The Mechanical General Trade Knowledge Examination is composed of 130 questions. It will be administered in one session via computer in the calm atmosphere of one of our convenient testing centers at a time of your choosing.

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

#### Pre-Installation and Design Engineering

<table>
<thead>
<tr>
<th>Content Area</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Pre-Installation and Design Engineering</td>
<td>9%</td>
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</table>

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 psychrometric 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 seasonally adjusted energy efficiency ratio
   - knowledge of pump curves
   - knowledge of fan curves

5. **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
6. Determining material and equipment live load requirements
   knowledge of weights of materials
   knowledge of structural capabilities
   knowledge of rigging

7. 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 wiring requirements, procedures and techniques
   knowledge of types of controls and requirements
   knowledge of refrigeration requirements

8. Designing duct systems
   knowledge of air flow and duct design
   knowledge of insulation requirements

9. 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

10. Determining proper pipe sizes
    knowledge of pipe sizing tables
    knowledge of valves and fittings
    knowledge of flow rate
    knowledge of resistance to flow and friction losses

11. 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

12. 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

13. Determining proper pipe insulations
    knowledge of heating and cooling loads
    knowledge of R and U factors
    knowledge of insulating techniques and requirements

14. Determining proper compressor capacities
    knowledge of heating and cooling loads
    knowledge of refrigeration requirements

15. 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
    knowledge of fire codes
    knowledge of requirements for installing Ansul system

16. Unloading, lifting and lowering materials
    knowledge of safety requirements
    knowledge of loading and lifting equipment
    knowledge of rigging techniques and requirements

17. Designing mechanical systems
    knowledge of safety requirements
    knowledge of fire codes
    knowledge of pump capacities and installation requirements
    knowledge of tank capacities and installation requirements
    knowledge of insulation requirements
    knowledge of boiler installation requirements
    knowledge of pressure requirements
    knowledge of gauges installation requirements

18. Determining proper mechanical equipment
    knowledge of fire codes
    knowledge of safety requirements
    knowledge of sprinkler and standpipe requirements
    knowledge of design requirements
19. Determining proper pump requirements
   knowledge of pump types, capacities, and requirements
   knowledge of fluid flow

20. Determining proper boiler requirements
   knowledge of boiler requirements
   knowledge of pressure requirements
   knowledge of steam properties
   knowledge of fuel gas requirements
   knowledge of fuel oil requirements

21. Layout and determining pipes, valves, fittings, and related components
   knowledge of pump types and requirements
   knowledge of valve and fitting types and requirements
   knowledge of tank sizing
   knowledge of fluid flow
   knowledge of pipe fitting
   knowledge of metal pipe requirements
   knowledge of plastic pipe requirements

22. Determining appropriate pipe sealants
   knowledge of welding
   knowledge of pipe fitting
   knowledge of metal pipe properties
   knowledge of plastic pipe properties

23. Complying with piping plans and specifications

24. Determining size and capacity of vents
   knowledge of fire codes
   knowledge of sprinkler and standpipe codes

Content Area B 9%
Ductwork and HVAC Materials

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

2. Fabricating rectangular ducts over 2 ft.
   knowledge of sheet metal duct
   knowledge of fiberglass duct
   knowledge of duct fittings
   knowledge of duct outlets and grilles

3. Fabricating round ducts
   knowledge of sheet metal duct
   knowledge of duct fittings
   knowledge of duct outlets and grilles
   knowledge of flex duct
   knowledge of duct socks

4. Taping duct seams
   knowledge of sheet metal duct
   knowledge of fiberglass duct
   knowledge of flex duct
   knowledge of duct fittings
   knowledge of duct outlets and grilles
   knowledge of mastics and tape

5. Fabricating standing seams for sheet metal ducts
   knowledge of duct fittings
   knowledge of sheet metal duct

6. Fabricating snap lock seams for sheet metal ducts
   knowledge of duct fittings
   knowledge of sheet metal duct design requirements

7. Fabricating interior lined sheet metal ducts
   knowledge of duct fittings
   knowledge of sheet metal duct design requirements

8. Fabricating fittings for rectangular ducts
   knowledge of duct fittings
   knowledge of sheet metal duct

9. Fabricating fittings for round ducts
   knowledge of duct fittings
   knowledge of sheet metal layout

10. Fabricating locks and seams
    knowledge of duct fittings
    knowledge of sheet metal duct

11. Fabricating kitchen hoods
    knowledge of codes
    knowledge of sheet metal layout

12. Fabricating kitchen hood exhausts
    knowledge of codes
    knowledge of sheet metal layout
Content Area C  12%
Installation of Refrigeration and HVAC Systems

1. Installing split system air conditioners
   - knowledge of duct fittings
   - knowledge of sheet metal duct
   - 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 cycle
   - 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 cycle
   - knowledge of condensers
   - knowledge of air handlers
   - knowledge of refrigerant piping
   - knowledge of insulation
   - 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 cycle
   - 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 requirement

7. Installing secondary coolant systems
   - knowledge of secondary coolant condensers

8. Installing chilled water (or other temperature) systems
   - knowledge of hydronics
   - knowledge of release vents
   - knowledge of air separators

9. Installing water towers
   - knowledge of evaporative cooling
   - knowledge of water tower principles forced drag and induced draft
   - 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 system 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 evaporators
    - knowledge of pipe fitting
    - knowledge of motor starters
    - knowledge of gauges
    - knowledge of valves and fittings

14. Installing absorption cycle systems
    - knowledge of absorption cycle
    - 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 CFCs, HFCs, 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 design
   knowledge of fire codes
   knowledge of scale dimensions
   knowledge of sheet metal duct
   knowledge of fiberglass duct
   knowledge of flex duct
   knowledge of duct fittings
   knowledge of duct outlets and grilles
   knowledge of handing 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 cycle

22. Installing smoke detectors
   knowledge of codes
   knowledge of equipment

23. Installing exhaust systems (make-up air)
   knowledge of fire codes
   knowledge of air flow and duct design
   knowledge of sheet metal duct
   knowledge of fan and motor capacities

24. Installing grease handling duct systems
   knowledge of fire codes
   knowledge of air flow and duct design
   knowledge of sheet metal duct
   knowledge of filter requirements

25. Installing ammonia refrigerant systems
   knowledge of absorption cycle
   knowledge of ammonia as refrigerant

26. Installing kitchen exhaust systems
   knowledge of fire codes
   knowledge of air flow and duct design
   knowledge of fan and motor capacities
   knowledge of sheet metal fabrication
   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 grilles
   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 14%
Installation of Mechanical Systems

1. Installing large mechanical systems
   knowledge of scale dimensioning
   knowledge of rigging requirements
   knowledge of wiring requirements, procedures and techniques
   knowledge of types of controls and requirements
   knowledge of pump capacities and requirements
   knowledge of valves and fittings
   knowledge of tanks
   knowledge of insulation requirements and installation techniques
   knowledge of boiler requirements and installation techniques
   knowledge of pressures
   knowledge of gauge installation requirements
   knowledge of steam
   knowledge of surveying and leveling equipment

2. Installing lift stations
   knowledge of scale dimensioning
   knowledge of pump capacities and installation requirements
   knowledge of valves and fittings capacities and installation requirements
   knowledge of gauge installation requirements
   knowledge of earth moving and excavating
   knowledge of surveying and leveling equipment
   knowledge of pipe fitting

3. Installing gasoline handling systems
   knowledge of pump installation requirements
   knowledge of valves and fittings installation requirements
   knowledge of tank installation requirements
   knowledge of wiring requirements, procedures and techniques
   knowledge of types of controls and requirements
   knowledge of safety requirements
   knowledge of electrolysis
   knowledge of fuel oils
   knowledge of fire codes
   knowledge of pipe fitting
   knowledge of fluid flow

4. Installing gaseous oxygen handling systems
   knowledge of dangers of various chemicals and fluids
   knowledge of pump installation requirements
   knowledge of valves and fittings installation requirements
   knowledge of tank installation requirements
   knowledge of electrolysis
   knowledge of types of controls and requirements
   knowledge of fire codes
   knowledge of pipe fitting
   knowledge of fluid flow
   knowledge of safety requirements

5. Installing other chemical systems
   knowledge of dangers of various chemicals and fluids
   knowledge of pump installation requirements
   knowledge of valves and fittings installation requirements
   knowledge of tank installation requirements
   knowledge of electrolysis
   knowledge of types of controls and requirements
   knowledge of fire codes
   knowledge of pipe fitting
   knowledge of fluid flow
   knowledge of safety requirements

6. Installing other fluid handling systems (gases and liquids)
   knowledge of dangers of various chemicals and fluids
   knowledge of pump capacities and installation requirements
   knowledge of valves and fittings installation requirements
   knowledge of tank installation requirements
   knowledge of electrolysis
   knowledge of types of controls and requirements
   knowledge of fire codes
   knowledge of pipe fitting
   knowledge of fluid flow
   knowledge of safety requirements
   knowledge of temperature/pressure ratings for valves
7. Installing vacuum systems
   - knowledge of vacuum pumps
   - knowledge of pump installation requirements
   - knowledge of valves and fittings installation requirements
   - knowledge of tank installation requirements
   - knowledge of types of controls and requirements
   - knowledge of safety requirements
   - knowledge of pipe fitting

8. Installing cathodic protection systems
   - knowledge of electrolysis
   - knowledge of cathode and anode current flow
   - knowledge of corrosion
   - knowledge of metal capacities

9. Installing continuous monitoring systems
   - knowledge of pressure requirements
   - knowledge of gauges

10. Installing line pressure monitoring systems
    - knowledge of pollution control
    - knowledge of well drilling
    - knowledge of water chemistry

11. Installing gauging systems
    - knowledge of gauges

12. Installing pre-engineered protection systems
    - knowledge of DC current flow
    - knowledge of electrolysis
    - knowledge of cathode and anode current flow

13. Installing impressed current systems
    - knowledge of cathode and anode current flow
    - knowledge of electrolysis
    - knowledge of DC current flow

14. Installing closed liquid and solar systems
    - knowledge of solar system installation requirements
    - knowledge of pipe fitting
    - knowledge of metal pipe compatibility
    - knowledge of plastic pipe joining
    - knowledge of welding
    - knowledge of brazing
    - knowledge of pump capacities and installation requirements
    - knowledge of valves and fittings
    - knowledge of tank installation requirements
    - knowledge of insulation requirements

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Content Area E
Installation of Refrigeration and HVAC Equipment and Components

1. Installing air-cooled condensers
   - knowledge of wiring requirements and procedures and techniques
   - knowledge of air-cooled condenser characteristics
   - knowledge of metal pipe
   - 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 pipe
   - knowledge of plastic pipe
   - knowledge of pipe fitting
   - 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 pipe
   - 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 rating
   - knowledge of metal pipe fitting
   - knowledge of refrigerant piping
5. Installing air handlers and evaporators
   knowledge of wiring requirements, procedures and techniques
   knowledge of metal pipe
   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 design
   knowledge of fans
   knowledge offan 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 design
   knowledge of fans
   knowledge of fan motors
   knowledge of air handlers

8. Installing sheet metal duct work
   knowledge of sheet metal duct
   knowledge of duct fittings
   knowledge of duct outlets and grilles

9. Installing fiberglass duct work
   knowledge of fiberglass duct
   knowledge of duct fittings
   knowledge of duct outlets and grilles

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 design
    knowledge of duct outlets and grilles

12. Installing fire dampers and metal chimneys
    knowledge of fire codes
    knowledge of fire dampers and metal chimney installation and fastening

13. Installing refrigerant piping
    knowledge of brazing
    knowledge of refrigerant piping
    knowledge of pipe fitting
    knowledge of pipe hanging
    knowledge of pipe sizing

14. Installing steel pipes
    knowledge of welding
    knowledge of metal pipe
    knowledge of pipe fitting

15. Installing steam and condensation piping
    knowledge of piping material required for different delivery systems
    knowledge of characteristics of steam and condensation
    knowledge of codes

16. Installing plastic pipe 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

17. Installing horizontally supported piping
    knowledge of weights of materials
    knowledge of structural capabilities
    knowledge of hangers
    knowledge of supports

18. Installing flues
    knowledge of sheet metal duct installation techniques
    knowledge of duct fittings
    knowledge of gas codes

19. Installing air filters
    knowledge of air filter installation techniques

20. Installing warm air appliances (heaters)
    knowledge of heater installation techniques
    knowledge of wiring procedures and techniques
    knowledge of fire codes

21. Installing gas appliances
    knowledge of fuel gases
    knowledge of gas appliances
    knowledge of controls installation
    knowledge of wiring procedures and techniques
    knowledge of gas codes
22. Installing fuel oil appliances
   knowledge of fuel oils
   knowledge of fuel appliance installation technique
   knowledge of types of controls and requirements
   knowledge of wiring requirements, procedures and techniques

23. Installing heat exchangers
   knowledge of heat transfer
   knowledge of controls installation
   knowledge of wiring requirements, procedures and techniques

24. Installing receivers
   knowledge of receivers
   knowledge of refrigerant piping
   knowledge of local codes

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

26. Installing copper tubing and fittings
   knowledge of copper tubing
   knowledge of refrigerant piping
   knowledge of brazing
   knowledge of pressure testing

27. Installing other tubing or fittings
   knowledge of metal pipe
   knowledge of welding
   knowledge of brazing
   knowledge of pressure testing

28. Welding and brazing copper tubing
   knowledge of welding
   knowledge of copper tubing

29. Silver brazing copper to steel joints
   knowledge of welding
   knowledge of copper tubing
   knowledge of metal pipe

30. Flaring copper tubing
   knowledge of copper tubing
   knowledge of flaring tools

31. Soft soldering copper tubing
   knowledge of brazing
   knowledge of copper tubing

32. Soldering swaged joints
   knowledge of brazing
   knowledge of copper tubing
   knowledge of metal pipe
   knowledge of swaying tools

33. Welding metal with filler rods
   knowledge of metal pipe
   knowledge of welding

34. Threading pipes
   knowledge of pipe fitting
   knowledge of metal pipe

35. Cutting mild steel with oxy-acetylene torches
   knowledge of oxy-acetylene torches
   knowledge of metal pipe characteristics

36. Installing refrigerant tubing under 2 inches
   knowledge of brazing
   knowledge of copper tubing
   knowledge of flaring tools
   knowledge of swaying tools
   knowledge of copper fittings
   knowledge of oxy-acetylene torches

37. Installing refrigerant tubing 2 inches or over
   knowledge of brazing
   knowledge of copper tubing
   knowledge of flaring tools
   knowledge of swaying tools
   knowledge of copper fittings
   knowledge of oxy-acetylene torches

38. Installing refrigerant metering devices
   knowledge of expansion valves
   knowledge of capillary tubes
   knowledge of brazing
   knowledge of copper tubing

39. Installing heat pump reversing valves
   knowledge of reversing valves
   knowledge of copper tubing
   knowledge of low-voltage wiring

40. Installing thermostatic expansion valves
   knowledge of expansion valves
   knowledge of copper tubing
41. Installing capillary tube metering devices
   - knowledge of capillary tubes
   - knowledge of copper tubing

42. Installing liquid line dryers and filters
   - knowledge of dryer and filters
   - knowledge of copper tubing
   - knowledge of vacuum systems
   - knowledge of refrigerant recovery

43. Installing suction line dryers and filters
   - knowledge of dryers and filters
   - knowledge of copper tubing
   - knowledge of vacuum systems
   - knowledge of refrigerant recovery

44. Installing heat pump line dryers and filters
   - knowledge of dryers and filters
   - knowledge of copper tubing
   - knowledge of vacuum systems
   - knowledge of refrigerant recovery

45. Installing oil traps
   - knowledge of oil traps
   - knowledge of copper tubing

46. Installing bellows-type temperature controls
   - knowledge of control requirements
   - knowledge of temperature requirements
   - knowledge of copper tubing
   - knowledge of bellows-type temperature controls

47. Installing chilled water low temperature controls
   - knowledge of low temperature control
   - knowledge of control requirements
   - knowledge of temperature requirements
   - knowledge of low-voltage wiring

48. 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

49. Installing temperature controls
   - knowledge of temperature requirements
   - knowledge of pressure requirements
   - knowledge of control requirements
   - knowledge of low-voltage wiring

50. Installing oil-pressure safety control switches
   - knowledge of pressure requirements
   - knowledge of safety requirements
   - knowledge of pipe fitting
   - knowledge of control characteristics
   - knowledge of low-voltage wiring

51. Installing summer-winter switch-over controls
   - knowledge of low-voltage wiring
   - knowledge of temperature requirements
   - knowledge of control requirements

52. Installing thermostats
   - knowledge of low-voltage wiring
   - knowledge of temperature requirements
   - knowledge of control characteristics

53. 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

54. Installing pressure regulators and strainers
   - knowledge of design pressure requirements
   - knowledge of control characteristics
   - knowledge of hot gas bypass

55. Installing humidity and thermostatic controls
   - knowledge of control characteristics
   - knowledge of calibration of controls
   - knowledge of low-voltage wiring
   - knowledge of manufacturer's recommendations

56. Installing pneumatic controls
   - knowledge of pneumatic piping
   - knowledge of pneumatic controls
   - knowledge of air compressors
   - knowledge of control requirements
57. Installing solid-state controls
   - knowledge of manufacturer's recommendations
   - knowledge of codes

58. Soldering electrical connections
   - knowledge of brazing
   - knowledge of electrical wiring procedures and techniques

59. Installing transformers
   - knowledge of electrical wiring procedures and techniques
   - ability to read wiring diagrams

60. Installing capacitors
   - knowledge of electrical wiring procedures and techniques

61. Installing contactors
   - knowledge of electrical wiring procedures and techniques

62. Installing current relays
   - knowledge of electrical wiring procedures and techniques

63. Installing safety disconnects
   - knowledge of electrical wiring procedures and techniques

64. 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

65. Installing defrost heaters
   - knowledge of electrical wiring procedures
   - knowledge of control requirements
   - knowledge of defrost operation

66. 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

67. 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

68. 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

69. Installing electronic air cleaners
   - knowledge of manufacturer's recommendations

70. 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

71. 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

72. 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

73. Installing single-phase equipment
   - knowledge of electrical wiring procedures and techniques
74. 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

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 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

77. 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

78. Installing fan control switches
   knowledge of electrical wiring procedures and techniques
   knowledge of fan motors
   knowledge of control requirements
   knowledge of low-voltage wiring

79. Installing fan belts
   knowledge of fans
   knowledge of motor amperage requirements

80. Installing drive pulleys
   knowledge of fans
   knowledge of pulley ratios
   knowledge of motor amperage requirements

81. Installing limit control switches
   knowledge of control characteristics
   knowledge of safety requirements

82. Installing hermetic compressor overload protectors
   knowledge of electrical wiring procedures and techniques
   knowledge of safety requirements

83. Installing solenoid coils
   knowledge of electrical wiring procedures and techniques
   knowledge of low-voltage wiring

84. Installing magnetic starters
   knowledge of electrical wiring procedures and techniques

85. Installing starting relays
   knowledge of electrical wiring procedures and techniques

86. Installing duty-motor protection devices
   knowledge of electrical wiring procedures and techniques

87. 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

88. Installing of surge protectors
   knowledge installation techniques
   knowledge of surge protectors sizing

89. Installing of phase monitors
   knowledge of PM installation
   knowledge of PM sizing

90. Installing of geothermal systems
   knowledge of sizing of geothermal loops
   knowledge of loop types
Content Area F  14%
Installation of Mechanical Equipment and Components

1. Installing gear reduction devices
   knowledge of gear ratios
   knowledge of motors for mechanical application
   knowledge of anchoring

2. Installing lift station pumps
   knowledge of pump requirements and installation techniques
   knowledge of anchoring
   knowledge of surveying and leveling equipment
   knowledge of wiring requirements, procedures and techniques
   knowledge of types of controls and requirements

3. Installing stand pipes
   knowledge of valves and fittings
   knowledge of pipe fitting
   knowledge of sprinkler and standpipe codes
   knowledge of welding
   knowledge of brazing

4. Installing vacuum lines
   knowledge of vacuum pumps
   knowledge of pipe fitting
   knowledge of pump installation techniques
   knowledge of valves and fittings installation techniques

5. Installing oxygen lines
   knowledge of dangers of various chemicals and fluids
   knowledge of pump installation requirements
   knowledge of valves and fittings
   knowledge of pipe fitting
   knowledge of metal pipe fitting
   knowledge of fire codes
   knowledge safety requirements

6. Installing nitrous oxide lines
   knowledge of dangers of various chemicals and fluids
   knowledge of valves and fittings
   knowledge of pipe fitting
   knowledge of metal pipe
   knowledge of fire codes
   knowledge of safety requirements

7. Installing ammonia lines
   knowledge of dangers of various chemicals and fluids
   knowledge of pump requirements
   knowledge of valves and fittings
   knowledge of pipe fitting
   knowledge of fire codes
   knowledge of safety requirements

8. Installing crude oil lines
   knowledge of dangers of various chemicals and fluids
   knowledge of pump requirements and installation techniques
   knowledge of valves and fittings installation requirements
   knowledge of pipe fitting
   knowledge of metal pipe
   knowledge of fire codes
   knowledge of safety requirements
   knowledge of EPA requirements

9. Installing other chemical lines
   knowledge of dangers of various chemicals and fluids
   knowledge of valves and fittings
   knowledge of pipe fitting
   knowledge of metal pipe
   knowledge of fire codes
   knowledge of safety requirements
   knowledge of EPA requirements

10. Installing transmission lines
    knowledge of dangers of various chemicals and fluids
    knowledge of fuel oils
    knowledge of pump installation requirements
    knowledge of valves and fittings
    knowledge of pipe fitting
    knowledge of metal pipe
    knowledge of fire codes
    knowledge of EPA requirements

11. Performing tightness test for pipes
    knowledge of pressure testing
    knowledge of gauges

12. Determining storage pipe slopes
    knowledge of surveying and leveling techniques
13. Installing double-wall pipes
   - knowledge of pipe sizing
   - knowledge of pipe fitting
   - knowledge of earth moving and excavation equipment
   - knowledge of compaction equipment

14. Installing fiberglass pipes
   - knowledge of pipe sizing
   - knowledge of pipe fitting
   - knowledge of earth moving and excavation equipment
   - knowledge of compaction equipment

15. Installing metal cathodic protected pipes
   - knowledge of pipe sizing
   - knowledge of pipe fitting
   - knowledge of earth moving and excavation equipment
   - knowledge of compaction equipment

16. Installing isolation and contraction joints
   - knowledge of coefficient of expansion

17. Installing dielectric fittings
   - knowledge of corrosion
   - knowledge of electrolysis
   - knowledge of wiring requirements and procedures and techniques

18. Applying dielectric fittings
   - knowledge of corrosion
   - knowledge of electrolysis
   - knowledge of coating requirements
   - knowledge of wiring requirements and procedures and techniques

19. Installing galvanic anodes
   - knowledge of cathode and anode current flow
   - knowledge of electrolysis
   - knowledge of wiring requirements, procedures and techniques

20. Installing field-applied coatings
   - knowledge of coating requirements
   - knowledge of coating techniques
   - knowledge of corrosion

21. Inspecting anodes and cathodic protection systems
   - knowledge of cathode and anode current flow
   - knowledge of corrosion

Content Area G 9%
Maintenance Analysis of Refrigeration and HVAC

1. Reading pressure and enthalpy diagrams for various refrigerants
   - knowledge of pressure and enthalpy relationship
   - knowledge of reading pressure
   - knowledge of gauges
   - knowledge of refrigeration testing equipment

2. Reading and analyze 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
   - ability to utilize an amprobe
   - ability to utilize a vohm-meter

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 for appropriate motor terminals
   knowledge of electrical wiring procedures and techniques
   knowledge of electrical testing equipment

12. Determining operating pressures of a refrigeration or air conditioning system
   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 design
   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 draws (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 voltages
   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 control

21. 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

22. Using chlorine and halogen leak detecting devices
    knowledge of refrigeration testing equipment
    knowledge of how and when to use

Content Area H  5%
Maintenance Service of Refrigeration and HVAC

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 control
   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 superheat 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 fitting
    knowledge of control requirements
    knowledge of low-voltage wiring
    knowledge of refrigeration testing equipment

17. Adjusting 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 measurement

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 sensing devices
   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 alignment

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 capacity

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

35. Cleaning condensate drain lines
   knowledge of safety switches
   knowledge of cleaning and adjusting techniques
   knowledge of repairing condensate drains
   knowledge of condensate pipe installation and traps

Content Area I 9%
Safety and Equipment

1. Wearing hearing and head protection
   knowledge of safety requirements

2. Installing warning signs and barricades
   knowledge of safety requirements
   knowledge of lock-out/tag-out

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 rigging

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
   - knowledge of toxic materials

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

Content Area J    2%
Excavating

1. Locating underground utilities
   - knowledge of where to find information
   - knowledge of how to identify obstructions on plans and specifications
   - knowledge of when and how to notify the appropriate authority
   - knowledge of permissible working conditions

2. Coordinating and directing soil preparation
   - knowledge of excavation
   - knowledge of soil composition
   - knowledge of soil testing procedures

3. Performing dewatering
   - knowledge of pump
   - knowledge of well points
   - knowledge of piping
   - knowledge of soil permeability
   - knowledge of water table
   - knowledge of drawdown

4. Installing sheet pilings
   - knowledge of soils
   - knowledge of stress
   - knowledge of wood and metal piling

5. Testing soil and ground water
   - knowledge of excavation
   - knowledge of soil composition
   - knowledge of soil and water testing procedures

6. Determining locations of excavations
   - knowledge of invert elevations
   - knowledge of basic surveying

7. Determining burial depths and slopes
   - knowledge of excavation
   - knowledge of plans and specifications
   - knowledge of math
   - knowledge of surveying and leveling techniques

Content Area K    5%
Energy Management

1. Conduct energy testing
   - knowledge of duct pressure testing
   - knowledge of blower door tests
   - knowledge of the effects of the building envelope on the operations of the HVAC

2. Promote energy efficiency equipment
   - knowledge of energy efficient equipment
   - knowledge of programmable and Wi-Fi enabled thermostats
   - knowledge of zoning system
   - knowledge of energy recovery ventilators (ERVs)
   - knowledge of cost analysis and cost effectiveness
   - knowledge of green buildings and renewable energy

3. Complete energy forms
   - knowledge of energy form software
   - knowledge of building material efficiencies (R and U factors)
   - knowledge of how to calculate thermal resistance
4. Preform load calculations
   knowledge of building materials (R and U Factors)
   knowledge of window efficiencies (heat gain)
   knowledge of impact of outside air change requirements
   knowledge of Florida energy codes
   knowledge of heating and cooling load calculations
   knowledge of how to calculate thermal resistances

Content Area L
Indoor Air Quality 3%

1. Manage indoor air quality
   knowledge of UV bulbs
   knowledge of filter types
   knowledge of humidity control systems
   knowledge of air cleaners
   knowledge of air flows (test and balances)
   knowledge of effects of poor air quality on humans