MODULE OVERVIEW

This module covers the principles of heating, ventilation, and air conditioning, career opportunities in HVAC, and apprenticeship programs.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum.*

OBJECTIVES

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

1. Explain the basic principles of heating, ventilation, and air conditioning.
2. Identify career opportunities available for people in the HVAC trade.
3. Explain the purpose and objectives of an apprenticeship training program.
4. Describe how certified apprentice training can start in high school.
5. Describe what the *Clean Air Act* means to the HVAC trade.
6. Describe types of regulatory codes encountered in the HVAC trade.
7. Identify the types of schedules/drawings used in the HVAC trade.

PERFORMANCE TASKS

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

1. Interpret the following within an HVAC drawing provided by the instructor:
   - Piping
   - Air-handling equipment
   - AC system(s)
   - HVAC component diagram
   - Schematics

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
HVAC drawings for a commercial building (optional)
Air conditioner
Commercial drawing set
Building codes
Copy of an employee manual
Job announcements for HVAC technicians from local newspapers (want ads)
NCCER Apprentice Training Recognition Forms
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. Emphasize basic site safety.

ADDITIONAL RESOURCES

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

Career Opportunities in Heating, Air Conditioning and Refrigeration, Latest Edition. Fairfax, VA: Air Conditioning and Refrigeration Institute (ARI).

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 *Introduction to HVAC.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	**Planned Time**
Session I. Introduction to HVAC	
A. Introduction	_____
B. Heating	_____
C. Ventilation	_____
D. Air Conditioning	_____
Session II. Blueprints, Careers, and Training	
A. Blueprints, Codes, and Specifications	_____
B. Laboratory—Trainees practice identifying various types of prints. This laboratory corresponds to Performance Task 1.	_____
C. Careers in HVAC	_____
D. Types of Training Programs	_____
Session III. Environmental Issues, Review, and Testing	
A. The HVAC Technician and the Environment	_____
B. Module Review	_____
C. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	
D. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module explains how to solve problems involving the measurement of lines, area, volume, weights, angles, pressure, vacuum, and temperature. It also introduces scientific notation, powers, roots, and basic algebra and geometry.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Module 03101-07.

OBJECTIVES

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

1. Identify similar units of measurement in both the inch-pound (English) and metric systems and state which units are larger.
2. Convert measured values in the inch-pound system to equivalent metric values and vice versa.
3. Express numbers as powers of ten.
4. Determine the powers and roots of numbers.
5. Solve basic algebraic equations.
6. Identify various geometric figures.
7. Use the Pythagorean theorem to make calculations involving right triangles.
8. Convert decimal feet to feet and inches and vice versa.
9. Calculate perimeter, area, and volume.
10. Convert temperature values between Celsius and Fahrenheit.

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
Containers to demonstrate units of measure:
- Bottle of oil or soda
- Length of pipe
- Bag of grout

Paper
Scissors
Rulers (English and metric)
Measuring tape
Temperature-pressure chart
Scientific calculator
Gauge manifold set
Vacuum pump
Vacuum gauge
Module Examinations*

*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.

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.

Fundamentals of Mechanical and Electrical Mathematics, Latest Edition. Upper Saddle River, NJ: Prentice Hall Publishing.

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 *Trade Mathematics.*

Topic **Planned Time**

Session I. Introduction and the Metric System

A. Introduction _____
B. Metric Units _____
C. Length, Area, and Volume _____
D. Mass Versus Weight _____
E. Pressure and Acceleration _____
F. Temperature Scales _____

Session II. Scientific Notation, Powers and Roots, and Algebra

A. Scientific Notation _____
B. Powers and Roots _____
C. Introduction to Algebra _____

Session III. Geometry and Right Triangles

A. Introduction to Geometry _____
B. Working with Right Triangles _____

Session IV Converting Units, Review, and Testing

A. Converting Decimal Feet to Feet and Inches and Visa Versa _____
B. Module Review _____
C. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module covers the selection, preparation, joining, and support of plastic and copper piping and fittings.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Modules 03101-07 and 03102-07.

OBJECTIVES

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

1. State the precautions that must be taken when installing refrigerant piping.
2. Select the right tubing for a job.
3. Cut and bend copper tubing.
4. Safely join tubing by using flare and compression fittings.
5. Determine the kinds of hangers and supports needed for refrigerant piping.
6. State the basic safety requirements for pressure-testing a system once it has been installed.
7. Identify types of plastic pipe and state their uses.
8. Cut and join lengths of plastic pipe.

PERFORMANCE TASKS

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

1. Correctly measure the diameter of copper tubing.
2. Cut and ream copper tubing using a tubing cutter.
3. Correctly bend copper tubing using bending tools.
4. Make a swage joint in a section of copper tubing.
5. Make and join flare connections.
6. Join two sections of tubing using a compression fitting.
7. Cut and join two sections of plastic pipe using appropriate fittings.
8. Identify correct types of copper pipe for given applications.
9. Identify copper pipe sizes and wall thicknesses.

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
12" rules
Selection of copper and plastic fittings:
- Elbows
- Tees
- Unions
- Nipples
- Transitions

Sections of copper tubing and pipe in various sizes
Sections of iron pipe for comparison purposes
Sections of plastic pipe
Plastic pipe cement and MSDS
Selection of pipe hangers and supports:
- Clevis hanger
- Ring hanger
- Anchor chair
- Riser clamps
- Beam clamps
- C-clamp
- Straps
- Hook

Flare fittings
Compression fittings
Emery cloth
Calipers
Tubing cutters

File
Hacksaw and sawing fixture
Flaring tools
Spring tube bender
Lever tube bender
Swaging tools
Brazing or soldering tools
Flare nut wrench

*Located in the Trainee Module.

Swaged joints
Compression joints
Sweat fittings
ProPress® system
Samples of insulating materials
Copies of the Quick Quiz*
Performance Profile Sheets**
Module Examinations**

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to use, cut, and join copper and plastic pipe. Ensure that trainees are properly briefed before operating any soldering or brazing equipment. Ensure that trainees are briefed on hand tool and chemical safety. Review shop safety procedures. Review the MSDS for any chemicals and emphasize first aid and safe disposal methods.

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.

Cast Copper Solder-Joint Pressure Fittings, ASME B16.18, Current Edition. New York, NY: American Society of Mechanical Engineers.

Specifications for Seamless Copper Water Tube, ASTM B88, Latest Edition. West Conshohocken, PA: American Society for Testing and Materials International.

Specifications for Seamless Copper Pipe, ASTM B42, Latest Edition. West Conshohocken, PA: American Society for Testing and Materials International.

Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings, ASME B16.22, Current Edition. New York, NY: American Society of Mechanical Engineers.

TEACHING TIME FOR THIS MODULE

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

Topic	**Planned Time**
Session I. Introduction to Copper Tubing	
A. Introduction	_____
B. Installation Precautions	_____
C. Materials	_____
D. Laboratory—Trainees practice measuring the diameters of copper tubing. This laboratory corresponds to Performance Task 1.	_____
E. Laboratory—Trainees practice identifying copper pipe sizes and wall thicknesses. This laboratory corresponds to Performance Task 9.	_____
F. Types of Copper Tubing	_____
G. Laboratory—Trainees practice identifying the correct types of copper pipe for a given application. This laboratory corresponds to Performance Task 8.	_____
H. Cutting Tubing	_____

I. Laboratory—Trainees practice cutting and reaming copper pipe. This laboratory corresponds to Performance Task 2. _____

J. Bending Tubing _____

K. Laboratory—Trainees practice bending copper pipe. This laboratory corresponds to Performance Task 3. _____

L. Joining Copper Tubing _____

M. Laboratory—Trainees practice joining copper tubing using swage connections, flared fittings, and compression fittings. This laboratory corresponds to Performance Tasks 4, 5, and 6. _____

Session II. Introduction to Plastic Pipe, Review, and Testing

A. Plastic Pipe _____

B. Laboratory—Trainees practice cutting and joining plastic pipe using appropriate fittings. This laboratory corresponds to Performance Task 7. _____

C. Hangers and Supports _____

D. Insulating _____

E. Pressure Testing _____

F. Piping Codes and Safety _____

G. Review _____

H. 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.

I. 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.

Soldering and Brazing
Annotated Instructor s Guide

Module 03104-07

MODULE OVERVIEW

This module covers the tools, materials, and safety precautions and depicts step-by-step procedures for soldering and brazing piping.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Modules 03101-07 through 03103-07.

OBJECTIVES

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

1. Assemble and operate the tools used for soldering.
2. Prepare tubing and fittings for soldering.
3. Identify the purposes and uses of solder and solder fluxes.
4. Solder copper tubing and fittings.
5. Assemble and operate the tools used for brazing.
6. Preparing tubing and fittings for brazing.
7. Identify the purposes and uses of filler metals and fluxes used for brazing.
8. Braze copper tubing and fittings.
9. Identify the inert gases that can be used safely to purge tubing when brazing.

PERFORMANCE TASKS

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

1. For both soldering and brazing:
   - Cut tubing to correct length.
   - Clean tubing and fittings.
   - Select and apply flux to tubing and fittings.
   - Assemble tubing and fittings.
2. For soldering:
   - Assemble a propane torch.
   - Light and adjust a propane torch flame.
   - Select correct solder for the intended soldering job.
   - Heat joint to the right temperature and apply solder to fill a joint.
   - Clean and cool a soldered joint.

     —Solder a joint using butane.

     —Solder a joint using acetylene.
3. For brazing:
   - Assemble an oxyacetylene torch, including selection of the proper size tip for the job.
   - Light and adjust an oxyacetylene torch flame.
   - Select correct filler metal rod for the intended brazing application.
   - Clean and cool the brazed joint.
4. Assemble and operate a pressure regulator system used with an inert gas to purge tubing for brazing.
5. Assemble a brass-to-copper joint.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard / chalkboard
Markers / chalk
Pencils and scratch paper
Solder
MSDS for solder
Soldering fluxes and associated MSDSs
Filler metals
Appropriate personal protective equipment:
- Safety goggles
- Face shields
- Welding helmets
- Ear protection
- Welding cap
- Leather jacket
- Leather pants or chaps
- Gauntlet-type welding gloves
- Respirators

MSDS for cutting products
Oxygen cylinder with cap
Fuel gas cylinder with cap
Regulators (oxygen and fuel gas)
Hose set
One-piece cutting torch
Combination cutting torch and torch tips
Assorted acetylene, liquefied fuel gas, and special-purpose cutting torch tips
Tip cleaners
Tip drills
Mechanical guide
Cylinder cart
Motorized oxyfuel track cutter
Framing squares
Combination squares with protractor head
Tape measure
Soapstone
Penknife
Pliers
Chipping hammer
Friction lighter
Vendor cutting tip chart
Wrenches (Torch, hose, and regulator)
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 requires that the trainees operate soldering and brazing equipment. Ensure that trainees are briefed on fire and shop safety policies prior to performing any work. Emphasize the special safety precautions associated with the use of cylinders and soldering and brazing equipment.

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.

Brazing (VHS Video / Slides / Book) Latest Edition. Syracuse, New York: Carrier Corporation, Literature Services.
Standards and Codes, Latest Edition. New York, NY: American Society of Mechanical Engineers (ASME).
Standards and Codes, Latest Edition. Miami, FL: American Welding Society (AWS).

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 *Soldering and Brazing*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic **Planned Time**

Session I. Introduction to Soldering

A. Introduction _____
B. Soldering _____
C. Solders and Soldering Fluxes _____
D. Preparing Tubing and Fittings for Solder _____
E. Soldering Joints _____
F. Laboratory—Trainees practice preparing tubing, setting up equipment, and soldering a joint using butane and acetylene. This laboratory corresponds to Performance Tasks 1 and 2. _____

Session II. Brazing Copper Fittings and Tubing

A. Filler Metal and Fluxes _____
B. Preparing Tubing and Fittings for Brazing _____
C. Setup of Brazing Heating Equipment _____
D. Purging _____
E. Laboratory—Trainees practice purging tubing for brazing. This laboratory corresponds to Performance Task 4. _____
F. Brazing Joints _____
G. Laboratory—Trainees practice preparing tubing, setting up equipment, and brazing a joint. This laboratory corresponds to Performance Tasks 1 and 3. _____

Session III. Brass-to-Copper Joints, Review, and Testing

A. Laboratory—Trainees practice assembling a brass-to-copper joint. This laboratory corresponds to Performance Task 5. _____
B. Review _____
C. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
D. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module covers various types of iron and steel pipe and fittings, and provides step-by-step instructions for cutting, threading, and joining ferrous piping.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Modules 03101-07 through 03104-07.

OBJECTIVES

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

1. Identify the types of ferrous metal pipes.
2. Measure the sizes of ferrous metal pipes.
3. Identify the common malleable iron fittings.
4. Cut, ream, and thread ferrous metal pipe.
5. Join lengths of threaded pipe together and install fittings.
6. Describe the main points to consider when installing pipe runs.
7. Describe the methods used to join grooved piping.

PERFORMANCE TASKS

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

1. Identify types of carbon steel pipe.
2. Identify pipe sizes and weights.
3. Identify various pipe fittings.
4. Use five methods for measuring pipe.
5. Cut, ream, thread, and assemble steel pipe.

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
Sections of black iron and galvanized steel pipe of different sizes and weights
Short sections of pipe for cutting and threading
Threaded sections of pipe
Assorted fittings:
- Tees
- Elbows
- Unions
- Couplings
- Nipples
- Crosses
- Plugs
- Caps
- Bushings

Examples of grooved pipe, typical fittings, and gaskets
Examples of flanged pipe and fittings
Drift pins
Pipe drawings and specifications
Cutting oil
Measuring tape
Framing squares
Fitting manufacturer's makeup chart
Pipe stand
Yoke and chain vises
Pipe cutters

Reamers
Pipe wrenches
Chain wrenches
Strap wrenches
Stock and dies
Thread gauge
Powered pipe threader

Rags
Teflon® tape
Pipe dope
Pipe hangers and supports
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 requires trainees to work with hand tools. Ensure that they are briefed on shop safety procedures.

ADDITIONAL RESOURCES

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

*Pipefitter's Handbook,*Latest Edition. New York, NY: Industrial Trade Press.

TEACHING TIME FOR THIS MODULE

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

Topic	**Planned Time**
Session I. Introduction to Ferrous Metal Pipe	
A. Introduction	_____
B. Steel Pipe	_____
C. Laboratory—Trainees practice identifying types of carbon steel pipe and pipe sizes and weights. This laboratory corresponds to Performance Tasks 1 and 2.	_____
D. Threads	_____
E. Pipe Fittings	_____
F. Laboratory—Trainees practice identifying various pipe fittings. This laboratory corresponds to Performance Task 3.	_____
G. Tools and Materials	_____

Session II. Joining Methods, Review, and Testing

A. Measuring Steel Pipe _____

B. Laboratory—Trainees practice using five methods to measure steel pipe. This laboratory corresponds to Performance Task 4. _____

C. Assembling Threaded Pipe _____

D. Laboratory—Trainees practice cutting, reaming, and assembling steel pipe. This laboratory corresponds to Performance Task 5. _____

E. Grooved Pipe _____

F. Flanged Pipe _____

G. Module Review _____

H. 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.

I. 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 basic power generation and distribution, electrical components, DC circuits, and electrical safety.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Modules 03101-07 through 03105-07.

OBJECTIVES

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

1. State how electrical power is distributed.
2. Describe how voltage, current, resistance, and power are related.
3. Use Ohm's law to calculate the current, voltage, and resistance in a circuit
4. Use the power formula to calculate how much power is consumed by a circuit.
5. Describe the difference between series and parallel circuits and calculate loads in each.
6. Describe the purpose and operation of the various electrical components used in HVAC equipment.
7. State and demonstrate the safety precautions that must be followed when working on electrical equipment.
8. Make voltage, current, and resistance measurements using electrical test equipment.
9. Read and interpret common electrical symbols.

PERFORMANCE TASKS

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

1. Use a multimeter to measure voltage.
2. Use a multimeter to measure current.
3. Use a multimeter to measure resistance.
4. Use a multimeter to check circuit continuity.
5. Assemble and test series and parallel circuits using a battery, wires, and selected load devices.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Iron filings
Breadboard
Horseshoe or bar magnets
Batteries of different voltages
Clamp-on ammeters
Multimeter and operator's manual
A selection of the following electrical components:
- Resistors with different resistance values
- Load devices
- Circuit breakers
- Fuses
- Overload protection devices
- Pressurestats
- Relays
- Solenoids
- Switches
- Thermostatic switches
- Transformers

Samples of various types of circuit diagrams
Circuit boards
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 requires trainees to work with electrical circuits and test equipment. Ensure that they are briefed on shop safety procedures and emphasize electrical safety precautions.

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.

Vest Pocket Guide to the National Electrical Code®, Latest Edition. Quincy, MA: National Fire Protection Association.

TEACHING TIME FOR THIS MODULE

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

Topic	**Planned Time**
Session I. Introduction to Electricity and Voltage	
A. Introduction	_____
B. Electricity	_____
C. AC and DC Voltage	_____
D. Electrical Current Characteristics	_____
Session II. Electrical Circuits and Components	
A. Electrical Circuits	_____
B. Magnetism	_____
C. Electrical Components	_____
Session III. Electrical Safety, Diagrams, and Controls	
A. Electrical Safety	_____
B. Circuit Diagrams	_____
C. Electrical Controls	_____
Session IV. Electrical Measuring Instruments	
A. Ammeter	_____
B. Multimeter	_____
C. Laboratory—Trainees practice assembling test circuits and performing various tests with a multimeter. This laboratory corresponds to Performance Tasks 1 though 5.	_____

Session V. Review and Testing

A. Module Review _____

B. Module Examination _____

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

C. Performance Testing _____

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

MODULE OVERVIEW

This module covers the basic principles of heat transfer, refrigeration, and pressure-temperature relationships and describes the components and accessories used in air conditioned systems.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Modules 03101-07 through 03106-07.

OBJECTIVES

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

1. Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
2. Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
3. Under supervision, use temperature- and pressure-measuring instruments to make readings at key points in the refrigeration cycle.
4. Identify commonly used refrigerants and demonstrate the proper procedures for handling these refrigerants.
5. Identify the major components of a cooling system and explain how each type works.
6. Identify the major accessories available for cooling systems and explain how each works.
7. Identify the control devices used in cooling systems and explain how each works.
8. State the correct methods to be used when piping a refrigeration system.

PERFORMANCE TASKS

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

1. Measure temperatures in an operating air conditioning system.
2. Use cylinder color codes to identify refrigerants.
3. Identify compressors, condensers, evaporators, metering devices, controls, and accessories.
4. Use service valves to gain access to an air conditioning system in order to measure pressures using a gauge manifold set.

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
Barometers
Temperature-pressure charts
Various types of thermometers, including infrared
Material Safety Data Sheets for refrigerants
One or more operating refrigeration and/or air conditioning systems
Compressors
Condensers
Evaporators
Gauge manifold sets
Metering devices
Service valves
Refrigerant cylinders
Accessories
Primary controls
Secondary controls
Portable hot plate and suitable container for boiling water
Multimeters
Manometers
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. This module requires trainees to work on equipment that is operating and to operate testing equipment. Ensure that they are briefed on shop safety procedures and emphasize electrical safety precautions.

ADDITIONAL RESOURCES

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

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

Basic Refrigeration (Slides and Student Handbook), Latest Edition. York, PA:York International Corporation, Publications Distribution Center.

General Training Air Conditioning (Fundamentals)–GTAC-I, Latest Edition. Syracuse, NY: Carrier Corporation, Literature Services.

TEACHING TIME FOR THIS MODULE

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

Topic	**Planned Time**
Sessions I and II. Fundamentals of Cooling	
A. Introduction	_____
B. Heat	_____
C. Heat Transfer	_____
D. Pressure	_____
E. Instruments Used to Measure Temperature and Pressure	_____
F. Laboratory—Trainees practice measuring temperatures in an operating air conditioning system. This laboratory corresponds to Performance Task 1.	_____
Session III. Mechanical Refrigeration System	
A. System Components	_____
B. Refrigeration Cycle	_____
Session IV. Refrigerants	
A. Trade Names	_____
B. Ammonia	_____
C. Fluorocarbon Refrigerants	_____
D. Refrigerant Containers	_____
E. Identifying Refrigerants	_____
F. Laboratory—Trainees practice identifying refrigerants. This laboratory corresponds to Performance Task 2.	_____
G. Refrigerant Safety Precautions	_____

Session V. Compressors

A. Reciprocating Compressors _____
B. Rotary Compressors _____
C. Scroll Compressors _____
D. Screw Compressors _____
E. Centrifugal Compressors _____

Session VI. Condensers

A. Air-Cooled Condensers _____
B. Water-Cooled Condensers _____
C. Evaporative Condensers _____

Session VII. Evaporators

A. Direct Expansion (DX) Evaporators _____
B. Flooded Evaporators _____
C. Evaporator Construction _____

Session VIII. Expansion (Metering) Devices

A. Fixed Metering Devices _____
B. Adjustable Metering Devices _____

Session IX. Other Components

A. Filter-Drier _____
B. Sight-Glass Moisture Liquid Indicator _____
C. Suction Line Accumulator _____
D. Crankcase Heater _____
E. Oil Separator _____
F. Heat Exchanger _____
G. Receiver _____
H. Service Valves _____
I. Laboratory—Trainees practice using service valves to gain access to air conditioning systems to measure pressure. This laboratory corresponds to Performance Task 4. _____
J. Compressor Muffler _____

Session X. Controls

A. Primary Controls _____
B. Secondary Controls _____

Session XI. Piping

A. Basic Principles _____
B. Suction Line _____
C. Hot Gas Line _____
D. Liquid Line Layout _____
E. Pipe Supports _____
F. Insulation _____
G. Laboratory—Trainees practice identifying air conditioning components. This laboratory corresponds to Performance Task 3. _____

Session XII. Review and Testing

A. Module Review _____

B. Module Examination _____

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

C. Performance Testing _____

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

MODULE OVERVIEW

This module covers heating fundamentals, types and designs of furnaces and their components, and basic procedures for installing and servicing furnaces.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Modules 03101-07 through 03107-07.

OBJECTIVES

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

1. Explain the three methods by which heat is transferred and give an example of each.
2. Describe how combustion occurs and identify the byproducts of combustion.
3. Identify various types of fuels used in heating.
4. Identify the major components and accessories of an induced draft and condensing gas furnace and explain the function of each component.
5. State the factors that must be considered when installing a furnace.
6. Identify the major components of a gas furnace and describe how each works.
7. With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
8. Identify the major components of an oil furnace and describe how each works.
9. Describe how an electric furnace works.
10. With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

PERFORMANCE TASKS

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

1. Identify the components of an induced draft and condensing gas furnace and state their purpose.
2. With supervision, turn on and check a gas furnace.
3. Identify symptoms of combustion problems in a gas furnace and adjust the manifold pressure.
4. With supervision, perform preventive maintenance procedures on a gas furnace, including filter replacement, cleaning of components, and temperature measurements.
5. Identify the components of an oil furnace and state their purpose.
6. With supervision, turn on and check an oil furnace.
7. With supervision, perform preventive maintenance procedures on an oil furnace, including filter replacement, cleaning of components, and temperature measurements.

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
GAMA venting tables
Copper pipe and light plastic bags for heat transfer experiments
Hair dryer for heat transfer experiments
Thermometers or temperature probes
Operating gas-fired furnace
Operating oil-fired furnace
Pressure-type oil burner
Gas manifold
Drill and brush
Manometer
Various grades of oil
Manufacturer's literature on various types of forced-air furnaces
Manufacturer's literature on multi-poise furnaces
Manufacturer's literature on condensing furnaces

Furnace air filters
Nozzles
Safety switches
Hydronic heat radiators

Copies of the Quick Quizzes*
Module Examinations**
Performance Profile Sheets**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work on equipment that is operating and to operate testing equipment. Ensure that they are briefed on shop safety procedures and emphasize electrical safety precautions.

ADDITIONAL RESOURCES

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

Fundamentals of Gas Heating, Latest Edition. Tyler, TX: The Trane Company.
General Training—Heating (GTH), Latest Edition. Syracuse, NY: Carrier Corporation.
Heating, Ventilating, and Air Conditioning Fundamentals, Latest Edition. Upper Saddle River, NJ: Prentice Hall.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Introduction to 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. Fundamentals of Heating	
A. Introduction	_____
B. Heat Transfer	_____
C. Temperature and Heat Measurement	_____
D. Combustion	_____
Session II. Forced-Air Furnaces	
A. Types	_____
B. Heat Exchangers	_____
C. Condensing Furnaces	_____
D Fans, Motors, Air Filters, and Blowers	_____
E. Humidifiers	_____
F. Installation	_____
G. Laboratory—Trainees practice identifying the components of an induced draft and condensing gas furnace and state their purpose. This laboratory corresponds to Performance Task 1.	_____

Session III. Gas Furnaces

A. Flame Ignition _____

B. Laboratory—Trainees practice turning on and checking a gas furnace. This laboratory corresponds to Performance Task 2. _____

C. Gas Valve Assembly _____

D. Components _____

E. Safety Switches _____

F. Maintenance _____

G. Laboratory—Trainees practice performing preventive maintenance procedures on a gas furnace. This laboratory corresponds to Performance Task 4. _____

H. Manifold Pressure _____

I. Laboratory—Trainees practice identifying symptoms of combustion problems in a gas furnace and adjusting the manifold pressure. This laboratory corresponds to Performance Task 3. _____

Session IV. Oil Furnaces

A. Oil Burner Operation _____

B. Laboratory—Trainees practice turning on and checking an oil furnace. This laboratory corresponds to Performance Task 6. _____

C. Combustion Chamber _____

D. Regulators and Safety Controls _____

E. Oil Storage _____

F. Laboratory—Trainees practice identifying the components of an oil furnace. This laboratory corresponds to Performance Task 5. _____

G. Maintenance _____

H. Laboratory—Trainees practice performing preventive maintenance procedures on an oil furnace. This laboratory corresponds to Performance Task 7. _____

Session V. Electric Heating

A. Heating Elements _____

B. Components _____

C. Power Supply _____

D. Hydronic Heating Systems _____

E. Summary _____

Session VI. Review and Testing

A. Module Review _____

B. Module Examination _____

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

C. Performance Testing _____

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

MODULE OVERVIEW

This module describes air distribution systems and their components, air flow measurement, duct work installation principles, and the use of instruments for measuring temperature, humidity, pressure, and velocity.

PREREQUISITES

Please refer to the Course Map in the Trainee Module. Prior to training with this module, it is recommended that the trainee shall have successfully completed the following: *Core Curriculum;* and *HVAC Level One,* Modules 03101-07 through 03108-07.

OBJECTIVES

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

1. Describe the airflow and pressures in a basic forced-air distribution system.
2. Explain the differences between propeller and centrifugal fans and blowers.
3. Identify the various types of duct systems and explain why and where each type is used.
4. Demonstrate or explain the installation of metal, fiberboard, and flexible duct.
5. Demonstrate or explain the installation of fittings and transitions used in duct systems.
6. Demonstrate or explain the use and installation of diffusers, registers, and grilles used in duct systems.
7. Demonstrate or explain the use and installation of dampers used in duct systems.
8. Demonstrate or explain the use and installation of insulation and vapor barriers used in duct systems.
9. Identify instruments used to make measurements in air systems and explain the use of each instrument.
10. Make basic temperature, air pressure, and velocity measurements in an air distribution system.

PERFORMANCE TASKS

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

1. Use a tachometer to measure blower motor rpm.
2. Read and interpret equivalent length charts and required air volume/duct size charts.
3. Assemble duct and fittings.
4. Assemble flexible duct.
5. Install insulation and vapor barriers on metal ducts.
6. Use a manometer to measure static pressure in a duct system.
7. Use a velometer to measure the velocity of airflow at the output of air system supply diffusers and registers.

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
Operating air distribution duct system
Various examples of blowers and fans
Manufacturer's literature on various types of blowers and fans
Various examples of diffusers, registers, and grilles
Manufacturer's literature on various types of diffusers, registers, and grilles
Metal duct sections of various sizes and types
Metal duct installation fasteners and attaching hardware
Ductboard sections of various sizes and shapes
Ductboard installation materials and attaching hardware
Fan curve charts
Metal duct fasteners
Fiberglass ductboard
Duct fittings and transitions
Duct hangers and supports
Flexible duct of various sizes and shapes

Flexible duct materials and attaching hardware
Duct tape
Samples of foil- and/or vinyl-backed fiberglass duct insulation
Samples of metal duct with insulation inside
Examples of equivalent length charts
Psychrometric charts
Psychrometers
Hygrometers
Tachometers
Manometers (as available):
- U-tube
- Inclined
- Inclined-vertical
- Electronic

Pitot tubes
Static pressure tips
Velometers (as available):
- Rotating vane
- Swing vane
- Hot wire
- Flow hood

Thermometers
Differential pressure gauges
Air volume balancer
Copies of Quick Quiz *
Module Examinations**
Performance Profile Sheets**

*Located in the back of the Trainee Guide.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work on equipment that is operating and to operate testing equipment. Ensure that they are briefed on shop safety procedures and emphasize electrical safety precautions.

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.

Residential Air System Design, 1993. Syracuse, NY: Carrier Corporation.

TEACHING TIME FOR THIS MODULE

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

Topic	**Planned Time**
Session I. Introduction to Air Distribution Systems	
A. Introduction	_____
B. Air Distribution Systems	_____
C. Fans and Blowers	_____
D. Laboratory—Trainees practice using a tachometer to measure blower rpm. This laboratory corresponds to Performance Task 1.	_____

Session II. Duct Systems

A. Duct Systems Used in Cold Climates _____
B. Duct Systems Used in Warm Climates _____
C. Duct System Components _____
D. Duct Hangers and Supports _____
E. Laboratory—Trainees practice reading and interpreting equivalent length charts. This laboratory corresponds to Performance Task 2. _____
F. Laboratory—Trainees practice installing various types of ductwork, including installation of insulation and vapor barriers. This laboratory corresponds to Performance Tasks 3 through 5. _____

Session III. Instruments and Measurements

A. Temperature and Humidity Measurements _____
B. Air Distribution System Measurements _____
C. Laboratory—Trainees practice using a manometer. This laboratory corresponds to Performance Task 6. _____
D. Air Velocity Measurements _____
E. Laboratory—Trainees practice using a velometer. This laboratory corresponds to Performance Task 7. _____
F. Summary _____

Session IV. Review and Testing

A. Module Review _____
B. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.
C. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.