

Apprenticeship and Industry Training

Transport Refrigeration Technician Apprenticeship Course Outline

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**Government
of Alberta** ■



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Course Outline

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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 journeyman 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 journeymen, 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 Transport Refrigeration Technician Provincial Apprenticeship Committee.

The graduate of the Transport Refrigeration Technician apprenticeship program is a certified journeyman 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

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 Enterprise and 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

Transport Refrigeration Technician PAC Members at the Time of Publication

Mr. J. Schmode	Calgary.....Presiding Officer
Mr. K. Bidulka	Edmonton.....Employer
Mr. R. Fleming	Calgary.....Employer
Mr. C. Grant	Ft. McMurray .Employer
Mr. D. Mueller	High RiverEmployer
Mr. R. Kranic	Edmonton.....Employee
Mr. J. Kopciuk	CalgaryEmployee
Mr. D. Romano	Edmonton.....Employee

Alberta Government

Alberta Enterprise and 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

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Enterprise and Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

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.gov.ab.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.

Workplace 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.

Workplace Health and Safety (Alberta Employment and Immigration) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.worksafely.org

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many 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 great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Transport Refrigeration Technician apprenticeship technical training:
Southern Alberta Institute of Technology (Main Campus)

Procedures for Recommending Revisions to the Course Outline

Enterprise and Advanced Education has prepared this course outline in partnership with the Transport Refrigeration Technician Provincial Apprenticeship Committee.

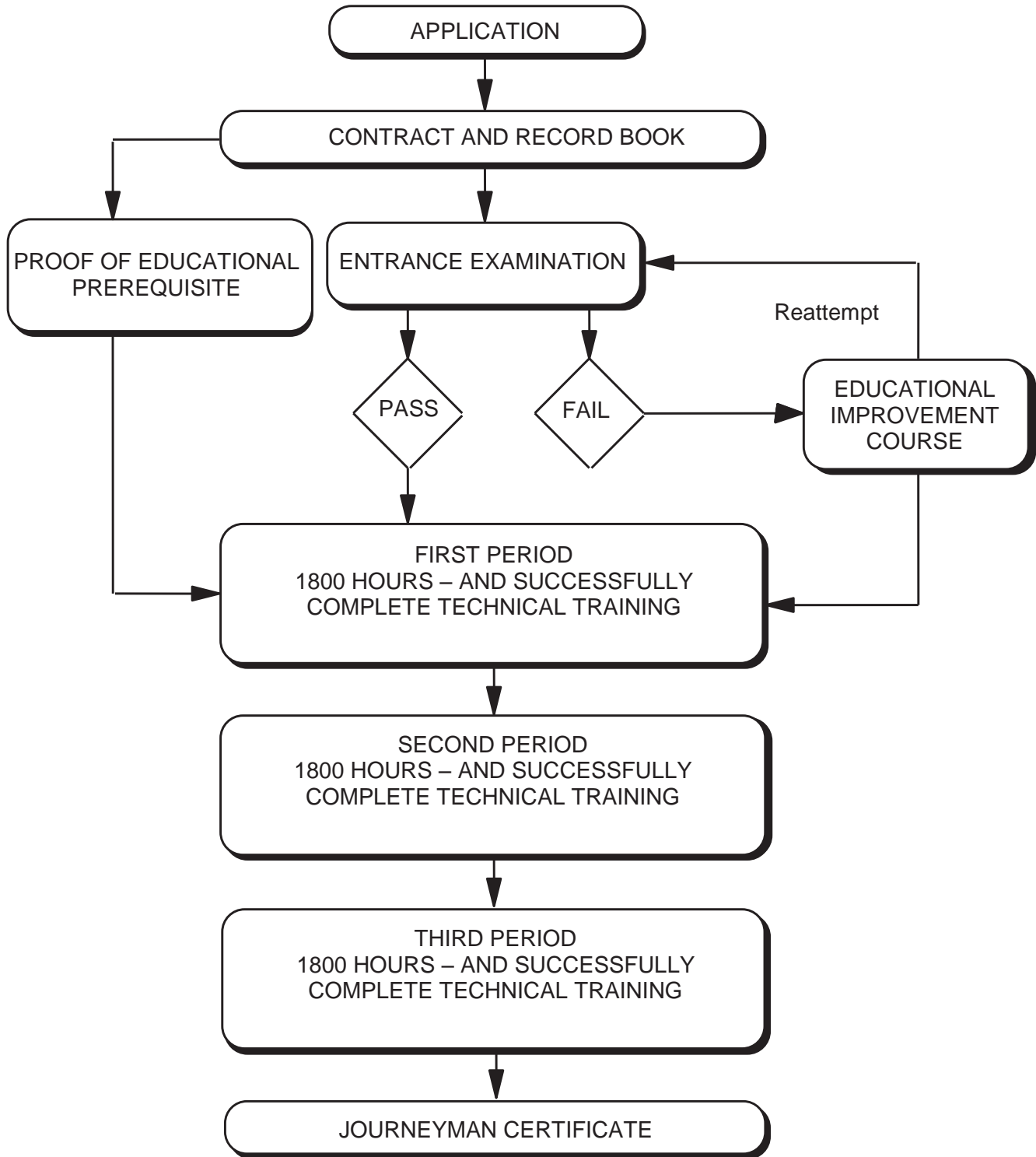
This course outline was approved on June 21, 2011 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

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

Transport Refrigeration Technician Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Enterprise and Advanced Education
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

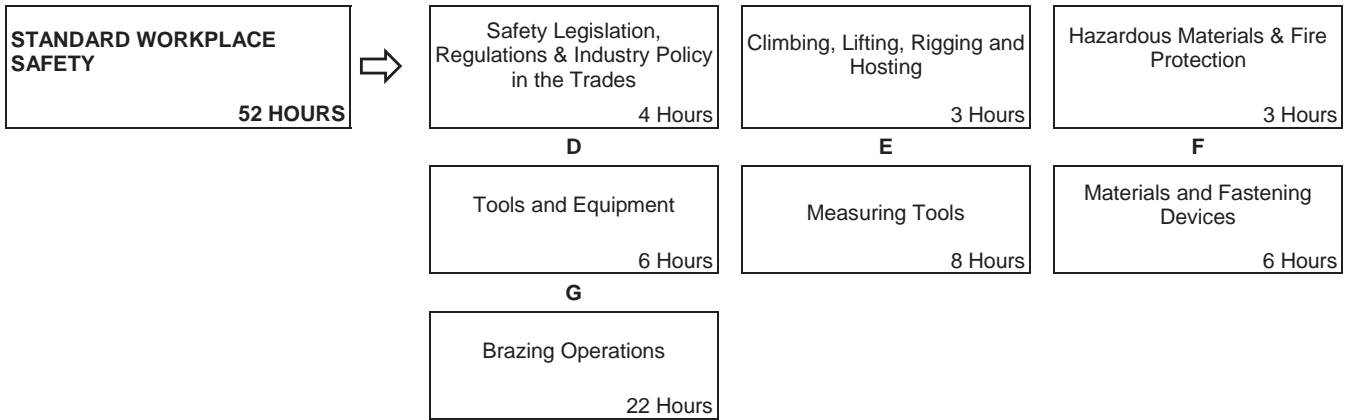
It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Transport Refrigeration Technician Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification

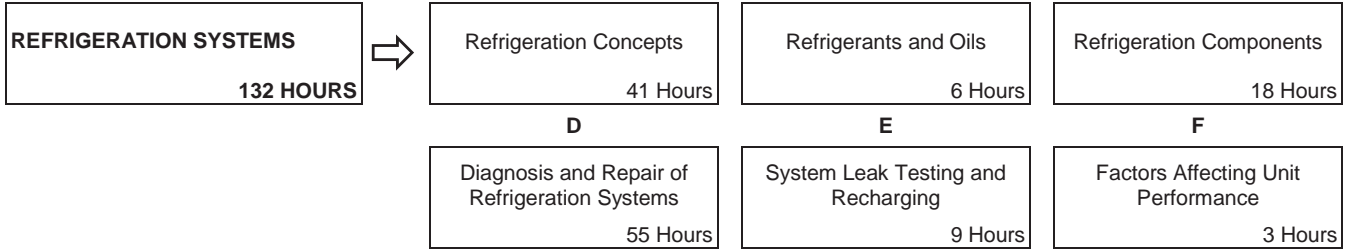


**Transport Refrigeration Technician Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)**

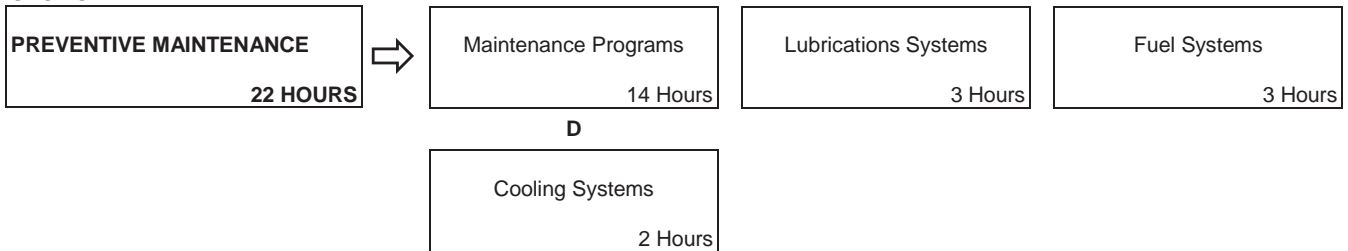
SECTION ONE



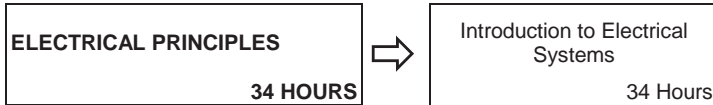
SECTION TWO



SECTION THREE



SECTION FOUR



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

SECTION ONE

REFRIGERATION
30 HOURS



A

Pressure Enthalpy and
 Psychrometry
30 Hours

SECTION TWO

DIRECT CURRENT
50 HOURS



A

Direct Current
50 Hours

SECTION THREE

ELECTRICAL COMPONENTS
44 HOURS



A

Electrical Components
44 Hours

SECTION FOUR

**MECHANICAL GENERATING AND
 STARTING SYSTEMS**
23 HOURS



A

Mechanical Generating
 Systems
17 Hours

B

Starting Systems
6 Hours

SECTION FIVE

**ELECTRICAL AND ELECTRONIC
 CIRCUITS**
60 HOURS



A

Electrical Circuits
23 Hours

B

Microprocessors
37 Hours

SECTION SIX

**ALTERNATING CURRENT
 THEORY**
33 HOURS



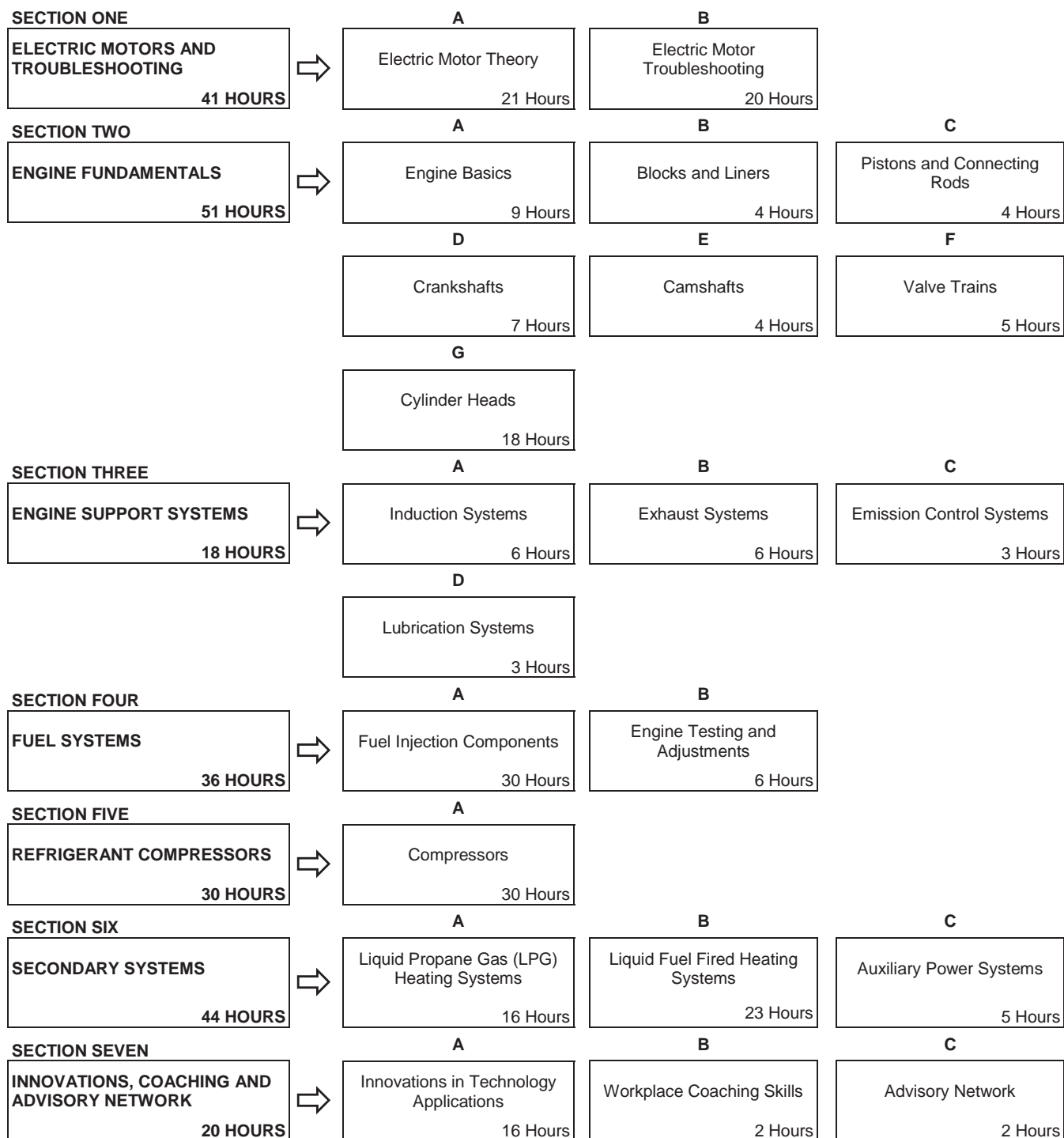
A

Electrical Power Supply
 System
9 Hours

B

AC Theory
24 Hours

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 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
TRANSPORT REFRIGERATION TECHNICIAN TRADE
COURSE OUTLINE**

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

SECTION ONE:STANDARD WORKPLACE SAFETY..... 10 HOURS

A. Safety Legislation, Regulations & Industry Policy in the Trades.....4 Hours

Outcome: Describe legislation, regulations and practices intended to ensure a safe work place in this trade.

1. Demonstrate the ability to apply the Occupational Health and Safety Act, Regulation and Code.
2. Explain the role of the employer and employee in regard to 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. Explain industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and employers to apply emergency procedures.
5. Describe positive tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with respect to the selection and use of personal protective equipment (PPE).
7. Select, use and maintain appropriate PPE for worksite applications.

B. Climbing, Lifting, Rigging and Hoisting 3 Hours

Outcome: Describe the use of personal protective equipment (PPE) and safe practices for climbing, lifting, rigging and hoisting in this trade.

1. Select, use and maintain specialized PPE for climbing, lifting and load moving equipment.
2. Describe manual lifting procedures using correct body mechanics.
3. Describe rigging hardware and the safety factor associated with each item.
4. Select the correct equipment for rigging typical loads.
5. Describe hoisting and load moving procedures.

C. Hazardous Materials & Fire Protection..... 3 Hours

Outcome: Describe the safety practices for hazardous materials and fire protection in this trade.

1. Describe the roles, responsibilities features and practices related to the workplace hazardous materials information system (WHMIS) program.
2. Describe the three key elements of WHMIS.
3. Describe handling, storing and transporting procedures when dealing with hazardous material.
4. Describe safe venting procedures when working with hazardous materials.
5. Describe fire hazards, classes, procedures and equipment related to fire protection.

D. Tools and Equipment.....6 Hours

Outcome: Demonstrate the care and safe use of hand tools and equipment.

1. Describe types, uses and care of hand tools and equipment.
2. Describe use of various types and capacities of shop pullers and pressing equipment.
3. Demonstrate the use of cutting and threading hand tools.
4. Describe the use and maintenance of pneumatic tools.

E. Measuring Tools.....8 Hours

Outcome: Demonstrate the care and use of measuring tools.

1. Perform calculations related to measurement using imperial and metric units.
2. Identify the function, care and storage of tools.
3. Perform linear measurements using basic measuring tools.
4. Perform linear measurements using precision measuring tools.
5. Demonstrate torque measurements and procedures.

F. Materials and Fastening Devices6 Hours

Outcome: Identify materials and fasteners commonly used in the trade.

1. Identify common metallic and non-metallic materials' characteristics and applications.
2. Identify types of threaded fasteners and their applications.
3. Demonstrate removal of seized and damaged nuts and bolts.
4. Describe thread repair systems and procedures.
5. Describe types of non-threaded fasteners and their applications.

G. Brazing Operations22 Hours

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.

SECTION TWO:REFRIGERATION SYSTEMS..... 132 HOURS**A. Refrigeration Concepts41 Hours**

Outcome: Describe the heat transfer concepts of a refrigeration system in a practical situation.

1. Define heat, temperature and types of heating.
2. Interpret the fixed points for different temperature scales.
3. Convert temperatures between temperature scales.
4. Describe principles, laws and types of heat transfer.
5. Explain the function of refrigeration in transportation for preservation.
6. Perform heating and cooling calculations.
7. Define industry terms related to work, power and energy.
8. Measure pressures using the instruments.
9. Describe pressure effects on a liquid.
10. Relate gravity and density in relation to water or a gas.

B. Refrigerants and Oils6 Hours

Outcome: Demonstrate recommended handling of refrigerant and oils.

1. Explain the purpose, terminology, classifications and properties of refrigerants.
2. Describe refrigerant hazards and safety precautions.
3. Describe the purpose, viscosities, compatibility, handling, testing and storage of compressor oils.
4. Describe aftermarket products available in the marketplace.
5. Describe refrigerant cylinders, filling procedures and testing requirements.
6. Describe the responsibilities and methods of recovering and recycling refrigerants.
7. Explain the problems related to water contamination.
8. Demonstrate moisture removal procedures.
9. Demonstrate cleaning procedures for a contaminated system.

C. Refrigeration Components18 Hours

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.

D. Diagnosis and Repair of Refrigeration Systems.....55 Hours

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.

E. System Leak Checking and Recharging.....9 Hours

Outcome: Perform procedures for leak testing and recharging.

- 1. Demonstrate leak detection.
- 2. Identify the refrigerant type for a given system.
- 3. Demonstrate charging, reclaiming, recycling, reuse and recovery tasks.

F. Factors Affecting Unit Performance3 Hours

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 THREE:PREVENTIVE MAINTENANCE..... 22 HOURS

A. Maintenance Programs.....14 Hours

Outcome: Describe common maintenance programs used on equipment.

1. Describe the types of maintenance systems.
2. Explain the principles and practices of preventive maintenance.
3. Demonstrate preventive maintenance and service procedures.
4. Write a work order and update maintenance records.
5. Describe the design, application and service of bearings, seals, belts, pulleys and idlers.
6. Demonstrate removal and replacement procedures for belts, bearings and idlers.
7. Convert temperatures between Celsius and Fahrenheit systems.

B. Lubrication Systems3 Hours

Outcome: Maintain engine lubrication systems.

1. Describe functions, classification and terminology of oil and additives.
2. Describe lubrication components, methods and filter systems.
3. State the purpose of crankcase ventilation systems.
4. Diagnose crankcase fuel dilution.
5. Describe lubrication system inspection and service.

C. Fuel Systems3 Hours

Outcome: Service engine fuel systems.

1. Describe fuel grades and additives.
2. Describe causes and effects of fuel contaminants.
3. Describe the location, features and functions of a fuel system and components.
4. Demonstrate filling, bleeding, testing, visible leak repair and service procedures.
5. Describe tank mounting methods and procedures.

D. Cooling Systems2 Hours

Outcome: Service engine cooling systems.

1. Describe the evolution of refrigeration and its definition.
2. Describe the function of refrigeration as it pertains to the industry for cooling and preservation.

SECTION FOUR: ELECTRICAL PRINCIPLES 34 HOURS

A. Introduction to Electrical Systems34 Hours

Outcome: Apply electrical fundamentals to diagnose an electrical system.

1. Explain the physical properties of conductors and insulators.
2. Explain electricity in terms of voltage, current and resistance.

3. Explain direct current, alternating current and static electricity.
4. List the components of a basic electrical circuit.
5. Describe the features and purpose of a schematic wiring diagram.
6. Describe the effects of circuit defects on circuit operation.
7. Explain electrical laws and formulas that apply to electrical circuits.
8. Apply electrical laws and formulas to calculate circuit values.
9. Describe the operation of voltmeters, ammeters and ohmmeters.
10. Measure circuits at various points and interpret the results.
11. Perform battery maintenance, testing and storage.
12. List safety precautions and procedures for boosting and charging batteries.
13. Describe multiple battery circuits in relation to connections and battery compatibility.
14. Trace electrical circuits using symbols that are common to the industry.
15. Perform wiring harness and connections inspection and repair.
16. Test circuit protection devices, switches, relays and solenoids.
17. Repair circuits for faults including shorts, grounds, opens, and high resistance.

**SECOND PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION TECHNICIAN TRADE
COURSE OUTLINE**

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

SECTION ONE:..... REFRIGERATION..... 30 HOURS

A. Pressure Enthalpy and Psychrometry.....30 Hours

Outcome: Apply the physics of heat transfer in refrigeration systems.

1. Define psychrometry.
2. Describe the meaning, function and uses of psychrometric charts.
3. Describe the properties of air in the design and operating refrigeration systems.
4. Plot and interpret a psychrometric chart.
5. Define enthalpy.
6. Describe the meaning, function and uses of enthalpy charts.
7. Define net refrigeration effect.
8. Describe the pressure temperature relationship of the various refrigerants.
9. Measure the pressure and temperature at components for diagnosis.

SECTION TWO:..... DIRECT CURRENT..... 50 HOURS

A. Direct Current.....50 Hours

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.

SECTION THREE: ELECTRICAL COMPONENTS..... 44 HOURS

A. Electrical Components 44 Hours

Outcome: Demonstrate the knowledge of electronic components for diagnosis and repair tasks.

1. Describe the operation and purpose of switches and solenoids.
2. Describe engine heater operation.
3. Identify the location, construction and operation of electrical components.
4. Perform electrical switch adjustments.
5. Describe the function and location of gauges and indicator lights.
6. Demonstrate the checking and calibrating of pressure transducers.
7. Describe the function, construction, location and testing of sensors and transducers.
8. Demonstrate sensor adjustments.
9. Describe the function and location of a relay-contactor.
10. Describe the test procedure for temperature sensors.
11. Explain the operating characteristics of a micro processor.
12. Describe the function, location and construction of the defrost circuit initiators.
13. Adjust defrost circuit initiators.
14. Describe the programming of the system from monitoring panels.

SECTION FOUR: MECHANICAL GENERATING AND STARTING SYSTEMS..... 23 HOURS

A. Mechanical Generating Systems 17 Hours

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.

B. Starting Systems.....6 Hours

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.

SECTION FIVE: ELECTRICAL AND ELECTRONIC CIRCUITS 60 HOURS

A. Electrical Circuits.....23 Hours

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

1. Identify the components within transport systems heating and cooling circuits.
2. Demonstrate trouble shooting 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.

B. Microprocessors37 Hours

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 SIX:..... ALTERNATING CURRENT THEORY 33 HOURS

A. Electrical Power Supply System9 Hours

Outcome: Identify ac circuit types and applications.

1. Identify ac circuit types and required protection devices.
2. Identify plugs, receptacles and required cable sizing.
3. Measure line loss and voltage drop in a circuit.
4. Demonstrate grounding procedures.

B. Alternating Current Theory24 Hours

Outcome: Identify ac theory of operation for servicing tasks.

1. Describe ac characteristics, terms, advantages and disadvantages.
2. Describe the mechanical generation of ac current for single and three phase units.

3. State the advantages for three phase systems over single phase systems.
4. Name types of three phase connections.
5. Describe the phase relationship for the 3 voltages in a three phase system.
6. Describe inductance and the factors which affect inductance.
7. Identify the capacitive reactance symbol, equation and unit of measurement.
8. State the phase relationship between voltage and current in a capacitive circuit.
9. List components of an impedance triangle.
10. Describe the importance of a balanced three-phase system.
11. Describe principles of operation and function of three phase ac generator sets.
12. Describe variable frequency drives.

**THIRD PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION TECHNICIAN TRADE
COURSE OUTLINE**

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

SECTION ONE:.....ELECTRIC MOTORS AND TROUBLESHOOTING..... 41 HOURS

A. Electric Motor Theory21 Hours

Outcome: Apply electric motor theory to diagnostic work.

1. Describe the principles, characteristics and applications of single-phase motors.
2. Draw circuit diagrams for a variety of electrical motors.
3. Describe protective devices for three phase motors
4. Describe motor controllers.
5. Describe the operation and application of a magnetic switch.
6. Demonstrate replacement of built-in thermal overload devices.
7. Demonstrate dc motor service.

B. Electric Motor Troubleshooting20 Hours

Outcome: Diagnose electric motor problems.

1. Diagnose electrical motor problems using systematic test flowcharts.
2. Describe the possible effects of over voltage and under voltage on motors.
3. Describe the importance of full load amps, lock rotor amps and free running amps.
4. Repair conditions that make motors operate at higher than normal temperatures.
5. Perform tests on other electrical devices related to motor circuits.

SECTION TWO:.....ENGINE FUNDAMENTALS 51 HOURS

A. Engine Basics9 Hours

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 Liners4 Hours

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..... 4 Hours

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 7 Hours

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..... 4 Hours

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..... 5 Hours

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..... 18 Hours

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 THREE: ENGINE SUPPORT SYSTEMS 18 HOURS

A. Induction Systems 6 Hours

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 6 Hours

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 3 Hours

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 Systems 8 Hours

Outcome: Diagnose lubrication system faults.

1. Describe function and operation of lubrication system components.
2. Demonstrate oil pressure test procedures.
3. Repair lubrication problems.

SECTION FOUR:FUEL SYSTEMS..... 36 HOURS

A. Fuel Injection Components..... 30 Hours

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 6 Hours

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.

SECTION FIVE:REFRIGERANT COMPRESSORS..... 30 HOURS

A. Compressors.....30 Hours

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.

SECTION SIX:.....SECONDARY SYSTEMS..... 44 HOURS

A. Liquid Propane Gas (LPG) Heating Systems16 Hours

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.....23 Hours

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 5 Hours

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: INNOVATIONS, COACHING, AND ADVISORY NETWORK 20 HOURS

A. Innovations in Technology Applications 16 Hours

Outcome: Describe innovative technological development in service and maintenance.

1. Use tools and equipment for diagnostic and inspection tasks.
2. Describe emergent technology for diagnosis and repair.
3. Describe on-line monitoring systems and applications.
4. Describe emergent technology for heating and cooling systems.

B. Workplace Coaching Skills 2 Hours

Outcome: Demonstrate coaching skills in the workplace.

1. Describe coaching skills used for training apprentices.

C. Advisory Network 2 Hours

Outcome: Describe the advisory network.

1. Describe the role and purpose of the advisory network and provincial apprenticeship committee for the Transport Refrigeration Technician Trade.



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