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
- 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®
- Several lengths of cable from No. 12 through 4/0 AWG
- Lubricant
- Several types of pulling ropes
- Several different types and lengths of conductors
- Measuring tape
- Setscrew cable grips
- Swivel rope clevis
- Basket-type pulling grips
- Cable cutters/stripping tools
- Self-contained hand-crank wire puller
- Fish tape
- Power blower/vacuum fish tape system
- Electrical cable puller
- Cable grips
- Clamps for supporting conductors
- Insulating supports
- Manufacturers’ catalogs for cable supports
- Cable manufacturers’ literature
- 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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction, Planning, and Setup</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Planning the Installation</td>
<td></td>
</tr>
<tr>
<td>C. Setting up for Wire Pulling</td>
<td></td>
</tr>
<tr>
<td>D. Laboratory</td>
<td>Trainees practice preparing multiple conductors for pulling using a wire-pulling basket. This laboratory corresponds to Performance Task 2.</td>
</tr>
<tr>
<td><strong>Session II. Cable-Pulling Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>A. Cable-Pulling Equipment</td>
<td></td>
</tr>
<tr>
<td>B. High-Force Cable Pulling</td>
<td></td>
</tr>
<tr>
<td>C. Mechanical Offsets</td>
<td></td>
</tr>
<tr>
<td><strong>Session III. Supporting and Pulling Cable</strong></td>
<td></td>
</tr>
<tr>
<td>A. Supporting Conductors</td>
<td></td>
</tr>
<tr>
<td>B. Pulling Cable in Cable Trays</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td>Trainees practice preparing multiple conductors for pulling in a raceway system. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>D. Physical Limitations of Cable</td>
<td></td>
</tr>
<tr>
<td>E. Cable-Pulling Instruments</td>
<td></td>
</tr>
<tr>
<td><strong>Session IV. Review and Testing</strong></td>
<td></td>
</tr>
<tr>
<td>A. Module Review</td>
<td></td>
</tr>
<tr>
<td>B. Module Examination</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
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</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
<td></td>
</tr>
<tr>
<td>C. Performance Testing</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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</tr>
</tbody>
</table>
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
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®

Cable tray samples:
- Metal ladder tray
- Metal trough tray
- Solid bottom tray
- Tray covers
- Nonmetallic tray

Examples of cable tray failures
Cable tray covers

*Located in the back of this module.

Splice plates
Alignment strips
Drop out plates
H-bar
Eight vertical adjustment splice plates
Cable tray supports, including:
- Beam clamps
- Anchor clips
- All-thread rods

Nuts, bolts, washers, and other hangers
Cable tray sections for cutting and offset
Felt-tip markers
Hacksaw and blades
Protractor
Conventional square
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 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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction to Cable Tray</strong></td>
<td></td>
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<tr>
<td>A. Introduction</td>
<td></td>
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<tr>
<td>B. Cable Tray Loading</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice joining cable tray sections. This laboratory corresponds to Performance Task 2.</td>
<td></td>
</tr>
<tr>
<td>D. Cable Tray Support</td>
<td></td>
</tr>
<tr>
<td><strong>Session II. Installation and Design</strong></td>
<td></td>
</tr>
<tr>
<td>A. Center Rail Cable Tray Systems</td>
<td></td>
</tr>
<tr>
<td>B. <em>NEC®</em> Requirements</td>
<td></td>
</tr>
<tr>
<td>C. Cable Installation</td>
<td></td>
</tr>
<tr>
<td>D. Cable Tray Drawings</td>
<td></td>
</tr>
<tr>
<td>E. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Trainees practice generating a list of materials for a cable tray layout. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td><strong>Session III. Pulling Cable, Safety, Review, and Testing</strong></td>
<td></td>
</tr>
<tr>
<td>A. Pulling Cable in Tray Systems</td>
<td></td>
</tr>
<tr>
<td>B. Safety</td>
<td></td>
</tr>
<tr>
<td>C. Module Review</td>
<td></td>
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<tr>
<td>D. Module Examination</td>
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<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
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<tr>
<td>E. Performance Testing</td>
<td></td>
</tr>
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</tr>
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</tr>
</tbody>
</table>
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 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

<table>
<thead>
<tr>
<th>Overhead projector and screen</th>
<th>Copy of the latest edition of the National Electrical Code®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparencies</td>
<td>OSHA Electrical Safety Guidelines (pocket guide)</td>
</tr>
<tr>
<td>Blank acetate sheets</td>
<td>No. 4 AWG bare copper grounding wire</td>
</tr>
<tr>
<td>Transparency pens</td>
<td>Small main panelboard</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Switch boxes</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Grounding clips, screws, and clamps</td>
</tr>
<tr>
<td>Pencils and scratch paper</td>
<td>Galvanized water pipe</td>
</tr>
</tbody>
</table>
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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction to Grounding and Bonding</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Purpose of Grounding and Bonding</td>
<td></td>
</tr>
<tr>
<td>C. NEC® Requirements for Grounding and Bonding</td>
<td></td>
</tr>
<tr>
<td>D. Short Circuit Versus Ground Fault</td>
<td></td>
</tr>
<tr>
<td>E. Types of Grounding Systems</td>
<td></td>
</tr>
<tr>
<td><strong>Session II. Grounding Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>A. NEC® Requirements for Grounding Equipment</td>
<td></td>
</tr>
</tbody>
</table>
| 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 40208-08

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

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

* 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.


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.

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Session I. Introduction; Hand Bending</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Hand Bending Equipment</td>
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</tr>
<tr>
<td>1. Geometry Required to Make a Bend</td>
<td></td>
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<tr>
<td>2. Making a 90-Degree Bend</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td>Have the trainees practice making 90-degree bends. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>D. Gain</td>
<td></td>
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<tr>
<td>E. Back-to-Back 90-Degree Bends</td>
<td></td>
</tr>
<tr>
<td>F. Laboratory</td>
<td>Have the trainees practice making back-to-back bends. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td><strong>Session II. Offsets; Saddle Bends</strong></td>
<td></td>
</tr>
<tr>
<td>A. Making an Offset</td>
<td></td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>Have the trainees practice making kicks. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>C. Parallel Offsets</td>
<td></td>
</tr>
<tr>
<td>D. Laboratory</td>
<td>Have the trainees practice making offset bends. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>E. Saddle Bends</td>
<td></td>
</tr>
<tr>
<td>F. Laboratory</td>
<td>Have the trainees practice making saddle bends. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td>G. Four-Bend Saddles</td>
<td></td>
</tr>
</tbody>
</table>
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
- 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®
- Lengths of ⅜” rigid, EMT, and IMC conduit
- Lengths of 1” rigid, EMT, and IMC conduit
- Lengths of 2” rigid, EMT, and IMC conduit
- Lengths of PVC conduit
- Lengths of 8” pipe
- Samples of elbows, offsets, saddles, and kicks
- 10” sample obstructions
- Bending charts to match mechanical, electrical, and hydraulic benders
- PVC solvent cements
- End plugs for PVC conduit
- Pipe reamer
- Shop towels
- Brushes
- Felt-tip markers
- Portable mechanical conduit benders
- Electric bender
- Hydraulic bender
- Bending table
- Magnetic torpedo level
- EMT bending tools
- Conduit bending protractor

continued
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.


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.

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<thead>
<tr>
<th>Topic</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction to Conduit Bending</strong></td>
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<td>A. Introduction</td>
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<td>B. NEC® Requirements</td>
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<td>C. Types of Bends</td>
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<td>D. The Geometry of Bending Conduit</td>
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<td><strong>Session II. Mechanical Bending</strong></td>
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<td>A. Mechanical Benders</td>
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<td>B. Mechanical Stub-Ups</td>
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<tr>
<td>C. Mechanical Offsets</td>
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</tbody>
</table>

* Located at the back of this module
**Located in the Test Booklet
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
      Have trainees practice making offsets and saddle bends using a hydraulic bender. This laboratory corresponds to Performance Tasks 2 and 3.
   C. Tricks of the Trade
   D. PVC Conduit Installations
   E. Bending PVC Conduit

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 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
Examples of manufacturers’ lighting fixture installation instructions
Electrical tape
Assortment of electric lamps, including:
   - Incandescent
   - Halogen
   - Fluorescent
   - High-intensity discharge (HID)
Electrician’s toolbox
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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
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<td><strong>Sessions I and II. Introduction to Lighting</strong></td>
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<tr>
<td>A. Introduction</td>
<td>_____________</td>
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<tr>
<td>B. Human Vision</td>
<td>_____________</td>
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<tr>
<td>C. Light Characteristics</td>
<td>_____________</td>
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<tr>
<td>D. Lamps</td>
<td>_____________</td>
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<tr>
<td>E. Laboratory</td>
<td>_____________</td>
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<tr>
<td>Trainees read and interpret information given in lamp manufacturers’ catalogs for one or more selected lamps. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td>F. Laboratory</td>
<td>_____________</td>
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<tr>
<td>Trainees practice selecting and installing lamps in lighting fixtures. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td><strong>Session III. Ballasts and Fixtures</strong></td>
<td></td>
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<tr>
<td>A. Ballasts</td>
<td>_____________</td>
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<tr>
<td>B. Lighting Fixtures</td>
<td>_____________</td>
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</tbody>
</table>
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

*Located in the Test Booklet.

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*
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.


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 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.

<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
<tr>
<td>Session I. Introduction; Lumens, Candlepower; Footcandles; Classification of Lighting Fixtures</td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Lumens, Candlepower, and Footcandles</td>
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<tr>
<td>C. Classification of Lighting Fixtures</td>
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<tr>
<td>Session II. Practical Applications of Lighting Fixtures</td>
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<tr>
<td>A. Practical Applications of Lighting Fixtures</td>
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<tr>
<td>1. Incandescent Lighting Fixtures</td>
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<td>2. Fluorescent Lighting Fixtures</td>
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<td>3. High-Intensity Discharge (HID) Lighting Fixtures</td>
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<td>4. Outdoor Lighting Fixtures</td>
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<td>5. Emergency and Exit Lighting Fixtures</td>
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<td>6. Induction Lighting Systems</td>
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<td>7. Light-Emitting Diode (LED) Technology</td>
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<td>8. Hazardous and Adverse Location Lighting Fixtures</td>
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<td>9. Vandal-Resistant Lighting Fixtures</td>
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<td>10. Lighting Fixture Illumination Control</td>
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<td>B. Laboratory</td>
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<tr>
<td>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.</td>
<td></td>
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</tbody>
</table>
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.
Hazardous Locations
Annotated Instructor’s Guide

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 National Electrical Code® | 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.


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 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.

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


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.

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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Circuit Breaker Ratings</td>
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<tr>
<td><strong>Session II. GFCI and Fuses</strong></td>
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<tr>
<td>A. Ground Fault Current Circuit Protection</td>
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<tr>
<td>B. Fuses</td>
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<tr>
<td>C. Laboratory</td>
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<tr>
<td>Trainees practice identifying fuses and circuit breakers. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td><strong>Session III. Overcurrents and Sizing</strong></td>
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<tr>
<td>A. Overcurrents</td>
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<tr>
<td>B. Guide to Sizing Fuses</td>
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<tr>
<td><strong>Session IV. Safety and Coordination</strong></td>
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<tr>
<td>A. Safety</td>
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<td>B. Coordination</td>
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<tr>
<td><strong>Session V. Review and Testing</strong></td>
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<tr>
<td>A. Module Review</td>
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<tr>
<td>B. Module Examination</td>
<td></td>
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<tr>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
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<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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<tr>
<td>C. Performance Testing</td>
<td></td>
</tr>
<tr>
<td>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.</td>
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<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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</tbody>
</table>
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.
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.


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 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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction; Specialty Transformers</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>1. Types of Transformers</td>
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<td>2. Internal Connections in Three-Phase Transformers</td>
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<td>B. Specialty Transformers</td>
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<td>1. Transformers with Multiple Secondaries</td>
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<td>2. Autotransformers</td>
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<td>3. Constant-Current Transformers</td>
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<td>4. Control Transformers</td>
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<td>5. Series Transformers</td>
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<td>6. Step-Voltage Regulators</td>
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<td>7. Other Specialty Transformers</td>
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<tr>
<td>C. Laboratory</td>
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<tr>
<td>Have the trainees practice identifying various specialty transformers. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td><strong>Session II. Instrument Transformers; Sizing Buck-and-Boost Transformers</strong></td>
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<tr>
<td>A. Instrument Transformers</td>
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<td>1. Current Transformers</td>
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<tr>
<td>2. Potential Transformers</td>
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<td>B. Laboratory</td>
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<tr>
<td>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.</td>
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<tr>
<td>C. Sizing Buck-and-Boost Transformers</td>
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<tr>
<td>D. Laboratory</td>
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<tr>
<td>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.</td>
<td></td>
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</tbody>
</table>
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.


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.

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<thead>
<tr>
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<tr>
<td>A. Introduction</td>
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<td>B. Voltage Classifications</td>
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<td>C. Switchboards</td>
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<tr>
<td><strong>Session II. Switchgear</strong></td>
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<tr>
<td>A. Switchgear</td>
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<tr>
<td><strong>Session III. Switchboard Testing and Maintenance; NEC® Requirements; Ground Faults</strong></td>
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<tr>
<td>A. Switchboard Testing and Maintenance</td>
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<tr>
<td>B. NEC® Requirements</td>
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<td>C. Ground Faults</td>
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<tr>
<td><strong>Session IV. HVL Switches; Bolted Pressure Switches; Transformers</strong></td>
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<td>A. HVL Switches</td>
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<td>B. Bolted Pressure Switches</td>
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<td>C. Transformers</td>
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<tr>
<td><strong>Session V. Instrument Transformers; Circuit Breakers</strong></td>
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<tr>
<td>A. Instrument Transformers</td>
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<tr>
<td>B. Circuit Breakers</td>
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<tr>
<td>C. Laboratory</td>
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<tr>
<td>Have the trainees identify the markings on a molded case circuit breaker. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td><strong>Session VI. Panelboards; NEC® Requirements for Services</strong></td>
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<tr>
<td>A. Panelboards</td>
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<tr>
<td>B. NEC® Requirements for Services</td>
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</tbody>
</table>
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
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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
<tr>
<td>Session I. Introduction; Plant Power Distribution</td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>1. Voltage Classifications and Characteristics</td>
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<tr>
<td>B. Plant Power Distribution</td>
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<tr>
<td>1. Normal Power Distribution</td>
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<tr>
<td>2. Transfer Switches and Kirk Key Interlocks</td>
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<tr>
<td>3. Emergency/Blackout Power</td>
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<tr>
<td>4. Grounded and Ungrounded Systems</td>
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<tr>
<td>5. Dual-Generator System</td>
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<tr>
<td>C. Laboratory</td>
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</tr>
<tr>
<td>Have trainees locate and identify the feeds for a power station. This laboratory corresponds to Performance Task 1</td>
<td></td>
</tr>
</tbody>
</table>
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
- 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®
- One length each of various solid, stranded, and compact conductors
- 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.

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.

<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Compact Conductors</td>
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<td><strong>Session II. Conductor Applications</strong></td>
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<tr>
<td>A. Conductor Applications</td>
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<td>1. Branch Circuits</td>
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<td>2. Conductor Protection</td>
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<td>a. Location of Overcurrent Protection in Circuits</td>
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<td><strong>Session III. Properties of Conductors</strong></td>
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<tr>
<td>A. Properties of Conductors</td>
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<td>1. Identifying Conductors</td>
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<td>a. Color Coding</td>
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<td>b. Changing Colors</td>
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<td>B. Laboratory</td>
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<tr>
<td>Have trainees identify conductors and their applications from a selection of conductors. This laboratory corresponds with Performance Task 1.</td>
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<tr>
<td>C. Laboratory</td>
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<tr>
<td>Have trainees identify an appropriate conductor for a given application. This laboratory corresponds with Performance Task 2.</td>
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<tr>
<td><strong>Session IV. Voltage Drop</strong></td>
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<tr>
<td>A. Voltage Drop</td>
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<td>1. Wire Sizes Based on Resistance</td>
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<td>a. Circular Mil-Unit of Conductor Area</td>
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<td>b. Conversion of Square Mils to Circular Mils</td>
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<tr>
<td>2. Resistance of Conductors</td>
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<td>3. Resistance of Copper per Mil Foot</td>
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<tr>
<td><strong>Session V. Voltage Drop Equations</strong></td>
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<tr>
<td>A. Voltage Drop Equations</td>
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<td>1. Equations for Voltage Drop Using Conductor Area or Conductor Resistance</td>
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<td>2. Use of Voltage Drop Equations</td>
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<tr>
<td>3. Practice Voltage Drop Equations</td>
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</tbody>
</table>
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
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Copy of the latest edition of the National Electrical Code

Multimeters
Megger
Various types of motors, including:
Three-phase wye/star and delta
Two-phase double-voltage
Low-voltage and high-voltage
Scientific calculator or trigonometric tables
Module Examinations*
Performance Profile Sheet*

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.


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.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Examples of automatic valve actuators:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead projector and screen</td>
<td>Electrical</td>
</tr>
<tr>
<td>Transparencies</td>
<td>Hydraulic</td>
</tr>
<tr>
<td>Blank acetate sheets</td>
<td>Pneumatic</td>
</tr>
<tr>
<td>Transparency pens</td>
<td>Limit switches</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Screwdriver</td>
</tr>
<tr>
<td>Markers/chalk</td>
<td>Module Examinations*</td>
</tr>
<tr>
<td>Pencils and scratch paper</td>
<td>Performance Profile Sheets*</td>
</tr>
<tr>
<td>Appropriate personal protective equipment</td>
<td></td>
</tr>
</tbody>
</table>

*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.

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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction; MOV Safety Issues</strong></td>
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<tr>
<td>A. Introduction</td>
<td></td>
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<tr>
<td>B. MOV Safety Issues</td>
<td></td>
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<tr>
<td>1. Hazardous Atmospheres</td>
<td></td>
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<tr>
<td>2. Emergency Shutdowns</td>
<td></td>
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<tr>
<td>3. MOV Operation Control</td>
<td></td>
</tr>
<tr>
<td><strong>Session II. Types of MOVs</strong></td>
<td></td>
</tr>
<tr>
<td>A. Actuator Gearing</td>
<td></td>
</tr>
<tr>
<td>1. Worm-Gear Actuators</td>
<td></td>
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<tr>
<td>2. Bevel-Gear Actuators</td>
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<tr>
<td>3. Variable-Reduction Actuators</td>
<td></td>
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<tr>
<td>B. Pneumatic and Hydraulic Actuators</td>
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<tr>
<td>1. Gas Actuators</td>
<td></td>
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<tr>
<td>2. Rotary Vane Actuator</td>
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<tr>
<td>3. Double-Cylinder Hydraulic Actuators</td>
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<tr>
<td>4. Electro-Hydraulic Actuators</td>
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<tr>
<td>5. Pneumatic Rack and Pinion Actuators</td>
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<td>6. Pneumatic Fail-Safe Actuators</td>
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<tr>
<td><strong>Sessions III–V. Setup Activities for MOVs</strong></td>
<td></td>
</tr>
<tr>
<td>A. Initial Installation</td>
<td></td>
</tr>
<tr>
<td>B. Verifying Pneumatic, Hydraulic, and Electrical MOV Controls</td>
<td></td>
</tr>
<tr>
<td>C. Test Operating Electrical MOVs</td>
<td></td>
</tr>
<tr>
<td>D. Inspecting and Adjusting Electrical MOV Cams and Limit Switches</td>
<td></td>
</tr>
<tr>
<td>E. Removing and Replacing Switching Assemblies</td>
<td></td>
</tr>
<tr>
<td>F. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have the trainees set up a MOV and remove and replace a limit switch. These laboratories correspond to Performance Tasks 1 and 2.</td>
<td></td>
</tr>
<tr>
<td><strong>Session VI. Review and Testing</strong></td>
<td></td>
</tr>
<tr>
<td>A. Module Review</td>
<td></td>
</tr>
<tr>
<td>B. Module Examination</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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<tr>
<td>C. Performance Testing</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.</td>
<td></td>
</tr>
<tr>
<td>2. Record the training results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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</tr>
</tbody>
</table>
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
- 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®
- 120V lighting contactors
- Pushbutton stations
- Lampholders and lamps
- Cable for connecting contactors
- Electrician’s tool set
- 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 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.


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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Sessions I and II. Introduction and Magnetic Contactors</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Magnetic Contactors</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td>Trainees practice connecting lighting contactors. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td><strong>Session III. Relays</strong></td>
<td></td>
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<tr>
<td>A. Relays</td>
<td></td>
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<tr>
<td>B. Solid-State Relays</td>
<td></td>
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<tr>
<td>C. Guidelines for Installing Connectors</td>
<td></td>
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<tr>
<td>D. Overload Relays</td>
<td></td>
</tr>
<tr>
<td><strong>Session IV. Protective Enclosures and Remote Control Switching</strong></td>
<td></td>
</tr>
<tr>
<td>A. Protective Enclosures</td>
<td></td>
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<tr>
<td>B. Low-Voltage Remote Control Switching</td>
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<tr>
<td><strong>Session V. Troubleshooting</strong></td>
<td></td>
</tr>
<tr>
<td>A. Troubleshooting</td>
<td></td>
</tr>
<tr>
<td><strong>Session VI. Review and Testing</strong></td>
<td></td>
</tr>
<tr>
<td>A. Module Review</td>
<td></td>
</tr>
<tr>
<td>B. Module Examination</td>
<td>Trainees must score 70% or higher to receive recognition from NCCER. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
</tr>
<tr>
<td>C. Performance Testing</td>
<td>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. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Overhead projector and screen</td>
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<tr>
<td>Transparencies</td>
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<td>Markers/chalk</td>
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<tr>
<td>Pencils and scratch paper</td>
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<tr>
<td>Appropriate personal protective equipment</td>
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<tr>
<td>Electrical safety analysis</td>
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<tr>
<td>Personal protective grounds</td>
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<tr>
<td>Lockout/tagout equipment</td>
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<tr>
<td>At least one copy of NFPA 70B, Recommended Practice for Electrical Equipment Maintenance</td>
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<tr>
<td>Hot stick and attachments</td>
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<tr>
<td>Insulating mats</td>
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<tr>
<td>Insulating covers</td>
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<tr>
<td>Grounding clamps</td>
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<tr>
<td>Grounding cables</td>
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<tr>
<td>Open-loop ammeter</td>
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<tr>
<td>Portable ground tester</td>
<td></td>
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<tr>
<td>Module Examinations*</td>
<td></td>
</tr>
<tr>
<td>Performance Profile Sheets*</td>
<td></td>
</tr>
</tbody>
</table>

*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.
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**


**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

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.


**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 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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction; Safety Analysis; Purpose of Temporary Grounding</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Electrical Safety Analyses</td>
<td></td>
</tr>
<tr>
<td>C. Purpose of Temporary Grounding</td>
<td></td>
</tr>
</tbody>
</table>
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.