RAC-0100 **SAFETY**

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 1.

Prerequisites:

None

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- practice safety and maintain a safe work environment.
- safely work around electricity.

Theory:

1. Identify types of personal protective equipment and describe their purpose and use.
   - hearing protection
   - dust mask
   - respirator
   - safety glasses
   - protective clothing
   - guards and shields

2. Identify types of equipment used for working at heights and describe their safe use and maintenance.
   - fall arrest systems
   - safety nets
   - safety ropes
   - life lines
   - lanyards
   - anchor points

3. Describe the procedures used to install, maintain and inspect fall protection

systems.

4. Identify relevant safety regulations and describe their application.
   - federal
     - WHMIS
   - provincial
     - Workers Compensation Board
     - code of practice
     - industry standards
   - municipal

5. Describe potential work hazards on-site.

6. Describe employer/employee responsibilities for workplace safety.

7. Describe the safety requirements for working in confined spaces.

8. Describe safety practices when working in or near trenches and excavations.

9. Describe the purpose of lockout/tag-out procedures and their application to the work site.

10. Define the term proximity work and describe its associated safety procedures.
    - barriers and barricades
    - adjacent perimeter areas
    - public safety

11. Identify types of ladders and scaffolding and describe their applications, use and inspection procedures.

12. Identify the classes of fires and their associated fire extinguishers.

13. Identify various flammable materials and describe the precautions to be taken to prevent combustion.

14. Describe safe working practices when working on electrical equipment.

15. Describe the factors involved in creating an electric shock and the conditions that determine its' severity.

16. Describe the type of fire extinguisher and safety considerations observed when extinguishing an electrical fire.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Perform a lock-out procedure on an operating refrigeration system.

RAC-1100 HAND/POWER TOOLS AND FASTENERS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 1.

Prerequisites:

RAC-0100

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- select, use and care for hand/power tools and fasteners to execute tasks.

Theory:

1. Identify the types of screwdrivers and describe their care, use and application.
    - standard type
        - Keystone
        - Cabinet
    - Robertson
    - star type
        - Phillips
        - Reed and Prince (Frearson)
    - Posidrive
    - Clutch
    - Torx
    - Screw-starter
    - Offset

2. Identify the types of hammers and describe their care, use and application.
    - claw
    - ball-peen

- sledge
- soft-face hammers and mallets

3. Identify the types of pliers and describe their care, use and application.
   - linesman
   - diagonal-cutting
   - long-nose
   - slip joint
   - high-leverage cutter
   - locking

4. Identify the types of wrenches and describe their care, use and application.
   - open-end
   - box-end
   - combination
   - flare-nut
   - hex-key (Allen)
   - adjustable
   - pipe
   - socket
   - sockets
   - torque

5. Identify the types of hacksaw blades and describe their care, use and application.

6. Identify the types of files and describe their care, use and application.

7. Identify the types of taps and dies and describe their care, use and application.

8. Identify the types of measuring and layout tools and describe their care, use and application.
   - vernier caliper
   - micrometer
   - dial indicator
   - wire gauge
   - feeler gauge
   - measuring tape
   - combination square
   - levels

9. Identify the types of punches and chisels, and describe their care, use and application.
   - starting punches
   - pin and drift punches

- taper punch
- center punch
- cape chisel
- round nose chisel
- diamond point chisel
- cold chisel
- gasket punch

10. Identify the types of hand operated, hydraulic knock-out punches and describe their care, use and application.
11. Identify the types of portable drills and describe their care, use and application.
    - cordless
    - electric
    - electric hammer
    - rotary hammer
    - angle

12. Identify types of drill presses and describe their operating procedures.

13. Identify the types of grinders and describe their care, use and application.
    - portable
    - pedestal

14. Identify the types of power saws and describe their care, use and application.
    - circular
    - sabre
    - reciprocating

15. Identify the types of fastening devices and describe their sizes, classifications, use and application.
    - nails
    - adhesives
    - wood screws
    - sheet metal screws
    - machine screws and bolts
    - nuts and washers
    - masonry anchors and shields
    - cavity fasteners
    - screw anchors
    - epoxy

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided

as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Install various fastening devices.

2. Torque fastening devices to specifications with torque wrenches.

3. Assemble and dis-assemble equipment using various tools.

RAC-1105 TUBE, PIPE, FITTINGS, SOLDERING AND BRAZING

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 4, 13, 16, 20, 21, 27, 32, 33, 36, 41, 43, 44, 46, 47, 49, 55, 63 and 65.

Prerequisites:

RAC-1100

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- cut, fit, swage, flare, bend, solder and braze copper tubing.
- cut, fit and thread pipe.

Theory:

1. Identify the types of copper tubing and describe their sizes, weight, applications and procedures for installation.
   - ACR
   - nominal
   - soft drawn
   - hard drawn

2. Identify the types of fittings and describe their use, applications and procedures for installation.
   - elbows
   - tees
   - couplings
   - bushings
   - “P” Traps
   - flared

3. Identify types of flaring and swaging tools and describe their use, care and applications.

4. Identify the various types of mechanical brass fittings and describe their sizes, use, applications and procedures for installation.

5. Describe the procedures used to bend copper tubing.
   - spring benders
   - mechanical benders
6. Describe the safe use of acetylene, oxygen, and nitrogen cylinders used in soldering and brazing.
   - identification
   - storage
   - handling
   - transport

7. Describe the safe use and care of air/acetylene and oxygen/acetylene equipment and accessories.
   - regulators
   - hoses
   - torch handle
   - torch tips
   - reverse-flow check valves

8. Describe the procedures, applications of soldering and brazing and identify the properties, use , care and applications of associated filler metals.
   - silver brazing rod
   - phos-copper brazing rod
   - soft solder

9. Describe the use, care and application of nitrogen when brazing copper tubing.

10. Describe the methods, use and applications of pipe hangers and supports.

11. Identify the types of threaded pipe and describe their sizes, weight, fittings and applications.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Assemble air-acetylene and oxy-acetylene equipment.

2. Install soft and hard drawn copper tubing.
   - different methods of cutting copper tubing
   - ream copper tubing
   - bend copper tubing
   - prepare tubing for soldering/brazing
   - solder and braze copper tubing
   - select copper/brass mechanical and sweat fittings

3. Fabricate flares and swages in various sized copper tubes.

4. Fabricate various pipe hangers and supports.

5. Assemble, light and adjust air-acetylene and oxy-acetylene equipment and demonstrate safe use.

RAC-1110 REFRIGERATION FUNDAMENTALS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-0100

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- understand and analyze the refrigeration cycle and operation.

Theory:

1. Describe the history of refrigeration and air conditioning.

2. Describe the refrigeration and air conditioning occupation in terms of:
   - maintenance
   - installation
   - service and repair
   - troubleshooting
   - component and system design
   - customer relations

3. Describe the basic concepts of:
   - temperature
   - mass and weight
   - density
   - specific gravity
   - specific volume

4. Describe the various temperature scales and explain procedures used to perform conversion calculations from one scale to another.
   - fahrenheit
   - celsius
   - rankin
   - kelvin

5. Define terminology associated with the Refrigeration and Air Conditioning occupation.
   - heat
   - British Thermal Unit (BTU)
   - sensible heat
   - latent heat
   - specific heat
   - atmospheric pressure
   - gauge pressure
   - absolute pressure
   - vacuum

6. Define matter and explain the characteristics in each state.

7. Describe basic gas laws.
   - Boyle's
   - Charles'
   - Dalton's
   - Perfect gas
   - Pascal's

8. Describe heat flow and identify methods of heat transfer.
   - convection
   - conduction
   - radiation

9. Describe the characteristic changes that take place during the "change of state."
   - evaporation
   - condensation
   - freezing
   - melting
   - sublimation

10. Describe the effect of pressure on evaporation, condensation, freezing and melting temperatures.

11. Describe superheat and subcooling and their significance in the refrigeration cycle.

12. Describe the vapour compression cycle.

13. Identify the components of the vapour compression cycle and describe their function.
    - compressor
    - condenser
    - metering device
    - evaporator

14. Describe the physical changes of the refrigerant as it circulates through the system.

15. Describe the pressure/temperature chart and the relationship between temperature and pressure of a refrigerant.

16. Describe the attributes of a pressure enthalpy diagram.

17. Describe the following terms and explain how to locate them as plotted on a pressure/enthalpy diagram of a vapour compression cycle.
    - compressor (suction) superheat
    - condenser subcooling
    - condenser temperature difference
    - direction of refrigerant flow
    - evaporator superheat
    - evaporator temperature difference
    - high side
    - low side
    - pressure drop
    - discharge temperature
    - saturated discharge pressure
    - saturated discharge temperature
    - saturated liquid
    - saturated suction pressure
    - saturated suction temperature
    - saturated vapour
    - subcooled liquid
    - superheated vapour
    - temperature drop
    - temperature rise

18. Describe the following concepts and how they effect capacity.
    - condensation
    - expansion
    - heat of compression

19. Define the following and describe how each is determined.
    - mass flow rate
    - heat of compression
    - net refrigeration effect
    - system capacity
    - ton of refrigeration

20. Describe factors that determine food quality.
    - moisture content
    - enzymes
    - microorganisms (bacteria, yeasts, and molds)
    - temperature

21. Describe how the refrigeration process preserves food.

22. Describe factors that optimize storage of refrigerated and frozen foods.
    - packaging
    - storage time
    - storage temperature
    - humidity
    - air movement
    - mixed storage
    - product condition at time of storage

23. Describe freezing methods.
    - slow (sharp)
    - quick freezing
        - air blast
        - direct contact
        - indirect contact
        - immersion

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Operate a refrigeration system to:
    - measure operating temperatures
    - obtain operating pressures
    - plot the operating characteristics on a pressure enthalpy diagram
    - determine the amount of superheat
    - determine the amount of subcooling
    - determine net refrigerating effect

2. Perform calculations:
    - convert temperatures from one scale to another
    - convert pressures from absolute to gauge pressure
    - use various gas laws

3. Identify components of a refrigeration system.
    - compressor
    - discharge line
    - condenser
    - liquid line
    - metering device
    - evaporator
    - suction line
    - system accessories
    - condensate line

RAC-1115 REFRIGERATION TOOLS AND INSTRUMENTS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1100, 1110

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- identify and utilize the appropriate specialty tool, instrument or accessory during system diagnosis and repair.

Theory:

1. Describe the use, application and types of thermometers.
    - glass
    - dial
    - electronic
        - analog

    - digital
- recording

2. Describe the types of electronic temperature sensors.
    - thermocouple
    - thermistor
    - resistance temperature device (RTD)

3. Describe the use and application of:
    - gauge manifold
    - schrader valve core tool
    - quick couplers
    - charging hoses

4. Describe the use and application of leak detectors.
    - electronic
    - fluorescent dye and ultraviolet lamp
    - halide
    - litmus paper
    - soap
    - sulphur test
    - ultrasonic

5. Describe the use and application of a vacuum pump.

6. Identity vacuum measuring instruments and describe their use and applications.
    - electronic thermistor
    - utube mercury manometer

7. Describe the use and application of a refrigerant recovery/recycle unit.

8. Describe the use and application of a sling psychrometer.

9. Describe the use and application of a refrigeration oil pump.

10. Describe the use and application of an acid test kit.

11. Describe the use and application of an oil conversion test kit.

12. Describe the use and application of a refractometer.

13. Describe the use and application of a refrigerant weighing equipment.
    - charging cylinder
    - scales
        - electronic
        - mechanical

14. Describe the use and application of electrical test meters.
    - ammeter
    - megger
    - multimeter
    - ohmmeter
    - voltmeter
    - wattmeter

15. Describe the use and application of air flow meters.
    - pitot tube and inclined manometer
    - flowhood
    - rotating vane anemometer

- thermal anemometer
- velometer

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Test systems with various test instruments, tools and accessories.

RAC-1120 REFRIGERANTS, OILS AND REFRIGERANT MANAGEMENT

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 12, 14, 15, 16, 17, 20, 34, 35, 37-41, 47, 48, 54, 56 and 59.

Prerequisites:

RAC-1115

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- identify desirable refrigerant properties.
- identify the appropriate refrigerants and their containers.
- understand refrigerant handling procedures.
- understand refrigerant oil handling procedures.
- understand compliance with the relevant Code of Practice/provincial regulations in the handling of CFC's.
- identify the use and application of ammonia as a refrigerant.
- identify the safety hazards of ammonia.

Theory:

1. Describe refrigerant properties.
   - thermodynamic
   - physical characteristics

2. Describe the temperature/pressure relationship of refrigerants.

3. Define the terminology associated with refrigerants.
   - azeotrope
   - blend
   - chlorofluorocarbon (CFC)
   - fractionation
   - glide
   - hydrocarbon (HC)
   - hydro chlorofluorocarbon (HCFC)
   - hydro fluorocarbon (HFC)
   - inorganic

- near azerotrope
- zeotrope

4. Define the following according to the B-52 Mechanical Refrigeration Code.
   - primary refrigerant
   - secondary refrigerant

5. Describe refrigerant migration and prevention.

6. Describe the procedures used to transport refrigerant cylinders.

7. Describe the procedures used to transfer refrigerants.

8. Identify refrigerant cylinders and describe their colour codes as per Air Conditioning and Refrigeration Institute (ARI) Guideline “N”.
   - container
   - approved container
   - approved cylinder
   - disposable container

9. Describe the following refrigerant handling terms.
   - recovery
   - reuse
   - reclaim
   - recycle
   - retrofit (conversion)

10. Describe the operating procedures used to recover refrigerant from a refrigeration system.
    - active
      - liquid method
      - vapour method
      - push/pull method
    - passive

11. Describe refrigerant applications.
    - low temperature
    - medium temperature
    - high temperature
    - ultralow

12. Describe and understand the effect of the ozone layer depletion theory and global warming potential (GWP).

13. Identify and interpret federal/provincial refrigerant regulations and describe how there are applied.

14. Describe the function of refrigerant oil in a refrigeration system.

15. Describe the following terms associated with refrigerant oils.
    - dielectric strength
    - flash point
    - floc point
    - hygroscopic
    - miscibility
    - pour point
    - viscosity

16. Describe the procedures to determine the types of oil used for various refrigerants.
    - alkylbenzene
    - mineral
    - polyolester
    - polyalkylene glycol (PAG)

17. Describe the use and handling of refrigerant oils.
    - storage
    - handling
    - disposal

18. Describe the procedures to use an acid test kit.

19. Describe refrigerant and oil conversion procedures.
    - mineral oil to alkylbenzene
    - mineral oil to polyolester

20. Describe the procedures to use an oil conversion test kit.

21. Describe the procedures to use a refractometer.

22. Describe how the refrigeration industry affects ozone depletion.

23. Describe the mechanic's responsibilities concerning working on refrigeration systems.

24. Describe how refrigerants can be contained and prevented from release when designing, installing and servicing systems.

25. Describe the disposal of refrigerant as per Environment Canada's Code of Practice.

26. Describe the determining factors requiring that a refrigeration system be converted to a lower ozone depletion potential (ODP) refrigerant.

27. Describe the following relating to oil and ammonia mixtures.
    - mixability
    - relative density of each
    - behavior of oil and ammonia

28. Describe the characteristics of ammonia.
    - safety
        - equipment
    - chemical make-up
    - cylinder identification
    - environmental concerns
    - leak detection
    - physical characteristics
        - boiling point
        - toxicity level and its' effects
        - flammability
    - reporting ammonia spills and clean-up procedure

29. Describe the pressure temperature relationship of ammonia.

30. Define primary refrigerant and secondary refrigerant.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. List procedures to remove, add and transfer ammonia in an operating system.

2. Identify the type of refrigerant in an operating system.

3. Identify the type of refrigerant oil in an operating system.

4. Demonstrate refrigerant and oil conversion.

5. Demonstrate compressor oil change.

6. Identify colour coded refrigerant containers.

7. Recover refrigerant from a refrigeration system.

8. Perform an acid test.

9. Perform an oil conversion test.

10. Demonstrate the use of a refractrometer.

RAC-1125 REFRIGERATION SYSTEM VALVES AND ACCESSORIES

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1110

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- identify various refrigeration valves, their use, operation and application.
- identify various refrigeration accessories, their use, operation and application.

Theory:

1. Identity types of shut-off valves and describe their use, operation and applications.
   - angle
   - ball
   - diaphragm
   - globe
   - service

2. Identify "service or access valves" and describe their use, operation and applications.
   - 3-way service
   - angle
   - charging
   - king
   - line tap (piercing)
   - schrader
3. Describe the use and application of a check valve.

4 Describe the use and application of water regulating valves.

5. Describe the use and application of:
    - inlet pressure regulators
    - outlet pressure regulators
    - pressure differential regulators
6. Describe the use and applications of solenoid valves.
    - direct acting
    - pilot operated
        - 2-way
        - 3-way
        - 4-way

7. Describe the use and applications of system filter, dehydration and acid removal devices.
    - filters (liquid, suction)
        - standard
        - removable core
    - filter/driers (liquid, suction)
        - standard
        - removable core
    - acid removal (liquid, suction)
    - bi-flow (heatpump)

8. Describe the use and application of a liquid/moisture Indicator.

9. Describe the use and application of a suction accumulator.

10. Describe the use and application of oil separators.

11. Describe the use and application of a liquid receiver.

12. Describe the use and application of pressure relief devices.

13. Describe the use and application of a heat exchanger.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Locate and explain the purpose of various system valves and accessories on operating refrigeration and air conditioning systems.

RAC-1130 LEAK TESTING, EVACUATION AND CHARGING

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 13, 15, 16, 17, 20, 21, 34, 35, 36, 40, 41, 43, 44, 46, 47, 51, 55, 56, 58, 59, 62, 63 and 65.

Prerequisites:

RAC-1125

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- leak test refrigeration systems using various leak detection methods.
- dehydrate and evacuate refrigeration systems to a deep vacuum.
- charge a refrigeration system.

Theory:

1. Describe leak detection methods according to:
   - B-52 Mechanical Refrigeration Code
   - environmental regulations

2. Define terminology associated with leak testing, evacuation and charging.

3. Describe various leak detection tools and/or methods and principles of operation.
   - halide
   - electronic
   - ultrasonic
   - fluorescent dye and ultraviolet light
   - bubble solutions
   - standing nitrogen pressure test
   - standing vacuum test

4. Describe leak testing of ammonia systems using:
   - sulphur sticks
   - litmus paper

5. Describe the reasons for dehydrating and evacuating refrigeration systems and how and why the process works.

6. Identity types of vacuum pumps and describe their oils and maintenance procedures.
   - single-stage
   - two-stage

7. Describe multiple or deep evacuation.

8. Describe the procedures to use a vacuum gauge.
   - electronic thermistor
   - u-tube mercury manometer

9. Describe the procedures to use a gauge manifold.
   - installation on system (service and schrader valve access)
   - removal from system (service and schrader valve access)

10. Describe the procedures used to evacuate a system.
    - schrader valve access
    - service valve access

11. Describe the use of refrigerant weighing devices and their procedures for weighing in a charge.
    - charging cylinder
    - mechanical scale
    - electronic scale

12. Describe the conversion of weight scales.
    - imperial
    - metric

13. Describe the charging procedures in the vapour and/or liquid state on a refrigeration system with a critical charge.

14. Describe the charging procedure in the vapour and/or liquid state on a refrigeration system with a receiver and sightglass.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided

as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Install and remove gauge manifold on refrigeration and air conditioning systems.

2. Evacuate a refrigeration system using a vacuum gauge.
   - schrader valves
   - service valves

3. Charge a refrigeration system:
   - using a refrigerant weighing device
   - with no refrigerant weighing device

RAC-1135 ELECTRICAL FUNDAMENTALS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-0100

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- apply the fundamental concepts of electricity and electrical safety.
- measure voltage, resistance, current and power, and calculate their interrelationship.
- identify the components of simple circuits.

Theory:

1. Define the terms:
   - Electricity
   - Conductor
   - Semiconductor
   - Insulator

2. Describe the law of electric charges.

3. Describe current and electron flow.
   - Alternating current
   - Direct current

4. Define electromotive force and describe its' sources.

5. Define the following electrical terms, their unit of measurement and symbol:
   - Current
   - Energy
   - Power
   - Resistance

- Voltage

6. Define and describe the function of the following in an electrical circuit.
   - Conductor
   - Load
   - Resistor

7. Define conductor ampacity rating and list the factors used in determining it.

8. Describe the factors considered in the selection of wire insulating materials.

9. Describe the factors that determine the resistance value of a conductor.

10. Describe how resistors are rated.

11. Describe colour coding for resistors.

12. Describe the relationship between current, energy, power, resistance and voltage.

13. Describe the magnetic effects of current.

14. Describe the components and function of a simple electrical circuit.

15. Describe the characteristics of an electrical circuit.
   - Series
   - Parallel
   - Series-parallel

16. Describe the law of conservation of energy and apply it to each component of an electric circuit.

17. Describe and apply Kirchhoff's laws of voltage and current in series, parallel, and combination circuits.

18. Describe the use , application and procedures of electrical test instruments.
   - Ammeter
   - Multimeter
   - Ohmmeter
   - Voltmeter

19. Describe the differences between an analogue and digital meter.

20. Describe the term continuity and how it can be checked with a voltmeter.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Measure the voltage, component resistance and current of a refrigeration system.

2. Conduct experiments to demonstrate the characteristics of series, parallel, and combination electrical circuits using Ohm's law and Kirchhoff voltage and current laws.

RAC-1140 SINGLE AND THREE PHASE MOTOR FUNDAMENTALS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 15, 19, 26, 27, 30, 34, 39, 40, 43, 44 and 53.

Prerequisites:

RAC-1135

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- identify, diagnose and service single and three phase motors.

Theory:

1. Describe the generation and application of electricity.
   - single phase
   - three phase

2. Describe the differences between a single and three-phase circuit.

3. Describe the procedure for measuring voltage, resistance and current in a single and three phase circuit.

4. Describe the principles of motor operation.

5. Describe the construction details of single and three-phase motors.

6. Describe the factors that determine the speed, direction and rotation of motors.

7. Identify types of motors and describe their characteristics and applications.
   - capacitor start induction run
   - capacitor start and run
   - permanent split capacitor
   - resistance start induction run
   - shaded pole
   - three phase

8. Describe the characteristics of a capacitor and how to test it out of the circuit.
9. Describe the use, operation and wiring configuration of single phase starting devices.
   - current relay
   - potential relay
   - electronic starting relay
   - centrifugal switch

10. Describe the use, operation and wiring configuration of three phase starting devices.
   - relay
   - contactor
   - motor starter

11. Describe the procedure to diagnose winding failure in a single phase motor.

12. Describe the procedure to diagnose winding failure in a three phase motor.

13. Describe the effects load and voltage changes have on motor operation.

14. Describe the factors that can cause motor overheating.

15. Describe the meaning and application of motor name plate information.

16. Describe the advantages and disadvantages of:
   - single phase motors
   - three phase motors

17. Describe the operation and application of three phase motors.

18. Describe the methods used to change speeds of three phase motors.

19. Describe the procedures used to reverse the direction of rotation of a three phase motor.

20. Describe the winding configurations for three phase motors.
   - delta
   - wye

21. Describe motor troubleshooting techniques.
   - noise
   - vibration
   - ground
   - shorts
   - bearings

- switches
- opens

22. Describe replacement motor selection criteria.

23. Describe the effects of motor pulley selection, adjustment and alignment.

24. Identify the types of motor overload protection devices and describe their use and applications.
    - internal overload protection
        - thermostatic devices
        - resistance temperature detector (RTD)
        - thermocouple
        - thermistor
    - external overload protection
        - magnetic
        - thermal
        - thermal/current
        - electronic
    - low and high voltage protection
    - phase failure, reversal and ground fault protection

25. Describe the procedures to use a megger meter.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Check out single and three phase motors.

2. Identify and install electrical starting components on single phase motors.

3. Connect, run and reverse three phase motors.

4. Check motor insulation resistance with a megger meter.

RAC-1145 ELECTRICAL COMPONENTS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1135

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- identify and understand the operation of conductors, switching relays, overloads and transformers.
- select and size conductors.
- check out and select replacement switching relays, overload devices and transformers.

Theory:

1. Describe a simple circuit and each of its components.

2. Describe an overloaded, grounded and short circuit.

3. Identity conductor types and describe their sizes and applications.

4. Describe the use, application of distribution panels and wiring configurations.
    - single phase
    - three phase

5. Identify types of overcurrent protection devices and describe their use and how they are rated.
    - fuses
        - plug
            - time delay
        - cartridge
            - renewable
            - non-renewable
            - time delay
    - circuit breakers
        - thermal

    - magnetic
    - thermal-magnetic
  - thermal overload

6. Identity types of switching relays and describe their component parts, uses, ratings and configurations.
   - electromechanical
   - magnetic-reed
   - solid state
   - timing

7. Identity the types of transformers and describe their use, applications, construction and operation..
   - single phase
   - three phase

8. Describe transformer voltages, current and power relationships.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Troubleshoot overload circuits and components for proper operation.

2. Troubleshoot and wire switching relays.

3. Troubleshoot transformers.

RAC-1150 CONTROL FUNDAMENTALS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1145

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- understand control fundamentals and applications.
- apply automatic control concepts.

Theory:

1. Define terminology associated with control fundamentals.
    - control point
        - cut in
        - cut out
    - differential
        - fixed
        - variable
    - offset
    - range
    - reset
    - set point
    - deadband
    - span
    - throttling range

2. Describe system control and the components of a control circuit.

3. Describe different categories of control devices.
    - electrical
    - mechanical
    - electromechanical

- electronic
- pneumatic

4. Describe and compare the application of control systems on refrigeration and air conditioning systems including:
   - energy conservation
   - monitoring
   - operation
   - safety

5. Describe and compare open loop and closed loop control using the following terms:
   - controller
   - control medium
   - controlled variable
   - controlled device
   - manipulated variable
   - control agent
   - corrective action

6. Describe the differences in the following types of control:
   - on/off
   - proportional or modulating
   - two position
   - timed two position

7. Describe control and control actions and include:
   - loads
   - switches
   - circuits

8. Describe specific sensors used for the measurement of the following:
   - flow
     - vane or paddle
     - pitot tube
     - vortex tube or orifice plate
   - humidity
     - electronic
     - mechanical (hyroscopic)
   - liquid level
     - electronic
     - mechanical
   - pressure and/or pressure difference
     - bellows
     - diaphragm
     - piezoresistive

- temperature
    - bi-metal strip
    - rod and tube
    - sealed bellows
    - sealed bellows and capillary and/or bulb
    - resistive wire
    - thermistor
    - thermocouple

9. Describe the differences in operating, safety and monitoring controls.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Draw and describe an open and closed loop control circuit.

2. Draw and describe various control circuits.

3. Draw and describe a typical residential heat/cool system control circuit.

RAC-1155 AIR CONDITIONING FUNDAMENTALS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 18.

Prerequisites:

RAC-1110, 1135

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- understand the factors that determine good air conditioning design.
- apply air conditioning principles.

Theory:

1. Describe the process of air conditioning including:
    - temperature
    - humidity
    - filtration
    - air movement

2. Describe the factors that affect human comfort.
    - rate of body heat loss or gain
        - convection
        - radiation
        - evaporation (humidity)
    - air quality
        - ventilation
        - contaminants
            - smoke
            - dust particles
            - biological microorganisms
            - toxic gases

3. Describe each component and subsystem of a comfort air conditioning system.

4. Describe the difference between air circulation and ventilation.

5. Define the terms:
   - dew point temperature
   - dry bulb temperature
   - enthalpy
   - moisture content
   - relative humidity
   - sensible heat factor
   - specific volume
   - wet bulb temperature

6. Describe the use and application of a psychrometric chart and identify the property points and constant property lines.

7. Describe the use of a psychrometric chart to determine air properties.

8. Describe the terms indoor and outdoor design conditions and describe their differences.

9. Describe comfort zone as it relates to indoor air conditions.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Plot air properties on a psychrometric chart.

RAC-1160 RIGGING TECHNIQUES

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 1, 16, 20, 21, 27, 30, 32, 36, 41, 52, 54, 55, 59, 63, 64 and 66.

Prerequisites:

RAC-0100

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- identify, apply and tie various knots.
- identify simple machines and calculate their mechanical advantage.
- reeve multiple pulleys.
- determine the safe working load of rigging equipment.
- lift and/or secure heavy tools and/or equipment.
- manipulate crane loads with crane operators by the use of appropriate hand signals.

Theory:

1. Identify the various classes of levers and describe their application.

2. Identify types of simple machines and describe procedures to calculate mechanical advantage.
   - inclined plane
   - lever
   - pulley
   - screw
   - wedge
   - wheel and axle

3. Describe the effect of load capacity of a sling when the sling angle to the load is decreased.

4. Identify types of knots and describe their applications and procedures to tie.
   - reef knot
   - clove hitch
   - bowline
   - running bowline
   - timber hitch
   - half hitch

5. Identify types of hitches and describe their applications.
   - single vertical
   - single choker
   - single basket

6. Describe the use and benefit of spreader bars when lifting a load.

7. Identify types of rigging hardware and describe their use and applications.
   - load hook
   - grab hook
   - eye bolt
   - shackle
   - turnbuckle

8. Describe safe working load as it pertains to fiber rope, wire rope and chain.

9. Describe the advantage of reeving a multi -sheave block rather than threading.

10. Describe hand signals for boom equipment.
    - raise load
    - raise load slowly
    - lower load
    - lower load slowly
    - raise boom
    - lower boom
    - swing load left and right
    - stop
    - emergency stop

11. Identify fall arrest equipment and describe its use and applications.

12. Describe methods of lifting heavy objects.

13. Describe the use of portable ladders.
    - extension ladder
    - step ladder

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Tie various knots for lifting and securing loads.

2. Demonstrate crane hand signals.

3. Demonstrate setup and use of ladders.

4. Reeve multiple pulleys.

RAC-1200 SYSTEM ANALYSIS WITH PRESSURE ENTHALPY DIAGRAMS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1110

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- troubleshoot refrigeration systems by plotting system performance on a pressure enthalpy diagram.

Theory:

1. Define terminology associated with system analysis with pressure enthyalpy diagrams.

2. Describe the properties of a pressure enthalpy diagram.

3. Identify the following areas of the pressure enthalpy diagram.
   - liquid
   - saturation
   - vapour
   - subcooling
   - superheat

4. Describe the location of temperature and pressure points of a refrigeration cycle on a pressure enthalpy diagram.

5. Describe the difference between the simple saturated refrigeration cycle and an actual refrigeration cycle.

6. Describe the affects on system capacity resulting from:
   - changes in saturated discharge temperature
   - changes in saturated suction temperature
   - liquid subcooling
   - suction superheat
   - suction to liquid heat exchanger
   - high and low side pressure drops

7. Describe the difference between theoretical horsepower and brake horsepower.

8. Describe the effects of pressure loss in refrigeration piping.

9. Describe the concept of system equilibrium and the factors that determine system balance.

10. Describe the effect on system performance in an unbalanced system.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Plot a refrigeration cycle on a pressure enthalpy diagram.

2. Calculate the following from plotted data:
   - actual displacement
   - brake horsepower
   - coefficient of performance
   - compression ratio
   - condenser heat of rejection
   - desuperheating
   - heat of compression
   - mass flow rate
   - net refrigeration effect
   - subcooling
   - system capacity
   - theoretical displacement
   - theoretical horsepower
   - total heat rejected from the condenser

- total heat rejected from the system

3. Apply cycle diagrams to assist with troubleshooting the following.
   - bent or damaged tubing
   - dirty condenser
   - dirty evaporator
   - dirty filter drier
   - dirt in coils
   - fully restricted metering device
   - loss of refrigerant
   - low load
   - low air flow
   - overcharge of refrigerant
   - moisture in system
   - non-condensables in system
   - partially restricted metering device
   - poorly serviced equipment
   - undercharge of refrigerant
   - undersized refrigerant lines

RAC-1205 COMPRESSORS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 36, 39, 40 and 41.

Prerequisites:

RAC-1110, 1140

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:
- check compressors electrically and mechanically for proper operation.
- check and replace electrical starting components of hermetic compressors.
- identify system problems that could lead to compressor failures.

Theory:

1. Describe the function of the compressor in the refrigeration system.

2. Identify the different major types of compressors used in the refrigeration and air conditioning industry and describe their applications.
   - reciprocating
   - screw
   - rotary
   - scroll
   - centrifugal

3. Describe the difference between open drive, hermetic and semi-hermetic compressors.

4. Describe belt drive and direct drive compressors.

5. Describe the use and application of a compressor shaft seal.

6. Describe the major component parts of a reciprocating compressor and their function.
    - crankshaft
        - crank throw
        - eccentric
    - connecting rod
    - piston
    - valves
        - reed valves
        - ring valves
        - discus valve
    - valve plate
    - head
    - motor
    - housing

7. Describe the mechanical operation of a reciprocating compressor and include:
    - compressor efficiency
    - lubrication
    - cooling

8. Describe hermetic compressor motor cooling.

9. Describe compressor classifications according to temperature ranges.

10. Describe the electrical terminals on single phase compressor motors and the identification procedures.

11. Identify the four types of single phase compressor motors and describe their components and operating characteristics.

12. Describe the starting principles of single phase motors.

13. Describe the relative differences in starting torques of the four types of motors.

14. Describe the operation of single phase compressor motor starting relays.
    - current
    - potential

15. Describe procedures used to check and replace compressor motor starting relays.
    - current
    - potential

16. Describe the operation of solid state motor starting relays.

17. Describe how motor starting torque can be improved.
18. Describe the construction and operation of run and start capacitors used with compressor motors.
19. Define the following capacitor terms.
    - applied voltage
    - bleed resistor
    - capacitor bank
    - identified terminal
    - microfarad
    - voltage rating

20. Describe how capacitors of different values may be substituted as replacements.

21. Describe the operating principles of overload and overcurrent devices.

22. Describe the difference between pilot duty and line duty, both inherent and non-inherent.

23. Describe hermetic motor burn-out and distinguish between a mild or severe burn.

24. Describe the factors that can contribute to motor burn-out.

25. Describe the clean up procedures following a hermetic motor burn-out, including acid testing.

26. Describe the difference between electrical and mechanical failure of a hermetic compressor.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Check and replace current and potential relays.

2. Check and replace start and run capacitors.

3. Sketch and explain overload operation.

4. Test and check compressor motor windings.

RAC-1210 CONDENSERS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 36, 46, 47 and 56.

Prerequisites:

RAC-1110

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:
- describe the selection, application, operation and servicing of condensers.
- install, service and repair condensers.

Theory:

1. Describe condenser function in terms of:
   - condensing
   - desuperheating
   - subcooling

2. Classify condensers according to the following configurations.
   - air or water cooled
   - circuits and passes
   - fins and fin spacing
   - plate
   - primary and secondary surface
   - shell and coil
   - shell and tube
   - tube and tube

3. Describe the two categories of water cooled condensers and their design considerations.
   - wastewater
   - recirculated

4. Describe the effect of the following on the capacity and efficiency of condensers.
    - air or water velocity
    - counter flow versus parallel flow
    - condensing temperature difference
    - fouling and fouling rates
    - number of circuits
    - number of passes
    - refrigerant pressure loss
    - refrigerant velocity
    - condenser subcooling
    - thick versus thin coils

5. Describe condenser capacity rating and the considerations for proper sizing.

6. Describe the service and repair of condensers.
    - descaling
    - retubing
    - fin / coil cleaning

7. Describe methods of head pressure control.
    - air cooled
        - fan cycling
        - flooded condenser
        - modulating dampers
        - variable speed fan
    - water cooled
        - wastewater
            - water valve
        - recirculated
            - temperature
            - flow
                - by-pass valves
                - diverter valves
                - fixed
                - modulating

8. Describe piping considerations for condensers.
    - discharge piping
    - liquid (condensate) piping
    - waterside piping
        - supply
        - drain
        - isolation valves

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Identify air and water cooled condensers in industry catalogues.

2. Select condensers based on given design criteria.

3. Demonstrate condenser cleaning procedures.

RAC-1215 EVAPORATORS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 36, 42, 43 and 56.

Prerequisites:

RAC-1110

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:

- demonstrate knowledge of the selection, application, operation, installation and servicing of evaporators.

Theory:

1. Classify evaporators according to:
    - types of construction
        - bare tubed
        - plate surface
        - finned
    - circuits and passes
    - counter, cross and parallel flow
    - direct expansion, flooded and liquid overfeed
    - fins and fin spacing
    - forced and induced
    - plate or eutectic
    - primary and secondary surface

2. Describe the evaporators used in each of the following applications.
    - air coolers
    - air driers
    - ice maker
    - water and brine chillers

3. Describe the various defrost methods and any piping considerations for each type:
   - off cycle
     - pressure initiated and terminated
     - time initiated and terminated
   - electric
     - time initiated, temperature and/or time terminated
     - time initiated, pressure and/or time terminated
   - hot gas
   - reverse flow
   - heat bank

4. Describe drain pan heaters and evaporator fan control for walk-in freezers.

5. Describe the use and application of evaporator drain lines, including drainline heaters, pipe slope and insulation.

6. Describe the differences in direct (dry) expansion and flooded chillers.

7. Describe the effect of the following on the capacity and efficiency of evaporators:
   - air or water velocity
   - counter flow versus parallel flow
   - evaporator temperature difference
   - frost accumulation and fin spacing
   - number of circuits
   - number of passes
   - oil circulation
   - refrigerant pressure loss
   - refrigerant velocity
   - evaporator superheat
   - surface wetting
   - thick versus thin coils

8. Describe evaporator capacity rating and the considerations for proper sizing.

9. Describe the service and repair of evaporators.
   - descaling
   - retubing
   - fin/coil cleaning

10. Describe considerations for the placement of evaporators in refrigerated boxes.

11. Describe piping considerations required for the following evaporator configurations:
   - evaporator located above compressor
   - evaporator located below compressor

- multiple evaporators, individual suction lines
- multiple evaporators, single suction line

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Identify air cooling evaporators and water chillers in industry catalogues.

2. Select evaporators based on given design criteria.

3. Demonstrate evaporator coil cleaning procedures.

RAC-1220 METERING DEVICES

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 17, 34, 36, 37, 44, 58 and 60.

Prerequisites:

RAC-1215

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:

- demonstrate knowledge of installation, servicing, adjusting and repairing metering devices.

Theory:

1. Describe the purpose of the evaporator metering device in a refrigeration system.

2. Describe the use, operation and construction of the following metering devices.
   - automatic expansion valve
   - capillary tube
   - electronic expansion valve
   - hand expansion valve
   - high and low side floats
   - liquid level controls
   - restrictor/orifice/piston
   - thermostatic expansion valves
   - thermal electric valve

3. Describe and compare the operation of metering devices in terms of the following:
   - refrigerant charge
   - system application (direct expansion, flooded, liquid overfeed)
   - responsiveness to load variations.

4. Describe the sizing, selection and installation of a capillary tube.

5. Describe the system characteristics of a capillary tube system under the following conditions.
   - high load
   - low load
   - refrigerant overcharge
   - refrigerant undercharge
   - separated capillary/suction heat exchanger

6. Describe the methods of clearing plugged capillary tubes.

7. Describe the charging procedures of a capillary tube system.

8. Define the following thermostatic expansion valve terms.
   - constant superheat
   - hunting
   - starving
   - flooding
   - tonnage capacity

9. Describe the following thermostatic expansion valve application differences based on:
   - bulb charges
   - bulb responsiveness
   - equalization (external or internal)
   - operating temperature range
   - temperature

10. Describe selection criteria for thermostatic and automatic expansion valves.

11. Describe thermostatic expansion valve tonnage ratings and the variables that affect valve capacity.

12. Describe the operation and application of pressure limiting thermostatic expansion valves.

13. Describe the service and adjustment procedures of thermostatic expansion valves.
   - single evaporator installation
   - multi-evaporator installation

14. Describe the term glide in regard to superheat measurement and adjustment.

15. Describe the installation and service of automatic expansion valves.

16. Describe the method of charging a system with an automatic expansion valve.

17. Describe the installation and service of electronic and thermal electric expansion valves.

18. Describe the service and adjustment of high and low side floats.

19. Describe the service and adjustment of liquid level controls.

20. Describe troubleshooting techniques with expansion valves operating in the following conditions:
    - high load conditions
    - low load conditions
    - refrigerant overcharge
    - refrigerant undercharge
    - restricted
    - defective power element

21. Identify the types of distributors and describe their use and applications.
    - venturi
    - pressure drop
    - centrifugal
    - manifold

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Select expansion valves based on various applications.

2. Install and adjust expansion valves on operating systems.

3. Troubleshoot systems operating with:
    - high load conditions
    - low load conditions
    - refrigerant overcharge
    - refrigerant undercharge
    - restricted expansion valve

RAC-1225 AUTOMATIC FLOW CONTROLS AND APPLICATION

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1125, 1220

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- understand the operation of, install, maintain, service, repair and troubleshoot refrigeration flow control devices.

Theory:

1. Describe the operation of direct acting and pilot operated.
    - solenoid valves
    - inlet pressure regulator
    - outlet pressure regulator
    - differential pressure regulator

2. Describe the operation, installation, maintenance, service, repair and troubleshooting procedures of valves.
    - check
    - slide
        - 3 way
        - 4 way (reversing)
        - heat reclaim
        - hot gas defrost
    - solenoid

3. Describe the operation, installation, maintenance, service, repair and troubleshooting procedures of regulators.
    - crankcase pressure
    - differential pressure
    - evaporator pressure
        - stop valve feature

- condenser flooding control
- hot gas bypass
- receiver pressure

4. Describe the operation, installation, maintenance, service, repair and troubleshooting procedures of oil level controls.
   - oil level regulator
     - mechanical
     - electro-mechanical
   - oil reservoir and check valve

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Disassemble, inspect, service and adjust various refrigeration flow control valves.

RAC-1230 SYSTEM ANCILLARY COMPONENTS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 36, 37, 41, 42, 43, 50, 51 and 52.

Prerequisites:

RAC-1225

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- understand the operation of, install, maintain, service, repair and troubleshoot refrigeration ancillary components.

Theory:

1. Describe the operation, installation, maintenance, service, repair and troubleshooting procedures of:
    - accumulator
    - crankcase heater
    - discharge muffler
    - hand valves
    - liquid receiver
        - flow through
        - surge type
    - liquid line filter/drier
    - oil separator
    - oil filters
    - relief devices
        - diaphragm
        - dual relief valve and manifold
        - fusible plug
        - spring loaded
    - service valves
    - schrader valves
    - sightglass
    - solenoid valve
    - suction filter

- suction to liquid heat exchanger
- vibration eliminators

2. Describe the operation, installation, maintenance, service, repair and troubleshooting procedures for electronic and mechanical controls.
   - oil failure
   - high pressure - low pressure - fan cycling

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

2. Install, wire, adjust, check operation and troubleshoot various pressure operated electrical controls.

3. Install, wire, adjust, check operation and troubleshoot various ancillary devices.

RAC-1235 EVAPORATIVE CONDENSERS AND COOLING TOWERS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 45, 46, 47, 48 and 49.

Prerequisites:

RAC-1110, 1210

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- understand the principles of cooling tower and evaporative condenser design.
- demonstrate knowledge of the selection, application, operation, installation and service of cooling towers and evaporative condensers.

Theory:

1. Demonstrate the knowledge of the application of cooling towers and evaporative condensers and their differences.

2. Describe the heat rejection principle used by cooling towers and evaporative condensers.

3. Describe the factors that influence the effectiveness of cooling towers.
    - wet bulb temperature
    - amount of exposed water surface and length of time of exposure
    - velocity of air moving through the tower
    - direction of the air flow with relation to the exposed water surface
        - parallel
        - crossflow
        - counter

4. Describe the differences between the following types of cooling towers.
    - natural draft
    - induced draft
    - forced draft

5. Describe the factors that influence the effectiveness of evaporative condensers.
6. Identify the components of an evaporative condenser and describe their applications.

7. Identify the components of a cooling tower and describe their applications.

8. Describe the differences between spray filled and splash deck towers.

9. Describe the differences between water tower and city waste water systems.

10. Describe the advantages of a closed circuit water cooler.

11. Describe a dry cooler and its advantages in cold climates.

12. Describe the factors to consider when installing a cooling tower or evaporative condenser in cold climates.

13. Describe head pressure control by controlling cooling tower heat rejection rate or evaporative condenser evaporation rate.

14. Describe and determine the capacity of a cooling tower and an evaporative condenser using psychrometric processes.

15. Define the terms approach and range as they apply to cooling towers.

16. Describe seasonal maintenance required for evaporative condensers and cooling towers.

17. Describe the following water problems incurred with cooling towers and evaporative condensers including control measures.
    - algae, slime and bacteria
    - corrosion
    - dirt and debris
    - scaling (bleed-off)

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Identify cooling towers and evaporative condensers in industry catalogues.

2. List troubleshooting procedures for cooling towers and evaporative condensers.

3. List seasonal start-up, operational and shut-down procedures.

RAC-1240 FLUID DYNAMICS AND PUMPS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 17, 19, 45, 49, 53, 54 and 55.

Prerequisites:

RAC-1100, 1110

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- understand the principles of fluid flow within duct and pipe systems.
- identify operational system performance based on fluid and/or air flow dynamics.

Theory:

1. Describe the principles of fluid flow within duct and piping systems.

2. Define the following terms and their relationships:
   - static pressure
   - total pressure
   - velocity
   - velocity pressure
   - volume

3. Describe the units used to measure:
   - fluid flow
   - air flow

4. Describe the application of formulas to solve relevant problems using the following:
   - Bernoullis' effect
   - Boyles' law
   - Charles' law
   - Dalton's law

- Pascals' law
- Perfect gas law

5. Describe the uses of circulating pumps in refrigeration and air conditioning systems.
   - open system
   - closed system

6. Identify the components of a water circulating pump.

7. Define the terms friction head, net positive suction head and the cause and prevention of cavitation.

8. Describe the factors to be considered when selecting a circulating pump and include the following terms:
   - friction head
   - static head
   - total pumping head
   - velocity head

9. Describe the use and interpretation of a pump curve.

10. Describe the use and operation of circulating pumps as they are applied either in series or in parallel.

11. Describe the effects of air in an open or closed water or brine system and the procedures for purging it from the system.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Select circulating pumps based on written system parameters.

2. Purge air from a water system.

3. Determine pump performance from a system pump curve.

4. Dismantle, repair and test circulating pumps.

5. Apply formulas to solve fluid flow problems.

RAC-1245 REFRIGERANT RECOVERY AND RECYCLING PROCEDURES

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 15, 20, 35, 36, 37, 38, 40, 43, 46, 51, 54, 59 and 62.

Prerequisites:

RAC-1115

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- demonstrate knowledge of refrigerant recovery from various systems.
- maintain refrigerant recovery/recycle equipment.

Theory:

1. Describe the recovery of liquid and vapour refrigerant from systems using service valves and schrader access valves.

2. Describe the procedures used to recycle refrigerants.

3. Describe the use and procedures for distillation of refrigerant.

4. Describe the procedures to field test recovered refrigerant.

5. Describe refrigerant recovery/recycle equipment maintenance procedures.

6. Describe refrigerant recovery cylinder testing procedures.
   - Department of Transportation stamp
   - testing intervals

7. Describe the safe use and application of refrigerant recovery cylinders.
   - water capacity (W.C.)
   - tare weight (T.W.)
   - pressure rating

- maximum fill capacity

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Recover refrigerant from various systems with different types of service/access valves.

2. Test refrigerants for acid and cross-contamination.

RAC-1250 REFRIGERATION AND A/C INSTALLATION 1

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 17, 34 and 37.

Prerequisites:

RAC-1130, 1135

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:

- identify and apply procedures, materials and components in the installation of refrigeration and air conditioning systems.

Theory:

1. Describe the factors to consider when selecting refrigeration and air conditioning equipment.

2. Describe the factors in determining the installed location of refrigeration and air conditioning equipment.

3. Compare copper and steel pipe.

4. Compare copper and steel fittings.

5. Describe the use and application of filter/driers, metering devices and solenoid valves.

6. Describe the use and application of electrical diagrams.

7. Describe the use and application of piping schematic diagrams.

8. Describe wiring techniques.

9. Describe approved leak testing methods.

10. Describe approved evacuation methods.
11. Describe refrigerant charging techniques.

12. Describe the procedures used to check and adjust controls for normal operation.

13. Describe the procedures used to check and adjust evaporator superheat.

14. Describe the use of equipment start-up reports.

15. Describe documentation of all control settings.

16. Describe documentation of all system operating temperatures and pressures.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Document control settings of an operating system.

2. Document system operating temperatures and pressures of an operating system.

RAC-1255 TROUBLESHOOTING TECHNIQUES

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 16 and 29

Prerequisites:

RAC-1250

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- apply troubleshooting techniques when servicing refrigeration and air conditioning systems.

Theory:

1. Describe the difference between a systematic check out procedure and the art of troubleshooting.

2. Describe troubleshooting procedures.

3. Describe how to read and interpret troubleshooting charts.

4. Describe the wear profile and its causes and effects on electrical components.

5. Describe mechanical and electrical component failure:
   - wear
   - causes
   - methods of reducing wear
   - replacement procedures

6. Describe how the senses are used to identify problems while troubleshooting.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Demonstrate troubleshooting procedures on systems.

2. Analyze abnormal circuit conditions. Use analog and digital meters to identify circuit conditions and component conditions.
   - ground fault
   - open circuit
   - overload
   - potential voltage
   - short circuit
   - system conditions

RAC-1260 INDUSTRY AND RELEVANT CODES

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1255

Course Outcomes:

Upon the successful completion of the course, the apprentice will be able to:
- understand the scope and jurisdiction of the B-52 Mechanical Refrigeration Code and other relevant codes.
- interpret the B-52 Mechanical Refrigeration Code and other relevant codes.

Theory:

1. Describe the scope and jurisdiction of the B-52 Mechanical Refrigeration Code.

2. Describe significant refrigeration terms using the B-52 Mechanical Refrigeration Code.

3. Describe the intent of the different code sections.

4. Describe the code sections of the B-52 Mechanical Refrigeration Code.
   - system selection and application requirements
   - equipment design and construction
   - installation
   - over pressure protection
   - maintenance of systems
   - precautions

5. Describe and interpret Environment Canada's Code of Practice for the Reduction of Chlorofluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

6. Identify and interpret relevant sections in the C22.1 National Electrical Code, including the "Hermetic Refrigeration Motor Compressors" section.

7. Identify and interpret municipal, provincial and other applicable plumbing codes sections that pertain to refrigeration and air conditioning installation and service.

8. Describe the importance of CSA and UL approved equipment.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Locate and review code sections in the "B-52 Mechanical Refrigeration Code".

2. Locate and review code sections in the "Code of Practice for the Reduction of Chlorofluorocarbon Emissions from Refrigeration and Air Conditioning Systems".

3. Locate and review municipal, provincial and other applicable plumbing sections that pertain to the installation and service of refrigeration and air conditioning equipment.

RAC-1265 CONTROL CIRCUITS AND WIRING DIAGRAMS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 13, 16, 17, 61, 64 and 65.

Prerequisites:

RAC-1150, 1230

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- install, service and repair various control circuits.
- demonstrate knowledge to wire control circuits to achieve the desired control functions.
- demonstrate knowledge of wiring diagrams.

Theory:

1. Describe the operation of a control system and how it is wired into a system using the listed components.
    - valves
    - dampers
    - actuators
    - double pole double throw switch
    - double pole single throw switch
    - power supply (for circuit boards)
    - relays (electrical and pneumatic)
    - single pole double throw switch
    - single pole single throw switch
    - starters and contactors
    - timers
    - transducers
    - transformers

2. Describe the operation of a safety control circuit and how it is wired into a system using the listed components.
   - alarm circuits
   - anti-short cycling devices
   - discharge gas temperature sensors
   - flow switches
   - high and low pressure controls
   - high and low limit thermostats
   - humidity controls
   - oil failure controls
   - overload devices
   - temperature control
   - winding thermostats

3. Describe and illustrate the following control applications.
   - off cycle defrost (temperature and pressure)
   - pump-down cycle
   - pump-out cycle
   - timed defrost
   - lock-out or reset circuit

4. Describe the difference between a pictorial and schematic wiring diagram.

5. Describe the legend and standard symbols of a schematic diagram.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Draw schematic diagrams based on a written sequence of control events complete with a legend.

2. Draw a schematic wiring diagram from a pictorial diagram.

3. Wire control circuits.

RAC-1270 MOTOR CONTROLS, RELAYS AND TRANSFORMERS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 16, 17, 19, 29, 30, 40, 47, 53, 55 and 61.

Prerequisites:

RAC-1265

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- understand the principle of operation of motor controls, relays and transformers.
- identify, service and wire motor controls, relays and transformers.

Theory:

1. Describe the principles of operation of a transformer.

2. Identify the components of a transformer.

3. Describe the use and application of transformers.
   - step-down
   - step-up
   - isolation
   - center-tapped
   - autotransformer

4. Describe transformer load limitations and determine load limitations from transformer ratings.

5. Describe the difference between open and closed circuit voltages of a class 2 transformer.

6. Describe the procedures used to check operation of a transformer.

7. Describe the operation, wiring and servicing of control or switching relays.

8. Describe the operation, wiring and servicing of motor overload protection devices.
   - internal
   - external

9. Describe the operation, wiring and servicing of motor starters.
   - electro-mechanical
   - solid state

10. Identify the components of a motor control circuit and describe their function.
    - safety
    - operating

11. Describe the procedures used to size or set the safety overload protection.
    - auto reset
    - manual reset

12. Compare the application and operation of full voltage, part winding and wye-delta starting.

13. Describe the application, operation and service of autotransformers and starters and their components.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Install and service motor controls, relays and transformers.

RAC-1275 REFRIGERATION EQUIPMENT

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 17, 66 and 68.

Prerequisites:

RAC-1105, 1120, 1160, 1200, 1205, 1210, 1245, 1260, 1270

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- demonstrate knowledge of installation, maintenance, servicing and repairing refrigeration equipment.

Theory:

1. Identify types of commercial refrigeration equipment and describe their operating characteristics, application, installation, service and repair.
   - merchandisers
   - process refrigeration
   - specialty equipment
   - vending machines
   - walk-in / reach-in coolers
   - walk-in / reach-in freezers
   - water fountains

2. Describe the differences to be considered during design, construction and service of freezers and coolers.
   - box construction
   - drain placement
   - control
   - defrost
3. Describe the operation of a commercial ice machine.
   - cuber
   - flaker

4. Describe the operation of an industrial ice flaker.

5. Describe various harvest methods for ice machines.

6. Describe the procedures used to troubleshoot ice machines.
   - water supply
   - refrigeration
   - electrical

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Demonstrate check out procedures for refrigeration equipment.

RAC-1280 AIR CONDITIONING EQUIPMENT

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 18, 34, 61 and 64.

Prerequisites:

RAC-1155

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- understand the application, construction and installation of unitary and split air conditioning systems.
- identify, maintain, service and repair window, rooftop, packaged room and split system air conditioning units.

Theory:

1. Describe the components, operating characteristics and applications of air conditioning units.

2. Describe installation, service and maintenance procedures for air conditioning units

3. Interpret wiring and control diagrams for air conditioning units.

4. Describe the operating temperatures and pressures of a direct expansion air conditioning system.
   - condenser temperature difference
   - discharge temperature
   - evaporator superheat
   - evaporator temperature difference
   - subcooling at the condenser
   - suction superheat
   - temperature drop
   - volumes and velocities of air flowing over the cooling coil

5. Describe a systematic check of a direct expansion air conditioning system.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Maintain, service and repair air conditioning equipment.

2. Demonstrate check out procedures of air conditioning equipment.

RAC-1300 REFRIGERATION LOAD CALCULATIONS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1110
RAC-1280 Air Conditioning Equipment

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- calculate a refrigeration heat load.

Theory:

1. Define refrigeration load and the need to determine an accurate load calculation.

2. Describe individual loads that must be considered when calculating the total refrigeration load.
   - transmission
   - air change
   - product
   - miscellaneous

3. Describe heat transfer rates and resistance using K, C, U and R values.

4. Define the term air change and describe the methods of determining the amount of infiltrated air.

5. Describe sources of heat gain that must be considered when calculating product load.
   - heat of respiration
   - load profile
   - latent heat

- sensible heat

6. Describe miscellaneous sources of heat gain that must be considered when calculating refrigeration loads.
   - fans
   - lights
   - motors
   - people

7. Describe the procedures used to calculate refrigeration loads.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Calculate heat of transmission loads for fixture temperatures above and below 32°F.

2. Calculate air infiltration loads for fixture temperatures above and below 32°F.

3. Calculate product loads for fixture temperatures above and below 32°F.

4. Calculate miscellaneous loads for fixture temperatures above and below 32°F.

5. Calculate total loads for fixture temperatures above and below 32°F.

6. Calculate and BTU/hr load required for:
   - air defrost
   - electric defrost
   - hot gas defrost

RAC-1305 REFRIGERATION SYSTEM AND PIPE DESIGN

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 39 and 41.

Prerequisites:

RAC-1300

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- apply the principles of refrigeration system design.
- select system components based on design criteria.

Theory:

1. Describe fundamental design considerations of a refrigeration system.
    - system cleanliness
    - capacity at design conditions
    - compressor safe operating conditions
    - oil return
        - pipe sizing
            - hot gas
            - suction
            - liquid
            - condensate
        - velocity
        - single and double risers
    - excessive liquid refrigerant at compressor
    - minimize pressure drop in the refrigeration piping

2. Describe the capacity ratings of major components according to industry standards.

3. Describe and compare the required horsepower per ton of a high, medium and low temperature system.

4. Describe the selection of compressors and condensing units.

5. Describe the selection of evaporators and air and water cooled condensers.

6. Describe sizing procedures using graphs and tables.
   - compressor
   - multiple compressors
   - compressors with cylinder unloading
   - evaporator
   - multiple evaporators operating at the same and different temperatures

7. Describe procedures to graph evaporator and compressor data on a saturated suction temperature capacity chart to determine:
   - balance point
   - operating saturated suction temperature
   - operating evaporator temperature difference
   - cabinet relative humidity
   - system operating capacity

8. Describe the selection of air cooled condensers for a given temperature difference using heat of rejection factors and/or pressure enthalpy diagram.

9. Describe the selection of thermostatic expansion valves.

10. Describe the selection of various system accessories.

11. Describe the suction, liquid, discharge and condensate lines and include the following:
   - acceptable fluid velocities
   - acceptable pressure loses
   - oil circulation
   - refrigerant circulation

12. Describe piping practices as applied to the following pipe sections.
   - condensate
   - discharge
   - liquid
   - suction

13. Describe the penalty imposed by pressure drop in a refrigeration or air conditioning system and recommended maximum pressure drop.

14. Describe equivalent pipe lengths for fittings and valves.

15. Describe procedures to determine refrigerant pressure losses and velocities from tables.

16. Describe the procedures for selection of refrigerant line sizes.

17. Describe the use, application and selection of double suction and discharge risers.
18. Describe piping problems and solutions.

19. Describe set, run, and travel measurements and apply to constructing offsets.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Select equipment from manufacturers catalogues based on design criteria ensuring that components selected are matched and balanced.

2. Calculate and select proper tubing size for suction, liquid, discharge and condensate lines.

3. Graphically analyze data gathered for the following system components.
   - compressor
   - multiple compressors
   - compressors with cylinder unloading
   - evaporator
   - multiple evaporators operating at the same and different temperatures

4. Determine refrigerant pressure losses and velocities from tables.

RAC-1310 REFRIGERATION AND A/C INSTALLATION 2

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 34, 37 and 66

Prerequisites:

RAC-1305

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- sketch a piping schematic.
- sketch an electrical schematic.
- install refrigeration and air conditioning systems.

Theory:

1. Describe procedures used to sketch a system piping schematic and include the following:
   - isolation valves
   - major components
   - piping and fittings
   - controls and accessories
   - safety devices
   - pipe sizes

2. Describe procedures used to sketch a system electrical schematic and include the following:
   - cycling controls
   - distribution lines for control and power circuits
   - major system components
   - operating controls
   - power sources
   - safety controls

3. Describe the factors that determine optimum location of evaporators and condensers.

4. Describe the selection of refrigerants for high, medium and low temperature applications.

5. Describe the procedures used to create a complete bill of material.

6. Describe the installation of evaporators.

7. Describe the installation of condensing units and condensers.

8. Describe the installation of connecting piping, including pipe supports, slope and insulation where required.

9. Describe the installation of:
   - filters and filter/driers
   - metering devices
   - solenoid valves
   - isolation valves
   - other flow controls and accessories

10. Describe the installation and wiring of operating and safety controls.

11. Describe the procedures used to perform a leak test.

12. Describe approved evacuation procedures.

13. Describe refrigerant charging procedures.

14. Describe the adjustment of operating and safety controls.

15. Describe system start-up and procedures to check:
   - compressor voltage, voltage imbalance and amperage
   - refrigerant charge
   - oil levels
   - operating pressures
   - superheat (evaporator and compressor)
   - discharge temperature
   - cabinet temperatures

16. Describe the check out and adjustment of all flow controls.

17. Describe the elements of and the procedures to complete an installation report.
   - project objective
   - equipment list
   - schematics and drawings
   - sizing and selection calculations

- refrigerant used
- balance graphs and charts
- system test results
- disposition of recovered refrigerants and hazardous wastes
- summarize complete installation and shutdown

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Install refrigeration and air conditioning systems and components.

2. Check and record system operating conditions.

3. Create a complete bill of material.

RAC-1315 SYSTEM CAPACITY CONTROL

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 19, 39, 45 and 57.

Prerequisites:

RAC-1280

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- demonstrate knowledge of the requirement for system capacity control.
- identify, install, adjust, service and troubleshoot capacity control devices.

Theory:

1. Describe capacity control and the importance of balancing system capacity with system load.

2. Describe the negative effects of system imbalance.

3. Describe the use, application, operation and service of evaporator capacity control.

4. Describe the use, application, operation and service of compressor capacity control.
    - cylinder unloading
        - cylinder by-pass unloading
        - cylinder suction valve unloading
    - compressor suction limiting
    - hot gas by-pass (artificial load)
    - multiple compressors
    - variable speed compressor

5. Describe the procedures used to troubleshoot capacity controls.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Install and adjust various capacity control devices.

2. Troubleshoot capacity controls.

RAC-1320 COMPRESSOR DIAGNOSTICS AND REPAIR

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 36, 39 and 40.

Prerequisites:

RAC-1310, 1315

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- analyze causes of compressor failures.

Theory:

1. Describe the two modes of compressor failure.
   - electrical
   - mechanical

2. Describe the difference between the primary reason for compressor failure and the resultant reason compressor failure.

3. Describe factors that can contribute to compressor electrical failure including:
   - defective motor or motor protector
   - improper clean up after a previous compressor failure
   - low, high, or unbalanced voltage/amperage
   - loose wiring or faulty controls
   - mechanical failure
   - misapplication of compressor

4. Describe factors that can contribute to compressor mechanical failure including:
   - mechanical component failure
   - improper lubrication/oil return
   - high discharge temperatures
   - slugging

5. Describe factors that can contribute to compressor lubrication problems.
   - improper liquid refrigerant control
   - refrigerant migration
   - refrigerant floodback
   - flooded starts
   - compressor overheating

6. Describe the use and application of:
   - pump down cycle
   - pump out cycle
   - solenoid drop

7. Describe compressor efficiency and how it is determined.

8. Describe the difference between oil pressure and net oil pressure.

9. Describe the procedures to determine net oil pressure.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Measure net oil pressure.

2. Disassemble compressors to identify failure.

RAC-1325 TROUBLESHOOTING SYSTEMS AND THEIR COMPONENTS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 12, 15, 20, 23, 26 and 28.

Prerequisites:

RAC-1320

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- troubleshoot system and component problems in refrigeration and air conditioning systems.

Theory:

1. Outline troubleshooting methods for problems with:
   - system
   - compressor
   - evaporator
   - condenser
   - metering devices
   - electrical components

2. Outline procedures used to troubleshoot systems and components.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

3. Troubleshoot:
   - systems
   - compressors
   - evaporators and condensers

- metering devices
- electrical controls and circuits

RAC-1330 PSYCHROMETRICS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task #14, 18, 25, 45 and 57.

Prerequisites:

RAC-1155

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- predict the changes in air properties in the air conditioning process.
- measure and plot the changes in air properties as it is being conditioned.

Theory:

1. Describe the following terms in relation to a psychrometric chart:
    - dry bulb temperature
    - wet bulb temperature
    - dew point
    - total heat content
        - latent
        - sensible
    - moisture content
    - relative humidity
    - specific volume

2. Identify the property points and constant property lines represented on a psychrometric chart.

3. Describe the air conditioning process, identify the air properties and the procedures used to plot on a psychrometric chart.
    - air mixing
    - by-pass factor
    - cooling and dehumidification
    - heating and humidification
    - evaporative cooling
    - dehumidication
    - humidification

- sensible cooling
- sensible heating

4. Describe the changes in air properties for the following situations:
   - sensible heating and cooling
   - heating and humidification
   - cooling and dehumidification
   - air mixing
   - evaporative cooling

5. Describe air volume flow rate required for a zone.

6. Describe the calculations for determining:
   - latent heat
   - sensible heat
   - total heat

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Plot system conditions on a psychrometric chart.

2. Calculate latent, sensible and total heat.

3. Determine the quantity of water required to raise the relative humidity to a pre-determined level.

RAC-1335 AIR CONDITIONING SYSTEM DESIGN

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task #13, 16, 18, 19, 20, 21, 27, 28, 29, 34 and 57.

Prerequisites:

RAC-1330

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- apply fundamental air conditioning design principles.

Theory:

1. Describe types of air conditioning systems.
   - air conditioning system
   - comfort air conditioning
   - industrial air conditioning
   - year round air conditioning

2. Identify and describe the components of a comfort air conditioning system.

3. Describe the conditioned variables controlled in a comfort zone.

4. Describe the difference between air recirculation and ventilation.

5. Describe the use, application and operation of economizers.
   - built-up
   - packaged

6. Describe air volumes and velocities of air circulation at various points in an air conditioning circuit.

7. Identify and describe the two main types of fans.
   - axial
   - centrifugal

8. Describe and identify the location of the following:
   - supply air grills/ducts
   - return air grills/ducts
   - exhaust air/ducts

9. Identify the following accessories and describe their use and applications.
   - humidifiers
   - air cleaners
   - economizers
   - heaters

10. Describe the use, application and methods of zoning.

11. Describe the following:
   - core areas
   - multi-purpose occupancies
   - perimeter areas
   - single purpose occupancies

12. Identify types of unitary equipment and describe their use and applications.

13. Describe the operation of the following systems:
   - constant volume single zone
   - constant volume terminal reheat
   - constant volume dual duct
   - constant volume multi-zone
   - constant volume face and by-pass
   - variable air volume

14. Describe the operation of chilled water systems, indicating system variations and methods of providing ventilation.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Select system components based on design criteria.

2. Compare operating capacity to design capacity using manufacturers data.

RAC-1340 HEAT PUMP SYSTEMS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 34.

Prerequisites:

RAC-1280, 1335

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- apply heat pump principles of operation in installing, servicing and troubleshooting heatpumps.

Theory:

3. Define heat pump and describe the principle of operation.

4. Describe the different classifications of heat pumps.
   - air to air heat pump
   - water/liquid to air heat pump

3. Describe the use and function of a four way valve.

4. Define the terms:
   - auxiliary heat
   - balance point
   - coefficient of performance (COP)
   - emergency heat
   - indoor coil
   - outdoor coil
   - energy efficiency rating (EER)
   - seasonal energy efficiency rating (SEER)

5. Describe the use, application and operation of the defrost cycle as related to heat pumps.

6. Describe the use and application of Geothermal heat pumps.
   - closed loop
   - open loop

7. Describe environmental considerations when selecting Geothermal heat pumps.

   - primary refrigerants.
   - secondary refrigerants.

8. Describe the use and application of freeze protection for water to air heat pumps.

9. Describe water quality as related to open loop systems.
   - volume of water available
   - temperature of well water
   - mineral content

10. Explain the formula to determine the quantity of water required to either absorb or reject the required heat in a Geothermal heat pump.

11. Describe typical control sequences for heat pumps.

12. Describe troubleshooting procedures:
   - 4-way valve
   - airside
   - defrost
   - waterside
   - controls

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Troubleshoot heat pump systems.

RAC-1345 FANS, MECHANICAL DRIVES AND AIR FILTRATION

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 17, 19, 20, 30, 31, 32, 33, 34, 50, 56, 57 and 64.

Prerequisites:

RAC-1110, 1340

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- apply the principles of air movement, fan operation and filter application.
- identify types of fans used in the industry.
- align and adjust fan and blower drives.
- identify and select filters for various applications.

Theory:

1. Describe fans and how they move air.

2. Describe the two types of fans or blowers used in air conditioning equipment.
    - axial
        - propeller type
        - vane type
    - centrifugal (squirrel cage)
        - backward curved
        - forward curved
        - radial

3. Define the following terms as they apply to fans.
    - blocked tight static pressure
    - centrifugal or radial flow
    - fan static pressure
    - fan total pressure
    - guide vanes
    - impeller and casing
    - propeller and casing
    - propeller or axial flow

- wide open volume flow

4. Describe clockwise and counter-clockwise rotation of a propeller fan and how to distinguish the proper rotation of a fan blade.

5. Describe the use, application and interpretation of a fan performance curve chart.

6. Describe the two types of drives for fans.
   - belt drive
   - direct drive

7. Identify types of bearings and describe methods of lubrication.

8. Describe factors that affect fan performance.
   - pitch
   - rotation
   - diameter
   - speed
   - number of blades
   - motor horsepower
   - balance

9. Describe the effects of fan speed changes using fan laws.

10. Describe the effects of varying pulley sizes on belt driven blower units.

11. Describe the use, application and adjustment of variable pitch pulleys.

12. Identify the types of V-belts and describe their sizes, installation and adjustment.

13. Identify the types of mechanical air filters and describe their operation, installation and servicing.

14. Identify special application type filters and describe their use.
   - HEPA
   - activated carbon
   - activated alumina with potassium permanganate
   - electrostatic
   - other

15. Describe how mechanical air filters are rated.
   - efficiency
   - resistance
   - particulate holding capacity

16. Describe methods to monitor filter efficiency.

17. Describe the use and operation of electronic air cleaners.
18. Describe the differences between the operation and efficiency of electronic air cleaners and mechanical filters.

19. Describe troubleshooting techniques for electronic air cleaners.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Demonstrate blower belt replacement, adjustment and alignment.

2. Demonstrate pulley/sheave removal, replacement, alignment and adjustment.

3. Troubleshoot electronic air cleaners.

4. Demonstrate blower fan speed adjustment.

RAC-1350 AIR MEASURING INSTRUMENTS AND SYSTEM BALANCING

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 19, 28, 31 and 34.

Prerequisites:

RAC-1110

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- apply the principles of air measurement in the servicing of air conditioning equipment.
- measure air quantities from grills, diffusers and ductwork.

Theory:

1. Describe the use, application and operating principles of the following instruments.
   - pitot tube and inclined manometer
   - flowhood
   - rotating vane anemometer
   - sling psychrometer
   - thermal anemometer
   - tachometer
   - velometer

2. Define the terms:
   - CFM
   - LS
   - FPM
   - MS
   - static pressure
   - velocity pressure
   - total pressure

3. Describe the procedures used to measure air flow using the “temperature rise” method.

4. Describe duct traverse and the procedures used to measure average air velocity in a square, rectangular or round duct.
5. Describe the use and application of a duct friction chart.

6. Describe the use, application and interpretation of the “circular equivalents of rectangular duct” chart.

7. Describe air balancing, the procedures and associated reports.

Practical:

Suggested practical activities are assigned to enhance the apprentice’s ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Demonstrate air measurement with various instruments.

RAC-1355 SYSTEM CONTROL APPLICATIONS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 19, 20 and 34.

Prerequisites:

RAC-1280

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- Identify and apply system control applications used in air conditioning systems.

Theory:

1. Describe sequence of operation, system layout and component inter-relationship of a ventilation control system using an H diagram.
   - fan interlock
   - minimum position
   - damper location

2. Describe sequence of operation, system layout and component inter-relationship of a mixed air control system using an H diagram.
   - fan interlock
   - mixed air control
   - minimum position
   - damper location

3. Describe sequence of operation, system layout and component inter-relationship of an economizer control system using an H diagram.
   - fan interlock
   - mixed air control
   - changeover thermostat and/or enthalpy control
   - minimum position
   - damper location

4. Describe sequence of operation, system layout and component inter-relationship of a heating control system, both space or discharge air controlled using an H diagram.
   - fan interlock
   - low limit
   - supply or space temperature

5. Describe sequence of operation, system layout and component inter-relationship of an outdoor air temperature reset (of discharge air) control system, using an H diagram.
   - fan interlock
   - discharge controller
   - outdoor air temperature reset controller
   - low limit

6. Describe sequence of operation, system layout and component inter-relationship of a VAV control system with cooling (c/w economizer) using an H diagram.
   - fan interlock
   - mixed air low limit
   - minimum position
   - changeover controller
   - static pressure controller and inlet vane motor
   - low limit controller
   - damper location
   - VAV controls
   - space thermostat

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Establish sequence of operation and line diagrams showing component inter-relationship for various control applications.

RAC-1360 UNDERSTANDING, INTERPRETING AND TROUBLESHOOTING WIRING DIAGRAMS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 13, 16, 17, 19, 20, 25, 28, 34, 36, 39, 41, 47, 48, 49, 51, 53, 55, 56, 57, 59 and 64.

Prerequisites:

RAC-1325

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- read, interpret and draw pictorial and schematic wiring diagrams.
- troubleshoot systems using wiring diagrams.

Theory:

1. Describe the difference between a pictorial wiring diagram and a schematic (ladder) wiring diagram.

2. Describe and illustrate standard wiring symbols used in schematic wiring diagrams.
   - capacitor
   - circuit breaker
   - crossing wires (no connection)
   - crossing wires (connection)
   - delay switches
   - double pole double throw switch
   - double pole single throw
   - flow switch
   - fuses
   - ground
   - humidity control
   - normally open and normally closed contacts
   - overloads
   - pressure control
   - relay coil
   - temperature

- transformer
- single pole single throw switch
- single pole double throw switch

3. Describe the format of a schematic wiring diagram.

4. Describe what is meant by “normally open” or “normally closed” when referring to a switch in a schematic wiring diagram.

5. Describe the procedure used to read a schematic wiring diagram when troubleshooting electric circuits.

6. Describe the “hopscotch” method when troubleshooting schematic wiring diagrams.

Practical:

Suggested practical activities are assigned to enhance the apprentice’s ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Draw schematic diagrams of various circuits.

2. Convert pictorial diagrams to schematic diagrams.

3. Determine system sequence of operation from schematic diagrams.

RAC-1365 INDUSTRIAL SYSTEM COMPONENTS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 44 and 54.

Prerequisites:

RAC-1325

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- Identify and troubleshoot components in industrial systems.

Theory:

1. Describe the use, application, operation and location of the following:
    - automatic purgers
    - distillers
        - isolation valves
        - relief valve arrangement
    - flow control valves (DX and flooded systems)
        - liquid level controls
        - level alarms
        - pressure regulators
        - solenoid and check valves
    - oil separators and receivers
    - traps and accumulators
    - safety valves
        - checkvalve
        - high and low side valves
        - fire valve
    - stop valves
        - isolation and bypass valves
        - service and charging valves

2. Describe oil return to compressors in industrial systems.
    - manual control

- automatic control
- oil accumulation (oil drains)

3. Describe methods of compressor cooling.
   - de-superheat jackets
   - water jackets

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Tour an operating industrial plant with the plant engineer and identify system components and review their operation.

RAC-1400 AIR CONDITIONING LOAD CALCULATIONS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 18.

Prerequisites:

RAC-1155

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- Calculate an air conditioning load.

Theory:

1. Describe air conditioning load.

2. Describe the variables that effect the heating and cooling load.

3. Describe peak load.

4. Describe the terms:
   - design conditions
   - solar load
   - conduction load
   - internal load
   - infiltration and/or ventilation load

5. Describe heat transfer rates using K, C, U and R values.

6. Describe "American Society of Heating Refrigerating Air-Conditioning Engineers" (ASHRAE) and discuss their role as a resource in the design of HVAC and R systems.

7. Describe the load calculation procedure for heating and cooling.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Perform heat loss/gain calculations and select equipment using manufacturers' data.
   - residential
   - commercial

RAC-1405 DUCT SYSTEMS AND DESIGN

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 13, 16, 18, 19, 20 and 57.

Prerequisites:

RAC-1400

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- apply duct design principles to troubleshoot, install and service air conditioning systems.

Theory:

1. Describe the use and application of the following duct systems:
   - high pressure
   - medium pressure
   - low pressure

2. Describe how duct size, shape and system operating pressure and velocity affect construction and operating costs of a duct system.

3. Describe velocity, static and total pressure and their effect on duct sizing.

4. Describe the use and application of the following segments of ductwork:
   - exhaust duct
   - outside air duct
   - relief duct
   - return duct
   - supply duct

5. Describe the use and application of duct insulation.
   - acoustic
   - thermal

6. Define the term “sound attenuation” and describe methods of reducing sound transmission.
7. Describe duct construction materials, shape, gauge and application.
    - round
    - flexible
    - oval
    - square
    - rectangular

8. Describe the use and application of the following dampers used in duct systems.
    - backdraft
    - balancing
    - fire
    - smoke
    - splitter
    - volume

9. Describe the term “equivalent length” when referring to duct fittings.

10. Describe “COANDA effect” in relation to ceiling diffusers.

11. Describe the following components:
    - diffuser
    - grill

12. Describe characteristics of a ducted air distribution system and include:
    - diffuser and grill placement
    - diffuser throw and terminal velocity

13. Describe the recommended face velocities for the following:
    - filters
    - louvers
    - coils
    - return air grills

14. Describe the use and application of the following duct fittings.
    - boot fitting
    - cleats
        - drive
        - “S”
    - end cap
    - elbow
        - horizontal
        - vertical
    - flexible duct connector

- offset
- plenums
- radius tee
- riser
- starting collar
- transitions
- take-offs
- turning vanes

15. Describe friction loss and the use and application of duct friction loss chart.

16. Describe the use and application of a circular equivalent of rectangular duct chart.

17. Describe methods of sizing duct.
    - equal friction
    - extended plenum (reduced velocity)

18. Describe air leakage and its control.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Size a residential duct system based on design criteria.

2. Size a commercial duct system based on design criteria.

RAC-1410 HUMIDIFICATION AND DEHUMIDIFICATION EQUIPMENT

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 25, 26, 57 and 64.

Prerequisites:

RAC-1100, 1305, 1335

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- apply the principles of humidification and dehumidifcation to select and install associated equipment.

Theory:

1. Define the terms:
   - dehumidifcation
   - humidification
   - relative humidity
   - dry bulb temperature
   - wet bulb temperature

2. Describe the following using a psychrometric chart.
   - dehumidification
   - humidification

3. Describe problems that can be created by excessively dry air.
   - comfort
   - health
   - static electricity
   - moisture stability of products in the production process
   - structural problems
4. Describe problems that can be created by excessively humid air.
   - condensation
   - mold
   - health

- comfort

5. Describe the use and operation of the following controls.
   - dehumidistat
   - humidistat

6. Describe the procedure for sizing a humidifier.

7. Describe the procedure for sizing a dehumidifier.

8. Identify types of humidifiers and describe their operation and installation.
   - atomizing
     - compressed air
     - impeller
     - ultrasonic
   - electric
     - steam injection
     - vaporizing
   - rotating plate
   - rotating drum
   - steam

9. Identify types of dehumidifiers and describe their operation and installation of dehumidifiers.
   - refrigerated
     - residential
     - commercial
       - pool dehumidification
       - rink dehumidification
   - desiccant
     - heat recovery ventilator
     - heat wheel

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Calculate the size of a humidifier based on a given criteria and select equipment from manufacturer's data.

2. Calculate the size of a dehumidifier based on a given criteria and select equipment from manufacturer's data.

RAC-1415 INSTALLATION OF AIR CONDITIONING EQUIPMENT

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 18.

Prerequisites:

RAC-1410

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- install residential and commercial air conditioning systems.

Theory:

1. Describe the installation of packaged rooftop air conditioners.
   - accessory installation
   - controls
   - drain piping and traps
   - duct connections
   - location
   - power supply
   - rigging and hoisting considerations
   - roof penetrations/roof curb
   - roof supports
   - start-up and check out

2. Describe the installation of a split air conditioning system.
   - controls
   - drain piping, traps and overflow protection
   - duct connections
   - location of indoor coil and condensing unit
   - refrigeration piping
   - power supply
   - rigging and hoisting considerations
   - support of indoor coil
   - start-up

- wall penetrations

3. Describe the installation of a ductless split air conditioning system:
   - controls
   - drain piping and traps
   - location of indoor coil and condensing unit
   - refrigeration piping
   - power supply
   - rigging and hoisting considerations
   - support of indoor coil
   - start-up
   - wall penetrations

4. Describe the installation of a “window” or ‘through the wall” air conditioning system.
   - location
   - power supply
   - rigging and hoisting considerations
   - support
   - start-up
   - wall penetrations
     - window mount
     - wall mount

5. Describe the installation of packaged water cooled air conditioners.
   - accessory installation
   - controls
   - drain piping and traps
   - duct connections and/or diffuser
   - location
   - power supply
   - rigging and hoisting considerations
   - start-up
   - water supply

Practical:

Suggested practical activities are assigned to enhance the apprentice’s ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Review manufacturers’ installation data.

2. Examine various air conditioning installations and discuss installation techniques.

RAC-1420 AIR CONDITIONING SYSTEM TROUBLESHOOTING

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1360

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- troubleshoot air conditioning system problems.

Theory:

1. Discuss problems resulting from incorrect velocities and volumes of air flow through cooling coils.

2. Describe factors that cause low and high air flow rates and corrective measures.

3. Describe and illustrate the effects, using fan laws, on fan motor operation when increasing or decreasing air flow.

4. Describe methods of determining mixed air temperature and percent of outside air.

5. Describe the troubleshooting procedures for the following components:
    - room thermostats
        - electro-mechanical
        - electronic
    - damper motors
    - damper motor stroking and linkage adjustment
    - economizers
        - enthalpy control or outside air thermostat
        - mixed air control

- minimum position

6. Describe the symptoms of the following problems and their corrective measures:
   - high and low head pressure
   - high and low load
   - inefficient compressor
   - liquid line restriction
   - system under/overcharge

7. Describe the symptoms of improper zone control and air distribution and their corrective measures.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Determine the ventilation air requirement and calculate the mixed air temperature to calibrate the minimum position of an economizer.

2. Set-up operation and calibrate a rooftop economizer system.

3. Analyze and adjust air flow on an operating air conditioning system.

RAC-1425 ENERGY MANAGEMENT AND INDOOR AIR QUALITY

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 17, 28, 31, 34 and 57.

Prerequisites:

RAC-1420

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- apply fundamental indoor air quality principles to identify indoor air quality problems and apply corrective measures.
- identify energy inefficiencies in the operation of refrigeration and air conditioning systems and apply corrective measures.

Theory:

1. Describe various indoor airborne contaminants, their sources and cost to the economy and health.
    - gaseous
    - liquid
    - organic
    - smoke
    - smog
    - solid

2. Describe methods of controlling indoor contaminants.
    - eliminate source of contamination
    - ventilation
        - heat recovery ventilator
        - heat exchanger
        - infiltration
        - mechanical ventilation
    - air cleaning
        - mechanical filters
        - electronic air cleaners

- ion generator

3. Describe how air conditioning systems can maximize indoor conditions for best comfort and health environments.

4. Describe ventilation air and discuss the recommended ventilation air quantities required for various applications.

5. Describe efficiency ratings.
   - energy efficiency rating (EER)
   - seasonal energy efficiency rating (SEER)
   - coefficient of performance (COP)
   - heating season performance factor (HSPF)

6. Describe the effect on refrigeration system efficiency including:
   - control settings
   - case loading
   - defrost
   - head pressure control
   - pipe sizing
   - system balance
   - system charge
   - component cleanliness

7. Describe the effect on air conditioning system efficiency including:
   - capacity control
   - system control
   - economizers
     - outside air temperature changeover
     - enthalpy control changeover
   - heat recovery
     - run around loop
     - heat wheel
     - heat pipes

8. Describe methods of energy management and their benefits.
   - ventilation control
     - minimize outdoor air for ventilation
       - low leakage dampers
     - close ventilation during unoccupied periods
   - free cooling
     - economizer
     - cooling tower
   - exhaust fan control
     - manual control (as opposed to continuous)
     - timed control
     - backdraft dampers
   - reset control of heating and cooling setpoints

- equipment scheduling
- night setback of heating and setup of cooling setpoints
- conversion of constant volume systems to variable air volume
- optimum start/stop

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Calculate ventilation requirements of a commercial air conditioning installation.

2. Develop an energy management strategy based on a given building model.

RAC-1430 CHILLERS AND CHILLER SYSTEMS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 41, 44 and 56.

Prerequisites:

RAC-1425

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- troubleshoot and service chiller systems.

Theory:

1. Describe the application of liquid chilling to commercial refrigeration, industrial refrigeration and to comfort air conditioning.

2. Describe the components and operation of a reciprocating comfort air conditioning chiller system.

3. Describe the components of an ice rink chiller system and its operation.

4. Describe control schematics of reciprocating comfort air conditioning chillers and identify specific controls including:
   - freeze protection
   - time delays
   - flow switches
   - interlocks

5. Describe control schematic diagrams of ice rink chillers.

6. Describe the motor cooling cycle of centrifugal chillers.

7. Describe the lubrication cycle of centrifugal chillers.

8. Identify types of high efficiency purge units and describe their use, applications

and service.

9 Describe the start-up procedure of a centrifugal chiller using an electrical schematic diagram.

10. Describe the methods of capacity control of chillers.
    - reciprocating
    - centrifugal
    - screw
    - scroll

11. Describe the function of the thrust balance disc and the labyrinth seals in a centrifugal chiller.

12. Describe the refrigeration cycle in a single and multistage centrifugal chiller.

13. Describe the differences in chiller barrels used with direct expansion and flooded chiller systems.

14. Describe chiller barrel components including:
    - baffles
    - tube sheet
    - passes
    - circuits
    - star inserts
    - range
    - approach
    - surge drum

15. Describe procedures to determine the fluid flow rate and the pump head required for a chiller application.

16. Describe the procedures to install a chiller system and include:
    - mounting
    - piping
    - cooling tower connections
    - power wiring
    - control wiring
    - chilled water pumps
    - all accessories

17. Describe the charging, checking and adding of brine to an ice rink (vented) system.

18. Describe the charging, checking and adding of water to an air conditioning chiller

(not vented) system.

19. Describe the service and the repair of chiller barrels including the repair and replacement of tubes.
20. Describe the start-up and shut-down of an air conditioning chiller system.

21. Describe the start-up and shut-down of an ice rink chiller.

22. Describe surging, its cause and cure in a centrifugal chiller system.

23. Explain the function of the load demand limiter.

24. Describe the application of free cooling with centrifugal chiller systems.

25. Describe the procedures and precautions associated with leak testing low pressure chillers.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. List start-up procedures of reciprocating chillers from manufacturer's data.

2. List start-up procedures of ice rink chillers from manufacturer's data.

3. List start-up procedures of centrifugal chillers from manufacturer's data.

RAC-1435 MULTIPLEX REFRIGERATION SYSTEMS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation.

Prerequisites:

RAC-1430

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- apply the principles of operation to install, service and troubleshoot multiplex refrigeration systems.

Theory:

1. Describe the use, application and advantages of multiplex refrigeration systems.

2. Describe operation, piping schematic, control valve placement, installation, service and troubleshooting of a commercial parallel rack refrigeration system and include:
    - alarms
    - defrost
        - hotgas
        - koolgas ®
        - defrost clock
            - electronic
            - mechanical
    - evaporator temperature control
        - evaporator pressure regulator
        - thermostat and solenoid
    - electronic metering devices
    - field piping
        - condenser
        - evaporators
        - heat reclaim
            - air
            - water

- head pressure control
    - flooded
    - temperature and/or pressure
    - split condenser
    - floating head
- low and medium temperature applications
- multi compressor control
    - pressure (conventional)
    - electronic
- oil level control
- split suction header

3. Describe the operation, installation, service, maintenance and troubleshooting of refrigerated cases and boxes including:
    - dairy case
    - frozen food case
        - coffin case
        - doors
        - open multi deck
    - fish case
    - meat prep room
    - meat case
    - produce case
    - walk-in freezer
    - walk-in cooler

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Review system operation from manufacturers service data.

2. Demonstrate service procedures and control adjustments on operating system.

3. Review refrigerated case installation from manufacturer's data.

RAC-1440 SPECIALTY SYSTEMS (ULTRA-LOW, CRYOGENIC)

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation throughout the NOA.

Prerequisites:

RAC-1325

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- apply the principles of operation to troubleshoot and service cryogenic and ultra-low refrigeration systems.

Theory:

1. Describe cryogenics and describe its applications.

2. Describe the fluid used in cryogenics.

3. Describe the safety precautions required when working on cryogenic systems.

4. Describe ultra low refrigeration and its applications.

5. Describe the use, operation and application of a cascade refrigeration system and include system components and controls.

6. Describe the use, operation and application of a compound refrigeration system and include system components and controls.

7. Describe the purpose of compound systems in ultra-low refrigeration and the suitable refrigerants.

8. Describe the start-up and charging procedure of a cascade refrigeration system.

9. Describe the start-up and charging procedure of a compound refrigeration system.

10. Describe the special precautions when installing and servicing cascade and compound refrigeration systems.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Sketch compound and cascade refrigeration systems' piping configurations.

2. Review charging procedures from manufacturer's data.

RAC-1445 CONTROL APPLICATION AND COMPONENTS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 19, 28 and 29.

Prerequisites:

RAC-1420

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- install, service, repair and troubleshoot refrigeration and air conditioning controls components.

Theory:

1. Describe operation, service and troubleshooting of control systems found on rooftop heat/cool packaged equipment.

2. Describe the difference between the application of two position controllers and modulating controllers.

3. Describe the operation of the following types of control.
   - Proportional (P)
   - Proportional plus Integral (PI)
   - Proportional plus Integral plus Derivative (PID)

4. Describe the use, application and operation of a pneumatic control system.

5. Define the terms:
   - direct acting
   - reverse acting

6. Identify types of electric and electronic damper motors and describe their operation, service and repair.
   - two-wire motor and controls
   - three-wire motor and controls

- spring return motors

7. Identify types of dampers and describe their purpose, operation, adjustment and service.

8. Identify types of valves and describe their purpose, operation, application and service.
   - two-way
   - tree-way
     - mixing
     - diverting

9. Describe the application, operation, service, maintenance and troubleshooting of an economizer and include.
   - actuator
   - ambient lock-out
   - controls
     - enthalpy control
     - outside air thermostat
     - minimum positioner
     - mixed air thermostat
   - dampers
   - relays
   - spring return
   - two position and modulating

10. Describe the use, application, operation and troubleshooting of time delay relays.

11. Describe the use, application operation and troubleshooting of impedance relays as used in a lockout circuit.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Troubleshoot various air conditioner control systems using manufacturer' electrical diagrams.

2. Troubleshoot economizers using various manufacturer's electrical diagrams.

3. Sketch the components of a basic pneumatic control system.

4. Wire time delay and lockout circuits.

RAC-1450 BASIC ELECTRONICS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 26, 31 and 53.

Prerequisites:

RAC-0100, 1135

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:
- identify and test fundamental electronic components related to circuit boards.

Theory:

1. Define and describe the use, application, operation and testing of the following:
    - diode
        - cathode
        - anode
        - forward and reverse biased
        - light emitting diode (LED)
        - symbols
    - full wave bridge rectifier power supply
        - polarity identification
        - symbol
    - photocell
    - thermistor
        - N.T.C.
        - P.T.C.
        - symbol
    - thermistors
        - silicon controlled rectifier (SAR)
            - cathode
            - anode
            - gate
            - symbol
        - trial

- main terminal 1
- main terminal 2
- gate
- symbol
- heatsink

2. Describe the use, application, operation, testing and color coding of resistors.

3. Describe the use, application and troubleshooting procedure of circuit boards.
   - manufacturer test procedures
   - inputs
   - outputs
   - power supply
   - wiring
     - connections
     - grounds
     - shorts

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

5. Outline manufacturer's electronic circuit board test procedures.

6. Test and identify various electronic components.

RAC-1455 **WIRING DIAGRAMS**

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation task # 14, 16, 17, 19, 20, 25, 28, 34, 36, 39, 41, 47, 48, 49, 51, 5, 55, 56, 57, 59 and 64.

Prerequisites:

RAC-1430

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- troubleshoot refrigeration and air conditioning systems from interpreting electrical wiring diagrams.

Theory:

1. Describe system sequence of operation for the following systems using their associated wiring diagrams.
    - chiller
    - heat pump
    - ice cuber
    - ice flaker
    - refrigeration condensing unit
    - refrigeration defrosts
        - electric
        - hotgas
    - rooftop air conditioner
    - split air conditioner
    - window air conditioner

2. Describe methods of troubleshooting electrical circuits using various meters.
    - ammeter
    - voltmeter
    - ohmmeter

3. Describe troubleshooting procedures when using a schematic wiring diagram.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. Using a wiring diagram, troubleshoot:
    - walk-in freezer
    - rooftop air conditioner
    - air conditioning chiller
    - ice rink chiller
    - ice machine
    - heat pump

RAC-1460 SPECIALIZED CONTROL SYSTEMS

NOA Reference:

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation.

Prerequisites:

RAC-1450

Course Outcomes:

Upon the successful completion of this course, the apprentice will be able to:

- identify D.D.C. (direct digital control) control applications and components and understand D.D.C. system capabilities.

Theory:

1. Define the terms:
    - application software
    - analog
    - converter
        - analog to digital
        - digital to analog
    - CPU front end
    - D.D.C.
    - digital
    - input/output devices
    - microprocessor-based controller
    - point
    - software
        - operating software
        - application software
            - direct digital control software
            - energy management software
                - optimum start/stop
                - night cycle
                - night purge
                - enthalpy
                - load reset

        - zero energy band
        - distributed power demand
    - building management software
        - alarm lockout
        - alarm monitoring
        - communications module
        - global points
        - run time
        - time and event programs

2. Describe advantages of a D.D.C. control system over a conventional control system.

3. Describe the types or levels of controllers found in commercial buildings.
    - system level controller
    - zone level controller

4. Describe and sketch a typical configuration of a microprocessor controller used for an automatic control application.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. List the control capabilities of a D.D.C. control system applied to a small commercial building.

2. View an operating D.D.C. control system installed at a facility.

RAC-1465 INDUSTRIAL REFRIGERATION SYSTEMS

NOA Reference

The material covered satisfies in whole or in part, the requirements of the National Occupational Analysis for the Refrigeration and Air Conditioning Mechanic occupation.

Prerequisites:

RAC-1365

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:

- install, maintain, service, repair and troubleshoot flooded, liquid recirculating, direct expansion and compound systems.

Theory:

1. Describe the types of compressors used in industrial refrigeration systems.
    - reciprocating
        - V type
        - W type
        - V.S.A. type
        - compound
    - helical screw
    - rotary booster

2. Describe the types of capacity control for the above compressors.

3. Describe the types of condensers used in industrial systems.
    - water cooled condensers
    - evaporative condensers

4. Describe the types of metering devices used in industrial systems.
    - high side float
    - low side float
    - liquid level control
        - float and solenoid
        - electronic sensor
        - level master control
    - thermostatic expansion valve
    - hand expansion valve
        - flow control
        - flow regulation

- throttle valves

5. Describe the types of evaporators used with industrial systems.
   - direct expansion
     - blower coils
     - bare pipe coils
   - flooded blower coils
     - upflow
     - downflow
   - flooded gravity systems
     - rate of recirculation
     - low pressure receiver
     - chiller barrels
     - separation header

6. Describe the function and location of the intercooler.
   - vertical
   - subcooling coil

7. Describe the function and location of these ancillary devices:
   - controlled pressure receiver
   - dump tanks
   - emergency fire box
     - emergency valve
     - emergency switch
   - liquid return drum
   - oil separator
   - oil return solenoid
   - oil drain valves
   - pumper drums
   - pilot receiver
   - surge drums

8. Describe the type and function of the centrifugal recirculating pump in the liquid overfeed system of an industrial system.
   - rate of recirculating
     - up flow evaporators
     - down flow evaporators
     - brine recirculating system

9. Describe the function and location of an automatic purger for an industrial system.

Practical:

Suggested practical activities are assigned to enhance the apprentice's ability to meet the objectives of the course. The practical activities outlined in this course are provided as suggestions only and may be substituted by the instructor for other relevant activities. Suggested practical activities include:

1. View operating refrigeration plant with the plant engineer and identify system components and review their operation.

Apprenticeship Training Standard Evaluation Form

Thank you for your interest in the development and revision of this document. Upon review of this document, please record your feedback in relation to the following items:

- course division and organization
- relevancy of the content
- errors or omissions
- other suggestions for improvement and consideration

Overall comments are to be entered on this evaluation form and specific changes are to be entered directly on the document in the relevant area(s). When making proposed corrections(s) in the curriculum outline, please use red ink. When all feedback has been recorded, return this evaluation form along with the curriculum outline to the Apprenticeship Office noted at the bottom of the page.

(PLEASE PRINT)

Trade: Refrigeration and Air Conditioning Mechanic

Full Name: _____

Type of Position: (Trade Practitioner, Instructor, etc.):

_____

Company: _____

Address: _____

Telephone: _____

Comments: (Use a separate sheet of paper if necessary)

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