Commercial Airside Systems
Annotated Instructor's Guide

Module 03201-07

MODULE OVERVIEW

This module introduces trainees to the various types of all-air systems used in commercial buildings.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum* and *HVAC Level One*.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Identify the differences in various types of commercial all-air systems.
2. Identify the type of building in which a particular type of system is used.
3. Explain the typical range of capacities for a commercial air system.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Through observation of the equipment, identify the types of commercial air systems installed in selected buildings.
2. Given a list of several commercial-type buildings, identify the type of airside system(s) commonly used in each application. Describe the reason why.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Ducts in different shapes and materials
Duct seams
Grilles and registers
Manufacturers' literature on air terminals
Manufacturers' literature on packaged equipment
Fan rating curves
Filters used with packaged equipment
Manufacturers' literature on packaged air handlers
Copies of the Quick Quiz*
Module Examinations**
Performance Profile Sheets**

* Located at the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Emphasize basic site safety. This module require that trainees visit commercial buildings and observe HVAC systems. Ensure all trainees are properly briefed on site safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

HVAC Systems, 1992. Samuel C. Monger. Englewood Cliffs, NJ: Prentice Hall.

HVAC Systems and Equipment Handbook, 2000. Atlanta, GA: American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Commercial Airside Systems*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction	
A. Introduction	_____
B. Zoning	_____
C. Commercial Systems	_____
D. Outdoor Air and Air Systems	_____
Session II. Types of All-Air Systems and Duct Systems	
A. Types of All-Air Systems	_____
B. Laboratory	_____
Trainees practice identifying the types of airside systems commonly used in each application. This laboratory corresponds to Performance Task 2.	
Session III. Air Terminals, Source Equipment, and Handlers	
A. Duct Systems	_____
B. Air Terminals	_____
C. Air Source Equipment	_____
Session IV. Identification of Commercial Air Systems	
A. Air Handlers	_____
B. Laboratory	_____
Trainees practice identifying the types of commercial air systems installed in selected buildings. This laboratory corresponds to Performance Task 1.	
Session V. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	
C. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

Chimneys, Vents, and Flues
Annotated Instructor's Guide

Module 03202-07

MODULE OVERVIEW

This module covers proper venting of fossil-fuel furnaces and the procedures for selecting and installing vents in all types of gas furnaces.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Module 03201-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Describe the principles of combustion and explain complete and incomplete combustion.
2. Describe the content of flue gas and explain how it is vented.
3. Identify the components of a furnace vent system.
4. Describe how to select and install a vent system.
5. Perform the adjustments necessary to achieve proper combustion in a gas furnace.
6. Describe the techniques for venting different types of furnaces.
7. Explain the various draft control devices used with natural-draft furnaces.
8. Calculate the size of a vent required for a given application.
9. Adjust a thermostat heat anticipator.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Measure supply and return temperature and determine the temperature rise of a furnace.
2. Adjust a thermostat heat anticipator.
3. Calculate the correct size and type of PVC pipe using manufacturer's instructions or *National Fuel Gas Code* or American Gas Association specifications.
4. Calculate the correct size and type of furnace vent connector and metal vent using manufacturer's instructions or *National Fuel Gas Code* or American Gas Association specifications.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Copy of latest edition of the *National Fuel Gas Code* or American Gas Association specifications
Various vent manufacturers' product data and catalogs
Videotape (optional) *Principles of Gas Combustion*
Videotape (optional) *Ventinox Chimney Solution*
TV/VCR/DVD player
Thermometer
Selection of vent piping:
  Double wall (Types B, L, and B-W)
  Single wall
  Schedule 40 PVC
High-temperature plastic
PVC and metal tubes
Smoke source
Flame source
Concentric vent termination
Temperature probes
Operating gas-fired furnace
Copies of the Quick Quiz*
Module Examinations**
Performance Profile Sheets**

* Located in the back of this module.
**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. The module requires that trainees work with operating gas-fired furnaces. Ensure all trainees are briefed on fire safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Mid-Efficiency Furnace Installation Awareness. Latest Edition. Syracuse, NY: Carrier Corporation.

National Fuel Gas Code (NFPA 54/ANSI/Z223.1). Latest Edition. Quincy, MA: National Fire Protection Association.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 5 hours are suggested to cover *Chimneys, Vents, and Flues*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction to Chimneys and Venting Requirements	
A. Introduction	_____
B. Combustion	_____
C. Flue Gases	_____
D. Furnace Venting	_____
E. Vent System Components	_____
F. Natural-Draft Furnaces	_____
G. Induced-Draft Furnaces	_____
H. Laboratory Trainees practice measuring the temperature and determining the temperature rise. This laboratory corresponds to Performance Task 1.	_____
I. Laboratory Trainees practice adjusting the thermostat anticipator. This laboratory corresponds to Performance Task 2.	_____
Session II. Vent Calculations, Review, and Testing	
A. Venting Considerations	_____
B. Laboratory Trainees practice calculating the correct size and type of vent connector and metal vent. This laboratory corresponds to Performance Task 4.	_____
C. Condensing Gas Furnaces	_____
D. Laboratory Trainees practice calculating the correct size and type of PVC pipe. This laboratory corresponds to Performance Task 3.	_____
E. Draft Controls	_____
F. Review	_____

G. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

H. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces hydronic systems. It covers the types of systems available and the various system components, including boilers, valves, radiators, and piping. Radiant floor heating systems are also covered.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Tw*o, Modules 03201-07 and 03202-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Explain the terms and concepts used when working with hot-water heating.
2. Identify the major components of hot-water heating.
3. Explain the purpose of each component of hot-water heating.
4. Demonstrate the safety precautions used when working with hot-water systems.
5. Demonstrate how to operate selected hot-water systems.
6. Demonstrate how to safely perform selected operating procedures on low-pressure systems.
7. Identify the common piping configurations used with hot-water heating.
8. Read the pressure across a water system circulating pump.
9. Calculate heating water flow rates.
10. Select a pump for a given application.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Demonstrate the safety precautions used when working on hot-water systems.
2. Identify the major components of a selected hot-water heating system.
3. Demonstrate how to safely perform selected operating procedures on hot-water boilers.
4. Identify the types of common piping configurations used with hot-water systems.
5. Calculate heating water gpm requirements from base information provided by the instructor.
6. Select a pump from manufacturer's data given the friction loss of a piping system and the gpm requirements from the previous performance task.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Appropriate personal protective equipment

Hot-water heating system(s) and assorted system components, including:
- Cast-iron and steel boiler parts
- Electric boiler heating elements and other parts
- Differential pressure gauges
- Pump curve chart
- Pressure-temperature gauges
- Pressure relief valves
- Low water controls
- Aquastats
- Electronic-type water level controls
- Expansion/compression tanks
- Air control devices
- Circulating pumps
- Assorted gate, ball, globe, and angle valves
- Pressure-reducing valves
- Backflow preventer valves
- Zone control valves
- Multipurpose valves
- Balancing and flow control valves
- Venturi and orifice-type flow meters
- Two-way and three-way valves

continued

Assorted hot-water terminals, including:
- Convectors
- Baseboard and finned-tube radiators
- Unit heaters
- Heating coils
- Shell-and-tube plate heat exchangers

Tankless water heaters

Indirect water heaters

Manufacturers' instructions for safety relief valves

Manufacturers' literature on expansion/compression tanks

Manufacturers' literature on circulating pumps

Copies of the Quick Quizzes*

Module Examinations**

Performance Profile Sheets**

* Located at the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. The module requires that trainees work with operating hot-water boilers. Ensure all trainees are briefed on appropriate safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

ASHRAE Handbook — HVAC Systems and Equipment, 2004. Atlanta, GA: American Society of Heating and Air Conditioning Engineers, Inc.

ASHRAE Handbook — HVAC Applications, 2007. Atlanta, GA: American Society of Heating and Air Conditioning Engineers, Inc.

HVAC Systems, 1992. Samuel C. Monger. Englewood Cliffs, NJ: Prentice Hall.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Introduction to Hydronic Systems*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction to Hot-Water Heating System Components and Boilers	
A. Introduction	_____
B. Water System Terms	_____
C. Hot-Water Heating Systems	_____
D. Hot-Water Boilers	_____
E. Safety Controls	_____
F. Laboratory Trainees practice demonstrating safety precautions when working on a boiler. This laboratory corresponds to Performance Task 1.	_____
G. Laboratory Trainees practice safely performing selected operating procedures on a boiler. This laboratory corresponds to Performance Task 3.	_____

Session II. Hot-Water Heating System Components

A. Expansion/Compression Tanks _____
B. System Air Control Devices _____
C. Pumps and Valves _____
D. Terminals _____
E. Tankless and Indirect Water Heaters _____
F. Laboratory _____

Trainees practice identifying the major components of a hot-water heating system. This laboratory corresponds to Performance Task 2. _____

G. Radiant Floor Heating Systems _____

Session III. Piping

A. One-Pipe Systems _____
B. Two-Pipe Systems _____
C. Hot-Water Zoning _____
D. Laboratory _____

Trainees practice identifying common piping configurations. This laboratory corresponds to Performance Task 4.

E. Dual-Temperature Water Systems _____

Session IV. Water Balance

A. Water Flow Measuring Devices and Flow-Control Devices _____
B. Laboratory

Trainees practice calculating the water gpm requirements. This laboratory corresponds to Performance Task 5.

C. Friction Losses
D. Laboratory _____

Trainees practice selecting a pump given gpm requirements and piping system friction loss. This laboratory corresponds to Performance Task 6.

Session V. Review and Testing

A. Review _____
B. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Air Quality Equipment
Annotated Instructor's Guide

Module 03204-07

MODULE OVERVIEW

This module covers common accessories used to control air quality, including dehumidifiers, humidifiers, and filters. It also covers energy conservation equipment.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03203-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Explain why it is important to control humidity in a building.
2. Recognize the various kinds of humidifiers used with HVAC systems and explain why each is used.
3. Demonstrate how to install and service the humidifiers used in HVAC systems.
4. Recognize the kinds of air filters used with HVAC systems and explain why each is used.
5. Demonstrate how to install and service the filters used in HVAC systems.
6. Use a manometer or differential pressure gauge to measure the friction loss of an air filter.
7. Identify accessories commonly used with air conditioning systems to improve indoor air quality and reduce energy cost, and explain the function of each, including:
   - Humidity control devices
   - Air filtration devices
   - Energy conservation devices
8. Demonstrate or describe how to clean an electronic air cleaner.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Demonstrate how to inspect, clean, and replace humidifiers.
2. Inspect disposable/permanent air filters for mechanical damage and cleanliness.
3. Clean permanent-type air filters.
4. Measure the differential pressure drop across an air filter with a manometer.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Humidifiers
Disposable air filters
Electronic air cleaner
Various types of air filters
Tools for removing and cleaning air filters
Manometer
Operating air filtration system
Manufacturers' literature on energy and heat recovery ventilators
Ultraviolet light purification system
Carbon monoxide and carbon dioxide monitors
Copies of the Quick Quiz*
Module Examinations**
Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. The module requires that trainees work with air filters and testing equipment. Ensure all trainees are briefed on appropriate safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Air Conditioning Systems, Principles, Equipment, and Service. 2000. Prentice Hall.

Refrigeration and Air Conditioning: An Introduction to HVAC. 2003. Prentice Hall.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 5 hours are suggested to cover *Air Quality Equipment.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction, Humidity Control, and Indoor Air Quality	
A. Introduction	_____
B. Process and Comfort Air Conditioning	_____
C. Humidity Control	_____
D. Laboratory Trainees practice inspecting, cleaning, and replacing humidifiers. This laboratory corresponds to Performance Task 1.	_____
E. Mechanical Air Filters	_____
F. Laboratory Trainees practice inspecting disposable/permanent air filters. This laboratory corresponds to Performance Task 2.	_____
G. Laboratory Trainees practice cleaning permanent air filters. This laboratory corresponds to Performance Task 3.	_____
Session II. Indoor Air Quality II, Review, and Testing	
A. Laboratory Trainees practice measuring the differential pressure drop across an air filter with a manometer. This laboratory corresponds to Performance Task 4.	_____
B. Air Conditioning Energy Conservation Equipment	_____
C. Ultraviolet Light Air Purification Systems	_____
D. Carbon Monoxide and Carbon Dioxide Monitors	_____
E. Review	_____

F. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

G. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Leak Detection, Evacuation, Recovery, and Charging Annotated Instructor's Guide

Module 03205-07

MODULE OVERVIEW

This module introduces the trainee to the leak detection, evacuation, recovery, and charging service procedures used to troubleshoot, repair, and/or maintain proper operation of the mechanical refrigeration systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03204-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Identify the common types of leak detectors and explain how each is used.
2. Perform leak detection tests using selected methods.
3. Identify the service equipment used for evacuating a system and explain why each item of equipment is used.
4. Perform system evacuation and dehydration.
5. Identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant, and explain why each item of equipment is used.
6. Perform a refrigerant recovery.
7. Evacuate a system to a deep vacuum.
8. Identify the service equipment used for charging refrigerant into a system, and explain why each item of equipment is used.
9. Use nitrogen to purge a system.
10. Charge refrigerant into a system by the following methods:
    - Weight
    - Superheat
    - Subcooling
    - Charging pressure chart

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify the common types of leak detectors and explain the advantages and disadvantages associated with each type.
2. Use selected electronic, ultrasonic, liquid (bubble), and ultraviolet/fluorescent leak detectors to leak test a pressurized operational system.
3. Under supervision, use a recovery and/or recovery/recycle unit to recover the refrigerant from a system.
4. Under supervision, use a mixture of nitrogen and a trace amount of HCFC-22 refrigerant to pressurize a refrigerant system in preparation for leak testing.
5. Under supervision, demonstrate and/or describe how to evacuate a system using the deep vacuum method.
6. Perform a vacuum leak test on an evacuated system.
7. Under supervision, demonstrate how to evacuate a system using the triple evacuation method.
8. Under supervision, demonstrate how to use dry nitrogen as the moisture-absorbing gas when triple evacuating a system.
9. Under supervision, demonstrate how to charge a system by weight.
10. Under supervision, demonstrate how to charge a system using the superheat method.
11. Under supervision, demonstrate how to charge a system using the subcooling method.
12. Under supervision, demonstrate how to charge a system using the charging pressure charts method.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Common leak detection devices
Various types of refrigerant cylinders
Cylinders of nitrogen
HCFC-22 refrigerant
Pressure regulator-relief valve
System pressure charging charts
Superheat charging calculator (optional)
Subcooling calculator (optional)
Videotape/DVD *Evacuation and Charging* (optional)
TV/VCR/DVD player (optional)
Operating air conditioning and/or refrigeration system(s)
Vacuum pump
Electronic vacuum gauges
Electronic charging scale
Leak detectors
  Halide torch
  Electronic
  Ultrasonic
  Ultraviolet/fluorescent
  Liquid (bubble)
Gauge manifold set
Certified recovery or recovery/recycle unit
Charging cylinder
Thermometers
Copies of Quick Quizzes*
Module Examinations**
Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module may require trainees to visit job sites. Make sure that all trainees are briefed on site safety procedures. This module requires that trainees work with refrigerants. Ensure that all trainees are properly briefed on refrigerant and pressure systems safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

Refrigerant Service Techniques, 1993. Syracuse, NY: Carrier Corporation.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *Leak Detection, Evacuation, Recovery, and Charging*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction and Leak Detection	
A. Introduction	_____
B. Detection Devices	_____
C. Laboratory	_____
Trainees practice identifying various leak detection devices. This laboratory corresponds to Performance Task 1.	
D. Leak Testing	_____
E. Laboratory	_____
Under your supervision, have trainees pressurize a system in preparation for leak testing, and then practice using selected leak detection devices to test the system. This laboratory corresponds to Performance Tasks 4 and 2.	
Session II. Refrigerant Containment	
A. Refrigerant Containment	_____
B. Refrigerant Recovery	_____
C. Laboratory	_____
Trainees practice recovering refrigerant from a system. This laboratory corresponds to Performance Task 3.	
Sessions III and IV. Evacuation	
A. Evacuation	_____
B. Service Equipment Used for Evacuation	_____
C. Methods of Evacuation	_____
D. Deep Vacuum Evacuation Method	_____
E. Laboratory	_____
Trainees practice demonstrating or describing how to evacuate a system using the deep vacuum method and performing a vacuum leak test on the system. This laboratory corresponds to Performance Tasks 5 and 6.	
F. Triple Evacuation Method	_____
G. Laboratory	_____
Trainees practice demonstrating or describing how to evacuate a system using the triple evacuation method with dry nitrogen as the moisture absorbing gas. This laboratory corresponds to Performance Tasks 7 and 8.	
Session V. Charging I	
A. Servicing Equipment Used for Charging	_____
B. Charge Determination and Accuracy	_____
C. Charging by Weight	_____
D. Laboratory	_____
Trainees practice demonstrating or describing how to charge a system by weight. This laboratory corresponds to Performance Task 9.	
Session VI. Charging II	
A. Charging by Superheat	_____
B. Laboratory	_____
Trainees practice demonstrating or describing how to charge a system by superheat. This laboratory corresponds to Performance Task 10.	
C. Charging by Subcooling	_____
D. Laboratory	_____
Trainees practice demonstrating or describing how to charge a system by subcooling. This laboratory corresponds to Performance Task 11.	

Session VII. Charging III

A. Charging Using Pressure Charts _____

B. Laboratory _____

Trainees practice demonstrating or describing how to charge a system by using pressure charts. This laboratory corresponds to Performance Task 12.

C. Using Zeotrope Refrigerants _____

Session VIII. Review and Testing

A. Review _____

B. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Alternating Current
Annotated Instructor's Guide

Module 03206-07

MODULE OVERVIEW

This module introduces the trainee to the production, transmission, and uses of alternating current in the HVAC field.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03205-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Describe the operation of various types of transformers.
2. Explain how alternating current is developed and draw a sine wave.
3. Identify single-phase and three-phase wiring arrangements.
4. Explain how phase shift occurs in inductors and capacitors.
5. Describe the types of capacitors and their applications.
6. Explain the operation of single-phase and three-phase induction motors.
7. Identify the various types of single-phase motors and their applications.
8. State and demonstrate the safety precautions that must be followed when working with electrical equipment.
9. Test AC components, including capacitors, transformers, and motors.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify the components used in a given AC circuit and explain their functions.
2. Identify types of single-phase and three-phase power distribution systems from electrical circuit diagrams.
3. Following applicable safety practices, test AC components, including transformers, capacitors, and motor windings.
4. Identify various types of AC motors from schematic diagrams.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Iron cores
Wire
Batteries
Various types of transformers
AC and DC power generation kits (optional)
Properly operating heating/cooling unit
Service entrance panel with circuit breakers
Fused disconnect box

continued

One each of the following for each team of two or three trainees:

- Split-phase induction motor
- Permanent split capacitor motor
- Capacitor-start motor
- Capacitor-start, capacitor-run motor
- Shaded-pole motor
- Tap wound motor
- Three-phase motor
- Various capacitors
- Inductor (coil)
- Various transformers
- Assortment of inoperative motors
- Oscilloscope
- Ohmmeter
- Megohmmeter (megger)
- Clamp-on ammeter
- In-line ammeter
- Capacitor analyzer
- Voltmeter or multimeter

Copies of Quick Quiz*

Module Examinations**

Performance Profile Sheet**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that trainees work with electrical circuits. Ensure that all trainees are properly briefed on electrical safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

ARI Refrigeration and Air Conditioning; An Introduction to HVAC/R, 4th Edition, Prentice Hall.

General Training—Electricity (GTE), 1993. Syracuse, NY: Carrier Corporation.

HVAC Servicing Procedures, 1995. Syracuse, NY: Carrier Corporation.

Pocket Guide to Electrical Installations Under NEC 2002, Volumes I and II, 2001. Quincy, MA: National Fire Protection Association.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Alternating Current*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction, Transformers, Power Generation, and Using AC Power	
A. Introduction	_____
B. Transformers	_____
C. Power Generation	_____
D. Laboratory Trainees practice identifying types of power distribution systems from electrical circuit diagrams. This laboratory corresponds to Performance Task 2.	_____
E. Using AC Power	_____

Session II. Induction Motors and Testing AC Components

A. Induction Motors _____

B. Laboratory _____

Have trainees practice identifying various types of AC motors from schematic diagrams. This laboratory corresponds to Performance Task 4.

C. Laboratory _____

Have trainees practice identifying AC components and explaining their functions. This laboratory corresponds to Performance Task 1.

D. Testing AC Components _____

Session III. Safety, AC Voltage on Circuit Diagrams, Review and Testing

A. Safety _____

B. Laboratory _____

Following applicable safety practices, have trainees practice testing various AC components. This laboratory corresponds to Performance Task 3. _____

C. Review _____

D. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

E. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the trainee to electronic components and circuits used in HVAC systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03206-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Explain the basic theory of electronics and semiconductors.
2. Explain how various semiconductor devices such as diodes, LEDs, and photo diodes work, and how they are used in power and control circuits.
3. Identify different types of resistors and explain how their resistance values can be determined.
4. Describe the operation and function of thermistors and cad cells.
5. Test semiconductor components.
6. Identify the connectors on a personal computer.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify various semiconductor components.
2. Test a cad-cell flame detector.
3. Test thermistors.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Index cards

Appropriate personal protective equipment

Ohmmeter

Voltmeter

Selection of wire-wound and carbon composition resistors

Printed circuitboard

TV/VCR/DVD (optional)

Video *Understanding Electronic Controls* (optional)

Selection of electronic components, including:
- Diodes
- LEDs
- Photo diodes
- Thermistors
- Thyristors
- Integrated circuit chips
- Cad cell flame detector
- Silicon-controlled rectifiers
- Diacs
- Triacs

Cooling system or furnace with built-in diagnostic capability

Personal computer system and examples of storage media

Copies of Quick Quiz*

Module Examinations**

Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that trainees work with electrical circuits. Ensure that all trainees are properly briefed on electrical safety procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Electronics Fundamentals: Circuits, Devices, and Applications, 2007. Thomas L. Floyd. Prentice Hall.

*Electric Circuit Fundamental*s, 2004. Thomas L. Floyd. Prentice Hall.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 5 hours are suggested to cover *Basic Electronics*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction to Electronics	
A. Introduction	_____
B. Theory of Electronics	_____
C. Semiconductor Fundamentals	_____
D. Electronic Components and Circuits	_____
E. Laboratory Trainees practice identifying various types of semiconductor components. This laboratory corresponds to Performance Task 1.	_____
F. Laboratory Trainees practice testing thermistors and flame-cell detectors. This laboratory corresponds to Performance Tasks 2 and 3.	_____
G. Printed Circuit Boards	_____
Session II. Computers, Review, and Testing	
A. Introduction to Computers	_____
B. Review	_____
C. Module Examination 1. Trainees must score 70% or higher to receive recognition from NCCER. 2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	_____
D. Performance Testing 1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements. 2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	_____

Introduction to Control Circuit Troubleshooting Annotated Instructor's Guide

Module 03208-07

MODULE OVERVIEW

This module covers the various types of thermostats used in HVAC systems. It also covers hydronic, pneumatic, and digital controls and introduces the trainee to control circuit analysis and troubleshooting.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03207-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Explain the function of a thermostat in an HVAC system.
2. Describe different types of thermostats and explain how they are used.
3. Demonstrate the correct installation and adjustment of a thermostat.
4. Explain the basic principles applicable to all control systems.
5. Identify the various types of electromechanical, electronic, and pneumatic HVAC controls, and explain their function and operation.
6. Describe a systematic approach for electrical troubleshooting of HVAC equipment and components.
7. Recognize and use equipment manufacturer's troubleshooting aids to troubleshoot HVAC equipment.
8. Demonstrate how to isolate electrical problems to faulty power distribution, load, or control circuits.
9. Identify the service instruments needed to troubleshoot HVAC electrical equipment.
10. Make electrical troubleshooting checks and measurements on circuits and components common to all HVAC equipment.
11. Isolate and correct malfunctions in a cooling system control circuit.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify various types of thermostats and explain their operation and uses.
2. Install a conventional 24V bimetal thermostat and hook it up using the standard coding system for thermostat wiring.
3. Check and adjust a thermostat, including heat anticipator setting and indicator adjustment.
4. Program an electronic programmable thermostat.
5. Identify electrical, electronic, and pneumatic components and circuits, recognize their diagram symbols, and explain their functions.
6. Interpret control circuit diagrams.
7. Perform electrical tests and troubleshooting as follows:
   - Single- and three-phase input voltage measurements
   - Fuse and circuit breaker checks
   - Resistive and inductive load checks
   - Switch and contactor/relay checks
   - Control transformer checks
8. Perform electrical tests and troubleshooting of compressor and fan motors as follows:
   - Start and run capacitor checks
   - Start relay and start thermistor checks
   - Open, shorted, and grounded winding check

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Appropriate personal protective equipment

Length of wire with alligator clips

Thermostat wire

Wire stripper

Fuses

Videotapes/DVDs (optional):
- *Electrical Components and Their Symbols*
- *Electrical Troubleshooting*
- *An Introduction to Hydronic Heating*

TV/VCR/DVD player (optional)

Programmable electronic thermostat

Mercury bulb thermostat

Line voltage thermostat

Selection of 24V thermostats:
- Heating only
- Cooling only
- Heating-cooling
- Automatic changeover
- Heat pump thermostat with emergency heat control

Level

Clamp-on ammeter

Lockout devices and tags

Relays

Contactors

Motor starters

Multimeter

Circuit breakers

Operating heating/cooling system

Manufacturers' troubleshooting aids

Copies of Quick Quiz*

Module Examinations**

Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with heating/cooling appliances. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety and lockout/tagout procedures.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Air Conditioning Systems, Principles, Equipment, and Service. Latest Edition. Joseph Moravek. Upper Saddle River, NJ: Prentice Hall.

HVAC Servicing Procedures, 1995. Syracuse, NY: Carrier Corporation.

Pocket Guide to Electrical Installations Under NEC 2002, Volumes I and II, 2001. Quincy, MA: National Fire Protection Association.

Refrigeration and Air Conditioning, An Introduction to HVAC/R, Fourth Edition. Larry Jeffus. Air Conditioning and Refrigeration Institute. Upper Saddle River, NJ: Prentice Hall.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 30 hours are suggested to cover *Introduction to Control Circuit Troubleshooting*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic **Planned Time**

Session I. Introduction and Thermostats

A. Introduction _____

B. Thermostats _____

C. Laboratory _____

Trainees practice identifying various types of thermostats and explaining the operation and uses of each. This laboratory corresponds to Performance Task 1.

D. Laboratory _____

Under your supervision, have trainees install a conventional 24V bimetal thermostat using the standard coding for thermostat wiring and make any necessary checks and adjustments. This laboratory corresponds to Performance Tasks 2 and 3.

E. Laboratory _____

Have trainees program an electronic thermostat. This laboratory corresponds to Performance Task 4.

Session II. HVAC Control Systems

A. HVAC Control Systems _____

B. Laboratory _____

Have trainees practice identifying and describing the function of various electrical, electronic, and pneumatic components and circuits. This laboratory corresponds to Performance Task 5. _____

Session III. Control Circuit Sequence of Operation

A. Control Circuit Sequence of Operation _____

B. Laboratory _____

Have trainees practice interpreting control circuit diagrams for selected HVAC equipment. This laboratory corresponds to Performance Task 6.

Session IV. Organization and Safety

A. Using an Organized Approach to Electrical Troubleshooting _____

B. Safety _____

Session V. Troubleshooting I: Input Power, Load, and Control Circuits

A. HVAC System Troubleshooting _____

B. HVAC Equipment Input Power, Load, and Control Circuits _____

Sessions VI and VII. Troubleshooting II: Electrical System

A. Electrical Troubleshooting Common to All HVAC Equipment _____

B. Laboratory _____

Under your supervision, have trainees perform various electrical tests and troubleshooting, including input voltage measurements and components testing. This laboratory corresponds to Performance Task 7.

Sessions VIII and IX. Troubleshooting III: Motors

A. Motors and Motor Circuit Troubleshooting _____

B. Laboratory _____

Under your supervision, have trainees perform various electrical tests and troubleshooting of compressors and fan motors. This laboratory corresponds to Performance Task 8.

Session X. Hydronic and Pneumatic Systems

A. Hydronic Systems _____

B. Pneumatic Systems _____

Session XI. Digital Systems

A. HVAC Digital Control Systems _____

Session XII. Review and Testing

A. Review _____

B. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Troubleshooting Gas Heating
Annotated Instructor's Guide

Module 03209-07

MODULE OVERVIEW

This module introduces the trainee to the procedures for recognizing, analyzing, and repairing malfunctions in gas heating equipment.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03208-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Describe the basic operating sequence for gas heating equipment.
2. Interpret control circuit diagrams for gas heating systems.
3. Describe the operation of various types of burner ignition methods.
4. Identify the tools and instruments used when troubleshooting gas heating systems.
5. Demonstrate using the tools and instruments required for troubleshooting gas heating systems.
6. Isolate and correct malfunctions in gas heating systems.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Develop a checklist for troubleshooting a gas heating appliance.
2. Select the tools and instruments needed to troubleshoot a gas heating appliance in a given situation.
3. Analyze control circuit diagram(s) for a selected gas heating appliance.
4. Isolate and correct malfunctions in a gas heating appliance.
   - Control circuits
   - Combustion system
   - Safety controls
   - Air system

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Insulated jumper wires
Microammeter
Millivoltmeter
Multimeter
Operating natural-draft and induced-draft gas heating systems
Selection of pre-faulted components
Manufacturers' literature on gas-fired furnaces
Hot surface ignitors
Flame sensors
Copies of Quick Quiz*
Module Examinations**
Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with gas heating appliances. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

Refrigeration and Air Conditioning, An Introduction to HVAC/R, Fourth Edition. Larry Jeffus. Air Conditioning and Refrigeration Institute. Upper Saddle River, NJ: Prentice Hall.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Troubleshooting Gas Heating*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Sessions I and II. Introduction and Control Circuits	
A. Introduction	_____
B. Control Circuits	_____
C. Laboratory Trainees practice developing a checklist for troubleshooting gas heating systems. This laboratory corresponds to Performance Task 1.	_____
D. Laboratory Trainees practice identifying the tools and instruments needed to troubleshoot a gas heating appliance. This laboratory corresponds to Performance Task 2.	_____
E. Laboratory Use pre-faulted components, jumpers, or other means to insert safety and control circuit malfunctions into a gas furnace. Provide trainees with the wiring diagram for the unit and have them isolate and correct the fault under your supervision. This laboratory corresponds to Performance Tasks 3 and 4.	_____
Session III. Combustion Systems	
A. Combustion Systems	_____
B. Laboratory Use pre-faulted components, jumpers, or other means to insert combustion system malfunctions into a gas furnace. Provide trainees with the wiring diagram for the unit and have them isolate and correct the fault under your supervision. This laboratory corresponds to Performance Tasks 3 and 4.	_____
Session IV. Air Systems	
A. Air Systems	_____
B. Laboratory Use pre-faulted components, jumpers, or other means to insert air system malfunctions into a gas furnace. Provide trainees with the wiring diagram for the unit and have them isolate and correct the fault under your supervision. This laboratory corresponds to Performance Tasks 3 and 4.	_____

Session V. Review and Testing

A. Review _____

B. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Troubleshooting Cooling
Annotated Instructor's Guide

Module 03210-07

MODULE OVERVIEW

This module covers the troubleshooting methods used with cooling systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03209-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Describe a systematic approach for troubleshooting cooling systems and components.
2. Isolate problems to electrical and/or mechanical functions in cooling systems.
3. Recognize and use equipment manufacturer's troubleshooting aids to troubleshoot cooling systems.
4. Identify and use the service instruments needed to troubleshoot cooling systems.
5. Successfully troubleshoot selected problems in cooling equipment.
6. State the safety precautions associated with cooling troubleshooting.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Develop a checklist for troubleshooting cooling systems.
2. Select the tools and instruments needed to troubleshoot a cooling system in a given situation.
3. Analyze control circuit diagram(s) for a selected cooling system.
4. Isolate and correct malfunctions in a cooling appliance:
   - Electrical problems
   - Compressor electrical failures
   - System-related compressor problems
   - Refrigerant overcharge and undercharge
   - Evaporator and condenser problems
   - Metering device problems
   - Refrigerant lines and accessories
   - Noncondensibles and contamination

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Dry-erase markers
Laminated copy of refrigeration cycle
Service literature for selected demonstration equipment
Cylinder of refrigerant of the type used in the demonstration system
Cylinder of nitrogen with regulators
Filter-driers
Oil test kit
Sealed tube-type acid/moisture test kit (Carrier TOTALTEST® or equivalent)
Samples of contaminated refrigerant oil
Refrigerant temperature-pressure charts*
Operating air conditioning and/or refrigeration system(s)
Boost start capacitors
Assortment of inoperative components as needed to simulate exercise troubleshooting problems
Lockout/tagout locks and tags
Multimeters (VOMs/DMMs)
Clamp-on ammeter
Compressor analyzers
Capacitor testers
Gauge manifold sets
Thermometers
Sling psychrometer
Manufacturer's standalone electronic module tester
Recovery/recycle unit and recovery cylinder
Fuse pullers
Inspection mirrors
Leak detectors
Mechanic's hand tool set
Copies of Quick Quiz**
Module Examinations***
Performance Profile Sheets***

* If the trainees do not already have temperature-pressure charts, you should be able to obtain these charts in card form from a local HVAC/R distributor.
** Located in the back of this module.
*** Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with cooling appliances. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Air Conditioning Systems, Principles, Equipment, and Service, 2001, Joseph Moravek. Upper Saddle River, NJ: Prentice Hall.

General Training Air Conditioning 2, GTAC, 1996. Syracuse, NY: Carrier Corporation.

HVAC Servicing Procedures, 1995. Syracuse, NY: Carrier Corporation.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *Troubleshooting Cooling*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction to Troubleshooting Cooling	
A. Introduction	_____
B. Operation of the Mechanical Refrigeration (Cooling) System	_____
C. Electrical Control of Mechanical Cooling Operation	_____
D. Troubleshooting Approach	_____
E. Laboratory Trainees practice identifying the tools and instruments needed to troubleshoot a cooling appliance. This laboratory corresponds to Performance Task 2.	_____
Sessions II and III. Troubleshooting I	
A. Electrical Troubleshooting	_____
B. Mechanical Refrigeration Cycle Troubleshooting	_____
Sessions IV and V. Troubleshooting II	
A. Low Charge or Overcharge of Refrigerant	_____
B. Evaporator and Condenser Airflow Problems	_____
C. Compressor Problems and Causes	_____
D. Metering Device Troubleshooting	_____
Sessions VI and VII. Troubleshooting III	
A. Troubleshooting Refrigeration Lines and Accessories	_____
B. Noncondensibles and Contamination in a System	_____
C. Condensate Water Disposal Problems	_____
D. Laboratory Trainees practice developing a checklist for troubleshooting cooling systems. This laboratory corresponds to Performance Task 1.	_____
E. Laboratory Use pre-faulted components, jumpers, or other means to insert system malfunctions into a cooling system. Provide trainees with the wiring diagram for the unit and have them isolate and correct the fault(s). This laboratory corresponds to Performance Tasks 3 and 4.	_____
Session VIII. Review and Testing	
A. Review	_____
B. Module Examination 1. Trainees must score 70% or higher to receive recognition from NCCER. 2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	_____
C. Performance Testing 1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements. 2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	_____

Heat Pumps
Annotated Instructor's Guide

Module 03211-07

MODULE OVERVIEW

This module introduces covers operation, installation, and control circuit analysis for heat pumps.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03210-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Describe the principles of reverse-cycle heating.
2. Identify heat pumps by type and general classification.
3. Describe various types of geothermal water loops and their application.
4. List the components of heat pump systems.
5. Describe the role and basic operation of electric heat in common heat pump systems.
6. Describe common heat pump ratings, such as Coefficient of Performance (COP), Heating Season Performance Factor (HSPF), and Seasonal Energy Efficiency Ratio (SEER).
7. Demonstrate heat pump installation and service procedures.
8. Identify and install refrigerant circuit accessories commonly associated with heat pumps.
9. Analyze a heat pump control circuit.
10. Isolate and correct malfunctions in a heat pump.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify components that are unique to heat pumps and explain the function of each.
2. Calculate the balance point of a heat pump.
3. Simulate the installation procedures for a heat pump.
4. Perform heat pump servicing procedures.
5. Analyze a heat pump circuit diagram and perform simulated troubleshooting exercises.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Copies of a heat pump wiring diagram
Reversing valve
Check valve
Metering device
Fan coil with electric heating elements
Applicable manufacturer's heat pump installation instructions
Transparency or sketch of structure in which heat pump will be installed
Manufacturers' heat pump balance point calculation sheets
Electrical wire, cable, connectors, conduit (if required)
Disconnect switch
Refrigerant
Videotape *Inside the Heat Pump* (optional)
Videotape *Troubleshooting Heat Pumps* (optional)
DVD/VCR/TV set (optional)
Disassembled air-to-air split-system heat pump with controls
TEV with built-in check valve
Refrigeration mechanic's tool set
Gauge manifold set
Electrical test instruments
Operational, properly wired and assembled air-to-air split-system heat pump
Air conditioning service tools and test equipment set
Copies of Quick Quiz*
Module Examinations**
Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with appliances. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety and chemical hazards.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

Inside the Heat Pump, Videotape. Catalog No. 020-538. Syracuse, NY: Carrier Corporation.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Heat Pumps*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic **Planned Time**

Session I. Introduction to Heat Pumps

A. Introduction _____

B. Heat Pump Operation _____

C. Heat Pump Classification _____

D. Heat Pump Refrigeration Cycle _____

Session II. Heat Pump Components and Controls

A. Heat Pump Components _____

B. Laboratory _____
Trainees practice identifying the components of a heat pump. This laboratory corresponds to Performance Task 1.

C. Supplemental Electric Heat _____

D. Heat Pump Performance _____

E. Heat Pump Balance Point _____

F. Laboratory _____
Trainees practice calculating the balance point of a heat pump. This laboratory corresponds to Performance Task 2.

Session III. Installation

A. Installation _____

B. Laboratory _____
Trainees practice simulating or describing the installation procedures for a heat pump. This laboratory corresponds to Performance Task 3.

Sessions IV and V. Servicing and Troubleshooting

A. Servicing _____

B. Laboratory _____
Trainees practice heat pump servicing procedures. This laboratory corresponds to Performance Task 4.

C. Laboratory _____
Trainees practice troubleshooting heat pumps. This laboratory corresponds to Performance Task 5.

D. Heat Pump Controls _____

Session VI. Review and Testing

A. Review _____

B. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Basic Installation and Maintenance Practices
Annotated Instructor's Guide

Module 03212-07

MODULE OVERVIEW

This module introduces the trainee to the basic mechanical procedures commonly performed in HVAC servicing work. Basic maintenance procedures, documentation, and customer relations are also covered.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03211-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Identify, explain, and install threaded and non-threaded fasteners.
2. Identify, explain, remove, and install types of gaskets, packings, and seals.
3. Identify types of lubricants, and explain their uses.
4. Use lubrication equipment to lubricate motor bearings.
5. Identify the types of belt drives, explain their uses, and demonstrate procedures used to install or adjust them.
6. Identify and explain types of couplings.
7. Demonstrate procedures used to remove, install, and align couplings.
8. Identify types of bearings, and explain their uses.
9. Explain causes of bearing failures.
10. Demonstrate procedures used to remove and install bearings.
11. Perform basic preventive maintenance inspection and cleaning procedures.
12. List ways to develop and maintain good customer relations.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify different types of threaded fasteners.
2. Identify non-threaded fasteners.
3. Identify different types of gaskets.
4. Identify mechanical seal parts.
5. Install an oil seal.
6. Align and properly adjust V-belts.
7. Identify different types of drive couplings.
8. Tighten a four-bolt flange.
9. Install an expandable anchor bolt.
10. Identify different types of bearings.
11. Recognize and use a manual bearing puller to remove a bearing.
12. Recognize and use a feeler gauge to measure bearing clearances.
13. Lubricate a bearing using a lever-type grease gun.
14. Fill out typical forms used for installation and service calls.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Appropriate personal protective equipment

Assortment of machine bolts, machine screws, cap screws, and stud bolts

Various types of the following:
- Set screws
- Flat and lock washers
- Nuts
- Thread-forming and thread-cutting screws
- Toggle and anchor bolts
- Thread repair inserts
- Retainer rings
- Pin fasteners
- Keys
- Rivets
- Preformed gaskets and gasket materials
- Packing materials
- Non-mechanical seals
- Lubricants
- Hydraulic fittings
- V-belts
- Couplings
- Mechanical seals

Measuring devices, including:
- Circumference rules
- Calipers and dividers
- Micrometers
- Feeler gauges
- Thread pitch gauges

Assortment of flange sets used to practice different bolt tightening sequences

Manufacturers' installation instructions for selected mechanical seals

Assortment of different types of sleeve, ball, and roller bearings

Examples of bearings that show the common types of bearing damage

Metal plates with holes drilled through and/or with threaded holes

Several pieces of sheet metal of different sizes and weights

Rags

Examples of job forms

Wrenches and pliers of the type and size used to fit selected fasteners

Torque wrenches for use with the size of selected fasteners

Tap and die set

Electric drill and drill bits

Blind rivet tool

Packing and seal removal/installation tools

Equipment to demonstrate and practice removing and installing packing and seals

Equipment to demonstrate and practice removing and installing mechanical seals

Equipment to demonstrate and practice removing and installing bearings

Various types of bearing/coupling pullers

Arbor press and/or hydraulic press

Feeler gauge

Equipment to demonstrate and practice the lubrication of motor bearings

Lever-type grease gun

Equipment to demonstrate and practice V-belt installation and pulley alignment

V-belt tension gauge

Equipment to demonstrate and practice removing and installing couplings

Straightedge

Copies of Quick Quiz*

Module Examinations**

Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with appliances. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety and chemical hazards.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

Air Conditioning Systems, Principles, Equipment, and Service, Latest Edition. Upper Saddle River, NJ: Prentice Hall.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 17½ hours are suggested to cover *Basic Installation and Maintenance Practices*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction and Mechanical Fasteners	
A. Introduction	_____
B. Mechanical Fasteners	_____
C. Laboratory	_____
Trainees practice identifying various threaded and non-threaded fasteners. This laboratory corresponds to Performance Tasks 1 and 2.	
D. Installing Threaded Fasteners	_____
E. Laboratory	_____
Trainees practice tightening a four-bolt flange. This laboratory corresponds to Performance Task 8.	
F. Installing Anchor Bolts	_____
G. Laboratory	_____
Trainees practice installing anchor bolts. This laboratory corresponds to Performance Task 9.	
Session II. Gaskets, Packing, and Seals	
A. Gaskets	_____
B. Laboratory	_____
Trainees practice identifying various types of gaskets. This laboratory corresponds to Performance Task 3.	
C. Packing	_____
D. Identifying Seals	_____
E. Laboratory	_____
Trainees practice identifying mechanical seal parts. This laboratory corresponds to Performance Task 4.	
F. Installing and Removing Seals	_____
G. Laboratory	_____
Trainees practice installing an oil seal. This laboratory corresponds to Performance Task 5.	

Session III. Bearings

A. Identifying Bearings _____

B. Laboratory _____

Trainees practice identifying different types of bearings. This laboratory corresponds to Performance Task 10.

C. Removing Bearings _____

D. Laboratory _____

Trainees practice using a manual bearing puller to remove a bearing. This laboratory corresponds to Performance Task 11.

E. Installing Bearings _____

F. Laboratory _____

Trainees practice using a feeler gauge to measure bearing clearances. This laboratory corresponds to Performance Task 12.

Session IV. Lubrication, Belts, and Belt Drives

A. Lubricating Bearings _____

B. Laboratory _____

Trainees practice lubricating a bearing using a lever-type grease gun. This laboratory corresponds to Performance Task 13.

C. Belts and Belt Drives _____

D. Laboratory _____

Trainees practice aligning and adjusting a V-belt. This laboratory corresponds to Performance Task 6.

Session V. Couplings and Direct Drives

A. Couplings and Direct Drives _____

B. Laboratory _____

Trainees practice identifying different types of drive couplings. This laboratory corresponds to Performance Task 7.

C. General Coupling Removal and Installation Methods _____

D. Coupling Alignment _____

E. Basic Maintenance Procedures _____

Session VI. Documentation and Customer Relations

A. Documentation _____

B. Laboratory _____

Trainees practice filling out forms used for installation and service calls. This laboratory corresponds to Performance Task 14.

C. Customer Relations _____

D. Customer Communications _____

Session VII. Review and Testing

A. Review _____

B. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Sheet Metal Duct Systems
Annotated Instructor's Guide

Module 03213-07

MODULE OVERVIEW

This module introduces sheet metal duct systems and explains how to lay out and install sheet metal and flexible ducts.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03212-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Identify and describe the basic types of sheet metal.
2. Define properties of steel and aluminum alloys.
3. Describe a basic layout method and perform proper cutting.
4. Join sheet metal duct sections using proper seams and connectors.
5. Describe proper hanging and support methods for sheet metal duct.
6. Describe thermal and acoustic insulation principles.
7. Select, apply, and seal the proper insulation for sheet metal ductwork.
8. Describe guidelines for installing components such as registers, diffusers, grilles, dampers, access doors, and zoning accessories.
9. Install takeoffs and attach flexible duct to a sheet metal duct.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Join duct sections and fittings.
2. Install takeoffs and attach flexible duct.

MATERIALS AND EQUIPMENT

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Sheet metal gauge
Several gauges of sheet metal
Samples of stainless steel and aluminum
Samples of various types of seams
Connectors
Hangers and supports
Grilles, registers, and diffusers
Sections of duct
Tools for joining ductwork
Insulation materials
Fibrous glass duct liner
Flexible blanket insulation
Measuring tape
Utility knife
Straightedge
Mechanical fasteners
Dampers
Takeoffs
Flexible duct
Tin snips and other sheet metalworking tools
Copies of Quick Quiz*
Module Examinations**
Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with sheet metal. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize the dangers posed by sharp metal edges and cutting tools, and appropriate safety precautions.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Air Distribution Basics for Residential and Small Commercial Buildings, 2000. Hank Rutkowski. Arlington, VA: Air Conditioning Contractors of America.

Air Distribution in Rooms: Ventilation for Health and Sustainable Environment, 2000. Hazim B. Awbi, editor. New York, NY: Elsevier Science.

Fibrous Glass Duct Liner Standard: Design, Fabrication, and Installation Guidelines, Third Edition, 2002. NAIMA. Alexandria, VA: North American Insulation Manufacturers Association.

HVAC Duct Construction Standard—Metal and Flexible. Chantilly, VA: Sheet Metal and Air Conditioning Contractors' National Association.

Standard for the Installation of Air Conditioning and Ventilating Systems, 1999. Quincy, MA: National Fire Protection Association.

Thermal Insulation Building Guide, 1990. Edin F. Strother and William C. Turner. Melbourne, FL: Krieger Publishing.

Ultimate Sheet Metal Fabrication, 1999. Tim Remus. Osceola, WI: Motorbooks International.

Working With Fiber Glass, Rock Wool, and Slag Wool Products, 2001. Alexandria, VA: North American Insulation Manufacturers Association.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 5 hours are suggested to cover *Sheet Metal Duct Systems*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction to Sheet Metal Duct Systems	
A. Introduction	_____
B. Steel and Other Metals	_____
C. Seams (Locks)	_____
D. Connectors	_____
E. Hangers and Supports for Sheet Metal Ducts	_____
F. Installing Registers, Grilles, and Diffusers	_____
G. Laboratory Trainees practice joining duct sections and fittings. This laboratory corresponds to Performance Task 1.	_____

Session II. Accessories, Review, and Testing

A. Insulation _____

B. Dampers and Access Doors _____

C. Takeoffs _____

D. Laboratory _____

Trainees practice installing takeoffs and attaching flexible duct. This laboratory corresponds to Performance Task 2.

E. Zoning Accessories and Coils _____

F. Review _____

G. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

H. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

Fiberglass and Flexible Duct Systems
Annotated Instructor's Guide

Module 03214-07

MODULE OVERVIEW

This module introduces fiberglass and flexible duct systems and explains how to lay out and install them.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *HVAC Level One*; and *HVAC Level Two*, Modules 03201-07 through 03213-07.

OBJECTIVES

Upon completion of this module, the trainee will be able to do the following:

1. Identify types of fiberglass duct, including flexible duct.
2. Describe fiberglass duct layout and some basic fabrication methods.
3. Describe the various closure methods for sealing fiberglass duct.
4. Fabricate selected duct modules and fittings using the appropriate tools.
5. Describe hanging and support methods for fiberglass duct.
6. Describe how to repair major and minor damage to fiberglass duct.
7. Install takeoffs and attach flexible duct to a fiberglass duct.

PERFORMANCE TASKS

Under the supervision of the instructor, the trainee should be able to do the following:

1. Fabricate and assemble fiberglass duct fittings and sections.
2. Install takeoffs and attach flexible duct.

MATERIALS AND EQUIPMENT

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Appropriate personal protective equipment

Rigid ductboard

Rigid round duct

Flexible round duct

Manufacturer's literature on ductboard

Copies of NFPA and UL standards for the fabrication and installation of fiberglass and flexible duct

Tapes and mastics and manufacturer's instructions

Iron, stapler, rubbing tool, and other tools to apply tape

Insulation knife and other tools to cut and fabricate ductwork

Wire, metal straps, and channel reinforcements

Copies of Quick Quiz*

Module Examinations**

Performance Profile Sheets**

* Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with fiberglass ductboard. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize chemical hazards and skin protection.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

"Energy Efficient Design of New Low-Rise Residential Buildings," 1992. *In National Voluntary Consensus Standard*. ANSI/ASHRAE.

Environmental Protection Agency Website, www.epa.gov, "Biocontaminant Control," reviewed July 2002.

Environmental Protection Agency Website, www.epa.gov, "Should You Have the Air Ducts in Your Home Cleaned," Indoor Environment Division, October 1997, reviewed July 2002.

Fibrous Glass Duct Construction Standard, Fourth Edition, 2001. Alexandria, VA: North American Insulation Manufacturers Association.

Flexible Duct Performance and Installation Standards®, Fourth Edition, 2007. Schaumberg, Illinois: Air Diffusion Council.

Fibrous Glass Duct Construction Standard, Third Edition, 1993. Alexandria, VA: North American Insulation Manufacturers Association.

Fibrous Glass Residential Duct Construction Standard, Second Edition, 1998. Alexandria, VA: North American Insulation Manufacturers Association.

UL 181, Standard for Factory-Made Air Ducts and Air Connectors, 2005. Northbrook, IL: Underwriters Laboratories, Inc.

UL 181A, Standard for Closure Systems for Use with Rigid Air Ducts and Air Connectors, 2005. Northbrook, IL: Underwriters Laboratories, Inc.

UL 181B, Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors, 2005. Northbrook, IL: Underwriters Laboratories, Inc.

NFPA 90A, Standard for the Installing of Air Conditioning and Ventilating Systems, 2002. Quincy, MA: National Fire Protection Association.

Working With Fiber Glass, Rock Wool, and Slag Wool Products. 2001. Alexandria, VA: North American Insulation Manufacturers Association.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Fiberglass and Flexible Duct Systems*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction to Fiberglass and Flexible Duct Systems	
A. Introduction	_____
B. Types and Standards of Fiberglass Duct	_____
C. Advantages of Modular Duct Construction	_____
D. Extended Plenum Supply System	_____
E. Closure Systems for Fiberglass Duct	_____
F. Fabricating and Joining a Duct Module	_____
G. Laboratory Trainees practice fabricating and assembling fiberglass duct and sections. This laboratory corresponds to Performance Task 1.	_____

Session II. Installation

A. Connecting Ductboard to Sheet Metal _____

B. Flexible Round Duct Connections _____

C. Laboratory _____

Trainees practice attaching flexible duct. This laboratory corresponds to Performance Task 2.

D. Hanging and Supporting Fiberglass Duct _____

E. Repairing Damage _____

F. Laboratory _____

Trainees practice installing takeoffs. This laboratory corresponds to Performance Task 2.

Session III. Review and Testing

A. Review _____

B. Module Examination _____

1. Trainees must score 70% or higher to receive recognition from NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.