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

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

* 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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session I. Introduction</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Zoning</td>
<td></td>
</tr>
<tr>
<td>C. Commercial Systems</td>
<td></td>
</tr>
<tr>
<td>D. Outdoor Air and Air Systems</td>
<td></td>
</tr>
<tr>
<td>Session II. Types of All-Air Systems and Duct Systems</td>
<td></td>
</tr>
<tr>
<td>A. Types of All-Air Systems</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>Trainees practice identifying the types of airside systems commonly used in each application. This laboratory corresponds to Performance Task 2.</td>
</tr>
<tr>
<td>Session III. Air Terminals, Source Equipment, and Handlers</td>
<td></td>
</tr>
<tr>
<td>A. Duct Systems</td>
<td></td>
</tr>
<tr>
<td>B. Air Terminals</td>
<td></td>
</tr>
<tr>
<td>C. Air Source Equipment</td>
<td></td>
</tr>
<tr>
<td>Session IV. Identification of Commercial Air Systems</td>
<td></td>
</tr>
<tr>
<td>A. Air Handlers</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>Trainees practice identifying the types of commercial air systems installed in selected buildings. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>Session V. Review and Testing</td>
<td></td>
</tr>
<tr>
<td>A. Review</td>
<td></td>
</tr>
<tr>
<td>B. Module Examination</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
<td></td>
</tr>
<tr>
<td>C. Performance Testing</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
<td></td>
</tr>
</tbody>
</table>
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.

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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction to Chimneys and Venting Requirements</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Combustion</td>
<td></td>
</tr>
<tr>
<td>C. Flue Gases</td>
<td></td>
</tr>
<tr>
<td>D. Furnace Venting</td>
<td></td>
</tr>
<tr>
<td>E. Vent System Components</td>
<td></td>
</tr>
<tr>
<td>F. Natural-Draft Furnaces</td>
<td></td>
</tr>
<tr>
<td>G. Induced-Draft Furnaces</td>
<td></td>
</tr>
<tr>
<td>H. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice measuring the temperature and determining the temperature rise. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td>I. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice adjusting the thermostat anticipator. This laboratory corresponds to Performance Task 2.</td>
<td></td>
</tr>
</tbody>
</table>

| **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 Two, 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.
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  Pressure-temperature gauges
Transparencies  Pressure relief valves
Blank acetate sheets  Low water controls
Transparency pens  Aquastats
Whiteboard/chalkboard  Electronic-type water level controls
Markers/chalk  Expansion/compression tanks
Pencils and scratch paper  Air control devices
Appropriate personal protective equipment  Circulating pumps
Hot-water heating system(s) and assorted system  Assorted gate, ball, globe, and angle valves
components, including:  Pressure-reducing valves
Cast-iron and steel boiler parts  Backflow preventer valves
Electric boiler heating elements and other parts  Zone control valves
Differential pressure gauges  Multipurpose valves
Pump curve chart  Balancing and flow control 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.


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.

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


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.

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


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.
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.
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

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

continued
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.


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 | ____________ |
| E. Using AC Power | ____________ |

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

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**
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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session I. Introduction to Electronics</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Theory of Electronics</td>
<td></td>
</tr>
<tr>
<td>C. Semiconductor Fundamentals</td>
<td></td>
</tr>
<tr>
<td>D. Electronic Components and Circuits</td>
<td></td>
</tr>
<tr>
<td>E. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice identifying various types of semiconductor components. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td>F. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice testing thermistors and flame-cell detectors. This laboratory corresponds to Performance Tasks 2 and 3.</td>
<td></td>
</tr>
<tr>
<td>G. Printed Circuit Boards</td>
<td></td>
</tr>
<tr>
<td>Session II. Computers, Review, and Testing</td>
<td></td>
</tr>
<tr>
<td>A. Introduction to Computers</td>
<td></td>
</tr>
<tr>
<td>B. Review</td>
<td></td>
</tr>
<tr>
<td>C. Module Examination</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
<td></td>
</tr>
<tr>
<td>D. Performance Testing</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
<td></td>
</tr>
</tbody>
</table>
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
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.


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.
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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction and Thermostats</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Thermostats</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice identifying various types of thermostats and explaining the operation and uses of each. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td>D. Laboratory</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>E. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees program an electronic thermostat. This laboratory corresponds to Performance Task 4.</td>
<td></td>
</tr>
<tr>
<td><strong>Session II. HVAC Control Systems</strong></td>
<td></td>
</tr>
<tr>
<td>A. HVAC Control Systems</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees practice identifying and describing the function of various electrical, electronic, and pneumatic components and circuits. This laboratory corresponds to Performance Task 5.</td>
<td></td>
</tr>
<tr>
<td><strong>Session III. Control Circuit Sequence of Operation</strong></td>
<td></td>
</tr>
<tr>
<td>A. Control Circuit Sequence of Operation</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees practice interpreting control circuit diagrams for selected HVAC equipment. This laboratory corresponds to Performance Task 6.</td>
<td></td>
</tr>
<tr>
<td><strong>Session IV. Organization and Safety</strong></td>
<td></td>
</tr>
<tr>
<td>A. Using an Organized Approach to Electrical Troubleshooting</td>
<td></td>
</tr>
<tr>
<td>B. Safety</td>
<td></td>
</tr>
<tr>
<td><strong>Session V. Troubleshooting I: Input Power, Load, and Control Circuits</strong></td>
<td></td>
</tr>
<tr>
<td>A. HVAC System Troubleshooting</td>
<td></td>
</tr>
<tr>
<td>B. HVAC Equipment Input Power, Load, and Control Circuits</td>
<td></td>
</tr>
<tr>
<td><strong>Sessions VI and VII. Troubleshooting II: Electrical System</strong></td>
<td></td>
</tr>
<tr>
<td>A. Electrical Troubleshooting Common to All HVAC Equipment</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
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.
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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sessions I and II. Introduction and Control Circuits</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Control Circuits</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td>Trainees practice developing a checklist for troubleshooting gas heating systems. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>D. Laboratory</td>
<td>Trainees practice identifying the tools and instruments needed to troubleshoot a gas heating appliance. This laboratory corresponds to Performance Task 2.</td>
</tr>
<tr>
<td>E. Laboratory</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Session III. Combustion Systems</strong></td>
<td></td>
</tr>
<tr>
<td>A. Combustion Systems</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Session IV. Air Systems</strong></td>
<td></td>
</tr>
<tr>
<td>A. Air Systems</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>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.</td>
</tr>
</tbody>
</table>
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.
**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
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.

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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session I. Introduction to Troubleshooting Cooling</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Operation of the Mechanical Refrigeration (Cooling) System</td>
<td></td>
</tr>
<tr>
<td>C. Electrical Control of Mechanical Cooling Operation</td>
<td></td>
</tr>
<tr>
<td>D. Troubleshooting Approach</td>
<td></td>
</tr>
<tr>
<td>E. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice identifying the tools and instruments needed to troubleshoot a cooling appliance. This laboratory corresponds to Performance Task 2.</td>
<td></td>
</tr>
<tr>
<td>Sessions II and III. Troubleshooting I</td>
<td></td>
</tr>
<tr>
<td>A. Electrical Troubleshooting</td>
<td></td>
</tr>
<tr>
<td>B. Mechanical Refrigeration Cycle Troubleshooting</td>
<td></td>
</tr>
<tr>
<td>Sessions IV and V. Troubleshooting II</td>
<td></td>
</tr>
<tr>
<td>A. Low Charge or Overcharge of Refrigerant</td>
<td></td>
</tr>
<tr>
<td>B. Evaporator and Condenser Airflow Problems</td>
<td></td>
</tr>
<tr>
<td>C. Compressor Problems and Causes</td>
<td></td>
</tr>
<tr>
<td>D. Metering Device Troubleshooting</td>
<td></td>
</tr>
<tr>
<td>Sessions VI and VII. Troubleshooting III</td>
<td></td>
</tr>
<tr>
<td>A. Troubleshooting Refrigeration Lines and Accessories</td>
<td></td>
</tr>
<tr>
<td>B. Noncondensibles and Contamination in a System</td>
<td></td>
</tr>
<tr>
<td>C. Condensate Water Disposal Problems</td>
<td></td>
</tr>
<tr>
<td>D. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice developing a checklist for troubleshooting cooling systems. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td>E. Laboratory</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Session VIII. Review and Testing</td>
<td></td>
</tr>
<tr>
<td>A. Review</td>
<td></td>
</tr>
<tr>
<td>B. Module Examination</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
<td></td>
</tr>
<tr>
<td>C. Performance Testing</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
<td></td>
</tr>
</tbody>
</table>
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.
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.


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.
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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session I. Introduction to Heat Pumps</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Heat Pump Operation</td>
<td></td>
</tr>
<tr>
<td>C. Heat Pump Classification</td>
<td></td>
</tr>
<tr>
<td>D. Heat Pump Refrigeration Cycle</td>
<td></td>
</tr>
<tr>
<td>Session II. Heat Pump Components and Controls</td>
<td></td>
</tr>
<tr>
<td>A. Heat Pump Components</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>Trainees practice identifying the components of a heat pump. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>C. Supplemental Electric Heat</td>
<td></td>
</tr>
<tr>
<td>D. Heat Pump Performance</td>
<td></td>
</tr>
<tr>
<td>E. Heat Pump Balance Point</td>
<td></td>
</tr>
<tr>
<td>F. Laboratory</td>
<td>Trainees practice calculating the balance point of a heat pump. This laboratory corresponds to Performance Task 2.</td>
</tr>
<tr>
<td>Session III. Installation</td>
<td></td>
</tr>
<tr>
<td>A. Installation</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>Trainees practice simulating or describing the installation procedures for a heat pump. This laboratory corresponds to Performance Task 3.</td>
</tr>
<tr>
<td>Sessions IV and V. Servicing and Troubleshooting</td>
<td></td>
</tr>
<tr>
<td>A. Servicing</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>Trainees practice heat pump servicing procedures. This laboratory corresponds to Performance Task 4.</td>
</tr>
<tr>
<td>C. Laboratory</td>
<td>Trainees practice troubleshooting heat pumps. This laboratory corresponds to Performance Task 5.</td>
</tr>
<tr>
<td>D. Heat Pump Controls</td>
<td></td>
</tr>
<tr>
<td>Session VI. Review and Testing</td>
<td></td>
</tr>
<tr>
<td>A. Review</td>
<td></td>
</tr>
<tr>
<td>B. Module Examination</td>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
</tr>
<tr>
<td></td>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
</tr>
<tr>
<td>C. Performance Testing</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
</tr>
</tbody>
</table>
Basic Installation and Maintenance Practices
Annotated Instructor’s Guide

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**

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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction and Mechanical Fasteners</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Mechanical Fasteners</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td></td>
</tr>
</tbody>
</table>
  - 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.
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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session I. Introduction to Sheet Metal Duct Systems</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Steel and Other Metals</td>
<td></td>
</tr>
<tr>
<td>C. Seams (Locks)</td>
<td></td>
</tr>
<tr>
<td>D. Connectors</td>
<td></td>
</tr>
<tr>
<td>E. Hangers and Supports for Sheet Metal Ducts</td>
<td></td>
</tr>
<tr>
<td>F. Installing Registers, Grilles, and Diffusers</td>
<td></td>
</tr>
<tr>
<td>G. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice joining duct sections and fittings. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
</tbody>
</table>
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.
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 | Copies of NFPA and UL standards for the fabrication and installation of fiberglass and flexible duct |
|--------------------------------|-------------------------------------------------------------------------------------------------
| Transparencies                | Tapes and mastics and manufacturer’s instructions                                               |
| Blank acetate sheets          | Iron, stapler, rubbing tool, and other tools to apply tape                                        |
| Transparency pens            | Insulation knife and other tools to cut and fabricate ductwork                                    |
| Whiteboard/chalkboard        | Wire, metal straps, and channel reinforcements                                                    |
| Markers/chalk                 | Copies of Quick Quiz*                                                                             |
| Pencils and scratch paper     | Module Examinations**                                                                             |
| Appropriate personal protective equipment | Performance Profile Sheets**                                                                  |
| Rigid ductboard              |                                                                                                 |
| Rigid round duct             |                                                                                                 |
| Flexible round duct          |                                                                                                 |
| Manufacturer’s literature on ductboard |                                                                                                    |

* 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.


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.

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