MECHANICAL 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 — 10%
Pre-Installation and Design Engineering

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 R and U factors
   knowledge of seasonally adjusted energy efficiency ratio
   knowledge of pump curves
   knowledge of fan curves

5. **Calculating thermal resistances**
   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 loads (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 livid 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 insulations**
    knowledge of heating and cooling loads
    knowledge of R and U factors
    knowledge of insulating techniques and requirements

16. **Determining proper compressor capacities**
    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

19. **Designing grease handling duct systems**
    knowledge of air flow and duct design
    knowledge of fire codes
    knowledge of requirements for installing ansul system

20. **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

21. **Determining proper mechanical equipment**
    knowledge of fire codes
    knowledge of safety requirements
    knowledge of sprinkler and standpipe requirements
    knowledge of design requirements

22. **Determining proper pump requirements**
    knowledge of pump types, capacities, and requirements
    knowledge of fluid flow

23. **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

24. **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

25. **Determining appropriate pipe sealants**
    knowledge of welding
    knowledge of pipe feting
    knowledge of metal pipe properties
    knowledge of plastic pipe properties

26. **Complying with piping plans and specifications**

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

28. **Designing concrete reinforcement requirements**
    knowledge of fluid flow
    knowledge of concrete and reinforcement and mixtures
    knowledge of form work

Content Area B 10%

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

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 lay out

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 lay out

12. Fabricating kitchen hood exhausts
knowledge of codes
knowledge of sheet metal lay out

Content Area C — 12 ½ %
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

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 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 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 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 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 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 safety 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

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 D/C 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 D/C 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

Content Area E 10%

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 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 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
   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 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 oxy-acetylene torches
knowledge of copper fittings

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 mercury-bulb 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

Content Area F 15%
Installation of Mechanical Equipment and Components

1. Installing automatic air release vents in solar systems
knowledge of effects on equipment efficiency
knowledge of energy codes
knowledge of valves and fittings
knowledge of tank requirements
knowledge of pipe fitting
knowledge of plastic pipe joining

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

3. 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

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

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

6. 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

7. 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

8. 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

9. 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

10. 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

11. 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 EPA requirements

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

13. Determining storage pipe slopes
knowledge of surveying and leveling techniques

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

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

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

17. Installing isolation and contraction joints
knowledge of coefficient of expansion

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

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

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

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

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

Content Area G 10%

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
   knowledge of electrical testing equipment
   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. **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

23. **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 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 fitting
    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 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 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 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

Content Area I — 10%
Safety and Equipment

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 requirement
6. **Using overhead hoists and cranes**
   knowledge of safety requirements
   knowledge of weights
   knowledge of rigging
7. **Using ventilation devices**
   knowledge of safety requirement
   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 ½ %
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