Module Overview

This module introduces trainees to the function of substations at all levels of the power grid, with an introduction to typical substation components included. Substation safety issues are reviewed, and trainees are introduced to one-line diagrams used in the power industry.

Objectives

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

1. Describe the functions performed by various substations.
2. Identify the voltage classes that exist in substations.
3. Identify the following medium- and high-voltage equipment:
   - Buses
   - Disconnect switches
   - Oil circuit breakers
   - Gas circuit breakers
   - Vacuum circuit breakers
   - Power transformers
   - Instrument transformers
   - Capacitors
   - Reactors
4. Interpret a one-line substation diagram.
5. Describe the safe work practices used in substations, including clearance zones and lockout/tagout requirements.

Performance Task

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

1. Interpret a one-line substation diagram.

Materials and Equipment

Multimedia projector and screen
* Pencils and paper
* One-line electrical diagram for a substation with an appropriate legend
* Hook switch disconnect (optional)
* Module Examinations*
* Performance Profile Sheets*


Computer

Whiteboard/chalkboard

Markers/chalk

* 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 any appropriate PPE and know how to use it properly. Emphasize the importance of proper housekeeping.
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 Introduction to Substations. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction; Substation Applications; Substation Equipment, Part One</strong></td>
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<tr>
<td>A. Introduction</td>
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<td>B. Substation Applications</td>
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<td>1. Transmission Substations</td>
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<td>2. Distribution Substations</td>
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<td>3. Collector Substations</td>
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<td>4. HVDC Substations</td>
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<tr>
<td>C. Substation Equipment</td>
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<tr>
<td>1. Buses</td>
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<td>2. Disconnect Switches</td>
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<td>3. Circuit Breakers</td>
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<td>4. Power Transformers</td>
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<td><strong>Session II. Substation Equipment, Part Two</strong></td>
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<tr>
<td>A. Substation Equipment</td>
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<td>1. Instrument Transformers</td>
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<td>3. Reactors</td>
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<tr>
<td>B. Substation Single-Line Diagrams</td>
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<tr>
<td>1. Collector Substation</td>
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<tr>
<td>2. Distribution Substation</td>
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<tr>
<td>C. PT/Laboratory</td>
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<tr>
<td>Have trainees examine a single-line substation drawing with a matching legend. Ask them to interpret the symbols, letters, and numbers associated with components on the drawing and document the information gathered on a separate sheet of paper. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
</tbody>
</table>
Session III. Substation Safety
   A. Substation Safety
      1. Substation Access
      2. Minimum Approach Distance
      3. Clearance Zones and Isolation Guarantees
      4. Temporary Protective Grounds
      5. Construction and Maintenance Equipment
      6. Switching

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

This module covers electrical shock and arc flash hazards and provides an introduction to NFPA 70E®, Standard for Electrical Safety in the Workplace.

Objectives

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

1. Identify electrical hazard types and locations, and explain related safety guidelines and terms.
2. Recognize and explain hazard boundaries.
3. Explain employer and employee responsibilities in recognizing and managing electrical hazards.
4. Identify common factors that lead to electrical incidents and explain the importance of using good judgment, appropriate procedures, and safe work practices.
5. Analyze the electrical hazards of a given task, plan the job, and complete an electrical work permit request.
6. Select, inspect, and maintain personal protective equipment (PPE) and test equipment used for electrical work.
7. Explain how to create an electrically safe work condition.

Performance Task

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

1. Given a specific electrical task and circumstances, complete an energized electrical work permit request.

Materials and Equipment

Computer
Managing Electrical Hazards PowerPoint®
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
NFPA 70E, Standard for Electrical Safety in the Workplace®
Various types of protective equipment, including rubber gloves, leathers, rubber blankets, face shields, and arc flash suits
Various insulated/insulating and live-line tools
Temporary grounding jumpers
Insulated rescue hook
Blank energized electrical work request forms
Example job drawings
Time-current curves for various molded-case and low-voltage power circuit breakers (both thermal-magnetic operators and electronic trip units)
Molded-case and low-voltage circuit breakers
Insulation tester
Proximity detectors
Module Examinations*
Performance Profile Sheets*

* Download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.
Additional Resources

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


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


Teaching Time For This Module

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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
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<td><strong>Session I. Introduction to Electrical Hazards; Electrical Equipment; Getting Started With NFPA 70E®</strong></td>
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<tr>
<td>A. Introduction to Electrical Hazards</td>
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<td>1. Electrical Shock</td>
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<td>2. Arc Flash and Blast Hazards</td>
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<td>B. Electrical Equipment, Including Specific Hazards Associated with Each Type</td>
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<td>C. Getting Started with NFPA 70E®</td>
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<td>1. Navigating NFPA 70E®</td>
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<td>2. Recognizing Hazard Boundaries</td>
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<td><strong>Session II. Employer/Employee Responsibilities; Electrical Incidents and Prevention</strong></td>
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<tr>
<td>A. Employer/Employee Responsibilities</td>
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<td>B. Electrical Incidents and Prevention</td>
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<tr>
<td>1. Electrical Incidents</td>
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<td>2. Safety-Related Work Practices</td>
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<td>3. Personal Protective Equipment</td>
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<td>4. Other Tools and Protective Equipment</td>
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<td><strong>Session III. Energized Electrical Work Permit</strong></td>
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<td>A. Completing Part I</td>
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<td>B. Completing Part II</td>
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<td>C. Completing Part III</td>
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<tr>
<td>D. PT/Laboratory</td>
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</tbody>
</table>

Have the trainees practice completing an energized electrical work permit request. This laboratory corresponds to Performance Task 1.
Session IV. Analyzing Electrical Hazards; Electrical Test Equipment Selection and Use

A. Analyzing Electrical Hazards
   1. Drawings and Documents
   2. Shock Hazard Analysis
   3. Arc Flash Hazard Analysis
   4. Identifying Flash Protection Boundaries and Selecting PPE

B. Electrical Test Equipment Selection and Use
   1. Inspection
   2. Training
   3. Meter Use

Session V. Establishing an Electrically Safe Work Condition; Emergency Response; Personal Safety Toolbox; Review and Testing

A. Establishing an Electrically Safe Work Condition
   1. Electrical Lockout/Tagout
   2. Hazardous Energy Control Procedures

B. Emergency Response
   1. Shock Victims
   2. Arc Flash Victims
   3. Teamwork
   4. Resuscitation

C. Personal Safety Toolbox
   1. Communication
   2. Changes in Scope
   3. Administrative Controls

D. Module Review

E. 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.

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

This module provides an introduction to the theory of alternating current, along with AC circuits, inductors, capacitors, transformers, and three-phase systems.

Objectives

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

1. Describe how single-phase and three-phase alternating current is developed.
2. Calculate the peak and effective voltage or current values for an AC waveform.
3. Describe phase relationships in AC circuits.
4. Describe impedance and explain how it affects AC circuits.
5. Describe the operating principles and functions of inductors.
6. Describe the operating principles and functions of capacitors.
7. Explain the principles and functions of transformers.
8. Explain the following terms as they relate to AC circuits:
   - True power
   - Apparent power
   - Reactive power
   - Power factor

Performance Tasks

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

Materials and Equipment

- Markers/chalk
- Pencils and scratch paper
- Whiteboard/chalkboard
- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Calculator
- Common capacitors
- Inductors, resistors, capacitors, power sources, and wiring to build RL, RC, RLC, and LC circuits
- Voltmeter
- Transformers
- Copies of the 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 and know how to use it properly. Ensure that trainees are briefed on basic electrical safety and shop safety policies.
This module presents thorough resources for task training. The following resource material is suggested for further study.


### Teaching Time For This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 17½ hours are suggested to cover *Alternating Current and Three-Phase Systems*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

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<td>A. Introduction</td>
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<td>B. Sine Wave Generation</td>
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<td>C. Sine Wave Terminology</td>
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<td><strong>Session II. AC Phase Relationships; Resistance; Inductance and Capacitance; Types of AC Circuits</strong></td>
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<td>A. AC Phase Relationships</td>
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<td>B. Resistance in AC Circuits</td>
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<td>C. Inductance in AC Circuits</td>
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<td>D. Capacitance</td>
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<td>E. RL, RC, LC, and RLC Circuits</td>
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<td><strong>Session III. Power in AC Circuits</strong></td>
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<td>A. Power in AC Circuits</td>
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<td>2. Apparent Power</td>
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<td>4. Power Factor</td>
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<td><strong>Sessions IV and V. Transformers</strong></td>
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<td>A. Transformers</td>
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<td>5. Transformer Selection</td>
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<td><strong>Session VI. Three-Phase Power Distribution Systems</strong></td>
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<td>A. Three-Phase Power Distribution Systems</td>
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<tr>
<td>1. Voltage and Current Imbalance in a Three-Phase System</td>
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</tbody>
</table>
Session VII. Review and Testing

A. Module Review

B. Module Examination

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

This module presents information concerning the conductors and cables typically used in the substation environment. Drawings and cable schedules are reviewed, and procedures for the installation of cables and conductors in conduit, cable trenches, and duct banks are included.

Objectives

Upon completion of this module, the trainee will be able to do the following:
1. Identify types, sizes, and applications of conductors and cables.
2. Interpret a cable drawing and schedule.
3. Explain below-grade methods for installing cables.

Performance Task

Under the supervision of the instructor, the trainee should be able to do the following:
1. Interpret a cable drawing and schedule.

Materials and Equipment

- Multimedia projector and screen
- Computer
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- Drawing or detail of substation cable installation that incorporates a cable schedule
- Short sections of various conductor cables and fiber-optic cable, with the conductor/cable designation visible on the sheath (optional)
- Fish tape (optional)
- Rodder (optional)
- Pulling grip (optional)
- Power cable puller (optional)
- Module Examinations*
- Performance Profile Sheets*

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

Safety Considerations

Ensure that the trainees are equipped with any appropriate PPE and know how to use it properly. Emphasize the importance of proper housekeeping.

Additional Resources

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

Teaching Time for This Module

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

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<th>Topic</th>
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<td>A. Introduction</td>
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<td>B. Safety</td>
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<td>C. Cables and Conductors</td>
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<td>1. Conductor and Cable Characteristics</td>
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<td>2. Fiber-Optic Cables</td>
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<td>D. Drawings and Schedules</td>
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<td>1. Drawings</td>
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<td>2. Schedules</td>
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<td>E. PT/Laboratory</td>
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<tr>
<td>Have trainees practice identifying the specifications of cable required from a drawing with a cable schedule. This laboratory corresponds to Performance Task 1.</td>
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<td>F. Below-Grade Cable Installation</td>
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<td>2. Direct-Buried Cable-in-Conduit</td>
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<td><strong>Session III. Cable Installation</strong></td>
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<td>2. Cable Pulling Equipment</td>
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<td>3. Cable Pulling Safety Precautions</td>
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<td>4. Pulling Equipment Types</td>
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<td>6. Installing Fiber-Optic Cable</td>
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<td><strong>Session IV. Review and Testing</strong></td>
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<td>A. Review</td>
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<td>B. Module Examination</td>
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<tr>
<td>1. Trainees must score 70% or higher to receive recognition from NCCER.</td>
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<tr>
<td>2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.</td>
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<td>C. Performance Testing</td>
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<tr>
<td>1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.</td>
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</table>
Module Overview

This module introduces the types of cable trays and their components, and focuses on the NEC® requirements for cable tray installations.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electrical Level One; and Electrical Level Two, Modules 26201-11 through 26206-11.

Objectives

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

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

Performance Tasks

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

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

Materials and Equipment

- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and scratch paper
- Copy of the latest edition of the National Electrical Code®
- Cable tray components:
  - Metal ladder tray
  - Metal trough tray
  - Solid bottom tray
  - Tray covers
  - Nonmetallic tray
- Examples of cable tray failures
- Splice plates
- Alignment strips
- Drop out plates
- H-bar
- Eight vertical adjustment splice plates
- Cable tray supports, including:
  - Beam clamps
  - Anchor clips
  - All-thread rods
- Nuts, bolts, washers, and hangers
- Cable tray sections for cutting and offset
- Felt-tip markers
- Hacksaw and blades
- Protractor
- Conventional square
- Quick Quiz*
- Module Examinations**
- Performance Profile Sheet**

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

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

Additional Resources

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


Teaching Time for this Module

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

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

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

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electrical Level One; and Electrical Level Two, Modules 26201-11 through 26203-11. It is also suggested that trainees be familiar with NEC® Articles 342, 344, 352, and 358.

Objectives

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

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

Performance Tasks

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

1. Use an electric or hydraulic bender to bend a 1" conduit stub-up to an exact distance of 15¼" above the deck.
2. Make an offset in a length of conduit to miss a 10" high obstruction with a clearance between the obstruction and the conduit of not less than 1" nor more than 1½".
3. Make a saddle in a length of conduit to cross an 8" pipe with 1" clearance between the pipe and the conduit.

Materials and Equipment

- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and scratch paper
- Copy of the latest edition of the NEC®
- Hand bender and manufacturer’s instructions
- Lengths of ¼", 1", and 2" rigid, EMT, and IMC conduit
- Lengths of PVC conduit
- Lengths of 8" pipe
- 10" sample obstructions
- Bending charts to match mechanical, electrical, and hydraulic benders
- PVC solvent cements and MSDSs
- End plugs for PVC conduit
- Pipe reamer
- Shop towels
- Brushes

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

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

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

Additional Resources

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


Teaching Time for This Module

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

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

A. Module Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on 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.
DESIGN SERVICES OF

Publishing Services
Module Overview

This module introduces the tools, materials, and techniques used in conductor installations.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electrical Level One; and Electrical Level Two, Modules 26201-11 through 26205-11.

Objectives

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

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

Performance Tasks

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

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

Materials and Equipment

- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and scratch paper
- Scientific calculator
- Copy of the latest edition of the National Electrical Code®
- Several lengths of cable from No. 12 through 4/0 AWG
- Wire lubricant
- Several types of pulling ropes
- Several different types and lengths of conductors
- Measuring tape
- Setscrew cable grips
- Swivel rope clevis
- Basket grips
- Cable cutters/striping tools
- Self-contained hand-crank wire puller
- Fish tape
- Power blower/vacuum fish tape system
- Electrical cable puller
- Cable grips
- Clamps for supporting conductors
- Cable supports
- Manufacturers’ catalogs for cable supports
- Cable manufacturers’ literature
- Quick Quiz*
- Module Examinations**
- Performance Profile Sheet**

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

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

Additional Resources

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


Teaching Time for this Module

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

<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction; Planning; Setting Up</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Planning the Installation</td>
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<tr>
<td>C. Setting Up for Wire Pulling</td>
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<tr>
<td>D. PT/Laboratory</td>
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<tr>
<td>Have trainees practice preparing multiple conductors for pulling using a wire-pulling basket. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td><strong>Session II. Cable-Pulling Equipment; High-Force Cable Pulling</strong></td>
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</tr>
<tr>
<td>A. Cable-Pulling Equipment</td>
<td></td>
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<tr>
<td>B. High-Force Cable Pulling</td>
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<tr>
<td>C. Mechanical Offsets</td>
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<tr>
<td><strong>Session III. Supporting Conductors; Pulling Cable</strong></td>
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<tr>
<td>A. Supporting Conductors</td>
<td></td>
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<tr>
<td>B. Pulling Cable in Cable Trays</td>
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<tr>
<td>C. PT/Laboratory</td>
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</tr>
<tr>
<td>Have trainees practice preparing multiple conductors for pulling in a raceway system. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td>D. Physical Limitations of Cable</td>
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<tr>
<td>E. Cable-Pulling Instruments</td>
<td></td>
</tr>
</tbody>
</table>
Session IV. Review and Testing

A. Module Review
B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on 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.
Title: Electrical Level one: AIG

DESIGN SERVICES OF

S4carliSle

Publishing Services
Module Overview

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

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electrical Level One; and Electrical Level Two, Modules 26201-11 through 26207-11.

Objectives

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

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

Performance Tasks

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

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

Materials and Equipment

- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and scratch paper
- Copy of the latest edition of the National Electrical Code®
- Wire strippers
- Heavy-duty strippers
- Ratchet-type cable cutters
- Assorted sizes and types of wire and cable connectors
- Crimp-type and mechanical compression connectors
- Heat-shrink insulators
- Heat gun for shrink insulators
- Assorted sizes and types of wire nuts
- Hand crimping tools and dies
- Hydraulic crimping tools and dies
- Metal-clad cable
- Type MC cable connectors
- Ratchet cable bender
- Hydraulic cable bender
- Heat-shrink and roll-on insulating tapes
- Propane torch
- Torque wrenches
- Terminal blocks/strips
- Multimeter
- Test circuit
- Quick Quiz*
- Module Examinations**
- Performance Profile Sheet**

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

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

## Additional Resources

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


## Teaching Time for this Module

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

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

A. Taping Electrical Joints

B. Motor Connection Kits

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

D. Module Review

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

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

This module introduces the grounding systems used at substations to ensure the safety of workers. The concept of grounding is presented, as well as the basic design parameters and construction of an underground substation ground grid.

Objectives

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

1. Explain the purpose of a ground grid system.
2. Describe the methods and materials for installing an underground grid.
3. Explain the safety precautions used and the PPE required when repairing and/or expanding an existing ground grid.
4. Describe how connections are made in a ground grid system using exothermic welded, compression, and mechanical connectors.

Performance Task

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

1. Make connections in a ground grid system using exothermic welded, compression, and mechanical connectors.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Two: Substation PowerPoint® Presentation Slides
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Assortment of ground grid mechanical connectors
Assortment of ground grid compression connectors
Exothermic welding kit designed for ground grid connections, complete with necessary molds, consumables, and ignition device
Copper cable suitable for substation ground grid use and matching the mold size of the available exothermic kit, compression connectors, and mechanical connectors on hand
Crimping tool with dies matching the compression connectors on hand
Welding gloves (to handle exothermic weld components)
Fire extinguisher
Beam-type torque wrench (optional)
Module Examinations*
Performance Profile Sheets*

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

Safety Considerations

Ensure that the trainees are equipped with the appropriate PPE and know how to use it properly. Review the specific safety guidelines and operating instructions associated with using exothermic welding kits, hand-held torches, and crimping tools. Ensure that a safe area, free of flammable materials, is selected for exothermic welding. Emphasize the importance of proper housekeeping.
Additional Resources

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


Electronic Engineers (IEEE).

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Grounding 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.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>Session I. Introduction; Safety; Electric Shock Hazards and the Grounding Grid; Ground Grid Design, Part One</td>
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</tr>
<tr>
<td>A. Introduction</td>
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<td>B. Safety</td>
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<td>C. Electric Shock Hazards and the Grounding Grid</td>
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<tr>
<td>1. Reducing Shock Hazards Through Grounding</td>
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<td>D. Ground Grid Design</td>
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<td>1. Soil Conductivity</td>
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<td>Session II. Ground Grid Design, Part Two</td>
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<tr>
<td>A. Ground Grid Design</td>
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<tr>
<td>1. Grid Conductors and Connectors</td>
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<tr>
<td>B. PT/Laboratory</td>
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<tr>
<td>Have trainees practice assembling mechanical connectors and crimping compression connectors onto copper ground conductors and rods. This laboratory corresponds with Performance Task 1.</td>
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<tr>
<td>Session III. Ground Grid Design, Part Three</td>
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<tr>
<td>A. Ground Grid Design</td>
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<tr>
<td>1. Grid Conductors and Connectors</td>
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<tr>
<td>B. PT/Laboratory</td>
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<tr>
<td>Have trainees practice making exothermic welded connections on copper ground conductors. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td>Session IV. Ground Grid Design, Part Four; Upgrading and Repairing a Ground Grid</td>
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<tr>
<td>A. Ground Grid Design</td>
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<td>1. Grid Spacing</td>
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<td>2. Spacing and Depth of Ground Rods</td>
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<td>3. Placement of Equipotential Grids</td>
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<td>B. Upgrading and Repairing a Ground Grid</td>
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<tr>
<td>1. Ground Grid Testing</td>
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<tr>
<td>2. Extending a Ground Grid</td>
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<tr>
<td>3. Repairing a Ground Grid</td>
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</tbody>
</table>
Session V. Review and Testing

A. Review

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

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

This module introduces the concept of preparing graded surfaces using heavy equipment. It also covers identification and interpretation of construction stakes and describes the methods for grading slopes.

**Objectives**

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

1. Explain the terms used in grade work.
2. Identify types of stakes and explain markings on grade stakes and benchmark (BM) stakes.
3. Identify equipment used by operators to check stakes.
4. Explain different types of slopes and slope ratio.
5. Check horizontal and vertical distance of cut and fill slope stakes.
6. Check finish subgrade on a cross slope.

**Performance Tasks**

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

1. Identify types of stakes and markings on stakes.
2. Check horizontal and vertical distances of cut and fill slope stakes.
3. Check finish subgrade on a cross slope.

**Materials and Equipment**

- Markers/chalk
- Pencils and scratch paper
- Whiteboard/chalkboard
- *Heavy Equipment Operations Level One* PowerPoint® Presentation Slides
- Multimedia projector and screen
- Computer
- Appropriate personal protective equipment
- Samples of marked surveyor stakes:
  - Center line stakes
  - Offset stakes
  - Grade stakes
  - Slope stakes
  - Edge of pavement stakes
- Construction plans including topographical and grade information
- Leveling rods
- Sight level
- Automatic level
- Laser level
- Tripod
- Pocket leveling rod
- Hand level
- Measuring tape
- 18" rulers
- String
- Trade Terms Quiz*
- Module Examinations**
- Performance Profile Sheets**

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

**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on or around heavy equipment. Emphasize the importance of proper housekeeping.
### Additional Resources

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


### Teaching Time for This Module

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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Sessions I and II. Introduction; Planning Grades; Site Layout</strong></td>
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<tr>
<td>A. Introduction</td>
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<td>B. Planning Grades</td>
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<td>1. Profiles</td>
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<td>2. Erosion Controls</td>
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<td>3. Roadways</td>
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<td>4. Buildings</td>
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<td>5. Grade Computation</td>
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<tr>
<td>C. Site Layout</td>
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<tr>
<td>1. Common Stake Markings</td>
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<tr>
<td>2. Setting Stakes</td>
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<tr>
<td>3. Slope Stake Interpretation</td>
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<tr>
<td>D. PT/Laboratory</td>
<td>Have trainees identify types of stakes and markings on stakes. This laboratory corresponds to Performance Task 1.</td>
</tr>
<tr>
<td><strong>Sessions III and IV. Performing Site Measurements</strong></td>
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<tr>
<td>A. Performing Site Measurements</td>
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<td>1. Manual Equipment</td>
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<td>2. Electronic Measuring Devices</td>
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<td>3. Global Positioning System Survey Devices</td>
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<td>4. Stakeless Systems</td>
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<tr>
<td>B. PT/Laboratory</td>
<td>Have trainees check horizontal and vertical distances of cut and fill slope stakes. This laboratory corresponds to Performance Task 2.</td>
</tr>
<tr>
<td><strong>Session V. Finish Grades</strong></td>
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<tr>
<td>A. Finish Grades</td>
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<tr>
<td>1. Finish Grade Stakes</td>
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<tr>
<td>2. Checking Grades</td>
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<tr>
<td>B. PT/Laboratory</td>
<td>Have trainees check finish subgrade on a cross slope. This laboratory corresponds to Performance Task 3.</td>
</tr>
</tbody>
</table>
Session VI. Review and Testing

A. Review

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

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
Concrete Work  
Annotated Instructor’s Guide  
Module 82204-12

Module Overview

This module introduces the trainee to basic techniques for building concrete slabs and low walls for substations. Topics include preparing the site, estimating concrete, building forms, installing rebar, setting anchor bolts, placing concrete, and finishing the concrete.

Objectives

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

1. Describe the properties of concrete.
2. Identify different types of forms.
3. Explain how to install and tie rebar.
4. Describe how to set anchor bolts to proper location and elevation.
5. Describe how to estimate concrete volume.
6. Identify methods used in placing and finishing concrete.
7. Construct a pier form and place anchor bolts.

Performance Task

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

1. Construct a pier form and place anchor bolts.

Materials and Equipment

Multimedia projector and screen  
*Power Line Worker Level Two: Substation*  
   PowerPoint® Presentation Slides  
Computer  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and paper  
If possible, a simple form, cement, fine aggregate, water, and some kind of admixture; containers and tools for mixing concrete  
Selection of leveling instruments  
An anchor bolt template  
Selection of stakes, edge forms, and screeds  
A simple site plan, stakes, boards, string, leveling instruments, and any other tools for laying out the form for a slab  
A drawing with specifications for a simple wood form and the wood, components, and tools needed for building the form  
Selection of rebar  
Selection of rebar bends and hooks  
Several bars from the bar list in *Figure 39*  
A variety of samples of tie wire and wire fabric  
Cement, aggregate, and water for concrete; cones for slump testing  
Materials and tools for building a pier form, including an appropriate template and anchor bolts  
Module Examinations*  
Performance Profile Sheets*

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

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines required when working on concrete and rebar and when building forms. Emphasize the importance of proper housekeeping.
Additional Resources

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


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 35 hours are suggested to cover *Concrete Work*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Sessions I and II. Introduction; Concrete</strong></td>
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<td>A. Introduction</td>
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<tr>
<td>B. Concrete</td>
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<tr>
<td>1. Types of Portland Cement</td>
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<td>2. Aggregates Used In Concrete</td>
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<td>3. Water for Concrete</td>
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<td>4. Admixtures of Concrete</td>
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<tr>
<td>C. Laboratory</td>
<td>Have trainees practice mixing and pouring a small batch of concrete in a simple form.</td>
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<tr>
<td><strong>Session III. Sitework</strong></td>
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<td>A. Sitework</td>
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<td>1. Objectives of Basic Building Layout</td>
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<td>2. Establishing Formwork Locations and Elevations</td>
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<td><strong>Sessions IV–V. Foundations and Flatwork Forms</strong></td>
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<td>A. Foundations and Flatwork Forms</td>
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<td>1. Footings</td>
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<td>2. Components of Continuous and Pier Footing Forms</td>
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<tr>
<td>3. Establishing the Slab Location on Site</td>
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<td>4. Laying Out and Constructing Footing Forms</td>
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<td>5. Templates for Anchor Bolts and Dowels</td>
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<td>6. Edge Forms</td>
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<tr>
<td>7. Laboratory</td>
<td>Have the trainees use a template and practice setting anchor bolts and dowels.</td>
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<tr>
<td>8. Ground Preparation</td>
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<tr>
<td>9. Reinforcing Concrete Slabs</td>
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<tr>
<td>10.Removing Forms</td>
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<tr>
<td>11. Laboratory</td>
<td>Have the trainees build a form to meet specifications.</td>
</tr>
</tbody>
</table>
Session VI. Rebar
   A. Rebar
      1. Reinforcing Bars
      2. Fabrication
      3. Bar Supports
      4. Welded-Wire Fabric

Session VII. Estimating Concrete Volume; Preparing to Place Concrete
   A. Estimating Concrete Volume
      1. Rectangular Volume Calculations
      2. Circular Concrete Volume Calculations
   B. Preparing to Place Concrete
      1. Checking Forms
      2. On-Site Equipment for Mixing, Conveying, and Placing Concrete
      3. Placing the Concrete
      4. Vibrating Concrete

Sessions VIII–IX. Concrete Testing
   A. Concrete Testing
      1. Sampling Concrete
      2. Concrete Slump Testing
      3. Concrete Compression Testing
   B. Laboratory
      Have the trainees practice performing a slump test.

Sessions X–XIII. Finishing Concrete; Curing of Concrete
   A. Finishing Concrete
      1. Screeding
      2. Leveling
      3. Finishing
   B. Laboratory
      Have the trainees practice finishing concrete.
   C. Curing Concrete
   D. PT/Laboratory
      Have trainees construct a pier form and place anchor bolts. This laboratory corresponds to Performance Task 1.

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

This module focuses on the primary structures found in substations. The materials used to build the various structures, as well as the methods of attachment, are presented. Different types of bus systems, their supporting structures, and the various connecting approaches are also explored.

Objectives

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

1. Identify the types and materials of steel structures.
2. Identify types of fasteners and torque methods and values.
3. Identify types of bus and connectors.
4. Identify the types of bus supports.

Performance Task

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

1. Properly torque fasteners.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Two: Substation
   PowerPoint® Presentation Slides
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Beam-type torque wrench
Click-type torque wrench
Digital torque wrench
Torque multiplier
Load-indicating washers
Common bolts, nuts, and washers to torque
Bell-type suspension insulator (optional)
Torque angle gauge (optional)
Various Belleville washers (optional)
Tension control bolts (optional)
Module Examinations*
Performance Profile Sheets*

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

Safety Considerations

Ensure that the trainees are equipped with any appropriate PPE and know how to use it properly. Emphasize the importance of proper housekeeping.

Additional Resources

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

www.nema.org
An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 17½ hours are suggested to cover *Mechanical Construction Methods and Materials*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
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<td><strong>Session I. Introduction; Safety; Steel Assembly and Erection</strong></td>
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<td>A. Introduction</td>
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<td>B. Safety</td>
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<td>1. Fall Protection</td>
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<td>2. Electrical Safety</td>
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<td>3. Welding Safety</td>
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<td>C. Steel Assembly and Erection</td>
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<td>1. Drawings</td>
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<td>2. Materials</td>
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<tr>
<td><strong>Session II. Support Types; Components</strong></td>
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<td>A. Support Types</td>
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<td>1. Lattice Structures</td>
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<td>2. Dead End</td>
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<td>3. A-Frame</td>
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<td>4. Lightning Masts</td>
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<td>B. Components</td>
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<td>1. Insulators</td>
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<td>2. Lightning Arresters</td>
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<td>3. Switches, Disconnects, and Circuit Breakers</td>
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<tr>
<td><strong>Session III. Structural Steel Threaded Fasteners</strong></td>
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<tr>
<td>A. Structural Steel Threaded Fasteners</td>
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<tr>
<td>1. Thread Standards</td>
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<td>2. Bolts for Structural Steel</td>
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<td>3. Care of Bolts</td>
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</tbody>
</table>
Sessions IV and V. Installing Threaded Fasteners

A. Installing Threaded Fasteners
   1. Bolt Charts
   2. Alignment of Members
   3. Used Bolts and Nuts
   4. Torque and Torque Wrenches
   5. Tension Control Bolts
   6. Load-Indicating Washers
   7. Belleville Washers
   8. Torque-To-Yield Method

B. PT/Laboratory
   Have trainees practice applying assigned torque values using the different torque wrenches and a torque multiplier with appropriate fasteners. This laboratory corresponds to Performance Task 1.

Session VI. Busbar Types; Busbar Connections

A. Busbar Types
   1. Material
   2. Rigid Busbar Shape
   3. Strain Busbars

B. Busbar Connections
   1. Bolted Connections
   2. Clamped Connections
   3. Compression Connections
   4. Welded Connections

Session VII. Review and Testing

A. Review

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

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

This module provides an overview of personnel lifting and lift planning, and introduces crane load charts and load balancing. It explains how the center of gravity is calculated and affects the lift. It also covers sling selection, and explains the uses of jacks, tuggers, hoists, skids, and rollers.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Basic Rigger.

Objectives

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

1. Describe the basic requirements to lift personnel.
2. Explain how a sling stress is determined.
3. Describe the basic elements of a lift plan.
4. Explain the purpose of a load chart.
5. Calculate and explain how the center of gravity is determined.
6. Given a particular load, select the appropriate sling(s) for a lift.
7. Describe how jacks, hoists, skids, and rollers are used to move load laterally.

Performance Tasks

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

1. Calculate the center of gravity of a load.
2. Given a particular load, select the appropriate sling(s) for a lift.

Materials and Equipment

Multimedia projector and screen
Basic Rigger / Intermediate Rigger / Advanced Rigger
PowerPoint® Presentation Slides
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
OSHA regulations on lifting personnel
OSHA guidance on personnel platforms:
Crane or Derrick Suspended Personnel Platforms
Various types of slings and hitches
Sample lift plan

Manufacturer’s literature for different types of cranes
Sample load charts
ASME B30.5
ANSI/SAE J987
Teeter-totter and weights
Several jacks
Grip hoist
Tuggers
Rollers
Skids
Copies of the 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 and know how to use it properly. This module requires trainees to work with hand tools and slings. Ensure that trainees are briefed on shop safety policies and hand tool safety.

Additional Resources

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


Teaching Time for This Module

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

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<tr>
<th>Topic</th>
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<tbody>
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<td>Session I. Introduction; Personnel Lifting; Slings</td>
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<td>A. Introduction</td>
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<td>B. Personnel Lifting</td>
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<td>1. Platform Requirements</td>
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<td>C. Slings</td>
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<td>1. Sling Tensions</td>
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<td>2. Bridle Hitches</td>
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<td>3. Basket Hitches</td>
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<td>4. Choker Hitches</td>
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<tr>
<td>D. PT/Laboratory</td>
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<tr>
<td>Have trainees practice selecting the appropriate sling(s) for a lift. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td>Session II. Lift Planning; Types of Cranes; Crane Load Charts</td>
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<tr>
<td>A. Lift Planning</td>
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<td>1. Lift Plan Data</td>
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<td>B. Types of Cranes</td>
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<td>1. Industrial Hydraulic Cranes</td>
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<td>2. Rough-Terrain Cranes</td>
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<td>3. All-Terrain Cranes</td>
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<td>4. Truck-Mounted Telescopic Crane</td>
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<td>5. Lattice Boom Cranes</td>
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<td>6. Crane Component Terminology</td>
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<td>C. Crane Load Charts</td>
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<tr>
<td>1. Importance of Load/Capacity Charts for Lift Planning</td>
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<tr>
<td>2. Operating Conditions</td>
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</tbody>
</table>
Session III. Load Balancing: Special Equipment Used for Lateral Movement of Loads

A. Load Balancing
   1. Center of Gravity
   2. Center of Gravity and Leverage

B. PT/Laboratory
   Have trainees practice calculating the center of gravity of a load. This laboratory corresponds to Performance Task 1.

C. Special Equipment Used for Lateral Movement of Loads
   1. Jacking
   2. Grip Hoists
   3. Skids
   4. Rollers

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.