

MODULE OVERVIEW

This module covers the refrigerants and oils commonly used in HVAC/R systems. It includes identification and classification of refrigerants, differences between pure and blended refrigerants, types and properties of oils, use and testing of oils, and refrigerant retrofits.

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*.

OBJECTIVES

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

1. Identify the refrigerants in common use and state the types of applications in which each is used.
2. Explain the effects of releasing refrigerants into the atmosphere.
3. Explain how refrigerants are classified by their chemical composition.
4. Describe the color-coding scheme used to identify refrigerant cylinders.
5. Describe how azeotropes and near-azeotropes differ from each other and from so-called pure refrigerants.
6. Interpret a P-T chart for an azeotrope refrigerant.
7. Calculate superheat and subcooling.
8. Demonstrate refrigerant leak detecting methods.
9. Identify the different types of oils used in refrigeration systems and explain their relationships to the various refrigerants.
10. Explain how to add and remove oil from a system.
11. Describe how to test oil for contamination.
12. Perform a refrigerant retrofit.

PERFORMANCE TASKS

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

1. Interpret a P-T chart for an azeotrope refrigerant.
2. Calculate superheat and subcooling.
3. Perform a refrigerant leak detection procedure.
4. Perform a refrigerant retrofit.

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

Selection of color-coded refrigerant cylinders

Refrigerant recovery cylinder

Electronic leak detector

Leak test solution

P-T charts for various refrigerants

Oil pump

Gauge manifold

Electronic thermometer

Oil-resistant gloves

Acid test kit

Tubing cutters

Quick Quiz*

Module Examinations**

Performance Profile Sheets**

* Located at the back of the 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 that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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.

Guide to the E.P.A. Refrigerant Handling Certification Exam, Prentice Hall, Upper Saddle River, NJ.

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 10 hours are suggested to cover *Refrigerants and Oils*. 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; Refrigerant Structure; Refrigerant Identification	
A. Introduction	_____
1. Desirable Refrigerant Characteristics	_____
2. Common Applications	_____
B. Refrigerant Structure	_____
1. Refrigerant Classifications	_____
2. Organic Refrigerants	_____
3. Refrigerants and the Environment	_____
C. Refrigerant Identification	_____
1. Safety Classifications	_____
2. Cylinder Safety	_____
Session II. Refrigerant Composition; Refrigerant Leaks	
A. Refrigerant Composition	_____
1. Azeotropes, Zeotropes, and Near-Azeotropes	_____
2. Pressure-Temperature Charts	_____
B. Laboratory	_____
Have the trainees practice interpreting a P-T chart to calculate superheat and subcooling for an azeotrope refrigerant. This laboratory corresponds to Performance Tasks 1 and 2.	
C. Refrigerant Leaks	_____
1. Finding and Isolating Leaks	_____
D. Laboratory	_____
Have the trainees practice performing leak testing procedures. This laboratory corresponds to Performance Task 3.	

Session III. Lubricating Oils; Oil and the Refrigeration System; Oil Handling Guidelines; System Conversion

- A. Lubricating Oils
 - 1. Lubricating Oil Properties
 - 2. Oil Types
- B. Oil and the Refrigeration System
 - 1. System Piping
 - 2. Contamination
- C. Oil Handling Guidelines
 - 1. Personal Protective Equipment
 - 2. Working with Oils
 - 3. Waste Oil Disposal
- D. System Conversion
- E. Laboratory

Have the trainees practice performing a refrigerant retrofit. This laboratory corresponds to Performance Task 4.

Session IV. Review and Testing

- A. Review
- B. Module Examination
 - 1. Trainees must score 70 percent 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.
 - 2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module explains the operating principles of the different types of compressors used in comfort air conditioning systems and the basic installation service and repair procedures for these compressors.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three, Module 03301-08.*

OBJECTIVES

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

1. Identify the different types of compressors.
2. Demonstrate or describe the mechanical operation for each type of compressor.
3. Demonstrate or explain compressor lubrication methods.
4. Demonstrate or explain methods used to control compressor capacity.
5. Demonstrate or describe how compressor protection devices operate.
6. Perform the common procedures used when field servicing open and semi-hermetic compressors, including:
 - Shaft seal removal and installation
 - Valve plate removal and installation
 - Unloader adjustment
7. Demonstrate the procedures used to identify system problems that cause compressor failures.
8. Demonstrate the system checkout procedure performed following a compressor failure.
9. Demonstrate or describe the procedures used to remove and install a compressor.
10. Demonstrate or describe the procedures used to clean up a system after a compressor burnout.

PERFORMANCE TASKS

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

1. Identify different types of compressor capacity controls.
2. Identify protection devices commonly used with compressors.
3. Under supervision, make electrical troubleshooting checks on single-phase and three-phase compressor motors.
4. Under supervision, use a sealed tube acid/moisture test kit to test a system for the presence of acid and/or moisture.
5. Under supervision, remove and install a hermetic compressor.
6. Remove and install a valve plate assembly and head on a semi-hermetic compressor.
7. Adjust the cylinder unloader on a semi-hermetic compressor.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Electronic head pressure control device
Transparencies	Solid-state reduced-voltage starter
Blank acetate sheets	Various compressor protection devices
Transparency pens	Crankcase heater
Whiteboard/chalkboard	Acid/moisture test kit
Markers/chalk	Quick Quiz*
Pencils and scratch paper	Module Examinations**
Appropriate personal protective equipment	Performance Profile Sheets**
Oil pressure safety switch	

* 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. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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.

Capacity Control – General Training Compressors, 1990. Syracuse, NY: Carrier Corporation.

Clean-Up After Burnout – General Training Compressors, 1985. Syracuse, NY: Carrier Corporation.

Compressors – General Training Air Conditioning, 1991. 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 *Compressors*. 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; the Role of the Compressor; Open, Hermetic, and Semi-Hermetic Compressors; Types of Compressors	
A. Introduction	_____
B. The Role of the Compressor	_____
C. Open, Hermetic, and Semi-Hermetic Compressors	_____
D. Types of Compressors	_____
1. Reciprocating Compressors	_____
2. Rotary Compressors	_____
3. Scroll, Screw, and Centrifugal Compressors	_____
Session II. Capacity Control of Compressors; Compressor Electric Motors	
A. Capacity Control of Compressors	_____
1. On/Off Cycling; Multiple Compressors	_____
2. Cylinder Unloading; Hot Gas Bypass	_____
3. Intake Slide Valve; Inlet Guide Vane	_____
4. Compressor Speed Control; Scroll Capacity Modulation	_____
B. Compressor Electric Motors	_____
1. Compressed Motor Cooling	_____
2. Compressor and Drive Motor Shaft Alignment	_____
3. Input Power	_____
4. Compressor Motor Overload Protection	_____

Session VI. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70 percent 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.
2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module covers operation and servicing of the various types of fixed-orifice and expansion valve metering devices used in refrigerant systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three*, Modules 03301-08 and 03302-08.

OBJECTIVES

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

1. Explain the function of metering devices.
2. Describe the operation of selected fixed-orifice and expansion valves.
3. Identify types of expansion valves.
4. Describe problems associated with replacement of expansion valves.
5. Describe the procedure for installing and adjusting selected expansion valves.

PERFORMANCE TASKS

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

1. Identify various types of metering devices.
2. Replace the orifice piston in a piston-type metering device.
3. Use catalog data to select a replacement metering device.
4. Install an externally equalized expansion valve, correctly placing the sensing bulb and equalizer tube.
5. Calculate superheat and adjust an expansion valve to obtain the correct superheat.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Selection of metering devices:
Transparencies	Capillary tubes
Blank acetate sheets	Fixed-orifice devices
Transparency pens	Thermal expansion valve (TEV or TXV)
Whiteboard/chalkboard	Thermal-electric expansion valve (TEEV or THEV)
Markers/chalk	Electronic expansion valve (EEV)
Pencils and scratch paper	Pulsing solenoid EEV
Appropriate personal protective equipment	Automatic expansion valve
Brazing filler metals	High-side float valve
Brazing fluxes	Low-side float valve
Manufacturer's selection tables for metering devices	Manual expansion valve
Spark lighter	Operating cooling system
Oxyacetylene torch and tips	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. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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, 2001. Joseph Moravek. Upper Saddle River, NJ: Prentice Hall, Inc.

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 *Metering Devices*. 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; Basic Operation; Fixed Metering Devices	
A. Introduction	_____
B. Basic Operation	_____
C. Fixed Metering Devices	_____
D. Laboratory	_____
Have the trainees replace the orifice piston in a piston-type metering device. This laboratory corresponds to Performance Task 2.	
Session II. Expansion Valves; Distributors; TXV Devices	
A. Expansion Valves	_____
B. Distributors	_____
C. TXV Replacement	_____
D. Laboratory	_____
Have the trainees practice using catalog data to select a replacement metering device. This laboratory corresponds to Performance Task 3.	
E. Laboratory	_____
Have the trainees calculate superheat and adjust an expansion valve to obtain the correct superheat. This laboratory corresponds to Performance Task 5.	
F. Laboratory	_____
Have the trainees practice installing an externally equalized expansion valve, correctly placing the sensing bulb and equalizer tube. This laboratory corresponds to Performance Task 4.	

Session III. Metering Device Problems; Review and Testing

A. Metering Device Problems

E. Review

F. Module Examination

1. Trainees must score 70 percent 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 covers the mechanical refrigeration systems normally found in retail establishments. This equipment includes reach-in and walk-in coolers and freezers, ice machines, and other appliances used in stores, restaurants, and hotels. This module includes a discussion of the refrigeration process and defrost techniques, as well as troubleshooting and maintenance procedures.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three*, Modules 03301-08 through 03303-08.

OBJECTIVES

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

1. Describe the mechanical refrigeration cycle as it applies to retail refrigeration systems.
2. Explain the differences in refrigerants and applications in low-, medium-, and high-temperature refrigeration systems.
3. Identify and describe the primary refrigeration cycle components used in retail refrigeration systems.
4. Identify and describe the supporting components and accessories used in retail refrigeration systems.
5. Describe the various methods of defrost used in retail refrigeration systems.
6. Identify and describe the applications for the various types of retail refrigeration systems.
7. Describe the control system components used in retail refrigeration systems.
8. Explain the operating sequence of a retail refrigeration system.
9. Interpret wiring diagrams and troubleshooting charts to isolate malfunctions in retail refrigeration systems.

PERFORMANCE TASKS

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

1. Clean an ice machine.
2. Isolate faults in refrigeration and ice machines.
3. Set up an electric defrost schedule for a refrigeration appliance.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Electromechanical timer
Transparencies	Defrost thermostat
Blank acetate sheets	Samples of refrigeration thermostats
Transparency pens	Samples of various pressure switches
Whiteboard/chalkboard	Time delay relay
Markers/chalk	Solenoid valve
Pencils and scratch paper	Suction accumulator
Appropriate personal protective equipment	Clock or watch
Crankcase pressure regulating valve	Ice machine cleaners/sanitizer solutions
Evaporator pressure regulating valve	Module Examinations*
Head pressure control valve	Performance Profile Sheets*
24-hour timer	

* 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 that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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, Latest Edition. Larry Jeffus. 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 20 hours are suggested to cover *Retail Refrigeration 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; Mechanical Refrigeration Systems	
A. Introduction	_____
B. Mechanical Refrigeration Systems	_____
1. The Refrigeration Cycle	_____
2. Devices and Components	_____
Session II. Defrost Systems	
A. Defrost Systems	_____
1. Off-Cycle Defrost	_____
2. Timed Defrost	_____
3. Electric Defrost	_____
Session III. Defrost Systems (continued)	
A. Defrost Systems	_____
1. Hot-Gas Defrost	_____
B. Laboratory	_____
Have the trainees practice setting up an electric defrost schedule for a refrigeration appliance. This laboratory corresponds to Performance Task 3.	
Session IV. Retail Refrigeration Equipment and Fixtures	
A. Retail Refrigeration Equipment and Fixtures	_____
1. Ice Merchandisers	_____
2. Reach-In Coolers and Freezers	_____
3. Merchandising Walk-In Systems	_____
4. Commercial Ice Makers	_____

Session V. Common Refrigeration System Controls

A. Common Refrigeration System Controls

- 1. Thermostats
- 2. Pressure Controls
- 3. Time Delay Relays
- 4. Solenoid Valves

Sessions VI and VII. Troubleshooting

A. Troubleshooting

- 1. Troubleshooting and Maintenance of a Reach-In Freezer
- 2. Troubleshooting and Maintenance of Cubed-Ice Machines

B. Laboratory

Have the trainees practice cleaning an ice machine. This laboratory corresponds to Performance Task 1.

C. Laboratory

Have the trainees practice isolating faults in refrigeration and ice machines machines. This laboratory corresponds to Performance Task 2.

Session VIII. Review and Testing

A. Review

B. Module Examination

- 1. Trainees must score 70 percent 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 types of hydronic heating and cooling systems used in commercial applications. It expands on the residential hydronic heating systems covered in *HVAC Level Two*. The module covers commercial boilers, as well as chillers, cooling towers, and piping systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three*, Modules 03301-08 through 03304-08.

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 and chilled-water cooling systems.
2. Identify the major components of hot-water heating, chilled-water cooling, and dual-temperature water systems.
3. Explain the purpose of each component of hot-water heating, chilled-water cooling, and dual-temperature water systems.
4. Describe the safety precautions used when working with hot-water/chilled-water systems.
5. Explain the differences between reciprocating, rotary screw, scroll, and centrifugal chillers.
6. Identify the common piping configurations used with hot-water heating and chilled-water cooling systems.
7. Explain the principles involved, and describe the procedures used, in balancing hydronic systems.
8. Select, calibrate, and properly use the tools and instruments needed to balance hydronic systems.
9. Read the pressure across a water system circulating pump.

PERFORMANCE TASKS

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

1. Identify the major components of hot-water heating, chilled-water cooling, and dual-temperature water systems.
2. Turn on, operate, and turn off a selected water system.
3. Identify the types of common piping configurations used with hot-water, chilled-water, and cooling tower systems.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Selection of valves
Transparencies	Multimeter
Blank acetate sheets	Clamp-on ammeter
Transparency pens	Pressure gauge
Whiteboard/chalkboard	Float-operated, low-water cutoff control
Markers/chalk	Quick Quiz*
Pencils and scratch paper	Module Examinations**
Appropriate personal protective equipment	Performance Profile Sheets**
Access to commercial hydronic systems	

* 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. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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-Cooled Chillers, TDP-622, Latest Edition. Syracuse, NY: Carrier Corporation.

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

Water-Cooled Chillers, TDP-623, Latest Edition. 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 12½ hours are suggested to cover *Commercial 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.

Note: If it is necessary to perform lab work at an off-site location, it may be desirable to consolidate all lab work into one or two sessions.

Topic	Planned Time
Session I. Introduction; Water Concept Review; Commercial Hot-Water Heating System Components	
A. Introduction	_____
B. Water Concept Review	_____
C. Commercial Hot-Water Heating System Components	_____
D. Laboratory	_____
Have the trainees practice identifying the major components of hot-water heating systems. This laboratory corresponds to Performance Task 1.	
Session II. Chilled-Water Cooling Systems; Chilled-Water System Components	
A. Chilled-Water Cooling Systems	_____
B. Chilled-Water System Components	_____
C. Laboratory	_____
Have the trainees practice identifying the major components of chilled-water cooling systems. This laboratory corresponds to Performance Task 1.	

Sessions III and IV. Dual-Temperature Water Systems; Commercial Water Piping Systems

A. Dual-Temperature Water Systems _____

B. Laboratory _____

Have trainees practice identifying the major components of dual-temperature water systems. This laboratory corresponds to Performance Task 1.

C. Commercial Water Piping Systems _____

D. Laboratory _____

Have the trainees practice identifying the types of common piping configurations used with hot-water, chilled-water, and cooling tower systems. This laboratory corresponds to Performance Task 3.

E. Laboratory _____

Have the trainees practice turning on, operating, and turning off a selected water system. This laboratory corresponds to Performance Task 2.

Session V. Water System Balancing; Review and Testing

A. Water System Balancing _____

B. Review _____

C. Module Examination _____

1. Trainees must score 70 percent 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.

MODULE OVERVIEW

This module covers heating systems that are based on steam boilers. Although these systems are hydronic, their operating principles, controls, and especially their safety devices, are different from those of hot-water systems. This module covers commercial steam boilers, components, and piping systems, as well as the maintenance activities associated with steam heating systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three, Modules 03301-08 through 03305-08.*

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 steam-heating systems.
2. Identify the major components of steam-heating systems.
3. Explain the purpose of each component of steam-heating systems.
4. Describe the basic steam-heating cycle.
5. Safely perform selected operating procedures on low-pressure steam boilers and systems.
6. Install and maintain selected steam traps.
7. Identify the common piping configurations used with steam-heating systems.
8. Identify the types of common piping configurations used with steam-heating systems.

PERFORMANCE TASKS

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

1. Perform selected operating procedures on low-pressure steam boilers and systems.
2. Install and maintain selected steam traps.
3. Identify the types of common piping configurations used with steam-heating systems.

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

Access to commercial steam heating systems

Selection of damaged steam traps

Portable ultrasonic tester

Examples of the following:

Pigtail and gauge siphons

Low- and high-water cutoff controls

Float switch

Pressuretrol

Snap-action and electric pressure switches

Pyrometer

Thermowells

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. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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.

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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 10 hours are suggested to cover *Steam 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.

Note: If it is necessary to perform lab work at an off-site location, it may be desirable to consolidate all lab work into one or two sessions.

Topic	Planned Time
Session I. Introduction; Fundamentals and Properties of Water; Steam Cycle Principles of Operation; Steam Boilers, Boiler Controls, and Accessories	
A. Introduction	_____
B. Fundamentals and Properties of Water	_____
C. Steam Cycle Principles of Operation	_____
D. Steam Boilers, Boiler Controls, and Accessories	_____
Session II. Valves; Heat Exchangers/Converters; Terminals; Steam Traps and Strainers	
A. Valves	_____
B. Heat Exchangers/Converters	_____
C. Terminals	_____
D. Steam Traps and Strainers	_____
E. Laboratory	_____
Have the trainees practice installing and maintaining selected steam traps. This laboratory corresponds to Performance Task 2.	
Session III. Troubleshooting Steam Traps; Condensate Return/Feedwater System Components; Flash Tanks; Steam System Piping; Steam and Condensate Pipe Sizing; Boiler Blowdown and Skimming; Boiler Water Treatment	
A. Troubleshooting Steam Traps	_____
B. Condensate Return/Feedwater System Components	_____
C. Flash Tanks	_____
D. Steam System Piping	_____
E. Laboratory	_____
Have the trainees practice identifying types of common piping configurations used with steam-heating systems. This laboratory corresponds to Performance Task 3.	

F. Steam and Condensate Pipe Sizing

G. Boiler Blowdown and Skimming

H. Boiler Water Treatment

I. Laboratory

Have the trainees practice performing selected operating procedures on low-pressure steam boilers and systems. This laboratory corresponds to Performance Task 1.

Session IV. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70 percent 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.
2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module describes the purpose of planned maintenance and outlines the procedures for servicing gas and oil furnaces, electric heating equipment, cooling equipment, and heat pumps.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three, Modules 03301-08 through 03306-08.*

OBJECTIVES

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

1. Describe planned maintenance and service procedures required for selected HVAC equipment and components.
2. Develop a planned maintenance and service checklist for selected HVAC equipment and accessories.
3. Perform identified service and maintenance tasks on selected HVAC equipment, components, and accessories.
4. Identify the tools and materials necessary for performing service and maintenance tasks.
5. State the safety practices associated with the servicing of selected HVAC equipment, components, and accessories.

PERFORMANCE TASKS

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

1. Develop a checklist for preventive maintenance of selected HVAC equipment.
 - Gas-fired heating equipment
 - Oil-fired furnaces
 - Cooling systems and heat pumps
 - HVAC accessories
2. Perform preventive maintenance inspection, cleaning, adjustment, and other applicable servicing procedures on the following equipment as prescribed by the instructor:
 - Gas-fired heating equipment
 - Oil-fired furnaces
 - Cooling systems and heat pumps
 - HVAC accessories

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Stack thermometers or electronic temperature probes
Transparencies	RTV-type sealant
Blank acetate sheets	Coil cleaner
Transparency pens	AC ammeter
Whiteboard/chalkboard	Bucket
Markers/chalk	Flashlight
Pencils and scratch paper	Hand mirror
Appropriate personal protective equipment	Utility knife
Refrigerant temperature-pressure cards*	Stiff brush
Various types of operative and inoperative HVAC equipment and accessories	Litmus paper or paste to check for water in the fuel tank
Ammeter (standard and microamp ranges)	Carbon dioxide tester
Carpenter's level	Draft gauge
Lubricating oil	Insulated jumper wire
Manometer	Smoke tester
Soap and water solution	Gauge manifold
Vacuum cleaner	Inclined manometer
Combustion efficiency tester (Bacharach or equivalent)	Plumber's putty
Drill with spring cable and wire brush attachment	Magnet
Feeler gauges	Sling psychrometer
Multimeter	Calculator
Propane torch	Module Examinations**
Spray bottle	Performance Profile Sheets**

* If the trainees do not already have temperature-pressure charts, you should be able to obtain such charts in card form from a local HVAC-R distributor.

**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 that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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. 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 20 hours are suggested to cover *Planned Maintenance*. 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 – III. Introduction; Animal Hazards; Fossil-Fuel Heating Appliances	
A. Introduction	_____
B. Animal Hazards	_____
C. Fossil-Fuel Heating Appliances	_____
1. Gas Heating Systems	_____
2. Oil Heating Systems	_____
D. Laboratory	_____
Have the trainees develop a checklist for preventive maintenance for gas-fired heating equipment and oil-fired furnaces. This laboratory corresponds to Performance Task 1.	
E. Laboratory	_____
Have the trainees practice performing preventive maintenance inspection, cleaning, adjustment, and other applicable servicing procedures for gas-fired heating equipment and oil-fired furnaces. This laboratory corresponds to Performance Task 2.	
Sessions IV and V. Cooling Units and Heat Pumps	
A. Service Procedures for Cooling Equipment	_____
B. Service Procedures for Heat Pumps	_____
C. Laboratory	_____
Have the trainees practice developing a checklist for preventive maintenance for cooling systems and heat pumps. This laboratory corresponds to Performance Task 1.	
D. Laboratory	_____
Have the trainees practice performing preventive maintenance inspection, cleaning, adjustment, and other applicable servicing procedures for cooling systems and heat pumps. This laboratory corresponds to Performance Task 2.	
Sessions VI and VII. Servicing Accessories	
A. Humidifiers	_____
B. Electronic Air Cleaners	_____
C. Standard Media Filters and Permanent (Washable) Filters	_____
D. Condensate Pumps	_____
E. Ultraviolet Lamps	_____
F. Outside Air Dampers	_____
G. Laboratory	_____
Have the trainees develop a checklist for preventive maintenance for HVAC accessories. This laboratory corresponds to Performance Task 1.	
H. Laboratory	_____
Have the trainees practice performing preventive maintenance inspection, cleaning, adjustment, and other applicable servicing procedures for HVAC accessories. This laboratory corresponds to Performance Task 2.	

Session VIII. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70 percent 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.
2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module covers common water problems encountered in heating and cooling systems and identifies various water treatment methods and equipment.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three, Modules 03301-08 through 03307-08.*

OBJECTIVES

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

1. Explain the reasons why water treatment programs are needed.
2. List symptoms in heating/cooling systems that indicate a water problem exists.
3. Describe the types of problems and related remedies associated with water problems that can occur in the different types of water and steam systems.
4. Recognize and perform general maintenance on selected mechanical types of HVAC equipment that are used to control and/or enhance water quality.
5. Use commercial water test kits to test water quality in selected water/steam systems.
6. Perform an inspection/evaluation of a cooling tower or evaporative condenser to identify potential causes and/or existing conditions that indicate water problems.
7. Clean open recirculating water systems and related cooling towers.
8. Inspect, blowdown, and clean steam boilers.

PERFORMANCE TASKS

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

1. Disassemble, clean, and reassemble a strainer.
2. Remove and replace a cartridge filter.
3. Test water using a water analysis test kit.
4. Prepare and operate a simple chemical feeder/dispenser used in water treatment systems.
5. Inspect a cooling tower and its related water piping system for signs of water treatment problems.
6. Inspect steam boilers and related piping for signs of water treatment problems.

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
Manufacturer's operation and service literature for demonstration equipment
Water analysis test kits
Litmus paper (red and blue)
pH test kit (paper color matching type)
pH test kit (dye color matching type)
Electronic pH meter
One-gallon container
Photos that show contaminants and/or damage caused by contaminants in water systems

Miscellaneous mechanical filtration devices:
Strainers
Cartridge filters
Multimedia filters
Bag-type filters
Evaporator unit
Water softeners
Deaerators
Centrifugal separators
Chemical feeders
Blowdown controllers
As available, operating water/steam systems:
Open recirculating chilled-water system
Closed recirculating hot- and/or chilled-water system
Steam boiler(s) and related steam heat system
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. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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 Applications. Atlanta, GA: American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.

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

Boilers Simplified. Troy, MI: Business News Publishing Company.

Water Treatment Specification Manual. Troy, MI: Business News Publishing Company.

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 10 hours are suggested to cover *Water Treatment*. 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; Water Characteristics and Analysis; Problems Caused by Using Untreated Water; Water Treatment	
A. Introduction	_____
B. Water Characteristics and Analysis	_____
C. Problems Caused by Using Untreated Water	_____
D. Water Treatment in Open Recirculating Water Systems	_____
E. Water Treatment in Closed Recirculating Water Systems	_____
F. Laboratory	_____
Have the trainees practice inspecting a cooling tower and its related water piping system for signs of water treatment problems. This laboratory corresponds to Performance Task 5.	
G. Water Treatment in Steam Boilers and Systems	_____
H. Laboratory	_____
Have the trainees practice inspecting steam boilers and related piping for signs of water treatment problems. This laboratory corresponds to Performance Task 6.	
Session II. Mechanical Water Treatment Equipment	
A. Mechanical Water Treatment Equipment	_____
B. Strainers and Cartridge Filters	_____
C. Laboratory	_____
Have the trainees practice disassembling, cleaning, and reassembling a strainer and removing and replacing a cartridge filter. This laboratory corresponds to Performance Tasks 1 and 2.	
D. Mechanical Water Treatment Equipment (continued)	_____
E. Laboratory	_____
Have the trainees practice preparing and operating a simple chemical feeder/dispenser used in water treatment systems. This laboratory corresponds to Performance Task 4.	
Session III. General Water Treatment Procedures and Guidelines; Water Treatment Chemical Safety Precautions	
A. General Water Treatment Procedures and Guidelines	_____
B. Laboratory	_____
Have the trainees practice testing water using a water analysis test kit. This laboratory corresponds to Performance Task 3.	
C. Cooling Tower and Open Recirculating System Treatment	_____
D. Steam Boiler Water Treatment Guidelines	_____
E. Water Treatment Chemical Safety Precautions	_____

Session IV. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70 percent 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.
2. Record the training 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 electronic controls.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three*, Modules 03301-08 through 03308-08.

OBJECTIVES

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

1. Describe the similarities and differences between electronic controls and conventional controls.
2. Analyze circuit diagrams and other manufacturers' literature to determine the operating sequence of microprocessor-controlled systems.
3. Use test equipment to diagnose a microprocessor-controlled comfort system.

PERFORMANCE TASKS

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

1. Develop a checklist for troubleshooting a microprocessor-controlled heating or cooling appliance.
2. Analyze circuit diagrams and other manufacturers' literature to determine the operating sequence of microprocessor-controlled systems.
3. Use test equipment to diagnose a microprocessor-controlled comfort system.
4. Isolate and correct malfunctions in a microprocessor-controlled heating appliance.
5. Isolate and correct malfunctions in a microprocessor-controlled cooling unit or heat pump.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Multimeter
Transparencies	Temperature probe
Blank acetate sheets	Gauge manifold
Transparency pens	Pre-faulted components
Whiteboard/chalkboard	Insulated jumper wires
Markers/chalk	Power protection devices
Pencils and scratch paper	Thermistors
Appropriate personal protective equipment	Flame sensor
Samples of electronic controls	Volt-ohm meter (VOM)
Operating heating/cooling system	Quick Quiz*
AC ammeter	Module Examinations**
Grounding wrist strap	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. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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.

Electronic Devices, 2002. Thomas L. Floyd. Upper Saddle River, NJ: Prentice Hall, Inc.

Electronics Fundamentals, 2001. Thomas L. Floyd. Upper Saddle River, NJ: Prentice Hall, Inc.

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 *Troubleshooting Electronic Controls*. 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; Microprocessor Controls; Troubleshooting Microprocessor-Controlled Systems; External Causes of Failure; Electronic Controls in Heating Systems	
A. Introduction	_____
B. Microprocessor Controls	_____
C. Troubleshooting Microprocessor-Controlled Systems	_____
D. External Causes of Failure	_____
E. Electronic Controls in Heating Systems	_____
F. Laboratory Have the trainees practice analyzing circuit diagrams and other manufacturers' literature to determine the operating sequence of microprocessor-controlled systems. This laboratory corresponds to Performance Task 2.	_____
G. Laboratory Have the trainees develop a checklist for troubleshooting a microprocessor-controlled heating or cooling appliance. This laboratory corresponds to Performance Task 1.	_____
Session II. Cooling Systems and Heat Pumps; Test Instruments; Standardization	
A. Cooling Systems and Heat Pumps	_____
B. Test Instruments	_____
C. Standardization	_____
D. Laboratory Have the trainees practice using test equipment to diagnose a microprocessor-controlled comfort system. This laboratory corresponds to Performance Task 3.	_____
E. Laboratory Have the trainees practice isolating and correcting malfunctions in a microprocessor-controlled heating appliance and in a cooling unit or heat pump. This laboratory corresponds to Performance Tasks 4 and 5.	_____

Session III. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70 percent 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.
2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module covers the troubleshooting of burners and control circuits in oil-fired furnaces.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three, Modules 03301-08 through 03309-08.*

OBJECTIVES

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

1. Describe the basic operating sequence for oil-fired heating equipment.
2. Interpret control circuit diagrams for an oil heating system.
3. Develop a troubleshooting chart for an oil heating system.
4. Identify the tools and instruments used in troubleshooting oil heating systems.
5. Correctly use the tools and instruments required for troubleshooting oil heating systems.
6. Isolate and correct malfunctions in oil heating systems.
7. Describe the safety precautions that must be taken when servicing oil 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 an oil furnace.
2. Analyze control circuit diagram(s) for a selected oil furnace.
3. Use the correct tools and instruments to isolate and correct malfunctions in an oil furnace.

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

Carbon dioxide tester

Draft gauge

Insulated jumper wires

Multimeters (VOMs/DMMs)

Smoke tester

Stack thermometers (or electronic temperature probes)

Burner nozzles

Nozzle wrench

Operating oil heating system

Pre-faulted components

Module Examinations*

Performance Profile Sheets*

* 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 that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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.

Heating, Ventilating, and Air Conditioning Fundamentals, 1995. Raymond A. Havrella. Englewood Cliffs, NJ: Prentice Hall, Inc.

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 10 hours are suggested to cover *Troubleshooting Oil 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
Session I. Introduction; Typical Operation; Oil Burner Troubleshooting	
A. Introduction	_____
B. Typical Operation	_____
C. Oil Burner Troubleshooting	_____
D. Laboratory	_____
Have the trainees practice analyzing control circuit diagram(s) for a selected oil furnace. This laboratory corresponds to Performance Task 2.	
Session II. Troubleshooting Controls	
A. Troubleshooting Controls	_____
1. Primary Controls	_____
2. Cad Cell Flame Detector	_____
3. Ignition Components	_____
4. Auxiliary Components	_____
Session III. System Troubleshooting; Condensing Oil Furnaces	
A. System Troubleshooting	_____
B. Condensing Oil Furnaces	_____
C. Laboratory	_____
Have the trainees practice developing a checklist for troubleshooting an oil furnace. This laboratory corresponds to Performance Task 1.	
D. Laboratory	_____
Have the trainees practice using the correct tools and instruments to isolate and correct malfunctions in an oil furnace. This laboratory corresponds to Performance Task 3.	
Session IV. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent 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 the NCCER.	
2. Record the training 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 heat pumps.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three, Modules 03301-08 through 03310-08.*

OBJECTIVES

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

1. Describe the basic operating sequence for an air-to-air heat pump.
2. Interpret control circuit diagrams for heat pumps.
3. Develop a checklist for troubleshooting a heat pump.
4. Identify the tools and instruments used in troubleshooting heat pumps.
5. Correctly use the tools and instruments required for troubleshooting heat pumps.
6. Isolate and correct malfunctions in heat pumps.
7. Describe the safety precautions associated with servicing heat pumps.

PERFORMANCE TASKS

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

1. Develop a checklist for troubleshooting a heat pump.
2. Analyze control circuit diagram(s) for a selected heat pump.
3. Isolate and correct malfunctions in a heat pump using the correct tools and instruments:
 - Cooling function
 - Reverse cycle heating function
 - Defrost cycle
 - Auxiliary electric heat

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Multimeter
Transparencies	Temperature probe
Blank acetate sheets	Short-hose gauge manifold
Transparency pens	Standard gauge manifold
Whiteboard/chalkboard	Pre-faulted components
Markers/chalk	Insulated jumper wires
Pencils and scratch paper	Direct-acting and pilot-controlled solenoid valves
Appropriate personal protective equipment	Permanent magnet
Operating heat pump system	Module Examinations*
AC ammeter	Performance Profile Sheets*

* 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 that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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.

Troubleshooting Heat Pumps (Residential-Light Commercial), 1999. 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 10 hours are suggested to cover *Troubleshooting 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; Heat Pump Operation; Electrical Operating Sequence	
A. Introduction	_____
B. Heat Pump Operation	_____
C. Electrical Operating Sequence	_____
D. Laboratory	_____
Have the trainees practice analyzing control circuit diagram(s) for a selected heat pump. This laboratory corresponds to Performance Task 2.	
Session II. Troubleshooting	
A. Control Circuit Field Wiring	_____
B. Thermostats	_____
C. Control Transformer Phasing	_____
D. Speed Controller	_____
E. Magnetic Relays and Solenoid	_____
Session III. Troubleshooting (continued)	
F. Check Valves	_____
G. Reversing Valves	_____
H. Defrost Control	_____
I. Refrigerant Charge	_____
J. Laboratory	_____
Have the trainees develop a checklist for troubleshooting a heat pump. This laboratory corresponds to Performance Task 1.	
K. Laboratory	_____
Have the trainees practice isolating and correcting malfunctions in a heat pump using the correct tools and instruments: cooling function, reverse cycle heating function, defrost cycle, and auxiliary electronic heat. This laboratory corresponds to Performance Task 3.	

Session IV. Review and Testing

A. Review

B. Module Examination

1. Trainees must score 70 percent 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.
2. Record the training 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 HVAC accessory equipment.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; HVAC Level One; HVAC Level Two; and HVAC Level Three, Modules 03301-08 through 03311-08.*

OBJECTIVES

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

1. Describe a systematic approach for troubleshooting HVAC system accessories.
2. Isolate problems with electrical and/or mechanical functions of HVAC system accessories.
3. Use equipment manufacturer's troubleshooting aids to troubleshoot HVAC system accessories.
4. Identify and properly use the service instruments needed to troubleshoot HVAC system accessories.
5. Troubleshoot problems in selected HVAC system accessories.
6. State the safety precautions associated with the troubleshooting of HVAC accessories.

PERFORMANCE TASKS

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

1. Analyze a control circuit diagram(s) for:
 - Humidifier
 - Electronic air cleaner
 - Economizer
 - Zone controls
 - Heat recovery ventilator
2. Using the correct tools, isolate and correct malfunctions in a(n):
 - Humidifier
 - Electronic air cleaner
 - Economizer
 - Zone controls
 - Heat recovery ventilator

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Lockout/tagout locks and tags
Transparencies	Assortment of inoperative components as needed to simulate troubleshooting exercises
Blank acetate sheets	Operating HVAC systems and accessories:
Transparency pens	Humidifiers
Whiteboard/chalkboard	Electronic air cleaner (EAC)
Markers/chalk	Heat recovery ventilator (HRV)
Pencils and scratch paper	Energy recovery ventilator (ERV)
Appropriate personal protective equipment	Operating HVAC system supplying a multizoned forced air distribution system
Manufacturer's instructions for various HVAC system accessories	Economizer and zoned system components:
Multimeters (VOMs/DMMs)	Thermostats
Sling psychrometer	Enthalpy sensors
Insulated jumper wires	Control panels and modules
Mechanic's hand tool set	Electric- and barometric-operated dampers
Inspection mirrors	Module Examinations*
Thermometers	Performance Profile Sheets*

* 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 that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.

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. 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 10 hours are suggested to cover *Troubleshooting Accessories*. 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; Troubleshooting Approach; Humidifiers	
A. Introduction	_____
B. Troubleshooting Approach	_____
C. Humidifiers	_____

**Sessions II and III. Electronic Air Cleaners; Ultraviolet Lamps;
Economizers, Zone Control, and Heat Recovery Ventilators**

- A. Electronic Air Cleaners _____
- B. Ultraviolet Lamps _____
- C. Economizers, Zone Control, and Heat Recovery Ventilators _____
- D. Laboratory _____

Have the trainees practice analyzing a control circuit diagram(s) for a humidifier, an electronic air cleaner, an economizer, zone controls, and/or a heat recovery ventilator. This laboratory corresponds to Performance Task 1.

- E. Laboratory _____
Have the trainees practice, using the correct tools, isolating and correcting malfunctions in a humidifier, an electronic air cleaner, an economizer, zone controls, and/or a heat recovery ventilator. This laboratory corresponds to Performance Task 2.

Session IV. Review and Testing

- A. Review _____
- B. Module Examination _____
 - 1. Trainees must score 70 percent 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.
 - 2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.