

Load Calculations – Feeders and Services Annotated Instructor’s Guide

Module 26401-11

Module Overview

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

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*.

Objectives

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

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

Materials and Equipment

Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)

Multimedia projector and screen

Computer

Appropriate personal protective equipment

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Quick Quiz*

Module Examinations**

* 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

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
Sessions I and II. Introduction; Basic Calculation Procedures	
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	_____
Sessions III – V. Load Calculations for a Minimum Size Service; Commercial Occupancy Calculations	
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	_____
Session VI. Restaurants; Optional Calculation for New Restaurants; Services for Hotels and Motels; Optional Calculations for Schools	
A. Restaurants	_____
B. Optional Calculation for New Restaurants	_____
C. Services for Hotels and Motels	_____
D. Optional Calculations for Schools	_____
Session VII. Shore Power Circuits for Marinas and Boatyards; Farm Load Calculations; Motors and Motor Circuits	
A. Shore Power Circuits for Marinas and Boatyards	_____
B. Farm Load Calculations	_____
C. Motors and Motor Circuits	_____
Session VIII. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.	

Module Overview

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

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*, Module 26401-11.

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

Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)
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 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.
Standard for Health Care Facilities (NFPA 99), 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 *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
Session I. Introduction; Essential Electrical System Types; Electrical Distribution Systems	
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	_____
Session II. Wiring and Devices	
A. Wiring and Devices	_____
1. Hospital-Grade Receptacles	_____
2. General Care Areas	_____
3. Critical Care Areas	_____
4. Grounding of Receptacles and Fixed Electric Equipment	_____
5. Inhalation Anesthetizing Locations	_____
6. Low-Voltage Equipment and Instruments	_____
7. X-Ray Installations	_____
Session III. Communication; Signaling, Data, and Fire Alarm Systems; Isolated Power Systems	
A. Communication, Signaling, Data, and Fire Alarm Systems	_____
B. Isolated Power Systems	_____
1. Installation of Isolated Power Systems	_____
2. Line Isolation Monitors	_____
Session IV. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.	

Module Overview

This module explains the *NEC*[®] installation requirements for electric generators and storage.

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 26401-11 and 26402-11.

Objectives

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*[®] (*NEC*[®]) 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

Electrical Level Four PowerPoint[®] Presentation
Slides (ISBN 978-0-13-257134-0)
Multimedia projector and screen
Computer
Appropriate personal protective equipment
Whiteboard/chalkboard
Markers/chalk
Pencils and paper

Appropriate personal protective equipment
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 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.

- 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

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
Session I. Introduction; Emergency and Standby Power System Components	
A. Introduction	_____
B. Emergency and Standby Power System Components	_____
1. Engine-Driven Generator Sets	_____
2. Transfer Switches	_____
3. Automatic Sequential Paralleling Emergency/Standby System	_____
Session II. Storage Batteries; Static Uninterruptible Power Supply	
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	_____
Session III. NEC® Requirements for Emergency Systems; Emergency System Circuits for Light and Power	
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	_____
Session IV. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	
2. Record the testing results on 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 26401-11 through 26403-11.

Objectives

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

Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)
Multimedia projector and screen
Computer
Appropriate personal protective equipment
Whiteboard/chalkboard
Markers/chalk
Pencils and 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

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.

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

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 *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
Session I. Introduction; Electricity Under Magnification; Semiconductor Fundamentals	
A. Introduction	_____
B. Electricity Under Magnification	_____
C. Semiconductor Fundamentals	_____
1. Conductors	_____
2. Insulators	_____
3. Semiconductors	_____
Session II. Diodes; Light-Emitting Diodes; Transistors	
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.	
Session III. Silicon-Controlled Rectifiers; Diacs; Triacs	
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 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 covers fire alarm control units, Digital Alarm Communicator Systems (DACS), installation wiring for alarm initiating and notification devices, and alarm system maintenance.

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 26401-11 through 26404-11.

Objectives

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

Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)
Multimedia projector and screen
Computer
Appropriate personal protective equipment
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
As available, examples of detectors:
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

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

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
Session I. Introduction; Codes and Standards; Fire Alarm Systems Overview; Fire Alarm System Equipment	
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	_____
Session II. Fire Alarm Initiating Devices	
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
Session III. Control Panels; FACP Primary and Secondary Power; Notification Appliances	
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	_____
Session IV. Communications and Monitoring; General Installation Guidelines	
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
Session V. Total Premises Fire Alarm System Installation Guidelines; Fire Alarm-Related Systems and Installation Guidelines; Troubleshooting	
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 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 covers various types of transformers and their applications, and presents information on selecting, sizing, and installing them.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-11 through 26405-11.

Objectives

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

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

Performance Tasks

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

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

Materials and Equipment

Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)
Multimedia projector and screen
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and paper

Appropriate personal protective equipment
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

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

Topic	Planned Time
Session III. Harmonics	
A. Harmonics	_____
1. Defining the Problem	_____
2. Office Buildings and Plants	_____
3. Survey the Situation	_____
4. Solving the Problem	_____
Session IV. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	
2. Record the testing results on 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 explains applications and operating principles of solid-state controls, reduced-voltage starters, and adjustable frequency drives. It also describes troubleshooting procedures.

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 26401-11 through 26406-11.

Objectives

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

Electrical Level Four PowerPoint® Presentation

Slides (ISBN 978-0-13-257134-0)

Multimedia projector and screen

Computer

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Appropriate personal protective equipment

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

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

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
Session I. Introduction; Solid-State Relays	
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	_____
Session II. Solid-State Protective Relays; Timing Relays	
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
Session III. Reduced-Voltage Starting Motor Control	
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	_____
Session IV. Adjustable Frequency Drives	
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	_____
Session V. PT/Laboratory	
A. PT/Laboratory	_____
Have the trainees practice identifying and connecting various control devices. This laboratory corresponds to Performance Task 1.	
Session VI. Motor Braking Methods; Precautions When Working with Solid-State Controls	
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	_____
Session VII. Motor Control Maintenance; Motor Control Troubleshooting	
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 NCCER.	
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.	
C. Performance Testing	_____
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.	
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.	

Module Overview

This module provides a basic overview of HVAC systems and their controls. Electrical troubleshooting and *NEC*[®] requirements are emphasized.

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 26401-11 through 26407-11.

Objectives

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*[®] (*NEC*[®]) requirements applicable to HVAC controls.

Performance Tasks

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

Electrical Level Four PowerPoint[®] Presentation

Slides (ISBN 978-0-13-257134-0)

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

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.

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

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
Session I. Introduction; Heating; Ventilation; Air Conditioning	
A. Introduction	_____
B. Heating	_____
C. Ventilation	_____
D. Air Conditioning	_____
1. System Components	_____
2. Refrigeration Cycle	_____
3. Heat Pumps	_____
Session II. Thermostats	
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	_____
Session III. PT/Laboratories	
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
Session IV. HVAC Control Systems; HVAC Digital Control Systems	
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	_____
Session V. Control Circuit Review; NEC® Requirements; Troubleshooting	
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	_____
C. Troubleshooting	_____
Session VI. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	
2. Record the testing results on 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 describes heat tracing systems, their applications, and installation requirements.

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 26401-11 through 26408-11.

Objectives

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

Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)

Multimedia projector and screen

Computer

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Appropriate personal protective equipment

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

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 *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
Session I. Introduction; Pipeline Heat Tracing Applications; Pipeline Electric Heat Tracing Systems; Equipment Selection and Installation for Pipe Heat Tracing Systems	
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	_____
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	
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
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	
A. Domestic Hot-Water Temperature Maintenance Systems	_____
B. Component Selection and Installation for Domestic Hot-Water Temperature Maintenance Systems	_____
1. Installation	_____
2. NEC® Requirements	_____
C. Floor Heating and Warming Systems	_____
D. Component Selection and Installation for Floor Heating Systems	_____
1. NEC® 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.	
Session IV. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	
2. Record the testing results on 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 covers basic motor operation and maintenance.

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 26401-11 through 26409-11.

Objectives

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

Multimedia projector and screen
Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)
Computer
Whiteboard/chalkboard
Markers/chalk

Pencils and paper
Appropriate personal protective equipment
Various couplings
Motors and megohmmeters for insulation resistance testing
Module Examinations*

* 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

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
Session I. Introduction; Squirrel Cage Motors; Motor Maintenance	
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	_____
Session II. Motor Bearing Maintenance; Motor Insulation Testing	
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	_____
Session III. Receiving and Storing Motors; Troubleshooting Motors; Motor Installation and Commissioning Guidelines	
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 NCCER.

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

Module Overview

This module offers an overview of the NEC® and cable manufacturers' requirements for medium-voltage 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; Electrical Level Two; Electrical Level Three; and Electrical Level Four*, Modules 26401-11 through 26410-11.

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

Electrical Level Four PowerPoint® Presentation
Slides (ISBN 978-0-13-257134-0)

Multimedia projector and screen

Computer

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

Appropriate personal protective equipment

Common types of medium-voltage cable

Inline tape splicing kits

Quick inline splicing kit

Various types of tape applied for primary insulation

Manufactured termination and splice kits

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
Session I. Introduction; Medium-Voltage Power Cable; Splicing, Part One	_____
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	_____
Session II. Splicing, Part Two	_____
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
Session III. Terminations; High-Potential (Hi-Pot) Testing	_____
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	_____
Session IV. Review; Testing	_____
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	_____
2. Record the testing results on 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 covers the *National Electrical Code*[®] (*NEC*[®]) requirements for special occupancies or installations.

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 26401-11 through 26411-11.

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*[®] 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*[®] 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

<i>Electrical Level Four</i> PowerPoint [®] Presentation	Markers/chalk
Slides (ISBN 978-0-13-257134-0)	Pencils and paper
Multimedia projector and screen	Appropriate personal protective equipment
Computer	Quick Quiz*
Whiteboard/chalkboard	Module Examinations**

* 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

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
Session I. Introduction; Assembly Occupancies; Theaters and Similar Locations	_____
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	_____
Session II. Carnivals, Circuses, Fairs, and Similar Events; Agricultural Buildings	_____
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	_____
Session III. Marinas and Boatyards	_____
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
Session IV. Temporary Installations; Wired Partitions	_____
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	_____
Sessions V and VI. Swimming Pools, Fountains, Hot Tubs, and Similar Installations	
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	_____
Session VII. Natural and Manmade Bodies of Water	
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	_____
Session VIII. Review and Testing	
A. Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from NCCER.	
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.	