Lesson Plans for Module 27204-13

EXTERIOR FINISHING

Module Three (27204-13) covers the various types of exterior finish materials and their installation procedures, including wood, metal, vinyl, and fiber-cement siding.

Objectives

Learning Objective 1
• Describe the safety hazards when working with exterior finish materials.
  a. Identify safety hazards that are present when working at elevations.
  b. Describe safety hazards when working with hand and power tools, equipment, and exterior finish materials.

Learning Objective 2
• Describe the various types and applications of exterior finish materials.
  a. Identify the types of wood siding.
  b. Identify vinyl and metal siding materials and components.
  c. List applications for fiber-cement siding.
  d. Discuss the types of veneer finishes.
  e. List specialty exterior finishes.
  f. Explain the purpose of flashing.

Learning Objective 3
• Explain how to install exterior finish materials.
  a. Describe surface preparation that must be performed prior to installing exterior finish materials.
  b. Discuss the types of furring and insulation that might be applied to exterior walls.
  c. Explain how to establish a straight reference line.
  d. Describe how to install wood siding.
  e. Describe how to install vinyl and metal siding.
  f. Describe how to install fiber-cement siding.
  g. Explain how to install cornices.

Learning Objective 4
• Describe the estimating procedure for exterior finish projects.
  a. Explain how to perform a takeoff on panel and board siding.

Performance Tasks

Performance Task 1 (Learning Objective 3)
• Install three of the most common siding types in your area.

Performance Task 2 (Learning Objective 4)
• Estimate the amount of lap or panel siding required for a structure.

Teaching Time: 35 hours
(Fourteen 2.5-hour classroom sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum and Carpentry Level One

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the Module Examinations and Performance Profile Sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70 percent or above for the Module Examination; performance testing is graded pass or fail.
**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- Carpenter Level Two PowerPoint® Presentation Slides
- Computer
- Copies of the Module Examination and Performance Profile Sheets
- Vendor-supplied videos/DVDs showing exterior finishing materials and installations (optional)
- TV/DVD player

**Equipment and Materials for Laboratories and Performance Testing**
- Personal protective equipment (PPE):
  - Hard hat
  - Eye protection
  - Fall protection, including body harness and lanyard
  - Gloves
  - Hearing protection
  - Respiratory protection
- 3/8”- or 1/2”-thick hardwood stock
- Aerial lift
- Assortment of vinyl and metal siding components
- Aviation snips
- Calculator
- Caulking gun
- Chalk box and chalkline
- Circular saw
- Duckbill snips
- Hacksaw
- Hammer
- Handsaw
- Ladder
- Lanyard
- Laser level
- Photographs of residential structures finished with wood siding
- Photographs of veneer finishes
- Portable brake
- Power nailer
- Power shears
- Rubber mallet
- Safety data sheets (SDSs) for fiber-cement siding
- Samples of fiber-cement siding
- Samples of flashing
- Samples of furring strips
- Samples of inside and outside corners of wood siding
- Samples of underlayment
- Samples of various types of wood siding
- Scaffold
- Screwdriver
- Set of residential construction drawings
- Shingle hatchet
- Siding installation tools
- Snaplock punch
- Table saw
- Tape measure
- Tin snips
- Utility knife
- Water level

**Safety Considerations**
This module requires that trainees work at elevated locations, work with hand and power tools, and work around fiber-cement siding. Safety is paramount in the carpentry trade and safe habits and practices must be emphasized whenever possible. Performance Tasks must be completed under your supervision. Each trainee must use required PPE and follow safe tool practices and procedures.

**Additional Resources and References**
This module presents thorough resources for task training. The following resource material is suggested for further study:

Vinyl Siding Institute website. [www.vinylsiding.org](http://www.vinylsiding.org)

Cedar Shake & Shingle Bureau website. [www.cedarbureau.org](http://www.cedarbureau.org)

There are a number of online resources available for trainees who would like more information on exterior finishing. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for 27204-13

EXTerior Finishing

The lesson plan for this module is divided into fourteen 2.5-hour sessions. Each session includes 10 minutes for administrative tasks and one 10-minute break.

**SESSION ONE**

Session One introduces exterior finishing safety.

1. Show Session One PowerPoint® presentation slides.
2. Identify safety hazards that are present when working at elevations, and review the use of personal fall arrest equipment.
3. Describe safety hazards when working with hand and power tools, equipment, and exterior finishing materials. Review the use of safety data sheets (SDSs).

**SESSION TWO**

Session Two introduces types of wood siding.

1. Show Session Two PowerPoint® presentation slides.
2. Discuss the use of beveled, board-and-batten, reverse batten, board-on-board, tongue-and-groove, shiplap, shingle, shake, and plywood siding.

**SESSION THREE**

Session Three introduces types of siding other than wood, including vinyl and metal siding, fiber-cement siding, veneer finishes, and specialty finishes.

1. Show Session Three PowerPoint® presentation slides.
2. Discuss the use of types of siding other than wood, including vinyl and metal siding, fiber-cement siding, veneer finishes, and specialty finishes.
3. Discuss the use of flashing for vertical surfaces.

**SESSION FOUR**

Session Four introduces surface preparation and furring and insulation techniques.

1. Show Session Four PowerPoint® presentation slides.
2. Identify items to consider when preparing a surface for exterior finishing materials.
3. Discuss the purpose of furring strips for exterior finish and the importance of properly installing furring members and insulation.

**SESSION FIVE**

Session Five introduces establishing a straight reference line and installing beveled siding.

1. Show Session Five PowerPoint® presentation slides.
2. Discuss the importance of establishing a straight reference line.
3. Show how beveled siding is installed and have trainees do it.

**SESSION SIX**

Session Six introduces installing board-and-batten siding, tongue-and-groove siding, shiplap siding, shakes and shingles, and plywood siding.

1. Show Session Six PowerPoint® presentation slides.
2. Discuss the proper procedure for installing board-and-batten siding, tongue-and-groove siding, shiplap siding, shakes, shingles, and plywood siding.
3. Have trainees properly install board-and-batten siding, tongue-and-groove siding, shiplap siding, shakes, shingles, and plywood siding are installed.
**Session Seven**

Session Seven introduces installing vinyl and metal siding components.

1. Show Session Seven PowerPoint® presentation slides.
2. Review tools and equipment needed when installing vinyl and metal siding.
3. Discuss and show the installation of corner posts and starter strips.

**Session Eight**

Session Eight introduces trimming out gable ends and around doors and windows, and cutting vinyl and metal siding.

1. Show Session Eight PowerPoint® presentation slides.
2. Discuss and show how gable ends and doors and windows are trimmed out prior to installing siding.
3. Discuss and show how to cut vinyl and metal siding.

**Session Nine**

Session Nine introduces installing vinyl and metal siding.

1. Show Session Nine PowerPoint® presentation slides.
2. Discuss and show how to install vinyl and metal siding.
3. Demonstrate how to install siding around windows and doors.
4. Have trainees properly install vinyl and metal siding.

**Session Ten**

Session Ten introduces installing vinyl and metal siding at gable ends and under the eaves. The session concludes with caulking and cleanup.

1. Show Session Ten PowerPoint® presentation slides.
2. Discuss and show how vinyl and metal siding are installed at gable ends and under the eaves.
3. Discuss the proper procedure for caulking and cleaning up vinyl and metal siding.

**Session Eleven**

Session Eleven introduces installing fiber-cement siding.

1. Show Session Eleven PowerPoint® presentation slides.
2. Discuss PPE that should be worn when working with fiber-cement siding.
3. Discuss and show the proper method for cutting and installing fiber-cement siding.
4. Have trainees properly install fiber-cement siding.

**Session Twelve**

Session Twelve introduces installing cornices, fascia, and soffits.

1. Show Session Twelve PowerPoint® presentation slides.
2. Discuss the types of cornices.
3. Explain how the fascia and soffits are installed.
4. Discuss and show how to construct a box cornice.
SESSION THIRTEEN

Session Thirteen introduces estimating exterior finish materials.

1. Show Session Thirteen PowerPoint® presentation slides.
2. Review the formulas for calculating area.
3. Discuss and show how to determine the amount of siding required for a building.
4. Have trainees determine the amount of siding required for a residential structure.

SESSION FOURTEEN

Session Fourteen is a review and testing session. Have trainees complete the module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Thirteen.) Answer any questions that trainees may have.

1. Have trainees complete the Module Examination. Any outstanding performance testing must be completed during this session.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Four (27203-13) covers the selection and installation of various types of insulating materials in walls, floors, and attics. It also covers the uses and installation practices for vapor barriers and waterproofing materials.

Objectives

Learning Objective 1
- Describe the safety and health hazards when working with insulation.
  a. List the personal protective equipment (PPE) that is required when working with insulation.
  b. Describe how to safely handle insulation.

Learning Objective 2
- Describe the various types of insulation and their characteristics.
  a. Explain how to determine R-value requirements.
  b. Describe flexible insulation and list its characteristics.
  c. Describe loose-fill insulation and list its characteristics.
  d. Describe rigid or semirigid insulation and list its characteristics.
  e. Describe reflective insulation and list its characteristics.
  f. List miscellaneous types of insulation.

Learning Objective 3
- Describe the various installation methods for insulation.
  a. Explain how to install flexible insulation.
  b. Explain how to install loose-fill insulation.
  c. Explain how to install rigid or semirigid insulation.
  d. Explain how to install reflective insulation.

Learning Objective 4
- Identify the requirements for moisture control, waterproofing, and ventilation, and describe the related installation methods.
  a. List various methods to control moisture in a structure.
  b. Identify methods to waterproof a structure.

Learning Objective 5
- Describe the estimating procedure for thermal and moisture projects.

Performance Tasks

Performance Task 1 (Learning Objective 3)
- Install blanket insulation in a wall.

Performance Task 2 (Learning Objective 3)
- Install a vapor barrier on a wall.

Performance Task 3 (Learning Objective 4)
- Install selected building wraps.

Teaching Time: 7.5 hours
(Three 2.5-hour classroom sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum and Carpentry Level One

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the Module Examinations and Performance Profile Sheets from www.nccerirc.com. The passing score for submission into NCCER's Registry is 70 percent or above for the Module Examination; performance testing is graded pass or fail.
### Safety Considerations

This module requires that trainees work with insulation, which may require special PPE. Safety is paramount in the carpentry trade and safe habits and practices must be emphasized whenever possible. Performance Tasks must be completed under your supervision. Each trainee must use required PPE and follow safe tool practices and procedures.

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### Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Carpentry Level Two PowerPoint® Presentation Slides*
- Computer
- Copies of the Module Examination and Performance Profile Sheets
- Vendor-supplied videos/DVDs showing thermal and moisture protection applications (optional)
- TV/DVD player

### Equipment and Materials for Laboratories and Performance Testing

- Personal protective equipment (PPE):
  - Eye protection
  - Gloves
  - Respiratory protection
- Building wrap
- Hand stapler
- Heat box
- Heat lamp
- Measuring tape
- Photographs of mold- or mildew-damaged buildings
- Photographs of water-damaged buildings
- Power stapler
- Safety data sheets (SDSs) for various types of insulation
- Samples of various types of insulation, including flexible, loose-fill, rigid or semirigid, and reflective insulation
- Utility knife
- Various types of vapor barriers

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### Additional Resources and References

This module presents thorough resources for task training. The following resource material is suggested for further study:


There are a number of online resources available for trainees who would like more information on thermal and moisture protection. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The lesson plan for this module is divided into three 2.5-hour sessions. Each session includes 10 minutes for administrative tasks and one 10-minute break.

**SESSION ONE**

Session One introduces types of insulation, insulation safety and health hazards and installation methods for various types of insulation.

1. Show Session One PowerPoint® presentation slides.
2. Discuss PPE required for insulation installation and safety data sheets (SDSs).
3. Identify various types of insulation, their properties and characteristics, and the methods of installation. Have trainees demonstrate insulation installation.

**SESSION TWO**

Session Two introduces moisture control, waterproofing, and estimating insulation needs.

1. Show Session Two PowerPoint® presentation slides.
2. Identify and discuss sources of water infiltration. Demonstrate how vapor barriers are installed and have trainees do it.
3. Identify and discuss sources of air infiltration, and discuss building wrap.
4. Demonstrate how building wrap is installed and have trainees do it.
5. Discuss how to estimate the amount of insulation required.

**SESSION THREE**

Session Three is a review and testing session. Have trainees complete the module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Two.) Answer any questions that trainees may have.

1. Have trainees complete the Module Examination. Any outstanding performance testing must be completed during this session.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Seven (27206-13) describes the various types of gypsum drywall, their uses, and the fastening devices and methods used to install them. The module also contains detailed instructions for installing drywall on walls and ceilings using nails, drywall screws, and adhesives. A discussion of fire- and sound-rated walls is also presented.

**Objectives**

**Learning Objective 1**
- Identify components of a drywall assembly.
  a. List the types of gypsum products.
  b. Identify drywall fasteners and list their uses.
  c. Identify drywall accessories and state their applications.

**Learning Objective 2**
- Describe the installation of drywall.
  a. Describe the purpose of a finish schedule.
  b. List the tools used for drywall application.
  c. Identify methods of sound-isolation construction.
  d. Describe the procedure for drywall construction.
  e. List special applications for drywall.

**Learning Objective 3**
- Contrast rated assemblies to nonrated assemblies.
  a. Describe single-ply drywall application.
  b. Describe how fire-rated walls are constructed.
  c. List multi-ply drywall applications.
  d. Describe how to prioritize walls.

**Learning Objective 4**
- Identify how to calculate a quantity takeoff for proper drywall installation.
  a. Explain how to perform a material takeoff for drywall.
  b. Explain how to perform a material takeoff for drywall fasteners.

**Performance Tasks**

**Performance Task 1** (Learning Objective 1)
- Select the type and thickness of drywall required for an installation.

**Performance Task 2** (Learning Objective 2)
- Install gypsum drywall panels on a stud wall and a ceiling using any or all of the following fastening systems:
  - Nails
  - Screws
  - Adhesives

**Performance Task 3** (Learning Objective 4)
- Estimate material quantities for an installation.

**Teaching Time: 15 hours**
(Six 2.5-hour classroom sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**
*Core Curriculum and Carpentry Level One*

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the Module Examinations and Performance Profile Sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER's Registry is 70 percent or above for the Module Examination; performance testing is graded pass or fail.
### Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Carpentry Level Two PowerPoint® Presentation Slides*
- Computer
- Copies of the Module Examination and Performance Profile Sheets
- Vendor-supplied videos/DVDs showing drywall installation (optional)
- TV/DVD player

### Equipment and Materials for Laboratories and Performance Testing
- Personal protective equipment (PPE):
  - Hard hat
  - Eye protection
  - Gloves
  - Hearing protection
  - Respiratory protection
- 4’ T-square
- Adhesive applicator
- Assortment of drywall adhesives
- Assortment of drywall nails
- Assortment of drywall screws
- Assortment of fire-stopping materials
- Assortment of furring channels
- Assortment of gypsum product samples
- Calculator
- Carbide cutter
- Circle cutter
- Drywall adhesive
- Drywall hammer
- Drywall lifter
- Drywall nails
- Drywall panels
- Drywall saw
- Drywall screws
- Hammer
- Hook-bill knife
- *International Building Code®*
- *International Residential Code®*
- Jab saw
- Light box cutter
- Local building code
- Rasp
- Screwgun
- Set of commercial construction drawings containing a fastening schedule
- Set of residential construction drawings
- T-brace
- Utility knife

### Safety Considerations
This module requires that trainees work with sharp cutting tools. In addition, sharp metal edges of furring channels and steel framing members may be encountered. Safety is paramount in the carpentry trade and safe habits and practices must be emphasized whenever possible. Performance Tasks must be completed under your supervision. Each trainee must use required PPE and follow safe tool practices and procedures.

### Additional Resources and References
This module presents thorough resources for task training. The following resource material is suggested for further study:


There are a number of online resources available for trainees who would like more information on drywall installation. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The lesson plan for this module is divided into six 2.5-hour sessions. Each session includes 10 minutes for administrative tasks and one 10-minute break.

**SESSION ONE**

Session One introduces gypsum products and their manufacture.

1. Show Session One PowerPoint® presentation slides.
2. Discuss the various types of gypsum products and their applications.
3. Discuss methods to attach drywall panels to the base materials.

**SESSION TWO**

Session Two introduces hand and power tools used for drywall installation and the use of furring channels.

1. Show Session Two PowerPoint® presentation slides.
2. Discuss and demonstrate the use of hand and power tools on drywall.
3. Discuss the application and installation of furring channels.

**SESSION THREE**

Session Three introduces drywall installation.

1. Show Session Three PowerPoint® presentation slides.
2. Discuss how to properly prepare a job site for drywall installation.
3. Discuss and demonstrate how to properly install drywall.

**SESSION FOUR**

1. Session Four introduces rated and nonrated assemblies.
2. Show Session Four PowerPoint® presentation slides.
3. Discuss the use of single- and multi-ply applications.
4. Discuss the use of fire-stops in wall construction.

**SESSION FIVE**

Session Five introduces the trainees to estimating drywall quantities.

1. Show Session Five PowerPoint® presentation slides.
2. Discuss and demonstrate how to estimate quantities of drywall.
3. Discuss and demonstrate how to estimate quantities of drywall fasteners.

**SESSION SIX**

Session Six is a review and testing session. Have trainees complete the module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Five.) Answer any questions that trainees may have.

1. Have trainees complete the Module Examination. Any outstanding performance testing must be completed during this session.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Overview

This module discusses the materials, schedules, and properties of copper tube, fittings, and valves. Trainees will learn how to measure, ream, cut, join, and groove copper tube, as well as how to hang and support copper tube.

Objectives

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

1. Identify the various types of copper tube.
2. Identify the material properties, storage, and handling requirements of copper tube.
3. Identify the types of fittings and valves used with copper tube.
4. Identify the techniques used in hanging and supporting copper tube.
5. Properly measure, cut, and join copper tube.
6. Identify the hazards and safety precautions associated with copper tube.

Performance Tasks

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

1. Select correct types of materials for copper tube systems.
2. Identify types of fittings and valves and their uses.
3. Select the appropriate personal protective equipment for working with copper tube.
4. Correctly measure, cut, ream, and join copper tube.
5. Select the correct support and spacing for the application.

Materials and Equipment

Computer
Markers/chalk
Pencils and paper
Whiteboard/chalkboard
Appropriate personal protective equipment
Copies of your local code
Access to a fire extinguisher
Sections of copper tube
Tee-pulling tool
Fittings and valves, including:
  Water supply fittings
  Water supply valves
  DWV fittings
  Alternative fittings
Tools for measuring copper tube
Copper cutter
Handheld tube cutter
Internal tube cutter
Sizing tool
Tools to form sweat joints, compression joints, and flare joints
Variety of soldering tools, including an acetylene torch
Tools to roll groove and cut groove copper tube
Tube attachments for wood-frame construction
National Fire Protection Association (NFPA) Chapter 13
Manufacturers Standardization Society MSS40 hanger standards
Pressure gauge
Test plug
Module Examinations*
Performance Profile Sheets*

*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
Safety Considerations

Ensure that trainees are equipped with appropriate personal protective equipment, and that they are properly instructed on its use. Emphasize safety precautions specific to tube-cutting operations. Stress the importance of following manufacturers’ recommendations when cutting or sawing tube or when using any flame, heat, or power tools. Remind trainees of the environmental and physical hazards related to soldering work.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


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 *Copper Tube and Fittings*. 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 to Copper Tube</strong></td>
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<tr>
<td>A. Types</td>
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<td>B. Sizing</td>
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<td>C. Labeling</td>
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<td>D. Applications</td>
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<td>E. Material Storage and Handling</td>
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<td>F. PT/Laboratory</td>
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<tr>
<td>Have trainees select correct types of materials for copper tube systems. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td><strong>Session II. Fittings and Valves</strong></td>
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<td>A. Water Supply Fittings</td>
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<td>B. Water Supply Valves</td>
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<td>C. DWV Fittings</td>
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<td>D. Alternative Fittings</td>
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<td>E. PT/Laboratory</td>
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<tr>
<td>Have trainees identify types of fittings and valves and their uses. This laboratory corresponds to Performance Task 2.</td>
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</table>
Sessions III-IV. Measuring, Cutting, Bending, Joining, and Grooving

A. Measuring 
B. Cutting 
C. Bending 
D. Joining 
E. Grooving 
F. PT/Laboratory
   Have the trainees select the appropriate personal protective equipment for working with copper tube and have them correctly measure, cut, ream, and join copper tube. This laboratory corresponds to Performance Tasks 3 and 4.

Session V. Installing, Insulating, and Pressure Testing; Review and Testing

A. Types of Tube Hangers and Supports 
B. PT/Laboratory
   Have trainees select the correct support and spacing for a given application. This laboratory corresponds to Performance Task 5.
C. Insulating Tubes 
D. Pressure Testing 
E. Review 
F. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on 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 Training Report Form 200, and submit the results to the Training Program Sponsor.
Lesson Plans for Module 02205-13

INSTALLING ROOF, FLOOR, AND AREA DRAINS

The Trainee Guide for Plumbing Level Two is available as an NCCERconnect ebook. Contact your NCCER customer service representative at 1-888-622-3720 for more information.

Module Five (02205-13) provides instruction on the proper techniques for locating, installing, and connecting roof, floor, and area drains and floor sinks according to code. It also covers the installation of waterproof membranes and flashing, drain components, shower pans, trap primers, and covers proper drain applications.

Objectives

Learning Objective 1
• Set an elevation using a builder’s or laser level.
  a. Set the elevation of a floor drain.
  b. Set the elevation of an area drain.
  c. Set the elevation of a floor sink.

Learning Objective 2
• Install floor drains, area drains, and floor sinks.

Learning Objective 3
• Install primary and secondary roof drains.
  a. Install a deck clamp.
  b. Install a deck pan.

Learning Objective 4
• Install waterproof membranes and flashing for a shower pan.

Learning Objective 5
• Install a trap primer.

Performance Tasks

Performance Task 1 (Learning Objective 1)
• Set the elevation for a floor drain, area drain, and floor sink using a builder’s or laser level.

Performance Task 2 (Learning Objectives 2 and 3)
• Install roof drains, floor drains, area drains, and floor sinks.

Performance Task 3 (Learning Objective 4)
• Install waterproof membranes and flashing for a shower pan.

Performance Task 4 (Learning Objective 5)
• Install a trap primer.

Teaching Time: 5 hours
(Two 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites

Core Curriculum and Plumbing Level One

Before you Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**

This module requires that trainees demonstrate the ability to safely and correctly locate, install, and connect roof, floor, and area drains and floor sinks according to code, as well as waterproof membranes and flashing, drain components, shower pans, and trap primers. Performance tasks must be completed under your supervision. Each trainee must use required PPE and follow safe tool practices and procedures.

**Classroom Equipment and Materials**

- Copies of the Module Examination and Performance Profile Sheets
- *Plumbing Level Two PowerPoint® Presentation Slides, DVD player*
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- LCD projector and screen
- Computer
- Vendor-supplied videos/DVDs showing how to install various types of drains (optional)
- TV/VCR/DVD player (optional)

**Equipment and Materials for Laboratories and Performance Testing**

- A variety of floor drains
- A variety of area drains
- A variety of floor sinks
- Backwater valve
- Waterproof membrane material
- Flashing material
- Rigid roof insulation
- Surveyor’s level
- Straight board
- Deck plate
- Expansion joint
- Tools for cutting roof deck material (such as a Sawzall, jigsaw, keyhole saw, or tin snips)
- Tools for installing roof, floor, and area drains and floor sinks
- Pencils
- Levels
- Rulers
- Plastic shower pans
- Mortar
- Trap primer
- Tools and equipment required to install trap primers
- Copies of the local applicable code

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on roof, floor, and area drains. A search for additional information may be assigned as homework to interested trainees.
Session Outline for 02205-13
Installing Roof, Floor, and Area Drains

The Lesson Plan for this module is divided into two 2.5-hour sessions. Each session includes 10 minutes for administrative tasks, and one 10-minute break.

**SESSION ONE**

Session One covers how to locate, install, and connect roof, floor, and area drains and floor sinks according to code. It also covers how to install waterproof membranes and flashing, drain components, shower pans, and trap primers, and discusses proper drain applications.

1. Show Session One PowerPoint slides.
2. Provide PPE and other safety-related items from the Equipment and Materials list for trainees to examine.
3. Bring in a surveyor’s level and straight board. Have trainees practice using the level to locate the top of a drain. This laboratory corresponds with Performance Task 1.
4. Set up stations around the classroom with various floor drains, area drains, and floor sinks along with waterproof membrane material and the tools required for installing the drains and sinks. The stations should be designed to simulate a floor installation. Have trainees practice installing the floor drains, area drains, and floor sinks. This laboratory corresponds with part of Performance Task 2.
5. Set up stations around the classroom with various roof drains along with waterproof membrane material and the tools required for installing the drains. The stations should be designed to simulate a roof installation. Have trainees practice installing the roof drains. This laboratory corresponds with part of Performance Task 2.

6. Have trainees practice installing waterproof membrane material in a simulated floor installation, securing it to the drain body with the membrane clamp, and setting the strainer at the correct elevation. Remind trainees that the drain body must initially be installed without the strainer in place in order to do this. This laboratory corresponds with Performance Task 3.

7. Set up stations around the classroom with trap primers and the tools and equipment required to install them. Have trainees practice installing the trap primers. This laboratory corresponds with Performance Task 4.

**SESSION TWO**

Session Two is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session One.) Answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
The Trainee Guide for *Plumbing Level Two* is available as an NCCERconnect ebook. Contact your NCCER customer service representative at 1-888-622-3720 for more information.

**Module Nine (02209-13)** provides an introduction to gas-fired, electric, tankless, heat pump, and indirect water heaters, components, and applications; reviews proper installation and testing techniques; and covers the latest code requirements for water heaters.

### Objectives

**Learning Objective 1**
- Identify the basic operation and components of various water heaters.
  - a. Identify the operation and components of a gas water heater.
  - b. Identify the operation and components of an electric water heater.
  - c. Identify the operation and components of tankless water heaters.
  - d. Identify the operation and components of a heat pump water heater.
  - e. Identify the operation and components of indirect water heaters.

**Learning Objective 2**
- Identify the safety hazards associated with water heaters.
  - a. Identify electrical safety hazards.
  - b. Identify gas safety hazards.
  - c. Identify steam safety hazards.

**Learning Objective 3**
- Install water heaters.
  - a. Install a gas water heater.
  - b. Install an electric water heater.
  - c. Install tankless water heaters.
  - d. Install a heat pump water heater.
  - e. Install an indirect water heater.

### Performance Tasks

**Performance Task 1 (Learning Objective 1)**
- Identify the basic functions and components of water heaters.

**Performance Task 2 (Learning Objective 3)**
- Install a water heater.

### Teaching Time: 10 hours

*(Four 2.5-Hour Classroom Sessions)*

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites

*Core Curriculum* and *Plumbing Level One*

### Before you Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**

This module requires that trainees demonstrate the ability to identify the basic functions and components of water heaters and to install a water heater. Performance tasks must be completed under your supervision. Each trainee must use required PPE and follow safe tool practices and procedures.

**Classroom Equipment and Materials**

- Copies of the Module Examination and Performance Profile Sheets
- *Plumbing Level Two PowerPoint® Presentation Slides, DVD player*
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- LCD projector and screen
- Computer
- Vendor-supplied videos/DVDs showing water heater operation and components, water heater safety, and water heater installation (optional)
- TV/VCR (optional)

**Equipment and Materials for Laboratories and Performance Testing**

- An electric, gas, tankless, heat pump, or indirect water heater, and the tools and equipment required to install the water heater, including unions, T/P relief valves, pipe, bends, and fittings
- A cross-section or exploded drawing of gas, electric, tankless, heat pump, and indirect water heaters from sets of manufacturers’ instructions
- An assortment of manufacturer’s installation manuals for various types of residential, commercial, and industrial water heaters, including gas, electric, tankless, heat pump, and indirect water heaters
- A rough-in drawing of a water heater
- An assortment of construction drawings showing a variety of water heater installations
- A temperature and pressure (T/P) relief valve
- A dip tube
- An antisiphon tube
- A thermocouple
- A thermostatic probe
- A heat exchanger
- A corroded anode
- Fuel gas odorant
- Photos or illustrations of parallel and series water heater connections
- An assortment of water heater pans in different shapes and sizes and of different materials
- Samples of galvanized and black iron pipe and fittings for use in connecting gas supply piping to water heaters
- A container of refrigerant used in heat pump water heaters
- A mixing valve designed for use on an indirect water heater
- Copies of the local applicable code

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on water heater operation, safety, and installation. A search for additional information may be assigned as homework to interested trainees.
The Lesson Plan for this module is divided into four 2.5-hour sessions. Each session includes 10 minutes for administrative tasks, and one 10-minute break.

**SESSION ONE**

Session One provides an overview of the various types of water heaters that are available, including identification, components, and selection.

1. Show Session One PowerPoint® slides.
2. Provide trainees with copies of manufacturer’s installation manuals for various types of residential, commercial, and industrial water heaters. Review the features found in large commercial and industrial gas-fired water heaters compared to those in residential water heaters. Identify the basic functions and components of these water heaters. This laboratory corresponds with Performance Task 1.
3. Provide trainees with copies of a cross-section or exploded drawing of an indirect water heater from a set of manufacturer’s instructions, with the terms and labels covered. Have trainees identify the components.
4. Discuss how a heat pump water heater works. Ensure that trainees understand the concept of a heat source and heat sink and how refrigerant is used to transfer heat. Explain the requirements for locating heat pump water heaters.

**SESSION TWO**

Session Two covers water heater safety, particularly the hazards associated with electricity, gas, and steam.

1. Show Session Two PowerPoint® slides.
2. Provide PPE and other safety-related items from the Materials and Equipment List for trainees to examine.
3. Have trainees refer to copies of the local applicable code to identify the section where electric water heater safety requirements are discussed. Review the text related to disconnecting the energy supply. Discuss these requirements in comparison to other types of water heaters.
4. Discuss the dangers of carbon monoxide, flammable vapors, and other combustion by-products when using gas water heaters.
5. Review the safety requirements for water and steam at temperatures hot enough to scald, as stated in the local applicable code and manufacturers’ instructions for water heaters.
Session Three instructs trainees in proper installation techniques for water heaters, with specifics and step-by-step instructions for each type of water heater.

1. Show Session Three PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review considerations for installing water heaters in a location other than a basement.
4. Have trainees refer to Appendix A in the Trainee Guide. Review the common problems, possible causes, and service tips for troubleshooting gas water heaters.
5. Set up a station in the classroom with an electric, gas, tankless, heat pump, or indirect water heater, and the tools and equipment required to install the water heater, including unions, T/P relief valves, pipe, bends, and fittings. Have the trainees practice installing the water heater according to the local applicable code and the manufacturer’s instructions. This laboratory corresponds with Performance Task 2.

Session Four is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Three.) Answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Lesson Plans for Module 02211-13
FUEL GAS AND FUEL OIL SYSTEMS

The Trainee Guide for *Plumbing Level Two* is available as an NCCERconnect ebook. Contact your NCCER customer service representative at 1-888-622-3720 for more information.

**Module Eleven (02211-13)** provides trainees with an introduction to the techniques required for the safe handling of natural gas, liquefied petroleum gas, and fuel oil, and also reviews fuel gas and fuel oil safety precautions and potential hazards, applications, systems installation, and testing.

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**Objectives**

**Learning Objective 1**
- Identify the safety precautions and potential hazards associated with fuel systems.
  - a. Identify the safety precautions and potential hazards of natural gas.
  - b. Identify the safety precautions and potential hazards of LP gas.
  - c. Identify the safety precautions and potential hazards of fuel oil.

**Learning Objective 2**
- Identify the major components of fuel systems:
  - a. Identify the properties and uses of natural gas.
  - b. Identify the properties and uses of LP gas (liquefied petroleum gas).
  - c. Identify the properties and uses of fuel oil.

**Learning Objective 3**
- Apply local codes to various fuel gas systems.
  - a. Identify proper fuel gas connection techniques.
  - b. Size, purge, and test fuel gas systems.

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**Performance Tasks**

**Performance Task 1 (Learning Objective 3)**
- Properly connect appliances to the fuel gas system.

**Performance Task 2 (Learning Objective 3)**
- Perform an air test or visual inspection of a connected fuel gas system.

**Performance Task 3 (Learning Objective 3)**
- Size and purge a fuel gas system.

**Performance Task 4 (Learning Objective 3)**
- Verify pressure of a fuel gas system, using a manometer.

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**Teaching Time:** 20 hours

**(Eight 2.5-Hour Classroom Sessions)**

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**
*Core Curriculum* and *Plumbing Level One*

**Before you Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER's Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**
This module requires that trainees demonstrate the ability to connect appliances to a fuel gas system, perform air tests or visual inspections of a connected fuel gas system, size and purge a fuel gas system, and verify the pressure of a fuel gas system using a manometer. Performance tasks must be completed under your supervision. Each trainee must use required PPE and follow safe tool practices and procedures.

### Classroom Equipment and Materials
- Copies of the Module Examination and Performance Profile Sheets
- *Plumbing Level Two PowerPoint® Presentation Slides, DVD player*
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- LCD projector and screen
- Computer
- Vendor-supplied videos/DVDs showing the techniques required for the safe handling of natural gas, liquefied petroleum gas, and fuel oil (optional)
- TV/VCR (optional)

### Equipment and Materials for Laboratories and Performance Testing
- A sample of a mercaptan
- A fuel gas valve
- A sample of fuel oil
- An assortment of LP gas containers
- An assortment of appliances with the fittings and tubing required to connect them to a fuel gas system
- Tools and equipment for connecting appliances to a fuel gas system
- An assortment of fuel gas piping
- A diaphragm meter
- An assortment of flat-head gas cock, lever-handle gas cock, and ball valves
- A union
- An assortment of anodes
- A relief valve
- An excess flow valve
- A pressure regulator
- A float gauge
- A water manometer
- Tools and materials required to design, size, test, and purge a small-scale fuel gas system

### Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on installing fuel gas and fuel oil systems. A search for additional information may be assigned as homework to interested trainees.
The Lesson Plan for this module is divided into eight 2.5-hour sessions. Each session includes 10 minutes for administrative tasks, and one 10-minute break.

**Session One**

Session One covers fuel gas and fuel oil safety, particularly the identification of safety precautions and potential hazards of natural gas, LP gas, and fuel oil.

1. Show Session One PowerPoint® slides.
2. Provide PPE and other safety-related items from the Equipment and Materials list for trainees to examine.
3. Explain that plumbers need to know about the characteristics of each type of fuel so that they will be able to design, size, install, and test safe and efficient fuel gas and fuel oil systems.
4. Provide copies of the manufacturer’s instructions for a fuel gas appliance. Review the safety instructions for dealing with leaks. Review the repair instructions and compare them with the requirements in the local applicable fuel gas code.

**Session Two**

Session Two introduces trainees to the components of fuel gas and fuel oil systems, and reviews the properties and uses of natural gas, LP gas, and fuel oil.

1. Show Session Two PowerPoint® slides.
2. Discuss the basic characteristics of each type of fuel, and explain why it is essential for plumbers to be familiar with these fuels.

**Session Three**

Session Three reviews the materials and manufacturers’ installation instructions for fuel gas systems.

1. Show Session Three PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review the common properties shared by natural gas, LP gas, and fuel oil.
4. Describe a variety of fuel systems. Have trainees determine which pipe is most suitable for the installation.

**Session Four**

Session Four covers combustion air, venting, appliances, and fire-stopping in fuel gas systems.

1. Show Session Four PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Discuss the importance of combustion air, venting, proper appliance selection, and fire-stopping when installing fuel gas systems.
4. Set up stations with an assortment of appliances with the fittings and tubing required to connect them to a fuel gas system, as well as the tools and equipment required to connect the appliance to a fuel gas system. Provide an assortment of fuel gas piping at each station as well. Have trainees practice connecting appliances to the fuel gas piping according to the local applicable fuel gas code. This laboratory corresponds with Performance Task 1.
Session Five

Session Five provides instruction on how to install natural gas systems.
1. Show Session Five PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review the factors that are specific to natural gas, LP gas, and fuel oil systems.
4. Using a list of materials, installation considerations, and other factors specific to natural gas, ask trainees to identify a specific requirement for each category. Have trainees highlight safety considerations.

Session Six

Session Six provides instruction on how to install LP gas systems.
1. Show Session Six PowerPoint slides.
2. Ensure that trainees are equipped with required PPE.
3. Review materials, installation considerations, and other factors specific to LP gas.
4. Review two-stage regulation, and explain how it provides more accurate control of gas pressure. Discuss the advantages of two-stage regulation over systems that use one regulator. Emphasize the importance of proper venting.
5. Explain how to use unions to connect appliances to gas lines and identify where they should be located.

Session Seven

Session Seven introduces trainees to the techniques required to size, purge, and test fuel gas systems.
1. Show Session Seven PowerPoint slides.
2. Ensure that trainees are equipped with required PPE.
3. Review and discuss the elements in a typical fuel gas piping plan.
4. Provide trainees with the tools and materials required to design, size, test, and purge a small-scale fuel gas system according to your specification. Have the trainees demonstrate the ability to size, test, and purge the system according to the local applicable fuel gas code. Have trainees use manometers to verify the pressure of the system. This laboratory corresponds with Performance Tasks 2 through 4.

Session Eight

Session Eight is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Seven.) Answer any questions that the trainees may have.
1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Lesson Plans for Module 26103-17

INTRODUCTION TO ELECTRICAL CIRCUITS

Module Three (26103-17) discusses basic atomic theory. It also covers units of electrical measurement and explains how unknown values can be determined using Ohm’s law and the power equation. It also provides an overview of schematic diagrams and describes how to calculate the value of a resistor.

Objectives

Learning Objective 1

• Describe atomic structure as it relates to electricity.
  a. Identify the components of an atom.
  b. Compare the atomic structures of conductors and insulators.
  c. Identify the role of magnetism in electrical devices.
  d. Identify the basic components in a power distribution system.

Learning Objective 2

• Identify electrical units of measurement.
  a. Define current.
  b. Define voltage.
  c. Define resistance.
  d. Use Ohm’s law to solve for unknown circuit values.

Learning Objective 3

• Read schematic diagrams.
  a. Identify the symbol for a resistor and determine its value based on color codes.
  b. Distinguish between series and parallel circuits.
  c. Identify the instruments used to measure circuit values.
  d. Calculate electrical power.

Performance Tasks

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

Teaching Time: 7.5 hours
(Three 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites

Core Curriculum

Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint Presentations® and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
**Safety Considerations**

There are no safety considerations for this module.

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**Classroom Equipment and Materials**

- Whiteboard and markers
- Pencils and paper
- *Electrical Level One* PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Sample schematics
- Module Review answer key
- Module Examinations

**Equipment and Materials for Laboratories and Performance Testing**

- Appropriate personal protective equipment
- Basic electrical circuit, including:
  - Battery/power source
  - Wiring
  - Loads
  - Switches
- Examples of conductors, insulators, and color-coded resistors
- Magnets
- Simple electromagnet
- Metal sheet
- Iron filings
- Various types of meters, including:
  - Multimeter
  - Voltmeter
  - Clamp-on ammeter
  - Ohmmeter
  - Continuity tester
  - Voltage tester

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**Additional Resources**

This module presents thorough resources for task training. The following reference material is recommended for further study.


There are a number of online resources available for trainees who would like more information on Ohm’s law and DC circuits. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26103-17

INTRODUCTION TO ELECTRICAL CIRCUITS

The Lesson Plan for this module is divided into three 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE

Session One covers Section 1.0.0, and describes atomic structure as it relates to electricity.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with atomic structure.
3. Identify the components of an atom.
4. Compare the atomic structures of conductors and insulators.
5. Identify the role of magnetism in electrical devices.
6. Identify the basic components in a power distribution system.

SESSION TWO

Session Two covers Section 2.0.0 and defines electrical units of measurement.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with electrical units of measurement.
3. Define current.
4. Define voltage.
5. Define resistance.
6. Use Ohm’s law to solve for unknown circuit values.

SESSION THREE

Session Three covers Section 3.0.0 and introduces schematic diagrams. In addition, this session includes a review of the complete module and the module exam is administered.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with schematic diagrams.
3. Identify the symbol for a resistor and demonstrate how to determine its value based on color codes.
4. Explain the differences between series and parallel circuits.
5. Identify the instruments used to measure circuit values.
6. Demonstrate how to calculate electrical power.
7. Have the trainees complete the module review questions. Go over the review questions in class prior to the exam, and answer any questions that the trainees may have.
8. Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.
## Objectives

### Learning Objective 1
- Calculate values in resistive circuits.
  - a. Identify resistances in series.
  - b. Identify resistances in parallel.
  - d. Apply Ohm’s law to various types of circuits.

### Learning Objective 2
- Apply Kirchhoff’s laws to various types of circuits.
  - a. Use Kirchhoff’s current law.
  - b. Use Kirchhoff’s voltage law.

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

## Teaching Time: 7.5 hours
(Three 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

## Prerequisites

### Core Curriculum

## Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint Presentations® and Performance Profile Sheets from [www.nccerirc.com](http://www.nccerirc.com). For information and updates about accessing the Module Examinations, visit [www.nccer.org/testing](http://www.nccer.org/testing). The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
**Safety Considerations**
There are no safety considerations for this module.

**Classroom Equipment and Materials**
- Whiteboard and markers
- Pencils and paper
- *Electrical Level One PowerPoint® Presentation Slides*
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Sample schematics
- Module Review answer key
- Module Examinations

**Additional Resources**
This module presents thorough resources for task training. The following resource material is recommended for further study.


There are a number of online resources available for trainees who would like more information on electrical theory. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Lesson Plans for Module 26107-17

HAND BENDING

Module Seven (26107-17) describes methods for hand bending conduit. It covers 90-degree bends, back-to-back bends, offsets, and saddle bends. It also describes how to cut, ream, and thread conduit.

Objectives

Learning Objective 1
- Select and use hand bending equipment.
  a. Use geometry to make a bend.
  b. Make 90° bends.
  c. Make offset bends.

Learning Objective 2
- Cut, ream, and thread conduit.
  a. Cut conduit using a hacksaw.
  b. Cut conduit using a pipe cutter.
  c. Ream conduit.
  d. Thread conduit.
  e. Cut and join PVC conduit.

Performance Tasks

Performance Task 1 (Learning Objective 1)
- Make 90° bends, back-to-back bends, offsets, and saddle bends using a hand bender.

Performance Task 2 (Learning Objective 2)
- Cut, ream, and thread conduit.

Note
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Teaching Time: 10 hours
(Four 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint Presentations® and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations
This module requires trainees to work with conduit bending, cutting, and threading equipment. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and remain aware of any safety hazards. Remind trainees that cut conduit has very sharp edges and gloves must be worn at all times. In addition, safety goggles must be worn to protect against hazardous metal debris.

Classroom Equipment and Materials
- Whiteboard and markers
- Pencils and paper
- Electrical Level One PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Copy of the latest edition of the

Equipment and Materials for Laboratories and Performance Testing
- Safety glasses/goggles
- Hard hats
- Work gloves
- Hand bender and manufacturer’s instructions
- Various pieces of conduit
- Hickey bar
- Manufacturers’ gain tables
- PVC heating unit and plug set
- Tape measure
- Calculator
- Pipe vise
- Pipe cutter
- Reamer
- Cutting oil
- Shop towels
- Hand-operated threader
- Sandbox or drip pan
- Torpedo level
- PVC conduit and fittings
- PVC cements
- Hacksaw

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on hand bending. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26107-17

HAND BENDING

The Lesson Plan for this module is divided into four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.2.2, and describes procedures for selecting and using hand bending equipment.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with hand bending.
3. Explain how to use geometry to make a bend.
4. Demonstrate how to make 90° and back-to-back bends using a hand bender.
5. Have the trainees practice making 90° and back-to-back bends using a hand bender. This laboratory corresponds to Performance Task 1.

**SESSION TWO**

Session Two covers Sections 1.3.0 through 1.3.3, and describes procedures for making offset bends.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with offset bends.
3. Demonstrate how to make parallel offset bends.
4. Demonstrate how to make various saddle bends.
5. Have the trainees practice making offset and saddle bends using a hand bender. This laboratory corresponds to Performance Task 1.

**SESSION THREE**

Session Three covers Sections 2.0.0 through 2.5.0, and describe procedures for cutting, reaming, and threading conduit.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with cutting, threading, and reaming conduit.
3. Describe how to cut conduit using a hacksaw.
4. Describe how to cut conduit using a pipe cutter.
5. Explain how to ream conduit.
6. Describe how to thread conduit.
7. Explain how to cut and join PVC conduit.

**SESSION FOUR**

Session Four is reserved for a laboratory and performance testing.

1. Demonstrate how to cut, ream, and thread conduit.
2. Have the trainees practice cutting, reaming, and threading conduit. This laboratory corresponds to Performance Task 2.
3. Have the trainees complete the module review questions. Go over the review questions in class prior to the exam and answer any questions that the trainees may have.
4. Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.
Module Eight (26108-17) describes various types of raceway systems, along with their installation and NEC® requirements. It also describes the use of various conduit bodies.

**Objectives**

**Learning Objective 1**
- Select and install raceway systems.
  - a. Identify types of conduit and their applications.
  - b. Properly bond conduit for use as a ground path.
  - c. Install metal conduit fittings.
  - d. Make conduit-to-box connections.
  - e. Identify raceway supports.
  - f. Identify installation requirements for various construction methods.

**Learning Objective 2**
- Select fasteners and anchors for the installation of raceway systems.
  - a. Select and install tie wraps.
  - b. Select and install screws.
  - c. Select and install hammer-driven pins and studs.
  - d. Identify the safety requirements for stud-type guns.
  - e. Select and install masonry anchors.
  - f. Select and install hollow-wall anchors.
  - g. Select and install epoxy anchoring systems.

**Learning Objective 3**
- Select and install wireways and other specialty raceways.
  - a. Identify types of wireways and their components.
  - b. Install wireway supports.
  - c. Identify and install specialty raceways.

**Learning Objective 4**
- Select and install cable trays.
  - a. Identify cable tray types and fittings.
  - b. Install cable tray supports.

**Learning Objective 5**
- Handle and store raceways.
  - a. Handle raceways.
  - b. Store raceways.

**Performance Tasks**

**Performance Task 1 (Learning Objective 1)**
- Identify the appropriate conduit body for a given application.

**Performance Task 2 (Learning Objective 2)**
- Identify and select various types and sizes of raceways, fittings, and fasteners for a given application.

**Performance Task 3 (Learning Objective 2)**
- Demonstrate how to install a raceway system.

**Performance Task 4 (Learning Objective 2)**
- Terminate a selected raceway system.

**Note**
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**Teaching Time: 20 hours**
(Eight 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**
Core Curriculum
Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® Presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.

Safety Considerations
This module requires trainees to work with conduit and fasteners with sharp edges. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and remain aware of any safety hazards.

Classroom Equipment and Materials
Whiteboard and markers
Pencils and paper
Electrical Level One PowerPoint® Presentation Slides
DVD player
LCD projector and screen
Computer
Internet access during class (optional)

Equipment and Materials for Laboratories and Performance Testing
Appropriate personal protective equipment
Sample sections and fittings for the following types of conduit:
  EMT
  RMC
  Plastic-coated RMC
  Aluminum
  Rigid black
  IMC
  EB and DB RNC
  LFNC
  Flexible metal
Various conduit couplings
Combination couplings
Offset nipples
Type C, Type L, Type T, and Type X conduit bodies
Various types of bushings
Insulated bushings
Threaded waterproof hubs
Seal fittings and packing material
Liquid sealing compound
Various straps
Standoff support
Framing channel

Copy of the latest edition of the National Electrical Code®
OSHA Electrical Safety Guidelines (pocket edition)
Powder-actuated tool operator’s certification training program
Calculator
Module Review answer key
Module Examinations
Performance Profile Sheets

Beam clamps
Concrete, masonry, and wood for fastener application
Assorted hand tools (wrenches, screwdrivers, hammers)
Drills/drivers and assorted drill bits
Hammer-driven tools with related pin and stud fasteners
Powder-actuated tool, powder charges, and related pin and stud fasteners
Assorted threaded fasteners, including:
  Bolts
  Cap screws
  Studs
  Machine screws
  Nuts
  Washers
  Special threaded fasteners
  Tie wraps
Assorted screws, including:
  Wood screws
  Lag screws and shields
  Concrete/masonry screws
  Thread-forming (sheet metal) and thread-cutting screws
  Deck screws
  Drywall screws
Equipment and Materials for Laboratories and Performance Testing
(Continued)

Assorted mechanical anchors and assorted anchor fastening tools, including:
- Wedge
- Stud
- Sleeve
- One-piece
- Hammer-driven
- Drop-in
- Expansion shields
- Screw (fiber, lead, plastic)
- Self-drilling
- Toggle bolts
- Sleeve-type
- Wallboard
- Metal drive-in
- Metal boxes
- Nonmetallic boxes
- Bushings and locknuts

Access to job site where trainees can observe a variety of wireway components, including:
- Connectors
- End plates
- Closing plates
- Tee fittings
- Crosses
- Elbows
- Nipples
- Slip fittings

Access to job site where trainees can observe a variety of cable tray support systems, including:
- Direct rod
- Trapeze mounting
- Center hung support
- Wall mounting
- Pipe rack mounting

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study:


There are a number of online resources available for trainees who would like more information on installing raceways and fittings. A search for additional information may be assigned as homework to interested trainees. Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into eight 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0–1.1.10, and describes various types of conduit and their applications.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with types of conduit.
3. Identify various types of conduit and their applications.

**SESSIONS TWO AND THREE**

Sessions Two and Three cover Sections 1.2.0–1.6.4, and describe procedures for bonding conduit and selecting metal conduit fittings.

1. Show the Session Two and Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with metal conduit fittings.
3. Demonstrate how to bond conduit for use as a ground path.
4. Demonstrate how to install metal conduit fittings.
5. Demonstrate how to make conduit-to-box connections.
6. Identify various types of raceway supports and describe how they are installed.
7. Identify the installation requirements for various construction methods.
8. Have the trainees identify the appropriate conduit body for a given application. This laboratory corresponds to Performance Task 1.

**SESSIONS FOUR THROUGH SIX**

Sessions Four through Six cover Section 2.0.0, and describe procedures for selecting fasteners and anchors.

1. Show the Sessions Four through Six PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the fasteners and anchors used in raceway systems.
3. Demonstrate how to select and install various fasteners, including tie wraps, screws, and hammer-driven pins and studs.
4. Identify the safety requirements for stud-type guns.
5. Demonstrate how to select and install various anchors, including masonry anchors, hollow-wall anchors, and epoxy anchoring systems.
6. Demonstrate how to install and terminate a raceway system.
7. Have the trainees complete the following tasks:
   - Identify and select various types and sizes of raceways, fittings, and fasteners for a given application.
   - Demonstrate how to install a raceway system.
   - Terminate a selected raceway system.

This laboratory corresponds to Performance Tasks 2 through 4.
# Session Outline for Module 26108-17

## Raceways and Fittings

### Session Seven

Session Seven covers Section 3.0.0, and describes procedures for selecting and installing wireways and other specialty raceways.

1. Show the Session Seven PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with wireways and raceways.
3. Identify various types of wireways and their components.
4. Explain how to install wireway supports.
5. Identify types of specialty raceways and describe how they are installed.

### Session Eight

Session Eight covers Sections 4.0.0 and 5.0.0, and describes procedures for selecting and installing cable trays. In addition, this session includes a review of the complete module and administering the module exam.

1. Show the Session Eight PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with cable tray systems.
3. Provide an overview of various cable tray types and fittings.
4. Explain how to install cable tray supports.
5. Demonstrate how to connect, bond, and support a cable tray system.
6. Discuss the proper storage and handling of raceways.
7. Have the trainees complete the module review questions. Go over the review questions in class prior to the exam and answer any questions that the trainees may have.
8. Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.
Lesson Plans for Module 26203-17

ELECTRIC LIGHTING

Module Three (26203-17) describes the principles of human vision and the characteristics of light. It describes how to identify and install incandescent, LED, fluorescent, and HID lamps and ballasts. It also examines how to select and install various types of lighting fixtures and lighting controls.

### Objectives

#### Learning Objective 1
- Explain the relationship between human vision and light.
  - a. Identify how the human eye operates.
  - b. Identify the characteristics of light.

#### Learning Objective 2
- Identify and install lamps and ballasts.
  - a. Identify and install lamps.
  - b. Identify and install ballasts.

#### Learning Objective 3
- Select and install lighting fixtures for various applications.
  - a. Identify lighting fixtures and their applications.
  - b. Store and handle lamps and lighting fixtures.
  - c. Install lighting fixtures.

#### Learning Objective 4
- Select lighting controls for various applications.
  - a. Select occupancy sensors.
  - b. Select photosensors.
  - c. Use lighting timers.
  - d. Program energy management systems.

### Performance Tasks

#### Performance Task 1 (Learning Objective 2)
- Properly select and install lamps into lighting fixtures.

#### Performance Task 2 (Learning Objective 3)
- Install one or more of the following lighting fixtures and their associated lamps:
  - Surface-mounted
  - Recessed
  - Suspended
  - Track-mounted

### Note
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### Teaching Time: 15 hours
(Six 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
**Safety Considerations**

Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC® requirements.

**Equipment, Materials, and Resources**

Whiteboard and markers
Pencils and paper
*Electrical Level Two PowerPoint® Presentation Slides*
DVD player
LCD projector and screen
Computer
Internet access during class (optional)
Module Examinations
Performance Profile Sheets
Prism
Lamp manufacturers’ catalogs
Various types of halogen lamps
LED lamps
Fluorescent lamps
CFLs
HID lamps
Various types of ballasts
Outlet boxes for surface-mounted fixtures
Various fixture mounting assemblies and manufacturer’s instructions

Different types of lighting fixtures, including:
- Surface-mounted
- Recessed
- Suspended
- Track-mounted

Hangers and supports used with suspended lighting fixtures
Components for a typical track lighting installation
Occupancy sensors
Photosensors
Timers
Module Review answer key
Standard eye protection
Work gloves
Hard hat
Proper footwear as designated by the instructor or training facility provider
Hearing protection as designated by the instructor or training facility provider

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


Online resources are available for trainees who would like more information on electric lighting. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26203-17

ELECTRIC LIGHTING

The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 2.1.7. It explains the relationship between human vision and light, and describes how to identify and install various types of lamps.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with electric lighting.
3. Describe how the human eye functions.
4. Identify the characteristics of light.
5. Explain the operation of incandescent lamps.
6. Describe how to choose light emitting diode (LED) lamps for various applications.
7. Describe how to choose fluorescent lamps for various applications.
8. Describe how to choose high-intensity discharge (HID) lamps for various applications.
9. Identify lamp color rendering and color temperature characteristics.
10. Explain how to install lamps.

**SESSION TWO**

Session Two covers Sections 2.2.0 through 3.2.0. It explains how to identify and install ballasts, and how to select lighting fixtures for various applications.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with various types of ballasts and lighting fixtures.
3. Identify and install fluorescent lighting fixture ballasts.
4. Identify and install HID lighting fixture ballasts.
5. Identify lighting fixtures and their applications.
6. Describe how to store and handle lamps and lighting fixtures.
Session Outline for Module 26203-17

**ELECTRIC LIGHTING**

### SESSION THREE

Session Three covers Sections 3.3.0 through 3.3.5, and explains how to install various types of lighting fixtures.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with installation procedures for different types of lighting fixtures.
3. Describe how to install surface-mounted lighting fixtures.
4. Describe how to install recessed lighting fixtures.
5. Describe how to install suspended lighting fixtures.
6. Describe how to install track lighting fixtures.
7. Explain how to make electrical connections to lighting fixtures.

### SESSION FOUR

Session Four covers Sections 4.0.0 through 4.4.0, and describes how to select lighting controls for various applications.

1. Show the Session Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with various types of lighting control devices.
3. Explain how to select occupancy sensors.
4. Explain how to select photosensors.
5. Describe how to use lighting timers.
6. Describe how to program energy management systems.

### SESSION FIVE

Session Five is set aside for lab work needed to satisfy the module performance tasks. You can allocate lab time for these activities based on class size and available facilities. One approach would be to have some trainees complete one performance task while others work on the other performance task.

1. Have the trainees demonstrate how to properly select and install lamps into lighting fixtures.
2. Have the trainees demonstrate how to install one or more of the following lighting fixtures and their associated lamps:
   - Surface-mounted
   - Recessed
   - Suspended
   - Track-mounted

Upon completion of the lab work, ask the trainees to complete the module Review Questions and Supplemental Exercises before the upcoming review and testing session.

### SESSION SIX

Session Six is a review and testing session. Go over the module Review Questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing.
2. Submit the results to your Training Program Sponsor through the Registry System.
The Trainee Guide for *HVAC Level One* is available as an NCCERconnect ebook. Contact your NCCER customer service representative at 1-888-622-3720 for more information.

**Module One (03101-13)** provides a broad introduction to the world of the HVAC technician. The most basic operating principles of HVAC systems are presented along with a review of technician licensing and trade-governing regulations. The final portion of the module describes potential career paths for the well-trained HVAC technician.

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**Objectives**

**Learning Objective 1**
- Explain the basic principles of heating, ventilation, air conditioning, and refrigeration.
  - a. Explain the principles of heating.
  - b. Explain the principles of ventilation.
  - c. Explain the principles of air conditioning.
  - d. Explain the principles of refrigeration.

**Learning Objective 2**
- Describe the principles that guide HVAC/R installation and service techniques.
  - a. Identify common safety principles and organizations.
  - b. Describe the importance of LEED construction and energy management.
  - c. Describe trade licensing and certification requirements.
  - d. Identify important codes and permits.

**Learning Objective 3**
- Identify career paths available in the HVAC/R trade.
  - a. Identify the responsibilities and characteristics needed to be a successful HVAC/R technician.
  - b. Identify residential, commercial, and industrial career opportunities.
  - c. Describe opportunities provided by equipment manufacturers.

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

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**Teaching Time: 7.5 hours**
(Three 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**
Completion of NCCER *Core Curriculum*.

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
### Safety Considerations

This is a knowledge-based module and no performance tasks are required. However, instructors may choose to expose trainees to the HVAC shop environment or an active job site. Ensure that trainees possess and use the required PPE during any exposure to these types of settings.

### Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level One PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Copies of the Module Examination

### Equipment and Materials for Laboratories and Performance Testing

- Personal protective equipment (if the HVAC shop area or a job site is visited):
  - Standard eye protection
  - Gloves
  - Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Hard hats

### Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

- *Your Role in the Green Environment*. Alachua, FL: NCCER.
- *Tools for Success*. Alachua, FL: NCCER.

There are a number of online resources available for trainees who would like more information on HVAC/R systems and their application. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper issues.

Instructors are also encouraged to locate additional audiovisual aids available through the internet, make personal videos, and take still pictures related to the HVAC/R trade and add them to the PowerPoint® presentations throughout the program.
Session Outline for 03101-13
INTRODUCTION TO HVAC

The Lesson Plan for this module is divided into three 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE
Session One introduces trainees to the basic principles of HVAC/R systems and some of the guiding principles of trade safety, LEED construction, and energy management.
1. Show Session One PowerPoint® slides.
2. Use the Kickoff Activity to get trainees engaged and introduce them to the subject matter.
3. Use both lecturing and visual aids to present the topics of the session.
4. Emphasize the important role of the HVAC technician in maintaining indoor air quality and energy efficiency.

SESSION TWO
Session Two covers HVAC trade licensing and certification, as well as an introduction to building codes and permits. The potential career paths for the well-trained technician are also explored.
1. Show Session Two PowerPoint® slides.
2. Explain licensure requirements for technicians and contractors.
3. Present information regarding refrigerants and the environment.
4. Talk about building codes and permits.
5. Present trainees with a variety of HVAC career options and review USDOL statistics on the trade.

SESSION THREE
Session Three is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Two.) Go over the Module Review Questions in class and answer any questions that the trainees may have.
1. Have trainees complete the written examination.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
The Trainee Guide for *HVAC Level One* is available as an NCCERconnect ebook. Contact your NCCER customer service representative at 1-888-622-3720 for more information.

**Module Four (03108-13)** provides HVAC technicians with an overview of common residential heating systems. Fundamental concepts of heating and combustion systems are described with an emphasis on gas forced-air heating systems. Hydronic heating systems and different types of electric forced-air heating systems are also described.

## Objectives

### Learning Objective 1
- Explain the fundamental concepts of heating and combustion.
  - a. Describe the heat transfer process.
  - b. Identify gas fuels and their combustion characteristics.

### Learning Objective 2
- Describe the role of forced-air gas furnaces in residential heating.
  - a. Describe the types of gas furnaces and how they operate.
  - b. Identify and describe the equipment and controls used in gas furnaces.
  - c. Describe the basic installation and maintenance requirements for gas furnaces.

### Learning Objective 3
- Describe hydronic and electric heating systems.
  - a. Describe the operation of hydronic heating systems.
  - b. Describe the operation of electric heating equipment.

## Performance Tasks

### Performance Task 1
- Identify components of induced-draft and condensing furnaces and describe their function.

### Performance Task 2
- Perform common maintenance tasks on a gas furnace including air filter replacement and temperature measurements.

## Teaching Time: 15 hours

(Six 2.5-Hour Sessions, 2.5 hours for Performance Testing)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

## Prerequisites

Completion of NCCER *Core Curriculum*.

## Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
### Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level One PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Copies of the Module Examination and Performance Profile Sheets

### Equipment and Materials for Laboratories and Performance Testing
- Thermometers for air and surface temperature measurement
- Short lengths of metal pipe (copper and steel)
- Light plastic bags
- Electric hair dryer
- Components and controls that have been removed from gas furnaces, including but not limited to:
  - Different types of gas valves
  - Clean and dirty air filters
  - Typical heat exchanger assembly
  - ECM motor
  - Standard PSC motor
  - Burner assemblies
  - Ignition controls and devices
  - Flame rectifier
  - Thermocouple and thermopile
  - Safety controls
  - Assorted gas-fired forced air furnace configurations (at least one operating furnace)
  - Assorted boiler controls and components (removed from boiler)
  - An electric furnace and/or heat pump fan coil with supplemental electric heaters
- A small gas-fired packaged boiler
- Furnace and boiler manufacturer’s product literature
- Heat pump balance point worksheets
- Typical metal and PVC furnace venting materials
- Assorted hand tools used to disassemble and/or gain access to components
- Gauge and/or manometer with necessary connecting devices to measure furnace gas manifold pressure
- Assorted disposable furnace air filters
- Small paper tags with strings
- Small paper stickers
- Personal protective equipment:
  - Standard eye protection
  - Work gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hats

### Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on both common and unique heating systems. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper issues.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the HVAC/R trade and add them to the PowerPoint® presentations throughout the program.
### Session Outline for 03108-13

**INTRODUCTION TO HEATING**

The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

<table>
<thead>
<tr>
<th>Session One</th>
<th>Session Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session One introduces trainees to the basic principles of combustion and heat transfer. This session is designed for the classroom environment only.</td>
<td>Session Three deals with gas furnace installation and maintenance. The need for adequate air for ventilation and combustion is discussed along with the need for adequate return air in the duct system.</td>
</tr>
<tr>
<td>1. Show the Session One PowerPoint® presentation.</td>
<td>1. Show the Session Three PowerPoint® presentation.</td>
</tr>
<tr>
<td>2. Use the Kickoff Activity to get trainees engaged and introduce them to the subject matter.</td>
<td>2. Explain that furnace location and the environment in which it is installed can affect furnace operation.</td>
</tr>
<tr>
<td>3. Use a demonstration to present the topic of heat transfer.</td>
<td>3. Describe combustion air and safety issues related to combustion byproducts.</td>
</tr>
<tr>
<td>4. Discuss the combustion process and the concept of combustion efficiency.</td>
<td>4. Review the importance of proper installation and maintenance.</td>
</tr>
<tr>
<td>5. Describe how various maintenance procedures are performed.</td>
<td>6. Describe how various maintenance procedures are performed.</td>
</tr>
</tbody>
</table>

**Session Two**

Session Two introduces gas furnaces. The components and controls of gas furnaces are also covered. This session should be presented in the classroom and the lab.

1. Show the Session Two PowerPoint® presentation.
2. Review the various gas furnace configurations.
3. Describe the various primary and secondary components and controls used in a gas furnace and the purpose of each one.
4. Use video to further familiarize trainees with various components.

**Session Four**

Session Four is devoted to demonstrations and Performance Tasks. Trainees will practice identifying all types of furnace components and performing specific maintenance activities.

1. Note that no PowerPoint® presentation is associated with this session.
2. Have trainees identify various furnace components in non-condensing and condensing furnaces.
3. Demonstrate how to replace an air filter, take temperature measurements, calculate temperature rise, and measure gas manifold pressures on an operational warm-air heating system.
4. Under your supervision, have trainees replace an air filter, measure supply and return air temperatures, calculate temperature rise, and measure gas manifold pressures.
**Session Outline for 03108-13**

**INTRODUCTION TO HEATING**

<table>
<thead>
<tr>
<th><strong>SESSION FIVE</strong></th>
<th><strong>SESSION SIX</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Session Five introduces hydronic and electric heating systems. Similarities and differences between gas forced-air systems and these systems are discussed.</td>
<td>Session Six is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. These may have been assigned as homework at the end of Session Five. Go over the Module Review Questions and Trade Terms Quiz in class and answer any questions that the trainees may have.</td>
</tr>
<tr>
<td>1. Show the Session Five PowerPoint® presentation.</td>
<td>1. Have trainees complete the written examination.</td>
</tr>
<tr>
<td>2. Describe the advantages and disadvantages of hydronic heating systems.</td>
<td>2. Complete any remaining Performance Tasks.</td>
</tr>
<tr>
<td>3. Point out the various components of a small packaged boiler including safety controls.</td>
<td>2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.</td>
</tr>
<tr>
<td>4. Describe the components found in an electric forced-air furnace. Discuss similarities and differences between an electric furnace and a gas-fired furnace.</td>
<td></td>
</tr>
<tr>
<td>5. Describe how a heat pump operates to provide heat efficiently.</td>
<td></td>
</tr>
<tr>
<td>6. Present the concept of a structure’s balance point.</td>
<td></td>
</tr>
</tbody>
</table>
Lesson Plans for Module 03107-13

INTRODUCTION TO COOLING

The Trainee Guide for HVAC Level One is available as an NCCERconnect ebook. Contact your NCCER customer service representative at 1-888-622-3720 for more information.

Module Five (03107-13) introduces the fundamental concepts of the mechanical refrigeration cycle and examples of the primary components required to make it work. Some common refrigerants and their characteristics are also introduced. Upon completion, trainees will be able to identify typical pressure and temperature measuring instruments and some of the most common primary and secondary controls used to manage the refrigeration cycle.

Objectives

Learning Objective 1
- Explain the fundamental concepts of the refrigeration cycle.
  a. Describe how heat affects the state of substances.
  b. Explain how heat is transferred from one substance to another.
  c. Describe pressure-temperature relationships.
  d. Describe the basic pattern of refrigerant flow and the changes of state that occur in the refrigeration cycle.
  e. Identify common instruments used to measure pressure and temperature.

Learning Objective 2
- Identify common refrigerants and their basic characteristics.
  a. Identify fluorocarbon refrigerants.
  b. Describe the use of ammonia as a refrigerant.
  c. Identify various refrigerant containers and their safe handling requirements.

Learning Objective 3
- Identify the major components of cooling systems and how they function.
  a. Identify basic compressors and their function in the system.
  b. Identify different condensers used to transfer heat.
  c. Identify different evaporators used to transfer heat.

Learning Objective 4
- Identify the common controls used in cooling systems and how they function.
  a. Identify common primary controls.
  b. Identify controls that are secondary to the process.
  d. Describe the devices used to meter refrigerant flow.
  e. Discuss basic refrigerant piping concepts.
  f. Identify various accessories used in refrigeration circuits.

Performance Tasks

Performance Task 1 (Learning Objective 1)
- Measure temperatures in an operating cooling system.

Performance Task 2 (Learning Objective 1)
- Calibrate a set of refrigerant gauges and thermometers.

Performance Task 3 (Learning Objective 1)
- Connect a refrigerant gauge manifold and properly calculate subcooling and superheat on an operating system using a temperature probe.

Performance Task 4 (Learning Objective 2)
- Identify refrigerants using cylinder color codes.

Performance Task 5 (Learning Objectives 3 and 4)
- Identify compressors, condensers, evaporators, metering devices, controls, and accessories.

Teaching Time: 30 hours
(Twelve 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Completion of NCCER Core Curriculum.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**
This module requires that trainees work with and in the vicinity of functioning HVAC equipment as well as live electrical circuits at less than 500VAC. Electrical, mechanical, and refrigerant safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards of energized and operating HVAC/R systems and refrigerant circuits. Any deficiencies must be corrected to ensure future trainee safety as they begin working with even more hazardous systems later in their training and career. All practice sessions and performance tasks must be completed under your direct supervision.

**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level One PowerPoint® Presentation
- DVD player
- LCD projector and screen
- Computer
- Calculators
- Copies of the Module Examination and Performance Profile Sheets

**Equipment and Materials for Laboratories and Performance Testing**
- Apparatus to boil water
- Suitable container, preferably clear, to boil water
- A material that conducts heat readily, such as a small metal box
- A material that insulates against heat transfer, such as a small polystyrene block
- A selection of temperature measurement instruments for examination
- Temperature measurement instruments suitable for measuring the temperature of both refrigerant lines and air
- Dial or digital pocket thermometers suitable to demonstrate calibration
- One or more beakers to boil water and hold an ice/water mixture
- A few fresh ice cubes
- Crushed or shaved ice and water
- Small adjustable or properly sized wrenches to adjust pocket thermometer(s)
- Refrigeration gauge sets
- Pocket screwdrivers
- Fire extinguisher
- Task sheets for trainee entries during practice/Performance Tasks with the following entries:
  - Air temperature entering the condenser:
  - Air temperature leaving the condenser:
  - Suction line temperature at the condensing unit:
  - Suction line pressure at the condensing unit:
  - Calculated superheat:
- Liquid line temperature at the condensing unit:
- Liquid line pressure at the condensing unit:
- Calculated subcooling:
- Air temperature entering the evaporator:
- Air temperature leaving the evaporator:
- A selection of different compressors (optional)
- A selection of different condensers (optional)
- A selection of different evaporators (optional)
- A selection of different metering devices
- A selection of primary and secondary control devices, including various temperature and pressure controls and an oil pressure safety switch
- A selection of refrigerant circuit accessories
- A variety of disposable refrigerant cylinders with colors clearly identifiable (at least four)
- Personal protective equipment:
  - Standard eye protection
  - Work gloves
  - Butyl-lined gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hats


**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on HVAC/R systems and their application. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper issues.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the HVAC/R trade and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into twelve 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**
Session One begins by refreshing trainees’ previous learning about the movement of heat and temperature measurement. The states of matter are discussed, as well as how matter changes from one state to another.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Review the conversion of temperature measurement units.
4. Review the states of matter and compare latent and sensible heat.
5. Define superheat and subcooling and explain their relevance to refrigeration.

**SESSION TWO**
Session Two focuses on the methods of heat transfer and how it is measured. Pressure-temperature relationships are explored along with how P-T charts are used.
1. Show the Session Two PowerPoint® presentation.
2. Describe and demonstrate conduction, convection, and radiation.
3. Discuss heat transfer rates.
4. Explain absolute and gauged pressure values.
5. Explain the relationship between the temperature and pressure of liquid and gaseous refrigerants.

**SESSION THREE**
Session Three introduces trainees to the primary components of the refrigeration cycle and the various changes of state that occur within the cycle. A complete HFC-410A refrigerant cycle is explored in its entirety.
1. Show the Session Three PowerPoint® presentation.
2. Identify the four primary components in the refrigeration cycle.
3. Identify the primary refrigerant lines that comprise a typical system.
4. Review a complete refrigerant cycle based on the characteristics of refrigerant HFC-410A.

**SESSION FOUR**
Session Four presents the various instruments used to measure temperature and refrigerant pressure in the HVAC/R industry. Trainees are also given an opportunity to practice and/or complete Performance Task 2.
1. Show the Session Four PowerPoint® presentation.
2. Explore different types of thermometers.
3. Demonstrate how to calibrate thermometers designed for field calibration.
4. Have trainees practice and/or satisfy some requirements of Performance Task 2 by calibrating thermometers with freezing and boiling water.
5. Discuss refrigerant gauges and gauge manifolds.
6. Demonstrate how to calibrate refrigerant gauges to zero.
7. Trainees practice and/or satisfy the remaining requirements of Performance Task 2 by calibrating refrigerant gauges.
8. Present different refrigerants and how they differ in chemical structure.
9. Differentiate between mixtures and compounds.
### Session Five
Session Five introduces ammonia as a refrigerant. In addition, various types of refrigerant cylinders and their characteristics and handling requirements are explored. Trainees are provided an opportunity to practice and/or complete Performance Task 4.

1. Show the Session Five PowerPoint® presentation.
2. Identify the common types of refrigerant cylinders.
3. Discuss the characteristics and color-coding of various cylinders.
5. Trainees practice and/or complete Performance Task 4 by identifying various refrigerants by cylinder color.

### Session Six
Session Six is devoted to Laboratories and Performance Tasks 1 and 3.

1. Note that there is no PowerPoint® presentation associated with this session.
2. Demonstrate the measurement of temperatures and refrigerant pressures on an operating cooling system.
3. Have trainees practice and/or complete the tasks associated with Performance Tasks 1 and 3.

### Session Seven
Session Seven provides greater insight into the types of compressors used in the HVAC/R trade. A short visit to a campus site served by screw and/or centrifugal compressors is recommended as part of the session.

1. Show the Session Seven PowerPoint® presentation.
2. Identify various types of compressors and explore their applications and differences.
3. Organize an opportunity for trainees to see screw and/or centrifugal compressors in operation.

### Session Eight
Session Eight explores the types of condensers and evaporators in detail. Their construction characteristics and applications are presented. An opportunity for trainees to see the steps associated with water-cooled condenser sizing and selection is also provided.

1. Show the Session Eight PowerPoint® presentation.
2. Describe the function of condensers.
3. Describe air-cooled and water-cooled condenser types.
4. Explain the function of cooling towers in water-cooled systems.
5. Describe the function of evaporators.
6. Differentiate between direct expansion and flooded evaporator types.

### Session Nine
Session Nine presents the various types of refrigerant metering devices used in HVAC/R systems. The basic design concepts of refrigerant piping systems are also explored.

1. Show the Session Nine PowerPoint® presentation.
2. Describe fixed and adjustable metering devices.
3. Explain how the precise amount of pressure drop must be provided by a metering device.
4. Describe the various types of adjustable metering devices.
5. Explore the operation of thermostatic expansion valves.
6. Describe the various refrigerant piping sections required for a system to operate.
7. Discuss the design and installation considerations related to each line type based on its function.
SESSION TEN

Session Ten focuses on some of the common accessories found in refrigerant circuits.

1. Show the Session Ten PowerPoint® presentation.
2. Describe and discuss the function of filter-driers and sight glasses.
3. Explain the function of suction accumulators.
4. Discuss compressor crankcase heaters and explain their function.
5. Describe the operation of oil separators and why they may be applied.
6. Explain the purpose of receivers.
7. Describe the various types of service valves and their uses.
8. Discuss the application of mufflers.

SESSION ELEVEN

Session Eleven discusses the common primary and secondary controls related to HVAC/R systems. In addition, trainees practice and/or complete the requirements of Performance Task 5.

1. Show the Session Eleven PowerPoint® presentation.
2. Present and differentiate between primary and secondary control devices.
3. Show how various thermostats and humidistats operate.
4. Discuss the applications for pressure controls.
5. Explain how time clocks and timers can be applied.
6. Describe various valves and flow switches associated with system control.
7. Explore pressure-relief devices.
8. Have trainees practice and/or complete the requirements for Performance Task 5.

SESSION TWELVE

Session Twelve is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. Alternatively, these may be assigned as homework at the end of Session Eleven. Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Six (03109-13) introduces the fundamental concepts of air movement and explains how these concepts form the basis for air distribution system design. With an understanding of these fundamentals, trainees are introduced to air measurement devices and the mechanical equipment used to initiate and maintain air movement. The module concludes with a review of air distribution system components and design strategies for different climates. Trainees will also practice using various air measurement devices and interpret charts related to air distribution system sizing.

Objectives

Learning Objective 1
• Describe the factors related to air movement and its measurement in air distribution systems.
  a. Describe how pressure, velocity, and volume are interrelated in airflow.
  b. Describe air distribution in a typical residential system.
  c. Identify common air measurement instruments.

Learning Objective 2
• Describe the mechanical equipment and materials used to create air distribution systems.
  a. Describe various blower styles and applications.
  b. Describe various fan designs and applications.
  c. Demonstrate an understanding of the Fan Laws.
  d. Describe common duct materials and fittings.
  e. Identify the characteristics of common grilles, registers, and dampers.

Learning Objective 3
• Identify the different approaches to air distribution system design and energy conservation.
  a. Identify air system design strategies for cold climates.
  b. Identify air system design strategies for warm climates.
  c. Explain the importance of maximizing energy efficiency through the proper insulation, sealing, and testing of air distribution systems.

Performance Tasks

Performance Task 1 (Learning Objective 1)
• Use a tachometer to measure blower motor rpm.

Performance Task 2 (Learning Objectives 1 and 2)
• Read and interpret equivalent length charts and required air volume/duct size charts.

Performance Task 3 (Learning Objective 1)
• Use a manometer to measure static pressure in a duct system.

Performance Task 4 (Learning Objective 2)
• Use a velometer to measure the velocity of airflow at the output of air system supply diffusers and registers.

Performance Task 5 (Learning Objective 1)
• Use a velometer to calculate system cfm.

Teaching Time: 15 hours
(Six 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Completion of NCCER Core Curriculum.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**
This module requires that trainees work with and in the vicinity of functioning HVAC equipment. Electrical and mechanical safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards of energized and operating HVAC/R systems. Any deficiencies must be corrected to ensure future trainee safety as they begin working with even more hazardous systems later in their training and career. All practice sessions and performance tasks must be completed under your direct supervision.

**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level One PowerPoint®
- Presentations
- DVD player
- LCD projector and screen
- Computer
- Calculators
- Copies of the Module Examination and Performance Profile Sheets

**Equipment and Performance Testing**
- U-tube manometers and/or inclined-tube manometers
- Electronic manometers (optional)
- Velometers
- Rotating vane anemometers (optional)
- Hot-wire anemometers (optional)
- Contact and non-contact tachometers, or instruments that combine the two functions
- SMACNA HVAC Duct Design Calculator, or equal tool, for sizing duct

**Personal protective equipment:**
- Standard eye protection
- Work gloves
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Hard hats

**Additional Resources**
This module presents thorough resources for task training. The following resource material is suggested for further study.

- *Thermal and Moisture Protection*. Alachua FL: NCCER.
- *Insulating Pipes, Ducts, and Water Heaters*. Alachua FL: NCCER.

There are a number of online resources available for trainees who would like more information on HVAC/R systems and their application. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper issues.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the HVAC/R trade and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One explores the relationship between airflow and pressure in air distribution systems. The instruments used to make various measurements in an air distribution system are introduced, along with information about their operation and use.

1. Show the Session One PowerPoint® presentation.
2. Assign the Kickoff Activity to get trainees engaged and provide them with a practical means of focusing their learning in this module.
3. Present the measurable pressure values in a duct system.
4. Review the movement of air through a simple, yet complete air distribution system.
5. Introduce temperature and humidity instruments.
6. Introduce pressure and velocity measurement devices.
7. Introduce measurements that measure rotational speed.

6. Demonstrate the use of velometers and/or anemometers to measure outlet and duct velocity.
7. Have trainees use a velometer to take various measurements and use the information to calculate airflow volume in a duct.

**SESSION THREE**

Session Three focuses on the equipment and materials that comprise a basic, complete air distribution system. The primary equipment, materials, and components are explored in detail individually.

1. Show the Session Three PowerPoint® presentation.
2. Identify different types of blowers and fans and their performance characteristics.
3. Present the Fan Laws and explain how they are used.
4. Introduce the basic concepts of design and related codes.
5. Review the materials and components used to construct duct.
**Session Four**

Session Four is a laboratory and Performance Task session. Instructors demonstrate the use of common duct-sizing aids using simple one-line layouts. Have trainees then practice sizing ducts and provide an opportunity to practice and/or complete Performance Task 2.

1. Note that no PowerPoint® presentation is associated with this session.
2. Demonstrate the use of duct-sizing aids based on a simple one-line diagram prepared prior to the session.
3. Have trainees practice sizing duct for a similar one-line layout using different air volume values.

**Session Five**

Session Five introduces trainees to the various air distribution system layouts used in residential applications. Duct sealing, insulation, and vapor barriers are also explored.

1. Show the Session Five PowerPoint® presentation.
2. Introduce various perimeter systems.
3. Introduce different extended plenum systems.
4. Compare and contrast approaches for warm and cold climates.
5. Introduce various overhead design approaches.
6. Emphasize the importance of duct sealing and insulation and discuss the process of duct leakage testing.

**Session Six**

Session Six is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. Alternatively, these may be assigned as homework at the end of Session Five. Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.