REFRIGERATION AND AIR-CONDITIONING CERTIFICATION SCHEME - BODY OF KNOWLEDGE

Knowledge requirements for candidates attempting the Certified Refrigeration Technician Examination

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INTRODUCTION

The Refrigeration and Air-conditioning Body of Knowledge (RABOK) for the Refrigeration and Air-conditioning Technician qualification describes the sum of knowledge within the profession at the technician level. The Technician is an individual who has demonstrated competence, knowledge and experience in the field of Refrigeration and Air Conditioning (RAC) and has fulfilled all requirements as outlined in the respective certification scheme. The RABOK includes knowledge of proven and traditional practices which are widely applied as well as knowledge of innovative and new technologies, and regulatory requirements.

PURPOSE OF DOCUMENT

The purpose of this document is to outline the topics, information and best practices a candidate seeking this qualification should know and practice. The document also outlines the topics and areas covered in the examination and other pertinent examination information.

This document should also serve as a reference for anyone interested in attaining the professional designation of Certified Refrigeration and Air Conditioning Technician, or interested in developing courses to assists persons prepare for the examination. These persons include, but are not limited to:

- System installers
- Maintenance and service staff
- Educators teaching refrigeration and air-conditioning and related subjects.
- Trainers / Training providers developing RAC programs.

Document Structure

The document follows the structure of the examination and is separated into the following sections:

- Section A – General Knowledge
- Section B (1) – Residential Specialisation
- Section B (2) – Commercial Specialisation
- Section B (3) – Mobile / Automotive Specialisations

Candidates are required to know / study the knowledge requirements for the General Knowledge Section (Section A) and all specialisations sections (Section B) in which they want to be certified.

This document is neither comprehensive nor all-inclusive. This document is subject to review and change at intervals the committee responsible for its development deems necessary. Changes may be made to cover advances or changes in technology and changes in the scope of the certification. All updates shall be made available.

SECTION A – GENERAL KNOWLEDGE

Common Body of Knowledge for both Residential, Commercial and Mobile:

Candidates should have knowledge and understanding of:

MECHANICAL PROCEDURES

1. the principles of refrigeration (heat; heat transfer, temperature; pressure, pressure-temperature relationship; pressure-volume relationship; change of state), superheat and sub-cool
2. the components and operation of a practical refrigeration cycle
3. a filter drier and its direction and location in a refrigeration system
4. the properties and uses of refrigerants
5. safety precautions which should be taken in handling refrigerants
6. recovering, re-using, recycling and reclaiming refrigerants
7. the significance of the Montreal Protocol with regard to the refrigeration and air-conditioning
8. the different types of leak detection equipment
9. pressure testing equipment
10. the safety precautions which should be taken when pressure testing the refrigeration system
11. the preferred pressure testing gas
12. the maximum pressures used for pressure testing the components and system
13. triple evacuation
14. vacuuming a refrigeration system
15. deep vacuum
16. methods of evacuation, inclusive of triple evacuation
17. the methods of charging a refrigeration system
18. the operation of the manifold gauge
19. the construction and operation of compressors
20. the different types of evaporators, condensers and metering devices
21. the construction and operation of evaporators, condensers and metering devices
22. the symptoms and problems of defective evaporators, condensers and metering devices
23. the safety precautions which should be taken when performing brazing and soldering on the refrigeration system
24. the difference between brazing and soldering
25. the difference between phosphorus zero percent and silver soldering rods
26. the importance of introducing nitrogen during brazing
27. the different types of leak detection equipment
28. the different types of evaporators, condensers and metering devices

ELECTRICAL PROCEDURES

1. voltage, resistance, current, continuity
2. electrical test equipment
3. simple wiring diagrams
1. magnetism &electromagnet
2. simple, series and parallel circuits,
3. ohm's law

SYSTEM COMPONENTS (IDENTIFICATION, INSPECTION AND TROUBLESHOOTING):

1. the types of filters and fans,
2. locating and accessing filters
3. appropriate methods for cleaning filters, condensers, compressors, evaporators (and surroundings) and fans
4. identifying defects on fans
5. inspecting compressor electrical terminals and conduct visual inspection
6. recognizing signs of refrigerant leaks
7. inspecting service valves, fan blades, motor brackets, wiring, and housings
8. inspecting blower wheels, metering devices, motor and bracket, insulation

INSTALL AIR-CONDITIONING, REFRIGERATION AND VENTILATION EQUIPMENT AND COMPONENTS

1. safety requirements for preparing site
2. manufacturer's guidelines for positioning equipment
3. identifying, selecting and using appropriate tools and equipment required for installation
4. the components required for installation
5. identifying and selecting pipes, tubing and insulation according to size and type
6. freeing pipes and tubing from debris
7. knowledge of condensate lines and their application

REFRIGERANTS

Candidates should have knowledge and understanding of the following:

Refrigerant Information:

- A **refrigerant** is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle. In most cycles it undergoes phase transitions from a liquid to a gas and back again.
- Fluorocarbons, chlorofluorocarbons, became commonplace in the 20th century, but they are being phased out because of their ozone depletion effects.
- Other common refrigerants used in various applications are ammonia, sulphur dioxide, and non-halogenated hydrocarbons such as propane.
- The ideal refrigerant would have favourable thermodynamic properties, be noncorrosive to mechanical components, and be safe, including free from toxicity and flammability. It would not cause ozone depletion or climate change.
- The desired thermodynamic properties are

- a boiling point somewhat below the target temperature,
- a high heat of vaporization, a moderate density in liquid form,
- a relatively high density in gaseous form,
- a high critical temperature.
- a particular application by choice of operating pressures.

- Chlorofluorocarbon (CFC) is an organic compound that contains carbon, chlorine, and fluorine, produced as a volatile derivative of methane and ethane

IDENTIFICATION OF REFRIGERANTS

Candidates should have knowledge and understanding of the following:

- All refrigerants are identified by having an 'R' in front for refrigerant and with a set of numbers after the 'R.'.
- In order for refrigerants to be easier to identify they have all also been colour coded. The colour coding prevents accidental mixing of refrigerants, improper application, and helps to inform the technician on how to handle the refrigerant. Having coloured cylinders will not only save you time but it can help to ensure that you are using the proper refrigerant.
- It should be noted that colour coding is not an end all be all for refrigerant identification. It is always best practice to check the label on the refrigerant you are dealing with. The refrigerant colouring system is not mandatory and not all manufacturers use the colour coding system and it is always best to be safe rather than sorry.

There is a published refrigerant colour guideline from the Air-Conditioning, Heating, and Refrigeration Institute out of Virginia and can be found at the following website:

http://www.ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Guideline_N-2015.pdf

TYPE OF REFRIGERANTS

Candidates should have knowledge and understanding of the different types of refrigerants.

Below is some notable blended HFC mixtures. There exist many more (see list of refrigerants). All R-400 (R-4xx) and R-500 (R-5xx) hydrofluorocarbons are blends, as noted above.

- **R-401A** is a HCFC zeotropic blend of R-22, R-152a, and R-124. It is designed as a replacement for R-12.1'1
- **R-404A** is a HFC "nearly zeotropic" blend of 52 wt.% R-1 43a, 44 wt.% R-125, and 4 wt.% R-134a. It is designed as a replacement of R-22 and R-502 CFC. Its boiling point at normal pressure is -46.5 °C, its liquid density is 0.485 g/cm3.1''
- **R-406A** is a zeotropic blend of 55 wt.% R-22, 4 wt.% R-600a, and 41 wt.% R-142b.

- **R-407A** is a HFC zeotropic blend of 20 wt.% R-32, 40 wt.% R-125, and 40 wt.% R-134a.L'i
- **R-407C** is a zeotropic hydrofluorocarbon blend of R-32, R-125, and R-134a. The R-32 serves to provide the heat capacity, R-125 decreases flammability, R-134a reduces pressure."—"
- **R-408A** is a zeotropic HCFC blend of R-22, R-125, and R-143a. It is a substitute for R-502. Its boiling point is -44.4 °C. w-1
- **R-409A** is a zeotropic HCFC blend of R-22, R-124, and R-142b. Its boiling point is -35.3 °C. Its critical temperature is 109.4 °CPI
- **R-410A** is a near-zeotropic blend of R-32 and R-125. The US Environmental Protection Agency recognizes it as an acceptable substitute for R-22 in household and light commercial air conditioning systems' It appears to have gained widespread market acceptance under several trade names.'
- **R-438A** another HFC blended replacement for R-22, with five components: R-32, R-125/R-134a, R-600, and R-601a, blended in respective ratios 8.5+.5, -1.5%; 45±1.5%; 44.2±1.5%; 1.7+.1, -.2%; 0.6+.1, -.2%. The mean molecular weight of this mix is 99, resulting in the tradename 1SCEON M099 from manufacturer DuPont (a line of blended HFC products developed initially by Rhoda, and sold to DuPont). I'll'''
    - **R-500** is a zeotropic blend of 73.8 wt.% R-12 and 26.2 wt.% of R-152a.
    - **R-502** is a zeotropic blend of R-22 and R-115.

THE THREE (3) R'S – RECOVERY, RECYCLING AND RECLAMATION

Recovery Principle — Most refrigerants are stable chemical substances and will therefore have very long lifespans. Apart from environmental impacts due to the emission of these gases, it will be of economic interest for the gases to be removed, recycled and re-used as much as possible. The service technician must be aware of acceptable methods of recovering refrigerants.

Recycling — Ensure that the recycling equipment is intended for the type of refrigerant being processed. Service organizations or service technicians must ensure that any recycled refrigerant is of the quality that meets appropriate industry standards of purity and an approved recycling machine must be used to recycle refrigerants.

Reclamation — This process Involves the chemical purification of contaminated refrigerants

Codes of Practice for Recovery, Recycling and Reclamation

- All refrigerants must be recovered during service and maintenance as well as at decommissioning for reuse, recycling, reclamation or final disposal and destruction.
- Use certified (recovery and recycling) R&R equipment that meets relevant specifications
- Recycling equipment MUST be able to separate lubricant from recovered refrigerant.
- Recovered contaminated refrigerant must be appropriately stored for final destruction, as guided by the NOU.

Requirements for Labelling of Refrigerant Containers

Requirements for refrigerant containers and recovery refrigerant containers

- Identify labelling information that should be present on refrigerant containers.
- Identify the colour scheme used to identify refrigerant recovery containers.
- Identify what the different colours represent.
- Identify what are the requirements for presentation of label information.

Review Questions

1. What is a Refrigerant?
2. What are the uses of Refrigerants?
3. How are refrigerants identified to end users?
4. What are Chlorofluorocarbons (CFC)?
5. What are Ozone Depleting Substances (ODS)?
6. How does Ozone Depletion happen?
7. What are the effects of Ozone Layer Depletion?
8. Should Refrigerants be vented into the atmosphere?
9. Describe briefly the process for Refrigerant recovery
10. Can Hydrocarbons be used in Refrigeration and Air Conditioning?
11. Name two types of Hydrocarbons used in Refrigeration and Air Cond.
12. Define the three (3) R's
13. What labelling information should be present on refrigerant containers?
14. List three pieces of information that should be present on a refrigerant container label?
15. How can refrigerant recovery containers be identified?
16. What colour scheme does refrigerant recovery containers follow?
17. List two (2) colours and of refrigerant recovery containers and what they represent?
18. What are the three requirements for the presentation of information on a refrigerant label?

Reference: Trinidad and Tobago Standard: - Requirements for Labelling – Part 20: Labelling of Refrigerant Containers, (TTS 76: Part 20:2015)

INVERTERS

Candidates should have knowledge and understanding of the following:

- Be able to describe what an inverter is and how it functions
- Be able to explain the difference between a non-inverter and an inverted air conditioning unit
- Be able to explain the benefits of an inverted system

Inverter information:

BENEFITS OF INVERTER AIR CONDITIONING

- At least 30% - 50% cheaper to run as it consumes less power
- Far quicker to achieve desired temperature
- The start-up time is reduced by 30%
- Much quieter
- No temperature fluctuations, maximising comfort level
- No voltage peaks from compressor
- Air conditioners maintain set temperature by cooling when room temperature rises above the set temperature and heating when the room temperature falls below the set temperature.

Difference between inverter and non-inverter air conditioning units?

- Motor speed in non-inverter type air conditioners remains constant and temperature is adjusted by turning the motor ON and OFF, which consumes more energy.
- In inverter type air conditioners, temperature is adjusted by changing motor speed without turning the motor ON and OFF. Compared to non-inverter type air conditioners, air conditioners with inverters have less power loss and can save 30% more in energy.

WORKING OF INVERTER AIR CONDITIONING UNITS

- The amount of cooling or heating required by an air conditioning unit varies depending on the outdoor temperature and the amount of heat in the room.
- When the cooling capacity needs to be increased, the compressor will operate at a high speed and will increase the amount of refrigerant flow.
- Conversely, during moderate outside temperatures for example, when the cooling and heating capacity needs to be decreased, the compressor will operate at a low speed and will decrease the amount of refrigerant flow.

REVIEW QUESTIONS

1. How is the speed of an alternating current motor changed?
2. How is the speed of a direct current motor changed?
3. What type of voltage is supplied to an inverter compressor?
4. Why is alternating current changed to direct current in an inverter?
5. What is an IGBT
6. What are the differences between an DC and AC Inverters?
7. What are the advantages and disadvantages of an Inverter air conditioner?

Reference: http://www.daikin.com/about/why_daikin/benefits/inverter/

CODE OF PRACTICE

PRACTICES TO ELIMINATE

The following are practices to eliminate as a practicing RAC technician:

1. NEVER use any equipment if you do not understand its operation
2. DO NOT exceed the manufacturer's recommended pressure or system strength test pressure when leak testing.
3. DO NOT overfill refrigerant containers, tanks, drums, recovery units, receivers etc.
4. DO NOT refill disposable cylinders.
5. DO NOT use open flame on any refrigerant system that has not been properly evacuated for servicing.
6. DO NOT service refrigeration systems unless wearing protective clothing, including goggles and gloves.
7. DO NOT attempt to service equipment unless fully trained in the safe handling of refrigerants.
8. DO NOT work with refrigerants in a confined space lacking ventilation.
9. DO NOT blow off a piping system with air or oxygen to remove welding brazing or cutting debris. This may cause contamination and possible explosion. ONLY dry nitrogen should be used for this task.
10. DO NOT pressurize refrigeration or piping systems with air or oxygen.
11. NEVER leave any refrigerant recovery or recovery-recycling machine ON and unsupervised.
12. NEVER overfill any storage cylinder beyond its rated capacity.
13. NEVER drop the cylinder or hit it with a hammer or any other object.
14. NEVER apply live steam or direct flame to the cylinder.
15. NEVER lift a cylinder by the valve cover or valve.
16. NEVER remove the valve from a cylinder or attempt to repair it.
17. NEVER operate where flammable vapour is present.
18. NEVER attempt to fill any vessels, containers, cylinders, charging equipment or storage tanks that are not approved or equipped with a safety-vent valve.
19. NEVER use the recovery unit in the vicinity of spilled or open containers of gasoline, thinners or any other flammable liquid or vapour, unless your equipment is expressly designed (explosion-proof designs) for such environments.
20. DO NOT transfer refrigerant to non-refillable cylinders.
21. DO NOT tamper with the safety device.
22. NEVER refill disposable cylinder.
23. DO NOT fill any storage tank or vessel with refrigerant beyond 80% of its capacity.
24. IT IS ILLEGAL to remove or attempt to alter any permanent cylinder markings.
25. DO NOT vent refrigerant in atmosphere.
26. DO NOT dispose of any refrigerant and refrigeration system by using methods other than R&R, reclaim, reuse, adequate storage or destruction,
27. DO NOT exceed the designated maximum working pressure shown on the refrigerant cylinder.
28. DO NOT mix refrigerants, in many cases reclamation by specialists will not be possible and destruction is the only alternative.
29. DO NOT connect refrigerant containers to systems or other containers at a higher pressure, temperature or height, because back flow of the refrigerants may result in overfilled and liquid-filled containers with a subsequent danger or bursting,

30. DO NOT heat refrigerant cylinders by flame, radiant heaters or direct contact heaters in order to drive refrigerant into another vessel.
31. DO NOT drop a cylinder. This may lead to valve or valve thread damage. Warning should be clearly shown in storage areas.
32. DO NOT cool down receiving refrigerant cylinder by venting refrigerant into the atmosphere in order to transfer the refrigerant.
33. DO NOT fill refrigerant cylinders with mixtures of refrigerant and oil.

Code of Practice for Safety Requirements

1. Use pressure relief valves to protect equipment from exceeding the maximum working pressure.
2. Use dual-relief valves with change-over devices to facilitate the repair or replacement of pressure-relief valves without impairing plant protection.
3. Ensure the maximum working pressure is not exceeded when combining a bursting disc and a pressure relief valve to prevent any restriction to the inlet of the relief valve in the event of a bursting disc rupture.
4. Avoid the trapping of liquid refrigerant between two points of a system when not protected by a pressure relief valve for example a bypass check valve, to lower vapour pressure side of the system.
5. Install alarm systems to warn of excessive machine pressure during shutdown.
6. Use specific colours for containers of different refrigeration types
7. Comply with mandatory safety precautions from systems retrofitted with alternative refrigerants, such as hydrocarbons or ammonia. These might be flammable or toxic. 8. Properly label all cylinders using country-approved hazard label where applicable.
8. Use proper protective caps over cylinder valves to prevent damage to the valve on top of the cylinder. 10. Always read your recovery equipment operator's manual before using equipment.
9. Always read the product label and the product safety data sheet.
10. Use only approved refillable storage cylinder.
11. Take proper safety precaution when using all AC equipment.
12. Exercise extreme caution when working with refrigerants. The hoses may contain liquid refrigerant under high pressure.
13. The sale of refrigerants is restricted only to people certified by the relevant body.
14. When handling refrigerants, wear side-shield safety glasses, impervious gloves and other protective equipment or clothing.
15. Ensure that shower and eye wash fountains of the deluge type are readily accessible in cause of refrigerant contact with the skin or eye.
16. Store auxiliary breathing apparatus in readily accessible areas in case an abnormally high concentration of refrigerant vapour should develop in the storage, handling or production areas.
17. As with any chemical, if a spill occurs, clear the area immediately and only return wearing an approved respirator and other personal protective equipment.
18. Before using or handling any refrigerant, personnel should be familiar with safety requirements for the specific product.

19. Good ventilation of at least four (4) air charges per hour must be provided in areas where high concentrations of the heavy vapours can accumulate and exclude oxygen. The vapours are several times heavier than air.
20. Prolonged inhalation of refrigerant Is extremely dangerous and can cause death.
21. Take care not to dent, cut or scratch cylinders or valves which are not known to be empty of liquid and vapour.
22. Protect cylinder from moisture, salt or corrosive chemicals.
23. Always open the valves slowly and close after each use.
24. Code of Practice: Trinidad and Tobago Refrigeration
25. Use pressure relief valves to protect equipment from exceeding the maximum working pressure.
26. Comply with mandatory safety precautions from systems retrofitted with alternative refrigerants, such as hydrocarbons or ammonia. These might be flammable or toxic.
27. Properly label all cylinders using country-approved hazard label where applicable.
28. Use proper protective caps over cylinder valves to prevent damage to the valve on top of the cylinder.
29. Always read your recovery equipment operator's manual before using equipment.
30. Always read the product label and the product safety data sheet.
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37. Store auxiliary breathing apparatus in readily accessible areas in case an abnormally high concentration of refrigerant vapour should develop in the storage, handling or production areas.
38. As with any chemical, if a spill occurs, clear the area immediately and only return wearing an approved respirator and other personal protective equipment.
39. Before using or handling any refrigerant, personnel should be familiar with safety requirements for the specific product.
40. Good ventilation of at least four (4) air charges per hour must be provided in areas where high concentrations of the heavy vapours can accumulate and exclude oxygen. The vapours are several times heavier than air.
41. Prolonged inhalation of refrigerant Is extremely dangerous and can cause death.
42. Take care not to dent, cut or scratch cylinders or valves which are not known to be empty of liquid and vapour.
43. Protect cylinder from moisture, salt or corrosive chemicals.
44. Always open the valves slowly and close after each use.

SECTION B (1) – RESIDENTIAL SPECIALISATION

Specific Body of Knowledge for Residential

Candidates should have knowledge and understanding of:

MECHANICAL PROCEDURES (RESIDENTIAL)

1. hermetic compressors
2. the different types of leak detection equipment
3. the construction and operation of reciprocating, scroll and rotary compressors
4. the different types of evaporators, condensers and metering devices
5. a filter drier and its direction and location in a refrigeration system
6. methods of evacuation inclusive of triple evacuation
7. the problems caused by moisture in low temperature refrigeration systems
8. acid formation in a refrigeration system
9. vacuuming a refrigeration system
10. the causes of the evaporator in a refrigeration / air-conditioning system to frost (ice up)

ELECTRICAL PROCEDURES (RESIDENTIAL)

1. basic construction and operation of single phase motors
2. problems and symptoms of a defective single phase motor
3. hermetic compressor motors
4. the different types of motors, e.g. Resistance start induction run motors (RSIR); Resistance start capacitor run motor (RSCR); Capacitor start capacitor run motor (CSR); Permanent split capacitor (PSC); Multi-speed single phase motors
5. single phase motor common, start and run terminals
6. the construction and operation of current and potential relay
7. the problems and symptoms of defective current and potential relays
8. the construction and operation of capacitors
9. start and run capacitors
10. the problems and symptoms of defective capacitors
11. the basic operation of the electronic circuit board
12. the problems and symptoms of a defective electronic circuit board

CONTROL AND PROTECTION PROCEDURES (RESIDENTIAL)

1. the operation and problems associated with inline thermostats
2. the operation and problems associated with overload protectors
3. the operation and problems associated with defrost timers and defrost thermostats (e.g. termination thermostat)
4. the operation and problems associated with contactors
5. troubleshooting the control circuit

INSTALL AIR-CONDITIONING, REFRIGERATION AND VENTILATION EQUIPMENT AND COMPONENTS (RESIDENTIAL)

1. identify indoor and outdoor units
2. identify wall mounted, floor and ceiling units
3. inspecting service valves, fan blades, motor brackets, grommets, wiring, and housings
4. identify top discharge and side discharge units for mini-split
5. Inverter technology – operations and benefits
6. the methods of and importance of Piping insulation, installation and the effects of

EXAMINATION SECTION B (2) – COMMERCIAL SPECIALISATION

Specific Body of Knowledge for Commercial Specialisation

Candidates should have knowledge and understanding of:

MECHANICAL PROCEDURES (COMMERCIAL)

1. the differences between micron and compound gauges
2. the problems caused by moisture in refrigeration systems
3. acid formation in a refrigeration system
4. the discharge and suction pressure of the refrigeration system
5. open, hermetic and semi-hermetic compressors
    a. the construction and operation of reciprocating, scroll and rotary compressors
6. the symptoms of an inefficient compressor
7. volumetric efficiency and compression ratio in relation to compressors
8. the causes of the evaporator in a refrigeration / air-conditioning system to frost (ice up)
9. the effects of high and low superheat and sub-cool in a refrigeration system
10. the operating principles and application of temperature and pressure measuring devices
11. procedure for compressor burnt-out
12. procedure for compressor burnt-out
13. the effects of high and low superheat and sub-cool in a refrigeration system

ELECTRICAL PROCEDURES (COMMERCIAL)

1. the basic construction and operation of single and three-phase motors
2. the problems and symptoms of defective single and three phase motors
3. the construction and operation of direct and part winding motors
4. the construction and operation of multi-voltage three phase motors
5. the effects of low and high voltage on motors
6. the effects of single phasing, phase reversal and voltage unbalance on a three phase motor
7. correcting the rotation in a three phase motor
8. how and why does long, undersize and loose connection affect the power consuming devices
9. hermetic and semi-hermetic compressor motors
10. the different types of motors, e.g. Resistance start induction run motors (RSIR); Resistance start capacitor run motor (RSCR); Capacitor start capacitor run motor (CSR); Permanent split capacitor (PSC); Multi-speed single phase motors
11. single phase motor common, start and run terminals
12. the construction and operation of current and potential relay
13. the problems and symptoms of defective current and potential relays
14. the construction and operation of capacitors
15. start and run capacitors
16. the problems and symptoms of defective capacitors
17. ladder, component and pictorial schematics diagrams
18. how and why does long, undersize and loose connection affect the power consuming devices

CONTROL AND PROTECTION PROCEDURES (COMMERCIAL)

1. the construction and operation of the following:
    - 24v thermostat
    - defrost timer
    - defrost heater
    - termination thermostat
    - current overload internal and external
    - solid state module
    - high pressure switch
    - low pressure switch
    - single and three phase monitors
    - crankcase heater and fuses
    - control transformers
    - relays
    - contactors and oil pressure switches
    - solenoid
    - time delay

2. the problems, symptoms and required solutions of a defective:
    - 24v thermostat
    - defrost timer
    - defrost heater
    - termination thermostat and current external and internal overload solid state module high pressure switch
    - low pressure switch
    - single and three phase monitors
    - crankcase heater and fuses
    - control transformers
    - relays
    - contactors and oil pressure switches
    - solenoid

3. the problems and symptoms of defective thermistors and the corrective action which should be taken
4. a pump-down system and its uses
5. the problems, symptoms of a pump-down system and what corrective action should be taken
6. a drop-solenoid system and what is it used for
7. the problems, symptoms of a drop-solenoid system and what corrective action should be taken
8. voltage problems, symptoms and solutions
9. troubleshooting the control circuit

10. the problems, symptoms of a defective defrost cycle and what corrective action should be taken
11. the problems, symptoms of a defective cool cycle and what corrective action should be taken
12. the differential, upper limit and lower limit of thermostats and high and low pressure switches
13. how to set the cut in, cut off and differential in thermostats, high pressure and low pressure switches?
14. the operation and problems associated with pressure switches

SYSTEM COMPONENTS (COMMERCIAL)

1. the operation of the compressor service valves
2. the manufacturer's superheat and sub cool values for refrigeration and air-conditioning systems
3. the different types of fans
4. evaporators and crankcase pressure regulators
5. inspecting service valves, fan blades, motor brackets, grommets, wiring, and housings
6.

INSTALL AIR-CONDITIONING, REFRIGERATION AND VENTILATION EQUIPMENT AND COMPONENTS (COMMERCIAL)

1. commercial indoor and outdoor units
2. ducted split AC units
3. package units

COMMISSION COMMERCIAL REFRIGERATION AND AIR-CONDITIONING SYSTEM

1. commissioning and its importance
2. pre-start checks, start up and adjustment procedures
3. proper documentation for / of the commissioning unit
4. the operation of the protective and control devices

PERFORM BASIC MAINTENANCE ON AN AIR DISTRIBUTION SYSTEM (COMMERCIAL)

1. static, velocity and total pressures
2. forward, backward and radial fans
3. the effects of changing the pulley size
4. the effect of a badly aligned pulley
5. the effect of a badly tensioned belt
6. the various types of duct fitting
7. anemometers, pitot static tubes and incline manometers

SECTION B (3) – MOBILE / AUTOMOTIVE SPECIALISATIONS

(Mobile refers to: Cars, Buses, trucks, heavy equipment, refrigerated trucks and refrigerated containers)

PERFORM MECHANICAL PROCEDURES (MOBILE)

- Recover and reuse the refrigerant
- Perform pressure testing operation
- Perform leak detection operation
- Evacuate and charge the system
- Perform lubrication
- Maintain work area

Candidates should have knowledge and understanding of:

1. troubleshooting the operation of high and low pressure switches and pressure transducers
2. the operation, use and troubleshooting of the electronic thermostat/ freezostat
3. the operation, use and troubleshooting of the clutch and clutch coil
4. the operation, use and troubleshooting of the 12 and 24 volt D.C. motors
5. the operation, use and troubleshooting of the 12 and 24 volt relays found in vehicle air-conditioning system
6. the operation, use and troubleshooting the blower control module (electronic and resistor)
7. the operation, use and troubleshooting of the blower switch
8. how to read and troubleshoot the vehicle air-conditioning wiring diagram
9. the purpose of a damper
10. testing the current overload on the compressor
11. the operation of the thermistor
12. the use of the appropriate type of oil in accordance with the manufacturer's specifications
13. the principles of refrigeration (heat; heat transfer, temperature; pressure, pressure-temperature relationship; pressure-volume relationship; change of state), superheat and sub-cool
14. the components and operation of a practical refrigeration cycle
15. a filter drier and its direction and location in a refrigeration system

16. the properties and uses of refrigerants
17. safety precautions which should be taken in handling refrigerants
18. recovering, re-using, recycling and reclaiming refrigerants
19. the significance of the Montreal Protocol with regard to the refrigeration and air-conditioning
20. the different types of leak detection equipment
21. pressure testing equipment
22. the safety precautions which should be taken when pressure testing the refrigeration system
23. the preferred pressure testing gas
24. the maximum pressures used for pressure testing the components and system
25. compound gauges
26. the methods of evacuation and charging a refrigeration system
27. the discharge and suction pressure of the refrigeration system
28. the operation of the manifold gauge
29. open compressors
30. the construction and operation of open reciprocating, scroll and rotary compressors
31. the symptoms and problems of malfunctioning open reciprocating, scroll and rotary compressors
32. the different types of evaporators and condensers
33. the construction and operation of evaporators and condensers
34. the symptoms and problems of defective evaporators and condensers
35. the operation and problems associated with the TXV and orifice
36. the different types of vehicle filter/drier (F/D)
37. the problems associated with the filter/drier (F/D)

PERFORM ELECTRICAL PROCEDURES (MOBILE)

- Perform wire joining operation
- Select and use electrical test equipment
- Remove, test and install D.C. motors
- Read, trace and interpret wire diagrams
- Test, remove and re-install the blower speed controller of D.C. motors
- Clean work area

Candidates should have knowledge and understanding of:

1. the basic construction and operation of D.C. motors
2. the problems and symptoms of a defective D.C motor
3. testing the voltage, resistance, current, continuity in a simple, series and parallel circuits
4. the use of appropriate test equipment
5. ladder, component and pictorial schematics diagrams
6. wire diagrams
7. the operation, us, testing and troubleshooting of the 12 and 24 volt relays found in vehicle air-conditioning system
8. locations and sizing (amperage) of fuses

9. testing and identification of fuses
10. troubleshooting the operation of high and low pressure switches and pressure transducers
11. the operation, use and troubleshooting of the electronic thermostat/ freezostat
12. the operation, use and troubleshooting of the clutch and clutch coil
13. the operation, use and troubleshooting of the 12 and 24 volt D.C. motors
14. the operation, use and troubleshooting of the 12 and 24 volt relays found in vehicle air-conditioning system
15. the operation, use and troubleshooting the blower control module (electronic and resistor)
16. the operation, use and troubleshooting of the blower switch
17. how to read and troubleshoot the vehicle air-conditioning wiring diagram
18. the purpose of a damper
19. testing the current overload on the compressor
20. the operation of the thermistor
21. the operation of the electronic circuit board (Electronic Control Module - ECM)
22. the problems and symptoms of a defective electronic circuit board (Electronic Control Module - ECM)

PERFORM CONTROL AND PROTECTION PROCEDURES (MOBILE)

- Test, remove and re-install thermostat
- Test, remove and re-install the vehicle air-conditioning protective devices
    - Thermostat
    - Current overload
    - Transducers
    - ECM
- Clean work area

Candidates should have knowledge and understanding of:

1. the construction and operation of the thermostat/freezostat, current overload, high and low pressure switches and transducers
2. the problems and symptoms of a defective thermostat/freezostat, current overload, high and low pressure switch and transducers
3. the basic operation of the electronic circuit board (Electronic Control Model) (ECM)
4. the problems and symptoms of a defective electronic circuit board (ECM)
5. voltage, resistance, current, continuity, magnetism, electromagnet, simple, series and parallel circuits

MAINTAIN SYSTEM COMPONENTS (MOBILE)

- Service filters
- Maintain compressor
- Maintain condenser
- Maintain evaporator
- Service fans
- Contribute to the maintenance or servicing of refrigeration system (cold storage)

Candidates should have knowledge and understanding of:

9. the types of filters and fans
10. locating and accessing filters
11. appropriate methods for cleaning filters, condensers, compressors, evaporators (and surroundings) and fans
12. the different types of evaporators and filter/driers
13. inspecting compressor electrical terminals and conduct visual inspection
14. recognizing signs of refrigerant leaks
15. inspecting service valves, fan blades, motor brackets, grommets, wiring, and housings
16. inspecting blower wheels, metering devices, motor and bracket, insulation
17. identifying defects on fans

INSTALL AIR-CONDITIONING AND REFRIGERATION EQUIPMENT AND COMPONENTS (MOBILE)

- Remove, test and re-install major refrigeration components
- Remove, test and re-install refrigeration accessories
- Contribute to the installation of pipes and tubing
- Install drain line
- Clean work area (housekeeping)

Candidates should have knowledge and understanding of:

8. manufacturer's guidelines for positioning equipment
9. identifying and using appropriate tools and equipment required for installation
10. the components required for installation
11. identifying pipes, tubing and insulation according to size and type
12. insulation required on pipes
13. methods of debris removal from pipes and tubing and reporting occurrences
14. identifying and reporting potential disruption to normal activities
15. the components and operation of the refrigeration and air conditioning system
16. the refrigeration system accessories
17. condensates

REFERENCE TEXT AND OTHER REFERENCES:

- Modern Refrigeration and Air-conditioning – 18th Edition, by Andrew D. Althouse, Carl H. Turnquist and A.F. Bracciano
- http://www.daikin.com/about/why_daikin/benefits/inverter/
- Trinidad and Tobago Standard: - Requirements for Labelling – Part 20: Labelling of Refrigerant Containers, (TTS 76: Part 20:2015)
- School of Refrigeration and Air-conditioning Manuals - CVQ Level 1 & 2, by Vernon Ramjattan