Module One (12115-14) covers safety guidelines and practices that instrument fitters and technicians must follow on the job. It describes safety precautions associated with electrical hazards, including lockout/tagout procedures. It reviews safe use of tools and materials in detail, focusing on safety practices to follow when using hand tools and power tools, potentially hazardous process fluids and solvents, and batteries.

### Objectives

#### Learning Objective 1

- Describe the electrical hazards that might be encountered by instrument fitters and technicians.
  - a. Describe the effects of electrical shock and how to reduce the risk.
  - b. Identify and describe common personal and general electrical protective equipment.
  - c. Identify specific requirements for electrical safety.
  - d. Describe the various approach boundaries related to electrical hazards.
  - e. Describe how to conduct a shock hazard analysis.

#### Learning Objective 2

- Describe how lockout/tagout procedures are used to prevent energy-related injury.
  - a. Describe the lockout/tagout procedure for electrical and non-electrical equipment.
  - b. Describe the voltage testing requirements to be applied before beginning work.

#### Learning Objective 3

- Identify safety practices related to potentially hazardous tools and materials.
  - a. Identify basic hand and power tool safety practices.
  - b. Identify the hazards associated with various process fluids and solvents.
  - c. Identify safety practices related to batteries.

### Performance Tasks

#### Performance Task 1 (Learning Objective 1)

- Complete a shock hazard analysis based on an activity assigned by the instructor.

#### Performance Task 2 (Learning Objective 2)

- Complete a lockout procedure for an electrical and/or non-electrical energy source(s).

### Teaching Time: 12.5 hours

(Five 2.5-Hour Classroom Sessions)

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

### Prerequisites

**Core Curriculum**

### Before You Begin

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

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70 percent or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work with energy sources and potentially hazardous tools, equipment, and materials. In those instances, trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards associated with the energy sources, tools, equipment, and materials. Any work performed on energized equipment must be done under the direct supervision of the instructor.

Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Instrumentation Level One* PowerPoint® Presentation
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Copies of the Module Examination and Performance Profile Sheets
- Protective rubber gloves with markings (new or damaged)
- A shorting probe
- Fuse pulling tool(s)
- One or more copies of the *National Electrical Code®* (NEC®)
- Multiple copies of *NFPA 70E®*
- One or more power distribution drawings for a work site
- One or more LOTO devices for electrically or pneumatically operated equipment
- Several copies of the NIOSH Pocket Guide to Chemical Hazards
- Copies of MSDS/SDS for a variety of common process fluids

Equipment and Materials for Laboratories and Performance Testing
- **PPE:**
  - Standard eye protection
  - Additional eye and face protection as designated by the instructor or training facility provider
  - Work gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provided
  - Specific tools and materials required for instructor demonstration of performing a shock hazard analysis (the relevant power distribution drawings and technical documentation, facility’s LOTO procedures, appropriate PPE, appropriate hand tools, power tools, etc.)
- **Specific tools and materials required for trainee performance of a shock hazard analysis for an activity assigned by the instructor:**
  - The relevant power distribution drawings and technical documentation, facility’s LOTO procedures, appropriate PPE, appropriate hand tools, power tools, etc.
  - Multiple copies of the Shock Hazard Analysis Checklist (provided herein at the end of the lesson plan)
  - Multimeter
  - Appropriate locks and tags to lockout energy sources
  - Multiple copies of an Energized Work Permit form, for the recording of the Shock Hazard Analysis results; use a form from your employer. Alternatively, various versions of the form can be located on the internet.
Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of on-line resources available for trainees who would like more information on safety practices, guidelines, and requirements related to the hazards that instrument fitters and technicians may encounter on the job. A search for additional information may be assigned as homework to interested trainees.

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

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for 12115-14

INSTRUMENTATION SAFETY PRACTICES

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

**SESSION ONE**

Session One discusses electrical hazards. It describes how electrical shock affects the human body and reviews various means that individuals can use to reduce their risk of electrical shock.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to introduce the subjects that will be covered in this module and stimulate trainee interest in the material to be covered.
3. Describe the effects of electrical shock on the human body and how the risk of electrical shock can be reduced.
4. Review the equipment, clothing, personal protective equipment (PPE), and tools that individuals can use to protect themselves from electrical shock and general hazards on the job.

**SESSION TWO**

Session Two introduces national consensus safety requirements, describes the use of hazard boundaries, and explains how to analyze electrical hazards.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to consider why workers may fail to follow the proper safety practices for electrical hazards.
3. Review OSHA and NFPA 70E® safety requirements.
4. Describe the following hazard boundaries: limited approach boundary, restricted approach boundary, prohibited approach boundary, arc flash boundary.
5. Describe how to perform a shock hazard analysis.
6. Describe how to perform an arc flash hazard analysis.
**Session Three**

Session Three describes lockout/tagout procedures and reviews safety practices for working with tools, hazardous materials, and batteries.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to review the material that was covered in the first two classroom sessions.
3. Explain how to perform lockouts/tagouts and test for voltage.
4. Review basic hand tool and power tool safety.
5. Describe safety precautions, resources, and equipment for working with hazardous process fluids and solvents.
6. Review safety concerns and protections associated with the use of batteries.

**Session Four**

Session Four is a lab session devoted to the practice and completion of Performance Tasks 1 and 2.

1. Note that there is no PowerPoint® presentation associated with this session.
2. Demonstrate how to conduct a shock hazard analysis and how to complete a lockout procedure on an energized energy source(s).
3. Have trainees practice and/or complete the tasks associated with Performance Tasks 1 and 2 in this hands-on session.

**Session Five**

Session Five is a review and testing session. Have trainees complete the Module Review and Trade Terms Quiz. Go over the Module Review and Trade Terms Quiz in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
### Materials Checklist for Module 12115-14, Instrumentation Safety Practices

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Personal protective equipment:</th>
<th>Multimeter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard eye protection</td>
<td>Multiple copies of <em>NFPA 70E®</em></td>
<td>Multimeter</td>
</tr>
<tr>
<td>Additional eye and face protection as designated by the instructor or training facility provider</td>
<td>Appropriate locks and tags to lockout energy sources</td>
<td>Multiple copies of the Shock Hazard Analysis Checklist (provided herein at the end of the lesson plan)</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Protective rubber gloves with markings (new or damaged)</td>
<td>Copies of MSDS/SDS for a variety of common process fluids</td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
<td>One or more copies of the <em>National Electrical Code® (NEC®)</em></td>
<td>One or more power distribution drawings for a work site</td>
</tr>
<tr>
<td>Hearing protection as designated by the instructor or training facility provided</td>
<td>One or more LOTO devices for electrically or pneumatically operated equipment</td>
<td>Several copies of the NIOSH Pocket Guide to Chemical Hazards</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Specific tools and materials required for instructor demonstration of performing a shock hazard analysis (the relevant power distribution drawings and technical documentation, facility's LOTO procedures, appropriate PPE, appropriate hand tools, power tools, etc.)</td>
<td>Specific tools and materials required for trainee performance of a shock hazard analysis for an activity assigned by the instructor (the relevant power distribution drawings and technical documentation, facility's LOTO procedures, appropriate PPE, appropriate hand tools, power tools, etc.)</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Multiple copies of an Energized Work Permit form, for the recording of the Shock Hazard Analysis results; use a form from your employer. Alternatively, various versions of the form can be located on the internet.</td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
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</tr>
<tr>
<td><em>Instrumentation Level One PowerPoint® Presentation Slides</em></td>
<td></td>
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<tr>
<td>DVD player</td>
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<td>Computer</td>
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<tr>
<td>Internet access during class (optional)</td>
<td></td>
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</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Lesson Plans for 12114-14

HAND AND POWER TOOLS FOR INSTRUMENTATION

Module Two (12114-14) identifies and describes the hand and power tools that are used by instrumentation fitters and technicians. This module goes beyond the coverage provided in the Core Curriculum modules. Trainees will learn about these tools and will be tested on their ability to correctly and safely use them.

Objectives

Learning Objective 1
- Identify and describe special hand tools related to threaded fasteners.
  a. Identify and describe how to use taps.
  b. Identify and describe how to use dies.
  c. Identify and describe how to use extractors.

Learning Objective 2
- Identify and describe the hand tools used in working with metal.
  a. Identify and describe the vises used to secure metal parts and pipe.
  b. Identify and describe the various types of snips used to cut sheet metal.
  c. Identify and describe conduit benders, cutters, and reamers.
  d. Identify and describe miscellaneous hand tools used in instrumentation work.

Learning Objective 3
- Identify and describe power tools used by instrument fitters and technicians.
  a. Identify and describe how to use hammer drills and rotary hammers.
  b. Identify and describe how to use soldering guns and irons.
  c. Identify and describe how to use hydraulic knockout punches.
  d. Describe the basic concepts of and safety guidelines for propellant-actuated tools.

Performance Tasks

Performance Task 1 (Learning Objectives 1, 2, and 3)
- Select and safely use six of the following instructor-selected hand and power tools, such as:
  - Extractors
  - Yoke or chain pipe vises
  - Snips
  - Knockout punches
  - Conduit benders, cutters, or reamers
  - Power hammer drills or rotary hammers
  - Soldering guns or irons
  - Hydraulic knockout punches
  - Fish tapes
  - Angle finders
  - Rodding-out tool

Performance Task 2 (Learning Objective 1)
- Drill and tap a hole.

Performance Task 3 (Learning Objective 1)
- Thread a rod using a die.

Teaching Time: 12.5 hours
(Five 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum

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

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work with tools that may have sharp edges, as well as tools that are electrically powered and rotate. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to the use of hand and power tools. Any deficiencies must be corrected to ensure future trainee safety. All practice sessions and performance tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Instrumentation Level One PowerPoint® Presentation
DVD player or a computer with a DVD drive
LCD projector and screen
Computer with internet access
Module Review Question and Trade Terms Quiz answer keys
Copies of the Module Examination and Performance Profile Sheets
Tap and die set, complete with diestock(s) and T-handle(s)
Straight-flute and spiral-tapered screw extractors
Tap extractors
Combination bench and pipe vise
Yoke pipe vise
Bench- or tripod-mounted chain vise
Selection of sheet metal snips
Reaming tool
Pipe cutters
PVC hand saw
Pipe wraparound
PVC ratcheting cutter
EMT hand bender
Conduit hickey
Knockout punches
Angle finder
Fish tape
Hammer drill and/or rotary hammer
Various concrete and masonry anchors
Masonry drill bits
Soldering iron and/or gun with various tips
Rosin-core solder
Desoldering pump
Hydraulic knockout punches

Equipment and Materials for Laboratories and Performance Testing
PPE:
Standard eye and face protection
Work gloves
Proper footwear as designated by the instructor or training facility provider
Hearing protection as designated by the instructor or training facility provider
Hard hat as designated by the instructor or training facility provider
Tap and die set, complete with diestock(s) and T-handle(s)
Straight-flute and spiral-tapered screw extractors
Tap extractors
Combination bench and pipe vise
Yoke pipe vise, either bench- or tripod-mounted
Chain vise, either bench- or tripod-mounted
Selection of sheet metal snips
Pipe wraparound
PVC hand saw
PVC ratcheting cutter
Pipe cutter
Reaming tools
EMT hand bender
Conduit hickey
Angle finder
Fish tape
Rodding-out tool
GFCI extension cord(s)
Corded or cordless drills
Common metal-drilling bits appropriate for the tap size to be used
Scrap sheet metal for punching holes
EMT and PVC conduit
Electrical wire for pulling with a fish tape
Metal rod for threading
Metal that can be drilled and tapped
EMT for cutting and bending
Conduit for cutting and bending
PVC conduit for cutting
Power hammer drills and/or rotary hammers
Various concrete anchors
Soldering guns and/or irons with appropriate tips
Hydraulic knockout punches
Concrete block, wall, or flooring that can be drilled
Scrap electrical wire for soldering practice
Rosin-core solder
Scrap sheet metal for punching holes
**Additional Resources**

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


There are a number of on-line resources available for trainees who would like more information on hand and power tools. A search for additional information may be assigned as homework to interested trainees.

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

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
**SESSION ONE**

Session One introduces trainees to taps and dies used to cut threads in materials such as metal, plastic, and hard rubber. It also covers the extractors used to remove fasteners or taps that have broken off flush to a surface or below it. This session will also introduce vises, snips, and benders.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Present taps and dies and how they are used to form threads.
4. Explain how fastener and tap extractors are used.
5. Describe bench, yoke, and chain vises and their uses.
6. Present the various types of sheet metal snips.
7. Discuss tools that are used to cut and bend various types of conduit.

**SESSION THREE**

Session Three is a laboratory session that provides an opportunity to practice and/or complete the Performance Tasks associated with hand tools presented in this module.

1. Note that no PowerPoint® presentation is associated with this laboratory session.
2. Demonstrate how to safely perform specific tasks using the hand tools selected for the Performance Task.
3. Trainees practice and/or complete the demonstrated tasks associated with Performance Tasks 1, 2, and 3. Note that Task 1 extends to the next session.

**SESSION TWO**

Session Two introduces the trainees to several more hand tools common in the instrumentation field as well as power tools.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe the safe use of knockout punches, fish tapes, angle finders, and rodding-out tools.
4. Present and describe the safe use of hammer drills and rotary hammers, soldering guns and irons, hydraulic knockout punches, and propellant-powered tools.

**SESSION FOUR**

Session Four is a laboratory session that provides an opportunity to practice and/or complete the Performance Tasks associated with power tools presented in this module.

1. Note that no PowerPoint® presentation is associated with this session.
2. Demonstrate how to safely perform specific tasks using the power tools selected for the Performance Task.
3. Trainees practice and/or complete the demonstrated tasks associated with Performance Task 1.

**SESSION FIVE**

Session Five 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 Four.) Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

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

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<th>Personal protective equipment:</th>
<th>Tap and die set, complete with diestock(s) and T-handle(s)</th>
<th>Straight-flute and spiral-tapered screw extractors</th>
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<tr>
<td>Standard eye and face protection</td>
<td>Tap extractors</td>
<td>Bench- or tripod-mounted yoke pipe vise</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Bench- or tripod-mounted chain vise</td>
<td>Combination bench and pipe vise</td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
<td>Hydraulic knockout punches</td>
<td>Selection of sheet metal snips</td>
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<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
<td>Reaming tool</td>
<td>Pipe cutters</td>
</tr>
<tr>
<td>Hard hat as designated by the instructor or training facility provider</td>
<td>PVC hand saw</td>
<td>Pipe wraparound</td>
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<td>PVC ratcheting cutter</td>
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</tr>
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<td>Pencils and paper</td>
<td>Angle finder</td>
<td>Fish tape</td>
</tr>
<tr>
<td>Instrumentation Level One PowerPoint® Presentation Slides</td>
<td>Power hammer drills and/or rotary hammers</td>
<td>Various concrete and masonry anchors</td>
</tr>
<tr>
<td>DVD player or computer with a DVD drive</td>
<td>Masonry drill bits</td>
<td>Soldering iron and/or gun with various tips</td>
</tr>
<tr>
<td>Computer with internet access</td>
<td>Rosin-core solder</td>
<td>Desoldering pump</td>
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<td>LCD projector and screen</td>
<td>Rodding-out tool</td>
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<td>Module Review Question and Trade Terms Quiz answer keys</td>
<td>Corded or cordless drills</td>
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<td>Scrap sheet metal for punching holes</td>
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</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Three (12119-14) reinforces and extends the math skills reviewed in the Core Curriculum. Common skills practiced include calculations for units of measurement in both the inch-pound and metric systems. Basic algebraic equations are practiced along with the identifying characteristics of various geometric figures.

### Objectives

#### Learning Objective 1
- Convert units of measurement from the inch-pound system to the metric system, and vice-versa.
  - a. Identify units of measure in the inch-pound and metric systems.
  - b. Describe how to convert, length, area, and volume values.
  - c. Describe how to convert weight values.
  - d. Describe how to convert pressure and temperature values.

#### Learning Objective 2
- Solve basic algebraic equations.
  - a. Define algebraic terms.
  - b. Demonstrate an understanding of the sequence of operations.
  - c. Solve basic algebraic equations.

#### Learning Objective 3
- Identify and describe geometric figures.
  - a. Describe the characteristics of a circle.
  - b. Identify and describe types of angles.
  - c. Identify and describe types of polygons.
  - d. Calculate various values associated with triangles.

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

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**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*

### Before You Begin

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

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**
This is a knowledge-based module and no performance tasks are required. However, instructors may choose to expose trainees to the instrumentation shop environment or an active job site. Ensure that trainees possess and use the required PPE during any exposure to these types of settings.

**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Instrumentation Level One*
- PowerPoint® Presentation Slides
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with Internet access
- Calculators
- Pythagorean theorem worksheets (see Session Three for details)
- Copies of the Module Examination
- Personal protective equipment (if a shop area or job site is visited):
  - Standard eye protection
  - Gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hats

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

- Metric-conversion.org: Metric Conversion Charts and Calculators.

There are a number of on-line resources available for trainees who would like more information on instrumentation systems and how math is an essential skill for all technicians. A search for additional information may be assigned as homework to interested trainees.
SESSION ONE

Session One introduces trainees to the procedures for calculating length, area, volume, weight, temperatures, and pressures. It also demonstrates how to convert various units of measurement between the inch-pound and metric systems.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to engage trainees and demonstrate that math can be entertaining.
3. Explain and demonstrate how to convert and/or calculate length, area, and volume calculations.
4. Explain and demonstrate how to convert and/or calculate weight values.
5. Explain and demonstrate how to convert and/or calculate pressure and temperature values.

SESSION TWO

Session Two provides an introduction to the basic principles of algebra and the important terms used to describe the components of an algebraic equation.

1. Show the Session Two PowerPoint® presentation.
2. Define algebraic terms associated with equations.
3. Explain and demonstrate the sequence of mathematical operations required for solving equations to reach an accurate result.
4. Demonstrate the solving of simple algebraic equations.
5. Use video resources to reinforce the lesson.

SESSION THREE

Session Three reviews the identification of various angles and plane geometric figures. Solving triangle-related problems using the Pythagorean theorem is presented and practiced.

1. Show the Session Three PowerPoint® presentation.
2. Define the two primary types of geometry.
3. Point out the characteristics of circles.
4. Describe and review the different types of angles.
5. Define and identify various polygons.
6. Demonstrate how to solve triangle problems using the Pythagorean theorem.

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.) Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
## Materials Checklist for Module 12119-14, Craft-Related Mathematics

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<thead>
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</tr>
<tr>
<td>Copies of the Module Examination</td>
</tr>
<tr>
<td>LCD projector and screen</td>
</tr>
<tr>
<td>Calculators</td>
</tr>
<tr>
<td>Pythagorean theorem worksheets (see Session Three for details)</td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Four (12107-14) introduces the trainees to the drawings, specifications, and other documents that are commonly used by instrument fitters and technicians. Coverage includes the specialized symbols used to identify lines on drawings, as well as those used to represent components and instrument locations. An introduction to the use of tag numbers for identifying instruments is included.

### Objectives

**Learning Objective 1**
- Identify and describe the types of drawings used in instrumentation work.
  - a. Describe the structure and use of an instrument index.
  - b. Explain the use and importance of instrument specifications.
  - c. Describe various types of drawings used in instrumentation projects.

**Learning Objective 2**
- Identify and interpret instrumentation-related symbols and markings used on drawings.
  - a. Interpret general instrument symbols used on instrumentation drawings.
  - b. Interpret graphic/pictorial and line symbols used on instrumentation drawings.
  - c. Describe the methods used to assign instrument tag numbers and identification abbreviations.

### Performance Task

**Performance Task 1**
(Learning Objectives 1 and 2)
- Locate and identify various instructor-specified drawing and documentation elements.

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

### Prerequisites
Core Curriculum

### 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 is intended to be taught in a classroom environment. However, if any training is conducted outside the classroom, safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to potential safety hazards. Any deficiencies must be corrected to ensure future trainee safety.

**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- Instrumentation Level One PowerPoint Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with internet access
- Module Review Question and Trade Terms Quiz answer keys
- Copies of the Module Examination and Performance Profile Sheets
- Copy of ISA Standard S5.1, Instrumentation Symbols and Identification (optional)

**Equipment and Materials for Laboratories and Performance Testing**
Several sets of instrumentation drawings, including:
- Instrument index
- General instrument specifications
- Instrumentation detail drawings
- Location drawings
- Loop drawings
Instructor-generated list of specific drawing and documentation elements to be located on a set of plans.

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

- ISA Standard S5.4 – Instrument Loop Diagrams
- ISA Standard S51.1 – Process Instrumentation Terminology

There are a number of on-line resources available for trainees who would like more information on the instrumentation trade and the related drawings. A search for additional information may be assigned as homework to interested trainees.
Session Outline for 12107-14

Session One introduces trainees to the drawings used in instrumentation work. The session covers the instrument index, general instrument specifications, and instrumentation drawings, including installation detail drawings, location drawings, control loops, and general notes.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Explain the purpose and structure of an instrument index.
4. Discuss general instrument specifications.
5. Explain the purpose and use of instrumentation-specific drawings.
6. Explain what a control loop is.
7. Describe how general notes and details are used.

Session Two introduces the trainees to the symbols used on instrumentation drawings, including symbols used to identify instrument locations. Trainees will also learn the purpose of the tag numbers used to identify instruments and how to interpret tags. The session concludes with the execution of Performance Task 1.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe and review the drawing symbols used to identify instruments and their locations.
4. Describe the various ways in which lines on drawings are used to represent instrumentation signals.
5. Explain how tag numbers are used to identify instruments.
6. Demonstrate how to recognize and locate specific items on a set of plans.
7. Trainees practice and/or complete the tasks associated with Performance Task 1.

The Lesson Plan for this module is divided into three 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.
Session Three is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (These may be assigned as homework at the end of Session Two.) Go over the Module Review Questions and Trade Terms Quiz in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.

2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Materials/Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>Instructor-generated list of specific drawing and documentation elements to be located on a set of plans</td>
</tr>
<tr>
<td>None</td>
<td>Copy of ISA Standard S5.1, Instrumentation Symbols and Identification (optional)</td>
</tr>
<tr>
<td></td>
<td>Several sets of instrumentation drawings, including:</td>
</tr>
<tr>
<td></td>
<td>• Instrument index</td>
</tr>
<tr>
<td></td>
<td>• General instrument specifications</td>
</tr>
<tr>
<td></td>
<td>• Instrumentation detail drawings</td>
</tr>
<tr>
<td></td>
<td>• Location drawings</td>
</tr>
<tr>
<td></td>
<td>• Loop drawings</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td></td>
</tr>
<tr>
<td>Markers/chalk</td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
</tr>
<tr>
<td><em>Instrumentation Level One</em></td>
<td>PowerPoint® Presentation Slides</td>
</tr>
<tr>
<td>DVD player or a computer with a DVD drive</td>
<td></td>
</tr>
<tr>
<td>Computer with internet access</td>
<td></td>
</tr>
<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
<td></td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Module Review Question and Trade Terms Quiz answer keys</td>
<td></td>
</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Five (12304-14) introduces the trainees to the methods and procedures for properly inspecting, storing, and handling materials used in instrumentation systems. The information and instructions provided in this module will help the trainees learn to verify and inspect received material; properly handle and store material to avoid damage to the material; and store material in a way that makes it easily retrievable.

### Objectives

**Learning Objective 1**
- Explain how to properly receive arriving instrumentation materials.
  - a. Explain how to inspect and handle arriving instrumentation materials.
  - b. Explain how to properly identify and verify instrumentation materials.

**Learning Objective 2**
- Explain how to properly store instrumentation materials.
  - a. Identify the various categories of instrumentation materials relative to storage.
  - b. Describe the storage conditions for the various categories of instrumentation materials.

### Performance Tasks

**Performance Task 1**  
(Learning Objective 1)  
- Inspect a carton or container for damage.

**Performance Task 2**  
(Learning Objective 1)  
- Inspect an instrumentation item for physical damage and compliance to a purchase order.

**Performance Task 3**  
(Learning Objective 2)  
- Select the proper category for storage of an instrumentation item.

### Teaching Time: 2.5 hours

(One 2.5-Hour Classroom Session)

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

### Prerequisites

*Core Curriculum*

### Before You Begin

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

Using your access code, download the 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 is intended to be taught in a classroom environment. However, if any training is conducted outside the classroom, safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards. Any deficiencies must be corrected to ensure future trainee safety.

Classroom Equipment and Materials
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Instrumentation Level One
PowerPoint® Presentation
DVD player or a computer
with a DVD drive
LCD projector and screen
Computer with internet access
Copies of the Module Examination and Performance Profile Sheets
Damaged cartons and containers
Instruments with existing damage
Various instruments to be used for inspection

Equipment and Materials for Laboratories and Performance Testing
Damaged cartons and containers
Various instruments to be used for inspection

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

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the instrumentation trade and add them to the PowerPoint® presentations throughout the program.
Session Outline for 12304-14

**INSPECT, HANDLE, AND STORE INSTRUMENTATION MATERIALS**

The Lesson Plan for this module consists of one 2.5-hour session. This time includes 10 minutes for administrative tasks and a 10-minute break.

**SESSION ONE**

Session One covers requirements and methods for receiving, identifying, and inspecting material as it arrives on the job site, along with instructions for lifting and handling of materials and determination of storage levels for various types of material. During this lesson, trainees will have the opportunity to demonstrate their understanding of inspection and storage requirements in order to satisfy the Performance Tasks for this module.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe methods and procedures for inspecting and handling cartons and containers.
4. Review safe lifting practices.
5. Explain how to identify instruments.
6. Describe the types of equipment related to the four categories of storage.
7. Explain the conditions associated with each of the four storage categories.
8. Trainees practice and/or complete the tasks associated with Performance Tasks 1, 2, and 3.
9. Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.
10. Have trainees complete the written examination.
11. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
# Materials Checklist for Module 12304-14, Inspect, Handle, and Store Instrumentation Materials

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Damaged cartons and containers</th>
<th>Instruments with existing damage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>None</td>
<td>Various instruments to be used for inspection</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Markers/chalk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pencils and paper</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| *Instrumentation Level One*  
PowerPoint® Presentation  
Slides | | |
| DVD player or coumputer with DVD drive | | |
| Computer with internet access | | |
| Copies of the Module  
Examination and Performance Profile Sheets | | |
| LCD projector and screen | | |

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Six (12116-14) introduces the trainees to basic electrical theory, components, and circuits. The module explains how electricity is generated and distributed, electrical safety practices, and the concepts of voltage, current, and resistance. The module also covers basic electrical test instruments, as well as electrical grounding principles.

### Objectives

#### Learning Objective 1
- Describe the fundamentals of electricity.
  a. State how electrical power is created and distributed.
  b. State the safety practices associated with electricity.
  c. Describe the difference between alternating current and direct current.

#### Learning Objective 2
- Explain basic electrical theory.
  a. Define voltage, current, resistance, and power and describe how they are related.
  b. Use Ohm’s law to calculate the current, voltage, and resistance in a circuit.
  c. Use the power formula to calculate how much power is consumed by a circuit.
  d. Describe the differences between series and parallel circuits and calculate circuit loads for each type.

#### Learning Objective 3
- Identify the electrical measuring instruments used in instrumentation work and describe their uses.
  a. Describe how voltage is measured.
  b. Describe how current is measured.
  c. Describe how resistance is measured.

#### Learning Objective 4
- Identify wiring related to instrumentation systems and describe their functions.
  a. Identify various types and ratings of wiring by size, jacket, and rating.
  b. Describe the purpose of electrical system grounding.

### Performance Tasks

#### Performance Task 1 (Learning Objective 3)
- Measure and record the current, voltage, and resistance in a DC circuit.

#### Performance Task 2 (Learning Objective 2)
- Calculate the power consumed by the same circuit, using any two of the measured values.

### Teaching Time: 12.5 hours

(Five 2.5-Hour Classroom Sessions)

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

### Prerequisites

Core Curriculum

### Before You Begin

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

Using your access code, download the 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**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Instrumentation Level One* PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with internet access
- Copies of the Module Examination and Performance Profile Sheets
- Multimeter
- Voltage tester
- Clamp-on ammeter
- Continuity tester
- Breadboard and electrical components such as conductors, lamps, batteries, and switches for construction of series and parallel DC circuits
- Megohmmeter
- Motor with intact windings for megohmmeter testing
- One or more copies of the NEC®
- A selection of single- and multi-conductor insulated cables

**Equipment and Materials for Laboratories and Performance Testing**
- Multimeter(s)
- Voltage tester
- Clamp-on ammeter
- Continuity tester
- Breadboards and electrical components such as lamps, batteries, and switches for construction of series and parallel DC circuits (enough for all trainees)
- Electrical conductors

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


There are a number of on-line resources available for trainees who would like more information on the instrumentation trade and related electrical systems. A search for additional information may be assigned as homework to interested trainees.

**Safety Considerations**
This module requires that trainees work around live electrical circuits. Safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen electrical hazards. Any deficiencies must be corrected to ensure future trainee safety. All practice sessions and performance tasks must be completed under your direct supervision.
Session Outline for 12116-14

Electrical Systems for Instrumentation

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

**Session One**

Session One begins by describing the different methods used to generate electricity and how the electricity is distributed from the source to the clients that depend on it. This session also covers basic electrical safety practices and describes the difference between AC and DC voltage.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe the different types of facilities used to generate electricity.
4. Explain how electricity is distributed to homes and businesses.
5. Review electrical safety practices.
6. Explain the difference between AC and DC voltage.
7. Describe how electromagnets are used in the generation of AC voltage.

**Session Two**

In Session Two, the trainees will learn about voltage, current, resistance, and power and the relationships among these electrical properties as established by Ohm's law. They will also learn how to calculate these properties of a simple electrical circuit using Ohm's law. The trainees will learn about series and parallel circuits and how to calculate resistance in these circuits.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Explain how current flow is established and how it is used to perform work.
4. Describe how to use Ohm's law to calculate voltage, current, and resistance.
5. Explain what electrical power is and how the power consumed by a circuit is calculated.
6. Explain the difference between series and parallel circuits.
7. Describe the methods used to calculate voltage, current, and resistance in series and parallel circuits.
SESSION THREE

In Session Three, the trainees will learn about the instruments they will use to measure voltage, current, and resistance when testing and troubleshooting electrical circuits. These include the multimeter, clamp-on ammeter, voltage tester, continuity tester, and megohmmeter.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Explain how to measure voltage using a multimeter.
4. Describe how to use a clamp-on ammeter to measure current.
5. Explain how to measure resistance using a multimeter.
6. Explain how to check circuit continuity using a multimeter and continuity tester.
7. Describe the purpose of a megohmmeter.
8. Demonstrate how to build a simple electrical circuit and measure various electrical values, and then make the necessary calculations related to power consumption.
9. Have trainees build a simple circuit and practice measuring and recording voltage, current, and resistance. This activity corresponds to Performance Task 1.
10. Have trainees make the necessary calculations to determine the power consumption of the circuits they have constructed. This activity corresponds to Performance Task 2.

SESSION FOUR

Session Four begins with a discussion of the electrical wiring used in instrumentation circuits, including wire markings, sizes, and ratings. This lesson also covers the principles of grounding and bonding, as well as the grounding and bonding methods used to protect personnel and equipment.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe the types of electrical wiring used in instrumentation circuits.
4. Explain wire gauges and ratings.
5. Discuss the special terms used in relation to grounding and bonding.
6. Discuss the principles of equipment grounding.
7. Explain the purpose of equipment bonding and the methods used to achieve it.

SESSION FIVE

Session Three is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (These may be assigned as homework at the end of Session Four.) Go over the Module Review Questions and Trade Terms Quiz in class prior to the exam and answer any questions that the trainees may have.

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

<table>
<thead>
<tr>
<th>Personal protective equipment:</th>
<th>Multimeter</th>
<th>Voltage tester</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Clamp-on ammeter</td>
<td>Continuity tester</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Electrical conductors</td>
<td>Megohmmeter</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Motor with intact windings for megohmmeter testing</td>
<td>One or more copies of the NEC&lt;sup&gt;®&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pencils and paper</td>
<td>A selection of single- and multi-conductor insulated cables</td>
<td>Breadboard and electrical components such as conductors, lamps, batteries, and switches for construction of series and parallel DC circuits</td>
</tr>
</tbody>
</table>

**Instrumentation Level One**

- PowerPoint<sup>®</sup> Presentation Slides
- DVD player or computer with a DVD drive
- Computer with internet access
- Copies of the Module Examination and Performance Profile Sheets
- LCD projector and screen

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Seven (12106-14) introduces the trainees to the various threaded fasteners, anchors, and non-threaded fasteners used in the installation of instrumentation equipment, including bolts, nuts and washers, concrete anchors, retainers, rivets, and tube mounting hardware. The module also covers torquing tools and methods.

### Objectives

#### Learning Objective 1
- Identify threaded fasteners and explain how they are used.
  - a. Identify various types and the uses of threaded fasteners.
  - b. Explain how to install and torque threaded fasteners to a specific value.
  - c. Identify and describe the installation of various types of anchors and anchor bolts.

#### Learning Objective 2
- Identify non-threaded fasteners and explain how they are used.
  - a. Identify various types of retainers and pins and describe how they are used.
  - b. Identify and describe the installation of blind rivets.
  - c. Identify and describe the use of various devices used to secure instrumentation tubing and hoses.

### Performance Tasks

#### Performance Task 1 (Learning Objective 1)
- From a selection of threaded fasteners, select the correct fastener(s) for one or more instructor-specified applications.

#### Performance Task 2 (Learning Objective 1)
- Drill a hole and install a toggle bolt.

#### Performance Task 3 (Learning Objective 1)
- Install a nut and bolt and torque to an instructor-specified value.

#### Performance Task 4 (Learning Objective 2)
- From a selection of non-threaded fasteners, select the correct fastener for one or more instructor-specified applications.

#### Performance Task 5 (Learning Objective 2)
- Install a blind rivet using a rivet gun.

### Teaching Time: 7.5 hours

(Three 2.5-Hour Classroom Sessions)

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

### Prerequisites

*Core Curriculum*

### 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**
Whenever the trainees are in a lab or other equipment environment, make sure they are wearing the required PPE and that they observe all site safety practices.

**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Instrumentation Level One* PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with internet access
- Module Review Question and Trade Terms Quiz answer keys
- Copies of the Module Examination and Performance Profile Sheets
- Selection of threaded fasteners, such as:
  - Bolts
  - Nuts
  - Washers
  - Screws
  - Toggle bolts
  - Thread-repair inserts
  - Set screws
- Torque wrenches
- Selection of concrete anchors
- Hammer-driven pins and studs
- Internal and external lock rings and/or retainers
- Lock ring pliers
- Blind rivet gun
- Blind rivets
- Selection of hose and tubing mounting hardware
- Various types of tie wraps

**Equipment and Materials for Laboratories and Performance Testing**
- PPE:
  - Standard eye protection
  - Work gloves
  - Proper footwear as designated by the instructor or training facility provider
  - Hearing protection as designated by the instructor or training facility provider
  - Breathing protection (if drilling concrete or sheetrock)
  - Prepared list of threaded fastener applications to which trainees must match a fastener type
  - Prepared list of non-threaded fastener applications to which trainees must match a fastener type
- Blind rivet gun
- Corded/cordless drill with bits appropriate for the rivets and toggle bolts to be installed
- Open- or box-end wrenches
- Torque wrench
- Blind rivets
- Toggle bolts
- Bolts and nuts
- Scrap sheet metal or thin plastic for riveting
- Plywood, sheetrock, or hollow concrete block for toggle bolt installation

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

Concrete Fastening Systems. [www.confast.com](http://www.confast.com).

There are a number of on-line resources available for trainees who would like more information on the instrumentation trade and fasteners. A search for additional information may be assigned as homework to interested trainees.
Session Outline for 12106-14

**FASTENERS**

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

### Session One

Session One introduces the trainees to the variety of threaded fasteners used for installation purposes, including bolts, nuts, and washers, as well as various types of screws. This session also covers torquing tools and methods. Trainees will also complete Performance Task 1, which covers the selection of threaded fasteners for specified applications.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Identify the types of threaded fasteners to be covered.
4. Discuss thread classes and grade designations.
5. Describe nuts, bolts, and washers and their uses.
6. Discuss the various types of screws and their uses.
7. Explain the purpose of torquing fasteners, along with the tools and methods used in torquing.
8. Trainees practice and/or complete the tasks associated with Performance Task 1.

### Session Two

Session Two begins with coverage of the various types of anchors and anchor bolts used to fasten material to concrete and masonry. Thereafter, the lesson focuses on non-threaded fasteners, including retainers and pins and the hardware used to mount hoses and tubing. Trainees will also complete Performance Task 4, which covers the selection of non-threaded fasteners for specified applications.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe the various types of anchors used to fasten material to concrete.
4. Explain how retainers, pins, and grating clips are used.
5. Describe how to install blind rivets.
6. Describe the various types of clamps used to install hoses and tubing.
7. Trainees practice and/or complete the tasks associated with Performance Task 4.
Session Three is used for performance testing and as a review and testing session. Review the Trade Terms Quiz and Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Demonstrate the proper methods for installing and torquing threaded fasteners.
2. Demonstrate how to install a blind rivet.
3. Demonstrate how to set up a torque wrench and torque a threaded fastener.
4. Trainees practice and complete the tasks associated with Performance Tasks 2, 3, and 5.
5. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
6. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Personal protective equipment:</th>
<th>Selection of concrete anchors</th>
<th>Lock ring pliers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard eye protection</td>
<td>Blind rivet gun</td>
<td>Blind rivets</td>
</tr>
<tr>
<td></td>
<td>Work gloves</td>
<td>Various types of tie wraps</td>
<td>Torque wrenches</td>
</tr>
<tr>
<td>Proper footwear as</td>
<td>Hammer-driven pins and studs</td>
<td>Selection of threaded</td>
<td></td>
</tr>
<tr>
<td>designated by the</td>
<td></td>
<td>fasteners, such as:</td>
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<tr>
<td>instructor or training</td>
<td></td>
<td>• Bolts</td>
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<tr>
<td>facility provider</td>
<td></td>
<td>• Nuts</td>
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<tr>
<td>Hearing protection</td>
<td>Selection of hose and tubing</td>
<td>• Washers</td>
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<tr>
<td>as designated by the</td>
<td>mounting hardware</td>
<td>• Screws</td>
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<tr>
<td>instructor or training</td>
<td></td>
<td>• Toggle bolts</td>
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<tr>
<td>facility provider</td>
<td></td>
<td>• Thread-repair inserts</td>
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<tr>
<td>Breathing protection</td>
<td>Prepared list of threaded</td>
<td>• Set screws</td>
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<tr>
<td>(if drilling concrete or</td>
<td>fastener applications to which</td>
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<tr>
<td>sheetrock)</td>
<td>trainees must match a fastener</td>
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<tr>
<td>Whiteboard/chalkboard</td>
<td>Open- or box-end wrenches</td>
<td>Corded/cordless drill with</td>
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<tr>
<td>Markers/chalk</td>
<td>Bolts and nuts</td>
<td>bits appropriate for the</td>
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<tr>
<td>Pencils and paper</td>
<td>Plywood, sheetrock, or hollow</td>
<td>rivets and toggle bolts to</td>
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<tr>
<td>Instrumentation Level One</td>
<td>concrete block for toggle bolt</td>
<td>be installed</td>
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<td>Slides</td>
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<td>LCD projector and screen</td>
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<td>Module Review Question</td>
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<td>and Trade Terms Quiz</td>
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<td>answer keys</td>
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<td>Copies of the Module</td>
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<tr>
<td>Examination and Performance</td>
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<tr>
<td>Profile Sheets</td>
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To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Lesson Plans for 12108-14

GASKETS, O-RINGS, AND PACKING

Module Eight (12108-14) introduces the trainees to the use of gaskets, O-rings, and packings used to seal flanges, valves, and other joints in process systems. The trainees will learn about the different types and their application limitations, with a focus on the importance of selecting those that are compatible with the process material, temperatures, and pressures. In the lab, the trainees will learn to remove and install gaskets, O-rings, and packings.

**Objectives**

**Learning Objective 1**
- Identify various types of gaskets and gasket materials, and describe their applications.
  a. Describe the different types of flange facings.
  b. Describe how gaskets are used and the importance of compatibility.
  c. Identify the various types of gaskets and describe their applications.
  d. Describe how to properly install gaskets.

**Learning Objective 2**
- Describe how O-rings and packings are used and identify their materials of construction.
  a. Identify and describe various types of O-rings and how they are installed.
  b. Identify and describe various types of packing and how they are installed.

**Performance Tasks**

**Performance Task 1 (Learning Objective 1)**
- Correctly select and install one or more instructor-specified gasket types.

**Performance Task 2 (Learning Objective 2)**
- Correctly select and install an O-ring.

**Performance Task 3 (Learning Objective 2)**
- Identify the correct packing material for an instructor-specified valve.

**Performance Task 4 (Learning Objective 2)**
- Remove an existing packing and install a new packing.

**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*

**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
Whenever the trainees are in a lab or other equipment environment, make sure they are wearing the required PPE and that they observe all site safety practices.

Classroom Equipment and Materials
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Instrumentation Level One PowerPoint® Presentation
DVD player or a computer with a DVD drive
LCD projector and screen
Computer with internet access
Module Review Question and Trade Terms Quiz answer keys
Copies of the Module Examination and Performance Profile Sheets
Selection of prefabricated gaskets matching those described in the text
Selection of various O-ring types and sizes
Selection of various packing materials
Valve assembly with replaceable packing
Packing puller

Equipment and Materials for Laboratories and Performance Testing
PPE:
- Standard eye protection
- Work gloves
- Proper footwear
- Hearing protection
Selection of gaskets of different styles and materials
Flanges and appropriate gaskets for trainee assembly
Open-end or combination wrenches to fit flange hardware
Torque wrench with socket to fit flange hardware
Selection of O-rings of different materials
O-ring equipped components for trainee disassembly
O-rings properly sized to fit the provided components
Cleaning solvent
Appropriate hand tools for O-ring equipped component disassembly
Selection of packing of different materials
Packing puller
Appropriate tool to cut packing material
Appropriate hand tools to disassemble and reassemble valve assemblies

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

- Spiral Wound Gaskets. Flexitallic LP. Deer Park, TX

There are a number of on-line resources available for trainees who would like more information on gaskets, O-rings, and packing material. A search for additional information may be assigned as homework to interested trainees.
The Lesson Plan for this module is divided into four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**
Trainees will learn about the various types of gaskets, the materials used in their manufacture, and their uses. This lesson also provides instructions for the removal and installation of gaskets.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Identify and discuss the different types of flange facings.
4. Discuss the factors that affect gasket selection and application.
5. Identify and describe the various types of gaskets and gasket materials.
6. Describe how to remove and install gaskets.

**SESSION TWO**
Trainees will learn about the various types of packings and O-rings and the materials used in their fabrication, as well as their application limitations. This session also provides instructions for the removal and installation of packings and O-rings. At the completion of the lecture, trainees will practice and perform the requirements of Performance Task 3.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Discuss the purpose of O-rings.
4. Describe the different types of O-rings and their applications.
5. Explain how to remove and install O-rings.
6. Explain the purpose of packings.
7. Describe how to remove and install packings.
8. Trainees practice and/or complete the tasks associated with Performance Task 3.

**SESSION THREE**
Session Three is devoted to laboratories and the completion of Performance Tasks 1, 2, and 4.

1. Note that there is no PowerPoint® presentation associated with these sessions.
2. Demonstrate how to properly install a gasket and assemble a flange set.
3. Demonstrate how to disassemble a component equipped with an O-ring and replace it.
4. Demonstrate how to remove packing from a valve stem and replace it.
5. Trainees practice and/or complete the tasks associated with Performance Tasks 1, 2, and 4.

**SESSION FOUR**
Session Four is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (These may be assigned as homework at the end of Session Two.) Go over the Module Review Questions and Trade Terms Quiz in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Materials/Equipment Description</th>
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</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>Selection of prefabricated gaskets matching those described in the text</td>
</tr>
<tr>
<td>Standard eye protection</td>
<td>Packing puller</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Appropriate hand tools to disassemble and reassemble valve assemblies</td>
</tr>
<tr>
<td>Proper footwear</td>
<td>O-ring equipped components for trainee disassembly</td>
</tr>
<tr>
<td>Hearing protection</td>
<td>Selection of various O-ring types and sizes</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Valve assembly with replaceable packing</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Torque wrench with socket to fit flange hardware</td>
</tr>
<tr>
<td>Pencils and paper</td>
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<td>Instrumentation Level One</td>
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<td>PowerPoint® Presentation Slides</td>
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<td>DVD player or computer with a DVD drive</td>
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<tr>
<td>Computer with internet access</td>
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<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
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<tr>
<td>LCD projector and screen</td>
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<tr>
<td>Module Review Question and Trade Terms Quiz answer keys</td>
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</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Nine (12109-14) introduces the trainees to the various types and purposes of lubricants, sealants, and cleaners used during the performance of instrumentation work. The module also discusses the importance of choosing the correct product for the task and how to safely use each one.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Learning Objective 1</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Identify lubricants used in instrumentation work and state their applications.</td>
</tr>
<tr>
<td></td>
<td>a. Identify various cutting fluids and explain how they are used.</td>
</tr>
<tr>
<td></td>
<td>b. Identify other common lubricants and explain how they are used.</td>
</tr>
<tr>
<td></td>
<td>c. Describe the safe handling and storage requirements for lubricants.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning Objective 2</th>
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</thead>
<tbody>
<tr>
<td>Identify sealants and adhesives used in instrumentation work and state their applications.</td>
</tr>
<tr>
<td>a. Identify and describe various pipe and hardware sealants and adhesives.</td>
</tr>
<tr>
<td>b. Identify and describe various other sealants and adhesives.</td>
</tr>
<tr>
<td>c. Describe the safe handling and storage requirements for sealants and adhesives.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning Objective 3</th>
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</thead>
<tbody>
<tr>
<td>Identify cleaning materials and products used in instrumentation work and describe their applications.</td>
</tr>
<tr>
<td>a. Identify cleaning tools and materials used in instrumentation work and describe their use.</td>
</tr>
<tr>
<td>b. Identify and describe various cleaning liquids used in and around instrumentation work.</td>
</tr>
<tr>
<td>c. Describe the safe handling and storage requirements for cleaners and solvents.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Performance Tasks</th>
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</thead>
<tbody>
<tr>
<td><strong>Performance Task 1</strong></td>
</tr>
<tr>
<td>(Learning Objectives 1, 2, and 3)</td>
</tr>
<tr>
<td>Choose the correct lubricant, sealant, and/or cleaner for an instructor-specified application(s).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance Task 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Learning Objectives 1, 2, and 3)</td>
</tr>
<tr>
<td>Identify the specific precautions of a given substance from an instructor-provided MSDS or SDS.</td>
</tr>
</tbody>
</table>

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

**Prerequisites**
*Core Curriculum*

**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**

Whenever the trainees are in a lab or other equipment environment, make sure they are wearing the required PPE and that they observe all site safety practices.

**Classroom Equipment and Materials**

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Instrumentation Level One* PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with internet access
- Module Review and Trade Terms Quiz answer keys
- Copies of the Module Examination and Performance Profile Sheets
- MSDS/SDS for WD-40™ lubricant
- Samples of lubricants and related substances, including:
  - Active (sulfurized mineral) cutting oil
  - Various inactive cutting oils
  - Emulsifiable cutting oil
  - Synthetic cutting fluid
  - One or more pipe joint compounds
  - PTFE tape; white and yellow (or pink)
  - Silicone lubricant
  - Penetrating oil
  - Aluminum antioxidant compound
- MSDSs or SDSs for various lubricants
- *NIOSH Pocket Guide to Chemical Hazards* (several copies)
- Anaerobic pipe thread compound
- RTV silicone sealant
- Two-part epoxy putty
- Samples of metal wools, including:
  - Bronze wool
  - Aluminum wool
  - Steel wool
  - Stainless steel wool
- Samples of sandpaper, including:
  - Silicone-carbide sandpaper
  - Flint sandpaper
  - Emery cloth
  - Crocus cloth
- Selection of wire brushes, including:
  - Carbon steel wire brushes
  - Stainless steel wire brushes
  - Brass wire brushes
- MSDS/SDS for a caustic cleaner

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

- Copies of MSDS/SDS documents for a variety of lubricants, sealants, and cleaners
- Copies of an instructor-prepared list of the different lubricants, sealants, and cleaners covered in this module

**Samples of metal wools, including:**

- Bronze wool
- Aluminum wool
- Steel wool
- Stainless steel wool

**Samples of sandpaper, including:**

- Silicone-carbide sandpaper
- Flint sandpaper
- Emery cloth
- Crocus cloth

**Selection of wire brushes, including:**

- Carbon steel wire brushes
- Stainless steel wire brushes
- Brass wire brushes

**MSDS/SDS for a caustic cleaner**

**Additional Resources**

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

- *NIOSH Pocket Guide to Chemical Hazards*. The National Institute for Occupational Safety and Health: Atlanta, GA.

Instructors are encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the Instrumentation trade and add them to the PowerPoint® presentations throughout the program.
Session Outline for 12109-14

LUBRICANTS, SEALANTS, AND CLEANERS

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

**SESSION ONE**

Session One introduces the trainees to the types and purposes of cutting fluids and lubricants, how to choose the right type for the task, and where to find product safety information.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Identify common types of cutting fluids and describe their uses.
4. Identify and describe other lubricants used in instrumentation work.
5. Describe how to safely handle and store lubricants.

**SESSION TWO**

Session Two focuses on introducing trainees to sealants, adhesives, and cleaning materials, how to choose the right type for the task, and where to find product safety information.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to reintroduce the subject matter.
3. Identify and describe the different types of pipe and hardware sealants and adhesives.
4. Describe how to safely store and handle sealants and adhesives.
5. Identify and describe the cleaning materials and products frequently used in instrumentation work.
6. Identify and describe the different types of cleaning tools and materials.
7. Identify various cleaning agents used in and around instrumentation work and describe their uses.
8. Describe how to safely handle and store sealants, adhesives, and cleaning materials.

**SESSION THREE**

Session Three is used for both performance testing and the module exam. Following the performance tests, have trainees complete the Module Review Questions and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Two.) Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Note that no PowerPoint® presentation is associated with this laboratory session.
2. Demonstrate how to properly perform the tasks to be completed during this session.
3. Trainees practice and/or complete the tasks associated with Performance Tasks 1 and 2.
4. Have trainees complete the written examination.
5. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
## Materials Checklist for Module 12109-14, Lubricants, Sealants, and Cleaners

| Equipment and Materials | Personal protective equipment: | None | RTV silicone sealant | Two-part epoxy putty | Anaerobic pipe thread compound | Samples of metal wools, including:  
  - Bronze wool  
  - Aluminum wool  
  - Steel wool  
  - Stainless steel wool | Samples of sandpaper, including:  
  - Silicone-carbide sandpaper  
  - Flint sandpaper  
  - Emery cloth  
  - Crocus cloth | NIOSH Pocket Guide to Chemical Hazards (several copies) | Copies of an instructor-prepared list of the different lubricants, sealants, and cleaners covered in this module |
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To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Ten (12111-14) introduces the trainees to the variety of tubing used in instrumentation work, including copper, stainless steel, and poly (plastic) tubing.

Objectives

Learning Objective 1
- Identify and describe the types of tubing and their uses.
  a. Describe the general sizing of tubing.
  b. Identify the various materials used in tubing and state their applications.
  c. Describe various standards that apply to tubing products.
  d. Describe the methods for properly handling and storing tubing.

Learning Objective 2
- Describe the tools and methods used to cut and bend tubing.
  a. Identify various tube-cutting tools and explain how they are used.
  b. Identify various bend types and the flaws that must be avoided during bending.
  c. Identify various bending devices and explain how they are used.

Learning Objective 3
- Identify and describe the various methods for joining tubing and related fittings.
  a. Identify various types of compression fittings and describe how to assemble a compression fitting.
  b. Identify flare fittings and describe how to form a flare.
  c. Describe fittings used for welding and brazing.
  d. Describe the method used to join PVC tubing.

Performance Tasks

Performance Task 1 (Learning Objective 2)
- Cut and deburr tubing using a hacksaw or tubing cutter.

Performance Task 2 (Learning Objective 2)
- Bend tubing to 45-degree and 90-degree angles using a hand bender.

Performance Task 3 (Learning Objective 3)
- Install a compression fitting on a section of instructor-chosen tubing.

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

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**
Whenever the trainees are in a lab or other equipment environment, make sure they are wearing the required PPE and that they observe all site safety practices.

**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *Instrumentation Level One* PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with internet access
- Copies of the Module Examination and Performance Profile Sheets
- Examples of different types of tubing, including:
  - Steel
  - Stainless steel
  - Copper
  - Metal alloy tubing
  - PVC
  - PE
- Ruler or tape measure
- Calipers
- Tubing cutter
- Deburring tool
- Spring bender
- Compression bender
- Selection of compression fittings

**Equipment and Materials for Laboratories and Performance Testing**
- PPE:
  - Eye and face protection
  - Gloves
  - Approved work boots
  - Hearing protection as designated by the instructor or training facility provider
  - Hard hat as designated by the instructor or training facility provider
- Tubing of instructor-chosen size and composition
- Tubing cutters, or appropriate saws and vises
- Compression-fitting gap gauge
- Flaring tools
- Flare fittings
- Selection of PVC fittings
- Tubing reamers
- Compression benders
- Various tubing fittings, such as unions, tees, and caps/plugs
- Compression-fitting gap gauges
- Hand tools, including open-end wrenches
- Nitrogen or compressed-air source, with regulators and hoses
- Leak detection soap

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


Plastic Pipe Institute, Inc. [http://www.plasticpipe.org](http://www.plasticpipe.org)


Swagelok® has uploaded several videos to YouTube related to tube bending and the installation of compression fittings. These can be located using common search tools for “Swagelok tube bending” or “Swagelok tube fitting” as search terms. Alternatively, Swagelok’s YouTube channel, containing all of its many public video offerings, can be found at [https://www.youtube.com/user/swagelok](https://www.youtube.com/user/swagelok).

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the Instrumentation trade and add them to the PowerPoint® presentations throughout the program.
Session Outline for 12111-14

TUBING

Session One

In Session One, the trainees will learn about the different types of tubing, along with their uses and limitations. The various types of plastic tubing used in the industry are also included. This lesson also covers the standards and specifications governing tubing, as well as storage and handling requirements for tubing.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe the various ways in which tubing is used in instrumentation systems.
4. Describe how tubing is sized.
5. Discuss the different materials used in the manufacture of tubing.
6. Discuss the standards and specifications that apply to tubing.
7. Describe the correct methods for handling and storing tubing.

Session Two

Session Two focuses on the tools and methods used to cut and bend tubing. The trainees will learn about the tools used to cut and deburr tubing and the tools used to bend copper, stainless steel, and other types of metal tubing.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Discuss the tools used to cut and deburr tubing.
4. Describe the methods used to cut tubing with a hacksaw or bandsaw.
5. Discuss the different tools used to bend metal tubing.
6. Describe how to use tube bending tools.

Session Three

Session Three covers methods used to join tubing, with a focus on the various types of compression fittings and the methods used to join them. The tools and methods used to join tubing with flare fittings are covered, as is the solvent-cement method of joining plastic tubing.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Identify common tube fittings and how they are designed to seal.
4. Describe how various fittings are assembled.
5. Describe flare fittings and how tube flares are formed.
6. Review fittings used for welding and brazing tubing.
7. Discuss the process of joining plastic tubing.

Session Four

Session Four is dedicated to lab work and performance testing in which the trainees will learn how to safely cut and bend tubing. The instructor will demonstrate the proper techniques and the trainees will practice making bends to satisfy the requirements of Performance Tasks 1 and 2.

1. Review the safety practices associated with the use of tools.
2. Demonstrate how to measure, mark, and cut tubing.
3. Trainees practice measuring, marking, and cutting tubing. This activity corresponds to Performance Task 1.
4. Demonstrate how to measure, mark, and bend tubing to various angles.
5. Trainees practice measuring, marking, and bending tubing to various angles, including 45- and 90-degree angles. This activity corresponds to Performance Task 2.
Session Five is a laboratory focusing on the assembly of tubing using compression fittings. The instructor will demonstrate the proper techniques and trainees will practice joining sections of tubing to satisfy the requirements of Performance Task 3.

1. Review the safety practices associated with the use of tools.
2. Demonstrate how to properly assemble one or more fittings to a section of tubing, and then preparing for a leak test.
3. Trainees practice assembling sections of tubing with compression fittings, followed by leak testing. This activity corresponds to Performance Task 3.

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

1. Have trainees complete the module review test and trade terms quiz if not previously completed.
2. Review the module review test and trade terms quiz answers with the trainees.
3. Have trainees complete any outstanding Performance Tasks.
4. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
5. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
## Materials Checklist for Module 12111-14, Tubing

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Equipment and Materials</th>
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</thead>
<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td><strong>Calipers</strong></td>
</tr>
<tr>
<td>Ruler or tape measure</td>
<td>Calipers</td>
</tr>
<tr>
<td>Eye and face protection</td>
<td>Tubing cutter</td>
</tr>
<tr>
<td>Tubing cutter</td>
<td>Deburring tool</td>
</tr>
<tr>
<td>Gloves</td>
<td>Spring bender</td>
</tr>
<tr>
<td>Spring bender</td>
<td>Compression bender</td>
</tr>
<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
<td>Flaring tools</td>
</tr>
<tr>
<td>Flaring tools</td>
<td>Flare fittings</td>
</tr>
<tr>
<td>Hard hat as designated by the instructor or training facility provider</td>
<td>Selection of PVC fittings</td>
</tr>
<tr>
<td>Selection of PVC fittings</td>
<td>Compression-fitting gap gauge</td>
</tr>
<tr>
<td>Approved work boots</td>
<td>Selection of compression fittings</td>
</tr>
<tr>
<td>Selection of compression fittings</td>
<td>Tubing of instructor-chosen size and composition</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Tubing reamers</td>
</tr>
<tr>
<td>Tubing reamers</td>
<td>Hand tools, including open-end wrenches</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Various tubing fittings, such as unions, tees, and caps/plugs</td>
</tr>
<tr>
<td>Various tubing fittings, such as unions, tees, and caps/plugs</td>
<td>Leak detection soap</td>
</tr>
<tr>
<td>Pencils and paper</td>
<td>Nitrogen or compressed-air source, with regulators and hoses</td>
</tr>
<tr>
<td>Nitrogen or compressed-air source, with regulators and hoses</td>
<td>Examples of different types of tubing, including:</td>
</tr>
<tr>
<td>Examples of different types of tubing, including:</td>
<td>Steel</td>
</tr>
<tr>
<td>Steel</td>
<td>Stainless steel</td>
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<tr>
<td>Stainless steel</td>
<td>Copper</td>
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<tr>
<td>Copper</td>
<td>Metal alloy tubing</td>
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<tr>
<td>Metal alloy tubing</td>
<td>PVC</td>
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<tr>
<td>PVC</td>
<td>PE</td>
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<tr>
<td>Instrumentation Level One PowerPoint® Presentation Slides</td>
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<tr>
<td>DVD player or computer with a DVD drive</td>
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<tr>
<td>LCD projector and screen</td>
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<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
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<tr>
<td>Computer with internet access</td>
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</tr>
</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Lesson Plans for 12117-14

STEEL PIPING PRACTICES

Module Eleven (12117-14) provides the basic knowledge and skills needed to cut, thread, install, and join steel piping systems. The module provides coverage of basic piping system installation considerations and coverage of piping system hangers and supports.

Objectives

Learning Objective 1
• Describe and identify the various types of steel pipe and fittings.
  a. Identify the characteristics and uses of steel pipe.
  b. Describe how pipe threads are classified and measured.
  c. Identify the various types of fittings used on steel pipe and describe how they are used.
  d. Describe how to properly measure lengths of steel pipe.

Learning Objective 2
• Describe the tools and methods used to cut and thread steel pipe.
  a. Identify pipe cutting and reaming tools and describe how they are used.
  b. Identify threading tools and describe how they are used.

Learning Objective 3
• Explain and demonstrate the methods of installing and mechanically joining steel pipe.
  a. Explain and demonstrate the methods and use of the tools to connect threaded pipe.
  b. Describe how to assemble flanged steel pipe.
  c. Describe the welding methods used to join steel pipe.
  d. Describe how to correctly install steel pipe.

Performance Tasks

Performance Task 1
(Learning Objectives 1 and 2)
• Cut, ream, and thread steel pipe.

Performance Task 2
(Learning Objective 3)
• Join lengths of threaded pipe using selected fittings.

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

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

Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Instrumentation Level One
PowerPoint® Presentation
DVD player or a computer with a DVD drive
LCD projector and screen
Computer with internet access
Copies of the Module
Examination and Performance Profile Sheets
Variations of different threaded pipe fittings, such as:
  - Tees
  - Crosses
  - Elbows
  - Unions
  - Flange unions
  - Couplings
  - Nipples
  - Plugs
  - Caps
  - Bushings

Single-wheel and/or a four-wheel pipe cutter
Chain and/or yoke vise
Pipe reamer
Hand-threading stock with various dies

Equipment and Materials for Laboratories and Performance Testing

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

Steel pipe for threading demonstration and trainee practice; size is optional
Assortment of fittings of the same pipe size used for threading practice

Various types and sizes of pipe wrenches
Raised-face pipe flange
Full-face pipe flange

Hand-threader stock and appropriate dies for threading
Power threader
Chain or yoke tripods
Pipe cutters
Pipe reamers
Measuring tapes
Thread cutting oil and pump basin
Pipe wrenches
Pipe joint compound and/or PTFE tape
Rags

Additional Resources

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


RIDGID® offers a number of pipe threading videos on-line. They can be accessed via a link on the RIDGID® home page (www.ridgid.com) or through RIDGID’s YouTube channel. These videos are presently two minutes in length or less, offering brief support for individual and specific threading tasks. The Model 1224 threader is featured in all the available videos at this time.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the Instrumentation trade and add them to the PowerPoint® presentations throughout the program.

Safety Considerations

This module requires trainees to work with steel piping materials, common hand tools, and powerful rotating machinery and/or power tools. Personal safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards of operating power tools and handling metal parts. Any deficiencies must be corrected to ensure future trainee safety as they begin working with even more hazardous systems later in their training and career. All practice sessions and performance tasks must be completed under your direct supervision.
The Lesson Plan for this module is divided into four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One introduces trainees to steel piping materials and fittings typically used in the instrumentation environment. The processes of cutting, reaming, and threading pipe are reviewed in the classroom.

1. Show the Session One PowerPoint® presentation.
2. Use the video(s) identified in the Kickoff Activity to get trainees engaged and give them an idea of what they will learn in this module.
3. Describe the various piping materials used in steel piping systems.
4. Familiarize trainees with tapered pipe threads.
5. Identify the common fittings used to assemble threaded piping systems.
6. Describe and discuss the processes of cutting and reaming steel pipe.
7. Describe and discuss the process of threading pipe using both manual and powered equipment.

**SESSION TWO**

Session Two begins by exploring the tools and materials used to assemble threaded piping systems. Flanged pipe systems are presented, along with basic assembly techniques. The session ends with coverage of installation considerations and an introduction to various hangers and pipe support components.

1. Show the Session Two PowerPoint® presentation.
2. Discuss joint compounds and PTFE tape.
3. Describe different types of pipe wrenches.
4. Discuss flanges as a means of connecting steel pipe.
5. Explore the use of hangers and supports in the installation of piping systems.

**SESSION THREE**

Session Three is a laboratory and Performance Task session. Instructors demonstrate how to cut, ream, and thread steel pipe. The assembly of threaded joints is also demonstrated. Trainees then practice those tasks and complete Performance Tasks 1 and 2 during this session.

1. Note that no PowerPoint® presentation is associated with this session.
2. Demonstrate measuring, cutting, and reaming steel pipe.
3. Demonstrate how to thread pipe using at least one method.
4. Have trainees cut, ream, and thread pipe. This corresponds to Performance Task 1.
5. Demonstrate how to properly assemble threaded pipe and fittings.
6. Have trainees assemble threaded pipe and fittings. This corresponds to Performance Task 2.

**SESSION FOUR**

Session Four is a review and testing session. Have trainees complete the Module Review Questions and Trade Terms Quiz. (These may have been assigned as homework at the end of Session Three.) Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
## Materials Checklist for Module 12117-14, Steel Piping Practices

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
<th>Chain and/or yoke vise</th>
<th>Pipe reamer</th>
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</thead>
<tbody>
<tr>
<td>Personal protective equipment:</td>
<td>Chain and/or yoke vise</td>
<td>Pipe reamer</td>
</tr>
<tr>
<td>Standard eye protection</td>
<td>Raised-face pipe flange</td>
<td>Full-face pipe flange</td>
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<tr>
<td>Work gloves</td>
<td>Hand-threading stock with various dies</td>
<td>Various types and sizes of pipe wrenches</td>
</tr>
<tr>
<td>Proper footwear as designated by the instructor or training facility provider</td>
<td>Single-wheel and/or a four-wheel pipe cutter</td>
<td>Steel pipe for threading demonstration and trainee practice; size is optional</td>
</tr>
<tr>
<td>Hearing protection as designated by the instructor or training facility provider</td>
<td>Assortment of fittings of the same pipe size used for threading practice</td>
<td>Thread cutting oil and pump basin</td>
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<tr>
<td>Hard hats</td>
<td>Power threader</td>
<td>Pipe cutters</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Measuring tapes</td>
<td>Pipe joint compound and/or PTFE tape</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Rags</td>
<td>Variations of different threaded pipe fittings, such as:</td>
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<td></td>
<td></td>
<td>Tees</td>
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<td></td>
<td></td>
<td>Crosses</td>
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<td>Elbows</td>
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<td>Unions</td>
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<td></td>
<td></td>
<td>Flange unions</td>
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<td>Couplings</td>
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<td>Nipples</td>
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<td>Plugs</td>
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<td>Caps</td>
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<td>Bushings</td>
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<td>Pencils and paper</td>
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<td>Instrumentation Level One</td>
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<tr>
<td>Copies of the Module Examination and Performance Profile Sheets</td>
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</tbody>
</table>

To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.
Module Twelve (12113-14) introduces the trainees to the various types of metallic and non-metallic hoses used in instrumentation work. The module covers standards for hoses as well as methods and practices for handling and storage of hoses. Also included are information and instructions related to hose fittings and their installation.

### Objectives

#### Learning Objective 1
- Identify and describe the types of hoses used in instrumentation systems.
  - Identify relevant hose standards and common sizing/pressure rating conventions.
  - Identify and describe various types of metallic hoses.
  - Identify and describe various types of non-metallic hoses.
  - Describe methods used in storing and handling hoses.

#### Learning Objective 2
- Identify and describe various approaches to hose construction and relevant hose fittings.
  - Describe the various approaches to hose construction and identify their applications.
  - Identify various fittings used to assemble hoses and describe their uses.
  - Explain how to install a standard reusable hose fitting.

### Performance Tasks

#### Performance Task 1
(Learning Objectives 1 and 2)
- Select and cut a section of the proper hose and install the appropriate fitting for an instructor-specified application(s).

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

### Prerequisites
**Core Curriculum**

### 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
Whenever the trainees are in a lab or other working environment, make sure they are wearing the required PPE and that they observe all site safety practices.

Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- Instrumentation Level One PowerPoint® Presentation
- DVD player or a computer with a DVD drive
- LCD projector and screen
- Computer with internet access
- Copies of the Module Examination and Performance Profile Sheets
- Short lengths of metallic and non-metallic hoses
- Selection of hose fittings

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

- Hose Safety Institute Handbook. The Association for Hose and Accessories Distribution (NAHAD).

There are a number of on-line resources available for trainees who would like more information on hoses and related materials. A search for additional information may be assigned as homework to interested trainees.

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

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the instrumentation trade and add them to the PowerPoint® presentations throughout the program.

Equipment and Materials for Laboratories and Performance Testing
- PPE:
  - Eye protection
  - Work gloves
  - Work boots
  - Reusable fittings
  - Lengths of hose compatible with the fittings
  - Vise

- Hose lubricant
- Cutting tools appropriate for the selected hose
- Compressed air tank, water or mineral oil, as appropriate for cleaning hose
- Nitrogen bottle and regulator for pressure-testing a completed hose
Session Outline for 12113-14

HOSES

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

**Session One**

In Session One, the trainees will learn about the factors that must be considered in hose selection based on application and pressure rating, as well as the various standards that apply to hoses. Trainees will also learn how to interpret imperial and metric size markings on hoses. Included in this lesson is information on the construction and applications of the various metallic and non-metallic hoses. The lesson concludes with a discussion of the methods and practices for storing and handling hoses.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Describe the factors that enter into the selection of hoses.
4. Explain how to interpret size and pressure ratings from hose markings.
5. Describe the categories and applications for metallic hoses.
6. Describe the various types of non-metallic hoses, along with their applications.
7. Discuss the proper methods for the handling and storage of hoses.

**Session Two**

Session Two covers the four basic methods used in hose construction and explains how the method of construction relates to the pressure ratings of the hoses. This session also covers the various types of fittings used to connect hoses, along with instructions for cutting hoses and installing fittings.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn from this module.
3. Discuss the methods used in the construction of hoses.
4. Describe how hose construction relates to pressure rating.
5. Present the various types of fittings used to connect hoses.
6. Explain how to properly cut hoses in preparation for fitting installation.
7. Describe and demonstrate the proper method for installing hose fittings.
Session Three

Session Three is used for performance testing and as a review and testing session. Following completion of the Performance Task, have trainees complete the Module Review and Trade Terms Quiz. (Alternatively, these may be assigned as homework at the end of Session Two.) Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Note that there is no PowerPoint® presentation associated with this session.
2. Demonstrate the proper method for selecting hoses.
3. Demonstrate how to cut hoses and install fittings.
4. Have the trainees practice cutting hoses and installing reusable fittings. This activity corresponds to Performance Task 1.
5. Have trainees complete the Module Review and Trade Terms Quiz if not previously completed.
6. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.

6. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
### Materials Checklist for Module 12113-14, Hoses

<table>
<thead>
<tr>
<th>Equipment and Materials</th>
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<tbody>
<tr>
<td><strong>Personal protective equipment:</strong></td>
<td>Short lengths of metallic and non-metallic hoses</td>
</tr>
<tr>
<td>Eye protection</td>
<td>Reusable fittings</td>
</tr>
<tr>
<td>Work gloves</td>
<td>Vise</td>
</tr>
<tr>
<td>Work boots</td>
<td>Cutting tools appropriate for the selected hose</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Nitrogen bottle and regulator for pressure-testing a completed hose</td>
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<tr>
<td>Markers/chalk</td>
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<td>Pencils and paper</td>
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To the extent possible, and as required for performance testing, provide a selection of the tools listed for each session; alternatively, photos may be used to teach tool identification.