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 LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Trade Terms Quiz*
Module Examinations**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *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 and 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 through V. Load Calculations for a Minimum Size Service and 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, and 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, and 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 Module Examination

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 Craft 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 26401-08.

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 LIST

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

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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, and 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 and 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 Module Examination

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 Craft 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 26401-08 and 26402-08.

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 LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Engine-driven AC generator
Transfer switches
Storage batteries
Tools to perform resistance and capacity checks on batteries
Module Examinations*

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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 and 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 and 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 Sytems _____

Session III. *NEC*® Requirements for Emergency Systems and 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 Module Examination

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 Craft 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 26401-08 through 26403-08.

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 LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Various diodes
Light-emitting diodes (LEDs)
Transistors
Silicon-controlled rectifiers (SCRs)
Schematic drawings
Trade Terms Quiz*
Module Examinations**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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. 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. 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.

Session IV. Review and Module Examination

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

MODULE OVERVIEW

This module covers 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 26401-08 through 26404-08.

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 TASKS

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

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
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
Trade Terms Quiz*
Module Examinations**
Performance Profile Sheets**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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 _____

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 _____

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. Laboratory _____

   Have the trainees practice connecting selected fire alarm systems. This laboratory corresponds to Performance Task 1.

Session VI. Review; 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

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

Specialty Transformers
Annotated Instructor's Guide

Module 26406-08

MODULE OVERVIEW

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

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One*; *Electrical Level Two; Electrical Level Three;* and *Electrical Level Four,* Modules 26401-08 through 26405-08.

OBJECTIVES

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

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

PERFORMANCE TASKS

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

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

MATERIALS AND EQUIPMENT LIST

Copy of the latest edition of the *National Electrical Code®*
Conductors for making transformer connections
Connectors and related hand tools for making transformer connections
Buck-and-boost transformer selection charts
Various types of specialty transformers
Buck-and-boost transformers
Potential (voltage) and current transformers
Clamp-on ammeter
Multimeter
Module Examinations*
Performance Profile Sheets*

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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

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. Laboratory _____

   Have the trainees practice identifying various specialty transformers. This laboratory corresponds to Performance Task 1.

Session II. Instrument Transformers; Sizing Buck-and-Boost Transformers

A. Instrument Transformers _____
   1. Current Transformers _____
   2. Potential Transformers _____

B. Laboratory _____

   Have the trainees practice using a clamp-on ammeter to demonstrate the principles of a current transformer. Have them identify the primary winding, then calculate and measure the effects of increasing the number of turns (loops) in the primary winding. This laboratory corresponds to Performance Task 2.

C. Sizing Buck-and-Boost Transformers _____

D. Laboratory _____

   Have the trainees practice connecting a buck-and-boost transformer to a single-phase circuit so that it will first be in the boost mode, and then in the buck mode. Have them record the voltage increase and decrease for each configuration. This laboratory corresponds to Performance Task 3.

Session III. Harmonics

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

Session IV. Review; 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

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

MODULE OVERVIEW

This module explains applications and operating principles of solid-state controls, reduced-voltage starters, and adjustable frequency drives, as well as 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 26401-08 through 26406-08.

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 TASKS

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

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch 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
Trade Terms Quiz*
Module Examinations**
Performance Profile Sheets**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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	_____
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. Laboratory

A. 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 _____

Session VIII. Review; 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

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

MODULE OVERVIEW

This module provides a basic overview of HVAC systems and their controls, and stresses electrical troubleshooting and *NEC*® 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 26401-08 through 26407-08.

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 LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Thermostats used in residential, commercial, and industrial applications
Trade Terms Quiz*
Module Examinations**
Performance Profile Sheets**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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. Laboratories	
A. Laboratory	_____
Have the trainees practice identifying various types of thermostats and explain their operation and uses. This laboratory corresponds to Performance Task 1.	
B. 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. 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.	

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

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

MODULE OVERVIEW

This module covers various heat tracing systems along with 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 26401-08 through 26408-08.

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 TASKS

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

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Self-regulating cables
Power-limiting cables
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)
Trade Terms Quiz*
Module Examinations**
Performance Profile Sheets**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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 _____

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. 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; 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

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

MODULE OVERVIEW

This module covers 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 26401-08 through 26409-08.

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 LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Various couplings
Motors and megohmmeters for insulation resistance testing
Module Examinations*

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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

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 _____

Session IV. Review; 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 Craft 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 26401-08 through 26410-08.

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 TASKS

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

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
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
Trade Terms Quiz*
Module Examinations**
Performance Profile Sheets**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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 I	
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 II	
A. Splicing	_____
1. Tee Tape Splice	_____
2. Manufactured Termination and Splice Kits	_____
3. Quick Inline Splicing Kits	_____
4. Paper-Insulated Cable Splices	_____
B. Laboratory	_____
Have the trainees practice preparing a cable and completing a splice or stress cone. This laboratory corresponds to Performance Task 1.	
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 the NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing _____

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

MODULE OVERVIEW

This module covers 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 26401-08 through 26411-08.

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 LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Trade Terms Quiz*
Module Examinations**

*Located in the back of this module.

**Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

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

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *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 _____

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; 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 Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the basic leadership skills a crew leader needs in order to supervise a crew.

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 26401-08 through 26412-08.

PERFORMANCE TASKS

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

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
OSHA log books
Sample MSDSs
Module Examinations*

*Located in the Test Booklet.

SAFETY CONSIDERATIONS

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

ADDITIONAL RESOURCES

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

National Association of Women in Construction (NAWIC), www.nawic.org
National Institute of Occupational Safety and Health (NIOSH), www.cdc.gov/niosh
National Safety Council, www.nsc.org
Occupational Safety and Health Administration (OSHA), www.osha.gov
Society for Human Resources Management (SHRM), www.shrm.org
United States Department of Labor, www.dol.gov

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 16 hours are suggested to cover *Introductory Skills for the Crew Leader.* 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. Orientation to the Job; Leadership Skills I	
A. Growth and Economics of the Construction Industry	_____
1. Changing Values of Workers	_____
B. The Construction Industry Today	_____
1. Training	_____
2. Impact of Developing Technology	_____
C. 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	_____
D. The Construction Organization	_____
1. Division of Responsibility	_____
2. Authority and Responsibility	_____
3. Job Descriptions	_____
4. Policies and Procedures	_____
E. Introduction to Supervision	_____
F. The Shift in Work Activities	_____
G. Becoming a Leader	_____
1. Characteristics of Leaders	_____
2. Functions of a Leader	_____
3. Leadership Styles	_____
4. Ethics in Leadership	_____
H. Communication	_____
1. Verbal Communication	_____
2. Non-Verbal Communication	_____
3. Written or Visual Communication	_____
4. Communication Issues	_____
I. Motivation	_____
1. Employee Motivators	_____
2. Motivating Employees	_____
Session II. Leadership Skills II; Safety Objectives	
A. Team Building	_____
1. Successful Teams	_____
2. Building Successful Teams	_____
B. Getting the Job Done	_____
1. Delegating Responsibilities	_____
2. Implementing Policies and Procedures	_____

C. Problem Solving and Decision Making _____
1. Problem Solving vs. Decision Making _____
2. Types of Decisions _____
3. Formal Problem-Solving Techniques _____
4. Special Leadership Problems _____

D. Safety Overview _____
1. Accident Statistics _____

E. Costs of Accidents _____
1. Insured Costs _____
2. Uninsured Costs _____

F. Safety Regulations _____
1. Workplace Inspections _____
2. Penalties for Violations _____

G. Safety Responsibilities _____
1. Safety Program _____
2. Safety Policies and Procedures _____
3. Hazard Identification and Assessment _____
4. Safety Information and Training _____
5. Safety Record Systems _____
6. Accident Investigation Procedures _____

H. Supervisor Involvement in Safety _____
1. Safety Meetings _____
2. Inspections _____
3. First Aid _____
4. Fire Protection and Prevention _____
5. Substance Abuse _____
6. Accident Investigations _____

I. Promoting Safety _____
1. Meetings _____
2. Contests _____
3. Recognition and Awards _____
4. Publicity _____

Sessions III and IV. Project Control; Review; Testing

A. Project Control Overview _____
1. Construction Projects _____

B. Project Delivery Systems _____
1. General Contracting _____
2. Design-Build _____
3. Construction Management _____

C. Planning _____
1. Why Plan? _____

D. Stages of Planning _____
1. Pre-Construction Planning _____
2. Construction Planning _____

E. The Planning Process _____
   1. Establishing a Goal _____
   2. Identifying the Work to Be Done _____
   3. Determining Tasks _____
   4. Communicating Responsibilities _____
   5. Follow-Up _____
F. Planning Resources _____
   1. Planning Materials _____
   2. Planning Equipment _____
   3. Planning Tools _____
   4. Planning Labor _____
G. Ways to Plan _____
H Estimating _____
   1. The Estimating Process _____
I. Scheduling _____
   1. The Scheduling Process _____
   2. Bar Charts _____
   3. Network Schedule _____
   4. Short-Interval Production Scheduling _____
   5. Updating a Schedule _____
J. Cost Awareness and Control _____
   1. Categories of Costs _____
   2. Field Reporting System _____
   3. Supervisor's Role in Cost Control _____
K. Resource Control _____
   1. Control _____
   2. Materials Control _____
   3. Equipment Control _____
   4. Tools Control _____
   5. Labor Control _____
L. Production and Productivity _____
M. Review _____
N. Module Examination _____
   1. Trainees must score 70 percent or higher to receive recognition from the NCCER.
   2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.