

## Module Overview

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This module describes the different sectors in the electrical trade, and the types of work and work environments electricians would find in the field. It covers apprenticeship, training programs, and career opportunities. The responsibilities and characteristics a worker should possess are also described.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*.

## Objectives

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

1. Describe the apprenticeship/training process for electricians.
2. Describe various career paths/opportunities one might follow in the electrical trade.
3. Define the various sectors of the electrical industry.
4. State the tasks typically performed by an electrician.
5. Explain the responsibilities and aptitudes of an electrician.

## Performance Tasks

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This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint® Presentation  
Slides  
Whiteboard/chalkboard  
Markers/chalk  
Computer  
Pencils and scratch paper  
Appropriate personal protective equipment  
*Careers in Construction*,  
© 2006, NCCER/Pearson Education

Copies of the latest editions of the *NEC*® and  
*NFPA 70E*® standards  
Help-wanted section from an electrical trade  
publication  
Samples of NCCER Training Credentials  
Employee manual  
*OSHA Safety and Health Standards for the  
Construction Industry (29 CFR, Part 1926)*  
TV/VCR/DVD player (*optional*)  
Module Examination\*

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

## Additional Resources

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

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

Safety videos or DVDs can often be obtained free of charge from professional associations, trade associations, or university safety offices. The following safety training videos are available free of charge at the OSHA website ([www.osha.gov](http://www.osha.gov)):

*Partner with OSHA: New Ways of Working*. OSHA Video (2001), 11 minutes.

*Protecting Workers: How OSHA Conducts Inspections*. OSHA Video (1994), 18 minutes.

*Protecting Workers: How OSHA Writes Standards*. OSHA Video (1992), 12 minutes.

*Construction Safety: Choice or Chance*. OSHA Video (2000), 15 minutes.

## Teaching Time for this Module

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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 2½ hours are suggested to cover *Orientation to the Electrical Trade*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; The Electrical Trade; Review and Testing</b>                                           |              |
| A. Introduction                                                                                                    | _____        |
| B. Career Opportunities in the Electrical Field                                                                    | _____        |
| C. Your Training Program                                                                                           | _____        |
| D. Responsibilities of the Employee                                                                                | _____        |
| E. Responsibilities of the Employer                                                                                | _____        |
| F. Safety                                                                                                          | _____        |
| G. Review                                                                                                          | _____        |
| H. Module Examination                                                                                              | _____        |
| 1. Trainees must score 70% 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. |              |

## Module Overview

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This module introduces the trainees to the safety rules and regulations for electricians, including the necessary precautions for avoiding various job site hazards.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One, Module 26101-14*.

## Objectives

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

1. Recognize safe working practices in the construction environment.
2. Explain the purpose of OSHA and how it promotes safety on the job.
3. Identify electrical hazards and how to avoid or minimize them in the workplace.
4. Explain electrical safety issues concerning lockout/tagout procedures, confined space entry, respiratory protection, and fall protection systems.
5. Develop a task plan and a hazard assessment for a given task and select the appropriate PPE and work methods to safely perform the task.

## Performance Tasks

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

1. Perform a visual inspection on various types of ladders.
2. Set up a ladder properly to perform a task.
3. Properly don a harness.
4. Perform a hazard assessment of a job such as replacing the lights in your classroom.
  - Discuss the work to be performed and the hazards involved.
  - Locate the phone closest to the work site and ensure that the local emergency telephone numbers are either posted at the phone or known by you and your partner(s).
  - Plan an escape route from the location in the event of an accident.

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint® Presentation  
Slides  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Copy of the latest edition of the *National Electrical Code*®  
*OSHA Electrical Safety Guidelines* (pocket guide)  
*NFPA 70E*®  
Company safety manual  
Solvent MSDS  
Access to eye wash station

Various types of personal protective and safety equipment, including:  
Rubber gloves  
Insulating blankets  
Hot sticks  
Fuse pullers  
Shorting probes  
Safety glasses  
Face shields  
Hard hats  
GFCI device  
Company lockout/tagout procedures  
Lockout/tagout devices and labels  
Stepladders  
Straight ladders

(continued)

Fall arrest system  
Safety harnesses  
TV/DVD/VCR player (*optional*)

Safety videos (*optional*)  
Module Examination\*  
Performance Profile Sheet\*

\* 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

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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 ladders. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety.

## Additional Resources

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

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

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

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

*Standards for Electrical Safety in the Workplace,* Latest Edition. Quincy, MA: National Fire Protection Association.

*Managing Electrical Hazards,* © 2009, NCCER/Pearson Education.

## Teaching Time for this Module

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

| Topic                                                                                                  | Planned Time |
|--------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Electrical Hazards</b>                                                     |              |
| A. Introduction                                                                                        | _____        |
| B. Electrical Shock                                                                                    | _____        |
| C. Protective Equipment                                                                                | _____        |
| D. OSHA                                                                                                | _____        |
| E. <i>NFPA 70E</i> ®                                                                                   | _____        |
| <b>Session II. Ladders, Lifts, and Lifting</b>                                                         |              |
| A. Ladders and Scaffolds                                                                               | _____        |
| B. PT/Laboratory                                                                                       | _____        |
| Have trainees practice visually inspecting ladders. This laboratory corresponds to Performance Task 1. |              |
| C. PT/Laboratory                                                                                       | _____        |
| Have trainees practice setting up a ladder. This laboratory corresponds to Performance Task 2.         |              |
| D. Lifts, Hoists, and Cranes                                                                           | _____        |
| E. Lifting                                                                                             | _____        |
| F. Basic Tool Safety                                                                                   | _____        |

**Session III. General Construction Safety Topics**

- A. Confined Space Entry Procedures
- B. First Aid
- C. Solvents and Toxic Vapors
- D. Asbestos, Batteries, PCBs, and Vapor Lamps
- E. Lead Safety

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**Session IV. Fall Protection; Hazard Assessment; Review and Testing**

- A. Fall Protection
- B. PT/Laboratory  
Have trainees practice donning a safety harness. This laboratory corresponds to Performance Task 3.
- C. Hazard Assessment
- D. PT/Laboratory  
Have trainees practice performing a hazard assessment. This laboratory corresponds to Performance Task 4.
- E. Review
- F. Module Examination
  - 1. Trainees must score 70% 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.
- G. 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.

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### Module Overview

This module introduces the trainee to electrical circuits. It offers a general introduction to electrical concepts used in Ohm's law. It includes atomic theory, electromagnetic force, resistance, and electric power equations. It also covers series, parallel, and series-parallel circuits.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 and 26102-14.

### Objectives

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

1. Define voltage and identify the ways in which it can be produced.
2. Explain the difference between conductors and insulators.
3. Define the units of measurement that are used to measure the properties of electricity.
4. Identify the meters used to measure voltage, current, and resistance.
5. Explain the basic characteristics of series and parallel circuits.

### Performance Tasks

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This is a knowledge-based module. There are no performance tasks.

### Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint®  
Presentation Slides

Computer

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Sample schematics

Basic electrical circuit, including:

Battery/power source

Wiring

Loads

Switches

Examples of conductors, insulators, and color-coded resistors

Magnets

Simple electromagnet

Metal sheet

Iron filings

Various types of meters, including:

Multimeter

Voltmeter

Clamp-on ammeter

Ohmmeter

Continuity tester

Voltage tester

Module Examination\*

\* 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

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

## Additional Resources

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

*Electronics Fundamentals: Circuits, Devices, and Applications*, Thomas L. Floyd. New York: Prentice Hall.  
*Principles of Electric Circuits*, Thomas L. Floyd. New York: Prentice Hall.

## Teaching Time for This Module

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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 *Introduction to Electrical Circuits*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to Electrical Theory</b>                                                                |              |
| A. Introduction                                                                                                    | _____        |
| B. Atomic Theory                                                                                                   | _____        |
| C. Electrical Power Generation and Distribution                                                                    | _____        |
| D. Electric Charge and Current                                                                                     | _____        |
| <b>Session II. Ohm's Law; Schematics; Measurements</b>                                                             |              |
| A. Ohm's Law                                                                                                       | _____        |
| B. Schematic Representation of Circuit Elements                                                                    | _____        |
| C. Resistors                                                                                                       | _____        |
| D. Electrical Circuits                                                                                             | _____        |
| E. Electrical Measuring Instruments                                                                                | _____        |
| <b>Session III. Power Equations; Review and Testing</b>                                                            |              |
| A. Electrical Power                                                                                                | _____        |
| B. Module Review                                                                                                   | _____        |
| C. Module Examination                                                                                              | _____        |
| 1. Trainees must score 70% 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. |              |

### Module Overview

This module introduces trainees to circuit calculations involving the application of Ohm's and Kirchoff's laws.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 through 26103-14.

### Objectives

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

1. Explain the basic characteristics of combination circuits.
2. Calculate, using Kirchoff's voltage law, the voltage drop in series, parallel, and series-parallel circuits.
3. Calculate, using Kirchoff's current law, the total current in parallel and series-parallel circuits.
4. Using Ohm's law, find the unknown parameters in series, parallel, and series-parallel circuits.

### Performance Tasks

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This is a knowledge-based module. There are no performance tasks.

### Materials and Equipment

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*Electrical Level One* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer

Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Module examination\*

\* 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

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

### Additional Resources

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

*Electronics Fundamentals: Circuits, Devices, and Applications*, Thomas L. Floyd. New York: Prentice Hall.  
*Principles of Electric Circuits*, Thomas L. Floyd. New York: Prentice Hall.



## Teaching Time for This Module

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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 *Electrical Theory*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Resistive Circuits</b>                                                                 |              |
| A. Introduction                                                                                                    | _____        |
| B. Resistances in Series                                                                                           | _____        |
| C. Resistances in Parallel                                                                                         | _____        |
| D. Series-Parallel Circuits                                                                                        | _____        |
| <b>Session II. Applying Ohm's Law to Resistive Circuits</b>                                                        |              |
| A. Voltage and Current in Series Circuits                                                                          | _____        |
| B. Voltage and Current in Parallel Circuits                                                                        | _____        |
| C. Voltage and Current in Series-Parallel Circuits                                                                 | _____        |
| <b>Session III. Kirchhoff's Law; Review and Testing</b>                                                            |              |
| A. Kirchhoff's Law                                                                                                 | _____        |
| B. Module Review                                                                                                   | _____        |
| C. Module Examination                                                                                              | _____        |
| 1. Trainees must score 70% 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. |              |

## Module Overview

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This module introduces trainees to the requirements and structure of the *National Electrical Code*<sup>®</sup>.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 through 26104-14.

## Objectives

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

1. Explain the purpose and history of the *NEC*<sup>®</sup>.
2. Describe the layout of the *NEC*<sup>®</sup>.
3. Demonstrate how to navigate the *NEC*<sup>®</sup>.
4. Describe the purpose of the National Electrical Manufacturers Association and the NFPA.
5. Explain the role of nationally recognized testing laboratories.

## Performance Tasks

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

1. Use *NEC Article 90* to determine the scope of the *NEC*<sup>®</sup>. State what is covered by the *NEC*<sup>®</sup> and what is not.
2. Find the definition of the term feeder in the *NEC*<sup>®</sup>.
3. Look up the *NEC*<sup>®</sup> specifications that you would need to follow if you were installing an outlet near a swimming pool.
4. Find the minimum wire bending space required for two No. 1/0 AWG conductors installed in a junction box or cabinet and entering opposite the terminal.

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint<sup>®</sup> Presentation  
Slides  
Computer  
Whiteboard/chalkboard  
Markers/chalk

Pencils and scratch paper  
Copy of the latest edition of the  
*National Electrical Code*<sup>®</sup>  
Module Examination\*  
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.

## Additional Resources

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

*National Electrical Code*<sup>®</sup> Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

## Teaching Time for this Module

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

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to the NEC®</b>                                                                                                                                                                                            |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Purpose and History of the NEC®                                                                                                                                                                                                    | _____        |
| C. The Layout of the NEC®                                                                                                                                                                                                             | _____        |
| <b>Session II. Navigating the NEC®, Part One</b>                                                                                                                                                                                      |              |
| A. Chapter 1 – General                                                                                                                                                                                                                | _____        |
| B. Chapter 2 – Wiring and Protection                                                                                                                                                                                                  | _____        |
| C. Chapter 3 – Wiring Methods and Materials                                                                                                                                                                                           | _____        |
| D. Chapter 4 – Equipment for General Use                                                                                                                                                                                              | _____        |
| E. Chapter 5 – Special Occupancies                                                                                                                                                                                                    | _____        |
| F. Chapters 6, 7, and 8 – Special Equipment, Special Conditions, and Communications Systems                                                                                                                                           | _____        |
| <b>Session III. Navigating the NEC®, Part Two; Review and Testing</b>                                                                                                                                                                 |              |
| A. Examples of Navigating the NEC®                                                                                                                                                                                                    | _____        |
| B. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice using the NEC®. This laboratory corresponds to Performance Tasks 1–4.                                                                                                                                          |              |
| C. Other Organizations                                                                                                                                                                                                                | _____        |
| D. Review                                                                                                                                                                                                                             | _____        |
| E. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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.                                                                                                                    |              |
| F. 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 explains how to select and size outlet boxes, pull boxes, and junction boxes pursuant to *NEC*<sup>®</sup> requirements.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 through 26105-14.

### Objectives

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

1. Describe the different types of nonmetallic and metallic boxes.
2. Calculate the *NEC*<sup>®</sup> fill requirements for boxes under 100 cubic inches.
3. Identify the appropriate box type and size for a given application.
4. Select and demonstrate the appropriate method for mounting a given box.

### Performance Tasks

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

1. Identify the appropriate box type and size for a given application.
2. Select the minimum size pull or junction box for the following applications:
  - Conduit entering and exiting for a straight pull.
  - Conduit entering and exiting at an angle.

### Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Conduit caps  
Copy of the latest edition of the *National Electrical Code*<sup>®</sup>

Examples of different types of metallic and nonmetallic boxes, device covers, and extension rings  
Examples of pull and junction boxes  
Examples of device boxes  
Wire nuts  
Stripping tools  
Wire  
Module Examination\*  
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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Trainees may work with device boxes. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety.

## Additional Resources

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

*American Electrician's Handbook*, Latest Edition. New York: Croft and Summers, McGraw-Hill.

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

## Teaching Time for this Module

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

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to Device Boxes</b>                                                                                                                                                                                        |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Types of Boxes                                                                                                                                                                                                                     | _____        |
| <b>Session II. Sizing Outlet Boxes</b>                                                                                                                                                                                                |              |
| A. Sizing Outlet Boxes                                                                                                                                                                                                                | _____        |
| B. PT/Laboratory<br>Have trainees practice identifying the appropriate type and size of box for a given application. This laboratory corresponds to Performance Task 1.                                                               | _____        |
| C. Pull and Junction Boxes                                                                                                                                                                                                            | _____        |
| D. PT/Laboratory<br>Have trainees practice selecting the minimum size pull or junction box. This laboratory corresponds to Performance Task 2.                                                                                        | _____        |
| <b>Session III. Installing Boxes</b>                                                                                                                                                                                                  |              |
| A. NEC® Requirements                                                                                                                                                                                                                  | _____        |
| B. Making Connections                                                                                                                                                                                                                 | _____        |
| <b>Session IV. Review and Testing</b>                                                                                                                                                                                                 |              |
| A. Module Review                                                                                                                                                                                                                      | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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 introduces trainees to the methods and procedures used in cutting, bending, and reaming conduit.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 through 26106-14.

## Objectives

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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. Determine conduit bends.
3. Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
4. Cut, ream, and thread conduit.

## Performance Tasks

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

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

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Appropriate personal protective equipment  
Copy of the latest edition of the *National Electrical Code*®  
*OSHA Electrical Safety Guidelines* (pocket edition)  
Hand bender and manufacturer's instructions  
Various pieces of conduit  
Hickey bar  
Manufacturers' gain tables

No. 10 or No. 12 solid wire  
Tape measure  
Calculator  
Hacksaw  
Pipe vise  
Pipe cutter  
Reamer  
Cutting oil  
Shop towels  
Hand-operated threader  
Sandbox or drip pan  
Torpedo level  
PVC pieces  
PVC cements  
Module Examination\*  
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

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

## Additional Resources

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

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

*National Electrical Code*<sup>®</sup> Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

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

## Teaching Time for this Module

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

| Topic                                                                                                                                  | Planned Time |
|----------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to Hand Bending</b>                                                                                         |              |
| A. Introduction                                                                                                                        | _____        |
| B. Hand Bending Equipment                                                                                                              | _____        |
| C. Geometry Required to Make a Bend                                                                                                    | _____        |
| D. Making a 90° Bend                                                                                                                   | _____        |
| E. PT/Laboratory<br>Have trainees practice making 90° bends. This laboratory corresponds to Performance Task 1.                        | _____        |
| F. Back-to-Back Bends                                                                                                                  | _____        |
| G. PT/Laboratory<br>Have trainees practice making back-to-back bends. This laboratory corresponds to Performance Task 1.               | _____        |
| <b>Session II. Offset and Saddle Bends</b>                                                                                             |              |
| A. Making an Offset                                                                                                                    | _____        |
| B. Parallel Offsets                                                                                                                    | _____        |
| C. PT/Laboratory<br>Have trainees practice making offset bends. This laboratory corresponds to Performance Task 1.                     | _____        |
| D. Saddle Bends                                                                                                                        | _____        |
| E. PT/Laboratory<br>Have trainees practice making saddle bends. This laboratory corresponds to Performance Task 1.                     | _____        |
| <b>Session III. Joining Conduit</b>                                                                                                    |              |
| A. Cutting, Reaming, and Threading Conduit                                                                                             | _____        |
| B. PT/Laboratory<br>Have 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% 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.

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## Module Overview

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This module introduces types and applications of raceways, wireways, and ducts. It stresses the appropriate *NEC*<sup>®</sup> requirements.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 through 26107-14.

## Objectives

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

1. Identify and select various types and sizes of raceways and fittings for a given application.
2. Identify various methods used to fabricate (join) and install raceway systems.
3. Identify uses permitted for selected raceways.
4. Demonstrate how to install a flexible raceway system.
5. Terminate a selected raceway system.
6. Identify the appropriate conduit body for a given application.

## Performance Tasks

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

1. Identify and select various types and sizes of raceways, fittings, and fasteners for a given application.
2. Demonstrate how to install a flexible raceway system.
3. Terminate a selected raceway system.
4. Identify the appropriate conduit body for a given application.

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Appropriate personal protective equipment  
Copy of the latest edition of the *National Electrical Code*<sup>®</sup>  
*OSHA Electrical Safety Guidelines* (pocket edition)  
Concrete, masonry, and wood for fastener application  
Assorted hand tools (wrenches, screwdrivers, hammers)  
Drills/drivers and assorted drill bits  
Hammer-driven tools and related pin and stud fasteners  
Powder-actuated tool, powder charges, and related pin and stud fasteners

Sample sections and fittings for the following types of conduit:  
EMT  
RMC  
Plastic-coated RMC  
Aluminum  
Rigid black  
IMC  
EB ans DB RNC  
LFNC  
Flexible metal  
Various conduit couplings  
Combination couplings  
Type C, Type L, Type T, and Type X conduit bodies  
Various types of bushings  
Insulated bushings  
Threaded waterproof hubs  
Offset nipples  
Sample loads

*continued*

Assorted threaded fasteners, including:

- Bolts
- Cap screws
- Studs
- Machine screws
- Nuts
- Washers
- Special threaded fasteners

Tie wraps

Assorted special threaded fasteners

Assorted screws, including:

- Wood screws
- Lag screws and shields
- Concrete/masonry screws
- Thread-forming (sheet metal) and thread-cutting screws
- Deck screws
- Drywall screws

Assorted mechanical anchors and assorted anchor fastening tools, including:

- Wedge
- Stud
- Sleeve
- One-piece
- Hammer-driven
- Drop-in
- Expansion shields
- Lead (caulk-in)
- Screw (fiber, lead, plastic)
- Self-drilling

Toggle bolts

Sleeve-type

Wallboard

Metal drive-in

Metal boxes

Nonmetallic boxes

Bushings and locknuts

Seal fittings and packing material

Liquid sealing compound

Various straps

Standoff support

Access to job site where trainees can observe a variety of wireway components, including:

- Connectors

- End plates

- Closing plates

- Tee fittings

- Crosses

- Elbows

- Nipples

- Slip fittings

Access to job site where trainees can observe a variety of cable tray support systems, including:

- Direct rod

- Trapeze mounting

- Center hung support

- Wall mounting

- Pipe rack mounting

Module Examination\*

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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to install and terminate raceway systems. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize hand tool, power tool, and electrical safety.

## Additional Resources

---

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

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

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

## Teaching Time for this Module

---

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

| Topic                                                                                                                    | Planned Time |
|--------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to Raceways and Conduit</b>                                                                   |              |
| A. Introduction                                                                                                          | _____        |
| B. Raceways                                                                                                              | _____        |
| C. Conduit                                                                                                               | _____        |
| <b>Sessions II and III. Metal Conduit</b>                                                                                |              |
| A. Metal Conduit Fittings                                                                                                | _____        |
| B. PT/Laboratory                                                                                                         | _____        |
| Have trainees practice identifying conduit bodies. This laboratory corresponds to Performance Task 4.                    |              |
| C. Making a Conduit-to-Box Connection                                                                                    | _____        |
| D. PT/Laboratory                                                                                                         | _____        |
| Have trainees practice terminating conduit. This laboratory corresponds to Performance Task 3.                           |              |
| <b>Session IV. Fittings, Fasteners, and Supports</b>                                                                     |              |
| A. Seal Fittings                                                                                                         | _____        |
| B. Fasteners and Anchors                                                                                                 | _____        |
| C. Raceway Supports                                                                                                      | _____        |
| D. PT/Laboratory                                                                                                         | _____        |
| Have trainees practice identifying raceways, fittings, and fasteners. This laboratory corresponds to Performance Task 1. |              |
| <b>Session V. Wireways and Cable Trays</b>                                                                               |              |
| A. Wireways                                                                                                              | _____        |
| B. Cable Trays                                                                                                           | _____        |
| C. Storing Raceways                                                                                                      | _____        |
| D. Handling Raceways                                                                                                     | _____        |
| E. Ducting                                                                                                               | _____        |
| <b>Sessions VI and VII. Construction Methods</b>                                                                         |              |
| A. Construction Methods                                                                                                  | _____        |
| B. PT/Laboratory                                                                                                         | _____        |
| Have trainees practice installing a flexible raceway system. This laboratory corresponds to Performance Task 2.          |              |

**Topic**

**Planned Time**

**Session VIII. Review and Testing**

A. Review

\_\_\_\_\_

B. Module Examination

\_\_\_\_\_

1. Trainees must score 70% 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

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This module focuses on the types and applications of conductors and covers proper wiring techniques. It also stresses the appropriate *NEC*<sup>®</sup> requirements.

### Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 through 26108-14.

### Objectives

---

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

1. From the cable markings, describe the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, and permitted uses.
2. Determine the allowable ampacity of a conductor for a given application.
3. Identify the *NEC*<sup>®</sup> requirements for color coding of conductors.
4. Install conductors in a raceway system.

### Performance Task

---

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

1. Install conductors in a raceway system.

### Materials and Equipment

---

Multimedia projector and screen  
*Electrical Level One* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Appropriate personal protective equipment  
Copy of the latest edition of the *National Electrical Code*<sup>®</sup>  
Electrician's hand tools  
Access to a conduit run  
Reel cart  
Pull lines  
Instrument control wiring  
Power fishing system  
Variety of solid wire conductors  
Samples of stranded conductors

Samples of cable, including:  
Type NM  
Type NMC  
Type SE  
Type UF  
Type NMS  
Type MV  
High-voltage shielded  
Type MC  
Type FC  
Type FCC  
Type TC  
Type USE  
Basket grip  
Wire grip  
Manual wire puller  
Power puller  
Module Examination\*  
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. This module requires trainees to install conductors. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize hand tool, power tool, and electrical safety.

## Additional Resources

---

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

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

## Teaching Time for this Module

---

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

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to Conductors</b>                                                                                                                                                                                          |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Wire Size                                                                                                                                                                                                                          | _____        |
| C. Ampacity                                                                                                                                                                                                                           | _____        |
| D. Conductor Material                                                                                                                                                                                                                 | _____        |
| E. Conductor Insulation                                                                                                                                                                                                               | _____        |
| <b>Session II. Specialty Conductors</b>                                                                                                                                                                                               |              |
| A. Fixture Wires                                                                                                                                                                                                                      | _____        |
| B. Cables                                                                                                                                                                                                                             | _____        |
| C. Instrumentation and Control Wiring                                                                                                                                                                                                 | _____        |
| <b>Session III. Installing Conductors in Conduit Systems</b>                                                                                                                                                                          |              |
| A. Pulling Equipment                                                                                                                                                                                                                  | _____        |
| B. Safety                                                                                                                                                                                                                             | _____        |
| C. Feeding Conductors into Conduit                                                                                                                                                                                                    | _____        |
| D. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice installing conductors in a raceway system. This laboratory corresponds to Performance Task 1.                                                                                                                  |              |
| E. Terminating Conductors                                                                                                                                                                                                             | _____        |
| <b>Session IV. Review and Testing</b>                                                                                                                                                                                                 |              |
| A. Review                                                                                                                                                                                                                             | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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

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This module describes the types and uses of construction drawings. It provides information about the format and content of basic electrical construction drawings and their use in conveying specific construction requirements. It describes the standard format for specifications.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; and *Electrical Level One*, Modules 26101-14 through 26109-14.

## Objectives

---

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

1. Explain the basic layout of a set of construction drawings.
2. Describe the information included in the title block of a construction drawing.
3. Identify the types of lines used on construction drawings.
4. Using an architect's scale, state the actual dimensions of a given drawing component.
5. Interpret electrical drawings, including site plans, floor plans, and detail drawings.
6. Interpret equipment schedules found on electrical drawings.
7. Describe the type of information included in electrical specifications.

## Performance Tasks

---

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

1. Using an architect's scale, state the actual dimensions of a given drawing component.
2. Make a materials takeoff of the lighting fixtures specified in Performance Profile Sheet 2 using the drawing provided on Performance Profile Sheet 3. The takeoff requires that all lighting fixtures be counted, and where applicable, the total number of lamps for each fixture type must be calculated.

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One*  
PowerPoint® Presentation Slides  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Appropriate personal protective equipment

Copy of the latest edition of the *National Electrical Code*®  
Set of electrical drawings  
Architect's scales (both flat and triangular)  
Engineer's scale  
Module Examination\*  
Performance Profile Sheet\*

\* 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. This module may require trainees to visit job sites. Make sure that all trainees are briefed on site safety procedures.

## Additional Resources

---

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

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

## Teaching Time for This Module

---

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Basic Electrical Construction Drawings*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; The Drawing Set</b>                                                                                                                                                                                       |              |
| A. Introduction to Construction Drawings                                                                                                                                                                                              | _____        |
| B. Drawing Layout                                                                                                                                                                                                                     | _____        |
| C. Drafting Lines                                                                                                                                                                                                                     | _____        |
| D. Electrical Symbols                                                                                                                                                                                                                 | _____        |
| E. Scale Drawings                                                                                                                                                                                                                     | _____        |
| F. PT/Laboratory<br>Have trainees practice using an architect's scale. This laboratory corresponds to Performance Task 1.                                                                                                             | _____        |
| <b>Session II. Analyzing Drawings</b>                                                                                                                                                                                                 |              |
| A. Analyzing Electrical Drawings                                                                                                                                                                                                      | _____        |
| B. Power Plans                                                                                                                                                                                                                        | _____        |
| C. Lighting Floor Plan                                                                                                                                                                                                                | _____        |
| D. PT/Laboratory<br>Have trainees practice preparing a materials takeoff. This laboratory corresponds to Performance Task 2.                                                                                                          | _____        |
| E. Electrical Details and Diagrams                                                                                                                                                                                                    | _____        |
| <b>Session III. Specifications; Review and Testing</b>                                                                                                                                                                                |              |
| A. Written Specifications                                                                                                                                                                                                             | _____        |
| B. Review                                                                                                                                                                                                                             | _____        |
| C. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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.                                                                                                                    |              |
| 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 Training Report Form 200, and submit the results to the Training Program Sponsor.                                                                                                                    |              |



## Module Overview

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This module introduces trainees to the various types of devices and installation procedures used in residential wiring. It also covers service-entrance and branch circuit calculations and *National Electrical Code*® requirements.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; and *Electrical Level One*, Modules 26101-14 through 26110-14.

## Objectives

---

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

1. Explain the role of the *National Electrical Code*® in residential wiring and describe how to determine electric service requirements for dwellings.
2. Explain the grounding requirements of a residential electric service.
3. Calculate and select service-entrance equipment.
4. Select the proper wiring methods for various types of residences.
5. Compute branch circuit loads and explain their installation requirements.
6. Explain the types and purposes of equipment grounding conductors.
7. Explain the purpose of ground fault circuit interrupters and tell where they must be installed.
8. Size outlet boxes and select the proper type for different wiring methods.
9. Describe rules for installing electric space heating and HVAC equipment.
10. Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs.
11. Explain how wiring devices are selected and installed.
12. Describe the installation and control of lighting fixtures.

## Performance Tasks

---

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

1. For a residential dwelling of a given size, and equipped with a given list of major appliances, demonstrate or explain how to:
  - Compute lighting, small appliance, and laundry loads.
  - Compute the loads for large appliances.
  - Determine the number of branch circuits required.
  - Size and select the service-entrance equipment (conductors, panelboard, and protective devices).
2. Using an unlabeled diagram of a panelboard (Performance Profile Sheet 3), label the lettered components.
3. Select the proper type and size outlet box needed for a given set of wiring conditions.

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One* PowerPoint®  
Presentation Slides  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Appropriate personal protective equipment

Copy of the latest edition of the *National Electrical Code*®  
Calculator  
Residential floor plan  
Blank worksheet for general lighting loads  
Various types of GFCIs  
Panelboard

(continued)

Examples of cable, including:

- Type NM
- Type AC
- Type UF
- Type SE/USE

Examples of raceways, including:

- Rigid
- IMC
- EMT
- Flexible
- PVC

Various grounding devices

Examples of made-type grounding electrodes

- Assortment of metallic and plastic outlet boxes
- Assorted types of electrical receptacles
- Assortment of switches, including:

- Single-pole
- Three-way
- Four-way
- Photoelectric switches
- Dimmer

- Relays
- Module Examination\*
- Performance Profile Sheet\*

\* 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. This module may require trainees to visit job sites. Make sure that all trainees are briefed on site safety procedures.

## Additional Resources

---

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

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

## Teaching Time for this Module

---

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

| Topic                                                                                                                 | Planned Time |
|-----------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Sessions I and II. Introduction; Sizing Electrical Service</b>                                                     |              |
| A. Introduction                                                                                                       | _____        |
| B. Sizing Electrical Service                                                                                          | _____        |
| C. Sizing Residential Neutral Conductors                                                                              | _____        |
| D. Sizing the Load Center                                                                                             | _____        |
| E. PT/Laboratory                                                                                                      | _____        |
| Have trainees practice computing various branch loads. This laboratory corresponds to Performance Task 1.             |              |
| <b>Session III. Grounding</b>                                                                                         |              |
| A. Grounding Electrical Services                                                                                      | _____        |
| B. Main Bonding Jumper                                                                                                | _____        |
| C. PT/Laboratory                                                                                                      | _____        |
| Have trainees practice identifying the components of a panelboard. This laboratory corresponds to Performance Task 2. |              |

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session IV. Installation, Part One</b>                                                                                                                                                                                             |              |
| A. Installing the Service Entrance                                                                                                                                                                                                    | _____        |
| B. Panelboard Location                                                                                                                                                                                                                | _____        |
| C. Wiring Methods                                                                                                                                                                                                                     | _____        |
| D. Equipment Grounding System                                                                                                                                                                                                         | _____        |
| E. Branch Circuit Layout for Power                                                                                                                                                                                                    | _____        |
| <b>Session V. Installation, Part Two</b>                                                                                                                                                                                              |              |
| A. Branch Circuit Layout for Lighting                                                                                                                                                                                                 | _____        |
| B. Outlet Boxes                                                                                                                                                                                                                       | _____        |
| C. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice selecting the proper type and size outlet box needed for a given set of wiring conditions. This laboratory corresponds to Performance Task 3.                                                                  |              |
| D. Wiring Devices                                                                                                                                                                                                                     | _____        |
| E. Lighting Control                                                                                                                                                                                                                   | _____        |
| <b>Session VI. Electric Heating; Pools; Review and Testing</b>                                                                                                                                                                        |              |
| A. Electric Heating                                                                                                                                                                                                                   | _____        |
| B. Residential Swimming Pools, Spas, and Hot Tubs                                                                                                                                                                                     | _____        |
| C. Review                                                                                                                                                                                                                             | _____        |
| D. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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.                                                                                                                    |              |
| E. Performance Testing                                                                                                                                                                                                                | _____        |
| 1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements. |              |
| 2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.                                                                                                                    |              |

## Module Overview

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This module introduces the trainee to electrical test equipment. It explains the purpose and use of voltmeters, ohmmeters, clamp-on ammeters, multimeters, megohmmeters, and motor and phase rotation testers. It also covers basic safety and explains category ratings.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*, Modules 26101-14 through 26111-14.

## Objectives

---

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

1. Explain the operations of and describe the following pieces of test equipment:
  - Voltmeter
  - Ohmmeter
  - Clamp-on ammeter
  - Multimeter
  - Megohmmeter
  - Motor and phase rotation testers
2. Select the appropriate meter for a given work environment based on category ratings.
3. Identify the safety hazards associated with the various types of test equipment.

## Performance Tasks

---

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

1. Under instructor supervision, measure the voltage in your classroom from line to neutral and neutral to ground.
2. Under instructor supervision, use an ohmmeter to measure the value of various resistors.

## Materials and Equipment

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Multimedia projector and screen  
*Electrical Level One*  
PowerPoint® Presentation Slides  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Appropriate personal protective equipment  
Analog meter  
Continuity tester  
Resistors  
Copy of the latest edition of the *National Electrical Code*®

Examples of the following test instruments with their operator's manuals:  
Voltmeter  
Voltage tester  
Ohmmeter  
Clamp-on ammeter  
Multimeter  
Megohmmeter  
Motor and phase rotation testers  
Safety video/DVD (*optional*)  
TV/Video/DVD player (*optional*)  
Module Examination\*  
Performance Profile Sheet\*

\* 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. This module requires trainees to work with electrical test equipment. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical safety.

## Additional Resources

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

*ABCs of Multimeter Safety*, Everett, WA: Fluke Corporation.

*ABCs of DMMs, Multimeter Features and Functions Explained*, Everett, WA: Fluke Corporation.

*Clamp Meter ABCs*, Everett, WA: Fluke Corporation.

*Electronics Fundamentals: Circuits, Devices, and Applications*, Thomas L. Floyd. New York: Prentice Hall.

*Power Quality Analyzer Uses for Electricians*, Everett, WA: Fluke Corporation.

*Principles of Electric Circuits*, Thomas L. Floyd. New York: Prentice Hall.

## Teaching Time for this Module

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

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Electrical Test Equipment</b>                                                                                                                                                                             |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Voltmeter                                                                                                                                                                                                                          | _____        |
| C. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice measuring voltage. This laboratory corresponds to Performance Task 1.                                                                                                                                          |              |
| D. Ohmmeter                                                                                                                                                                                                                           | _____        |
| E. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice using an ohmmeter. This laboratory corresponds to Performance Task 2.                                                                                                                                          |              |
| F. Ammeter and Multimeter                                                                                                                                                                                                             | _____        |
| G. Megohmmeter and Other Instruments                                                                                                                                                                                                  | _____        |
| H. Category Ratings and Safety                                                                                                                                                                                                        | _____        |
| I. Review                                                                                                                                                                                                                             | _____        |
| J. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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.                                                                                                                    |              |
| K. 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 introduces the principles of alternating current.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum* and *Electrical Level One*.

## Objectives

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

1. Calculate the peak and effective voltage or current values for an AC waveform.
2. Calculate the phase relationship between two AC waveforms.
3. Describe the voltage and current phase relationship in a resistive AC circuit.
4. Describe the voltage and current transients that occur in an inductive circuit.
5. Define inductive reactance and state how it is affected by frequency.
6. Describe the voltage and current transients that occur in a capacitive circuit.
7. Define capacitive reactance and state how it is affected by frequency.
8. Explain the relationship between voltage and current in the following types of AC circuits:
  - RL circuit
  - RC circuit
  - LC circuit
  - RLC circuit
9. Explain the following terms as they relate to AC circuits:
  - True power
  - Apparent power
  - Reactive power
  - Power factor
10. Explain basic transformer action.

## Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment

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|                                                                                                              |                                               |
|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| <i>Electrical Level Two</i> PowerPoint® Presentation                                                         | Markers/chalk                                 |
| Slides can be downloaded (with your access code) from <a href="http://www.nccerirc.com">www.nccerirc.com</a> | Pencils and scratch paper                     |
| Multimedia projector and screen                                                                              | Scientific calculator or trigonometric tables |
| Computer                                                                                                     | Examples of capacitors                        |
| Appropriate personal protective equipment                                                                    | Examples of transformers                      |
| Whiteboard/chalkboard                                                                                        | Module Examination*                           |

\* 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.

## Additional Resources

---

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

*Introduction to Electric Circuits and Machines*, 1992. New York: Prentice-Hall.  
*Principles of DC/AC Circuits*, 1998. New York: Prentice-Hall.

## Teaching Time for this Module

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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 *Alternating Current*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Sine Wave Generation and Terminology</b>                                               |              |
| A. Introduction                                                                                                    | _____        |
| B. Sine Wave Generation                                                                                            | _____        |
| C. Sine Wave Terminology                                                                                           | _____        |
| <b>Session II. AC Phase Relationships</b>                                                                          |              |
| A. AC Phase Relationships                                                                                          | _____        |
| B. Nonsinusoidal Waveforms                                                                                         | _____        |
| <b>Session III. AC Circuits, Part One</b>                                                                          |              |
| A. Resistance in AC Circuits                                                                                       | _____        |
| B. Inductance in AC Circuits                                                                                       | _____        |
| <b>Session IV. Capacitance</b>                                                                                     |              |
| A. Capacitance                                                                                                     | _____        |
| B. Calculating Equivalent Capacitance                                                                              | _____        |
| C. Capacitor Specifications                                                                                        | _____        |
| D. Voltage and Current in a Capacitive AC Circuit                                                                  | _____        |
| E. Capacitive Resistance                                                                                           | _____        |
| <b>Session V. AC Circuits, Part Two</b>                                                                            |              |
| A. LC and RLC Circuits                                                                                             | _____        |
| B. Power in AC Circuits                                                                                            | _____        |
| <b>Session VI. Transformers</b>                                                                                    |              |
| A. Transformer Construction                                                                                        | _____        |
| B. Operating Characteristics                                                                                       | _____        |
| C. Turns and Voltage Ratio                                                                                         | _____        |
| D. Types of Transformers                                                                                           | _____        |
| <b>Session VII. Review and Testing</b>                                                                             |              |
| A. Review                                                                                                          | _____        |
| B. Module Examination                                                                                              | _____        |
| 1. Trainees must score 70% 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. |              |

### Module Overview

This module introduces the operation and applications of various types of motors. It also explains how motors are rated and covers motor enclosures and braking requirements.

### Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *Electrical Level One*; and *Electrical Level Two*, Module 26201-14.

### 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*<sup>®</sup> (*NEC*<sup>®</sup>).
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

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Electrical Level Two PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
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  
Momentary contact, normally open push-button switch  
Quick Quiz\*  
Module Examination\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\* 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. 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 presents thorough resources for task training. The following resource material is suggested for further study.

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

## Teaching Time for this Module

---

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

| Topic                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Sessions I through III. Introduction to Motors; Types of Motors</b>                                                                |              |
| A. Introduction                                                                                                                       | _____        |
| B. DC Motor Principles                                                                                                                | _____        |
| C. Types of DC Motors                                                                                                                 | _____        |
| D. Alternating Current Motors                                                                                                         | _____        |
| E. Multi-Speed Induction Motors                                                                                                       | _____        |
| F. Variable-Speed Drives                                                                                                              | _____        |
| G. PT/Laboratory                                                                                                                      | _____        |
| Have trainees practice identifying various types of motors and their applications. This laboratory corresponds to Performance Task 2. |              |

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Sessions IV and V. Motor Enclosures; Frame Designations; Ratings; Nameplate Data</b>                                                                                                                                               |              |
| A. Motor Enclosures                                                                                                                                                                                                                   | _____        |
| B. NEMA Frame Designations                                                                                                                                                                                                            | _____        |
| C. Motor Ratings and Nameplate Data                                                                                                                                                                                                   | _____        |
| D. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice collecting data from motor nameplates. This laboratory corresponds to Performance Task 1.                                                                                                                      |              |
| <b>Sessions VI and VII. Motor Connections; Motor Installation</b>                                                                                                                                                                     |              |
| A. Connections and Terminal Markings for AC motors                                                                                                                                                                                    | _____        |
| B. NEC® Requirements                                                                                                                                                                                                                  | _____        |
| C. Braking                                                                                                                                                                                                                            | _____        |
| D. Motor Installation                                                                                                                                                                                                                 | _____        |
| E. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice connecting the terminals for a dual-voltage motor. This laboratory corresponds to Performance Task 3.                                                                                                          |              |
| <b>Session VIII. Review and Testing</b>                                                                                                                                                                                               |              |
| A. Module Review                                                                                                                                                                                                                      | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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

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

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *Electrical Level One*; and *Electrical Level Two*, Modules 26201-14 and 26202-14.

## 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

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*Electrical Level Two* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Prism  
Copy of the latest edition of the *National Electrical Code*®  
Examples of manufacturers' lighting and fixture catalogs  
Examples of manufacturers' lighting fixture installation instructions  
Examples of typical lighting plans and lighting fixtures schedule  
Assortment of wire nuts  
Electrical tape  
Electrician's toolbox  
Occupancy sensors and photosensors  
Timers

Assortment of electric lamps, including:  
Incandescent  
Halogen  
Fluorescent  
High-intensity discharge (HID)  
Assortment of lighting fixtures, including:  
Surface-mounted  
Recessed  
Suspended  
Track-mounted  
Ceiling fans/fixtures  
Assortment of electrical boxes, mounting hardware, and support hardware used to install different types of lighting fixtures  
Assortment of track lighting components and accessories  
Hangers and supports used with suspended lighting fixtures  
Structure for installing surface-mounted and recessed fixtures  
Quick Quiz\*  
Module Examination\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\* 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. 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 presents thorough resources for task training. The following resource material is suggested for further study.

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

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

## Teaching Time for this Module

---

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

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Sessions I and II. Introduction to Lighting</b>                                                                                                                                                                                    |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Human Vision                                                                                                                                                                                                                       | _____        |
| C. Light Characteristics                                                                                                                                                                                                              | _____        |
| D. Lamps                                                                                                                                                                                                                              | _____        |
| E. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees read and interpret information given in lamp manufacturers' catalogs for one or more selected lamps. This laboratory corresponds to Performance Task 1.                                                                 |              |
| F. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice selecting and installing lamps in lighting fixtures. This laboratory corresponds to Performance Task 2.                                                                                                        |              |
| <b>Session III. Ballasts; Lighting Fixtures</b>                                                                                                                                                                                       |              |
| A. Ballasts                                                                                                                                                                                                                           | _____        |
| B. Lighting Fixtures                                                                                                                                                                                                                  | _____        |
| <b>Sessions IV and V. Lighting Fixture Installation</b>                                                                                                                                                                               |              |
| A. Surface-Mounted Lighting Fixtures                                                                                                                                                                                                  | _____        |
| B. Recessed Lighting Fixtures                                                                                                                                                                                                         | _____        |
| C. Suspended Lighting Fixtures                                                                                                                                                                                                        | _____        |
| D. Track Lighting Fixtures                                                                                                                                                                                                            | _____        |
| E. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice installing lighting fixtures and their associated lamps. This laboratory corresponds to Performance Task 3.                                                                                                    |              |
| F. Controls for Lighting                                                                                                                                                                                                              | _____        |
| G. Energy Management Systems                                                                                                                                                                                                          | _____        |
| <b>Session VI. Review and Testing</b>                                                                                                                                                                                                 |              |
| A. Module Review                                                                                                                                                                                                                      | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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 introduces the methods and procedures used in conduit bending.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; and Electrical Level Two*, Modules 26201-14 through 26203-14. It is also suggested that trainees be familiar with *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" nor 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

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*Electrical Level Two* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Copy of the latest edition of the *NEC®*  
Hand bender and manufacturer's instructions  
Lengths of ¾", 1", and 2" rigid, EMT, and IMC conduit  
Lengths of PVC conduit  
Lengths of 8" pipe  
10" sample obstructions  
Bending charts to match mechanical, electrical, and hydraulic benders  
PVC solvent cements and MSDSs  
End plugs for PVC conduit  
Pipe reamer  
Shop towels

Brushes  
Felt-tip markers  
Portable mechanical conduit benders  
Magnetic torpedo level  
EMT bending tools  
Conduit bending gauge and protractor  
Hickey bar  
Tape measure  
Straightedge  
Conduit leveling tools  
PVC heater  
Scientific calculator  
Hacksaw  
Pipe vise  
Pipe cutter  
Cutting oil  
Examples of elbows, offsets, saddles, and kicks  
Magnetic angle finder  
Bending table  
Quick Quizzes\*  
Module Examinations\*\*  
Performance Profile Sheet\*\*

\* Located at the back of this module.

\*\* 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. This module requires trainees to bend conduit. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize hand tool and hydraulic safety.

## Additional Resources

---

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

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

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

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

## Teaching Time for This Module

---

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

| Topic                                                                                                 | Planned Time |
|-------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to Conduit Bending</b>                                                     |              |
| A. Introduction                                                                                       | _____        |
| B. NEC® Requirements                                                                                  | _____        |
| C. Types of Bends                                                                                     | _____        |
| D. The Geometry of Bending Conduit                                                                    | _____        |
| <b>Session II. Mechanical Bending</b>                                                                 |              |
| A. Mechanical Benders                                                                                 | _____        |
| B. Mechanical Stub-Ups                                                                                | _____        |
| C. Mechanical Offsets                                                                                 | _____        |
| <b>Session III. Electric Conduit Benders; Hydraulic Conduit Benders</b>                               |              |
| A. Electric Conduit Benders                                                                           | _____        |
| B. Hydraulic Conduit Benders                                                                          | _____        |
| <b>Sessions IV and V. Bending Techniques</b>                                                          |              |
| A. Segment Bending Techniques                                                                         | _____        |
| B. Tricks of the Trade                                                                                | _____        |
| C. PT/Laboratory                                                                                      | _____        |
| Have trainees practice bending conduit. This laboratory corresponds to Performance Tasks 1 through 3. |              |
| D. PVC Conduit Installations                                                                          | _____        |
| E. Bending PVC Conduit                                                                                | _____        |

**Topic**

**Planned Time**

**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 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 introduces the trainees to the methods and procedures used in the selection and installation of pull and junction boxes.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; and Electrical Level Two*, Modules 26201-14 through 26204-14.

## Objectives

---

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

1. Describe the different types of nonmetallic and metallic pull and junction boxes.
2. Properly select, install, and support pull and junction boxes and their associated fittings.
3. Describe the *National Electrical Code*<sup>®</sup> (NEC<sup>®</sup>) regulations governing pull and junction boxes.
4. Size pull and junction boxes for various applications.
5. Understand the NEMA and IP classifications for pull and junction boxes.
6. Describe the purpose of conduit bodies and Type FS boxes.

## Performance Tasks

---

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

1. Identify various NEMA boxes.
2. Properly select, install, and support pull and junction boxes over 100 cubic inches in size.
3. Identify various conduit bodies and fittings.

## Materials and Equipment

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*Electrical Level Two* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)

Multimedia projector and screen

Computer

Appropriate personal protective equipment

Whiteboard/chalkboard

Markers/chalk

Pencils and scratch paper

Copy of the latest edition of the *National Electrical Code*<sup>®</sup>

Index cards

Seal fittings

Handholes

Examples of pull and junction boxes

Examples of FS and FD boxes

Examples of different types of conduit bodies, pulling elbows, SLBs, and moguls

Examples of different types of boxes used in hazardous locations

Examples of fittings, including:

EMT

Rigid

Aluminum

IMC

Locknuts and bushings

Quick Quiz\*

Module Examinations\*\*

Performance Profile Sheet\*\*

\* Located at the back of this module.

\*\* 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

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

## Additional Resources

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

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

## Teaching Time for this Module

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

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction to Pull and Junction Boxes</b>                                                                                                                                                                             |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Boxes for Damp and Wet Locations                                                                                                                                                                                                   | _____        |
| C. NEMA and IP Enclosure Classifications                                                                                                                                                                                              | _____        |
| D. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice identifying various NEMA boxes. This laboratory corresponds to Performance Task 1.                                                                                                                             |              |
| E. Sizing Pull and Junction Boxes                                                                                                                                                                                                     | _____        |
| <b>Sessions II and III. Conduit Bodies and Fittings</b>                                                                                                                                                                               |              |
| A. Conduit Bodies                                                                                                                                                                                                                     | _____        |
| B. Handholes                                                                                                                                                                                                                          | _____        |
| C. Fittings                                                                                                                                                                                                                           | _____        |
| D. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice identifying various conduit bodies and fittings. This laboratory corresponds to Performance Task 3.                                                                                                            |              |
| <b>Sessions IV. Installing Pull and Junction Boxes</b>                                                                                                                                                                                |              |
| A. Installing Pull and Junction Boxes                                                                                                                                                                                                 | _____        |
| B. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice selecting, installing, and supporting pull and junction boxes. This laboratory corresponds to Performance Task 2.                                                                                              |              |
| <b>Session V. Review and Testing</b>                                                                                                                                                                                                  |              |
| A. Module Review                                                                                                                                                                                                                      | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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 introduces the tools, materials, and techniques used in conductor installations.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; and Electrical Level Two*, Modules 26201-14 through 26205-14.

## 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

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*Electrical Level Two* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Scientific calculator  
Copy of the latest edition of the *National Electrical Code*®  
Several lengths of cable from No. 12 through 4/0 AWG  
Wire lubricant  
Several types of pulling ropes  
Several different types and lengths of conductors

Measuring tape  
Setscrew cable grips  
Swivel rope clevis  
Basket 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  
Cable supports  
Manufacturers' catalogs for cable supports  
Cable manufacturers' literature  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheet\*\*

\* Located at the back of this module.

\*\* 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

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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

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

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

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

## Teaching Time for this Module

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

| Topic                                                                                                                                            | Planned Time |
|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Planning; Setting Up</b>                                                                                             |              |
| A. Introduction                                                                                                                                  | _____        |
| B. Planning the Installation                                                                                                                     | _____        |
| C. Setting Up for Wire Pulling                                                                                                                   | _____        |
| D. PT/Laboratory                                                                                                                                 | _____        |
| Have trainees practice preparing multiple conductors for pulling using a wire-pulling basket. This laboratory corresponds to Performance Task 2. |              |
| <b>Session II. Cable-Pulling Equipment; High-Force Cable Pulling</b>                                                                             |              |
| A. Cable-Pulling Equipment                                                                                                                       | _____        |
| B. High-Force Cable Pulling                                                                                                                      | _____        |
| C. Mechanical Offsets                                                                                                                            | _____        |
| <b>Session III. Supporting Conductors; Pulling Cable</b>                                                                                         |              |
| A. Supporting Conductors                                                                                                                         | _____        |
| B. Pulling Cable in Cable Trays                                                                                                                  | _____        |
| C. PT/Laboratory                                                                                                                                 | _____        |
| Have trainees practice preparing multiple conductors for pulling in a raceway system. This laboratory corresponds to Performance Task 1.         |              |
| D. Physical Limitations of Cable                                                                                                                 | _____        |
| E. Cable-Pulling Instruments                                                                                                                     | _____        |

**Topic**

**Planned Time**

**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 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 introduces the types of cable trays and their components, and focuses on the *NEC*<sup>®</sup> requirements for cable tray installations.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; and Electrical Level Two*, Modules 26201-14 through 26206-14.

## 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*<sup>®</sup> (*NEC*<sup>®</sup>) 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

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*Electrical Level Two* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Copy of the latest edition of the *National Electrical Code*<sup>®</sup>  
Cable tray components:  
Metal ladder tray  
Metal trough tray  
Solid bottom tray  
Tray covers  
Nonmetallic tray  
Examples of cable tray failures

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 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 at the back of this module.

\*\* 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. This module requires trainees to work with cable tray. Make sure that all trainees are briefed on appropriate safety procedures. Emphasize electrical and tool safety.

## Additional Resources

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

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

## Teaching Time for this Module

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

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

## Module Overview

This module introduces the methods and procedures used when making conductor terminations and splices.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; and Electrical Level Two*, Modules 26201-14 through 26207-14.

## Objectives

---

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

1. Describe how to make a good conductor termination.
2. Prepare cable ends for terminations and splices and connect using lugs or connectors.
3. Train cable at termination points.
4. Understand the *National Electrical Code® (NEC®)* requirements for making cable terminations and splices.
5. Demonstrate crimping techniques.
6. Select the proper lug or connector for the job.

## Performance Tasks

---

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

1. Terminate conductors using selected crimp-type and mechanical-type terminals and connectors.
2. Terminate conductors on a terminal strip.
3. Insulate selected types of wire splices and/or install a motor connection kit.

## Materials and Equipment

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*Electrical Level Two* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Copy of the latest edition of the *National Electrical Code®*  
Wire strippers  
Heavy-duty strippers  
Ratchet-type cable cutters  
Assorted sizes and types of wire and cable  
Crimp-type and mechanical compression connectors  
Heat-shrink insulators

Heat gun for shrink insulators  
Assorted sizes and types of wire nuts  
Hand crimping tools and dies  
Hydraulic crimping tools and dies  
Metal-clad cable  
Type MC cable connectors  
Ratchet cable bender  
Hydraulic cable bender  
Heat-shrink and roll-on insulating tapes  
Propane torch  
Torque wrenches  
Terminal blocks/strips  
Multimeter  
Test circuit  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheet\*\*

\* Located at the back of this module.

\*\* 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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to terminate 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 all trainees are properly briefed on site safety.

## Additional Resources

---

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

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

## Teaching Time for this Module

---

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 7½ hours are suggested to cover *Conductor Terminations and Splices*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

| Topic                                                                                                                                                 | Planned Time |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Stripping; Wire Connections Under 600V; Heat-Shrink Insulators</b>                                                        |              |
| A. Introduction                                                                                                                                       | _____        |
| B. Stripping and Cleaning Conductors                                                                                                                  | _____        |
| 1. Laboratory                                                                                                                                         | _____        |
| Have trainees practice stripping insulation from the ends of cables.                                                                                  |              |
| C. Wire Connections Under 600V                                                                                                                        | _____        |
| D. Heat-Shrink Insulators                                                                                                                             | _____        |
| D. PT/Laboratory                                                                                                                                      | _____        |
| Have trainees practice installing heat-shrink insulators. This laboratory corresponds to Performance Task 3.                                          |              |
| <b>Session II. Terminating Cable</b>                                                                                                                  |              |
| A. Control and Signal Cable                                                                                                                           | _____        |
| B. Low-Voltage Connectors and Terminals                                                                                                               | _____        |
| C. Guidelines for Installing Connectors                                                                                                               | _____        |
| D. PT/Laboratory                                                                                                                                      | _____        |
| Have trainees practice terminating conductors using crimpers and crimp-type mechanical connectors. This laboratory corresponds to Performance Task 1. |              |
| E. PT/Laboratory                                                                                                                                      | _____        |
| 1. Have trainees practice terminating connectors on a terminal strip. This laboratory corresponds to Performance Task 2.                              |              |
| F. Bending Cable and Training Conductors                                                                                                              | _____        |
| 1. Laboratory                                                                                                                                         | _____        |
| Have trainees practice using hydraulic and ratchet cable benders.                                                                                     |              |
| G. NEC® Termination Requirements                                                                                                                      | _____        |

**Session III. Taping Electrical Joints; Motor Connection Kits;  
Review and Testing**

A. Taping Electrical Joints

\_\_\_\_\_

B. Motor Connection Kits

\_\_\_\_\_

C. PT/Laboratory

\_\_\_\_\_

Have trainees practice insulating selected types of wire splices and/or installing a motor connection kit. This laboratory corresponds to Performance Task 3.

D. Module Review

\_\_\_\_\_

E. Module Examination

\_\_\_\_\_

1. Trainees must score 70% 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.

F. 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 introduces the *NEC*® requirements and procedures for proper grounding and bonding.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; and Electrical Level Two*, Modules 26201-14 through 26208-14.

## Objectives

---

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

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

## Performance Tasks

---

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

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

## Materials and Equipment

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|                                                                                                              |                                       |
|--------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <i>Electrical Level Two</i> PowerPoint® Presentation                                                         | No. 4 AWG bare copper grounding wire  |
| Slides can be downloaded (with your access code) from <a href="http://www.nccerirc.com">www.nccerirc.com</a> | Small main panelboard                 |
| Multimedia projector and screen                                                                              | Switch boxes                          |
| Computer                                                                                                     | Grounding clips, screws, and clamps   |
| Appropriate personal protective equipment                                                                    | Galvanized water pipe                 |
| Whiteboard/chalkboard                                                                                        | Various lengths of Type NM cable      |
| Markers/chalk                                                                                                | Wire strippers                        |
| Pencils and scratch paper                                                                                    | Earth ground resistance tester        |
| Copy of the latest edition of the <i>National Electrical Code</i> ®                                          | Quick Quiz*                           |
| <i>OSHA Electrical Safety Guidelines</i> (pocket guide)                                                      | Module Examinations**                 |
|                                                                                                              | Performance Profile Sheet**           |
|                                                                                                              | * Located at the back of this module. |

\*\* 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. 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

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

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

## Teaching Time for this Module

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

| Topic                                                   | Planned Time |
|---------------------------------------------------------|--------------|
| <b>Session I. Introduction to Grounding and Bonding</b> |              |
| A. Introduction                                         | _____        |
| B. Purpose of Grounding and Bonding                     | _____        |
| C. NEC® Requirements for Grounding and Bonding          | _____        |
| D. Short Circuit Versus Ground Fault                    | _____        |
| E. Types of Grounding Systems                           | _____        |

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session II. Grounding Equipment</b>                                                                                                                                                                                                |              |
| A. NEC® Requirements for Grounding Equipment                                                                                                                                                                                          | _____        |
| B. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice sizing grounding electrode conductors. This laboratory corresponds to Performance Task 3.                                                                                                                      |              |
| C. Equipment Grounding                                                                                                                                                                                                                | _____        |
| D. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice sizing and installing equipment grounding conductors. This laboratory corresponds to Performance Tasks 2 and 4.                                                                                                |              |
| <b>Session III.</b>                                                                                                                                                                                                                   |              |
| A. Bonding Service Equipment                                                                                                                                                                                                          | _____        |
| B. Effective Grounding Path                                                                                                                                                                                                           | _____        |
| C. Grounded Conductor                                                                                                                                                                                                                 | _____        |
| D. Separately Derived Systems                                                                                                                                                                                                         | _____        |
| E. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice sizing and installing bonding jumpers. This laboratory corresponds to Performance Tasks 1 and 5.                                                                                                               |              |
| <b>Session IV.</b>                                                                                                                                                                                                                    |              |
| A. Grounding at More Than One Building                                                                                                                                                                                                | _____        |
| B. Systems Over 1,000 Volts                                                                                                                                                                                                           | _____        |
| C. Testing for Effective Grounds                                                                                                                                                                                                      | _____        |
| D. Measuring the Earth's Resistance                                                                                                                                                                                                   | _____        |
| <b>Session V. Three-Point Testing</b>                                                                                                                                                                                                 |              |
| A. Three-Point Testing Procedure for Single Electrode or Triad                                                                                                                                                                        | _____        |
| B. Procedures                                                                                                                                                                                                                         | _____        |
| C. Electrode Arrangements                                                                                                                                                                                                             | _____        |
| D. Equipotential Grounding                                                                                                                                                                                                            | _____        |
| <b>Session VI. Review and Testing</b>                                                                                                                                                                                                 |              |
| A. Module Review                                                                                                                                                                                                                      | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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 introduces the methods and procedures used in the selection and installation of circuit breakers and fuses.

## Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *Electrical Level One*; and *Electrical Level Two*, Modules 26201-14 through 26209-14.

## 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*<sup>®</sup> (NEC<sup>®</sup>) 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

---

*Electrical Level Two* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Copy of the latest edition of the *National Electrical Code*<sup>®</sup>  
*OSHA Electrical Safety Guidelines* (pocket guide)  
Several blown renewable cartridge fuses with renewable links

Various types of GFCIs  
Samples of circuit breakers, including:  
Single-pole  
Two-pole  
Three-pole  
Samples of various types of fuses, including:  
Edison-base fuses  
Type S fuses and adapters  
Nonrenewable cartridge fuses  
Renewable cartridge fuses  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheet\*\*

\* Located at the back of this module.

\*\* 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. 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 presents thorough resources for task training. The following resource material is suggested for further study.

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

## Teaching Time for This Module

---

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Circuit Breakers and Fuses*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Circuit Breaker Ratings</b>                                                                                                                                                                               |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Circuit Breaker Ratings                                                                                                                                                                                                            | _____        |
| <b>Session II. Ground Fault Circuit Protection; Fuses</b>                                                                                                                                                                             |              |
| A. Ground Fault Current Circuit Protection                                                                                                                                                                                            | _____        |
| B. Fuses                                                                                                                                                                                                                              | _____        |
| C. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice identifying fuses and circuit breakers. This laboratory corresponds to Performance Task 1.                                                                                                                     |              |
| <b>Session III. Overcurrents; Sizing Fuses</b>                                                                                                                                                                                        |              |
| A. Overcurrents                                                                                                                                                                                                                       | _____        |
| B. Guide to Sizing Fuses                                                                                                                                                                                                              | _____        |
| <b>Session IV. Safety; Coordination</b>                                                                                                                                                                                               |              |
| A. Safety                                                                                                                                                                                                                             | _____        |
| B. Coordination                                                                                                                                                                                                                       | _____        |
| <b>Session V. Review and Testing</b>                                                                                                                                                                                                  |              |
| A. Module Review                                                                                                                                                                                                                      | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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 introduces the *NEC*<sup>®</sup> requirements and procedures used in the selection and installation of contactors and relays.

### Prerequisites

---

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; and Electrical Level Two*, Modules 26201-14 through 26210-14.

### 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*<sup>®</sup> 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 Task

---

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

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*Electrical Level Two* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Electrician's tool set

Copy of the latest edition of the *National Electrical Code*<sup>®</sup>  
120V lighting contactors  
Pushbutton stations  
Lampholders and lamps  
Cable for connecting contactors  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheet\*\*

\* Located at the back of this module.

\*\* 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. This module requires trainees to connect lighting controls. Make sure that all trainees are briefed on appropriate safety procedures. Stress the importance of following the proper safety precautions and procedures when installing various types of contactors and relays. This module may require that trainees visit job sites. Ensure that all trainees are properly briefed on site safety.



## Additional Resources

---

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

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

## Teaching Time for this Module

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

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Sessions I and II. Introduction; Magnetic Contactors</b>                                                                                                                                                                           |              |
| A. Introduction                                                                                                                                                                                                                       | _____        |
| B. Magnetic Contactors                                                                                                                                                                                                                | _____        |
| C. PT/Laboratory                                                                                                                                                                                                                      | _____        |
| Have trainees practice connecting lighting contactors. This laboratory corresponds to Performance Task 1.                                                                                                                             |              |
| <b>Session III. Relays</b>                                                                                                                                                                                                            |              |
| A. Relays                                                                                                                                                                                                                             | _____        |
| B. Solid-State Relays                                                                                                                                                                                                                 | _____        |
| C. Guidelines for Installing Connectors                                                                                                                                                                                               | _____        |
| D. Overload Relays                                                                                                                                                                                                                    | _____        |
| <b>Session IV. Protective Enclosures; Remote Control Switching</b>                                                                                                                                                                    |              |
| A. Protective Enclosures                                                                                                                                                                                                              | _____        |
| B. Low-Voltage Remote Control Switching                                                                                                                                                                                               | _____        |
| <b>Session V. Troubleshooting</b>                                                                                                                                                                                                     |              |
| A. Troubleshooting                                                                                                                                                                                                                    | _____        |
| <b>Session VI. Review and Testing</b>                                                                                                                                                                                                 |              |
| A. Module Review                                                                                                                                                                                                                      | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70% 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.                                                                                                                    |              |

# Load Calculations – Branch and Feeder Circuits

## Annotated Instructor’s Guide

Module 26301-14

### Module Overview

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This module introduces the load calculations and *National Electrical Code*® (NEC®) requirements for branch and feeder circuits.

### Prerequisites

---

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

### Objectives

---

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

1. Calculate loads for single-phase and three-phase branch circuits.
2. Size branch circuit overcurrent protection devices (circuit breakers and fuses) for noncontinuous duty and continuous duty circuits.
3. Apply derating factors to size branch circuits.
4. Calculate ampacity for single-phase and three-phase loads.
5. Use load calculations to determine branch circuit conductor sizes.
6. Use *NEC Table 220.55* to calculate residential cooking equipment loads.
7. Select branch circuit conductors and overcurrent protection devices for electric heat, air conditioning equipment, motors, and welders.

### Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

### Materials and Equipment

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*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard

Markers/chalk  
Pencils and paper  
Copy of the latest edition of the *National Electrical Code*®  
Calculator  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

### Safety Considerations

---

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

### Additional Resources

---

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

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

## Teaching Time for this Module

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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 *Load Calculations – Branch and Feeder Circuits*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                 | Planned Time |
|-------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Branch Circuit Ratings; Derating; Calculating Branch Circuit Ampacity</b> |              |
| A. Introduction                                                                                       | _____        |
| B. Branch Circuit Ratings                                                                             | _____        |
| C. Derating                                                                                           | _____        |
| 1. Temperature Derating                                                                               | _____        |
| 2. Voltage Drop Derating for Single-Phase Circuits                                                    | _____        |
| 3. Voltage Drop Derating for Three-Phase Circuits                                                     | _____        |
| D. Calculating Branch Circuit Ampacity                                                                | _____        |
| <b>Session II. Lighting Loads; Receptacle Loads; Multi-Outlet Assemblies</b>                          |              |
| A. Lighting Loads                                                                                     | _____        |
| 1. Recessed Lighting                                                                                  | _____        |
| 2. Heavy-Duty Lamp Holder Outlets                                                                     | _____        |
| B. Receptacle Loads                                                                                   | _____        |
| C. Multi-Outlet Assemblies                                                                            | _____        |
| <b>Session III. Show Window Loads; Sign Load</b>                                                      |              |
| A. Show Window Loads                                                                                  | _____        |
| B. Sign Load                                                                                          | _____        |
| <b>Session IV. Residential Branch Circuits; Commercial Kitchen Equipment</b>                          |              |
| A. Residential Branch Circuits                                                                        | _____        |
| 1. Small Appliance Load                                                                               | _____        |
| 2. Laundry Circuit                                                                                    | _____        |
| 3. Dryers                                                                                             | _____        |
| 4. Cooking Appliances                                                                                 | _____        |
| B. Commercial Kitchen Equipment                                                                       | _____        |
| <b>Session V. Water Heaters; Electric Heating Loads; Air Conditioning Loads</b>                       |              |
| A. Water Heaters                                                                                      | _____        |
| B. Electric Heating Loads                                                                             | _____        |
| C. Air Conditioning Loads                                                                             | _____        |
| <b>Session VI. Motor Loads; Welders</b>                                                               |              |
| A. Motor Loads                                                                                        | _____        |
| B. Welders                                                                                            | _____        |

**Topic**

**Planned Time**

**Session VII. 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 Training Report Form 200, and submit the results to the Training Program Sponsor.

# Conductor Selection and Calculations Module 26302-14 Annotated Instructor's Guide

## Module Overview

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This module introduces the procedures for 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; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Module 26301-14.

## 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

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment

---

*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard

Markers/chalk  
Pencils and paper  
Copy of the latest edition of the *National Electrical Code*®  
One length each of various solid and stranded conductors  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

---

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

## Additional Resources

---

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

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

## Teaching Time for This Module

---

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *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.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Compact Conductors</b>                                                                 |              |
| A. Introduction                                                                                                    | _____        |
| B. Compact Conductors                                                                                              | _____        |
| <b>Session II. Conductor Applications</b>                                                                          |              |
| A. Conductor Applications                                                                                          | _____        |
| 1. Branch Circuits                                                                                                 | _____        |
| 2. Conductor Protection                                                                                            | _____        |
| 3. Location of Overcurrent Protection in Circuits                                                                  | _____        |
| <b>Session III. Properties of Conductors</b>                                                                       |              |
| A. Properties of Conductors                                                                                        | _____        |
| 1. Identifying Conductors                                                                                          | _____        |
| 2. Color Coding                                                                                                    | _____        |
| 3. Changing Colors                                                                                                 | _____        |
| <b>Session IV. Voltage Drop</b>                                                                                    |              |
| A. Voltage Drop                                                                                                    | _____        |
| 1. Wire Sizes Based on Resistance                                                                                  | _____        |
| 2. Circular Mil-Unit of Conductor Area                                                                             | _____        |
| 3. Conversion of Square Mils to Circular Mils                                                                      | _____        |
| 4. Resistance of Conductors                                                                                        | _____        |
| 5. Resistance of Copper per Mil Foot                                                                               | _____        |
| <b>Session V. Voltage Drop Equations</b>                                                                           |              |
| A. Voltage Drop Equations                                                                                          | _____        |
| 1. Equations for Voltage Drop Using Conductor Area or Conductor Resistance                                         | _____        |
| 2. Use of Voltage Drop Equations                                                                                   | _____        |
| 3. Miscellaneous Voltage Drop Equations                                                                            | _____        |
| <b>Session VI. Review and Testing</b>                                                                              |              |
| 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 Training Report Form 200, and submit the results to the Training Program Sponsor. | _____        |

## Module Overview

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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 26301-14 and 26302-14.

## 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

---

*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper  
Copy of the latest edition of the *National Electrical Code*®  
Light meter

Examples of lighting fixture manufacturers' catalogs  
Assortment of incandescent, halogen, fluorescent, and HID lighting fixtures, including:

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

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

\* 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.

## Additional Resources

---

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

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

## Teaching Time for this Module

---

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Practical Applications of Lighting*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

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



| Topic                                                                                                                                                                                                                                                                                       | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session III. Applications of Lighting</b>                                                                                                                                                                                                                                                |              |
| 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                                                                                                                                                                                                                                                                          | _____        |
| <b>Session IV. Special-Purpose Wiring Systems Used for Lighting; Dimming</b>                                                                                                                                                                                                                |              |
| 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                                                                                                                                                                                                                                                                     | _____        |
| C. PT/Laboratory                                                                                                                                                                                                                                                                            | _____        |
| <p>Trainees tour selected structures to observe their lighting systems and identify the various types of lighting fixtures used, the specific purpose(s) served by the different fixtures, and the lighting system class of service. This laboratory corresponds to Performance Task 2.</p> |              |
| <b>Session V. Review and Testing</b>                                                                                                                                                                                                                                                        |              |
| 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 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 Training Report Form 200, and submit the results to the Training Program Sponsor.                                                                                                                                                                          |              |

## Module Overview

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This module introduces the *National Electrical Code*® (NEC®) requirements and installation procedures related to electrical equipment installed in hazardous locations.

## Prerequisites

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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 26301-14 through 26303-14.

## 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 explosionproof 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 amount of threads are engaged.
  - Pull the three THHN conductors through the nipples and seal so that about 6" is protruding from each nipple.
  - Pack the fiber as per 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

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*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper  
Copy of the latest edition of the *National Electrical Code*®

Sealoff fittings, packing fiber, and sealing compound  
Short conduit nipples  
No. 12 THHN conductors  
Various types of explosionproof fittings  
Various types of sealing fittings used in hazardous locations, including those with drains  
Portable conduit threader  
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

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

## Additional Resources

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

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

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

## Teaching Time for This Module

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

| Topic                                                                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction</b>                                                                                                                                     |              |
| A. Introduction                                                                                                                                                    | _____        |
| 1. Class I Locations                                                                                                                                               | _____        |
| 2. Class II Locations                                                                                                                                              | _____        |
| 3. Class III Locations                                                                                                                                             | _____        |
| 4. Applications                                                                                                                                                    | _____        |
| <b>Session II. Prevention of External Ignition/Explosion</b>                                                                                                       |              |
| A. Prevention of External Ignition/Explosion                                                                                                                       | _____        |
| 1. Sources of Ignition                                                                                                                                             | _____        |
| 2. Combustion Principles                                                                                                                                           | _____        |
| <b>Session III. Explosionproof Equipment</b>                                                                                                                       |              |
| A. Explosionproof Equipment                                                                                                                                        | _____        |
| 1. Intrinsically Safe Equipment                                                                                                                                    | _____        |
| 2. Explosionproof Conduit and Fittings                                                                                                                             | _____        |
| 3. Seals and Drains                                                                                                                                                | _____        |
| <b>Session IV. PT/Laboratory</b>                                                                                                                                   |              |
| A. PT/Laboratory                                                                                                                                                   | _____        |
| Have the trainees practice installing sealoff fittings and pouring seals. Note the proficiency of each trainee. This laboratory corresponds to Performance Task 1. |              |

| <b>Topic</b>                                                                                                                        | <b>Planned Time</b> |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <b>Session V. Garages and Similar Locations; Airport Hangars; Hospitals; Petrochemical Hazardous Locations; Manufacturers' Data</b> |                     |
| A. Garages and Similar Locations                                                                                                    | _____               |
| B. Airport Hangars                                                                                                                  | _____               |
| C. Hospitals                                                                                                                        | _____               |
| D. Petrochemical Hazardous Locations                                                                                                | _____               |
| E. Manufacturers' Data                                                                                                              | _____               |
| <b>Session VI. Review and Testing</b>                                                                                               |                     |
| 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 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 Training Report Form 200, and submit the results to the Training Program Sponsor.                  |                     |

## Module Overview

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This module covers the procedures used when sizing and selecting overcurrent protection, along with the applicable *National Electrical Code*<sup>®</sup> (NEC<sup>®</sup>) requirements.

## Prerequisites

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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 26301-14 through 26304-14.

## Objectives

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

1. Apply the key *National Electrical Code*<sup>®</sup> (NEC<sup>®</sup>) requirements regarding overcurrent protection.
2. Check specific applications for conformance to NEC<sup>®</sup> sections that cover short circuit current, fault currents, interrupting ratings, and other sections relating to overcurrent protection.
3. Determine let-through current values (peak and rms) when current-limiting overcurrent devices are used.
4. Select and size overcurrent protection for specific applications.

## Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment

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*Electrical Level Three* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper

Copy of the latest edition of the *National Electrical Code*<sup>®</sup>  
Various types of circuit breakers  
Various types of fuses, including electronic fuses  
Sample fuse blocks and holders with nonrejection bases  
Sample fuse blocks and holders with rejection clips that accept only Class R fuses  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

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

## Additional Resources

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

*National Electrical Code*<sup>®</sup> Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

## Teaching Time for this Module

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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 25 hours are suggested to cover *Overcurrent Protection*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                         | Planned Time |
|---------------------------------------------------------------|--------------|
| <b>Session I. Introduction</b>                                |              |
| A. Introduction                                               | _____        |
| 1. Fault Currents                                             | _____        |
| <b>Session II. Fuses</b>                                      |              |
| A. Fuses                                                      | _____        |
| 1. Types of Fuses                                             | _____        |
| 2. Voltage Rating                                             | _____        |
| 3. Ampere Rating                                              | _____        |
| 4. Interrupting Rating                                        | _____        |
| 5. Selective Coordination                                     | _____        |
| 6. Current Limitation                                         | _____        |
| <b>Session III. Operating Principles of Fuses</b>             |              |
| A. Operating Principles of Fuses                              | _____        |
| 1. Nontime-Delay Fuses                                        | _____        |
| 2. Dual-Element, Time-Delay Fuses                             | _____        |
| <b>Session IV. UL Fuse Classes</b>                            |              |
| A. UL Fuse Classes                                            | _____        |
| 1. Branch Circuit Listed Fuses                                | _____        |
| 2. Medium-Voltage Fuses                                       | _____        |
| 3. Current-Limiting Fuses                                     | _____        |
| 4. Fuses for Selective Coordination                           | _____        |
| 5. Fuse Time-Current Curves                                   | _____        |
| <b>Session V. Motor Overload and Short Circuit Protection</b> |              |
| A. Motor Overload and Short Circuit Protection                | _____        |
| <b>Session VI. Circuit Breakers</b>                           |              |
| A. Circuit Breakers                                           | _____        |
| 1. Interrupting Capacity Rating                               | _____        |
| <b>Session VII. Circuit Protection</b>                        |              |
| A. Circuit Protection                                         | _____        |
| 1. Lighting/Appliance Branch Circuits                         | _____        |

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session VIII. Short Circuit Calculations</b>                                                                    |              |
| A. Short Circuit Calculations                                                                                      | _____        |
| 1. Basic Short Circuit Calculation Procedure                                                                       | _____        |
| 2. Practical Application                                                                                           | _____        |
| 3. Peak Let-Through Charts                                                                                         | _____        |
| <b>Session IX. Troubleshooting and Testing Circuit Breakers and Fuses</b>                                          |              |
| A. Troubleshooting and Testing Circuit Breakers and Fuses                                                          | _____        |
| 1. Circuit Breakers                                                                                                | _____        |
| 2. Fuses                                                                                                           | _____        |
| <b>Session X. Review and Testing</b>                                                                               |              |
| 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 Training Report Form 200, and submit the results to the Training Program Sponsor. |              |

### Module Overview

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

### Prerequisites

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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 26301-14 through 26305-14.

### Objectives

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

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

### Performance Tasks

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This is a knowledge-based module. There are no Performance Tasks.

### Materials and Equipment

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*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard

Markers/chalk  
Pencils and paper  
Copy of the latest edition of the *National Electrical Code*®  
Manufacturer's literature for various types of distribution equipment  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

### Safety Considerations

---

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

### Additional Resources

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

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



## Teaching Time for This Module

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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 *Distribution Equipment*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Voltage Classifications; Switchboards; Switchgear</b>                                  |              |
| A. Introduction                                                                                                    | _____        |
| B. Voltage Classifications                                                                                         | _____        |
| C. Switchboards                                                                                                    | _____        |
| D. Switchgear                                                                                                      | _____        |
| <b>Session II. Switchboard Testing and Maintenance; NEC® Requirements; Ground Faults</b>                           |              |
| A. Switchboard Testing and Maintenance                                                                             | _____        |
| B. NEC® Requirements                                                                                               | _____        |
| C. Ground Faults                                                                                                   | _____        |
| <b>Session III. HVL Switches; Bolted Pressure Switches; Transformers</b>                                           |              |
| A. HVL Switches                                                                                                    | _____        |
| B. Bolted Pressure Switches                                                                                        | _____        |
| C. Transformers                                                                                                    | _____        |
| <b>Session IV. Instrument Transformers; Circuit Breakers; Electrical Drawing Identification</b>                    |              |
| A. Instrument Transformers                                                                                         | _____        |
| B. Circuit Breakers                                                                                                | _____        |
| C. Electrical Drawing Identification                                                                               | _____        |
| <b>Session V. Electrical Prints; Manufacturer Drawings; Panelboards; Review and Testing</b>                        |              |
| A. Electrical Prints                                                                                               | _____        |
| B. Manufacturer Drawings                                                                                           | _____        |
| C. Panelboards                                                                                                     | _____        |
| D. Module Review                                                                                                   | _____        |
| E. Module Examination                                                                                              | _____        |
| 1. Trainees must score 70 percent or higher to receive recognition from the NCCER.                                 |              |
| 2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor. |              |

### Module Overview

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This module introduces the methods and procedures used in selecting and wiring transformers.

### 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 26301-14 through 26306-14.

### Objectives

---

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

1. Describe transformer operation.
2. Explain the principle of mutual induction.
3. Describe the operating characteristics of various types of transformers.
4. Connect a multi-tap transformer for the required secondary voltage.
5. Explain *National Electrical Code*® (*NEC*®) requirements governing the installation of transformers.
6. Compute transformer sizes for various applications.
7. Connect a control transformer for a given application.
8. Describe how current transformers are used in conjunction with watt-hour meters.

### Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

### Materials and Equipment

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|                                                                                        |                                                           |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------|
| <i>Electrical Level Three</i> PowerPoint® Presentation Slides (ISBN 978-0-13-257133-3) | Samples of transformer cores, including:                  |
| Multimedia projector and screen                                                        | Mitered                                                   |
| Computer                                                                               | Butt                                                      |
| Appropriate personal protective equipment                                              | Wound                                                     |
| Whiteboard/chalkboard                                                                  | Iron filings                                              |
| Markers/chalk                                                                          | Multi-tap control transformers                            |
| Pencils and paper                                                                      | Control cable                                             |
| Copy of the latest edition of the <i>National Electrical Code</i> ®                    | Volt-ohm-milliammeter (VOM)                               |
| Samples of various types of transformers                                               | Tools necessary for making transformer wiring connections |
|                                                                                        | Module Examinations*                                      |

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

### Safety Considerations

---

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

## Additional Resources

---

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

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

## Teaching Time for This Module

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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 *Transformers*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Transformer Basics; Transformer Construction; Transformer Taps</b>                     |              |
| A. Introduction                                                                                                    | _____        |
| B. Transformer Basics                                                                                              | _____        |
| 1. Inductive                                                                                                       | _____        |
| 2. Magnetic Flux                                                                                                   | _____        |
| C. Transformer Construction                                                                                        | _____        |
| 1. Cores                                                                                                           | _____        |
| D. Transformer Taps                                                                                                | _____        |
| <b>Session II. Basic Transformer Connections; Autotransformers</b>                                                 |              |
| A. Basic Transformer Connections                                                                                   | _____        |
| 1. Single Phase                                                                                                    | _____        |
| 2. Three-Phase                                                                                                     | _____        |
| 3. Parallel-Operated Transformers                                                                                  | _____        |
| B. Autotransformers                                                                                                | _____        |
| <b>Session III. Transformer Data; Control Transformers; NEC® Requirements</b>                                      |              |
| A. Transformer Data                                                                                                | _____        |
| B. Control Transformers                                                                                            | _____        |
| C. NEC® Requirements                                                                                               | _____        |
| 1. Overcurrent Protection                                                                                          | _____        |
| 2. Grounding                                                                                                       | _____        |
| <b>Session IV. Power Factor; Vectors</b>                                                                           |              |
| A. Power Factor                                                                                                    | _____        |
| B. Vectors                                                                                                         | _____        |
| <b>Session V. Troubleshooting; Transformer Maintenance</b>                                                         |              |
| A. Troubleshooting                                                                                                 | _____        |
| B. Transformer Maintenance                                                                                         | _____        |
| <b>Session VI. Review and Testing</b>                                                                              |              |
| 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 Training Report Form 200, and submit the results to the Training Program Sponsor. |              |

## Module Overview

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This module covers the applicable *National Electrical Code*<sup>®</sup> (NEC<sup>®</sup>) requirements and general installation considerations for commercial electrical services.

## Prerequisites

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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 26301-14 through 26307-14.

## Objectives

---

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

1. Describe various types of electric services for commercial and industrial installations.
2. Read electrical diagrams describing service installations.
3. Select service-entrance equipment for various applications.
4. Explain the role of the *National Electrical Code*<sup>®</sup> in service installations.
5. Install main disconnect switches, panelboards, and overcurrent protection devices.
6. Identify the *National Electrical Code*<sup>®</sup> requirements and purposes of service grounding.
7. Describe single-phase service connections.
8. Describe both wye- and delta-connected three-phase services.

## Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment

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|                                                                                                              |                                                  |
|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| <i>Electrical Level Three</i> PowerPoint <sup>®</sup> Presentation                                           | Samples of common service components, including: |
| Slides can be downloaded (with your access code) from <a href="http://www.nccerirc.com">www.nccerirc.com</a> |                                                  |
| Multimedia projector and screen                                                                              | Service disconnect                               |
| Computer                                                                                                     | Meter                                            |
| Appropriate personal protective equipment                                                                    | Transformers                                     |
| Whiteboard/chalkboard                                                                                        | Wireways                                         |
| Markers/chalk                                                                                                | Gutters                                          |
| Pencils and paper                                                                                            | Weatherhead and service mast                     |
| Copy of the latest edition of the <i>National Electrical Code</i> <sup>®</sup>                               | Panelboards                                      |
|                                                                                                              | Module Examinations*                             |

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

---

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

## Additional Resources

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

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

## Teaching Time for This Module

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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 *Commercial Electrical Services*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Drawings and Specifications; General Installation Considerations</b>                   |              |
| A. Introduction                                                                                                    | _____        |
| B. Drawings and Specifications                                                                                     | _____        |
| C. General Installation Considerations                                                                             | _____        |
| <b>Session II. Service Components</b>                                                                              |              |
| A. Service Components                                                                                              | _____        |
| 1. Service Disconnecting Means                                                                                     | _____        |
| 2. Metering                                                                                                        | _____        |
| 3. Current Transformers                                                                                            | _____        |
| 4. Metal Wireways                                                                                                  | _____        |
| 5. Bussed Gutters                                                                                                  | _____        |
| 6. Weatherhead and Service Mast                                                                                    | _____        |
| 7. Panelboards                                                                                                     | _____        |
| <b>Session III. NEC® Requirements; Typical Installations</b>                                                       |              |
| A. NEC® Requirements                                                                                               | _____        |
| B. Typical Installations                                                                                           | _____        |
| <b>Session IV. Review and Testing</b>                                                                              |              |
| 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 Training Report Form 200, and submit the results to the Training Program Sponsor. |              |

## Module Overview

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This module introduces the calculations used to size motor branch and feeder circuits, overcurrent protection, and disconnects.

## 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 26301-14 through 26308-14.

## Objectives

---

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

1. Size branch circuits and feeders for electric motors.
2. Size and select overcurrent protective devices for motors.
3. Size and select overload relays for electric motors.
4. Size and select devices to improve the power factor at motor locations.
5. Size motor short circuit protectors.
6. Size multi-motor branch circuits.
7. Size motor disconnects.

## Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment

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*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper  
Copy of the latest edition of the *National Electrical Code*®  
Motor short circuit protector

Devices used to provide motor overload protection, including:  
Overload relays  
Fuses  
Circuit breakers  
Various types of fuses, including:  
Nontime-delay  
Dual-element, time-delay fuses  
Various types of disassembled motors, including:  
Squirrel cage  
Wound-rotor  
Synchronous  
Various types of circuit breakers  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

---

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

## Additional Resources

---

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

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

## Teaching Time for This Module

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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 *Motor Calculations*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                                                                           | Planned Time |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Motor Basics</b>                                                                                                                    |              |
| A. Introduction                                                                                                                                                 | _____        |
| B. Motor Basics                                                                                                                                                 | _____        |
| 1. Stator Windings                                                                                                                                              | _____        |
| 2. Special Connections                                                                                                                                          | _____        |
| <b>Session II. Calculating Motor Circuit Conductors</b>                                                                                                         |              |
| A. Calculating Motor Circuit Conductors                                                                                                                         | _____        |
| 1. Wound-Rotor Motors                                                                                                                                           | _____        |
| 2. Conductors for DC Motors                                                                                                                                     | _____        |
| 3. Conductors for Miscellaneous Motor Applications                                                                                                              | _____        |
| <b>Session III. Motor Protective Devices; Circuit Breakers</b>                                                                                                  |              |
| A. Motor Protective Devices                                                                                                                                     | _____        |
| B. Circuit Breakers                                                                                                                                             | _____        |
| 1. Application of MCPs                                                                                                                                          | _____        |
| 2. Motor Short Circuit Protectors                                                                                                                               | _____        |
| <b>Session IV. Multi-Motor Branch Circuits; Equipment Grounding Conductors for Motor Feeder and Branch Circuits; Power Factor Correction at Motor Terminals</b> |              |
| A. Multi-Motor Branch Circuits                                                                                                                                  | _____        |
| B. Equipment Grounding Conductors for Motor Feeder and Branch Circuits                                                                                          | _____        |
| C. Power Factor Correction at Motor Terminals                                                                                                                   | _____        |
| <b>Session V. Review and Testing</b>                                                                                                                            |              |
| 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 Training Report Form 200, and submit the results to the Training Program Sponsor.                                              |              |

## Module Overview

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This module covers the procedures used when selecting, installing, and maintaining cable systems for voice, data, and video systems.

## Prerequisites

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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 26301-14 through 26309-14.

## Objectives

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

1. Define the different categories for voice-data-video (VDV) cabling systems.
2. Install raceways, boxes, and enclosures for VDV systems.
3. Interpret and apply *NEC*® requirements for installing and grounding VDV systems.
4. Explain the requirements for firestopping.

## Performance Tasks

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This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment

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*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper

Copy of the latest edition of the *National Electrical Code*®  
Samples of:  
Fiber-optic cable  
Coaxial cable  
UTP cable  
Coax F-type connector terminations  
Innerduct  
Various types of coax stripping tools  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

---

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



## Additional Resources

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

- Cisco Home Technology Integration Fundamentals and Certification*, 2004. Engelwood, CO: Upper Saddle River, NJ: Pearson Education, Inc.
- National Electrical Code® Handbook*, Latest Edition. Quincy, MA: National Fire Protection Association.
- The Cabling Handbook*, 2nd Edition. 2000. Upper Saddle River, NJ: Pearson Education, Inc.
- TIA/EIA Telecommunications Building Wiring Standards*, Latest Edition. Engelwood, CO: Global Engineering Documents.

## Teaching Time for This Module

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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 *Voice, Data, and Video*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Structured Cabling Systems</b>                                                         |              |
| A. Introduction                                                                                                    | _____        |
| B. Structured Cabling Systems                                                                                      | _____        |
| 1. Campus Backbone Subsystem                                                                                       | _____        |
| 2. Equipment/Telecom Room Subsystem                                                                                | _____        |
| 3. Riser Subsystem                                                                                                 | _____        |
| 4. Horizontal Subsystem                                                                                            | _____        |
| 5. Work Area Subsystem                                                                                             | _____        |
| <b>Session II. UTP and Coax Cable Terminations</b>                                                                 |              |
| A. UTP and Coax Cable Terminations                                                                                 | _____        |
| 1. UTP Jack and Plug Terminations                                                                                  | _____        |
| 2. RG6 Coax F-Type Terminations                                                                                    | _____        |
| <b>Session III. Fiber-Optic Installation Considerations; Grounding and Bonding; Testing</b>                        |              |
| A. Fiber-Optic Installation Considerations                                                                         | _____        |
| 1. Tray and Duct Installation                                                                                      | _____        |
| 2. Conduit Installation                                                                                            | _____        |
| 3. Splice Closures/Organizers                                                                                      | _____        |
| 4. Distribution Hardware                                                                                           | _____        |
| 5. Patch Panels                                                                                                    | _____        |
| 6. Outlet Boxes                                                                                                    | _____        |
| B. Grounding and Bonding                                                                                           | _____        |
| C. Testing                                                                                                         | _____        |
| <b>Session IV. Review and Testing</b>                                                                              |              |
| 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 Training Report Form 200, and submit the results to the Training Program Sponsor. |              |

## Module Overview

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This module introduces the methods and procedures used in selecting and wiring motor controls.

## 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 26301-14 through 26310-14.

## Objectives

---

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

1. Identify contactors and relays both physically and schematically and describe their operating principles.
2. Identify pilot devices both physically and schematically and describe their operating principles.
3. Interpret motor control wiring, connection, and ladder diagrams.
4. Select and size contactors and relays for use in specific electrical motor control systems.
5. Select and size pilot devices for use in specific electrical motor control systems.
6. Connect motor controllers for specific applications according to *National Electrical Code® (NEC®)* requirements.

## Performance Task

---

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

1. Make all connections for a magnetic motor controller, controlled by two pushbutton stations, including the connections for holding the circuit interlock.

## Materials and Equipment

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*Electrical Level Three* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper  
Copy of the latest edition of the *National Electrical Code®*  
Assorted wire and connectors necessary for making control circuit wiring connections  
Assorted NEMA and IEC magnetic and manual contactors and motor starters  
Assorted manufacturer's motor control device catalogs/data sheets  
Contactor/motor starter accessories including:  
Power-pole adder kit  
Timer attachment  
Fuse kit

Transient suppression module  
Internal auxiliary contacts  
Control transformers  
Pushbutton switches  
Push-pull pushbutton switches  
Selector switches  
Pilot lights  
Assorted pushbutton stations  
Temperature switches  
Pressure switches  
Mechanical limit switches  
Flow switches  
Float switches  
Foot switches  
Jogging and plugging switches  
Inductive and capacitive proximity sensors  
Photoelectric switches/sensors  
Drum switches  
Assorted NEMA enclosures  
240V motor  
Tools necessary for making wiring connections

(continued)

Examples of wiring diagrams  
 Examples of circuit schedules/wire lists  
 Examples of control ladder diagrams  
 Examples of logic diagrams  
 Open-frame electromechanical power relays  
 Miniature electromechanical plug-in relays

Melting-alloy thermal overload relays  
 Bimetallic overload relays  
 Magnetic overload relays  
 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.

## Additional Resources ---

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

*Electrical Motor Controls*, Gary Rockis and Glen Mazur. Homewood, IL: American Technical Publishers, Inc., 1997.

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

*NFPA 70E® Recommended Practice for Electrical Equipment Maintenance*. Quincy, MA: National Fire Protection Association, 2004.

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

| Topic                                                                                              | Planned Time |
|----------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Electromechanical Relays; Magnetic Contactors; Overload Protection</b> |              |
| A. Introduction                                                                                    | _____        |
| B. Electromechanical Relays                                                                        | _____        |
| C. Magnetic Contactors                                                                             | _____        |
| D. Overload Protection                                                                             | _____        |

| Topic                                                                                                                                                                                                                                   | Planned Time |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session II. Magnetic and Manual Motor Starters; Control Transformers and Pilot Devices</b>                                                                                                                                           |              |
| A. Magnetic and Manual Motor Starters                                                                                                                                                                                                   | _____        |
| 1. Nonreversing and Reversing Magnetic Motor Starters                                                                                                                                                                                   | _____        |
| 2. NEMA Magnetic Contactors/Motor Starters                                                                                                                                                                                              | _____        |
| 3. IEC Magnetic Contactors/Motor Starters                                                                                                                                                                                               | _____        |
| 4. Manual Motor Starters                                                                                                                                                                                                                | _____        |
| 5. Accessories                                                                                                                                                                                                                          | _____        |
| B. Control Transformers and Pilot Devices                                                                                                                                                                                               | _____        |
| 1. Pushbutton and Selector Switches; Pilot Lights                                                                                                                                                                                       | _____        |
| 2. Temperature and Pressure Switches                                                                                                                                                                                                    | _____        |
| 3. Mechanical Limit Switches                                                                                                                                                                                                            | _____        |
| 4. Flow, Float, and Foot Switches                                                                                                                                                                                                       | _____        |
| 5. Jogging and Plugging Switches                                                                                                                                                                                                        | _____        |
| 6. Proximity and Photoelectric Switches/Sensors                                                                                                                                                                                         | _____        |
| <b>Session III. Drum Switches; Enclosures; Diagrams</b>                                                                                                                                                                                 |              |
| A. Drum Switches                                                                                                                                                                                                                        | _____        |
| B. Enclosures                                                                                                                                                                                                                           | _____        |
| C. Diagrams                                                                                                                                                                                                                             | _____        |
| 1. Relating Diagrams to Equipment Wiring and Operation                                                                                                                                                                                  | _____        |
| <b>Session IV. NEC® Regulations for the Installation of Motor Control Circuits; Connecting Motor Controllers for Specific Applications</b>                                                                                              |              |
| A. NEC® Regulations for the Installation of Motor Control Circuits                                                                                                                                                                      | _____        |
| B. Connecting Motor Controllers for Specific Applications                                                                                                                                                                               | _____        |
| C. PT/Laboratory                                                                                                                                                                                                                        | _____        |
| <p>Have the trainees make all connections for a magnetic motor controller, controlled by two pushbutton stations, including the connections for holding the circuit interlock. This laboratory corresponds with Performance Task 1.</p> |              |
| <b>Session V. Review and Testing</b>                                                                                                                                                                                                    |              |
| 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 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 Training Report Form 200, and submit the results to the Training Program Sponsor.                                                                                                                      |              |

## Module Overview

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This module describes basic calculation procedures and calculations for commercial and residential applications.

## Prerequisites

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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.*

## Objectives

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

1. Size feeders and services in accordance with *National Electrical Code® (NEC®)* requirements.
2. Calculate loads and ampacities for single-phase and three-phase feeders.
3. Apply derating factors to size feeders.
4. Size feeder overcurrent protection devices (circuit breakers and fuses) for noncontinuous duty and continuous duty loads.
5. Apply tap rules.
6. Calculate loads for various residential and commercial applications.
7. Calculate loads for schools and other institutional projects.
8. Perform feeder and service calculations for farms.
9. Calculate the power and supply feeders for marinas and boatyards.
10. Calculate electric motor loads on feeders.

## Performance Tasks

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This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment List

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment

Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Quick Quiz\*  
Module Examinations\*\*

\* Located in the back of this module.

\*\*Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

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

## Additional Resources

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

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

## Teaching Time for This Module

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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 *Load Calculations – Feeders and Services*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                                                       | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Sessions I and II. Introduction; Basic Calculation Procedures</b>                                                                        |              |
| A. Introduction                                                                                                                             | _____        |
| B. Basic Calculation Procedures                                                                                                             | _____        |
| 1. Load Calculations – Basic Considerations                                                                                                 | _____        |
| 2. Conductor Adjustments                                                                                                                    | _____        |
| 3. Calculating Feeder Ampacity                                                                                                              | _____        |
| 4. Tap Rules                                                                                                                                | _____        |
| 5. Applying Demand Factors                                                                                                                  | _____        |
| 6. Lighting Loads                                                                                                                           | _____        |
| 7. Basic Steps for Load Calculations                                                                                                        | _____        |
| <b>Sessions III through V. Load Calculations for a Minimum Size Service; Commercial Occupancy Calculations</b>                              |              |
| A. Load Calculations for a Minimum Size Service                                                                                             | _____        |
| 1. Minimum Service Ratings                                                                                                                  | _____        |
| 2. Sizing Neutral Conductors                                                                                                                | _____        |
| 3. Multi-Family Calculations                                                                                                                | _____        |
| B. Commercial Occupancy Calculations                                                                                                        | _____        |
| 1. Commercial and Industrial Load Calculations                                                                                              | _____        |
| 2. Retail Stores with Show Windows                                                                                                          | _____        |
| 3. Office Buildings                                                                                                                         | _____        |
| <b>Session VI. Restaurants; Optional Calculation for New Restaurants; Services for Hotels and Motels; Optional Calculations for Schools</b> |              |
| A. Restaurants                                                                                                                              | _____        |
| B. Optional Calculation for New Restaurants                                                                                                 | _____        |
| C. Services for Hotels and Motels                                                                                                           | _____        |
| D. Optional Calculations for Schools                                                                                                        | _____        |
| <b>Session VII. Shore Power Circuits for Marinas and Boatyards; Farm Load Calculations; Motors and Motor Circuits</b>                       |              |
| A. Shore Power Circuits for Marinas and Boatyards                                                                                           | _____        |
| B. Farm Load Calculations                                                                                                                   | _____        |
| C. Motors and Motor Circuits                                                                                                                | _____        |
| <b>Session VIII. Review and Testing</b>                                                                                                     |              |
| A. Review                                                                                                                                   | _____        |
| B. Module Examination                                                                                                                       | _____        |
| 1. Trainees must score 70 percent or higher to receive recognition from the NCCER.                                                          |              |
| 2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.                          |              |

### Module Overview

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This module describes the required backup power and special communication systems and wiring devices necessary for health care facilities.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Module 26401-14.

### Objectives

---

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

1. List the types of electrical distribution systems used in the medical industry.
2. Describe the categories and branch portions of the distribution circuits.
3. List the items allowed in the life safety branch and critical branch.
4. Describe the ground fault protection required to ensure a safe environment.
5. List the required wiring methods in a health care facility.
6. Explain the application of special wiring devices in critical care locations.
7. Describe the requirements for the installation of specialty equipment.
8. Describe the applications of isolated power systems.

### Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

### Materials and Equipment

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer

Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

### Safety Considerations

---

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

### Additional Resources

---

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

*National Electrical Code® Handbook*, Latest Edition. Quincy, MA: National Fire Protection Association.  
*Standard for Health Care Facilities (NFPA 99)*, Latest Edition. Quincy, MA: National Fire Protection Association.

## Teaching Time for This Module

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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 *Health Care Facilities*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Essential Electrical System Types; Electrical Distribution Systems</b>                 |              |
| A. Introduction                                                                                                    | _____        |
| B. Essential Electrical System Types                                                                               | _____        |
| 1. Type 1 EES                                                                                                      | _____        |
| 2. Type 2 EES                                                                                                      | _____        |
| 3. Type 3 EES                                                                                                      | _____        |
| C. Electrical Distribution Systems                                                                                 | _____        |
| 1. Double-Ended System Arrangement                                                                                 | _____        |
| 2. Alternate Power Source Arrangement                                                                              | _____        |
| 3. Ground Fault Protection                                                                                         | _____        |
| 4. Additional Distribution System Grounding and Bonding Requirements                                               | _____        |
| <b>Session II. Wiring and Devices</b>                                                                              |              |
| A. Wiring and Devices                                                                                              | _____        |
| 1. Hospital-Grade Receptacles                                                                                      | _____        |
| 2. General Care Spaces                                                                                             | _____        |
| 3. Critical Care Spaces                                                                                            | _____        |
| 4. Grounding of Receptacles and Fixed Electric Equipment                                                           | _____        |
| 5. Inhalation Anesthetizing Locations                                                                              | _____        |
| 6. Low-Voltage Equipment and Instruments                                                                           | _____        |
| 7. X-Ray Installations                                                                                             | _____        |
| <b>Session III. Communication; Signaling, Data, and Fire Alarm Systems; Isolated Power Systems</b>                 |              |
| A. Communication, Signaling, Data, and Fire Alarm Systems                                                          | _____        |
| B. Isolated Power Systems                                                                                          | _____        |
| 1. Installation of Isolated Power Systems                                                                          | _____        |
| 2. Line Isolation Monitors                                                                                         | _____        |
| <b>Session IV. Review and Testing</b>                                                                              |              |
| A. 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. |              |



## Module Overview

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This module explains the *NEC*<sup>®</sup> installation requirements for electric generators and storage.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 and 26402-14.

## Objectives

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

1. Explain the basic differences between emergency systems, legally required standby systems, and optional standby systems.
2. Describe the operating principles of an engine-driven standby AC generator.
3. Describe the different types and characteristics of standby and emergency generators.
4. Recognize and describe the operating principles of both automatic and manual transfer switches.
5. Recognize the different types of storage batteries used in emergency and standby systems and explain how batteries charge and discharge.
6. For selected types of batteries, describe their characteristics, applications, maintenance, and testing.
7. Recognize double-conversion and single-conversion types of uninterruptible power supplies (UPSs) and describe how they operate.
8. Describe the *National Electrical Code*<sup>®</sup> (*NEC*<sup>®</sup>) requirements that pertain to the installation of standby and emergency power systems.

## Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment List

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*Electrical Level Four* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk

Pencils and scratch paper  
Engine-driven AC generator  
Transfer switches  
Storage batteries  
Tools to perform resistance and capacity checks on batteries  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

---

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

## Additional Resources

---

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

*Liquid-Cooled Generator Sets Application Manual*, Latest Edition. Minneapolis, MN: Cummins Onan.

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

*OT III Transfer Switches Application Manual*, Latest Edition. Minneapolis, MN: Cummins Onan.

## Teaching Time for This Module

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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 *Standby and Emergency Systems*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Emergency and Standby Power System Components</b>                                      |              |
| A. Introduction                                                                                                    | _____        |
| B. Emergency and Standby Power System Components                                                                   | _____        |
| 1. Engine-Driven Generator Sets                                                                                    | _____        |
| 2. Transfer Switches                                                                                               | _____        |
| 3. Automatic Sequential Paralleling Emergency/Standby System                                                       | _____        |
| <b>Session II. Storage Batteries; Static Uninterruptible Power Supply</b>                                          |              |
| A. Storage Batteries                                                                                               | _____        |
| 1. Lead-Acid Batteries                                                                                             | _____        |
| 2. Nickel Cadmium Batteries                                                                                        | _____        |
| 3. Battery Maintenance                                                                                             | _____        |
| 4. Battery and Battery Charger Operation                                                                           | _____        |
| B. Static Uninterruptible Power Supply                                                                             | _____        |
| 1. Double-Conversion UPS Systems                                                                                   | _____        |
| 2. Single-Conversion UPS Systems                                                                                   | _____        |
| <b>Session III. NEC® Requirements for Emergency Systems; Emergency System Circuits for Light and Power</b>         |              |
| A. NEC® Requirements for Emergency Systems                                                                         | _____        |
| 1. Legally Required Standby Systems                                                                                | _____        |
| 2. Sources of Power                                                                                                | _____        |
| B. Emergency System Circuits for Light and Power                                                                   | _____        |
| 1. Health Care Facilities                                                                                          | _____        |
| 2. Battery-Powered Emergency Lighting                                                                              | _____        |
| 3. Emergency Lighting Units                                                                                        | _____        |
| 4. Places of Assembly                                                                                              | _____        |
| <b>Session IV. Review and Testing</b>                                                                              |              |
| A. Review                                                                                                          | _____        |
| B. Module Examination                                                                                              | _____        |
| 1. Trainees must score 70 percent or higher to receive recognition from the NCCER.                                 |              |
| 2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor. |              |

### Module Overview

---

This module explains the function and operation of basic electronic devices, including semiconductors, diodes, rectifiers, and transistors.

### 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; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26403-14.

### Objectives

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

1. Identify electronic system components.
2. Describe the electrical characteristics of solid-state devices.
3. Describe the basic materials that make up solid-state devices.
4. Describe and identify the various types of transistors and explain how they operate.
5. Interpret electronic schematic diagrams.
6. Describe and connect diodes.
7. Describe and connect light-emitting diodes (LEDs).
8. Describe how to connect silicon-controlled rectifiers (SCRs).
9. Identify the leads of various solid-state devices.

### Performance Tasks

---

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

1. Test a transistor to determine whether it is an NPN or PNP.
2. Identify the cathode on three different styles of SCRs, using the shape or markings for identification.

### Materials and Equipment List

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper

Various diodes  
Light-emitting diodes (LEDs)  
Transistors  
Silicon-controlled rectifiers (SCRs)  
Schematic drawings  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\*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

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

## Additional Resources

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

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

*Solid-State Fundamentals for Electricians*, Gary Rockis. Homewood, IL: American Technical Publishers, 1993.

## Teaching Time for This Module

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

| Topic                                                                                                                                                                                    | Planned Time |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Electricity Under Magnification; Semiconductor Fundamentals</b>                                                                                              |              |
| A. Introduction                                                                                                                                                                          | _____        |
| B. Electricity Under Magnification                                                                                                                                                       | _____        |
| C. Semiconductor Fundamentals                                                                                                                                                            | _____        |
| 1. Conductors                                                                                                                                                                            | _____        |
| 2. Insulators                                                                                                                                                                            | _____        |
| 3. Semiconductors                                                                                                                                                                        | _____        |
| <b>Session II. Diodes; Light-Emitting Diodes; Transistors</b>                                                                                                                            |              |
| A. Diodes                                                                                                                                                                                | _____        |
| 1. Rectifiers                                                                                                                                                                            | _____        |
| 2. Diode Identification                                                                                                                                                                  | _____        |
| B. Light-Emitting Diodes                                                                                                                                                                 | _____        |
| C. Transistors                                                                                                                                                                           | _____        |
| 1. NPN Transistors                                                                                                                                                                       | _____        |
| 2. PNP Transistors                                                                                                                                                                       | _____        |
| 3. Identifying Transistor Leads                                                                                                                                                          | _____        |
| 4. Field-Effect Transistors                                                                                                                                                              | _____        |
| D. PT/Laboratory                                                                                                                                                                         | _____        |
| Have the trainees practice testing a transistor to determine whether it is an NPN or PNP. This laboratory corresponds to Performance Task 1.                                             |              |
| <b>Session III. Silicon-Controlled Rectifiers; Diacs; Triacs</b>                                                                                                                         |              |
| A. Silicon-Controlled Rectifiers                                                                                                                                                         | _____        |
| B. Diacs                                                                                                                                                                                 | _____        |
| C. Triacs                                                                                                                                                                                | _____        |
| D. PT/Laboratory                                                                                                                                                                         | _____        |
| Have the trainees practice identifying the cathode on three different styles of SCRs, using the shape or markings for identification. This laboratory corresponds to Performance Task 2. |              |

**Topic**

**Planned Time**

**Session IV. Review and Testing**

A. Review

\_\_\_\_\_

B. Module Examination

\_\_\_\_\_

1. Trainees must score 70 percent or higher to receive recognition from the 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

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This module covers fire alarm control units, Digital Alarm Communicator Systems (DACS), installation wiring for alarm initiating and notification devices, and alarm system maintenance.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26404-14.

### Objectives

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

1. Define the unique terminology associated with fire alarm systems.
2. Describe the relationship between fire alarm systems and life safety.
3. Explain the role that various codes and standards play in both commercial and residential fire alarm applications.
4. Describe the characteristics and functions of various fire alarm system components.
5. Identify the different types of circuitry that connect fire alarm system components.
6. Describe the theory behind conventional, addressable, and analog fire alarm systems and explain how these systems function.

### Performance Task

---

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

1. Connect selected fire alarm system(s).

### Materials and Equipment List

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
If possible, provide samples of:  
Automatic detectors  
Fixed-temperature heat detectors  
Combination heat detectors  
Photoelectric smoke detectors  
Ionization smoke detectors

Projected beam smoke detectors  
Duct detectors  
Cloud chamber smoke detectors  
Semiconductor heat detectors  
Fusible line-type heat detectors  
Ultraviolet and infrared flame detectors  
Water flow detectors  
UV and IR flame detectors  
Photoelectric beam smoke detectors  
Spot detectors  
Tools used to connect fire alarm systems  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\* 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.

## Additional Resources

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

*Certified Alarm Technician Level 1*, Latest Edition. Silver Spring, MD: National Burglar and Fire Alarm Association.

*Practical Fire Alarm Course*, Latest Edition. Silver Spring, MD: National Burglar and Fire Alarm Association.

*Understanding Alarm Systems*, Latest Edition. Silver Spring, MD: National Burglar and Fire Alarm Association.

## Teaching Time for This Module

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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 *Fire Alarm 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 the trainees may be noted during these exercises for Performance Testing purposes.

| Topic                                                                                                         | Planned Time |
|---------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Codes and Standards; Fire Alarm Systems Overview; Fire Alarm System Equipment</b> |              |
| A. Introduction                                                                                               | _____        |
| B. Codes and Standards                                                                                        | _____        |
| 1. The National Fire Protection Association                                                                   | _____        |
| C. Fire Alarm Systems Overview                                                                                | _____        |
| 1. Conventional Hardwired Systems                                                                             | _____        |
| 2. Multiplex Systems                                                                                          | _____        |
| 3. Addressable and Analog Addressable Systems                                                                 | _____        |
| D. Fire Alarm System Equipment                                                                                | _____        |
| <b>Session II. Fire Alarm Initiating Devices</b>                                                              |              |
| A. Fire Alarm Initiating Devices                                                                              | _____        |
| 1. Conventional versus Addressable Commercial Detectors                                                       | _____        |
| 2. Automatic Detectors                                                                                        | _____        |
| 3. Heat Detectors                                                                                             | _____        |
| 4. Smoke Detectors                                                                                            | _____        |
| 5. Other Types of Detectors                                                                                   | _____        |
| 6. Manual (Pull Station) Fire Detection Devices                                                               | _____        |
| 7. Auto-Mechanical Fire Detection Equipment                                                                   | _____        |

| Topic                                                                                         | Planned Time |
|-----------------------------------------------------------------------------------------------|--------------|
| <b>Session III. Control Panels; FACP Primary and Secondary Power; Notification Appliances</b> |              |
| A. Control Panels                                                                             | _____        |
| 1. User Control Points                                                                        | _____        |
| 2. FACP Initiating Circuits                                                                   | _____        |
| 3. Types of FACP Alarm Outputs                                                                | _____        |
| 4. FACP Listings                                                                              | _____        |
| B. FACP Primary and Secondary Power                                                           | _____        |
| C. Notification Appliances                                                                    | _____        |
| 1. Visual Notification Devices                                                                | _____        |
| 2. Audible Notification Devices                                                               | _____        |
| 3. Voice Evacuation Systems                                                                   | _____        |
| 4. Signal Considerations                                                                      | _____        |
| <b>Session IV. Communications and Monitoring; General Installation Guidelines</b>             |              |
| A. Communications and Monitoring                                                              | _____        |
| 1. Monitoring Options                                                                         | _____        |
| 2. Digital Communicators                                                                      | _____        |
| 3. Cellular Backup                                                                            | _____        |
| B. General Installation Guidelines                                                            | _____        |
| 1. General Wiring Requirements                                                                | _____        |
| 2. Workmanship                                                                                | _____        |
| 3. Access to Equipment                                                                        | _____        |
| 4. Fire Alarm Circuit Identification                                                          | _____        |
| 5. Power-Limited Circuits in Raceways                                                         | _____        |
| 6. Mounting of Detectors                                                                      | _____        |
| 7. Outdoor Wiring                                                                             | _____        |
| 8. Fire Seals                                                                                 | _____        |
| 9. Wiring in Air Handling Spaces                                                              | _____        |
| 10. Wiring in Hazardous Locations                                                             | _____        |
| 11. Remote Control Signaling Circuits                                                         | _____        |
| 12. Cables Running Floor to Floor                                                             | _____        |
| 13. Cables Running in Raceways                                                                | _____        |
| 14. Cable Spacing                                                                             | _____        |
| 15. Elevator Shafts                                                                           | _____        |
| 16. Terminal Wiring Methods                                                                   | _____        |
| 17. Conventional Initiation Device Circuits                                                   | _____        |
| 18. Notification Appliance Circuits                                                           | _____        |
| 19. Primary Power Requirements                                                                | _____        |
| 20. Secondary Power Requirements                                                              | _____        |



| Topic                                                                                                                                               | Planned Time |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session V. Total Premises Fire Alarm System Installation Guidelines; Fire Alarm-Related Systems and Installation Guidelines; Troubleshooting</b> |              |
| A. Total Premises Fire Alarm System Installation Guidelines                                                                                         | _____        |
| 1. Manual Fire Alarm Box (Pull Station) Installation                                                                                                | _____        |
| 2. Flame Detector Installation                                                                                                                      | _____        |
| 3. Smoke Chamber Definition, Smoke Spread Phenomena, and Stratification Phenomena                                                                   | _____        |
| 4. General Precautions for Detector Installation                                                                                                    | _____        |
| 5. Spot Detector Installations on Flat, Smooth Ceilings                                                                                             | _____        |
| 6. Photoelectric Beam Smoke Detector Installations on Flat, Smooth Ceilings                                                                         | _____        |
| 7. Spot Detector Installations on Irregular Ceilings                                                                                                | _____        |
| 8. Notification Appliance Installation                                                                                                              | _____        |
| 9. Fire Alarm Control Panel Installation Guidelines                                                                                                 | _____        |
| B. Fire Alarm-Related Systems and Installation Guidelines                                                                                           | _____        |
| 1. Ancillary Control Relay Installation Guidelines                                                                                                  | _____        |
| 2. Duct Smoke Detectors                                                                                                                             | _____        |
| 3. Elevator Recall                                                                                                                                  | _____        |
| 4. Special Door Locking Arrangements                                                                                                                | _____        |
| 5. Suppression System Supervision                                                                                                                   | _____        |
| 6. Supervision of Suppression Systems                                                                                                               | _____        |
| C. Troubleshooting                                                                                                                                  | _____        |
| 1. Alarm System Troubleshooting Guidelines                                                                                                          | _____        |
| 2. Addressable System Troubleshooting Guidelines                                                                                                    | _____        |
| D. PT/Laboratory                                                                                                                                    | _____        |
| Have the trainees practice connecting selected fire alarm systems. This laboratory corresponds to Performance Task 1.                               |              |

**Session VI. Review and Testing**

|                                                                                                                                                                                                                                       |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| A. Review                                                                                                                                                                                                                             | _____ |
| B. Module Examination                                                                                                                                                                                                                 | _____ |
| 1. Trainees must score 70 percent or higher to receive recognition from the 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

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

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26405-14.

## Objectives

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

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

## Performance Tasks

---

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

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

## Materials and Equipment List

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard

Markers/chalk  
Pencils and scratch paper  
Potential (voltage) and current transformers  
Various specialty transformers  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\* 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.

## Additional Resources

---

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

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

## Teaching Time for This Module

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

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

| <b>Topic</b>                                                                                                                                                                                                                          | <b>Planned Time</b> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <b>Session III. Harmonics</b>                                                                                                                                                                                                         |                     |
| A. Harmonics                                                                                                                                                                                                                          | _____               |
| 1. Defining the Problem                                                                                                                                                                                                               | _____               |
| 2. Office Buildings and Plants                                                                                                                                                                                                        | _____               |
| 3. Survey the Situation                                                                                                                                                                                                               | _____               |
| 4. Solving the Problem                                                                                                                                                                                                                | _____               |
| <b>Session IV. Review and Testing</b>                                                                                                                                                                                                 |                     |
| A. Review                                                                                                                                                                                                                             | _____               |
| B. Module Examination                                                                                                                                                                                                                 | _____               |
| 1. Trainees must score 70 percent or higher to receive recognition from the 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

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This module explains applications and operating principles of solid-state controls, reduced-voltage starters, and adjustable frequency drives, as well as troubleshooting procedures.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26406-14.

### Objectives

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

1. Select and install solid-state relays for specific applications in motor control circuits.
2. Install non-programmable/programmable motor circuit protectors (solid-state overload relays) in accordance with the manufacturer's instructions.
3. Select and install electromechanical and solid-state timing relays for specific applications in motor circuits.
4. Recognize the different types of reduced-voltage starting motor controllers and describe their operating principles.
5. Connect and program adjustable frequency drives to control a motor in accordance with the manufacturer's instructions.
6. Demonstrate and/or describe the special precautions used when handling and working with solid-state motor controls.
7. Recognize common types of motor braking and explain the operating principles of motor brakes.
8. Perform preventive maintenance and troubleshooting tasks in motor control circuits.

### Performance Task

---

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

1. Identify and connect various control devices.

### Materials and Equipment List

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Heat sinks  
Non-programmable solid-state overload relays (SSOLRs)

Programmable solid-state overload relays (SSOLRs)  
Programmable overload relays  
Timing relays  
Pneumatic timing relay  
Dashpot timing relay  
Solid-state plug-in timing relays  
Good and faulty contacts  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheets\*\*

\* Located in the back of this module.

\*\* 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.

## Additional Resources

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

*Adjustable Frequency Drives, Application Guide*, Latest Edition. Milwaukee, WI: Cutler-Hammer.

*Consulting Application Guide, Distribution and Control*, Latest Edition. Pittsburgh, PA: Cutler-Hammer.

*Electrical Motor Controls*, Gary Rockis and Glen A. Mazur. Homewood, IL: American Technical Publishers, Inc., 1997.

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

*NFPA 70B Recommended Practice for Electrical Equipment Maintenance*. Quincy, MA: National Fire Protection Association, 1998.

## Teaching Time for This Module

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

| Topic                                                           | Planned Time |
|-----------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Solid-State Relays</b>              |              |
| A. Introduction                                                 | _____        |
| B. Solid-State Relays                                           | _____        |
| 1. Solid-State Relay Operation                                  | _____        |
| 2. Comparison of Electromechanical Relays to Solid-State Relays | _____        |
| 3. Two-Wire and Three-Wire SSR Control                          | _____        |
| 4. Connecting SSRs to Achieve Multiple Outputs                  | _____        |
| 5. SSR Temperature Considerations                               | _____        |
| 6. Solid-State Relay Overvoltage and Overcurrent Protection     | _____        |
| <b>Session II. Solid-State Protective Relays; Timing Relays</b> |              |
| A. Solid-State Protective Relays                                | _____        |
| 1. Non-Programmable Solid-State Overload Relays                 | _____        |
| 2. Programmable Solid-State Overload Relays                     | _____        |
| B. Timing Relays                                                | _____        |
| 1. Pneumatic Timing Relays                                      | _____        |
| 2. Dashpot Timing Relays                                        | _____        |
| 3. Solid-State Timing Relays                                    | _____        |
| 4. Timing Relay Applications                                    | _____        |

| Topic                                                                                                                             | Planned Time |
|-----------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session III. Reduced-Voltage Starting Motor Control</b>                                                                        |              |
| A. Reduced-Voltage Starting Motor Control                                                                                         | _____        |
| 1. Autotransformer Reduced-Voltage Starting Motor Control                                                                         | _____        |
| 2. Part-Winding, Reduced-Voltage Starting Motor Control                                                                           | _____        |
| 3. Wye-Delta, Reduced-Voltage Starting Motor Control                                                                              | _____        |
| 4. Solid-State, Reduced-Voltage Starting Motor Control                                                                            | _____        |
| 5. Selection of Reduced-Voltage Controllers                                                                                       | _____        |
| <b>Session IV. Adjustable Frequency Drives</b>                                                                                    |              |
| A. Adjustable Frequency Drives                                                                                                    | _____        |
| 1. Basic Adjustable Frequency Drive Operation                                                                                     | _____        |
| 2. AFD Parameters That Can Be Programmed or Monitored                                                                             | _____        |
| 3. Classifications and Nameplate Markings for AFDs                                                                                | _____        |
| 4. Types of Adjustable Speed Loads                                                                                                | _____        |
| 5. AFD Selection Considerations                                                                                                   | _____        |
| <b>Session V. PT/Laboratory</b>                                                                                                   |              |
| A. PT/Laboratory                                                                                                                  | _____        |
| Have the trainees practice identifying and connecting various control devices. This laboratory corresponds to Performance Task 1. |              |
| <b>Session VI. Motor Braking Methods; Precautions When Working with Solid-State Controls</b>                                      |              |
| A. Motor Braking Methods                                                                                                          | _____        |
| 1. Dynamic Braking (DC Electric Braking) of an AC Motor                                                                           | _____        |
| 2. Dynamic Braking (AC Drives)                                                                                                    | _____        |
| 3. Electromechanical Braking                                                                                                      | _____        |
| B. Precautions When Working with Solid-State Controls                                                                             | _____        |
| <b>Session VII. Motor Control Maintenance; Motor Control Troubleshooting</b>                                                      |              |
| A. Motor Control Maintenance                                                                                                      | _____        |
| 1. Preventive Maintenance Tasks                                                                                                   | _____        |
| B. Motor Control Troubleshooting                                                                                                  | _____        |
| 1. Customer Interface                                                                                                             | _____        |
| 2. Physical Examination of the System                                                                                             | _____        |
| 3. Basic System Analysis                                                                                                          | _____        |
| 4. Use of Manufacturer's Troubleshooting Aids                                                                                     | _____        |
| 5. Troubleshooting Motor Control Circuits and Components                                                                          | _____        |
| 6. Electrical Troubleshooting Procedures Common to All Motor Control Circuits                                                     | _____        |

**Topic**

**Planned Time**

**Session VIII. Review and Testing**

A. Review

\_\_\_\_\_

B. Module Examination

\_\_\_\_\_

1. Trainees must score 70 percent or higher to receive recognition from the 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

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This module provides a basic overview of HVAC systems and their controls. Electrical troubleshooting and *NEC*<sup>®</sup> requirements are emphasized.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26407-14.

### Objectives

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

1. Identify the major mechanical components common to all HVAC systems.
2. Explain the function of a thermostat in an HVAC system.
3. Describe different types of thermostats and explain how they are used.
4. Demonstrate the correct installation and adjustment of a thermostat using proper siting and wiring techniques.
5. Explain the basic principles applicable to all control systems.
6. Identify the various types of electromechanical and electronic HVAC controls, and explain their function and operation.
7. State the *National Electrical Code*<sup>®</sup> (*NEC*<sup>®</sup>) requirements applicable to HVAC controls.

### Performance Tasks

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

1. Identify various types of thermostats and explain their operation and uses.
2. Install a conventional 24V bimetal thermostat and hook it up using the standard coding system for thermostat wiring.
3. Check and adjust a thermostat, including the heat anticipator setting and indicator adjustment.

### Materials and Equipment

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*Electrical Level Four* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Whiteboard/chalkboard  
Markers/chalk

Pencils and paper  
Appropriate personal protective equipment  
Thermostats used in residential, commercial, and industrial applications  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\* 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

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

## Additional Resources

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

*Modern Refrigeration and Air Conditioning*, A. D. Althouse, C. H. Turnquist, A. F. Bracciano. Tinley Park, IL: The Goodheart-Willcox Company, Inc., 2000.

*Remote-Mounted Thermostats*, Latest Edition. Syracuse, NY: Carrier Corporation.

## Teaching Time for this Module

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

| Topic                                                                                                                                                                                                 | Planned Time |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Heating; Ventilation; Air Conditioning</b>                                                                                                                                |              |
| A. Introduction                                                                                                                                                                                       | _____        |
| B. Heating                                                                                                                                                                                            | _____        |
| C. Ventilation                                                                                                                                                                                        | _____        |
| D. Air Conditioning                                                                                                                                                                                   | _____        |
| 1. System Components                                                                                                                                                                                  | _____        |
| 2. Refrigeration Cycle                                                                                                                                                                                | _____        |
| 3. Heat Pumps                                                                                                                                                                                         | _____        |
| <b>Session II. Thermostats</b>                                                                                                                                                                        |              |
| A. Thermostats                                                                                                                                                                                        | _____        |
| 1. Principles of Operation                                                                                                                                                                            | _____        |
| 2. Heating-Only Thermostats                                                                                                                                                                           | _____        |
| 3. Cooling-Only Thermostats                                                                                                                                                                           | _____        |
| 4. Heating-Cooling Thermostats                                                                                                                                                                        | _____        |
| 5. Heating-Cooling Automatic Changeover Thermostats                                                                                                                                                   | _____        |
| 6. Multi-Stage Thermostats                                                                                                                                                                            | _____        |
| 7. Programmable Thermostats                                                                                                                                                                           | _____        |
| 8. Line-Voltage Thermostats                                                                                                                                                                           | _____        |
| 9. Thermostat Installation                                                                                                                                                                            | _____        |
| <b>Session III. PT/Laboratories</b>                                                                                                                                                                   |              |
| A. PT/Laboratory                                                                                                                                                                                      | _____        |
| Have the trainees practice identifying various types of thermostats and explain their operation and uses. This laboratory corresponds to Performance Task 1.                                          |              |
| B. PT/Laboratory                                                                                                                                                                                      | _____        |
| Have the trainees practice installing a conventional 24V bimetal thermostat and hook it up using the standard coding system for thermostat wiring. This laboratory corresponds to Performance Task 2. |              |
| C. PT/Laboratory                                                                                                                                                                                      | _____        |
| Have the trainees practice checking and adjusting a thermostat, including the heat anticipator setting and indicator adjustment. This laboratory corresponds to Performance Task 3.                   |              |

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session IV. HVAC Control Systems; HVAC Digital Control Systems</b>                                                                                                                                                                 |              |
| A. HVAC Control Systems                                                                                                                                                                                                               | _____        |
| 1. Motor Speed Controls                                                                                                                                                                                                               | _____        |
| 2. Lockout Control Circuit                                                                                                                                                                                                            | _____        |
| 3. Time Delay Relays                                                                                                                                                                                                                  | _____        |
| 4. Compressor Short-Cycle Timer                                                                                                                                                                                                       | _____        |
| 5. Control Circuit Safety Switches                                                                                                                                                                                                    | _____        |
| 6. Furnace Controls                                                                                                                                                                                                                   | _____        |
| 7. Heat Pump Defrost Controls                                                                                                                                                                                                         | _____        |
| B. HVAC Digital Control Systems                                                                                                                                                                                                       | _____        |
| 1. Direct Digital Control                                                                                                                                                                                                             | _____        |
| 2. Controlling Devices                                                                                                                                                                                                                | _____        |
| 3. Example of a Digital Control System                                                                                                                                                                                                | _____        |
| <b>Session V. Control Circuit Review; NEC® Requirements; Troubleshooting</b>                                                                                                                                                          |              |
| A. Control Circuit Review                                                                                                                                                                                                             | _____        |
| B. NEC® Requirements                                                                                                                                                                                                                  | _____        |
| 1. NEC® Requirements for HVAC Controls                                                                                                                                                                                                | _____        |
| 2. NEC® Requirements for Compressors                                                                                                                                                                                                  | _____        |
| 3. NEC® Requirements for Room Air Conditioners                                                                                                                                                                                        | _____        |
| 4. NEC® Requirements for Electric Baseboard Heaters                                                                                                                                                                                   | _____        |
| 5. NEC® Requirements for Electric Space Heating Cables                                                                                                                                                                                | _____        |
| 6. NEC® Requirements for Energy Management Systems                                                                                                                                                                                    | _____        |
| C. Troubleshooting                                                                                                                                                                                                                    | _____        |
| <b>Session VI. Review and Testing</b>                                                                                                                                                                                                 |              |
| A. 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

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This module covers various heat tracing systems along with their applications and installation requirements.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26408-14.

## Objectives

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

1. Identify and describe the purpose of electric heat tracing equipment used with pipelines and vessels.
2. Select, size, and install electric heat tracing equipment on selected pipelines and vessels in accordance with the manufacturer's instructions and *National Electrical Code*® (*NEC*®) requirements.
3. Identify and describe the purpose of electric heating equipment used with roof, gutter, and downspout de-icing systems.
4. Select, size, and install selected roof, gutter, and downspout de-icing systems in accordance with the manufacturer's instructions and *NEC*® requirements.
5. Identify and describe the purpose of electric heating equipment used with snow-melting and anti-icing systems.
6. Select, size, and install selected snow-melting and anti-icing systems in accordance with the manufacturer's instructions and *NEC*® requirements.
7. Identify and describe the purpose of electric heat tracing equipment used with domestic hot-water temperature maintenance systems.
8. Select, size, and install selected electric heat traced domestic hot-water systems in accordance with the manufacturer's instructions and *NEC*® requirements.
9. Identify and describe the purpose of electric floor heating/warming systems.
10. Select, size, and install selected electric floor heating/warming systems in accordance with the manufacturer's instructions and *NEC*® requirements.

## Performance Task

---

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

1. Prepare and connect heat tracing cable in a power connection box or splice box.

## Materials and Equipment List

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Self-regulating cables, power-limiting cables, and mineral-insulated cables

Manufacturer's application/design guides  
Components used in pipeline heat tracing systems  
Components used in roof, gutter, and downspout de-icing systems  
Components used in snow-melting and anti-icing systems  
Electric heating mats and cables  
TV with DVD or VHS player (optional)  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\* 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

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

## Additional Resources

---

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

*American Electrician's Handbook*, Terrell Croft and Wilfred I. Summers. New York, NY: McGraw-Hill, 1996.

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

## Teaching Time for This Module

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

| Topic                                                                                                                                                                                                                                                                     | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Pipeline Heat Tracing Applications; Pipeline Electric Heat Tracing Systems; Equipment Selection and Installation for Pipe Heat Tracing Systems</b>                                                                                            |              |
| A. Introduction                                                                                                                                                                                                                                                           | _____        |
| B. Pipeline Heat Tracing Applications                                                                                                                                                                                                                                     | _____        |
| C. Pipeline Electric Heat Tracing Systems                                                                                                                                                                                                                                 | _____        |
| 1. Heat Tracing System Power Distribution                                                                                                                                                                                                                                 | _____        |
| 2. Heat Tracing System Cables                                                                                                                                                                                                                                             | _____        |
| 3. Heat Tracing System Control                                                                                                                                                                                                                                            | _____        |
| 4. Heat Tracing System Monitoring                                                                                                                                                                                                                                         | _____        |
| 5. Typical Heat Tracing System Operation                                                                                                                                                                                                                                  | _____        |
| D. Equipment Selection and Installation for Pipe Heat Tracing Systems                                                                                                                                                                                                     | _____        |
| 1. Installation Guidelines                                                                                                                                                                                                                                                | _____        |
| <b>Session II. Roof, Gutter, and Downspout De-Icing Systems; Component Selection and Installation for Roof, Gutter, and Downspout De-Icing Systems; Snow-Melting and Anti-Icing Systems; Component Selection and Installation for Snow-Melting and Anti-Icing Systems</b> |              |
| A. Roof, Gutter, and Downspout De-Icing Systems                                                                                                                                                                                                                           | _____        |
| B. Component Selection and Installation for Roof, Gutter, and Downspout De-Icing Systems                                                                                                                                                                                  | _____        |
| 1. Installation Guidelines                                                                                                                                                                                                                                                | _____        |
| C. Snow-Melting and Anti-Icing Systems                                                                                                                                                                                                                                    | _____        |
| D. Component Selection and Installation for Snow-Melting and Anti-Icing Systems                                                                                                                                                                                           | _____        |
| 1. Installation Guidelines                                                                                                                                                                                                                                                | _____        |

| Topic                                                                                                                                                                                                                                                                  | Planned Time |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session III. Domestic Hot-Water Temperature Maintenance Systems; Component Selection and Installation for Domestic Hot-Water Temperature Maintenance Systems; Floor Heating and Warming Systems; Component Selection and Installation for Floor Heating Systems</b> |              |
| A. Domestic Hot-Water Temperature Maintenance Systems                                                                                                                                                                                                                  | _____        |
| B. Component Selection and Installation for Domestic Hot-Water Temperature Maintenance Systems                                                                                                                                                                         | _____        |
| 1. Installation                                                                                                                                                                                                                                                        | _____        |
| 2. <i>NEC</i> ® Requirements                                                                                                                                                                                                                                           | _____        |
| C. Floor Heating and Warming Systems                                                                                                                                                                                                                                   | _____        |
| D. Component Selection and Installation for Floor Heating Systems                                                                                                                                                                                                      | _____        |
| 1. <i>NEC</i> ® Requirements                                                                                                                                                                                                                                           | _____        |
| E. PT/Laboratory                                                                                                                                                                                                                                                       | _____        |
| Have the trainees practice preparing and connecting heat tracing cable in a power connection box or splice box. This laboratory corresponds to Performance Task 1.                                                                                                     |              |
| <b>Session IV. Review and Testing</b>                                                                                                                                                                                                                                  |              |
| A. Review                                                                                                                                                                                                                                                              | _____        |
| B. Module Examination                                                                                                                                                                                                                                                  | _____        |
| 1. Trainees must score 70 percent or higher to receive recognition from the 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

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This module covers basic motor operation and maintenance.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26409-14.

## Objectives

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

1. Recognize the factors related to motor reliability and life span.
2. Measure motor winding insulation resistance and compensate for temperature.
3. Identify motors needing replacement.

## Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment List

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*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard

Markers/chalk  
Pencils and scratch paper  
Various couplings  
Motors and megohmmeters for insulation resistance testing  
Module Examinations\*

\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

---

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

## Additional Resources

---

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

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

## Teaching Time for This Module

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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 *Motor Operation and Maintenance*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                                                     | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Squirrel Cage Motors; Motor Maintenance</b>                                                   |              |
| A. Introduction                                                                                                           | _____        |
| 1. Usual Service Conditions                                                                                               | _____        |
| 2. Unusual Service Conditions                                                                                             | _____        |
| 3. Effects of Overloading and Single-Phasing                                                                              | _____        |
| 4. Insulation Systems                                                                                                     | _____        |
| B. Squirrel Cage Motors                                                                                                   | _____        |
| 1. Starting Configurations                                                                                                | _____        |
| 2. Typical Squirrel Cage Motor Winding Failures                                                                           | _____        |
| C. Motor Maintenance                                                                                                      | _____        |
| 1. Tools for Maintenance and Troubleshooting                                                                              | _____        |
| 2. Basic Care and Maintenance                                                                                             | _____        |
| 3. Periodic Predictive Testing                                                                                            | _____        |
| <b>Session II. Motor Bearing Maintenance; Motor Insulation Testing</b>                                                    |              |
| A. Motor Bearing Maintenance                                                                                              | _____        |
| 1. Frequency of Lubrication                                                                                               | _____        |
| 2. Lubrication Procedure                                                                                                  | _____        |
| 3. Checking Bearings                                                                                                      | _____        |
| B. Motor Insulation Testing                                                                                               | _____        |
| 1. Insulation Resistance Tests                                                                                            | _____        |
| 2. Determining the Polarization Index                                                                                     | _____        |
| 3. Insulation Testing Considerations                                                                                      | _____        |
| <b>Session III. Receiving and Storing Motors; Troubleshooting Motors; Motor Installation and Commissioning Guidelines</b> |              |
| A. Receiving and Storing Motors                                                                                           | _____        |
| B. Troubleshooting Motors                                                                                                 | _____        |
| 1. Insulation Testing                                                                                                     | _____        |
| 2. Grounded Coils                                                                                                         | _____        |
| 3. Water-Damaged Motors                                                                                                   | _____        |
| C. Laboratory                                                                                                             | _____        |
| Have the trainees practice performing an insulation resistance test.                                                      |              |
| D. Motor Installation and Commissioning Guidelines                                                                        | _____        |
| 1. Alignment                                                                                                              | _____        |
| 2. Endplay Adjustment                                                                                                     | _____        |
| 3. First-Time Startup                                                                                                     | _____        |
| 4. Coupled Startup                                                                                                        | _____        |
| 5. Doweling                                                                                                               | _____        |



**Topic**

**Planned Time**

**Session IV. Review and Testing**

A. Review

\_\_\_\_\_

B. Module Examination

\_\_\_\_\_

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

### Module Overview

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This module offers an overview of the *NEC*<sup>®</sup> and cable manufacturers' requirements for medium-voltage terminations and splices.

### Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26410-14.

### Objectives

---

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

1. Select the proper materials and tools for medium-voltage terminations and splices.
2. Prepare medium-voltage cable for terminations and splices.
3. Complete cable assemblies using terminations and splices.
4. Inspect and test medium-voltage terminations and splices.

### Performance Task

---

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

1. Prepare a cable and complete a splice or stress cone.

### Materials and Equipment List

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*Electrical Level Four* PowerPoint<sup>®</sup> Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com))  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Common types of medium-voltage cable  
Inline tape splicing kits

Various types of tape applied for primary insulation  
Manufactured termination and splice kits  
Quick inline splicing kit  
Photos of terminations/cables that have been damaged by flashover and/or tracking  
Insulators used with medium-voltage terminations  
Quick Quiz\*  
Module Examinations\*\*  
Performance Profile Sheets\*\*

\* Located at the back of this module.

\*\* 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.

## Additional Resources

---

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

*American Electrician's Handbook*, Terrell Croft and Wilfred I. Summers. New York, NY: McGraw-Hill, 1996.

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

## Teaching Time for This Module

---

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

| Topic                                                                                                                                   | Planned Time |
|-----------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Medium-Voltage Power Cable; Splicing I</b>                                                                  | _____        |
| A. Introduction                                                                                                                         | _____        |
| 1. Straight Splices                                                                                                                     | _____        |
| B. Medium-Voltage Power Cable                                                                                                           | _____        |
| 1. Medium-Voltage Cable Components                                                                                                      | _____        |
| 2. Strand Shielding                                                                                                                     | _____        |
| 3. Insulation                                                                                                                           | _____        |
| 4. Insulation Shield System                                                                                                             | _____        |
| 5. Jacket                                                                                                                               | _____        |
| C. Splicing                                                                                                                             | _____        |
| 1. Splicing Steps                                                                                                                       | _____        |
| 2. Inline Tape Splices                                                                                                                  | _____        |
| <b>Session II. Splicing II</b>                                                                                                          | _____        |
| A. Splicing                                                                                                                             | _____        |
| 1. Tee Tape Splice                                                                                                                      | _____        |
| 2. Manufactured Termination and Splice Kits                                                                                             | _____        |
| 3. Quick Inline Splicing Kits                                                                                                           | _____        |
| 4. Paper-Insulated Cable Splices                                                                                                        | _____        |
| B. PT/Laboratory                                                                                                                        | _____        |
| Have the trainees practice preparing a cable and completing a splice or stress cone. This laboratory corresponds to Performance Task 1. |              |

| Topic                                                                                                                                                                                                                                 | Planned Time |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session III. Terminations; High-Potential (Hi-Pot) Testing</b>                                                                                                                                                                     | _____        |
| A. Terminations                                                                                                                                                                                                                       | _____        |
| 1. Stress Control                                                                                                                                                                                                                     | _____        |
| 2. Sealing to the External Environment                                                                                                                                                                                                | _____        |
| B. High-Potential (Hi-Pot) Testing                                                                                                                                                                                                    | _____        |
| 1. Method of Application                                                                                                                                                                                                              | _____        |
| 2. Selective Guard Circuits                                                                                                                                                                                                           | _____        |
| 3. Connections                                                                                                                                                                                                                        | _____        |
| 4. Selective Guard Service Connections                                                                                                                                                                                                | _____        |
| 5. Corona Guard Ring and Guard Shield                                                                                                                                                                                                 | _____        |
| 6. Detailed Operating Procedure                                                                                                                                                                                                       | _____        |
| 7. Go/No-Go Testing                                                                                                                                                                                                                   | _____        |
| 8. Insulation Resistance Measurements                                                                                                                                                                                                 | _____        |
| <b>Session IV. Review; Testing</b>                                                                                                                                                                                                    | _____        |
| A. Review                                                                                                                                                                                                                             | _____        |
| B. Module Examination                                                                                                                                                                                                                 | _____        |
| 1. Trainees must score 70 percent or higher to receive recognition from the 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

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This module covers the *National Electrical Code*<sup>®</sup> (NEC<sup>®</sup>) requirements for special occupancies or installations.

## Prerequisites

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Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-14 through 26411-14.

## Objectives

---

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

1. Identify and select equipment, enclosures, devices, and wiring methods approved by the current NEC<sup>®</sup> for the following special occupancies or installations:
  - Places of assembly
  - Theaters
  - Carnivals, circuses, and fairs
  - Agricultural buildings
  - Marinas and boatyards
  - Temporary wiring
  - Office partitions
  - Swimming pools, fountains, hot tubs, and similar installations
  - Natural and manmade bodies of water
2. Comply with NEC<sup>®</sup> requirements regarding equipotential planes as they refer to bonding and grounding in water-related installations.
3. Determine electrical datum planes in water-related installations.

## Performance Tasks

---

This is a knowledge-based module. There are no Performance Tasks.

## Materials and Equipment List

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|                                                                                                              |                           |
|--------------------------------------------------------------------------------------------------------------|---------------------------|
| <i>Electrical Level Four</i> PowerPoint <sup>®</sup> Presentation                                            | Whiteboard/chalkboard     |
| Slides can be downloaded (with your access code) from <a href="http://www.nccerirc.com">www.nccerirc.com</a> | Markers/chalk             |
| Multimedia projector and screen                                                                              | Pencils and scratch paper |
| Computer                                                                                                     | Quick Quiz*               |
| Appropriate personal protective equipment                                                                    | Module Examinations**     |

\* Located at the back of this module.

\*\* Single-module AIG purchases include the printed exam. If you have purchased the perfect-bound version of this title, download this material from the IRC using your access code.

## Safety Considerations

---

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

## Additional Resources

---

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

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

## Teaching Time for This Module

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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 *Special Locations*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

| Topic                                                                                     | Planned Time |
|-------------------------------------------------------------------------------------------|--------------|
| <b>Session I. Introduction; Assembly Occupancies; Theaters and Similar Locations</b>      |              |
| A. Introduction                                                                           | _____        |
| B. Assembly Occupancies                                                                   | _____        |
| 1. Wiring Methods in Assembly Occupancies                                                 | _____        |
| 2. Finish Ratings                                                                         | _____        |
| C. Theaters and Similar Locations                                                         | _____        |
| 1. Wiring Methods in Theaters, Audience Areas, and Similar Locations                      | _____        |
| 2. Fixed Stage Switchboards                                                               | _____        |
| 3. Wiring Methods for Fixed Equipment (Other Than Switchboards)                           | _____        |
| 4. On-Stage Portable Switchboards                                                         | _____        |
| 5. Dressing Rooms                                                                         | _____        |
| <b>Session II. Carnivals, Circuses, Fairs, and Similar Events; Agricultural Buildings</b> |              |
| A. Carnivals, Circuses, Fairs, and Similar Events                                         | _____        |
| 1. Overhead Conductor Clearances                                                          | _____        |
| 2. Power Sources                                                                          | _____        |
| 3. Wiring Methods—Cords, Cables, and Connectors                                           | _____        |
| 4. Wiring Methods—Rides, Tents, and Concessions                                           | _____        |
| 5. Grounding and Bonding                                                                  | _____        |
| B. Agricultural Buildings                                                                 | _____        |
| 1. Wiring Methods                                                                         | _____        |
| 2. Motors and Luminaires                                                                  | _____        |
| 3. Electrical Supply from a Distribution Point                                            | _____        |
| 4. Equipotential Planes                                                                   | _____        |
| <b>Session III. Marinas and Boatyards</b>                                                 |              |
| A. Marinas and Boatyards                                                                  | _____        |
| 1. General Requirements for Devices, Equipment, and Enclosures                            | _____        |
| 2. Service and Feeder Conductor Load Calculations                                         | _____        |
| 3. Wiring Methods                                                                         | _____        |
| 4. Grounding                                                                              | _____        |
| 5. Disconnecting Means for Shore Power                                                    | _____        |
| 6. Receptacles                                                                            | _____        |
| 7. Hazardous Locations in and Around Marinas and Boatyards                                | _____        |

| Topic                                                                                                              | Planned Time |
|--------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Session IV. Temporary Installations; Wired Partitions</b>                                                       |              |
| A. Temporary Installations                                                                                         | _____        |
| 1. Feeder and Branch Circuit Conductors                                                                            | _____        |
| 2. Receptacles                                                                                                     | _____        |
| 3. Temporary Lighting                                                                                              | _____        |
| 4. Wiring and Equipment Greater Than 600V                                                                          | _____        |
| 5. Ground Fault Protection                                                                                         | _____        |
| 6. Assured Equipment Grounding Conductor Program                                                                   | _____        |
| B. Wired Partitions                                                                                                | _____        |
| <b>Sessions V and VI. Swimming Pools, Fountains, Hot Tubs, and Similar Installations</b>                           |              |
| A. Swimming Pools, Fountains, Hot Tubs, and Similar Installations                                                  | _____        |
| 1. General Wiring Requirements                                                                                     | _____        |
| 2. Permanently Installed Pools                                                                                     | _____        |
| 3. Storable Pools                                                                                                  | _____        |
| 4. Spas and Hot Tubs                                                                                               | _____        |
| 5. Fountains                                                                                                       | _____        |
| 6. Therapeutic Pools and Tubs                                                                                      | _____        |
| 7. Hydromassage Bathtubs                                                                                           | _____        |
| <b>Session VII. Natural and Manmade Bodies of Water</b>                                                            |              |
| A. Natural and Manmade Bodies of Water                                                                             | _____        |
| 1. Electrical Datum Plane                                                                                          | _____        |
| 2. Location of Equipment and Enclosures                                                                            | _____        |
| 3. GFCI Protection, Grounding, and Bonding                                                                         | _____        |
| 4. Equipotential Planes                                                                                            | _____        |
| <b>Session VIII. Review and Testing</b>                                                                            |              |
| A. Review                                                                                                          | _____        |
| B. Module Examination                                                                                              | _____        |
| 1. Trainees must score 70 percent or higher to receive recognition from the NCCER.                                 |              |
| 2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor. |              |

### Module Overview

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Today's leaders face a complex and challenging workforce, and having a capable leader is essential to the success of any team. This module introduces the trainee to the principles of leadership. Trainees will learn about:

- The construction industry today
- Business organizations
- Team building
- Gender and minority issues
- Communication
- Motivation
- Problem solving
- Decision making
- Safety
- Project control

### Prerequisites

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There are no prerequisites for this course.

### Objectives

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

1. Discuss current issues and organizational structure in industry today.
2. Understand and incorporate leadership skills into work habits, including communications, motivation, team building, problem solving, and decision-making skills.
3. Demonstrate an awareness of safety issues, including the cost of accidents and safety regulations.
4. Identify a crew leader's typical safety responsibilities.
5. Show a basic understanding of the planning process, scheduling, and cost and resource control.

### Performance Tasks

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

1. Develop an estimate for a given work activity.
2. Develop and present a look-ahead schedule.

### Note to Instructors

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If you are training under an Accredited NCCER Sponsor, note that you may be eligible for dual credentials for successful completion of *Fundamentals of Crew Leadership*. When submitting the Form 200, indicate completion of the two module numbers that apply to *Fundamentals of Crew Leadership – 46101-11* (from NCCER's Management Series) and the applicable craft module (if used as part of a craft training program) and transcripts will be issued to you accordingly.



## Materials and Equipment

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Markers/chalk  
Pencils and scratch paper  
Whiteboard/chalkboard  
*Electrical Level Four* PowerPoint® Presentation  
Slides can be downloaded (with your access code) from [www.nccerirc.com](http://www.nccerirc.com)  
Multimedia projector and screen  
Computer  
Several construction job descriptions, including one that is very vague and one that is overly detailed  
Several MSDSs appropriate to the craft  
Original and as-built drawings of the same project  
A redline drawing  
Sufficient copies of a roofing formwork detail drawing  
Sufficient copies of the worksheet with entries

Examples of schedules:\*

- Bar chart
- Network schedule
- Short-term or look-ahead schedule

Two or three typical job schedules  
Two job plans and pictures of each site  
Construction drawings of a work platform with a concrete footing, including specifications, to be built on site:

- Materials cost list including lumber, concrete, and hardware
- Labor cost list including concrete finishers, carpenters, and masonry workers
- Photographs of the planned site
- Set of construction drawings

Module Examinations\*\*  
Performance Profile Sheets\*\*

- \* Because this module may be used for different industries, materials such as project schedules should be appropriate to the craft where possible.
- \*\*Single-module AIG purchases include the printed exam and Performance Profile Sheets. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

## Additional Resources

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

- Aging Workforce News, [www.agingworkforcenews.com](http://www.agingworkforcenews.com).
  - American Society for Training and Development (ASTD), [www.astd.org](http://www.astd.org).
  - Architecture, Engineering, and Construction Industry (AEC), [www.aecinfo.com](http://www.aecinfo.com).
  - CIT Group, [www.citgroup.com](http://www.citgroup.com).
  - Equal Employment Opportunity Commission (EEOC), [www.eeoc.gov](http://www.eeoc.gov).
  - National Association of Women in Construction (NAWIC), [www.nawic.org](http://www.nawic.org).
  - National Census of Fatal Occupational Injuries (NCFOTI), [www.bls.gov](http://www.bls.gov).
  - National Center for Construction Education and Research, [www.nccer.org](http://www.nccer.org).
  - National Institute of Occupational Safety and Health (NIOSH), [www.cdc.gov/niosh](http://www.cdc.gov/niosh).
  - National Safety Council, [www.nsc.org](http://www.nsc.org).
- NCCER Publications:
- *Your Role in the Green Environment*
  - *Sustainable Construction Supervisor*
- Occupational Safety and Health Administration (OSHA), [www.osha.gov](http://www.osha.gov).
  - Society for Human Resources Management (SHRM), [www.shrm.org](http://www.shrm.org).
  - United States Census Bureau, [www.census.gov](http://www.census.gov).
  - United States Department of Labor, [www.dol.gov](http://www.dol.gov).
  - USA Today, [www.usatoday.com](http://www.usatoday.com).

## Teaching Time for This Module

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An outline for use in developing your lesson plan is presented below. This course is designed to be taught in one of two formats: two 8-hour sessions (such as all-day workshops) or eight 2-hour sessions (such as after-work training seminars). Because of this, each session below has a suggested time period of two hours. If leading 8-hour sessions, simply teach four of these 2-hour sessions both times your class meets. All instructors will need to adjust the time required for participant activities and testing based on class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

| Topic                                                        | Planned Time |
|--------------------------------------------------------------|--------------|
| <b>Session I. Section One – The Basics</b>                   |              |
| A. Industry Today                                            | _____        |
| 1. The Need for Training                                     | _____        |
| 2. Impact of Technology                                      | _____        |
| B. Gender and Cultural Issues                                | _____        |
| 1. Communication Styles of Men and Women                     | _____        |
| 2. Language Barriers                                         | _____        |
| 3. Cultural Differences                                      | _____        |
| 4. Sexual Harassment                                         | _____        |
| 5. Gender and Minority Discrimination                        | _____        |
| C. Business Organizations                                    | _____        |
| 1. Division of Responsibility                                | _____        |
| 2. Authority, Responsibility, and Accountability             | _____        |
| 3. Job Descriptions                                          | _____        |
| 4. Policies and Procedures                                   | _____        |
| <b>Session II. Section Two – Leadership Skills, Part One</b> |              |
| A. Introduction to Leadership                                | _____        |
| B. The Shift in Work Activities                              | _____        |
| C. Becoming a Leader                                         | _____        |
| 1. Characteristics of a Leader                               | _____        |
| 2. Functions of a Leader                                     | _____        |
| 3. Leadership Styles                                         | _____        |
| 4. Ethics in Leadership                                      | _____        |
| D. Communication                                             | _____        |
| 1. Verbal Communication                                      | _____        |
| 2. Nonverbal Communication                                   | _____        |
| 3. Written or Visual Communication                           | _____        |
| 4. Communication Issues                                      | _____        |
| E. Motivation                                                | _____        |
| 1. Employee Motivators                                       | _____        |
| 2. Motivating Employees                                      | _____        |
| F. Team Building                                             | _____        |
| 1. Successful Teams                                          | _____        |
| 2. Building Successful Teams                                 | _____        |



**Session VI. Section Four – Project Control, Part Two**

A. Planning

1. Why Plan?

2. Stages of Planning

B. PT/Laboratory

Have the trainees develop and present a look-ahead schedule based on one of the plans. This laboratory corresponds to Performance Task 2.

C. The Planning Process

1. Establish a Goal

2. Identify the Work to Be Done

3. Identify Tasks to Be Performed

4. Communicating Responsibilities

5. Follow-Up Activities

D. Planning Resources

1. Safety Planning

2. Materials Planning

3. Site Planning

4. Equipment Planning

5. Tool Planning

6. Labor Planning

**Session VII. Section Four – Project Control, Part Three**

A. Scheduling

1. The Scheduling Process

2. Bar Chart Schedule

3. Network Schedule

4. Short-Term Scheduling

5. Updating a Schedule

B. Cost Control

1. Assessing Cost Performance

2. Field Reporting System

3. Crew Leader's Role in Cost Control

C. Resource Control

1. Materials Control

2. Equipment Control

3. Tool Control

4. Labor Control

D. Production and Productivity

**Session VIII. Review; 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. Trainee must perform each task to the satisfaction of the instructor to receive recognition from NCCER.

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