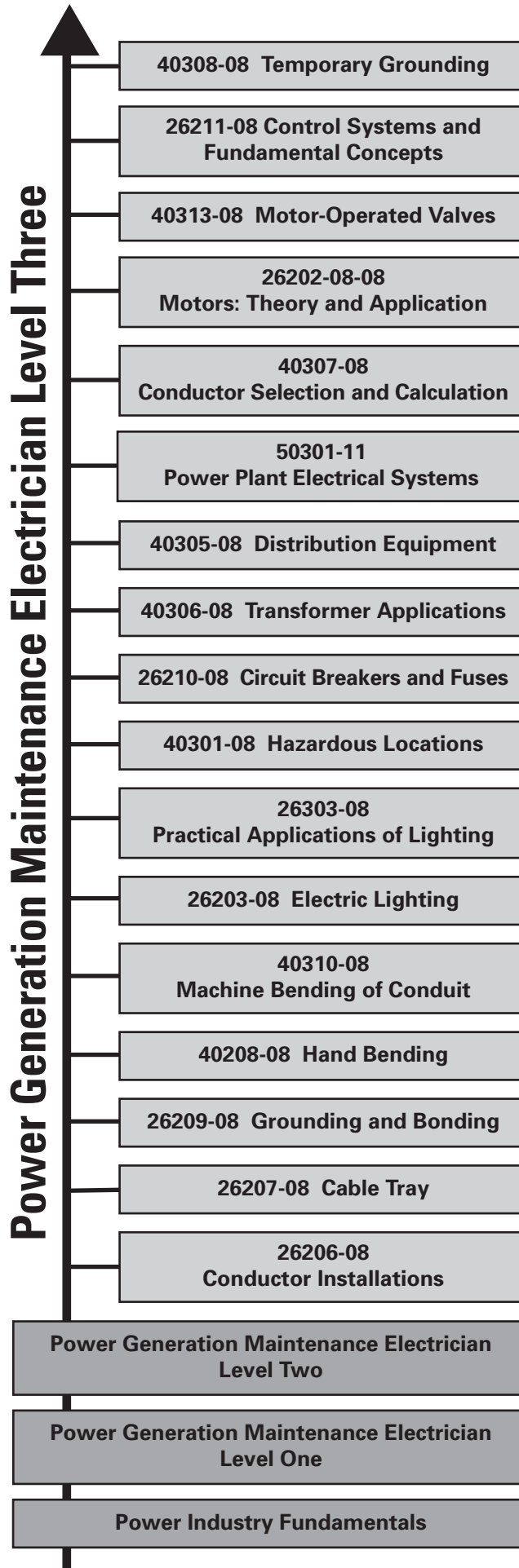


COMPTENCIES, OBJECTIVES, AND PERFORMANCE TASKS



MODULE OVERVIEW

This module introduces the methods and procedures used in conductor installations.

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*; *Electrical Level One*; and *Electrical Level Two*, Modules 26201-08 through 26205-08.

OBJECTIVES

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

1. Explain the importance of communication during a cable-pulling operation.
2. Plan and set up for a cable pull.
3. Set up reel stands and spindles for a wire-pulling installation.
4. Explain how mandrels, swabs, and brushes are used to prepare conduit for conductors.
5. Properly install a pull line for a cable-pulling operation.
6. Explain how and when to support conductors in vertical conduit runs.
7. Describe the installation of cables in cable trays.
8. Calculate the probable stress or tension in cable pulls.

PERFORMANCE TASKS

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

1. Prepare multiple conductors for pulling in a raceway system.
2. Prepare multiple conductors for pulling using a wire-pulling basket.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Setscrew cable grips
Transparencies	Swivel rope clevis
Blank acetate sheets	Basket-type pulling grips
Transparency pens	Cable cutters/stripping tools
Whiteboard/chalkboard	Self-contained hand-crank wire puller
Markers/chalk	Fish tape
Pencils and scratch paper	Power blower/vacuum fish tape system
Prism	Electrical cable puller
Copy of the latest edition of the <i>National Electrical Code</i> [®]	Cable grips
Several lengths of cable from No. 12 through 4/0 AWG	Clamps for supporting conductors
Lubricant	Insulating supports
Several types of pulling ropes	Manufacturers' catalogs for cable supports
Several different types and lengths of conductors	Cable manufacturers' literature
Measuring tape	Quick Quiz*
	Module Examinations**
	Performance Profile Sheet**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to prepare cable ends for installation. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize hand tool safety. This module may require trainees to visit job sites. Ensure that all trainees are properly briefed on site safety procedures.

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.

Cable Installation Manual, Latest Edition. New York: Cablec Corp.

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

TEACHING TIME FOR THIS MODULE

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

Topic	Planned Time
Session I. Introduction, Planning, and Setup	
A. Introduction	_____
B. Planning the Installation	_____
C. Setting up for Wire Pulling	_____
D. Laboratory Trainees practice preparing multiple conductors for pulling using a wire-pulling basket. This laboratory corresponds to Performance Task 2.	_____
Session II. Cable-Pulling Equipment	
A. Cable-Pulling Equipment	_____
B. High-Force Cable Pulling	_____
C. Mechanical Offsets	_____
Session III. Supporting and Pulling Cable	
A. Supporting Conductors	_____
B. Pulling Cable in Cable Trays	_____
C. Laboratory Trainees practice preparing multiple conductors for pulling in a raceway system. This laboratory corresponds to Performance Task 1.	_____
D. Physical Limitations of Cable	_____
E. Cable-Pulling Instruments	_____
Session IV. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	
C. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the methods and procedures used in the selection and installation of cable tray.

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; Electrical Level One; and Electrical Level Two*, Modules 26201-08 through 26206-08.

OBJECTIVES

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

1. Describe the components that make up a cable tray assembly.
2. Explain the methods used to hang and secure cable tray.
3. Describe how cable enters and exits cable tray.
4. Select the proper cable tray fitting for the situation.
5. Explain the *National Electrical Code*[®] (*NEC*[®]) requirements for cable tray installations.
6. Select the required fittings to ensure equipment grounding continuity in cable tray systems.
7. Interpret electrical working drawings showing cable tray fittings.
8. Size cable tray for the number and type of conductors contained in the system.

PERFORMANCE TASKS

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

1. Generate a list of materials for a cable tray layout. List all the components required, including the fasteners required to complete the system.
2. Join two straight, ladder-type cable tray sections together.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Splice plates
Transparencies	Alignment strips
Blank acetate sheets	Drop out plates
Transparency pens	H-bar
Whiteboard/chalkboard	Eight vertical adjustment splice plates
Markers/chalk	Cable tray supports, including:
Pencils and scratch paper	Beam clamps
Prism	Anchor clips
Copy of the latest edition of the <i>National Electrical Code</i> [®]	All-thread rods
Cable tray samples:	Nuts, bolts, washers, and other hangers
Metal ladder tray	Cable tray sections for cutting and offset
Metal trough tray	Felt-tip markers
Solid bottom tray	Hacksaw and blades
Tray covers	Protractor
Nonmetallic tray	Conventional square
Examples of cable tray failures	Quick Quiz*
Cable tray covers	Module Examinations**
	Performance Profile Sheet**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with cable tray. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical tool safety.

ADDITIONAL RESOURCES

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

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

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7.5 hours are suggested to cover *Cable Tray*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction to Cable Tray	
A. Introduction	_____
B. Cable Tray Loading	_____
C. Laboratory Trainees practice joining cable tray sections. This laboratory corresponds to Performance Task 2.	_____
D. Cable Tray Support	_____
Session II. Installation and Design	
A. Center Rail Cable Tray Systems	_____
B. NEC® Requirements	_____
C. Cable Installation	_____
D. Cable Tray Drawings	_____
E. Laboratory Trainees practice generating a list of materials for a cable tray layout. This laboratory corresponds to Performance Task 1.	_____
Session III. Pulling Cable, Safety, Review, and Testing	
A. Pulling Cable in Tray Systems	_____
B. Safety	_____
C. Module Review	_____
D. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	
E. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the *NEC*[®] requirements and procedures for proper grounding and bonding.

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*; *Electrical Level One*; and *Electrical Level Two*, Modules 26201-08 through 26208-08.

OBJECTIVES

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

1. Explain the purpose of grounding and bonding and the scope of *NEC Article 250*.
2. Distinguish between a short circuit and a ground fault.
3. Define the *National Electrical Code*[®] requirements related to bonding and grounding.
4. Distinguish between grounded systems and equipment grounding.
5. Use *NEC Table 250.66* to size the grounding electrode conductor for various AC systems.
6. Explain the function of the grounding electrode system and determine the grounding electrodes to be used.
7. Define electrodes and explain the resistance requirements for electrodes using *NEC Section 250.56*.
8. Use *NEC Table 250.122* to size the equipment grounding conductor for raceways and equipment.
9. Explain the function of the main and system bonding jumpers in the grounding system and size the main and system bonding jumpers for various applications.
10. Size the main bonding jumper for a service utilizing multiple service disconnecting means.
11. Explain the importance of bonding equipment in clearing ground faults in a system.
12. Explain the purposes of the grounded conductor (neutral) in the operation of overcurrent devices.

PERFORMANCE TASKS

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

1. Using the proper fittings, connect one end of a No. 4 AWG bare copper grounding wire to a length of $\frac{3}{4}$ " galvanized water pipe and the other end to the correct terminal in a main panelboard.
2. Install two lengths of Type NM cable in a switch box using Type NM cable clamps:
 - Strip the ends of the cable to conform with *National Electrical Code*[®] requirements.
 - Secure the cable in the switch box and tighten the cable clamps.
 - Connect and secure the equipment grounding conductors according to *NEC*[®] requirements, and secure to the switch box with either a ground clip or a grounding screw.
3. Size the minimum required grounding electrode conductor for a 200A service fed by 3/0 copper.
4. Size the minimum required equipment grounding conductor in each conduit for a 400A feeder gap using two parallel runs of 3/0 copper.
5. Size the minimum required bonding jumper for a copper water pipe near a separately derived system (transformer) where the secondary conductors are 500 kcmil copper.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Prism

Copy of the latest edition of the *National Electrical Code*[®]
OSHA Electrical Safety Guidelines (pocket guide)
No. 4 AWG bare copper grounding wire
Small main panelboard
Switch boxes
Grounding clips, screws, and clamps
Galvanized water pipe

Various lengths of Type NM cable
Wire strippers
Earth ground resistance tester

Quick Quiz*
Module Examinations**
Performance Profile Sheet**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to terminate and install cable. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety. This module may require that trainees visit job sites. Ensure that all trainees are properly briefed on site safety.

ADDITIONAL RESOURCES

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

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

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Grounding and Bonding*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction to Grounding and Bonding	
A. Introduction	_____
B. Purpose of Grounding and Bonding	_____
C. NEC® Requirements for Grounding and Bonding	_____
D. Short Circuit Versus Ground Fault	_____
E. Types of Grounding Systems	_____
Session II. Grounding Equipment	
A. NEC® Requirements for Grounding Equipment	_____
B. Laboratory Trainees practice sizing grounding electrode conductors. This laboratory corresponds to Performance Task 3.	_____
C. Equipment Grounding	_____
D. Laboratory Trainees practice sizing equipment grounding conductors. This laboratory corresponds to Performance Tasks 2 and 4.	_____
Session III.	
A. Bonding Service Equipment	_____
B. Effective Grounding Path	_____
C. Grounded Conductor	_____
D. Separately Derived Systems	_____
E. Laboratory Trainees practice sizing and installing grounding jumpers. This laboratory corresponds to Performance Tasks 1 and 5.	_____

Session IV.

- A. Grounding at More Than One Building
- B. Systems Over 1,000 Volts
- C. Testing for Effective Grounds
- D. Measuring the Earth's Resistance

Session V. Three-Point Testing

- A. Three-Point Testing Procedure for Single Electrode or Triad
- B. Procedures
- C. Electrode Arrangements
- D. Equipotential Grounding

Session VI. Review and Testing

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

MODULE OVERVIEW

This module introduces trainees to the methods and procedures used in cutting, hand bending, reaming, and threading conduit.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One*; and *Industrial Maintenance E & I Technician Level Two*, Modules 40201-08 through 40207-08.

OBJECTIVES

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

1. Identify the methods for hand bending and installing conduit.
2. Calculate conduit bends.
3. Make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
4. Cut, ream, and thread conduit.

PERFORMANCE TASKS

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

1. Make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
2. Cut, ream, and thread conduit.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Tape measure
Transparencies	Calculator
Blank acetate sheets	Hacksaw
Transparency pens	Pipe vise
Whiteboard/chalkboard	Pipe cutter
Markers/chalk	Reamer
Pencils and scratch paper	Cutting oil
Appropriate personal protective equipment	Shop towels
Copy of the latest edition of the <i>National Electrical Code</i> [®]	Hand-operated threader
<i>OSHA Electrical Safety Guidelines</i> (pocket edition)	Sandbox or drip pan
Hand bender and manufacturer's instructions	Torpedo level
Various pieces of conduit	PVC pieces
Hickey	PVC cements
Manufacturers' gain tables	Trade Terms Quiz*
No. 10 or No. 12 solid wire	Module Examinations**
	Performance Profile Sheets**

* Located in the back of this module

** Located in the Test Booklet

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to cut, bend, ream, and thread pipe. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize hand tool safety.

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.

Benfield Conduit Bending Manual, 2nd Edition. Overland Park, KS: EC&M Books.

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

Tom Henry's Conduit Bending Package (includes video, book, and bending chart). Winter Park, FL: Code Electrical Classes, 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 10 hours are suggested to cover *Hand Bending*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Hand Bending	
A. Introduction	_____
B. Hand Bending Equipment	_____
1. Geometry Required to Make a Bend	_____
2. Making a 90-Degree Bend	_____
C. Laboratory	_____
Have the trainees practice making 90-degree bends. This laboratory corresponds to Performance Task 1.	_____
D. Gain	_____
E. Back-to-Back 90-Degree Bends	_____
F. Laboratory	_____
Have the trainees practice making back-to-back bends. This laboratory corresponds to Performance Task 1.	_____
Session II. Offsets; Saddle Bends	
A. Making an Offset	_____
B. Laboratory	_____
Have the trainees practice making kicks. This laboratory corresponds to Performance Task 1.	_____
C. Parallel Offsets	_____
D. Laboratory	_____
Have the trainees practice making offset bends. This laboratory corresponds to Performance Task 1.	_____
E. Saddle Bends	_____
F. Laboratory	_____
Have the trainees practice making saddle bends. This laboratory corresponds to Performance Task 1.	_____
G. Four-Bend Saddles	_____

Session III. Cutting, Reaming, and Threading Conduit; Cutting and Joining PVC Conduit

A. Cutting, Reaming, and Threading Conduit

1. Hacksaw Method of Cutting Conduit
2. Pipe Cutter Method
3. Reaming Conduit
4. Threading Conduit

B. Laboratory

Have the trainees practice cutting, reaming, and threading conduit. This laboratory corresponds to Performance Task 2.

C. Cutting and Joining PVC Conduit

Session IV. Review and Testing

A. Review

B. Module Examination

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

C. Performance Testing

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

MODULE OVERVIEW

This module introduces the methods and procedures used in conduit bending.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One; Industrial Maintenance E & I Technician Level Two; and Industrial Maintenance E & I Technician Level Three*, Modules 40301-09 through 40309-09. It is also recommended that trainees read *NEC Articles 342, 344, 352, and 358*.

OBJECTIVES

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

1. Describe the process of conduit bending using power tools.
2. Identify all parts of electric and hydraulic benders.
3. Bend offsets, kicks, saddles, segmented, and parallel bends.
4. Explain the requirements of the *National Electrical Code® (NEC®)* for bending conduit.
5. Compute the radius, degrees in bend, developed length, and gain for conduit up to six inches.

PERFORMANCE TASKS

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

1. Use an electric or hydraulic bender to bend a 1" conduit stub-up to an exact distance of 15¼" above the deck.
2. Make an offset in a length of conduit to miss a 10" high obstruction with a clearance between the obstruction and the conduit of not less than 1" and no more than 1½".
3. Make a saddle in a length of conduit to cross an 8" pipe with 1" clearance between the pipe and the conduit.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	10" sample obstructions
Transparencies	Bending charts to match mechanical, electrical, and hydraulic benders
Blank acetate sheets	PVC solvent cements
Transparency pens	End plugs for PVC conduit
Whiteboard/chalkboard	Pipe reamer
Markers/chalk	Shop towels
Pencils and scratch paper	Brushes
Appropriate personal protective equipment	Felt-tip markers
Copy of the latest edition of the <i>National Electrical Code®</i>	Portable mechanical conduit benders
Lengths of ¾" rigid, EMT, and IMC conduit	Electric bender
Lengths of 1" rigid, EMT, and IMC conduit	Hydraulic bender
Lengths of 2" rigid, EMT, and IMC conduit	Bending table
Lengths of PVC conduit	Magnetic torpedo level
Lengths of 8" pipe	EMT bending tools
Samples of elbows, offsets, saddles, and kicks	Conduit bending protractor

continued

Hickey bar
 Tape measure
 Straightedge
 Conduit leveling tools
 PVC heater
 Scientific calculator
 Hacksaw

Pipe vise
 Pipe cutter
 Cutting oil
 Copies of Quick Quiz*
 Module Examinations**
 Performance Profile Sheets**

* Located at the back of this module

** Located in the Test Booklet

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to bend conduit. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize hand tool and hydraulic tool safety.

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.

Benfield Conduit Bending Manual, 2nd Edition. Overland Park, KS: EC&M Books.

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

Tom Henry's Conduit Bending Package (includes video, book, and bending chart). Winter Park, FL: Code Electrical Classes, Inc.

NOTE

NFPA 70®, *National Electrical Code®*, and *NEC®* are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All *National Electrical Code®* and *NEC®* references in this module refer to the 2008 edition of the *National Electrical Code®*.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Machine Bending of Conduit*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction to Conduit Bending	
A. Introduction	_____
B. <i>NEC®</i> Requirements	_____
C. Types of Bends	_____
D. The Geometry of Bending Conduit	_____
Session II. Mechanical Bending	
A. Mechanical Benders	_____
B. Mechanical Stub-Ups	_____
C. Mechanical Offsets	_____

Session III. Electric and Hydraulic Conduit Bending

- A. Electric Conduit Benders
- B. Hydraulic Conduit Benders
- C. Laboratory

Have trainees practice using a hydraulic bender to form stub-ups. Note the proficiency of each trainee. This laboratory corresponds to Performance Task 1.

Sessions IV and V. Bending Techniques

- A. Segment Bending Techniques
- B. Laboratory
- C. Tricks of the Trade
- D. PVC Conduit Installations
- E. Bending PVC Conduit

Have trainees practice making offsets and saddle bends using a hydraulic bender. This laboratory corresponds to Performance Tasks 2 and 3.

Session VI. Review and Testing

- A. Module Review
- B. Module Examination
- C. Performance Testing

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

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

MODULE OVERVIEW

This module introduces the methods and procedures used in the handling and installation of different types of lamps and lighting fixtures.

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; Electrical Level One*; and *Electrical Level Two*, Modules 26201-08 and 26202-08.

OBJECTIVES

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

1. Describe the characteristics of light.
2. Recognize the different kinds of lamps and explain the advantages and disadvantages of each type:
 - Incandescent
 - Halogen
 - Fluorescent
 - High-intensity discharge (HID)
3. Properly select and install various lamps in lighting fixtures.
4. Recognize and describe the installation requirements for various types of lighting fixtures:
 - Surface-mounted
 - Recessed
 - Suspended
 - Track-mounted
5. Recognize ballasts and describe their use in fluorescent and HID lighting fixtures.
6. Explain the relationship of Kelvin temperature to the color of light produced by a lamp.
7. Recognize basic occupancy sensors, photoelectric sensors, and timers used to control lighting circuits and describe how each device operates.

PERFORMANCE TASKS

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

1. Read and interpret information given in lamp manufacturers' catalogs for one or more selected lamps.
2. Properly select and install lamps into lighting fixtures.
3. Install one or more of the following lighting fixtures and their associated lamps:
 - Surface-mounted
 - Recessed
 - Suspended
 - Track-mounted

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Prism
Copy of the latest edition of the *National Electrical Code*[®]
Examples of manufacturers' lighting and fixture catalogs

Examples of manufacturers' lighting fixture installation instructions
Examples of typical lighting plans and lighting fixtures schedule
Assortment of wire nuts
Electrical tape
Assortment of electric lamps, including:
Incandescent
Halogen
Fluorescent
High-intensity discharge (HID)
Electrician's toolbox

Assortment of lighting fixtures, including:
 Surface-mounted
 Recessed
 Suspended
 Track-mounted
 Ceiling fans/fixtures
 Assortment of electrical boxes, mounting hardware, and support hardware used to install different types of lighting fixtures

Assortment of track lighting components and accessories
 Hangers and supports used with suspended lighting fixtures
 Occupancy sensors and photosensors
 Timers
 Quick Quiz*
 Module Examinations**
 Performance Profile Sheet**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to install lighting fixtures. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety.

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.

Lighting Handbook, Latest Edition, New York: Illuminating Engineering Society of North America (IESNA).

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

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Electric Lighting*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Sessions I and II. Introduction to Lighting	
A. Introduction	_____
B. Human Vision	_____
C. Light Characteristics	_____
D. Lamps	_____
E. Laboratory Trainees read and interpret information given in lamp manufacturers' catalogs for one or more selected lamps. This laboratory corresponds to Performance Task 1.	_____
F. Laboratory Trainees practice selecting and installing lamps in lighting fixtures. This laboratory corresponds to Performance Task 2.	_____
Session III. Ballasts and Fixtures	
A. Ballasts	_____
B. Lighting Fixtures	_____

Sessions IV and V. Lighting Fixture Installation

A. Surface-Mounted Lighting Fixtures

B. Recessed Lighting Fixtures

C. Suspended Lighting Fixtures

D. Track Lighting Fixtures

E. Laboratory

Trainees practice installing lighting fixtures and their associated lamps. This laboratory corresponds to Performance Task 3.

F. Controls for Lighting

G. Energy Management Systems

Session VI. Review and Testing

A. Module Review

B. Module Examination

1. Trainees must score 70% or higher to receive recognition from NCCER.

2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.

2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module builds on the information and lighting principles previously covered in the *Electrical Level Two* module, *Electric Lighting*. It describes specific applications for the different designs of incandescent, fluorescent, LED, induction, and HID lighting fixtures. It also provides an overview of the major applications and requirements for lighting systems, as well as an introduction to special wiring systems and dimming systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 and 26302-08.

OBJECTIVES

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

1. Explain how the lighting terms lumen, candlepower, and footcandle relate to one another.
2. Classify lighting fixtures by type and application.
3. Identify the general lighting pattern produced by each type of fixture.
4. Identify the lighting requirements associated with lighting systems used in selected applications such as office buildings, schools, theaters, hazardous areas, etc.
5. Identify various dimming systems and their components.
6. Use manufacturers' lighting fixture catalogs to select the appropriate lighting fixtures for specific lighting applications.

PERFORMANCE TASKS

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

1. Using manufacturers' catalogs, select the appropriate lighting fixtures for specific lighting situations.
2. While touring selected structures to observe their lighting systems:
 - Identify the various types of lighting fixtures used.
 - Explain the specific purpose(s) served by the different fixtures.
 - Identify the lighting system class of service.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Copy of the latest edition of the *National Electrical Code*[®]
Light meter
Examples of lighting fixture manufacturers' catalogs

Assortment of incandescent, halogen, fluorescent, and HID lighting fixtures, including:

- Surface-mounted
- Recessed
- Suspended
- Track-mounted

Assortment of incandescent, fluorescent, and HID dimming controls and ballasts
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

Lighting Handbook. New York, NY: Illuminating Engineering Society of North America (IESNA), 2000.
National Electrical Code® Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

NOTE

NFPA 70®, *National Electrical Code®*, and NEC® are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All *National Electrical Code®* and NEC® references in this module refer to the 2008 edition of the *National Electrical Code®*.

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

Topic	Planned Time
Session I. Introduction; Lumens, Candlepower; Footcandles; Classification of Lighting Fixtures	
A. Introduction	_____
B. Lumens, Candlepower, and Footcandles	_____
C. Classification of Lighting Fixtures	_____
Session II. Practical Applications of Lighting Fixtures	
A. Practical Applications of Lighting Fixtures	_____
1. Incandescent Lighting Fixtures	_____
2. Fluorescent Lighting Fixtures	_____
3. High-Intensity Discharge (HID) Lighting Fixtures	_____
4. Outdoor Lighting Fixtures	_____
5. Emergency and Exit Lighting Fixtures	_____
6. Induction Lighting Systems	_____
7. Light-Emitting Diode (LED) Technology	_____
8. Hazardous and Adverse Location Lighting Fixtures	_____
9. Vandal-Resistant Lighting Fixtures	_____
10. Lighting Fixture Illumination Control	_____
B. Laboratory	_____
Under your supervision, have the trainees use manufacturers' catalogs to select the appropriate lighting fixtures for specific lighting situations. This laboratory corresponds to Performance Task 1.	

Session III. Applications of Lighting

A. Applications of Lighting

- 1. Office Buildings
- 2. Schools
- 3. Retail Store Merchandise Areas
- 4. Health Care Facilities
- 5. Theaters and Auditoriums
- 6. Industrial Locations
- 7. Outdoor Lighting
- 8. Sports Lighting

Session IV. Special-Purpose Wiring Systems Used for Lighting; Dimming

A. Special-Purpose Wiring Systems Used for Lighting

- 1. Manufactured System Wiring
- 2. Lighting Trolley Busways
- 3. Strut-Type Channel Systems

B. Dimming

- 1. Incandescent Lamps
- 2. Fluorescent Lamps
- 3. HID Lamps
- 4. Dimmer Control Racks

Session V. Review and Testing

A. Module Review

B. Module Examination

- 1. Trainees must score 70 percent 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 *National Electrical Code*[®] (NEC[®]) requirements and installation procedures related to electrical equipment installed in hazardous locations. It also describes the methods used by the NEC[®] to classify hazardous locations.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One; and Industrial Maintenance E & I Technician Level Two.*

OBJECTIVES

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

1. Define the various classifications of hazardous locations.
2. Describe the wiring methods permitted for branch circuits and feeders in specific hazardous locations.
3. Select seals and drains for specific hazardous locations.
4. Select wiring methods for Class I, Class II, and Class III hazardous locations.
5. Follow *National Electrical Code*[®] (NEC[®]) requirements for installing explosion-proof fittings in specific hazardous locations.

PERFORMANCE TASKS

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

1. Using two rigid metal conduit nipples, a sealing fitting, three pieces of No. 12 THHN conductors, and a packing fiber/sealing kit, perform the following operations:
 - Secure one conduit nipple in each end of the seal.
 - Make sure the required number of threads are engaged.
 - Pull through the three THHN conductors through the nipples and seal so that about 6" is protruding from each nipple.
 - Pack the fiber following the instructions furnished with the sealing kit.
 - Mix the sealing compound.
 - Position the unit in the required location and pour in the sealing compound.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Sealoff fittings, packing fiber, and sealing compound
Transparencies	Short conduit nipples
Blank acetate sheets	No. 12 THHN conductors
Transparency pens	Various types of explosion-proof fittings
Whiteboard/chalkboard	Various types of sealing fittings used in hazardous locations, including those with drains
Markers/chalk	Portable conduit threader
Pencils and scratch paper	Explosion-proof flexible connectors
Appropriate personal protective equipment	Module Examinations*
Copy of the latest edition of the <i>National Electrical Code</i> [®]	Performance Profile Sheets*

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly.

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 material for continued education rather than for task training.

Code Digest. Latest Edition. Syracuse, NY: Cooper Crouse-Hinds.

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

NOTE

NFPA 70®, *National Electrical Code®*, and *NEC®* are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All *National Electrical Code®* and *NEC®* references in this module refer to the 2008 edition of the *National Electrical Code®*.

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

Topic	Planned Time
Session I. Introduction; Prevention of External Ignition/Explosion	
A. Introduction	_____
1. Class I Locations	_____
2. Class II Locations	_____
3. Class III Locations	_____
4. Applications	_____
B. Prevention of External Ignition/Explosion	_____
1. Sources of Ignition	_____
2. Combustion Principles	_____
Session II. Explosion-Proof Equipment	
A. Explosion-Proof Equipment	_____
1. Intrinsically Safe Equipment	_____
2. Explosion-Proof Conduit and Fittings	_____
3. Seals and Drains	_____
B. Laboratory	_____
Have trainees practice installing sealoff fittings and pouring seals.	
This laboratory corresponds to Performance Task 1.	
Session III. Garages and Similar Locations; Airport Hangars; Hospitals; Petrochemical Hazardous Locations; Manufacturers' Data	
A. Garages and Similar Locations	_____
B. Airport Hangars	_____
C. Hospitals	_____
D. Petrochemical Hazardous Locations	_____
E. Manufacturers' Data	_____

Session IV. Review and Testing

A. Module Review

B. Module Examination

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

C. Performance Testing

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

MODULE OVERVIEW

This module introduces the methods and procedures used in the selection and installation of circuit breakers and fuses.

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; Electrical Level One*; and *Electrical Level Two*, Modules 26201-08 through 26209-08.

OBJECTIVES

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

1. Explain the necessity of overcurrent protection devices in electrical circuits.
2. Define the terms associated with fuses and circuit breakers.
3. Describe the operation of a circuit breaker.
4. Apply the *National Electrical Code*[®] (*NEC*[®]) requirements for overcurrent devices.
5. Describe the operation of single-element and time-delay fuses.

PERFORMANCE TASKS

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

1. Identify the following on one or more circuit breaker(s) and fuse(s):
 - Number of poles
 - Load rating
 - Voltage rating
 - Amperage interrupting rating

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Prism
Copy of the latest edition of the *National Electrical Code*[®]
OSHA Electrical Safety Guidelines (pocket guide)
Samples of circuit breakers, including:

- Single-pole
- Two-pole
- Three-pole

Various types of GFCIs
Samples of various types of fuses, including:

- Edison-base fuses
- Type S fuses and adapters
- Nonrenewable cartridge fuses
- Renewable cartridge fuses

Several blown renewable cartridge fuses with renewable links
Quick Quiz*
Module Examinations**
Performance Profile Sheet**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with circuit breakers and fuses. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety. This module may require that trainees visit job sites. Ensure that all trainees are properly briefed on site safety.

ADDITIONAL RESOURCES

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

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

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12.5 hours are suggested to cover *Circuit Breakers and Fuses*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction and Circuit Breaker Ratings	
A. Introduction	_____
B. Circuit Breaker Ratings	_____
Session II. GFCI and Fuses	
A. Ground Fault Current Circuit Protection	_____
B. Fuses	_____
C. Laboratory Trainees practice identifying fuses and circuit breakers. This laboratory corresponds to Performance Task 1.	_____
Session III. Overcurrents and Sizing	
A. Overcurrents	_____
B. Guide to Sizing Fuses	_____
Session IV. Safety and Coordination	
A. Safety	_____
B. Coordination	_____
Session V. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	
C. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module covers various types of transformers and their applications, as well as information on selecting, sizing, and installing them.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One; Industrial Maintenance E & I Technician Level Two; and Industrial Maintenance E & I Technician Level Three, Modules 40301-09 through 40305-09.*

OBJECTIVES

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

1. Identify three-phase transformer connections.
2. Identify specialty transformer applications.
3. Size and select buck-and-boost transformers.
4. Calculate and install overcurrent protection for specialty transformers.
5. Ground specialty transformers in accordance with *National Electrical Code*[®] (*NEC*[®]) requirements.
6. Calculate transformer derating to account for the effects of harmonics.

PERFORMANCE TASKS

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

1. Identify various specialty transformers.
2. Using a clamp-on ammeter, demonstrate the principles of a current transformer. Identify the primary winding, then calculate and measure the effects of increasing the number of turns (loops) in the primary winding.
3. Connect a buck-and-boost transformer to a single-phase circuit so that it will first be in the boost mode, and then in the buck mode. Record the voltage increase and decrease for each configuration.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Appropriate personal protective equipment

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

Conductors for making transformer connections

Connectors and related hand tools for making transformer connections

Buck-and-boost transformer selection charts

Various types of specialty transformers

Buck-and-boost transformers

Potential (voltage) and current transformers

Clamp-on ammeter

Multimeter

Module Examinations*

Performance Profile Sheets*

*Located in the Test Booklet

SAFETY CONSIDERATIONS

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

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.

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

NOTE

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

Topic	Planned Time
Session I. Introduction; Specialty Transformers	
A. Introduction	_____
1. Types of Transformers	_____
2. Internal Connections in Three-Phase Transformers	_____
B. Specialty Transformers	_____
1. Transformers with Multiple Secondaries	_____
2. Autotransformers	_____
3. Constant-Current Transformers	_____
4. Control Transformers	_____
5. Series Transformers	_____
6. Step-Voltage Regulators	_____
7. Other Specialty Transformers	_____
C. Laboratory	_____
Have the trainees practice identifying various specialty transformers. This laboratory corresponds to Performance Task 1.	
Session II. Instrument Transformers; Sizing Buck-and-Boost Transformers	
A. Instrument Transformers	_____
1. Current Transformers	_____
2. Potential Transformers	_____
B. Laboratory	_____
Have the trainees practice using a clamp-on ammeter to demonstrate the principles of a current transformer. Have them identify the primary winding, then calculate and measure the effects of increasing the number of turns (loops) in the primary winding. This laboratory corresponds to Performance Task 2.	
C. Sizing Buck-and-Boost Transformers	_____
D. Laboratory	_____
Have the trainees practice connecting a buck-and-boost transformer to a single-phase circuit so that it will first be in the boost mode, and then in the buck mode. Have them record the voltage increase and decrease for each configuration. This laboratory corresponds to Performance Task 3.	

Session III. Harmonics; Review and Testing

A. Harmonics

1. Defining the Problem
2. Office Buildings and Plants
3. Survey the Situation
4. Solving the Problem

B. Module Review

C. Module Examination

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

D. Performance Testing

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

MODULE OVERVIEW

This module introduces the trainee to the methods and procedures related to distribution equipment, including grounding, switchboard testing and maintenance, ground fault sensing, and interpreting electrical drawings.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One; Industrial Maintenance E & I Technician Level Two; and Industrial Maintenance E & I Technician Level Three, Modules 40301-09 through 40304-09.*

OBJECTIVES

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

1. Explain the necessity of overcurrent protection devices in electrical circuits.
2. Define the terms associated with fuses and circuit breakers.
3. Describe the purpose of switchgear.
4. Describe the four general classifications of circuit breakers and list the major circuit breaker ratings.
5. Describe switchgear construction, metering layouts, wiring requirements, and maintenance.
6. List *National Electrical Code® (NEC®)* requirements pertaining to switchgear.
7. Describe the visual and mechanical inspections and electrical tests associated with low-voltage and medium-voltage cables, metal-enclosed busways, and metering and instrumentation.
8. Describe a ground fault relay system and explain how to test it.

PERFORMANCE TASKS

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

1. Identify the following on a molded case circuit breaker:
 - Frame size
 - Trip unit rating
 - Pick up values

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Appropriate personal protective equipment

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

Molded case circuit breaker

Manufacturer's literature for various types of distribution equipment

Module Examinations*

Performance Profile Sheets*

*Located in the Test Booklet

SAFETY CONSIDERATIONS

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

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.

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

NOTE

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

Topic	Planned Time
Session I. Introduction; Voltage Classifications; Switchboards	
A. Introduction	_____
B. Voltage Classifications	_____
C. Switchboards	_____
Session II. Switchgear	
A. Switchgear	_____
Session III. Switchboard Testing and Maintenance; NEC® Requirements; Ground Faults	
A. Switchboard Testing and Maintenance	_____
B. NEC® Requirements	_____
C. Ground Faults	_____
Session IV. HVL Switches; Bolted Pressure Switches; Transformers	
A. HVL Switches	_____
B. Bolted Pressure Switches	_____
C. Transformers	_____
Session V. Instrument Transformers; Circuit Breakers	
A. Instrument Transformers	_____
B. Circuit Breakers	_____
C. Laboratory	_____
Have the trainees identify the markings on a molded case circuit breaker. This laboratory corresponds to Performance Task 1.	
Session VI. Panelboards; NEC® Requirements for Services	
A. Panelboards	_____
B. NEC® Requirements for Services	_____

Session VII. Review and Testing

A. Module Review

B. Module Examination

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

C. Performance Testing

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from 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 electrical distribution systems and equipment within a power plant. It covers the distribution of medium- and low-voltage AC, as well as DC control voltages. The module introduces the medium- and low-voltage switchgear, circuit breakers, and motor control centers (MCCs) used in power plants.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Power Industry Fundamentals*; *Power Generation Maintenance Electrician Level One*; *Power Generation Maintenance Electrician Level Two*; and *Power Generation Maintenance Electrician Level Three*, Modules 26206-08, 26207-08, 26209-08, 40208-08, 40310-09, 26203-08, 26303-08, 40301-09, 26210-08, 40306-09, and 40305-09.

Objectives

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

1. Explain electrical power distribution associated with a power-generating facility:
 - Identify how the power distribution system within a plant is configured and how it ties into the grid.
 - Identify and describe alternate supply paths.
 - Interpret plant drawings to identify distribution paths, alternate feeds, and the different paths of the distribution system.
2. Describe switchgear and breaker hardware and operations.
3. Explain the functions of medium-voltage and low-voltage motor control centers (MCCs).
4. Locate and identify the feeds for a power station.

Performance Task

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

1. Locate and identify the feeds for a power station.

Materials and Equipment

Markers/chalk

Pencils and scratch paper

Whiteboard/chalkboard

Power Generation Maintenance Electrician Level 3

PowerPoint® Presentation Slides

(ISBN 978-0-13-230587-7)

Multimedia projector and screen

Computer

Appropriate personal protective equipment

Several types of circuit breakers

Circuit breaker with legible nameplate

MCC with typical components

Access to arc-resistant switchgear

Detailed, unlabeled one-line diagrams of a power station

Module Examinations*

Performance Profile Sheets*

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

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on electrical systems and equipment. Emphasize the importance of proper housekeeping.

Additional Resources

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

ABB: <http://www.abb.com>.

Arc Flash Hazard Incident Energy Calculations: A Historical Perspective and Comparative Study of the Standards IEEE 1584 and NFPA 70E® (2007). R.F. Ammerman, P.K. Sen, and J.P. Nelson: Calgary, Canada.

Eaton (Cutler-Hammer): www.eaton.com.

Electric Power System Basics. Hoboken, NJ: IEEE Press/Wiley Interscience.

General Electric (GE) Electrical: www.geindustrial.com.

IEEE C2-2007, National Electrical Safety Code. New York, NY: Institute of Electrical and Electronics Engineers.

IEEE 1584-2002, IEEE Guide for Performing Arc-Flash Hazard Calculations. New York, NY: Institute of Electrical and Electronics Engineers.

NFPA 70B-2010, Recommended Practice for Electrical Equipment Maintenance. Quincy, MA: National Fire Protection Association.

NFPA 70E®-2009, Standard for Electrical Safety in the Workplace. Quincy, MA: National Fire Protection Association.

Siemens: www.sea.siemens.com.

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

Topic	Planned Time
Session I. Introduction; Plant Power Distribution	
A. Introduction	_____
1. Voltage Classifications and Characteristics	_____
B. Plant Power Distribution	_____
1. Normal Power Distribution	_____
2. Transfer Switches and Kirk Key Interlocks	_____
3. Emergency/Blackout Power	_____
4. Grounded and Ungrounded Systems	_____
5. Dual-Generator System	_____
C. Laboratory	_____
Have trainees locate and identify the feeds for a power station. This laboratory corresponds to Performance Task 1.	

Session II. Circuit Breakers

A. Circuit Breakers

- 1. Circuit Breaker Ratings
- 2. Air Circuit Breakers
- 3. Vacuum Circuit Breakers (VCBs)
- 4. Gas-Insulated Circuit Breakers
- 5. Oil Circuit Breakers (OCBs)
- 6. Tripping Devices

Session III. Switchgear

A. Switchgear

- 1. Medium-Voltage Switchgear
- 2. Low-Voltage Switchgear
- 3. Load Centers
- 4. Arc-Resistant Switchgear

Sessions IV. Motor Control Centers

A. Motor Control Centers

- 1. Controller Components and Symbols
- 2. AC Reduced-Voltage Motor Starters
- 3. Magnetic Starters
- 4. Overload Protection
- 5. Medium-Voltage MCCs
- 6. Low-Voltage MCCs

B. Laboratory

Have trainees locate and identify the components of an MCC.

Session V. Review and Testing

A. Module Review

B. Module Examination

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

C. Performance Testing

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

MODULE OVERVIEW

This module provides information on conductor selection and calculations using various tables in the *National Electrical Code*® (NEC®).

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One; Industrial Maintenance E & I Technician Level Two; and Industrial Maintenance E & I Technician Level Three, Modules 40301-09 through 40306-09.*

OBJECTIVES

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

1. Select electrical conductors for specific applications.
2. Calculate voltage drop in both single-phase and three-phase applications.
3. Apply *National Electrical Code*® (NEC®) regulations governing conductors to a specific application.
4. Calculate and apply NEC® tap rules to a specific application.
5. Size conductors for the load.
6. Derate conductors for fill, temperature, and voltage drop.
7. Select conductors for various temperature ranges and atmospheres.

PERFORMANCE TASKS

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

1. From a selection of conductors, identify the applications for which they can be used.
2. Given an application, identify the conductors that can be used for it.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Appropriate personal protective equipment
Transparencies	Copy of the latest edition of the <i>National Electrical Code</i> ®
Blank acetate sheets	One length each of various solid, stranded, and compact conductors
Transparency pens	Module Examinations*
Whiteboard/chalkboard	Performance Profile Sheets*
Markers/chalk	
Pencils and scratch paper	

*Located in the Test Booklet

SAFETY CONSIDERATIONS

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

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.

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

NOTE

NFPA 70®, National Electrical Code®, and NEC® are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All National Electrical Code® and NEC® references in this module refer to the 2008 edition of the National Electrical Code®.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Conductor Selection and Calculations*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Compact Conductors	
A. Introduction	_____
B. Compact Conductors	_____
Session II. Conductor Applications	
A. Conductor Applications	_____
1. Branch Circuits	_____
2. Conductor Protection	_____
a. Location of Overcurrent Protection in Circuits	_____
Session III. Properties of Conductors	
A. Properties of Conductors	_____
1. Identifying Conductors	_____
a. Color Coding	_____
b. Changing Colors	_____
B. Laboratory	_____
Have trainees identify conductors and their applications from a selection of conductors. This laboratory corresponds with Performance Task 1.	
C. Laboratory	_____
Have trainees identify an appropriate conductor for a given application. This laboratory corresponds with Performance Task 2.	
Session IV. Voltage Drop	
A. Voltage Drop	_____
1. Wire Sizes Based on Resistance	_____
a. Circular Mil-Unit of Conductor Area	_____
b. Conversion of Square Mils to Circular Mils	_____
2. Resistance of Conductors	_____
3. Resistance of Copper per Mil Foot	_____
Session V. Voltage Drop Equations	
A. Voltage Drop Equations	_____
1. Equations for Voltage Drop Using Conductor Area or Conductor Resistance	_____
2. Use of Voltage Drop Equations	_____
3. Practice Voltage Drop Equations	_____

Session VI. Review and Testing

A. Module Review

B. Module Examination

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

C. Performance Testing

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

MODULE OVERVIEW

This module introduces the operations and applications of various types of motors.

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; Electrical Level One*; and *Electrical Level Two*, Module 26201-08.

OBJECTIVES

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

1. Define the following terms:
 - Controller
 - Duty cycle
 - Full-load amps
 - Interrupting rating
 - Thermal protection
 - NEMA design letter
 - Overcurrent
 - Overload
 - Power factor
 - Rated full-load speed
 - Rated horsepower
 - Service factor
2. Describe the various types of motor enclosures.
3. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.
4. Define percent slip and speed regulation.
5. Explain how the direction of a three-phase motor is changed.
6. Describe the component parts and operating characteristics of a three-phase wound-rotor induction motor.
7. Describe the component parts and operating characteristics of a three-phase synchronous motor.
8. Describe the design and operating characteristics of various DC motors.
9. Describe the methods for determining various motor connections.
10. Describe general motor protection requirements as delineated in the *National Electrical Code*[®] (*NEC*[®]).
11. Define the braking requirements for AC and DC motors.

PERFORMANCE TASKS

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

1. Collect data from a motor nameplate.
2. Identify various types of motors and their application(s).
3. Connect the terminals for a dual-voltage motor.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Multimeters
Transparencies	Megger
Blank acetate sheets	Various types of motors, including:
Transparency pens	Three-phase wye/star and delta
Whiteboard/chalkboard	Two-phase double-voltage
Markers/chalk	Low-voltage and high-voltage
Pencils and scratch paper	Scientific calculator or trigonometric tables
Copy of the latest edition of the <i>National Electrical Code</i> [®]	Module Examinations*
	Performance Profile Sheet*

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with motors. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety.

ADDITIONAL RESOURCES

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

National Electrical Code[®] *Handbook*, Latest Edition. Quincy, MA: National Fire Protection Association.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *Motors: Theory and Application*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Sessions I through III. Introduction to Motors	
A. Introduction	_____
B. DC Motor Principles	_____
C. Types of DC Motors	_____
D. Alternating Current Motors	_____
E. Multi-Speed Induction Motors	_____
F. Variable-Speed Drives	_____
G. Laboratory	_____
Trainees practice identifying various types of motors and their applications.	
This laboratory corresponds to Performance Task 2.	
Sessions IV and V. Motor Enclosures	
A. Motor Enclosures	_____
B. NEMA Frame Designations	_____
C. Motor Ratings and Nameplate Data	_____
D. Laboratory	_____
Trainees practice collecting data from motor nameplates. This laboratory corresponds to Performance Task 1.	

Sessions VI and VII. Motor Connections and Installation

- A. Connections and Terminal Markings for AC motors
- B. NEC® Requirements
- C. Braking
- D. Motor Installation
- E. Laboratory

Trainees practice connecting the terminals for a dual-voltage motor. This laboratory corresponds to Performance Task 3.

Session VIII. Review and Testing

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

MODULE OVERVIEW

This module introduces the trainees to motor-operated valves that are controlled by programmable devices, such as PLCs.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One; Industrial Maintenance E & I Technician Level Two; and Industrial Maintenance E & I Technician Level Three, Modules 40301-09 through 40312-09.*

OBJECTIVES

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

1. State safety regulations associated with motor-operated valves (MOVs).
2. Explain the operating principles of various types of MOVs.
3. Identify applications of MOVs.
4. Set up a MOV.
5. Remove and replace a limit switch.

PERFORMANCE TASKS

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

1. Set up a MOV.
2. Remove and replace a limit switch.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen

Transparencies

Blank acetate sheets

Transparency pens

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Appropriate personal protective equipment

Examples of automatic valve actuators:

Electrical

Hydraulic

Pneumatic

Limit switches

Screwdriver

Module Examinations*

Performance Profile Sheets*

*Located in the Test Booklet

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly.

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.

The Steam and Condensate Loop Book, Spirax Sarco, 2007.

Flowserve Corporation – Limitorque website: <http://www.flowserve.com>

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Motor-Operated Valves*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; MOV Safety Issues	
A. Introduction	_____
B. MOV Safety Issues	_____
1. Hazardous Atmospheres	_____
2. Emergency Shutdowns	_____
3. MOV Operation Control	_____
Session II. Types of MOVs	
A. Actuator Gearing	_____
1. Worm-Gear Actuators	_____
2. Bevel-Gear Actuators	_____
3. Variable-Reduction Actuators	_____
B. Pneumatic and Hydraulic Actuators	_____
1. Gas Actuators	_____
2. Rotary Vane Actuator	_____
3. Double-Cylinder Hydraulic Actuators	_____
4. Electro-Hydraulic Actuators	_____
5. Pneumatic Rack and Pinion Actuators	_____
6. Pneumatic Fail-Safe Actuators	_____
Sessions III–V. Setup Activities for MOVs	
A. Initial Installation	_____
B. Verifying Pneumatic, Hydraulic, and Electrical MOV Controls	_____
C. Test Operating Electrical MOVs	_____
D. Inspecting and Adjusting Electrical MOV Cams and Limit Switches	_____
E. Removing and Replacing Switching Assemblies	_____
F. Laboratory	_____
Have the trainees set up a MOV and remove and replace a limit switch.	
These laboratories correspond to Performance Tasks 1 and 2.	
Session VI. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	
C. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.	
2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the *NEC*[®] requirements and procedures used in the selection and installation of conductors and relays.

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*; *Electrical Level One*; and *Electrical Level Two*, Modules 26201-08 through 26210-08.

OBJECTIVES

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

1. Describe the operating principles of contactors and relays.
2. Select contactors and relays for use in specific electrical systems.
3. Explain how mechanical contactors operate.
4. Explain how solid-state contactors operate.
5. Install contactors and relays according to the *NEC*[®] requirements.
6. Select and install contactors and relays for lighting control.
7. Read wiring diagrams involving contactors and relays.
8. Describe how overload relays operate.
9. Connect a simple control circuit.
10. Test control circuits.

PERFORMANCE TASKS

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

1. Mount and connect a 120V lighting contactor with a three-wire pushbutton control.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	120V lighting contactors
Transparencies	Pushbutton stations
Blank acetate sheets	Lampholders and lamps
Transparency pens	Cable for connecting contactors
Whiteboard/chalkboard	Electrician's tool set
Markers/chalk	Quick Quiz*
Pencils and scratch paper	Module Examinations**
Prism	Performance Profile Sheet**
Copy of the latest edition of the <i>National Electrical Code</i> [®]	

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to connect lighting controls. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety. This module may require that trainees visit job sites. Stress the importance of following the proper safety precautions and procedures when installing various types of contactors and relays.

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.

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

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12.5 hours are suggested to cover *Control Systems and Fundamental Concepts*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Sessions I and II. Introduction and Magnetic Contactors	
A. Introduction	_____
B. Magnetic Contactors	_____
C. Laboratory Trainees practice connecting lighting contactors. This laboratory corresponds to Performance Task 1.	_____
Session III. Relays	
A. Relays	_____
B. Solid-State Relays	_____
C. Guidelines for Installing Connectors	_____
D. Overload Relays	_____
Session IV. Protective Enclosures and Remote Control Switching	
A. Protective Enclosures	_____
B. Low-Voltage Remote Control Switching	_____
Session V. Troubleshooting	
A. Troubleshooting	_____
Session VI. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70% or higher to receive recognition from NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	
C. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the trainees to the equipment and methods used to ground de-energized high-voltage circuits during maintenance activities. An understanding of these principles is essential to the safety of electrical maintenance workers.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Industrial Maintenance E & I Technician Level One; Industrial Maintenance E & I Technician Level Two; and Industrial Maintenance E & I Technician Level Three, Modules 40301-09 through 40307-09.*

OBJECTIVES

When you have completed this module, you will be able to do the following:

1. Explain the purpose of temporary grounding.
2. Explain requirements associated with temporary grounding devices.
3. Identify and explain temporary grounding equipment.
4. Explain how to install and remove temporary grounding devices.

PERFORMANCE TASKS

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

1. Apply temporary grounding for a given application with correct PPE, tools, and parts.
2. Demonstrate inspection and storage of temporary grounding components.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	At least one copy of <i>NFPA 70B, Recommended Practice for Electrical Equipment Maintenance</i>
Transparencies	
Blank acetate sheets	Hot stick and attachments
Transparency pens	Insulating mats
Whiteboard/chalkboard	Insulating covers
Markers/chalk	Grounding clamps
Pencils and scratch paper	Grounding cables
Appropriate personal protective equipment	Open-loop ammeter
Electrical safety analysis	Portable ground tester
Personal protective grounds	Module Examinations*
Lockout/tagout equipment	Performance Profile Sheets*

*Located in the Test Booklet

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Ensure that trainees are briefed on shop safety procedures. Emphasize any special safety precautions associated with working on or near high-voltage equipment and circuits. Review the different hazards that could cause voltage to be present on a de-energized circuit. Explain that grounding of the circuit being worked on will prevent such hazards. Review the requirements for an electrically safe work condition.

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 optional materials are for continued education rather than for task training.

OSHA Standard 1910.269, Electric Power Generation, Transmission, and Distribution

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9868

ANSI/IEEE C2-2007 (National Electrical Safety Code). New York, NY: Institute of Electrical and Electronic Engineers.

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

NFPA 70B (Recommended Practice for Electrical Equipment Maintenance)

<http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70B>

NFPA 70E (Standard for Electrical Safety in the Workplace)

<http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70E>

Hubbell Power Systems, Inc., source for products and training.

<http://www.hubbellpowersystems.com>

Codebook City, source for NEC® explanations.

<http://www.codebookcity.com/codearticles/nec/index.htm>

U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado.

Offers a variety of manuals covering several maintenance-related career fields, including a Facilities Instructions, Standards, and Techniques manual, Volume 5-1 (FIST 5-1), which covers Personal Protective Grounding for Electric Power Facilities and Power Lines, 2005.

http://www.usbr.gov/power/data/fist_pub.html

ASTM F855-04, Standard Specifications for Temporary Protective Grounds to Be Used on De-Energized Electric Power Lines and Equipment, 2004. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959.

ASTM F2249-03 Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-Energized Electric Power Lines and Equipment, 2003. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959.

NOTE

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TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Temporary Grounding*. You will need to adjust the time required for testing based on your class size and resources. There are no performance tasks for this module. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic

Planned Time

Session I. Introduction; Safety Analysis; Purpose of Temporary Grounding

A. Introduction

B. Electrical Safety Analyses

C. Purpose of Temporary Grounding

Session II. Temporary Grounding Terms; Sources of Hazardous Energy

- A. Terms
- B. Sources of Hazardous Energy
 - 1. Stored Energy
 - 2. Static Buildup
 - 3. Backfeeding
 - 4. Faulted Equipment
 - 5. Induced-Voltage Areas
 - 6. High-Voltage Testing

Session III. Temporary Grounding Preparations; Requirements for Temporary Grounding Devices

- A. Temporary Grounding Preparation
- B. Requirements for Temporary Grounding Devices
 - 1. General Requirements
 - 2. Specific Requirements
 - 3. Installation Requirements

Session IV. Selection and Evaluation of Temporary Grounding Devices; Installation and Removal of Temporary Grounding Devices

- A. Ground Cable Assemblies
- B. Insulation Devices
- C. Specialized Grounding and Testing Devices
- D. Evaluating Ground Cable Assemblies
 - 1. Cables
 - 2. Ferrules and Clamps
- E. Evaluating Hot Sticks and Attachments
- F. Ground Tester Equipment
- G. Installation of Temporary Grounding Devices
- H. Removing PPGs

Session V. Laboratory

- A. Laboratory
Have trainees practice installing temporary grounding equipment.
This laboratory corresponds to Performance Task 1.

Session VI. Laboratory; Review and Testing

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