Lesson Plans for Module 02201-13
PLUMBING MATH TWO

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 One (02201-13) explains the Pythagorean theorem, reviews methods for laying out square corners, and discusses the techniques used to calculate simple and rolling offsets, as well as offsets on parallel runs of pipe.

Objectives

Learning Objective 1
• Produce a square corner using the 3-4-5 ratio.
  a. Check the squareness of a corner.
  b. Lay out square corners.

Learning Objective 2
• Determine the run, travel, and rise of an offset.
  a. Determine a true offset.
  b. Calculate 45-degree offsets around obstructions.
  c. Calculate 11⅛-, 22½-, 45-, 60-, and 72-degree offsets.
  d. Calculate 11¼-, 22⅓-, 45-, 60-, and 72-degree parallel offsets.
  e. Calculate rolling offsets using constants for the angled fittings.
  f. Calculate rolling offsets using a framing square.
  g. Calculate a 45- and 90-degree angle using a plumber’s folding rule.

Performance Tasks

Performance Task 1 (Learning Objective 1)
• Verify the squareness of a corner using the 3-4-5 ratio.

Performance Task 2 (Learning Objective 1)
• Lay out square corners using the 3-4-5 ratio.

Performance Task 3 (Learning Objective 2)
• Calculate 11¼-, 22½-, 45-, 60-, and 72-degree offsets.

Performance Task 4 (Learning Objective 2)
• Calculate travel in an offset using a framing square.

Performance Task 5 (Learning Objective 2)
• Determine the true offset using a framing square.

Performance Task 6 (Learning Objective 2)
• Calculate travel on a rolling offset.

Performance Task 7 (Learning Objective 2)
• Calculate a 45- and 90-degree angle using a plumber’s folding rule.

Performance Task 8 (Learning Objective 2)
• Calculate 11¼-, 22½-, 45-, 60-, and 72-degree parallel offsets.

Performance Task 9 (Learning Objective 2)
• Calculate rolling offsets using constants for the angled fittings.

Performance Task 10 (Learning Objective 2)
• Calculate 45-degree offsets around obstructions.

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 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 calculate square corners and offsets. Performance tasks must be completed under your supervision. Each trainee must follow safe tool practices and procedures.

Classroom Equipment and Materials
- Copies of the Module Examination and Performance Profile Sheets
- *Plumbing Level Two* PowerPoint®, DVD player
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- LCD projector and screen
- Computer
- Manufacturer-supplied videos/DVDs showing how to calculate square corners and offsets (optional)
- TV/VCR (optional)

Equipment and Materials for Laboratories and Performance Testing
- Scientific calculators with trigonometric functions
- Chalk, wooden rules or tape measures, and several 2 × 4s
- Conversion charts for decimals of an inch
- Pencils and paper
- Framing squares
- Rulers or tape measures
- Plumbers’ folding rules
- An assortment of offsets

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 calculating square corners and offsets. A search for additional information may be assigned as homework to interested trainees.
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 trainees to the techniques for calculating square corners, including checking the squareness of a corner and laying out square corners.

1. Show Session One PowerPoint® slides.
2. Demonstrate how to find the travel of a 45-degree right triangle by using the constant 1.414. Ask if trainees have any questions.
3. Have trainees use rulers, pencils, and paper to lay out square corners and verify their squareness using the 3-4-5 ratio. This laboratory corresponds with Performance Tasks 1 and 2.

**Session Two**

Session Two introduces trainees to offsets and how to calculate 45-degree offsets around obstructions.

1. Show Session Two PowerPoint® slides.
2. Explain how to find the travel in a 45-degree offset. Answer any questions trainees may have.
3. Review the steps for calculating the end-to-end length of pipe for a 45-degree offset. Ensure that trainees understand how to convert the answer into the nearest sixteenth of an inch.
4. Using examples that you provide, have trainees practice calculating 45-degree offsets around obstructions. This laboratory corresponds with Performance Task 8.

**Session Three**

Session Three covers how to calculate 11¼-, 22½-, 45-, 60-, and 72-degree offsets and parallel offsets.

1. Show Session Three PowerPoint® slides.
2. Draw several 11¼-, 22½-, 45-, 60-, and 72-degree offsets. Provide the information that trainees will require to calculate the offsets, including the angled fitting constants. Have trainees calculate the offsets. This laboratory corresponds with Performance Task 10.
3. Draw several parallel 11¼-, 22½-, 45-, 60-, and 72-degree offsets of both equal and unequal lengths. Provide the information that trainees will require to calculate the offsets, including the travel between fittings and the angled fitting constants. Have trainees calculate the offsets. This laboratory corresponds with Performance Task 8.

**Session Four**

Session Four provides instruction on calculating true offsets and rolling offsets using constants.

1. Show Session Four PowerPoint® slides.
2. List the rise and roll for several hypothetical offsets. Have trainees calculate travel for these offsets using the table of constants in the Trainee Guide and a framing square. This laboratory corresponds with Performance Tasks 5 and 6.
3. List the true offsets and fitting angles for several hypothetical rolling offsets. Have trainees refer to the table of constants for rolling offsets in the Trainee Guide and use their calculators to calculate rolling offsets using constants for the angled fittings. This laboratory corresponds with Performance Task 9.
Session Outline for 02201-13

PLUMBING MATH TWO

SESSION FIVE

Session Five covers how to use a framing square and a folding rule to calculate rolling offsets and 45- and 90-degree angles.

1. Show Session Five PowerPoint® slides.

2. Set up an assortment of offsets in the classroom and provide the trainees with framing squares and rulers or tape measures. Have trainees use the framing squares to calculate travel in the offsets. This laboratory corresponds with Performance Task 4.

3. Provide trainees with plumbers’ folding rules and have trainees use them to calculate a 45- and 90-degree angles. This laboratory corresponds with Performance Task 7.

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 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 02202-13

READING COMMERCIAL DRAWINGS

The Trainee Guide for Plumbing Level 2 is available as an NCCERconnect ebook. Contact your NCCER customer service representative at 1-888-622-3720 for more information.

Module Two (02202-13) provides instruction in the identification and interpretation of civil, architectural, structural, HVAC/mechanical, plumbing, and electrical drawings, as well as how to use them to ensure accurate dimensions, generate RFIs, locate plumbing entry points, and establish piping routes and fixture locations.

Objectives

Learning Objective 1
- Interpret information from given site plans.
  a. Locate utilities.
  b. Locate the highest elevation.

Learning Objective 2
- Verify the information on commercial drawings.
  a. Ensure the accuracy of the dimensions as they relate to the building.
  b. Generate a request for information (RFI) to address discrepancies.
  c. Locate plumbing entry points, walls, and chases.

Learning Objective 3
- Lay out plumbing systems and fixture rough-ins.
  a. Establish a piping route.
  b. Establish fixture locations using commercial drawings and approved submittals.
  c. Recognize the need for coordination drawings and shop drawings.
  d. Use building information modeling (BIM) for coordination.

Learning Objective 4
- Complete a material takeoff for drainage, waste, and vent (DWV) and water supply systems from information shown on drawings.
  a. Create an isometric drawing.

Performance Tasks

Performance Task 1 (Learning Objective 1)
- Interpret information on a site plan as required by the instructor.

Performance Task 2 (Learning Objective 2)
- Locate plumbing entry points on the site plan provided.

Performance Task 3
- Write an RFI based on a scenario provided by your instructor.

Performance Task 4 (Learning Objective 3)
- Lay out fixture rough-ins using approved submittals and floor plans.

Performance Task 5 (Learning Objective 4)
- Prepare a material takeoff for DWV and water supply systems.

Performance Task 6
- Draw an isometric sketch.

Teaching Time: 25 hours
(Ten 2.5-Hour 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 read and interpret commercial drawings used in construction. 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 read commercial drawings (optional)
TV/VCR (optional)

Equipment and Materials for Laboratories and Performance Testing
A complete set of commercial construction drawings that includes:
- Civil drawings
- Architectural drawings
- Structural drawings
- HVAC/mechanical drawings
- Plumbing drawings, at least one of which has a riser diagram
- Plumbing fixture schedules
- Electrical drawings
Samples of contractual documents used to make changes to construction drawings, including:
- Addendum
- Revision
- Change order
- Request for information (RFI)
- Clarification
A set of residential construction drawings
Several sets of civil drawings of various scales
A variety of isometric drawings from plumbing plans
A selection of approved submittal data sheets
A selection of cut sheets for various plumbing fixtures
Assorted coordination drawings, shop drawings, and as-built drawings
A set of BIM files for a construction project that includes detailed illustrations of the plumbing system
Computers that can display BIM files
Material takeoffs for water supply and DWV systems
Isometric sketches
Rulers

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 reading commercial drawings. A search for additional information may be assigned as homework to interested trainees.
The Lesson Plan for this module is divided into ten 2.5-hour sessions. Each session includes 10 minutes for administrative tasks, and one 10-minute break.

### Session Outline for 02202-13

**Reading Commercial Drawings**

#### Session One

Session One reintroduces trainees to the names of the various types of commercial drawings that they first learned about in *Plumbing Level One*, and discusses how plumbers use civil and architectural drawings on a project.

1. Show Session One PowerPoint® slides.
2. Have trainees identify the letter codes used to represent the various categories of commercial drawing.
3. Have trainees examine a set of commercial drawings to identify the types of information included on civil and architectural drawings such as building drains and sewers and building projections. This laboratory corresponds with Performance Task 1.

#### Session Two

Session Two discusses how plumbers use structural and HVAC/mechanical drawings on a project.

1. Show Session Two PowerPoint® slides.
2. Have trainees examine a set of commercial drawings to identify the types of information included on structural and HVAC/mechanical drawings such as the materials used in the building framework and the components of the HVAC system.

#### Session Three

Session Three describes how plumbers use plumbing and electrical drawings on a project.

1. Show Session Three PowerPoint® slides.
2. Have trainees examine a set of commercial drawings to identify the types of information included on plumbing and electrical drawings such as the location and size of DWV and water distribution piping and the location of electrical fixtures.

#### Session Four

Session Four provides the steps required to ensure the accuracy of drawing dimensions.

1. Show Session Four PowerPoint® slides.
2. Discuss how to use commercial drawings to identify whether measurements should be taken off from a finished or unfinished wall.

#### Session Five

Session Five covers the steps required to generate addenda and revisions to address changes to construction drawings and using drawings to locate plumbing entry points, walls, and chases.

1. Show Session Five PowerPoint® slides.
2. Have trainees examine a set of commercial drawings to identify the plumbing entry points into the building. This laboratory corresponds with Performance Task 2.
3. Provide trainees with a hypothetical scenario in which a construction drawing appears to contain a mistake and have them prepare an RFI to point out the mistake to the architect or engineer. This laboratory corresponds with Performance Task 3.

#### Session Six

Session Six guides trainees through the process of laying out plumbing systems and roughing in fixtures, including the techniques for establishing a piping route and interpreting schedules.

1. Show Session Six PowerPoint® slides.
2. Have trainees review the schedules in a set of commercial drawings and find and describe various fixtures that you name.
Session Outline for 02202-13

Reading Commercial Drawings

**Session Seven**

Session Seven covers how to establish fixture locations using the information contained in commercial drawings and approved submittal data.

1. Show Session Seven PowerPoint® slides.
2. Using approved submittals and floor plans that you provide, have trainees practice laying out various fixture rough-ins. This laboratory corresponds with Performance Task 4.

**Session Eight**

Session Eight covers coordination drawings and building information modeling (BIM), as well as shop and as-built drawings.

1. Show Session Eight PowerPoint® slides.
2. Discuss how plumbers use coordination drawings and shop drawings and how they differ.
3. Provide an example of a building design rendered in BIM and allow trainees to use the program to navigate the building. Have them identify the various plumbing-related elements shown.

**Session Nine**

Session Nine introduces trainees to material takeoffs and the steps required to prepare an isometric drawing.

1. Show Session Nine PowerPoint® slides.
2. Provide trainees with isometric drawings and plumbing plans of a hypothetical or actual commercial construction project. Have the trainees use these materials to prepare a material takeoff for the building’s DWV and water supply systems. This laboratory corresponds with Performance Task 5.
3. Provide trainees with three-view drawings of various objects such as appliances or building exteriors. Have the trainees use these materials to draw isometric sketches of the objects. This laboratory corresponds with Performance Task 6.

**Session Ten**

Session Ten 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 Nine.) 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 02203-13

STRUCTURAL PENETRATIONS, INSULATION, AND FIRE-STOPPING

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 Three (02203-13) covers how to cut, bore, and sleeve structural members using the appropriate tools including proper locations, restrictions, and reinforcement techniques; how to install fiberglass and flexible foam insulation on pipe; and how to install fire-stopping on walls, floors, and ceiling according to code.

Objectives

Learning Objective 1
- Cut, bore, and sleeve structural members using the appropriate tools.
  a. Identify proper locations for cutting, boring, and sleeving based on applicable codes.
  b. Identify the restrictions of holes and notches.
  c. Identify proper reinforcement techniques.

Learning Objective 2
- Identify insulating materials and their properties.
  a. Size hangers and sleeves to accommodate pipe insulation.
  b. Identify the various applications of insulating materials.

Learning Objective 3
- Identify and install common types of fire-stopping materials and assemblies.
  a. Identify walls, floors, and ceilings that require fire-stopping.

Performance Tasks

Performance Task 1 (Learning Objective 1)
- Identify proper locations for cutting, boring, and sleeving based on applicable codes.

Performance Task 2 (Learning Objective 3)
- Install common types of fire-stopping materials in penetrations through walls, floors, and ceilings.

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 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.
**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 prepare structural penetrations, install insulation, and install fire-stopping (optional)*

*TV/VCR/DVD player (optional)*

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

*Drills and drill bits suitable for modifying floor joists*

*Saws and tools suitable for notching structural members*

*Wood, nails, and hammers for constructing reinforcing double headers*

*A variety of hangars and sleeves for pipe insulation*

*Insulation protection shields*

*A variety of sizes and lengths of fiberglass pipe insulation, including insulation with an all-service jacket (ASJ)*

*Tools and materials for installing hangers and sleeves*

*Tools and materials for installing fiberglass pipe insulation*

*Tools and materials to prepare trapeze assemblies*

*Stapler suitable for sealing fiberglass insulation jackets*

*Tape, wire, and bands for sealing fiberglass insulation without ASJs*

*A variety of rubber, polyethylene, and polyolefin flexible foam insulation, including tube, sheet, and roll*

*Manufacturers’ instructions for installing various kinds of flexible foam insulation*

*Tools and materials for installing flexible foam insulation*

*Flexible foam insulation adhesive*

*A variety of approved and unapproved fire-stopping materials and sealants, including intumescent material, fire-stopping collars, fire blocks, putty pads, and cast-in-place fire stops*

*Manufacturers’ instructions for installing various kinds of fire-stopping*

*Section of fire-rated wall material*

*Tools and materials for installing fire-stopping*

*A news article that highlights the importance of fire-stopping materials*

*Sections of pipe*

*Sharp utility knife*

*Copies of the local applicable code*

---

**Safety Considerations**

This module requires that trainees demonstrate the ability to identify proper locations for cutting, boring, and sleeving based on applicable codes and install common types of fire-stopping materials in penetrations through walls, floors, and ceilings. Performance tasks must be completed under your supervision. Each trainee must use required PPE and follow safe tool practices and procedures.

---

**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 structural penetrations, insulation, and fire-stopping. A search for additional information may be assigned as homework to interested trainees.
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 the steps required to adjust structural members by cutting, boring, and sleeving, as well as restrictions on holes and notches and proper reinforcement techniques.

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. Set up stations with a variety of pipe attachments. Have trainees identify whether the supports can be used with horizontal or vertical runs of pipe. Ask trainees to determine the type of material with which each attachment may be used.
4. Set up stations with floor joists, sections of pipe, and materials to drill. Divide the class into small groups. Ask each group to drill a hole in an appropriate size for the joist and the pipe. This laboratory corresponds with Performance Task 1.

**Session Two**

Session Two introduces the applications for pipe insulation, provides instruction on sizing hangers and sleeves to accommodate pipe insulation, and discusses how to measure and cut fiberglass insulation.

1. Show Session Two PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Have trainees practice identifying different types and sizes of fiberglass insulation, including insulation of different thicknesses and diameters, and with different types of jackets.
4. Have trainees practice measuring and cutting fiberglass insulation.

**Session Three**

Session Three covers how to install and seal fiberglass insulation, and how to install fiberglass insulation without a jacket.

1. Show Session Three PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Have trainees practice installing and sealing different types of jacketed fiberglass pipe insulation, including the use of vapor barrier adhesives and staples. Have trainees demonstrate proper vapor sealing of the insulation.
4. Have trainees demonstrate how to install fiberglass insulation that does not have an all service jacket using tape, wire, or bands. Trainees should also practice installing a jacket over fiberglass insulation that does not have an all service jacket.

**Session Four**

Session Four provides an introduction to flexible foam insulation and covers the steps required to install flexible foam insulation using the slip-on and slit-snap methods.

1. Show Session Four PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Have trainees demonstrate how to install flexible foam insulation on pipe using the slip-on method. Review the steps required and discuss why it is important to follow the instructions provided by the manufacturer.
4. Have trainees practice installing flexible foam insulation on pipe using the slit-snap method. Have trainees practice cutting various thicknesses and diameters of flexible foam insulation.
**Session Outline for 02203-13**

**Structural Penetrations, Insulation, and Fire-Stopping**

---

**Session Five**

Session Five covers the installation of fire-stopping materials in fire-rated walls, floors, and ceilings.

1. Show Session Five PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Bring in a variety of approved and unapproved fire-stopping materials and sealants. Have trainees inspect the packaging and determine whether the materials are permitted by a recognized organization. Have trainees explain how they would install common types of fire-stopping materials in penetrations through fire-rated structural members, walls, floors, and ceilings. This laboratory corresponds to Performance Task 2.

---

**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 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 Four (02204-13)** provides instruction in locating, installing, connecting, and testing a complete drain, waste, and vent (DWV) system including how to develop material takeoffs, set up and use levels, locate building sewers and building drains, locate fixtures, and test a DWV system.

### Objectives

**Learning Objective 1**
- Develop a material takeoff from a given set of plans.

**Learning Objective 2**
- Correctly set up levels.
  - Use a builder's level to calculate grade.
  - Use a laser level to calculate grade.

**Learning Objective 3**
- Identify the building sewer and building drain location.
  - Calculate inverts for below-grade piping.
  - Identify correct grade of underground piping per local codes.
  - Locate the stack within the structure.
  - Install underground DWV piping.
  - Test the underground piping system.

**Learning Objective 4**
- Determine the location of fixtures and the route of the aboveground plumbing, using plans and fixture rough-in sheets.
  - Lay out in-wall piping at rough-in elevations.
  - Install an aboveground DWV system using appropriate hangers and correct grade or slope.
  - Install bathtubs, shower stalls, and shower pans.
  - Install washing machine boxes.
  - Test an aboveground DWV system.

**Learning Objective 5**
- Locate fixture rough-ins using submittals.
  - Locate the residential water closet.
  - Locate the commercial water closet.
  - Locate urinals and other fixtures.
  - Locate the residential lavatory.

**Learning Objective 6**
- Test the underground and aboveground DWV systems.

### Performance Tasks

**Performance Task 1 (Learning Objective 1)**
- Develop a material takeoff from a given set of plans.

**Performance Task 2 (Learning Objective 3)**
- Demonstrate the ability to correctly size and install a building sewer and a building drain, and final connection.

**Performance Task 3 (Learning Objectives 4, 5)**
- Use plans and fixture rough-in sheets or rough-in book to determine the location of fixtures and route of the aboveground and underground plumbing, as required by the instructor.

**Performance Task 4 (Learning Objective 3)**
- Locate the stack within the structure.

**Performance Task 5 (Learning Objective 4)**
- Demonstrate an ability to install a DWV system using appropriate hangers and correct grade.

**Performance Task 6 (Learning Objective 6)**
- Test a DWV system according to code.

### Teaching Time: 30 hours

**(Twelve 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 develop material takeoffs; correctly size and install building sewers, building drains, and final connections; determine the location of fixtures and the route of aboveground and underground plumbing; locate the stack; and install and test a DWV system. 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 locate, install, connect, and test a complete drain, waste, and vent (DWV) system (optional)
TV/VCR (optional)

Equipment and Materials for Laboratories and Performance Testing
A general-purpose level
A builder’s level
A stadia rod
A cold beam laser
An assortment of builder’s levels
A sanitary wye
A building cleanout
An assortment of DWV pipe and fittings for a building drain, building sewer, and final connection to the sewer main
Tools required to join DWV pipe and fittings for a building drain, building sewer, and final connection to the sewer main
Plumb bobs
A closet fitting
A sanitary increaser
An assortment of vent flashing and the manufacturers’ installation instructions
Assorted lengths of pipe
Roof deck material
A body harness with a lanyard attached to a D-ring in the center of the back
Samples of roof decking material and vent pipe
Vent flashing material
Tools required to install vent flashing on a vent stack
An assortment of washing machine boxes and the manufacturers’ installation instructions

Stations with framed studs or mounting brackets, cold- and hot-water supply fittings, and washing machine drain hoses
A pipe trapeze with short lengths of pipe attached
Basic framing
A DWV stack
An assortment of fixture drains and fittings
Tools for completing the installation
Stations with an assortment of DWV pipe, fittings, and hangers
Tools required to grade, join, and hang DWV pipes and fittings
An assortment of fixture carriers, including water closet carriers, and the manufacturers’ installation instructions
An assortment of fixture carriers, including carriers for lavatories and sinks (both behind-wall and wall-mounted), water coolers, and corner sinks
A bedpan washer
Blocking materials
An assortment of testing tools and equipment
An assortment of test plugs
Lengths of DWV pipe
A test gauge assembly
Manufacturer’s instructions for a smoke bomb used in smoke-testing a DWV system
**Equipment and Materials for Laboratories and Performance Testing (continued)**

A daily log  
Copies of the OSHA requirements for fall protection  
Copies of 29 C.F.R. 1926 Subpart P  
An assortment of project specifications  
An assortment of plot plans  
An assortment of architectural plans without the fixture locations marked  
Copies of the manufacturer’s instructions for a cold beam laser  
Residential and commercial floor plans  
Manufacturer’s specifications for a back-to-back water closet carrier  
Manufacturers’ rough-in sheets for various fixtures, including floor- and wall-mounted water closets  
Material takeoff forms  
A complete set of construction drawings  
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 installing and testing DWV systems. A search for additional information may be assigned as homework to interested trainees.
The Lesson Plan for this module is divided into twelve 2.5-hour sessions. Each session includes 10 minutes for administrative tasks, and one 10-minute break.

**SESSION ONE**

Session One covers the steps required to develop a material takeoff.

1. Show Session One PowerPoint® slides.
2. Distribute sample material takeoff forms and a complete set of construction drawings. Have trainees complete the material takeoff from the set of plans. This laboratory corresponds with Performance Task 1.

**SESSION TWO**

Session Two provides trainees with instruction on how to set up a level to measure grade.

1. Show Session Two PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Explain how to determine the elevation for lines of pipe that run above the builder’s level.
4. Have trainees practice using the cold beam laser to determine a level.

**SESSION THREE**

Session Three reviews techniques for verifying the layout, calculating inverts, and determining grade using velocity tables, specifications, and construction plans.

1. Show Session Three PowerPoint® slides.
2. Review the steps for verifying the layout, calculating inverts, and determining grade using velocity tables, specifications, and construction plans.
3. Provide trainees with copies of the local applicable code and an assortment of specifications. Have trainees determine the required grade for various pipe sizes and plumbing applications using the data in the velocity tables in the local applicable code.

**SESSION FOUR**

Session Four introduces trainees to the steps required to calculate grade in DWV systems.

1. Show Session Four PowerPoint® slides.
2. Review the various ways to calculate grade.
3. On the whiteboard/chalkboard, write the formula for calculating grade. Demonstrate how to use the formula on several hypothetical examples that you provide.

**SESSION FIVE**

Session Five covers how to install underground DWV piping.

1. Show Session Five PowerPoint® slides.
2. Provide PPE and other safety-related items from the Equipment and Materials list for trainees to examine.
3. Review the individual phases for installing underground DWV piping and the steps required for each phase.
4. Provide trainees with copies of the local applicable code. Ask trainees to locate the section of the code that specifies the distance that a building’s drain must extend from the building.
5. Set up stations with an assortment of DWV pipe and fittings for a building drain, building sewer, and final connection to the sewer main. Provide the tools required to join those pipes and fittings. Have trainees demonstrate the ability to correctly size and install them. This laboratory corresponds with Performance Task 2.
### Session Outline for 02204-13

#### Installing and Testing DWV Piping

<table>
<thead>
<tr>
<th>Session Six</th>
<th>Session Eight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session Six discusses how to locate the stack run and the center lines of main and secondary stacks.</td>
<td>Session Eight covers how to locate fixtures and aboveground piping.</td>
</tr>
<tr>
<td>2. Ensure that trainees are equipped with required PPE.</td>
<td>2. Ensure that trainees are equipped with required PPE.</td>
</tr>
<tr>
<td>3. Review the steps for locating stack runs within wall frames and locating the center lines of the main and secondary stacks.</td>
<td>3. Review the steps for locating fixtures and aboveground plumbing.</td>
</tr>
<tr>
<td>4. Provide trainees with plumb bobs and a cold beam laser level. Have trainees take turns using these tools to practice locating stack openings and the center lines of the main and secondary stacks in hypothetical installations. This laboratory corresponds with Performance Task 4.</td>
<td>4. Provide trainees with residential and commercial floor plans and manufacturers’ rough-in sheets for various fixtures. Have trainees use the plans and fixture rough-in sheets to determine the location of fixtures and route of both the aboveground and underground DWV piping for the facility shown on the floor plans. This laboratory corresponds with Performance Task 3.</td>
</tr>
<tr>
<td>5. Set up stations with an assortment of DWV pipe, fittings, and hangers. Provide the tools required to grade, join, and hang those pipes and fittings. This laboratory corresponds with Performance Task 5.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Session Seven</th>
<th>Session Nine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session Seven introduces trainees to the process of completing the location of the stack within the structure.</td>
<td>Session Nine provides trainees with instruction in the location of water closets and urinals using rough-in data.</td>
</tr>
<tr>
<td>1. Show Session Seven PowerPoint® slides.</td>
<td>1. Show Session Nine PowerPoint® slides.</td>
</tr>
<tr>
<td>2. Provide PPE and other safety-related items from the Equipment and Materials list for trainees to examine.</td>
<td>2. Review the procedures for using rough-in data to locate water closets and urinals.</td>
</tr>
<tr>
<td>3. Review the steps for selecting and installing closet fittings, installing lavatory drainage fittings, extending and flashing the stack, and connecting fixture drains.</td>
<td>3. Provide trainees with manufacturers’ rough-in sheets for various fixtures. Have trainees explain how to determine the distance from the rear wall to the center of the closet flange for the fixtures.</td>
</tr>
<tr>
<td>4. Provide trainees with an assortment of vent flashing and the manufacturers’ installation instructions. Using lengths of pipe and roof deck material that you provide, have trainees practice flashing a vent.</td>
<td>4. Explain the steps for measuring and marking the center of the location where the closet flange will be installed.</td>
</tr>
</tbody>
</table>
Session Outline for 02204-13

INSTALLING AND TESTING DWV PIPING

**SESSION TEN**

Session Ten reviews the procedures for locating water coolers, sinks, and lavatories.

1. Show Session Ten PowerPoint® slides.

2. Review the steps for locating water coolers, sinks, and lavatories once the DWV piping has been installed.

3. Provide trainees with copies of the American National Standards Institute (ANSI) standard A117.1, Accessible and Usable Buildings and Facilities, and copies of the local applicable code. Have trainees identify the applicable standards for installing the fixtures discussed in this section so that they are accessible for the physically challenged. Have trainees refer to the same sections in the local applicable code. Compare and contrast the standards in each.

**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.) 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.

**SESSION ELEVEN**

Session Eleven covers the testing of DWV systems.

1. Show Session Eleven PowerPoint® slides.

2. Review the procedures for conducting water, air, smoke, and peppermint tests of a DWV system according to the local applicable code.

3. Describe a variety of scenarios in which a system must be tested for leaks. Ask trainees to determine which testing method they would use and to explain why they selected the particular method. Discuss the advantages and disadvantages of each test. Have trainees explain how to test a DWV system according to the local applicable code. This laboratory corresponds with Performance Task 6.
**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](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 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.
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.
Lesson Plans for Module 02206-13

INSTALLING AND TESTING WATER SUPPLY PIPING

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 Six (02206-13) provides trainees with the proper techniques for locating, installing, and testing complete water service and distribution systems, including meters, water heaters, water softeners, and hose bibbs. The module also introduces basic backflow prevention and water hammer prevention, and discusses the installation of shower and tub valves, ice maker and washing machine boxes, and pipe stubouts and supports.

Objectives

Learning Objective 1
• Evaluate the domestic water distribution system using plans and fixture rough-in sheets.
  a. Determine the location of fixtures.
  b. Identify the size of the pipe to be installed.
  c. Determine the route of the water supply piping.
  d. Determine the location the water heater, water softener, and hose bibbs.

Learning Objective 2
• Install water service and a water distribution system.
  a. Install water service and rough-ins.
  b. Install proper water hammer protection.
  c. Install shower and tub valves.
  d. Install ice maker and washing machine boxes.
  e. Install puncture protection and in-wall supports.

Learning Objective 3
• Test a water supply system.
  a. Perform an air test.
  b. Perform a hydrostatic test.

Performance Tasks

Performance Task 1 (Learning Objective 2)
• Correctly size and install a water service line including backflow preventer.

Performance Task 2 (Learning Objective 2)
• Locate a water meter.

Performance Task 3 (Learning Objective 1)
• Develop a water supply piping material takeoff from a given set of plans.

Performance Task 4 (Learning Objective 1)
Using instructor-provided plans and fixture rough-in sheets, determine the location of fixtures and the route of the water supply piping.

Performance Task 5 (Learning Objective 4)
Test a water supply system.

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. 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 install and test a water supply system. 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 and test a water supply system (optional)
TV/VCR (optional)

---

**Equipment and Materials for Laboratories and Performance Testing**
An assortment of hose bibs, both with and without air gaps
An assortment of water meters larger than 1½ inches in diameter
Tools to plumb and set water meters
A curb stop
An assortment of water meters with a variety of measurement capacities
An assortment of water hammer arresters of various sizes
Tools to plumb and set the arresters
Stations with piping and fittings for showers and tubs
Shower and tub valves
Tools required to install shower and tub valves
Ice maker box
Washing machine box
Stations with the pipe, fittings, tools, and fixtures required for trainees to practice installing a water service line including backflow preventer
An assortment of pipe sleeves
A length of water supply pipe
An assortment of nailer plates
An assortment of floor plans, approved submittal data, sizing tables, and rough-in sheets for various construction projects
Manufacturers’ installation instructions for shower and tub valves
A test gauge assembly
An assortment of test plugs
Lengths of water supply piping
A hydrostatic test pump
A test stand with a mockup of a water supply system suitable for air or hydrostatic testing
Tools and equipment for conducting an air or hydrostatic test
A copy of an inspector’s test record
Copies of submittal data
An assortment of elevation drawings of houses with a variety of floor plans
A complete set of construction plans
Copies of the local applicable code
Copies of the latest edition of the *International Plumbing 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 installing and testing water supply piping. 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 introduces the techniques required to locate fixtures on domestic water distribution systems.

1. Show Session One PowerPoint® slides.
2. Discuss the options when locating water softeners. Remind trainees of the importance of maintaining an air gap when draining water softeners to floor drains.
3. Provide trainees with a complete set of construction plans and have them develop a water supply piping material takeoff using the information in the plans. This laboratory corresponds with Performance Task 3.

**Session Two**

Session Two covers how to identify pipe materials and sizes, and how to determine the route of water supply piping.

1. Show Session Two PowerPoint® slides.
2. Have trainees refer to the local applicable code to find the requirements for water supply pipe routing. Using examples from your own experience, discuss how these requirements can affect the installation of water supply piping.
3. Provide trainees with an assortment of floor plans and rough-in sheets for various construction projects. Have trainees use those documents to determine the location of fixtures and the route of the water supply piping on that project. Review the results and discuss any mistakes or incorrect assumptions that the trainees made. This laboratory corresponds with Performance Task 4.

**Session Three**

Session Three explains locating and sizing water meters and installing freeze protection and backflow prevention.

1. Show Session Three PowerPoint® slides.
2. Discuss where water service piping begins in your jurisdiction and in surrounding jurisdictions.
3. Have trainees use copies of the local applicable code and a complete set of construction drawings to locate a water meter. This laboratory corresponds with Performance Task 2.
4. Explain how the climate affects the decision to locate the service entrance under, or away from, sidewalks, driveways, and patios. Discuss the benefit of locating water pipes under lawns.
5. Review the various types of backflow preventers that can be installed on water supply lines, fixtures, and appliances. Discuss when and where backflow prevention is required. Review the backflow prevention requirements in the local applicable code.

**Session Four**

Session Four covers how to use rough-ins to install water service as well as how to install water hammer protection.

1. Show Session Four PowerPoint® slides.
2. Provide PPE and other safety-related items from the Equipment and Materials list for trainees to examine.
3. Have trainees consult the pipe sizing tables in the local applicable code. Have trainees identify water- and energy-saving measures.
4. Refer to the local applicable code and review guidelines and requirements for the placement of valves and meters. Discuss the consequences of locating valves and meters in inaccessible areas.
**Session Five**

Session Five teaches trainees how to install shower and tub valves; ice maker and washing machine boxes; and stubouts, in-wall supports, and puncture protection for piping.

1. Show Session Five PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Provide copies of manufacturers’ installation instructions for shower and tub valves for trainees to review. Compare these to the installation requirements in the local applicable code. Discuss the differences and similarities between them. Answer any questions the trainees may have.
4. Provide trainees with an assortment of floor plans, approved submittal data, sizing tables, and rough-in sheets for various construction projects, and copies of the local applicable code. Have trainees use the information in those documents to correctly size a water service line including backflow preventer. Set up stations with the pipe, fittings, tools, and fixtures required for trainees to practice installing a water service line including backflow preventer. This laboratory corresponds with Performance Task 1.
5. Review the procedures for assembling and installing stubouts.
6. Explain the consequences of failing to protect pipes using sleeves.

**Session Six**

Session Six covers air testing of water distribution systems.

1. Show Session Six PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review the two types of tests that may be used to test all water supply piping. Explain when to test the system at one time and when to test the piping in sections. Explain why plumbers should conduct at least one test before calling the inspector.
4. Provide trainees with an assortment of test plugs and lengths of water supply pipe. Ask trainees to demonstrate how to install the test plugs according to the manufacturers’ instructions. Explain that test plugs are generally not used to close openings in the system during a test.
5. Review the procedures for conducting an air test.

**Session Seven**

Session Seven covers hydrostatic testing of water distribution systems.

1. Show Session Seven PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review the procedures for conducting a hydrostatic test.
4. Set up a test stand with a mockup of a water supply system suitable for air or hydrostatic testing, and provide the tools and equipment needed to conducting an air or hydrostatic test. Have trainees test a water supply system according to the local applicable code. This laboratory corresponds with Performance Task 5.

**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.
Module Seven (02207-13) provides trainees with an overview of the many types of valves, their components, and valve applications, and explains how to service common valves.

Objectives

Learning Objective 1
- Identify the basic types of valves.
  a. Identify straight through flow valves and how they function.
  b. Identify full flow valves and how they function.
  c. Identify throttled flow valves and how they function.
  d. Identify check valves and how they function.

Learning Objective 2
- Select a valve for a specific application.
  a. Identify the pressure ratings for valves.
  b. Identify the materials used in valves.
  c. Identify valve sizing requirements.

Learning Objective 3
- Install and service various types of valves.
  a. Service globe valves.
  b. Service gate valves.
  c. Service flushometers.
  d. Service float control and ball cocks.
  e. Service flush valves.

Performance Tasks

Performance Task 1 (Learning Objective 1)
- Identify the basic types of valves and their parts.

Performance Task 2 (Learning Objective 2)
- Identify the functions of valves and their applications.

Performance Task 3 (Learning Objective 3)
- Service various valves.

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 identify common valves and their parts and explain their functions and applications, and to service various types of valves. 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 valve types, applications, and servicing techniques (optional)
TV/VCR/DVD player (optional)

Equipment and Materials for Laboratories and Performance Testing
An assortment of valve components, including:
- Stems
- Packing
- Bonnets
- End connections
An assortment of straight-through flow valves
An assortment of full flow valves, including:
- Ball valves
- Temperature and pressure (T/P) safety and relief valves
- Pressure regulator valves
An assortment of throttled flow valves, including:
- Globe valves
- Angle valves
- Butterfly valves
- Flushometer valves
- Flush valves
- Plug valves
- Supply stop valves
- Float-controlled valves
An assortment of check valves, including:
- Ball-check valves
- Swing-check valves
- Lift-check valves
- Spring-check valves
- Backwater valves
Flushometer and float-controlled valve repair kits
Valve packing
An assortment of faulty valves, including faulty flushometer and float-controlled valves
An assortment of valves with damaged end connections
Valve repair kits
Tools to repair valves
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 identifying and servicing valves. A search for additional information may be assigned as homework to interested trainees.
Session Outline for 02207-13

TYPES OF VALVES

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 provides trainees with a review of the various types of valves commonly found in plumbing installations, their components, and valve applications. Trainees will also learn how to service commonly used valves.

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. Display a variety of valves of different categories (straight-through flow, full flow, throttled flow, and check valves). Ask trainees to identify the various components and explain the role of each component in the valve. This laboratory corresponds with Performance Task 1.
4. Write several hypothetical scenarios involving valve selection on the whiteboard/chalkboard. Ask trainees to review the scenarios and determine which materials should be used in the system and which type of valve is best suited for each application. This laboratory corresponds with Performance Task 2.
5. Provide trainees with an assortment of faulty valves and repair kits for those valves. Have trainees review the kits, repair parts, and manufacturer's specifications. Have trainees practice repairing the valves using the materials provided. This laboratory corresponds with Performance Task 3.

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.
Lesson Plans for Module 02208-13
INSTALLING FIXTURES AND VALVES

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 Eight (02208-13) provides instruction on how to install basic plumbing fixtures, including bathtubs, shower stalls, lavatories, sinks, water closets, and urinals; reviews the installation of associated valves, faucets, and components; and discusses how to connect appliances such as dishwashers, food-waste disposers, refrigerators and ice makers, and washing machines.

Objectives

Learning Objective 1
- Identify the pre-installation techniques to follow when installing fixtures and valves.
  a. Identify ADA requirements for installing fixtures.

Learning Objective 2
- Install fixtures and valves at rough-in.
  a. Install bathtubs.
  b. Install shower stalls.
  c. Install valves.
  d. Install carriers.

Learning Objective 3
- Install fixtures and valves at trim-out.
  a. Install water closets.
  b. Install urinals.
  c. Install lavatories.
  d. Install sinks.
  e. Test and protect fixtures.

Learning Objective 4
- Identify connection procedures for various appliances.
  a. Connect a dishwasher.
  b. Connect a garbage disposal.
  c. Connect a refrigerator and ice maker.
  d. Connect a washing machine.

Performance Tasks

Performance Task 1 (Learning Objective 3)
- Test and protect a bathtub, a lavatory, and a water closet.

Performance Task 2 (Learning Objective 3)
- Trim-out a bathtub, a lavatory, and a water closet.

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 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 trim-out, test, and protect bathtubs, lavatories, and water closets. 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 trim-out, test, and protect bathtubs, lavatories, and water closets (optional)
TV/VCR player (optional)

Equipment and Materials for Laboratories and Performance Testing
An assortment of packed fixtures with manufacturers’ submittal data
An assortment of submittal data for similar but different fixtures than the above
An assortment of valves, including threaded, soldered, solvent-welded, flanged, and compression valves
Teflon® tape or pipe dope (if allowed)
Wrenches
Lengths of threaded pipe
A station with a bathtub and blocking
An assortment of valves, including solvent-welded, flanged, and compression valves
CPVC primer and solvent
A stubout
An assortment of compression and noncompression faucets including cartridge, rotating ball, and ceramic disc faucets
A carrier for a water closet, urinal, lavatory, or sink
An assortment of float-controlled valves and manual flush valves
An assortment of water closets and the manufacturers’ installation instructions
Tools and materials required to install water closets
A float-controlled valve assembly
A flush valve
A flushometer control stop
A urinal drain fitting
Stations with water supply and waste piping and fittings for urinal installation
Several new urinals
Tools and fittings required to install urinals
A urinal carrier
Urinal carriers and their manufacturers’ instructions
Carrier-mounted urinals and their manufacturers’ instructions
Tools and materials required to attach urinals to carriers
An assortment of lavatory and sink carriers and their manufacturers’ instructions
A pop-up drain assembly
A lift rod assembly
An uncut countertop
A rim-mounted sink
Tools required to measure and mark a sink opening on a countertop
Fixture sealant
A refrigerator with an ice maker
A length of ¼”-O.D. tubing
A length of copper tubing used for hot water supply to a dishwasher
A tool for cutting copper tubing
A dishwasher and its connecting electrical wires and water supply lines and drain hoses
Tools for connecting the supply and drainage lines to the dishwasher
A food-waste disposer and its gasket, mounting ring, and antivibration mountings
A washer box
Copies of Figure 1 from the Trainee Guide with the callouts obscured
Manufacturers’ instructions for lavatories, sinks, and pop-up drains
Stations with a bathtub, a lavatory, and a water closet and the tools required to trim-out, test, and protect them
An assortment of exploded or cutaway diagrams of urinals from manufacturers’ instructions
Copies of manufacturers’ instructions for flushometers
Copies of a set of floor plans
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 installing fixtures and valves. A search for additional information may be assigned as homework to interested trainees.
SESSION ONE

Session One reviews pre-installation tips and techniques, including Americans with Disabilities Act (ADA) requirements for fixture installations.

1. Show Session One PowerPoint® slides.
2. Emphasize the importance of using approved submittal data and following manufacturers’ instructions when installing fixtures. Discuss the care and skill plumbers should apply when performing finish work.
3. Ensure that trainees understand how to verify that fixtures meet project specifications and that dimensions are correct. Explain that plumbers must verify the condition of fixtures and trim and protect the fixtures after delivery and before occupancy. Discuss the benefit of saving the packing materials and manufacturers’ instructions and warranty materials.

SESSION TWO

Session Two covers the installation of threaded and soldered valves as well as threaded check valves at the rough-in stage.

1. Show Session Two PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review the procedures to install a typical bathtub. Explain how to brace the tub and how to brace the riser to the framing. Emphasize the importance of following the manufacturer’s instructions when positioning the blocking.
4. Explain when and how to use a threaded copper adapter. Emphasize the importance of following the manufacturer’s instructions and guidelines.
5. Have trainees practice applying Teflon® tape or pipe dope (if allowed) to the threads of a valve.

SESSION THREE

Session Three provides instruction on the installation of soldered, solvent-welded, flanged, and compression connection valves; faucets; and carriers at the rough-in stage.

1. Show Session Three PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Explain when to use solvent welding and how to properly install a solvent-welded shutoff valve.
4. Set up stations with an assortment of valves, including solvent-welded, flanged, and compression valves. Have trainees identify the valve, explain how it is used, and compare the installation procedures with other types of valves.

SESSION FOUR

Session Four covers the installation of water closets at the trim-out stage, including carrier-mounted closets, float-controlled valves, flush valves, and flushometers.

1. Show Session Four PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review the steps for installing water closets and the valves associated with them.
4. Set up stations with an assortment of water closets and the manufacturers’ installation instructions. At each station, provide the tools and materials required to install water closets. Have trainees review the steps involved in installing the water closet in the manufacturer’s instructions. Discuss any questions trainees have about installation steps or requirements, tools, and preparations for installing water closets.
Session Five reviews the process of installing urinals at the trim-out stage.

1. Show Session Five PowerPoint® slides.
2. Show trainees a urinal carrier. Demonstrate how the various components work. Point out the floor attachment points and show how to adjust the arms. Explain how and why escutcheons are used.

Session Six instructs trainees in the proper techniques for installing lavatories and sinks at the trim-out stage.

1. Show Session Six PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Review the steps for installing carrier-mounted lavatories and sinks. Have trainees compare these to the installation steps for other types of carrier-mounted fixtures.
4. Set up stations with a bathtub, a lavatory, and a water closet and the tools required to trim-out, test, and protect them. Have trainees practice trimming-out, testing, and protecting a bathtub, lavatory, and water closet. This laboratory corresponds with Performance Tasks 1 and 2.

Session Seven covers the procedures for connecting appliances after trim-out, including dishwashers, food-waste disposers, refrigerators and ice makers, and washing machines.

1. Show Session Seven PowerPoint® slides.
2. Show trainees a food-waste disposer. Explain the ways that disposers can be installed. Point out the gasket and mounting ring, and explain how they are used. Point out the connection points for the electrical wires and ground. Discuss how to install the antivibration mountings on the disposer.
3. Review how refrigerators and ice makers work. Point out that the water supply pressure for an ice maker is typically between 40 and 120 pounds per square inch (psi) depending on the manufacturer’s requirements.

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 02209-13

INSTALLING WATER HEATERS

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

---

**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.
### Session Outline for 02209-13

**Installing Water Heaters**

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.

<table>
<thead>
<tr>
<th>Session One</th>
<th>Session Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session One provides an overview of the various types of water heaters that are available, including identification, components, and selection.</td>
<td>Session Two covers water heater safety, particularly the hazards associated with electricity, gas, and steam.</td>
</tr>
<tr>
<td>1. Show Session One PowerPoint® slides.</td>
<td>1. Show Session Two PowerPoint® slides.</td>
</tr>
<tr>
<td>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.</td>
<td>2. Provide PPE and other safety-related items from the Materials and Equipment List for trainees to examine.</td>
</tr>
<tr>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
<td>4. Discuss the dangers of carbon monoxide, flammable vapors, and other combustion by-products when using gas water heaters.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
Session Three

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

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.
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 Ten (02210-13)** provides an introduction to electrical safety and the principles of electricity, including voltage, current, resistance, and power. Trainees will learn about important electrical formulas, circuitry, and common plumbing-related electrical applications.

**Objectives**

**Learning Objective 1**
- Identify the safety precautions that must be followed when working on electrical equipment.
  - 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 how voltage, current, resistance, and power are related.
  - a. Identify electrical safety hazards.
  - b. Identify gas safety hazards.
  - c. Identify steam safety hazards.

**Learning Objective 3**
- Identify the purpose and operation of the various electrical components used in plumbing equipment.
  - 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 Task**

**Performance Task 1 (Learning Objective 1)**
- Perform a continuity test on an electric water heater using an ohmmeter.

**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 perform a continuity test on an electric water heater using an ohmmeter. 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 identification and installation techniques (optional)
TV/VCR (optional)

Equipment and Materials for Laboratories and Performance Testing
An assortment of meters, including in-line and clamp-on ammeters, voltage meters, ohmmeters, and multimeters
An assortment of fuses
Stations with simple AC and DC circuits
An assortment of AC and DC motors and the materials and equipment needed to power them
Batteries
Electrical wire
Light bulbs
An assortment of conductor and insulator materials
An electric water heater and its manufacturer’s instructions
An electric heater
An assortment of switches, including light-sensitive switches, thermostatic switches, and pressure-sensing switches
An assortment of relays
An assortment of overload protection devices
A circuit board and a digital readout for diagnosing an electrical system
A water heater immersion element
Electrical symbols from a set of construction drawings
Copies of the graphic representation of Ohm’s law as shown in the Trainee Guide
Circuit diagrams, including ladder diagrams and manufacturer’s diagrams
Copies of the local applicable electrical code
Copies of the current National Electrical Code®

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

NFPA 70®, National Electrical Code®, latest edition. Quincy, MA: NFPA.

There are a number of online resources available for trainees who would like more information on electrical safety; voltage, current, resistance, and power; and electricity in plumbing. A search for additional information may be assigned as homework to interested trainees.
Session Outline for 02210-13

AIR DISTRIBUTION SYSTEMS

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 covers electrical safety, including the effects of electrical current, proper safety practices, and how to make measurements.

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. Using company manuals and manufacturers’ instructions, review the general safety practices that should be followed whenever working around electrical systems.
4. Have trainees take turns performing a continuity test on an electric water heater using an ohmmeter. Point out correct and incorrect actions taken by the trainees. Answer any questions the trainees have. This laboratory corresponds with Performance Task 1.

**SESSION TWO**

Session Two provides an introduction to the basic electrical measurements of voltage, current, resistance, and power, including the difference between AC and DC voltage, Ohm’s law and the power formula, and series and parallel circuitry.

1. Show Session Two PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Discuss voltage fluctuations and how they create patterns called sine waves. Compare a single-phase current with a three-phase current.
4. Discuss the properties of resistance, and explain how it causes a material to resist or impede current flow.
5. Distribute copies of circuit diagrams. Ask trainees to identify the series and parallel circuits on the diagrams. Have trainees describe the difference between a series and a parallel circuit.

**SESSION THREE**

Session Three covers how electricity is used in plumbing, including load and control devices, electronic controls, and water heater electrical systems.

1. Show Session Three PowerPoint® slides.
2. Ensure that trainees are equipped with required PPE.
3. Using a variety of AC and DC electric motors, demonstrate how motors are used in plumbing, and explain how motors are depicted on schematics.
4. Bring in an assortment of switches. Ask trainees to examine the switches and identify how they are used. Have trainees provide examples of how to use each switch.

**SESSION FOUR**

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.

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.

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.

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. 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

Copies of Figure 20 in the Trainee Guide
An assortment of plumbing drawings and gas supplier installation information
An assortment of manufacturer’s appliance labels
An assortment of manufacturer’s installation instructions for gas-fueled appliances
A list of Underwriters Laboratories, Inc. (UL)-listed underground gas storage tanks
An assortment of manufacturer’s instructions and product warranties for fuel gas and fuel oil equipment and appliances
Copies of the local applicable fire code
Copies of the local applicable fuel gas 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 installing fuel gas and fuel oil systems. A search for additional information may be assigned as homework to interested trainees.
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.