



CLASS A – AIR CONDITIONING CONTRACTORS GENERAL TRADE KNOWLEDGE EXAMINATION CONTENT INFORMATION

Revised March 2009

The General Trade Knowledge portion of the examination will be administered in two sessions on the second day of the examination. The morning and afternoon sessions will each consist of 65 equally weighted questions. The scores for the morning and afternoon sessions will be combined to determine your score for this portion of the examination.

The examination will have questions relating to the following content areas and necessary knowledge for each area includes:

- reading and interpreting plans and specifications
- reading and interpreting codes
- basic mathematics (addition, subtraction, multiplication, division, calculations of area and volume, fractions, decimals, percentages, calculating the sides of triangles, square roots, powers of numbers, and solving simple algebraic equations for unknown variables)

You should be prepared to respond to examination questions on any of the content areas listed. Questions asked and content areas tested on previous examinations should not be assumed to be the only possible questions to be asked or content areas to be tested on this examination.

The percentage of questions shown for each content area may vary by as much as plus or minus three (3) percent. Please refer to the Candidate Information Brochure and the Reference List for additional information.

Content Area A **15%** **Pre-Installation**

- 1. Reading and interpreting plans and specifications**
 - knowledge of symbols
 - knowledge of scales

- 2. Recommending changes to plans and specifications**

- knowledge of equipment costing
- knowledge of equipment efficiency
- knowledge of design requirements

- 3. Recommending different types of equipment**

- knowledge of equipment costing
- knowledge of effects on equipment efficiency
- knowledge of heating and cooling loads
- knowledge of seasonally adjusted and energy efficiency ratio
- knowledge of air flow and duct design
- knowledge of psychrometrics diagrams
- knowledge of pump curves
- knowledge of fan curves

- 4. Applying energy conservation principles**

- knowledge of effects on equipment efficiency
- knowledge of Florida energy codes
- knowledge of R and U factors
- knowledge of seasonally adjusted energy efficiency ratio
- knowledge of pump curves
- knowledge of fan curves

- 5. Calculating thermal resistance**

- knowledge of R and U factors
- knowledge of Florida energy codes

- 6. Discussing EER and SEER with owners and architects**

- knowledge of EER and SEER calculations
- knowledge of Florida Energy Codes
- knowledge of Florida Building Energy Rating System
- knowledge of ARI listings
- knowledge of cost analysis and cost effectiveness

- 7. Determining HVAC load (Heating, Ventilation, Air Conditioning)**
 knowledge of Florida energy codes
 knowledge of heating and cooling load calculations
 knowledge of R and U factors
- 8. Determining material and equipment live load requirements**
 knowledge of weights of materials
 knowledge of structural capabilities
 knowledge of rigging
- 9. Designing HVAC systems (Heating, Ventilation, Air Conditioning)**
 knowledge of equipment efficiency
 knowledge of psychrometrics
 knowledge of heating and cooling loads
 knowledge of seasonally adjusted and energy efficiency ratio
 knowledge of pressure and enthalpy relationship (diagrams)
 knowledge of air flow and duct design
 knowledge of pipe sizing
 knowledge of wiring requirements, procedures and techniques
 knowledge of types of controls and requirements
 knowledge of refrigeration requirements
- 10. Designing duct systems**
 knowledge of air flow and duct design
 knowledge of insulation requirements
- 11. Determining proper HVAC equipment (Heating, Ventilation, Air Conditioning)**
 knowledge of manufacturer's equipment
 knowledge of proper sizing
 knowledge of loads
 knowledge of psychrometrics
 knowledge of proper locations of equipment
 knowledge of codes
- 12. Determining proper pipe sizes**
 knowledge of pipe sizing tables
 knowledge of valves and fittings
 knowledge of liquid flow
 knowledge of resistance to flow and friction losses

- 13. Determining proper control requirements**
 knowledge of wiring requirements and procedures and techniques
 knowledge of types of control and requirements
 knowledge of air conditioning equipment
 knowledge of refrigeration equipment
- 14. Determining proper fan motor requirements**
 knowledge of wiring requirements, procedures and techniques
 knowledge of fans
 knowledge of fan motors
 knowledge of fan performance and CFM
- 15. Determining proper pipe insulation**
 knowledge of heating and cooling loads
 knowledge of R and U factors
 knowledge of insulating techniques and requirements
- 16. Determining proper compressor capacity**
 knowledge of heating and cooling loads
 knowledge of refrigeration requirements
- 17. Designing grease handling duct systems**
 knowledge of air flow and duct design
 knowledge of sizing
 knowledge of fan and motor capabilities
 knowledge of filter requirements
 knowledge of fire and building codes
- 18. Unloading, lifting and lowering materials**
 knowledge of safety requirements
 knowledge of loading and lifting equipment
 knowledge of rigging techniques and requirements

Content Area B **10%**
Sheet Metal Ducts

- 1. Fabricating rectangular ducts under 2 ft**
 knowledge of sheet metal ducts
 knowledge of fiberglass ducts
 knowledge of flex ducts
 knowledge of duct fittings
 knowledge of duct outlets and grilles
- 2. Fabricating rectangular ducts over 2 ft.**
 knowledge of sheet metal ducts
 knowledge of fiberglass ducts
 knowledge of duct fittings
 knowledge of duct outlets and grilles

3. Fabricating round sheet metal ducts

knowledge of sheet metal ducts
knowledge of duct fittings
knowledge of duct outlets and grilles
knowledge of flex ducts

4. Taping duct seams

knowledge of sheet metal ducts
knowledge of fiberglass ducts
knowledge of flex ducts
knowledge of duct fittings
knowledge of duct outlets and grilles
knowledge of mastics and tapes

5. Fabricating standing seams for sheet metal ducts

knowledge of duct fittings
knowledge of sheet metal ducts

6. Fabricating snap lock seams for sheet metal ducts

knowledge of duct fittings
knowledge of sheet metal duct design requirements

7. Fabricating other locks and seams

knowledge of sheet metal ducts
knowledge of fiberglass duct liners

8. Fabricating interior lined sheet metal ducts

knowledge of duct fittings
knowledge of sheet metal duct design requirements

9. Fabricating fittings for rectangular ducts

knowledge of duct fittings
knowledge of sheet metal ducts

10. Fabricating fittings for round ducts

knowledge of duct fittings
knowledge of sheet metal lay out

11. Fabricating kitchen hoods

knowledge of codes
knowledge of sheet metal lay out

12. Fabricating kitchen hood exhausts

knowledge of codes
knowledge of sheet metal lay out

13. Fabricating drain pans

knowledge of codes
knowledge of sheet metal lay out

Content Area C

25 %

Installation of Refrigeration and HVAC Systems

1. Installing split system air conditioners

knowledge of duct fittings
knowledge of sheet metal ducts
knowledge of air handlers
knowledge of refrigerant piping
knowledge of insulation requirements
knowledge of thermostats
knowledge of heat strips
knowledge of condensate piping
knowledge of condensate overflow protection

2. Installing package system air conditioners

knowledge of refrigeration cycles
knowledge of thermostats
knowledge of heat strips
knowledge of condensate piping
knowledge of condensate overflow protection

3. Installing split system heat pumps

knowledge of refrigeration cycles
knowledge of condensers
knowledge of air handlers
knowledge of refrigerant piping
knowledge of insulations
knowledge of thermostats
knowledge of heat strips
knowledge of condensate piping
knowledge of condensate overflow protection
knowledge of fire stats

4. Installing package heat pumps

knowledge of refrigeration cycles
knowledge of heat pump installation requirements
knowledge of thermostats
knowledge of heat strips
knowledge of condensate piping
knowledge of condensate overflow protection
knowledge of fire stats

5. Installing air cooled systems

knowledge of air cooled condensers
knowledge of air cooled system installation requirements

6. Installing water cooled systems

knowledge of water cooled condensers
knowledge of water cooled system installation requirements

7. Installing secondary coolant systems
knowledge of secondary coolant condensers

8. Installing chilled water (or other temperature) systems
knowledge of chilled water loops
knowledge of water chillers and evaporators

9. Installing water towers
knowledge of evaporative cooling
knowledge of water tower principles, forced drag and induced drafts
knowledge of secondary coolant condensers

10. Installing systems under 25 tons
knowledge of installation techniques for system and associated components
knowledge of dead loads
knowledge of controls
knowledge of wiring procedures and techniques
knowledge of compressor capacities

11. Installing systems between 25 - 100 tons
knowledge of installation techniques for system and associated components
knowledge of dead loads
knowledge of wiring procedures and techniques
knowledge of compressor capacities

12. Installing systems over 100 tons
knowledge of installation techniques for systems and associated components
knowledge of dead loads
knowledge of wiring procedures and techniques
knowledge of compressor capacities

13. Installing centrifugal compressor systems
knowledge of centrifugal compressors
knowledge of chilled water systems
knowledge of chilled water loops
knowledge of water chillers and evaporators
knowledge of pipe fittings
knowledge of motor starters
knowledge of gauges
knowledge of valves and fittings

14. Installing absorption cycle systems
knowledge of absorption cycles
knowledge of absorption cycle refrigerants
knowledge of refrigerant piping

15. Installing ultra low temperature systems
knowledge of multistage refrigeration
knowledge of cryogenics
knowledge of low temperature refrigerants
knowledge of refrigeration equipment
knowledge of refrigerant piping techniques

16. Installing low and medium temperature systems
knowledge of refrigeration equipment
knowledge of refrigerant piping techniques
knowledge of CFC's, HFC's, and blends
knowledge of refrigerant recovery and retrofit
knowledge of EPA regulations

17. Installing walk-in coolers
knowledge of refrigeration equipment
knowledge of evaporators
knowledge of expansion valves
knowledge of defrost equipment
knowledge of refrigerant piping
knowledge of controls

18. Installing reach-in coolers
knowledge of refrigeration equipment
knowledge of evaporators
knowledge of expansion valves
knowledge of defrost equipment
knowledge of refrigerant piping
knowledge of controls

19. Installing ventilation systems (duct work)
knowledge of air flow and duct designs
knowledge of fire codes
knowledge of scale dimensions
knowledge of sheet metal ducts
knowledge of fiberglass ducts
knowledge of flex ducts
knowledge of duct fittings
knowledge of duct outlets and grilles
knowledge of hanging requirements

20. Installing pneumatic control systems
knowledge of control requirements
knowledge of pneumatic piping
knowledge of pneumatic controls

21. Installing ground water (geothermal) heat pumps
knowledge of water cooled condensers
knowledge of refrigeration cycles

- 22. Installing smoke detectors**
 - knowledge of codes
 - knowledge of equipment
- 23. Installing exhaust (or make-up air) systems**
 - knowledge of fire codes
 - knowledge of air flow and duct designs
 - knowledge of sheet metal ducts
 - knowledge of fan and motor capacities
- 24. Installing grease handling duct systems**
 - knowledge of fire codes
 - knowledge of air flow and duct designs
 - knowledge of sheet metal ducts
 - knowledge of filter requirements
- 25. Installing ammonia refrigerant systems**
 - knowledge of absorption cycles
 - knowledge of ammonia as a refrigerant
- 26. Installing kitchen exhaust systems**
 - knowledge of air flow and duct designs
 - knowledge of fan and motor capacities
 - knowledge of sheet metal fabrications
 - knowledge of national and local fire and building codes
 - knowledge of welding
- 27. Testing and balancing systems**
 - knowledge of properties of air
 - knowledge of fans
 - knowledge of testing instruments
 - knowledge of duct systems
 - knowledge of register and grills
 - knowledge of equations
- 28. Performing fire department required smoke tests**
 - knowledge of properties of air
 - knowledge of fans
 - knowledge of duct systems
 - knowledge of codes
- 29. Installing DDC control systems**
 - knowledge of control requirements
 - knowledge of DDC controls

Content Area D **15%**
Installation of Refrigeration and HVAC Equipment Components

- 1. Installing air-cooled condensers**
 - knowledge of wiring requirements, procedures and techniques
 - knowledge of air cooled condenser characteristics
 - knowledge of metal pipes
 - knowledge of refrigerant piping
- 2. Installing water-cooled condensers**
 - knowledge of wiring requirements and procedures and techniques
 - knowledge of water tower characteristics
 - knowledge of water cooled condensers characteristics
 - knowledge of secondary coolant condensers
 - knowledge of metal pipes
 - knowledge of plastic pipes
 - knowledge of pipe fittings
 - knowledge of refrigerant piping
 - knowledge of all refrigerants
- 3. Installing hermetic and semi-hermetic compressors**
 - knowledge of wiring requirements, procedures and techniques
 - knowledge of compressor characteristics
 - knowledge of metal pipes
 - knowledge of refrigerant piping
 - knowledge of all refrigerants
- 4. Installing centrifugal compressors**
 - knowledge of wiring requirements, procedures and techniques
 - knowledge of centrifugal compressor characteristics
 - knowledge of types of refrigerants
 - knowledge of power requirements
 - knowledge of design operating pressures
 - knowledge of motor efficiency ratings
 - knowledge of metal pipe fittings
 - knowledge of refrigerant piping

- 5. Installing air handlers and evaporators**
 - knowledge of wiring requirements, procedures and techniques
 - knowledge of metal pipes
 - knowledge of refrigerant piping
 - knowledge of all refrigerants
 - knowledge of control needs and requirements
 - knowledge of air handlers and characteristics
- 6. Installing fans and blowers**
 - knowledge of wiring requirements, procedures and techniques
 - knowledge of air flow and duct designs
 - knowledge of fans
 - knowledge of fan motors
 - knowledge of air handlers
 - knowledge of condensers
- 7. Installing motors for fans and blowers**
 - knowledge of wiring requirements, procedures and techniques
 - knowledge of air flow and duct designs
 - knowledge of fans
 - knowledge of fan motors
 - knowledge of air handlers
- 8. Installing sheet metal duct work**
 - knowledge of sheet metal ducts
 - knowledge of duct fittings
 - knowledge of duct outlets and grilles
- 9. Installing fiberglass duct work**
 - knowledge of fiberglass ducts
 - knowledge of duct fittings
 - knowledge of duct outlets and grilles
 - knowledge of duct hanging techniques and requirements
- 10. Installing other duct work (flexible)**
 - knowledge of air flex duct installation and fastening techniques
 - knowledge of duct fittings
 - knowledge of duct outlets and grilles
- 11. Installing grilles, registers and volume dampers**
 - knowledge of air flow and duct designs
 - knowledge of duct outlets and grilles
- 12. Installing fire dampers and metal chimneys**
 - knowledge of fire codes
 - knowledge of fire dampers and metal chimney installations and fastenings

- 13. Installing refrigerant piping**
 - knowledge of brazing
 - knowledge of refrigerant piping
 - knowledge of pipe fittings
 - knowledge of pipe hanging
 - knowledge of pipe sizing
- 14. Installing horizontally supported piping**
 - knowledge of weights of materials
 - knowledge of structural capabilities
 - knowledge of hangers
 - knowledge of supports
- 15. Installing flues**
 - knowledge of sheet metal duct installation techniques
 - knowledge of duct fittings
 - knowledge of gas codes
- 16. Installing air filters**
 - knowledge of air filter installation techniques
- 17. Installing warm air appliances (heaters)**
 - knowledge of heater installation techniques
 - knowledge of wiring procedures and techniques
 - knowledge of fire codes
- 18. Installing gas appliances**
 - knowledge of fuel gases
 - knowledge of gas appliances
 - knowledge of installing controls
 - knowledge of wiring procedures and techniques
 - knowledge of gas codes
- 19. Installing fuel oil appliances**
 - knowledge of fuel oils
 - knowledge of fuel appliance installation techniques
 - knowledge of types of controls and requirements
 - knowledge of wiring requirements, procedures and techniques
- 20. Installing heat exchangers**
 - knowledge of heat transfer
 - knowledge of installing controls
 - knowledge of wiring requirements, procedures and techniques

21. Installing receivers

knowledge of receivers
knowledge of refrigerant piping
knowledge of local codes

22. Installing heat strips

knowledge of wiring requirements, procedures and techniques
knowledge of heat strips
knowledge of fire stats
knowledge of fire codes

23. Installing copper tubing and fittings

knowledge of copper tubing
knowledge of refrigerant piping
knowledge of brazing
knowledge of pressure testing

24. Installing other tubing or fittings

knowledge of metal pipes
knowledge of welding
knowledge of brazing
knowledge of pressure testing

25. Welding and brazing copper tubing

knowledge of welding
knowledge of copper tubing

26. Silver brazing copper to steel joints

knowledge of welding
knowledge of copper tubing
knowledge of metal pipes

27. Flaring copper tubing

knowledge of copper tubing
knowledge of flaring tools

28. Mechanically connecting tubing

knowledge of manufacturer's recommendations

29. Soft soldering copper tubing

knowledge of brazing
knowledge of copper tubing

30. Soldering swaged joints

knowledge of brazing
knowledge of copper tubing
knowledge of metal pipe
knowledge of swaging tools

31. Welding metal with filler rods

knowledge of metal pipes
knowledge of welding

32. Installing steel pipes

knowledge of piping and steel pipes
knowledge of pipe fittings
knowledge of hangers
knowledge of welding

33. Threading pipes

knowledge of pipe fittings
knowledge of metal pipes

34. Cutting mild steel with oxy-acetylene torches

knowledge of oxy-acetylene torches
knowledge of metal pipe characteristics

35. Installing refrigerant tubing under 2 inches

knowledge of brazing
knowledge of copper tubing
knowledge of flaring tools
knowledge of swaging tools
knowledge of copper fittings
knowledge of oxy-acetylene torches

36. Installing refrigerant tubing 2 inches or over

knowledge of brazing
knowledge of copper tubing
knowledge of flaring tools
knowledge of swaging tools
knowledge of copper fittings
knowledge of oxy-acetylene torches

37. Installing refrigerant metering devices

knowledge of expansion valves
knowledge of capillary tubes
knowledge of brazing
knowledge of copper tubing

38. Installing heat pump reversing valves

knowledge of reversing valves
knowledge of copper tubing
knowledge of low voltage wiring

39. Installing thermostatic expansion valves

knowledge of expansion valves
knowledge of copper tubing

40. Installing capillary tube metering device

knowledge of capillary tubes
knowledge of copper tubing

41. Installing liquid line dryers and filters

knowledge of dryer and filters
knowledge of copper tubing
knowledge of vacuum systems
knowledge of refrigerant recovery

42. Installing suction line dryers and filters

knowledge of dryers and filters
knowledge of copper tubing
knowledge of vacuum systems
knowledge of refrigerant recovery

43. Installing heat pump line dryers and filters

knowledge of dryers and filters
knowledge of copper tubing
knowledge of vacuum systems
knowledge of refrigerant recovery

44. Installing oil traps

knowledge of oil traps
knowledge of copper tubing

45. Installing bellows-type temperature controls

knowledge of control requirements
knowledge of temperature requirements
knowledge of copper tubing
knowledge of bellows type temperature controls

46. Installing chilled water low temperature controls

knowledge of low temperature controls
knowledge of control requirements
knowledge of temperature requirements
knowledge of low voltage wiring

47. Installing dual, high or low-pressure control switches

knowledge of high and low pressure control characteristics
knowledge of brazing
knowledge of copper tubing
knowledge of pressure requirements
knowledge of low voltage wiring
knowledge of control installation techniques

48. Installing mercury-bulb temperature controls

knowledge of temperature requirements
knowledge of pressure requirements
knowledge of control requirements
knowledge of low voltage wiring

49. Installing oil-pressure safety control switches

knowledge of pressure requirements
knowledge of safety requirements
knowledge of pipe fittings
knowledge of control characteristics
knowledge of low voltage wiring

50. Installing summer-winter switch-over controls

knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of control requirements

51. Installing thermostats

knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of control characteristics

52. Installing water regulating valves

knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of control requirements
knowledge of pressure requirements
knowledge of bellows type temperature controls
knowledge of water valves

53. Installing pressure regulators and strainers

knowledge of design pressure requirements
knowledge of control characteristics
knowledge of hot gas bypasses

54. Installing humidity and thermostatic controls

knowledge of control characteristics
knowledge of calibrating controls
knowledge of low voltage wiring
knowledge of manufacturer's recommendations

55. Installing pneumatic controls

knowledge of pneumatic piping
knowledge of pneumatic controls
knowledge of air compressors
knowledge of control requirements

56. Soldering electrical connections

knowledge of brazing
knowledge of electrical wiring procedures and techniques

57. Installing transformers

knowledge of electrical wiring procedures and techniques
ability to read wiring diagrams

58. Installing capacitors

knowledge of electrical wiring procedures and techniques

59. Installing contactors

knowledge of electrical wiring procedures and techniques

60. Installing current relays

knowledge of electrical wiring procedures and techniques

61. Installing safety disconnects

knowledge of electrical wiring procedures and techniques

62. Installing defrost timers

knowledge of electrical wiring procedures and techniques
knowledge of control requirements
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical relationship between current voltage and resistance

63. Installing defrost heaters

knowledge of electrical wiring procedures
knowledge of control requirements
knowledge of defrost operation

64. Installing defrost thermostats

knowledge of electrical wiring procedures and techniques
knowledge of control requirements
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical-relationship between current voltage and resistance

65. Installing air-pressure switches

knowledge of pneumatic piping
knowledge of pneumatic controls
knowledge of air compressors
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical-relationship between current voltage and resistance

66. Installing electric humidistats

knowledge of electrical wiring procedures and techniques
knowledge of humidity control requirements
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical relationship between current voltage and resistance

67. Installing electronic air cleaners

knowledge of electrical wiring procedures and techniques
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical relationship between current voltage and resistance
knowledge of manufacturer's recommendations

68. Wiring three-phase equipment

knowledge of electrical wiring procedures and techniques
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical relationship between current voltage and resistance

69. Wiring single-phase equipment

knowledge of electrical wiring procedures and techniques
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical relationship between current voltage and resistance

70. Installing three-phase equipment

knowledge of electrical wiring procedures and techniques
knowledge of wiring diagrams
knowledge of placement of electrical wires
knowledge of electrical relationship between current voltage and resistance

71. Installing single-phase equipment

knowledge of electrical wiring procedures and techniques

- 72. Installing capacitor start motors**
 knowledge of electrical wiring procedures and techniques
 knowledge of wiring diagrams
 knowledge of placement of electrical wires
 knowledge of electrical relationship between current voltage and resistance
 knowledge of fan motors
 knowledge of compressor requirements
- 73. Installing shaded pole-motors**
 knowledge of electrical wiring procedures and techniques
 knowledge of fan motors
 knowledge of wiring diagrams
 knowledge of placement of electrical wires
 knowledge of electrical relationship between current voltage and resistance
- 74. Installing split-phase motors**
 knowledge of electrical wiring procedures and techniques
 knowledge of fan motors
 knowledge of wiring diagrams
 knowledge of placement of electrical wires
 knowledge of electrical relationship between current voltage and resistance
- 75. Installing fan blades**
 knowledge of fans
 knowledge of wiring diagrams
 knowledge of placement of electrical wires
 knowledge of electrical relationship between current voltage and resistance
- 76. Installing fan control switches**
 knowledge of electrical wiring procedures and techniques
 knowledge of fan motors
 knowledge of control requirements
 knowledge of low voltage wiring
- 77. Installing hermetic compressor overload protectors**
 knowledge of electrical wiring procedures and techniques
 knowledge of safety requirements
- 78. Installing fan belts**
 knowledge of fans
 knowledge of motor amperage requirements

- 79. Installing drive pulleys**
 knowledge of fans
 knowledge of pulley ratios
 knowledge of motor amperage requirements
- 80. Installing limit control switches**
 knowledge of control characteristics
 knowledge of safety requirements
- 81. Installing solenoid coils**
 knowledge of electrical wiring procedures and techniques
 knowledge of low voltage wiring
- 82. Installing magnetic starters**
 knowledge of electrical wiring procedures and techniques
- 83. Installing starting relays**
 knowledge of electrical wiring procedures and techniques
- 84. Installing duty-motor protection devices**
 knowledge of electrical wiring procedures and techniques
- 85. Installing motor controllers**
 knowledge of motor controllers
 knowledge of proper motor and overcurrent protection
 knowledge of circuit breakers and fuses
 knowledge of electrical wiring procedures
 knowledge of controls
- 86. Installing plastic pipes and fittings**
 knowledge of plastic pipes and fittings
 knowledge of different grades of pipe
 knowledge of pressure testing
 knowledge of safety codes
 knowledge of joining materials
 knowledge of cleaning and gluing materials

Content Area E **10%**
Maintenance Analysis of Refrigeration and HVAC Systems

- 1. Reading pressure and enthalpy diagrams for various refrigerants**
knowledge of pressure and enthalpy relationships
knowledge of reading pressures
knowledge of gauges
knowledge of refrigeration testing equipment
- 2. Reading and analyzing electrical circuits**
knowledge of electrical wiring procedures and techniques
knowledge of low voltage wiring
knowledge of electrical testing equipment
- 3. Testing current relays**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
- 4. Testing capacitors**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
- 5. Testing defrost thermostats**
knowledge of controls
knowledge of manufacturer's recommendations
- 6. Testing high-voltage transformers**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
- 7. Testing high voltage relays**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
- 8. Testing low voltage relays**
knowledge of low voltage electrical wiring procedures and techniques
knowledge of electrical testing equipment
ability to utilize a amprobe
ability to utilize a ohmmeter
- 9. Testing magnetic starters**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment

- 10. Testing potential relays**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
- 11. Testing appropriate motor terminals**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
- 12. Determining operating pressures of refrigeration or air conditioning systems**
knowledge of design pressure requirements
knowledge of refrigerant pressure gauges
knowledge of pressure and temperature relationships
- 13. Determining air volumes**
knowledge of air flow and duct designs
ability to utilize a velometer
ability to utilize a pitot tube
ability to utilize a manometer
ability to utilize a volume flow meter (flow hood)
- 14. Determining changes in enthalpy**
knowledge of refrigeration testing equipment
knowledge of psychrometrics
ability to utilize a thermometer
ability to utilize a psychrometer
- 15. Determining wet bulb and dry bulb temperatures**
knowledge of refrigeration testing equipment
knowledge of psychrometrics
ability to utilize a thermometer
ability to utilize a psychrometer
- 16. Determining current draw (amperage)**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
ability to utilize an amprobe
ability to utilize a volt-ohm meter
- 17. Determining voltage**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
ability to utilize an amprobe
ability to utilize a volt-ohm meter

- 18. Determining power consumption**
knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment
- 19. Determining working pressure in pipes**
knowledge of pressure testing gauges
knowledge of access valves
- 20. Testing non-pressure type storage tanks**
knowledge of tanks and pollution controls
- 21. Testing closed-liquid solar systems (either water or air)**
knowledge of solar collector types and characteristics
knowledge of solar collector controls
knowledge of solar collector piping
knowledge of solar heating
knowledge of solar hot water heating
knowledge of refrigeration testing equipment
- 22. Using testing equipment (velometer, amprobe, volt-ohm meter, vacuum gauges, etc.)**
knowledge of electrical testing equipment
knowledge of refrigeration testing equipment
knowledge of how and when to use equipment
- 23. Using chlorine and halogen leak detecting devices**
knowledge of refrigeration testing equipment
knowledge of how and when to use devices

Content Area F **15%**
Maintenance Service of Refrigeration and HVAC Systems

- 1. Using nitrogen regulators**
knowledge of pressure regulators
- 2. Using other gas regulators**
knowledge of pressure regulators
- 3. Repairing semi-hermetic compressors**
knowledge of electrical wiring procedures and techniques
knowledge of mechanical methods and procedures

- 4. Repairing hermetic compressors**
knowledge of electrical wiring procedure and techniques
knowledge of mechanical methods and procedures
- 5. Repairing centrifugal compressors**
knowledge of electrical wiring procedure and techniques
knowledge of mechanical methods and procedures
- 6. Repairing blowers**
knowledge of electrical wiring procedures and techniques
knowledge of fans
knowledge of fan motors
- 7. Calibrating air sensitive thermostats**
knowledge of electrical wiring procedures and techniques
knowledge of fans
knowledge of fan motors
- 8. Calibrating chilled-water low temperature controls**
knowledge of low temperature controls
knowledge of control requirements
knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of refrigeration testing equipment
- 9. Calibrating dual or low pressure control switches**
knowledge of high and low pressure controls
knowledge of brazing
knowledge of copper tubing
knowledge of refrigeration testing equipment
- 10. Calibrating pneumatic controls**
knowledge of pneumatic piping
knowledge of pneumatic controls
knowledge of air compressors
- 11. Calibrating proportional thermostats**
knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of control requirements
knowledge of refrigeration testing equipment

12. Calibrating summer-winter switch-over controls

knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of control requirements
knowledge of refrigeration testing equipment

13. Adjusting thermostatic temperature controls

knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of control requirements
knowledge of refrigeration testing equipment

14. Adjusting thermostatic motor controls

knowledge of low voltage wiring
knowledge of temperature requirements
knowledge of control requirements
knowledge of refrigeration testing equipment
knowledge of electrical wiring procedures and techniques

15. Adjusting super heat setting on expansion valves

knowledge of expansion valves
knowledge of control requirements
knowledge of refrigeration testing equipment
knowledge of superheat

16. Adjusting oil pressure safety controls

knowledge of pressure
knowledge of gauges
knowledge of pipe fittings
knowledge of control requirements
knowledge of low voltage wiring
knowledge of refrigeration testing equipment

17. Adjusting mercury bulb temperature controls

knowledge of temperature requirements
knowledge of pressure requirements
knowledge of control requirements
knowledge of low voltage wiring
knowledge of refrigeration testing equipment

18. Adjusting high pressure safety cutouts

knowledge of high and low temperature controls
knowledge of electrical wiring procedures and techniques
knowledge of low voltage wiring
knowledge of control operating requirements
knowledge of refrigeration testing equipment
knowledge of pressure gauges

19. Adjusting freezer controls

knowledge of control operating requirements
knowledge of low voltage wiring
knowledge of temperature measurements

20. Adjusting defrost time clocks

knowledge of control requirements
knowledge of low voltage wiring
knowledge of electrical wiring procedures and techniques
knowledge of temperature measurement

21. Adjusting bellows-type temperature controls

knowledge of control requirements
knowledge of temperature requirements
knowledge of bellows-type temperature controls operating requirements

22. Operating oil safety control solid state pressure censoring device

knowledge of pressure requirements
knowledge of safety requirements
knowledge of control operating requirements
knowledge of low voltage wiring
knowledge of refrigeration testing equipment

23. Aligning drive pulleys

knowledge of mechanical alignments

24. Adjusting tension of v-belts

knowledge of how and when to adjust

25. Calibrating electric actuating valves

knowledge of mechanical operation requirements
knowledge of refrigeration testing equipment

26. Calibrating electric humidistats

knowledge of humidity control requirements
knowledge of control requirements
knowledge of low voltage wiring
knowledge of refrigeration testing equipment

27. Reversing the rotation of three-phase or single-phase motors

knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment

28. Starting seized hermetic compressor motors

knowledge of electrical wiring procedures and techniques
knowledge of electrical testing equipment

29. Adjusting crankcase pressure regulating valves

knowledge of pressure regulators
knowledge of pressure measurement
knowledge of evaporators
knowledge of compressors

30. Adjusting evaporator pressure regulating valves

knowledge of pressure regulators
knowledge of pressure measurement
knowledge of evaporators
knowledge of superheat

31. Adjusting unloaders

knowledge of pressure measurement (gauges)
knowledge of effect of pressure on compressor capacities

32. Cleaning cooling towers

knowledge of cleaning chemicals
knowledge of scale properties
knowledge of water deposit controls
knowledge of bleed-off

33. Cleaning foreign matter from systems

knowledge of cleaning chemicals
knowledge of solvents

34. Cleaning water-cooled condensers

knowledge of cleaning chemicals
knowledge of water-cooled condensers
knowledge of organic water problems

**Content Area G
Safety and Equipment**

10%

1. Wearing hearing and head protection

knowledge of safety requirements

2. Installing warning signs and barricades

knowledge of safety requirements

3. Wearing eye and face protection

knowledge of safety requirements

4. Using respiratory protection

knowledge of safety requirements

5. Digging with backhoes, trenchers or tractors

knowledge of safety requirements

6. Using overhead hoists and cranes

knowledge of safety requirements
knowledge of weights
knowledge of riggings

7. Using ventilation devices

knowledge of safety requirements
knowledge of toxic materials

8. Using mobile equipment (e.g., forklifts, hi-lifts and cranes)

knowledge of safety requirements

9. Using ladders, scaffolds and rolling platforms

knowledge of safety requirements
knowledge of assembly

10. Using various hand and power tools (e.g., power shears, wrenches and snips)

knowledge of safety requirements
knowledge of proper operation procedures

11. Using air compressors

knowledge of safe operating pressures
knowledge of safety requirements