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 $2\frac{1}{2}$ 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>
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<tbody>
<tr>
<td><strong>Session I. Introduction, Humidity Control, and Indoor Air Quality</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Process and Comfort Air Conditioning</td>
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<tr>
<td>C. Humidity Control</td>
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<tr>
<td>D. Laboratory</td>
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</tr>
<tr>
<td>Trainees practice inspecting, cleaning, and replacing humidifiers. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td>E. Mechanical Air Filters</td>
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<tr>
<td>F. Laboratory</td>
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<tr>
<td>Trainees practice inspecting disposable/permanent air filters. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td>G. Laboratory</td>
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<tr>
<td>Trainees practice cleaning permanent air filters. This laboratory corresponds to Performance Task 3.</td>
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<tr>
<td><strong>Session II. Indoor Air Quality II, Review, and Testing</strong></td>
<td></td>
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<tr>
<td>A. Laboratory</td>
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<tr>
<td>Trainees practice measuring the differential pressure drop across an air filter with a manometer. This laboratory corresponds to Performance Task 4.</td>
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<tr>
<td>B. Air Conditioning Energy Conservation Equipment</td>
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<tr>
<td>C. Ultraviolet Light Air Purification Systems</td>
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</tr>
<tr>
<td>D. Carbon Monoxide and Carbon Dioxide Monitors</td>
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<tr>
<td>E. Review</td>
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</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 covers indoor air quality and its effect on the health and comfort of building occupants. It provides guidelines for performing a building IAQ survey and identifies the equipment and methods used to test and control indoor air quality.

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; HVAC Level Three; and HVAC Level Four, Modules 03401-09 and 03402-09.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:
1. Explain the need for good indoor air quality.
2. List the symptoms of poor indoor air quality.
3. Perform an inspection/evaluation of a building’s structure and equipment for potential causes of poor indoor air quality.
4. Identify the causes and corrective actions used to remedy common indoor air problems.
5. Identify the HVAC equipment and accessories that are used to sense, control, and/or enhance indoor air quality.
6. Use selected test instruments to measure or monitor the quality of indoor air.
7. Clean HVAC air system ductwork and components.

PERFORMANCE TASKS
Under the supervision of the instructor, the trainee should be able to do the following:
1. Use selected radon monitors and/or test kits.
2. Perform a building indoor air quality (IAQ) inspection/evaluation.
3. Make air measurements using each of the following:
   • Carbon dioxide (CO₂) detector/sensor
   • Carbon monoxide (CO) detector/sensor
   • Volatile organic compound (VOC) detector/sensor
   • Combustion analyzer
4. Use a manufacturer’s humidifier capacity chart to find the humidifier capacity needed for various building types and sizes.
5. Use a manufacturer’s portable dehumidifier capacity chart to find the dehumidifier capacity needed for various building types and sizes.
6. Clean and inspect ductwork using one or more approved methods:
   • Contact vacuum
   • Air washing
   • Power brushing

MATERIALS AND EQUIPMENT LIST

<table>
<thead>
<tr>
<th>Material/Equipment</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Overhead projector and screen</td>
<td>Markers/chalk</td>
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<tr>
<td>Transparencies</td>
<td>Pencils and scratch paper</td>
</tr>
<tr>
<td>Blank acetate sheets</td>
<td>Appropriate personal protective equipment</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
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</tbody>
</table>

continued
Manufacturer’s operation and service literature for demonstration equipment
Radon monitors and/or test kits
Access to a building to be IAQ inspected/surveyed
Checklists for IAQ evaluation
Set of building plans and specifications for the specific building to be IAQ inspected/surveyed
Manufacturers’ humidifier and dehumidifier capacity charts
Access to a commercial or industrial facility with operating HVAC systems incorporating one or more of the following:
Air handler units
Unit ventilators
Mechanical filters
Conventional
Extended surface
Electrostatic permanent
Steel/aluminum mesh
Bag-type
Box
Close-pleated rigid
HEPA
Adsorption filters
Electronic and nonelectronic air cleaners
Ultraviolet light air purification equipment
Humidifiers
Wetted-element
Atomizing
Infrared
Steam
Portable dehumidifiers
Portable or stationary gas detectors and analyzers, including:
Carbon dioxide detectors
Carbon monoxide detectors
VOC sensors/detectors
Combustion analyzers
Other gas detectors
Access to a building with a radon control subslab depressurization system
Duct cleaning equipment:
Portable HEPA-filtered vacuuming equipment
Power brushing, air washing, and power whip equipment
Borescopes
Black and white and/or color video cameras and portable videocassette recorder
Copies of the 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. Trainees will be required to use radon monitors and/or test kits, perform building IAQ inspection/evaluation, use gas detectors and combustion analyzers to make air measurements, and clean and inspect ductwork. Trainees may be required to visit facilities and/or construction sites. Ensure that trainees are 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.


* 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 2 1⁄2 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 Indoor Air Quality. 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>
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<tbody>
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<td><strong>Session I. Introduction to Indoor Air Quality (IAQ)</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Long-Term and Short-Term Effects of Poor IAQ</td>
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<tr>
<td>C. Good Indoor Air Quality</td>
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<tr>
<td>D. Sources of Building Contaminants</td>
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<td>1. Building Construction</td>
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<td>2. Human Occupancy</td>
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<td>3. Building Materials and Furnishings</td>
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<td>4. HVAC and Other Building Equipment</td>
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<td>5. Cleaning Compounds and Pesticides</td>
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<td>6. Contaminant Sources Located Outside the Building</td>
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<tr>
<td>E. Laboratory</td>
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<tr>
<td>Have trainees use selected radon monitors and/or test kits. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td><strong>Session II. Elements of a Building IAQ Inspection Survey</strong></td>
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<tr>
<td>A. Elements of a Building IAQ Inspection Survey</td>
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<tr>
<td>1. Problem Description</td>
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<td>2. Site Visit and Building Walk-Through</td>
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<tr>
<td>3. Building HVAC Equipment and Ventilation System Inspection</td>
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<tr>
<td>4. Air Sampling and Testing for Specific Contaminants</td>
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<tr>
<td>5. Interpreting Test Results and Corrective Actions</td>
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<tr>
<td>B. Laboratory</td>
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<tr>
<td>Have trainees perform a building indoor air quality (IAQ) inspection/evaluation. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td><strong>Session III. Achieving Acceptable Indoor Air Quality; IAQ and Energy-Efficient Systems and Equipment</strong></td>
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<tr>
<td>A. Achieving Acceptable Indoor Air Quality</td>
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<tr>
<td>1. Initial Building Design</td>
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<td>2. Ventilation Control</td>
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<td>3. Thermal Comfort Control</td>
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<td>4. Controlling Chemical Contaminants</td>
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<td>5. Controlling Microbial Contaminants</td>
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<td>B. IAQ and Energy-Efficient Systems and Equipment</td>
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<tr>
<td>1. Automated Building Management Systems</td>
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<tr>
<td>2. Air Handling Units</td>
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<td>3. Unit Ventilators</td>
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<tr>
<td>4. Air Filtration Equipment</td>
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<td>5. Humidifiers and Dehumidifiers</td>
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<tr>
<td>6. Ozone Generators</td>
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<tr>
<td>7. Ultraviolet Light Air Purification Systems</td>
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</tbody>
</table>
C. Laboratory

Have trainees use manufacturers’ capacity charts to find the humidifier and dehumidifier capacities needed for various building types and sizes. This laboratory corresponds to Performance Tasks 4 and 5.

Session IV. Gas Detectors and Analyzers

A. Gas Detectors and Analyzers

1. Carbon Dioxide Detectors
2. Carbon Monoxide Detectors
3. Volatile Organic Compound Sensors
4. Other Gas Detectors/Analyzers

B. Laboratory

Have trainees make air measurements using selected detectors/sensors and combustion analyzers. This laboratory corresponds to Performance Task 3.

Session V. Duct Cleaning

A. Duct Cleaning

1. Duct Cleaning Equipment
2. Duct Cleaning Methods

B. Laboratory

Have trainees clean and inspect ductwork using one or more approved methods. This laboratory corresponds to Performance Task 6.

Session VI. IAQ and Forced-Air Duct Systems; HVAC Contractor Liability; Review and Testing

A. IAQ and Forced-Air Duct Systems

1. Supply and Return Duct Leaks
2. Sealing Air Duct Leaks

B. HVAC Contractor Liability

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.
Energy Conservation Equipment
Annotated Instructor's Guide

Module 03404-09

MODULE OVERVIEW
This module covers various heat recovery/reclaim devices and other energy conservation equipment. It includes information on their operation as well as 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; HVAC Level Three; and HVAC Level Four, Modules 03401-09 through 03403-09.

OBJECTIVES
Upon completion of this module, the trainee will be able to do the following:
1. Identify selected air-to-air heat exchangers and describe how they operate.
2. Identify selected condenser heat recovery systems and explain how they operate.
3. Identify a coil energy recovery loop and explain how it operates.
4. Identify a heat pipe heat exchanger and explain how it operates.
5. Identify a thermosiphon heat exchanger and explain how it operates.
6. Identify a twin tower enthalpy recovery loop system and explain how it operates.
7. Identify air-side and water-side economizers and explain how each type operates.
8. Identify selected steam system heat recovery systems and explain how they operate.
9. Identify an ice bank-type off-peak hours energy reduction system.
10. Operate selected energy conversion equipment.

PERFORMANCE TASK
Under the supervision of the instructor, the trainee should be able to do the following:
1. Adjust an economizer for the proper setting in a local area.

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
As available, operating HVAC systems incorporating one or more of the following:
- Heat recovery ventilators/fixed-plate ERV and/or HRV energy/heat recovery units
- Dual-condenser refrigeration system
- Chilled-water system with heat recovery condenser
- Swimming pool heat recovery system
- Coil energy recovery loops
Heat pipe heat exchangers
Coil-loop thermosiphon heat exchangers
Twin tower enthalpy recovery loops
Air-side economizers
Water-side economizers
Flash steam (flash tank) heat recovery system
Flue gas heat recovery system
Blowdown and heat recovery system
Manufacturer’s operation and service literature for demonstration equipment
Electric utility energy demand reduction system interface equipment, such as modems, radio receivers, etc.
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. Trainees will be required to operate selected energy conversion equipment. Ensure that trainees are 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 10 hours are suggested to cover Energy Conservation 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.

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<thead>
<tr>
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<tbody>
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<td><strong>Session I. Introduction; Heat Recovery/Reclaim Methods and Equipment</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Heat Recovery/Reclaim Methods and Equipment</td>
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<tr>
<td>1. Energy and Heat Recovery Ventilators</td>
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<tr>
<td>2. Fixed-Plate and Rotary Air-to-Air Heat Exchangers</td>
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<tr>
<td>3. Condenser Heat Recovery Systems</td>
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<td>4. Coil Energy Recovery Loops</td>
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<td>5. Heat Pipe Heat Exchangers</td>
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<td>6. Thermosiphon Heat Exchangers</td>
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<tr>
<td>7. Twin Tower Enthalpy Recovery Loops</td>
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<tr>
<td><strong>Session II. Economizers; Heat Recovery in Steam Systems</strong></td>
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<tr>
<td>A. Economizers</td>
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<tr>
<td>1. Air-side Economizers</td>
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<td>2. Water-side Economizers</td>
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<tr>
<td>B. Heat Recovery in Steam Systems</td>
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<tr>
<td>1. Flash Steam (Flash Tank) Heat Recovery</td>
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<td>2. Flue Gas Heat Recovery System</td>
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<tr>
<td>3. Blowdown and Heat Recovery System</td>
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<tr>
<td>C. Laboratory</td>
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<tr>
<td>Have trainees adjust an economizer for the proper setting in a local area. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td><strong>Session III. Electric Utility Energy Demand Reduction Systems; Food Processing Cooling Water Recovery System</strong></td>
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<tr>
<td>A. Electric Utility Energy Demand Reduction Systems</td>
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<tr>
<td>1. Off-Peak Utility Usage</td>
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<tr>
<td>B. Food Processing Cooling Water Recovery System</td>
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</tr>
</tbody>
</table>
Session IV. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from the 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

Alternative heating and cooling systems are being employed for the purpose of reducing energy consumption and its associated impact on the environment. This module introduces several of these alternative 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; HVAC Level Three; and HVAC Level Four, Modules 03401-09 through 03408-09.

OBJECTIVES

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

1. Describe alternative technologies for heating, including:
   - In-floor
   - Direct-fired makeup unit (DFMU)
   - Solar
   - Air turnover
   - Corn or wood pellet burners
   - Waste oil/multi-fuel
   - Fireplace inserts
2. Describe alternative technologies for cooling, including:
   - Ductless system (DX/hydronic)
   - Computer room
   - Chilled beams
   - Multi-zone

PERFORMANCE TASKS

This is a knowledge-based module; there are no performance tasks.

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
Samples of wood pellets and shelled corn
Section of Type HT vent
Examples of brushes used to clean wood-burning appliances
Copies of the Quick Quiz*
Module Examination**

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module may require 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.

http://warmair.net

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 Alternative Heating and Cooling Systems. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction; Alternative Heating Methods and Systems; Solid Fuel Appliances</strong>&lt;br&gt; A. Introduction</td>
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<tr>
<td>B. Alternative Heating Methods and Systems</td>
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<tr>
<td>C. Solid Fuel Appliances&lt;br&gt; 1. Wood-Burning Stoves</td>
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<tr>
<td>2. Wood-Burning Furnaces</td>
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<tr>
<td>3. Wood-Burning Boilers</td>
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<tr>
<td>4. Installation and Maintenance</td>
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<tr>
<td><strong>Session II. Waste Oil Heaters; Geothermal and Water-Source Heat Pumps; Solar Heating Systems; In-Floor Radiant Heating Systems; Direct-Fired Makeup Units</strong>&lt;br&gt; A. Waste Oil Heaters</td>
<td>____________</td>
</tr>
<tr>
<td>1. Waste Oil Heating Issues</td>
<td>____________</td>
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<tr>
<td>B. Geothermal and Water-Source Heat Pumps&lt;br&gt; 1. Ground-Source Heat Pumps</td>
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<tr>
<td>2. Water-Source Heat Pumps</td>
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<td>2. Active Solar Heating Systems</td>
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<tr>
<td>D. In-Floor Radiant Heating Systems&lt;br&gt; 1. Electric Radiant Heating Systems</td>
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<tr>
<td>2. Radiant Hydronic Heating Systems</td>
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<tr>
<td>E. Direct-Fired Makeup Units</td>
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</tbody>
</table>
Session III. Alternative Cooling Methods and Systems; Ductless Split Systems; Computer Rack Cooling Systems; Valance Cooling Systems; Chilled-Beam Cooling Systems

A. Alternative Cooling Methods and Systems

B. Ductless Split Systems
   1. Condensing Units
   2. Air Handlers
   3. Multiple Ductless Split Systems
   4. Installation and Service
   5. Chilled-Water Ductless Split Systems

C. Computer Room Cooling Systems
   1. Raised-Floor Cooling Systems
   2. Free-Standing Air Handlers
   3. Liquid Chillers
   4. Cooled Equipment Enclosures
   5. Spot Coolers

D. Valance Cooling Systems

E. Chilled-Beam Cooling Systems
   1. Passive Chilled-Beam Systems
   2. Active Chilled-Beam Systems

Session IV. Evaporative Coolers; Alternative Energy-Saving Systems and Devices; Air Turnover Systems; Review and Testing

A. Evaporative Coolers

B. Alternative Energy-Saving Systems and Devices
   1. Heat Pump Water Heaters
   2. Waste Heat Water Heaters
   3. Evaporative Pre-Coolers

C. Air Turnover Systems

D. Review

E. 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.