MODULE OVERVIEW

This module introduces the trainee to the craft-specific hand tools used by instrumentation personnel.

PREREQUISITES

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

Core Curriculum

OBJECTIVES

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

1. Identify hand tools used in instrumentation.
2. Select the proper hand tool for a job.
3. Inspect the condition of tools.
4. Properly maintain hand tools.
5. Use hand tools safely.
6. Assemble and safely operate oxyacetylene cutting equipment.

PERFORMANCE TASKS

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

1. Safely use selected hand tools such as:
   - Yoke vise
   - Wrap around
   - Hacksaw
   - Flat file
   - Fish tape
   - Knockout punch
   - Extractor
   - Angle finder
   - Rodding-out tool
2. Drill and tap a hole using a tap wrench and tap.
3. Thread a rod using a die and diestock.
4. Safely set up an oxyacetylene system.

NCCER STANDARDIZED CRAFT TRAINING PROGRAM

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If you see the Teaching Tip icon, that means there is a teaching tip associated with this section. Also refer to any suggested teaching tips at the end of the module.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Whiteboard/chalkboard
Transparencies
Markers/chalk
Eraser
Pencils/Paper
Cutting fluid
Sheet aluminum
Mild steel plate
10″ length of conduit with a 90-degree bend
15″ length of wire
Roll of electrical tape
Pipe or conduit
Bolt that fits tapped hole
Nut that fits threaded rod
Rod stock
Light oil
Blind rivets
Soft rag
Appropriate personal protective equipment for cutting and welding
Tap handle
Plug tap
Taper tap
Bottoming tap
Small square
Solid die
Adjustable split die
Adjustable screw plate die
Collet diestock
Fish tape
Combination bench and pipe vise
Yoke pipe vise
Chain pipe vise
Straight pattern snips
Aviation pattern snips
Knockout punch
Oxygen cylinder
Acetylene cylinder
Straight flute extractor
Spiral tapered extracator
Tap extractor
Rivet gun
Oxyacetylene system, including:
- Oxygen regulator
- Acetylene regulator
- Cutting torch
- Cutting tips

Gang wrench
Oxygen and acetylene hoses
Wire brush
Tape measure
Electric drill
Drill bit set
Angle finder
Wrap around
Hacksaw
Flat metal file
Adjustable wrench (10-inch)
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide

ADDITIONAL RESOURCES

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

Modern Welding. Althouse, Turnquist, Bowditch and Bowditch. Tinley Park, IL: The Goodheart Willcox Company Inc.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Hand Tools for Instrumentation*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	**Planned Time**
Session I. Taps and Dies	
A. Introduction	_____
B. Taps	_____
1. Cutting Fluids	_____
2. Procedure for Tapping a Hole	_____
C. Dies	_____
1. Procedure for Threading a Rod	_____
D. Laboratory/Performance Testing	_____
Under your supervision, have the trainees drill and tap a hole and thread a rod. Note the proficiency of each trainee.	
Session II. Fish Tape, Vises, Snips, and Knockout Punches	
A. Fish Tape	_____
1. Procedure for Using a Fish Tape	_____
2. Laboratory/Performance Testing	_____
Have the trainees use a fish tape to pull a conductor through a section of conduit. Note the proficiency of each trainee.	
B. Vises	_____
1. Procedure for Using a Combination Bench and Pipe Vise	_____
2. Procedure for Using a Yoke Pipe Vise	_____
3. Procedure for Using a Chain Pipe Vise	_____
4. Laboratory/Performance Testing	_____
Under your supervision, have the trainees use a combination bench and pipe vise; yoke pipe vise; and chain pipe vise. Note the proficiency of each trainee.	
C. Snips	_____
1. Straight Pattern Snips	_____
2. Aviation Snips	_____
3. Procedure for Using Snips	_____
4. Laboratory	_____
Under your supervision, have the trainees use straight pattern and aviation snips to cut sheet metal. Note the proficiency of each trainee.	
D. Knockout Punches	_____
1. Procedure for Using a Knockout Punch	_____
2. Laboratory/Performance Testing	_____
Under your supervision, have the trainees safely use a knockout punch. Note the proficiency of each trainee.	
Session III. Oxyacetylene System	
A. Oxygen and Acetylene Gas Cylinders	_____
B. Oxygen and Acetylene Regulators	_____
C. Flashback Arrestors and Check Valves	_____

D. Oxygen and Acetylene Hoses _____
E. Cutting Torch _____
F. Cutting Tips _____
G. Procedure for Assembling an Oxyacetylene System _____
H. Preparing Metal for Cutting _____
I. Lighting an Oxyacetylene Torch and Adjusting the Flame _____
J. Cutting Metals With Oxyacetylene Equipment _____
K. Shutting Down the Oxyacetylene Equipment _____
L. Laboratory/Performance Testing _____

Under your supervision, have the trainees safely set up an oxyacetylene system. Note the proficiency of each trainee.

Session IV. Extractors, Rivet Guns, Angle Finders, Wrap Arounds, and Rodding-Out Tools

A. Extractors _____
1. Procedure for Removing a Broken Screw _____
2. Procedure for Removing a Broken Tap _____
3. Laboratory _____

Under your supervision, have the trainees use screw and tap extractors. Note the proficiency of each trainee.

B. Rivet Gun _____
1. Procedure for Using a Rivet Gun _____
2. Laboratory _____

Under your supervision, have the trainees use a rivet gun. Note the proficiency of each trainee.

C. Angle Finder _____
D. Wrap Around _____
E. Rodding-Out Tool _____
F. Laboratory/Performance Testing _____

Under your supervision, have the trainees use the angle finder, wrap around, and rodding-out tool. Note the proficiency of each trainee.

Session V: Summary, Module Examination, and Performance Testing

A. Summary
1. Summarize module _____
2. Answer questions _____

B. Module Examination _____
1. Trainees must score 70% or higher to receive recognition from the NCCER.
2. Record the testing results on Craft Training Report Form 200 and submit the results to the training program sponsor.

C. Performance Testing _____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER
2. Record the testing results on Craft Training Report Form 200 and submit the results to the training program sponsor.

MODULE OVERVIEW

This course introduces the trainee to the safety rules and regulations for electrical work, including the necessary precautions for avoiding various job site hazards.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Module 12101

OBJECTIVES

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

1. Demonstrate safe working procedures in a construction environment.
2. Explain the purpose of OSHA and how it promotes safety on the job.
3. Identify electrical hazards and how to avoid or minimize them in the workplace.
4. Explain safety issues concerning lockout/tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection systems.

PERFORMANCE TASKS

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

1. Perform a visual inspection and an air test on rubber gloves.
2. Perform a hazard assessment of a job such as replacing the lights in your classroom.
   - Discuss the work to be performed and the hazards involved.
   - Locate the closest phone to the work site and ensure that the local emergency telephone numbers are either posted at the phone or known by you and your partner(s).
   - Plan an escape route from the location in the event of an accident.

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Transparencies

Markers/chalk

Lockout/tagout devices and labels

Copy of the latest edition of the *National Electrical Code®*

OSHA Electrical Safety Guidelines (pocket guide)

Module Examinations*

Performance Profile Sheets*

Overhead projector and screen

Whiteboard/chalkboard

Various types of personal protective and safety equipment, including rubber gloves, insulating blankets, lockout/tagout devices, hot sticks, fuse pullers, shorting probes, safety glasses, and face shields

Access to an eye wash station

Appropriate personal protective equipment

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

29 CFR Parts 1900 – 1910, Standards for General Industry. Occupational Safety and Health Administration, US Department of Labor.

29 CFR Part 1926, Standards for the Construction Industry. Occupational Safety and Health Administration, US Department of Labor.

National Electrical Code Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

National Electrical Safety Code, Latest Edition. Quincy, MA: National Fire Protection Association.

NOTES

The designations "National Electrical Code," "NE Code," and "NEC," where used in this document, refer to the *National Electrical Code®*, which is a registered trademark of the National Fire Protection Association, Quincy, MA. All National Electrical Code (NEC) references in this module refer to the 1999 edition of the NEC.

If you feel that additional math instruction would be helpful, Prentice Hall offers a basic math textbook entitled *Fundamentals of Electrical and Mechanical Mathematics*. It covers the basic math requirements for electrical trainees and may be ordered by contacting Prentice Hall Customer Service at 1-800-922-0579.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Electrical Safety.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I. Introduction to Electrical Hazards

A. Electrical Shock _____
   1. Body Resistance _____
   2. Burns _____

B. Protective Equipment _____
   1. Rubber Protective Equipment _____
   2. Protective Apparel _____
   3. Personal Clothing _____
   4. Hot Sticks _____
   5. Fuse Pullers _____
   6. Shorting Probes _____
   7. Eye and Face Protection _____

C. Laboratory/Performance Testing _____

   Under instructor supervision, have the trainees practice examining rubber gloves using the visual inspection and air tests.

D. Verifying De-Energized Circuits _____

E. Basic Safety Precautions _____

F. Laboratory/Performance Testing _____

   Under instructor supervision, have the trainees perform a hazard assessment of a job such as replacing the lights in the classroom.

Session II. OSHA Standards

A. Section-by-Section Review of OSHA Standards 1910 and 1926 _____

B. OSHA Safety Topics _____
   1. Safety Philosophy and General Safety Precautions _____
   2. Electrical Regulations and Lockout/Tagout Rule _____
   3. Other OSHA Regulations _____

Session III. Ladders and Scaffolds

A. Ladders _____
   1. Straight Ladders _____
   2. Extension Ladders _____
   3. Step Ladders _____

B. Scaffolds _____

Session IV. General Construction Safety Topics

A. Lifts, Hoists, and Cranes _____

B. Lifting _____

C. Laboratory _____

   Under instructor supervision, have the trainees practice proper lifting procedures.

D. Basic Tool Safety _____

E. Confined Space Entry Procedures _____

1. General Guidelines _____
2. Confined Space Hazard Review _____
3. Entry and Work Procedures _____

F. First Aid _____

Session V. Hazardous Materials, Fall Protection, Module Examination and Performance Testing

A. Solvents and Toxic Vapors _____

B. Asbestos _____

C. Batteries _____

D. Laboratory _____

Under instructor supervision, have the trainees practice using an eye wash station.

E. PCBs _____

F. Fall Protection _____

G. Summary

1. Summarize module _____
2. Answer questions _____

H. Module Examination _____

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

I. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the trainee to the craft-specific power tools used by instrumentation personnel.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 and 12102

OBJECTIVES

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

1. Identify power tools used in instrumentation.
2. Select the proper power tool for a job.
3. Inspect the condition of the power tool.
4. Properly maintain power tools.
5. Use power tools safely.

PERFORMANCE TASKS

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

1. Safely use selected power tools such as:
   - Electric and pneumatic power hammers and drills
   - Electric soldering gun or iron
   - Hydraulic knockout punch
2. Safely use a threading machine to cut, thread, and ream a section of pipe.

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

- Overhead projector and screen
- Whiteboard/chalkboard
- Transparencies
- Chalk/eraser
- Pencils/Paper
- Appropriate personal protective equipment
- Rolls of solder
  - Flux core
  - Rosin core
  - Acid core
  - Solid wire
  - Lead free
  - Aluminum
- Wires for soldering
- Flux
- Thread cutting oil
- Thread gauge
- Metal plate (no thicker than 10 gauge)
- Concrete blocks
- Percussion electic hammer
- Rotary electric hammer
- Drill bits
  - Masonry
  - Concrete
  - Metal
  - Wood
- Chisels
  - Brick
  - Bull point
  - Mortar
  - Cold
  - Scaling
  - Floor cleaning
- Pneumatic roatary drill
- Pneumatic hammers
  - Light-duty chipping
  - Heavy-duty chipping
  - Riveting
  - Drilling
- Electric soldering gun
- Electric soldering iron
- Electric threading machine
- Hydraulic knockout punch
- Pneumatic tool lubricator
- Powder-actuated tool kit
- Powder charges
- Powder-actuated charges
- Heat sinks
- Air supply
- Desoldering tools
- Soldering tips
- Die head with dies
- Nipple chuck and adapters
- Hydraulic knockout punch
- Lengths of pipe or conduit
- Module Examinations*
- Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide

ADDITIONAL RESOURCES

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

Operating manuals from applicable power tool manufacturers

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Power Tools for Instrumentation.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I. Electric and Pneumatic Power Hammers and Drills

A. Introduction _____
B. Electric and Pneumatic Power Hammers and Drills _____
   1. Safety Precautions _____
   2. Electric Hammers _____
   3. Pneumatic Hammers and Rotary Drills _____
   4. Drill Bits _____
   5. Chisels _____
   6. Procedure for Using an Electric Percussion Hammer _____
C. Laboratory/Performance Testing _____

   Under your supervision, have the trainees use electric and/or pneumatic drilling and hammering tools.

Session II. Electric Soldering Guns and Irons; Hydraulic Knockout Punches

A. Electric Soldering Guns and Irons _____
   1. Electric Soldering Guns _____
   2. Electric Soldering Irons _____
   3. Solder _____
   4. Safety Precautions _____
   5. Procedure for Using a Soldering Gun _____
B. Hydraulic Knockout Punches _____
   1. Safety Precautions _____
   2. Procedure for Using a Hydraulic Knockout Punch _____
C. Laboratory/Performance Testing _____

   Under your supervision, have the trainees use a soldering gun or iron and a pneumatic knockout punch.

Session III. Electric Threading Machines and Powder-Actuated Tools

A. Electric Threading Machines _____
   1. Threading Dies _____
   2. Safety Precautions _____
   3. Procedures for Using a Threading Machine _____
B. Powder-Actuated Tools _____
C. Laboratory/Performance Testing _____

   Under your supervision, have the trainees cut, ream, and thread a section of pipe.

Session IV: Summary, Module Examination, and Performance Testing

A. Summary
   1. Summarize module _____
   2. Answer questions _____
B. Module Examination _____

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

C. Performance Testing

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER
2. Record the testing results on Craft Training Report Form 200 and submit the results to the training program sponsor.

MODULE OVERVIEW

This module introduces the trainee to the basic electrical concepts and skills needed to test electrical circuits.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12103

OBJECTIVES

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

1. Define the following terms:
   - Alternating current (AC)
   - Capacitance
   - Conductor
   - Current
   - Direct current (DC)
   - Electrical circuit
   - Inductance
   - Insulator
   - Ohm's law
   - Resistance
   - Voltage
2. State the two requirements for current flow in a circuit.
3. Use a multimeter and clamp-on ammeter to measure voltage, current, and resistance in a circuit.
4. State Ohm's law in equation form.
5. Use Ohm's law to calculate individual component values and total values for I, E, R, and P in a simple DC series circuit, given any two of the following properties: resistance, current, and voltage.
6. Demonstrate a knowledge of safety considerations when working with electricity.
7. Calculate the value and determine the tolerance of a resistor.
8. Identify correct wire sizes used for different instrumentation applications.
9. Identify various types of electrical fittings used for different instrumentation applications.

PERFORMANCE TASKS

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

1. Measure and record the current, voltage, and resistance in a DC circuit.
2. Calculate the power consumed by the circuit, using any two of the measured values.

NCCER STANDARDIZED CRAFT TRAINING PROGRAM

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Whiteboard/chalkboard
Markers/chalk
Latest edition of the *National Electrical Code*
Module Examinations*
Performance Profile Sheets*
Analog multimeters
Digital multimeters
Clamp-on ammeters
Various types and sizes of capacitors
Capacitor color chart
Various types and sizes of resistors
Wire gauge
Various types and sizes of wire
Various types and sizes of thermocouples
Various types and sizes of conduit couplings
Various types and sizes of coaxial cable connectors
Various types and sizes of insulating bushings
Various types and sizes of flex connectors
Various types and sizes of explosion-proof housings

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

ADDITIONAL RESOURCES

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

Electronics Fundamentals: Circuits, Devices, and Applications, 2000. Thomas L. Floyd. Upper Saddle River, NJ: Prentice Hall.

Cooper Crouse-Hinds Catalog of Fittings. Syracuse, NY: Crouse-Hinds.

General Training – Electricity, Syracuse. NY: Carrier Corporation.

NOTES

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If you feel that additional math instruction would be helpful, Prentice Hall offers a basic math textbook entitled *Fundamentals of Electrical and Mechanical Mathematics*. It covers the basic math requirements for electrical trainees and may be ordered by contacting Prentice Hall Customer Service at 1-800-922-0579.

TEACHING TIME FOR THIS MODULE

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Topic	**Planned Time**
Session I. Introduction to Electrical Systems	
A. Introduction	_____
B. Terms and Definitions	_____
C. Simple Circuit	_____
Session II. Ohm's Law and Series DC Circuits	
A. Ohm's Law	_____
B. Series DC Circuits	_____
1. Current, Voltage, and Resistance	_____
2. Power	_____
C. Laboratory / Performance Testing – Calculating Power	_____
Session III. Methods of Measuring Electrical Properties	
A. Measuring Voltage with a Multimeter	_____
B. Measuring Resistance with a Multimeter	_____
C. Measuring Current with a Multimeter	_____
D. Measuring Current with a Clamp-on Ammeter	_____
Session IV. Laboratory/Performance Testing – Current Measurement	_____
Session V. Laboratory/Performance Testing – Voltage Measurement	_____
Session VI. Laboratory/Performance Testing – Resistance Measurement	_____
Session VII. Resistors, Capacitors, and Instrumentation Control Wiring	
A. Resistors and Color Codes	_____
B. Capacitors and Color Codes	_____
C. Instrumentation Control Wiring	_____
1. Shields	_____
2. Grounding	_____
3. Jackets	_____
4. Wire Sizes	_____
5. Wire Ratings	_____
Session VIII. Thermocouples, Electrical Fittings, and Explosion-Proof Housings	
A. Thermocouples	_____
B. Electrical Fittings	_____
C. Explosion-Proof Housings	_____

Session IX. Summary, Module Examination, and Performance Testing

A. Summary
   1. Summarize module _____
   2. Answer questions _____

B. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the training program sponsor.

C. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the training program sponsor.

MODULE OVERVIEW

This module introduces the trainee to the types, properties, and composition of the metals commonly found in instrumentation work.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One; Modules 12101 through 12104

OBJECTIVES

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

1. Define metallurgy.
2. Identify types of common metals.
3. Describe uses and applications of metals in instrumentation.

PERFORMANCE TASKS

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

1. Identify selected steel samples from their SAE or AISI code.
2. Identify the material composition of a bolt from its ASTM markings.

NCCER STANDARDIZED CRAFT TRAINING PROGRAM

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If you see the Teaching Tip icon, that means there is a teaching tip associated with this section. Also refer to any suggested teaching tips at the end of the module.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Whiteboard/chalkboard
Markers/chalk
Samples of various ferrous metals
Samples of various nonferrous metals
Samples of various SAE bolts and screws
Electric grinder
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

Crouse-Hinds Catalogs of Fittings. Syracuse, NY: Crouse-Hinds.
Electrical Standards and Product Guide. National Electric Manufacturer's Association (NEMA).
National Electrical Code Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.
National Electrical Safety Code, Latest Edition. Quincy, MA: NationalFire Protection Association.
Ugly's Electrical References, 1999. George V Hart and Sammie Hart. Houston, TX: United Printing Arts.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Metallurgy for Instrumentation.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I. Introduction to Ferrous Metals, Non-Ferrous Metals, and Metal Properties

A. Introduction _____
B. Ferrous Metals _____
C. Nonferrous Metals _____
D. Metal Properties _____

Session II. Classification and Applications of Metals

A. Classification of Metals _____
   1. Steel _____
   2 Identification of Steel Stock _____
   3. Aluminum _____
   4. Magnesium Alloys _____
   5. Gray Cast Iron _____
   6. Stainless Steel _____
   7. Laboratory/Performance Testing _____
      Have the trainees identify types of metals from their SAE or AISI code.
B. Applications of Metals in the Instrumentation Craft _____
   1. Laboratory/Performance Testing _____
      Have the trainees identify bolt composition from ASTM markings.

Session III. Summary, Module Examination, and Performance Testing

A. Summary
   1. Summarize module _____
   2. Answer questions _____
B. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.
C. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the trainee to the various types of threaded and unthreaded fasteners commonly found in instrumentation work.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12105

OBJECTIVES

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

1. Identify and explain the use of threaded fasteners.
2. Identify and explain the use of non-threaded fasteners.
3. Describe various types of fasteners.
4. Demonstrate the correct applications for fasteners.
5. Install fasteners.

PERFORMANCE TASKS

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

1. From a selection of threaded fasteners, select the correct fastener(s) for one or more applications specified by the instructor.
2. From a selection of non-threaded fasteners, select the correct fastener for one or more applications specified by the instructor.
3. Install a blind rivet using a rivet gun.
4. Drill a hole and install a toggle bolt.
5. Install a nut and bolt and torque them to a torque value specified by the instructor.

NCCER STANDARDIZED CRAFT TRAINING PROGRAM

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

- Overhead projector and screen
- Whiteboard/chalkboard
- Transparencies
- Markers/chalk
- Appropriate personal protective equipment
- Paper/Pencil
- Module Examinations*
- Performance Profile Sheets*
- ANSI specifications and standards for fasteners
- ASTM specifications and standards for fasteners
- SAE specifications and standards for fasterners
- Vendor manuals for various types of fasteners
- Unified National Coarse (UNC) bolt, screw, and nut
- Unified National Fine (UNF) bolt, screw, and nut
- Unified National Extra Fine (UNEF) bolt, screw, and nut
- Wrenches
- Screwdrivers
- Allen wrenches
- Torque wrench
- Blind (pop) rivet tool
- Rivets
- Hex head and square head bolts
- Machine screws
- Cap screws
- Set screws
- Stud bolts
- Thread forming screws
- Thread cutting screws
- Drive screws
- Finished, non-finished, castellated, slotted, self-locking, acorn, and wing nuts
- Retainer fasterners
- Keys (Gib head, Woodruff, Pratt & Whitney, square)
- Pin fasteners
- Yoke, spacer, bundle lock clamps
- Threaded inserts
- Flat, lock, and fender washers
- Tie wraps
- Gang clamps
- Eye bolts
- Toggle bolts
- Anchor bolts
- J-bolts
- Drill
- Drill bits
- Metal stock
- Wall board

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

ISO Standards Handbook: Fasteners and Screw Threads, Volume 1, 1998. Warrendale, PA: Society of Automotive Engineers (SAE).

Specifications and Standards for Fasteners, 2000. New York, NY: American National Standards Institute (ANSI).

Specifications and Standards for Fasteners, Volume 01.08, 2000. Philadelphia, PA: American Society for Testing and Materials (ASTM).

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Fasteners*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	**Planned Time**
Session 1. Introduction to Threaded Fasteners and Non-Threaded Fasteners	
A. Introduction	_____
B. Threaded Fasteners	_____
1. Thread Standards	_____
2. Types of Bolts And Screws	_____
3. Nuts	_____
4. Laboratory/Performance Testing	_____
From a selection of threaded fasteners, have the trainees select the correct fasteners for specific applications.	
C. Non-Threaded Fasteners	_____
1. Retainer Fasteners	_____
2. Keys	_____
3. Pin Fasteners	_____
4. Yoke Clamps	_____
5. Spacer Clamps	_____
6. Bundle Lock Clamps	_____
7. Blind Rivets	_____
8. Inserts	_____
9. Washers	_____
10. Gang Clamps	_____
11. Tie Wraps	_____
D. Laboratory/Performance Testing	_____
From a selection of non-threaded fasteners, have the trainees select the correct fasteners for specific applications.	
Session II. Special Threaded Fasteners and Installing Fasteners	
A. Special Threaded Fasteners	_____
1. Eye Bolts	_____
2. Toggle Bolts	_____
3. Anchor-Type Fastening Devices	_____
4. J-Bolts	_____

B. Installing Fasteners _____

1. Torque Tightening _____
2. Tightening Sequence _____
3. Installing Threaded Fasteners _____
4. Installing Blind Rivets _____
5. Installing Toggle Bolts _____
6. Installing Anchor Bolts _____

7. Laboratory/Performance Testing _____

   Have the trainees install a blind rivet, drill a hole and install a toggle bolt, and install a nut and bolt and torque them to a specified value.

Session III. Summary, Module Examination, and Performance Testing

A. Summary

1. Summarize module _____
2. Answer questions _____

B. Module Examination _____

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

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module teaches the trainees how to read and understand the kinds of information presented in various types of drawings and documents used to identify, locate, install, repair, maintain, and troubleshoot instrument systems and equipment.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12106

OBJECTIVES

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

1. Identify and describe standard Instrument Society of America (ISA) instrument symbols and abbreviations.
2. Read and interpret instrument indexes.
3. Read and interpret general instrument specifications.
4. Read and interpret general notes and details included on instrument drawings and documents.
5. Read and interpret installation detail drawings.
6. Read and interpret location drawings.

PERFORMANCE TASKS

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

1. Locate and identify drawing elements as specified in the performance exercise.

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Whiteboard/chalkboard
Appropriate personal protective equipment
Transparencies
Markers/chalk
ISA standard S5.1, *Instrument Symbols and Identification*
Samples of piping and instrument drawings
Samples of loop drawings
Samples of installation detail drawings
Samples of location drawings
Samples of piping drawings
Samples of instrumentation specification sheets
Samples of instrument indexes
Samples of general instrument specifications
Performance Exercise Sheets*
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

ISA Standards. Research Triangle Park, NC: Instrument Society of America.

- ISA Standard S5.1 – *Instrumentation Symbols and Identification*
- ISA Standard S5.2 – *Binary Logic Diagrams for Process Operations*
- ISA Standard S5.3 – *Graphic Symbols for Distributed Control/ Shared Display Instrumentation, Logic, and Computer Systems*
- ISA Standard S5.4 – *Instrument Loop Diagrams*
- ISA Standard S51.1 – *Process Instrumentation Terminology*

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Instrument Drawings and Documents, Part One*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I. Introduction to Instrument Symbols and Identification

A. Introduction _____
B. Instrument Symbols and Identification _____
   1. Instrument Symbols _____
   2. Instrument Tag Numbers and Identification Abbreviations _____

Session II. Instrument Symbols and Identification and Instrument Index

A. Instrument Symbols and Identification (Continued) _____
   1. Instrument Tag Numbers and Identification Abbreviations (Continued) _____
   2. Graphic or Pictorial Instrument Symbols _____
   3. Line Symbols _____
B. Instrument Index _____

Session III. Instrument Drawings and Documents

A. General Instrument Specifications _____
B. General Notes and Details _____
C. Installation Detail Drawings _____
D. Location Drawings _____
E. Control Loops _____

Session IV. Summary, Module Examination and Performance Testing

A. Performance Testing _____

   Have the trainees locate and identify drawing elements as specified in the performance/laboratory exercise. Note the proficiency of each trainee.

B. Summary
   1. Summarize module _____
   2. Answer questions _____
C. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.
D. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module covers the selection and installation of the different gaskets, O-rings, and packings used to seal joints in instrumentation work.

PREREQUISITES

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

Core Curriculumn; Instrumentation Level One, Modules 12101 through 12107

OBJECTIVES

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

1. Identify the different types of gaskets and gasket material.
2. Identify the different types of packing.
3. Describe uses of packing.
4. Describe uses of O-rings.
5. Describe uses of gaskets.
6. Fabricate gaskets.

PERFORMANCE TASKS

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

1. Correctly select, cut, and install one or more gaskets as specified by the instructor.
2. Remove an existing packing and install a new packing.
3. Correctly select and install an O-ring.

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Whiteboard/chalkboard
Transparencies
Markers/chalk
Pencils/Paper
SAE standards and specifications for gaskets and packing
Specification sheets for gaskets and packing
ANSI standards and specifications for gaskets and packing
ASTM standards and specifications for gaskets and packing
Vendor manuals for gaskets and packing
Various types of gaskets
Various types of packing
Various types of O-rings
Dividers
Protractor
Gasket cutter
Hole punch
Hammer
Flange
Pieces of hardwood
Tin snips
Graphite
Packing extractor tool
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

Specifications for Gaskets, O-Rings, and Packing. Washington, DC: American National Standards Institute (ANSI).

Specifications for Gaskets, O-Rings, and Packing. West Conshohoken, PA: American Society for Testing and Materials.

Specifications for Gaskets, O-Rings, and Packing. Warrendale, PA: Society of Automotive Engineers.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Gaskets and Packing*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I. Introduction to Gaskets

A. Introduction _____
B. Gaskets _____
C. Gasket Materials _____
D. Fabricating Gaskets _____
   1. Laying Out a New Gasket _____
   2. Tracing a New Gasket _____
E. Laboratory/Performance Testing _____

   Have the trainees trace and cut a new metal gasket.

Session II. Introduction to Packing and O-Rings

A. Packing _____
   1. Types of Packing _____
   2. Removing and Installing Packings _____
B. O-Rings _____
   1. Types of O-Rings _____
   2. Removing and Installing O-Rings _____
C. Laboratory/Performance Testing _____
   1. Have the trainees remove an existing packing and install a new packing.
   2. Have the trainees correctly select and install an O-ring.

Session III. Summary, Module Examination, and Performance Testing

A. Summary
   1. Summarize module _____
   2. Answer questions _____
B. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.
C. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the trainee to the different kinds of lubricants, sealers, and cleaners commonly used in instrumentation work. The interpretation and use of the information given in Material Safety Data Sheets (MSDSs) for hazardous materials is also covered.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12108

OBJECTIVES

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

1. Identify and select the appropriate lubricants for use in specific applications.
2. Identify and select the appropriate sealants for use in specific applications.
3. Identify and select the appropriate cleaners for specific applications.
4. Describe the differences between lubricants, sealants, and cleaners.
5. Describe proper applications of lubricants, sealants, and cleaners.
6. Properly handle and store lubricants, sealants, and cleaners.
7. Explain Material Safety Data Sheets (MSDSs).

PERFORMANCE TASKS

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

1. Choose the correct cutting fluid, sealant, and cleaner as specified in the performance exercise.
2. Interpret the MSDS as specified in the performance exercise.

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Whiteboard/chalkboard
Pencils and paper
Transparencies
Markers/chalk
Appropriate personal protective equipment
MSDSs (one for each lubricant, sealant and cleaner used in class)
Various type of lubricants
Various type of sealants
Various type of cleaners
Aluminum wire electrical connections
Rags
Approved containers for acids and caustics
Approved containers for cutting oils
Cartridge-type respirators
Different types of respirator cartridges
Performance Exercise Sheets*
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

Hazard Communication Standards. Washington, DC: Occupational Safety and Health Administration.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Lubricants, Sealants, and Cleaners.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Section I. Introduction to Material Safety Data Sheets and Lubricants

A. Introduction _____
B. Material Safety Data Sheets _____
C. Lubricants _____
   1. Cutting Fluids _____
   2. Penetrating Oil _____
   3. Aluminum Oxidizing Compound _____
   4. Silicone Lubricants _____
   5. Teflon® Tape _____
   6. Special Coolants _____
   7. Storing and Handling Lubricants _____

Session II. Sealants and Cleaners

A. Sealants _____
   1. Teflon® Paste _____
   2. Other Sealant Pastes _____
   3. Silicone _____
   4. Epoxy _____
   5 Graphite Paste _____
   6. PVC-Solvent Cement _____
   7. Storing and Handling Sealants _____
B. Cleaners _____
C. Storing and Handling Cleaners _____

Session III. Summary, Module Examination and Performance Testing

A. Performance Testing _____
   1. Have the trainees answer the questions in the Performance Exercise. Note the proficiency of each trainee.
   2. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
   3. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.
B. Summary
   1. Summarize module _____
   2. Answer questions _____
C. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the trainee to four of the process variables most frequently measured in instrumentation and control systems: flow, pressure, level, and temperature. Several types of instruments used to measure each of these are also introduced, along with a description of the principles of operation for these devices.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12109

OBJECTIVES

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

1. Identify and describe characteristics of flow measurement.
2. Identify and describe characteristics of pressure measurement.
3. Identify and describe characteristics of temperature measurement.
4. Identify and describe characteristics of level measurement.

PERFORMANCE TASKS

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

1. Identify measurement devices, state the variable each device measures, and describe the principles of operation of each device as specified in the performance exercise.

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If you see the Teaching Tip icon, that means there is a teaching tip associated with this section. Also refer to any suggested teaching tips at the end of the module.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Transparencies
Markers/chalk
Performance Exercise Sheets*
Module Examinations*
Performance Profile Sheets*
Overhead projector and screen
Whiteboard/chalkboard
Appropriate personal protective equipment
U-tube manometer
Well manometer
Inclined manometer
Bellows
Bourdon tube pressure gauge
Spiral bourdon tube
Helix bourdon tube
Diaphragm
Concentric orifice plate
Eccentric orifice plate
Flow nozzle
Venturi tube
Pitot tube
Target flowmeter
Coriolis tube
Magnetic flowmeter
Turbine flowmeter
Vortex flowmeter
Roatmeter
Fluid thermometer
Bimetallic thermometer
Thermocouple
Thermowell
Resistance temperature detector (RTD)
Dip stick
Sight glass
Float-cable level arrangement
Displacer
Magnetic-type float device

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

Industrial Pressure, Level & Density Measurement, 1995. Donald R. Gillum. Research Triangle Park, NC: Instrument Society of America.

Instrument Engineers' Handbook, Volume 1: Process Measurement, 1995. Bela G. Liptak. Boca Raton, FL: CRC Press.

Instrument Engineers' Handbook, Volume 2: Process Control, 1995. Bela G. Liptak. Boca Raton, FL: CRC Press.

Process Control Systems, 1996. F. Greg Shinskey. New York, NY: McGraw-Hill Professional Publishing.

Purdy's Instrument Handbook. 1996. Ralph G. Dewey. Deer Park, TX: Good News Balloons.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Flow, Pressure, Level, and Temperature*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	**Planned Time**
Session I. Introduction to Pressure	
A. Introduction	_____
B. Pressure	_____
1. Units of Pressure Measurement	_____
2. Pressure Measurement Devices	_____
3. Conditions That Damage Pressure Elements	_____
4. Pressure Element Protection Devices	_____
Session II. Introduction to Flow and Temperature	
A. Flow	_____
1. Flow Measurement Units	_____
2. Differential Pressure and Flow Relationship	_____
3. Differential Pressure Flow Devices	_____
4. Other Types of Flow Measurement Devices	_____
5. Flow Device Installation Considerations	_____
B. Temperature	_____
1. Temperature Scales	_____
2. Temperature Measurement Devices	_____
Session III. Introduction to Level Measurement	
A. Level	_____
1. Level Measurement and Pressure	_____
2. Direct Level Measurement Devices	_____
3. Indirect Level Measurement Devices	_____
4. Special Level Measurement Instruments	_____
Session IV. Summary, Module Examination, and Performance Testing	
A. Performance Testing	_____
1. Have the trainees identify measurement devices, state the variable each device measures, and describe the principles of operation of each device as specified in the performance exercise.	
2. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.	
3. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.	
B. Summary	
1. Summarize module	_____
2. Answer questions	_____
C. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the trainee to the different kinds of tubing and tubing fittings commonly used in instrumentation installations in plants and other facilities. Procedures for handling, cutting, and bending tubing and for installing fittings on tubing are also covered.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12110

OBJECTIVES

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

1. Identify the different kinds of tubing and describe the properties and common uses for each kind.
2. Explain the purpose for tubing standards and specifications.
3. Properly handle and store tubing.
4. Cut tubing using the proper tools, cutting methods, and safety procedures.
5. Bend tubing using the proper tools, bending methods, and safety procedures.
6. Identify and select proper tubing fittings for selected instrumentation applications.
7. Flare tubing using the proper tools, flaring methods, and safety procedures.

PERFORMANCE TASKS

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

1. Bend copper tubing at 45-degree and 90-degree angles using a compression-type bender.
2. Cut and deburr copper tubing using a hacksaw or tubing cutter.
3. Install a flare fitting on a section of copper tubing.

NCCER STANDARDIZED CRAFT TRAINING PROGRAM

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If you see the Teaching Tip icon, that means there is a teaching tip associated with this section. Also refer to any suggested teaching tips at the end of the module.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Whiteboard/chalkboard
Transparencies
Markers/chalk
Appropriate personal protective equipment
Various sizes and types of metal, PVC, and poly tubing
Flared tubing fittings
Compression tubing fittings
Socket-welded tubing fittings
Butt-welded tubing fittings
ASTM, ASME, and ANSI tubing standards and specifications
Piping specifications
Instrument specifications
Piping drawings
Instrument installation drawings
Tubing vendor catalogs
Rule
Outside calipers
Caliper rule
Tubing cutters
Hacksaw with various blade sizes
Guidelocks for cutting tubing with a hacksaw
Bandsaw with various blade sizes
Flat files
Reamers for tubing
Deburring tool
Spring tube bender
Compression-type hand tube bender
Table- or bench-mounted tubing bender
Hydraulic tubing bender
Flaring tools (hand and hydraulic)
Tubing snips
Tubing stretcher
Wrenches
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

Standards and Specifications for Tubing. Washington, DC: American National Standards Institute (ANSI).

Standards and Specifications for Tubing. New York, NY: American Society of Mechanical Engineers (ASME).

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Tubing.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I. Introduction to Tubing

A. Introduction _____
B. Sizes and Types of Tubing _____
   1. General Sizing Measurements for Tubing _____
   2. Tubing Materials _____
   3. Tubing Standards and Specifications _____
C. Proper and Safe Methods for Storing Tubing _____
D. Proper and Safe Methods for Handling Tubing _____

Session II. Cutting Tubing

A. Cutting Tubing _____
   1. Types and Sizes of Tubing Cutters _____
   2. Cutting Tubing with a Tube Cutter _____
   3. Cutting Tubing with a Hacksaw _____
   4. Cutting Tubing with a Bandsaw _____
   5. Cutting Poly Tubing with Snips _____
   6. Deburring Tubing _____
B. Laboratory/Performance Testing _____

   Under your supervision, have the trainees cut tubing with a hacksaw, then deburr the outside and inside of the tubing.

Session III. Bending Tubing

A. Bending Tubing _____
   1. Standard Tubing Bends _____
   2. Tubing Bending Methods _____
   3. Types of Tubing Benders _____
      a. Using a Spring Tube Bender _____
      b. Using a Compression-Type Hand Bender _____
      c. Using Table- or Bench-Mounted Tubing Benders _____
      d. Using a Hydraulic Tubing Bender _____
B. Laboratory/Performance Testing _____

   Under your supervision, have the trainees bend copper tubing 45 degrees and 90 degrees with a compression-type hand tubing bender.

Session IV. Tubing Fittings and Flaring Tubing

A. Tubing Fittings _____
   1. Flare Fittings _____
   2. Compression Fittings _____
   3. Socket-Welded Fittings _____
   4. Butt-Welded Fittings _____
   5. Types of Tubing Fittings _____
B. Flaring Tubing _____

C. Laboratory/Performance Testing _____

Under your supervision, have the trainees cut, flare, and attach a flared fitting to tubing.

Session V. Summary, Module Examination, and Performance Testing

A. Summary

1. Summarize module _____
2. Answer questions _____

B. Module Examination _____

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

C. Performance Testing _____

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the trainee to the different kinds of piping and piping fittings commonly used in instrumentation installations in plants and other facilities. Procedures for handling, cutting, reaming and threading pipe are also covered.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12111

OBJECTIVES

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

1. Identify the different kinds of welded and seamless piping and give their process applications.
2. Discuss national tubing standards.
3. Store and handle pipe properly to prevent damage and/or contamination to the pipe or personal injury.
4. Use proper procedures for cutting piping.
5. Use proper procedures for threading piping.
6. Identify and select appropriate fittings for selected piping applications.

PERFORMANCE TASKS

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

1. Cut, ream, and thread a section of pipe.

NCCER STANDARDIZED CRAFT TRAINING PROGRAM

The National Center for Construction Education and Research (NCCER) provides a standardized national program of accredited craft training. Key features of the program include instructor certification, competency-based training, and performance testing. The program provides trainees, instructors, and companies with a standard form of recognition through a National Craft Training Registry. The program is described in full in the *Guidelines for Accreditation*, published by the NCCER. For more information on standardized craft training, contact the NCCER by writing us at P.O. Box 141104, Gainesville, FL 32614-1104; calling 352-334-0911; or e-mailing info@nccer.org. More information may be found at our Web site, www.nccer.org.

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If you see the Teaching Tip icon, that means there is a teaching tip associated with this section. Also refer to any suggested teaching tips at the end of the module.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Whiteboard/chalkboard
Transparencies
Markers/chalk
Appropriate personal protective equipment
Pencils/Paper
Various sizes and types of piping
Various sizes and types of fittings
Pipe cutting oil (with appropriate MSDS)
Thread lubricant
Rags
Vendor manuals for pipe and pipe fittings
ANSI standards and specifications for piping and pipe fittings
ASME standards and specifications for piping and pipe fittings
ASTM standards and specifications for piping and pipe fittings
Various types of pipe cutters
Various types of hand pipe threaders
Various types and sizes of pipe dies
Various sizes pipe wrenches
Hacksaw
Band saw
Beveling tool
Rat tail file
Flat file
Half-round file
Rule
Wire brush
Wrap-around
Thread gauge
Pipe vise
Pipe reamer
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

Standards and Specifications for Piping. Washington, DC: American National Standards Institute (ANSI).

Standards and Specifications for Piping. New York, NY: American Society for Mechanical Engineers (ASME).

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Piping – 2 Inches and Under*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I. Introduction to Piping, Part One

A. Introduction _____
B. Types and Sizes of Pipe _____
C. Pipe and Pipe Fitting Identification Systems _____
D. Types of Pipe Joints _____
   1. Threaded Joints _____
   2. Socket-Weld Joints _____
   3. Flanged Joints _____
   4. Butt-Weld Joints _____

Session II. Introduction to Piping, Part Two

A. Fittings _____
B. Proper and Safe Methods for Storing Pipe _____
C. Proper and Safe Methods for Handling Pipe _____
D. Pipe Length Calculation Methods _____
E. Pipe Cutting Tools _____
   1. Pipe Cutters _____
   2. Saws _____
   3. Beveling Machine _____
   4. Cutting Torch _____

Session III. Pipe Run Preparation

A. Pipe Run Preparation _____
   1. Calculating Pipe Length _____
   2. Cutting Pipe _____
   3. Threading Pipe _____
B. Laboratory/Performance Testing _____

   Under your supervision, have the trainees cut, ream, and thread a section of pipe.

Session IV. Summary, Module Examination, and Performance Testing

A. Summary
   1. Summarize module _____
   2. Answer questions _____
B. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.
C. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the trainee to the different kinds of hoses and hose fittings commonly used in instrumentation installations in plants and other facilities. Procedures for handling and cutting hoses and for installing fittings on hoses are also covered.

PREREQUISITES

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

Core Curriculum; Instrumentation Level One, Modules 12101 through 12112

OBJECTIVES

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

1. Identify various types of hoses and fittings.
2. Select appropriate types and sizes of hoses and fittings for selected applications.
3. Recognize standards and codes used to identify hoses and fittings.
4. Store and handle hose properly to prevent damage and/or contamination to the hose or personal injury.
5. Install a reusable fitting on a hose.

PERFORMANCE TASKS

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

1. Select the proper hose, cut a section of hose, and install a fitting appropriate for a given application.

NCCER STANDARDIZED CRAFT TRAINING PROGRAM

The National Center for Construction Education and Research (NCCER) provides a standardized national program of accredited craft training. Key features of the program include instructor certification, competency-based training, and performance testing. The program provides trainees, instructors, and companies with a standard form of recognition through a National Craft Training Registry. The program is described in full in the *Guidelines for Accreditation*, published by the NCCER. For more information on standardized craft training, contact the NCCER by writing us at P.O. Box 141104, Gainesville, FL 32614-1104; calling 352-334-0911; or e-mailing info@nccer.org. More information may be found at our Web site, www.nccer.org.

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SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

PREPARATION

Before teaching this module, you should review the Module Outline, Objectives, Performance Tasks, and the Materials and Equipment List. Be sure to allow ample time to prepare your own training or lesson plan and gather all required equipment and materials.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Whiteboard/chalkboard
Transparencies
Markers/chalk
Appropriate personal protective equipment
Mineral oil
Heavy oil
Rags
MSDS for oils used
SAE, MIL, and FDA hose standards and specifications
Hose manufacturer catalogs
Various types and sizes of hoses
Various types and sizes of hose fittings
Hacksaw
Vise
Adjustable wrench
Source of compressed air
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet packaged with this Annotated Instructor's Guide.

ADDITIONAL RESOURCES

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

Standards and Specifications for Hose. Rockville, MD: Food and Drug Administration.

MIL Standards and Specifications for Hose. Washington, DC: Government Printing Office.

Standards and Specifications for Hose. Warrendale, PA: Society of Automotive Engineers.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Hoses*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic **Planned Time**

Session I Introduction to Hoses, Part One

A. Introduction _____
B. Hose Standards and Specifications _____
C. Types of Hoses _____
   1. Metallic Hoses _____
   2. Nonmetallic Hoses _____
D. Hose Construction _____

Session II Introduction to Hoses, Part Two

A. Hose Fittings _____
B. Proper and Safe Methods for Storing Hoses _____
C. Proper and Safe Methods for Handling Hoses _____
D. Reusable Fitting Installation _____
E. Laboratory/Performance Testing _____

   Under your supervision, have the trainees select the proper hose, cut a section of hose, and install a fitting appropriate for a given application.

Session III. Summary, Module Examination, and Performance Testing

A. Summary
   1. Summarize module _____
   2. Answer questions _____
B. Module Examination _____
   1. Trainees must score 70% or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.
C. Performance Testing _____
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200 and submit the results to the Training Program Sponsor.