and long methods of load calculating.
4. Calculate HVAC load requirements.
5. Describe terminology and formulas used in system design and equipment selection.
6. Describe HVAC systems and equipment.
7. Describe equipment applications and limitations.
8. Select HVAC equipment components.

B. Advanced Air Properties.....10 Hours

Outcome: ***Explain the properties of air as it relates to advanced air flow design.***

1. Describe terminology and formulas used in advanced air flow calculations.
2. Describe the psychrometric chart as it relates to air conditioning systems.
3. Identify the points and lines represented on a psychrometric chart.
4. Describe tools used for measuring air properties.
5. Measure and plot an HVAC system to determine its characteristics.
6. Describe troubleshooting techniques used for air handling equipment in HVAC systems.
7. Demonstrate troubleshooting techniques for air handling equipment in an HVAC system.

C. Air Conditioning Systems.....32 Hours

Outcome: ***Apply knowledge of the principle operations of an air conditioning system in servicing RAC equipment.***

1. Describe terms associated with air conditioning systems.
2. Describe the components and their applications of comfort air conditioning systems.
3. Describe the components and their applications of year round air conditioning systems.
4. Describe the components and their applications of process air conditioning systems.
5. Analyze the operation of an air conditioning system.
6. Plot readings from an air conditioning system on a psychrometric chart.
7. Measure and analyze a residential split system.
8. Measure and analyze a commercial air conditioning system.
9. Measure and analyze a heat pump system.
10. Measure and analyze a process air conditioning system.

D. Air Instruments and System Balancing .....6 Hours

Outcome: ***Use air instruments to analyze and balance HVAC systems.***

1. Define terms used in air balancing.
2. Describe the tools and instruments used in system balancing.
3. Calculate air velocity and volumes using tables and charts.
4. Use air instruments to measure, analyze and balance a HVAC system.

FOURTH PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

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

SECTION ONE: .....ADVANCED REFRIGERATION THEORY ..... 80 HOURS

A. Chillers.....14 Hours

Outcome: Service a chiller system.

1. Define terms used with chiller systems.
2. Describe chiller system components and their applications.
3. Describe an absorption cycle.
4. Describe cooling towers and evaporative condensers.
5. Describe refrigerants specific to chiller systems.
6. Describe start-up and shut-down procedures of chiller systems.
7. List and identify cross connection control devices and describe their operation.
8. Observe a chiller and tower system in operation.
9. Observe a centrifugal chiller tear-down.

B. Ultra Low Compressions Systems .....10 Hours

Outcome: Service ultra-low compression systems.

1. Define terms used in ultra-low compression systems.
2. Describe the components and their applications of ultra-low compression systems.
3. Describe the refrigerants specific to ultra-low compression systems.
4. Describe special precautions required in the installation and servicing of ultra-low compression systems.
5. Describe troubleshooting techniques used on ultra-low compression systems.
6. Operate and analyze an ultra-low compression system.

C. Multiplex Systems .....16 Hours

Outcome: Service multiplex systems.

1. Define terms related to multiplex systems.
2. Describe the components and their applications of multiplex systems.
3. Describe the operation of multiplex systems.
4. Describe troubleshooting techniques used on multiplex systems.
5. Observe and analyze the operation of a multiplex system.

D. Industrial Refrigeration Systems .....20 Hours

Outcome: Service industrial refrigeration systems.

1. Define terms related to industrial refrigeration systems.

2. Describe the components and their applications of industrial refrigeration systems.
3. Describe the operation of industrial refrigeration systems.
4. Describe troubleshooting techniques used on industrial refrigeration systems.
5. Observe and analyze the operation of an industrial refrigeration system.
6. Overhaul an industrial refrigeration compressor.

E. Circulating Pumps ..... 8 Hours

Outcome: Service circulating pumps.

1. Define terms related to circulating pumps.
2. Describe the components and their applications of circulating pumps.
3. Describe the operation of circulating pumps.
4. Describe troubleshooting techniques used on circulating pumps.
5. Calculate performance of a circulating pump using system curve and pump curve.
6. Observe and analyze the operation of a circulating pump.

F. B52 Piping Codes and Canadian Code of Practice ..... 4 Hours

Outcome: Apply the B52 Mechanical Refrigeration Code and the Canadian Code of Practice to install Air Conditioning piping systems in Alberta.

1. Describe how the B52 relates to the Refrigeration and Air Conditioning piping systems design and construction.
2. Describe how to use the practical hand book for implementing B52 code.
3. Describe how the Canadian Code of Practice relates to the Refrigeration and Air Conditioning piping systems design and construction.

G. Advanced Drawing Interpretation ..... 8 Hours

Outcome: Interpret RAC drawings.

1. Describe the process for developing a material takeoff list.
2. Develop a scale layout for refrigeration or HVAC system.
3. Compile a list of equipment.
4. Compile a list of supply materials.
5. Develop a material takeoff list from drawings.

SECTION TWO: ..... ADVANCED HEATING THEORY ..... 48 HOURS

A. Troubleshooting Gas Fired Equipment ..... 10 Hours

Outcome: Troubleshoot gas fired equipment.

1. Describe problems associated with gas fired equipment.
2. Describe a systematic approach to troubleshooting gas fired equipment.
3. Troubleshoot and solve problems associated with gas fired equipment.

B. Combustion Analysis ..... 8 Hours

Outcome: Perform combustion analysis.

1. Define terms associated with combustion analysis.
2. Describe tools and equipment used for combustion analysis.
3. Describe procedures used in combustion analysis.
4. Describe safety concerns associated with combustion analysis.
5. Perform combustion analysis.

C. Advanced Make-up Air Systems ..... 16 Hours

Outcome: Service make-up air systems.

1. Describe auxiliary components of make-up air systems.
2. Describe control systems of make-up air units.
3. Describe burner operations of make-up air systems.
4. Describe cooling control systems of make-up air units.
5. Observe operation of a make-up air system.

D. Troubleshooting Make-up Air Systems ..... 10 Hours

Outcome: Troubleshoot make-up air systems.

1. Describe problems associated with make-up air equipment.
2. Describe a systematic approach to troubleshooting make-up air equipment.
3. Commission and start-up a make-up air system.
4. Troubleshoot to solve problems associated with make-up air equipment.

E. Workplace Coaching Skills ..... 4 Hours

Outcome: Use coaching skills when training an apprentice.

1. Describe the process for coaching an apprentice.

SECTION THREE: ..... COMPLEX AIR SYSTEM THEORY ..... 40 HOURS

A. Complex HVAC Systems ..... 10 Hours

Outcome: Service complex HVAC systems.

1. Define terms used in complex HVAC systems.
2. Describe components and their applications in complex HVAC systems.
3. Describe methods used to control complex HVAC systems.
4. Describe designs of complex HVAC systems.
5. Describe the operation of complex HVAC systems.
6. Operate and analyze a complex HVAC system.

B. Troubleshooting Complex HVAC Systems ..... 12 Hours

Outcome: ***Troubleshoot complex air conditioning systems.***

1. Define problems associated with complex HVAC equipment.
2. Describe a systematic approach to troubleshooting complex HVAC equipment.
3. Describe maintenance procedures of complex HVAC equipment.
4. Troubleshoot complex HVAC equipment.

C. Advance Mechanical Drives for Fan Systems ..... 4 Hours

Outcome: ***Service mechanical drives for fan systems.***

1. Define terms used for advanced mechanical drives for fan systems.
2. Describe components and their applications of mechanical drives for fan systems.
3. Describe the properties of fan performance for fan systems.
4. Describe maintenance and adjustment procedures of advanced mechanical drives for fan systems.
5. Troubleshoot complex mechanical drive systems problems.

D. Installation of HVAC Equipment ..... 8 Hours

Outcome: ***Install and maintain HVAC equipment.***

1. Define installation procedures used in installing HVAC units.
2. Describe considerations of location and equipment when installing HVAC systems.
3. Describe start-up and shut-down procedures of HVAC systems.
4. Describe system maintenance procedures of HVAC systems.
5. Demonstrate start-up and shut-down procedures of HVAC systems.

E. Energy Management Systems (EMS) and Indoor Air Quality ..... 4 Hours

Outcome: ***Service energy management systems to optimize indoor air quality.***

1. Define terms used in EMS and indoor air quality.
2. Describe the components and their applications of EMS and indoor air quality equipment.
3. Describe designs and principles of EMS.
4. Describe maintenance procedures of indoor air quality equipment.

F. Alberta's Industry Network ..... 2 Hours

Outcome: ***Describe the role of the network of industry committees that represent trades and occupations in Alberta.***

1. Describe Alberta's Apprenticeship and Industry Training system.
2. Describe roles and responsibilities of the Alberta Apprenticeship and Industry Training Board, the Government of Alberta and post-secondary institutions.
3. Describe roles and responsibilities of the Provincial Apprenticeship Committees (PACs), Local Apprenticeship Committees (LACs) and Occupational Committees (OCs).

Classification: Public

SECTION FOUR: .....ADVANCED CONTROL SYTEMS..... 72 HOURS

A. Specialized Electronic Control Systems.....16 Hours

Outcome: Install and maintain specialized electronic control systems.

1. Define terms used in specialized electronic control systems.
2. Describe components and their applications of specialized electronic control systems.
3. Describe programming methods of specialized electronic control systems.
4. Describe design and application of specialized electronic control systems.
5. Describe maintenance procedures of specialized electronic control systems.
6. Connect and program a specialized electronic control system.

B. Electromechanical Control Systems.....12 Hours

Outcome: Install and maintain electromechanical control systems.

1. Define terms used in electromechanical control systems.
2. Describe components and their applications of electromechanical control systems.
3. Describe calibration methods of electromechanical control systems.
4. Describe design and application of electromechanical control systems.
5. Describe maintenance procedures of electromechanical control systems.
6. Connect and calibrate an electromechanical control system.

C. Advanced Electrical Troubleshooting.....10 Hours

Outcome: Maintain electrical components found in HVAC and refrigeration equipment.

1. Identify problems associated with electrical components in HVAC and refrigeration equipment.
2. Describe a systematic approach to troubleshooting HVAC and refrigeration equipment.
3. Use advanced electrical schematic drawings in troubleshooting electrical problems in HVAC and refrigeration equipment.
4. Troubleshoot to solve problems associated with HVAC and refrigeration equipment.

D. Schematic Diagrams .....10 Hours

Outcome: Interpret schematic diagrams used in refrigeration and HVAC systems.

1. Describe types of schematic diagrams used in refrigeration and HVAC systems.
2. Describe symbols and terminology used in refrigeration and HVAC schematic diagrams.
3. Interpret schematic diagrams for refrigeration and HVAC systems.
4. Draw schematic diagrams for a refrigeration and HVAC system.

E. Economizer Controls and Accessories .....14 Hours

Outcome: Service economizer controls and accessories.

1. Define terms used with economizer controls and accessories.
2. Describe components and their application of economizer controls and accessories.
3. Describe calibration methods of economizer controls and accessories.

4. Describe retrofit techniques for economizer controls for HVAC systems.
5. Describe design and applications of economizer controls and accessories.
6. Connect and calibrate an economizer control system with accessories.

F. New Environmental Technology ..... 8 Hours

Outcome: Apply changing trends in environmental technology to upgrade RAC equipment.

1. Define terms related to environmental technology as it relates to the HVAC and refrigeration industry.
2. Identify issues that relate to environmental technology as it relates to the HVAC and refrigeration industry.
3. Describe authorities having jurisdiction on environmental technology as it relates to the HVAC and refrigeration industry.
4. Identify legislation and codes as it relates to environmental technology for the HVAC and refrigeration industry.

G. Interprovincial Standards Red Seal Program ..... 2 Hours

Outcome: Use Red Seal products to challenge an Interprovincial examination.

1. Identify Red Seal products used to develop Interprovincial examinations.
2. Use Red Seal products to prepare for an interprovincial examination.

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