

### Module Overview

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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

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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

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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

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Multimedia projector and screen  
*Power Line Worker Level Two: Substation*  
PowerPoint® Presentation Slides  
(ISBN 978-0-13-296747-1)  
Computer  
Whiteboard/chalkboard  
Markers/chalk

Pencils and paper  
One-line electrical diagram for a substation with  
an appropriate legend  
Hook switch disconnect (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

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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

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

*Electric Power Equipment Maintenance and Testing*, 2<sup>nd</sup> Edition. Paul Gill. Boca Raton, FL: CRC Press.

*Electric Power Substation Engineering*, 2<sup>nd</sup> Edition. John McDonald, ed. Boca Raton, FL: CRC Press.

## Teaching Time for This Module

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

Topic	Planned Time
<b>Session I. Introduction; Substation Applications; Substation Equipment, Part One</b>	
A. Introduction	_____
B. Substation Applications	_____
1. Transmission Substations	_____
2. Distribution Substations	_____
3. Collector Substations	_____
4. HVDC Substations	_____
C. Substation Equipment	_____
1. Buses	_____
2. Disconnect Switches	_____
3. Circuit Breakers	_____
4. Power Transformers	_____
<b>Session II. Substation Equipment, Part Two</b>	
A. Substation Equipment	_____
1. Instrument Transformers	_____
2. Capacitors	_____
3. Reactors	_____
B. Substation Single-Line Diagrams	_____
1. Collector Substation	_____
2. Distribution Substation	_____
C. PT/Laboratory	_____
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.	

**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

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**Session IV. Review and Testing**

A. Review

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B. Module Examination

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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

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



### Module Overview

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

### Objectives

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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

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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

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Computer

*Managing Electrical Hazards* PowerPoint<sup>®</sup>  
Presentation Slides (ISBN 978-0-13-294909-5)

Whiteboard/chalkboard

Markers/chalk

Pencils and paper

*NFPA 70E, Standard for Electrical Safety in the Workplace*<sup>®</sup>

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

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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

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

*Arc Flash Hazard Incident Energy Calculations: A Historical Perspective and Comparative Study of the Standards IEEE 1584 and NFPA 70E®*, 2007. R.F. Ammerman, P.K. Sen, and J.P. Nelson: Calgary, Canada.

*IEEE C2-2012, National Electrical Safety Code*. Institute of Electrical and Electronics Engineers: New York, NY.

*IEEE 1584-2002, IEEE Guide for Performing Arc-Flash Hazard Calculations*. Institute of Electrical and Electronics Engineers: New York, NY.

*Improved Models for Predicting Incident Thermal Energy Exposures Caused by High Energy Arcing Faults in Low- and Medium-Voltage Power Systems*, 2008. R.F. Ammerman, Colorado School of Mines: Golden, CO.

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

*NFPA 70E®-2012, Standard for Electrical Safety in the Workplace*. National Fire Protection Association: Quincy, MA.

## Teaching Time For This Module

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

Topic	Planned Time
<b>Session I. Introduction to Electrical Hazards; Electrical Equipment; Getting Started With NFPA 70E®</b>	
A. Introduction to Electrical Hazards	_____
1. Electrical Shock	_____
2. Arc Flash and Blast Hazards	_____
B. Electrical Equipment, Including Specific Hazards Associated with Each Type	_____
C. Getting Started with NFPA 70E®	_____
1. Navigating NFPA 70E®	_____
2. Recognizing Hazard Boundaries	_____
<b>Session II. Employer/Employee Responsibilities; Electrical Incidents and Prevention</b>	
A. Employer/Employee Responsibilities	_____
B. Electrical Incidents and Prevention	_____
1. Electrical Incidents	_____
2. Safety-Related Work Practices	_____
3. Personal Protective Equipment	_____
4. Other Tools and Protective Equipment	_____
<b>Session III. Energized Electrical Work Permit</b>	
A. Completing Part I	_____
B. Completing Part II	_____
C. Completing Part III	_____
D. PT/Laboratory	_____
Have the trainees practice completing an energized electrical work permit request. This laboratory corresponds to Performance Task 1.	







### Module Overview

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

### Objectives

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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

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

### Materials and Equipment

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Markers/chalk	Calculator
Pencils and scratch paper	Common capacitors
Whiteboard/chalkboard	Inductors, resistors, capacitors, power sources, and wiring to build RL, RC, RLC, and LC
<i>Power Line Worker Level Two: Transmission</i>	circuits
PowerPoint® Presentation Slides	Voltmeter
(ISBN 978-0-13-274333-4)	Transformers
Multimedia projector and screen	Copies of the Quick Quiz*
Computer	Module Examinations**
Appropriate personal protective equipment	

\* Located at the back of this module.

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

### Safety Considerations

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Ensure that trainees are briefed on basic electrical safety and shop safety policies.

## Additional Resources

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

*Principles of Electric Circuits: Conventional Current Version*, 2009. Thomas L. Floyd. New York: Prentice Hall.

## Teaching Time For This Module

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

Topic	Planned Time
<b>Session I. Introduction; Sine Wave Generation and Terminology</b>	
A. Introduction	_____
B. Sine Wave Generation	_____
C. Sine Wave Terminology	_____
<b>Session II. AC Phase Relationships; Resistance; Inductance and Capacitance; Types of AC Circuits</b>	
A. AC Phase Relationships	_____
B. Resistance in AC Circuits	_____
C. Inductance in AC Circuits	_____
D. Capacitance	_____
E. RL, RC, LC, and RLC Circuits	_____
<b>Session III. Power in AC Circuits</b>	
A. Power in AC Circuits	_____
1. True Power	_____
2. Apparent Power	_____
3. Reactive Power	_____
4. Power Factor	_____
5. Power Triangle	_____
<b>Sessions IV and V. Transformers</b>	
A. Transformers	_____
1. Transformer Construction	_____
2. Operating Characteristics	_____
3. Turns and Voltage Ratios	_____
4. Types of Transformers	_____
5. Transformer Selection	_____
<b>Session VI. Three-Phase Power Distribution Systems</b>	
A. Three-Phase Power Distribution Systems	_____
1. Voltage and Current Imbalance in a Three-Phase System	_____

## **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

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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

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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

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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

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Multimedia projector and screen  
*Power Line Worker Level Two: Substation*  
PowerPoint® Presentation Slides  
(ISBN 978-0-13-296747-1)

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

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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

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

*Electric Power Substations Engineering*, 2nd Edition. Boca Raton, FL: CRC Press.

*The Cabling Handbook*, 2nd Edition. John R. Vacca. Upper Saddle River, NJ: Pearson Education.

*Fiber Optic Reference Guide*, 3rd Edition. David Goff. Woburn, MA: Focal Press.

## Teaching Time for This Module

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

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

## Module Overview

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

## Prerequisites

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

## Objectives

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

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

## Performance Tasks

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

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

## Materials and Equipment

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<i>Electrical Level Two</i> PowerPoint <sup>®</sup> Presentation Slides (ISBN 978-0-13-257132-6)	Alignment strips
Multimedia projector and screen	Drop out plates
Computer	H-bar
Appropriate personal protective equipment	Eight vertical adjustment splice plates
Whiteboard/chalkboard	Cable tray supports, including:
Markers/chalk	Beam clamps
Pencils and scratch paper	Anchor clips
Copy of the latest edition of the <i>National Electrical Code</i> <sup>®</sup>	All-thread rods
Cable tray components:	Nuts, bolts, washers, and hangers
Metal ladder tray	Cable tray sections for cutting and offset
Metal trough tray	Felt-tip markers
Solid bottom tray	Hacksaw and blades
Tray covers	Protractor
Nonmetallic tray	Conventional square
Examples of cable tray failures	Quick Quiz*
Splice plates	Module Examinations**
	Performance Profile Sheet**

\* Located at the back of this module.

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

## Safety Considerations

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

## Additional Resources

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

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

## Teaching Time for this Module

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

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



## Module Overview

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

## Prerequisites

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

## Objectives

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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

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

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

## Materials and Equipment

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*Electrical Level Two* PowerPoint® Presentation  
Slides (ISBN 978-0-13-257132-6)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Copy of the latest edition of the *NEC®*  
Hand bender and manufacturer's instructions  
Lengths of ¾", 1", and 2" rigid, EMT, and IMC  
conduit  
Lengths of PVC conduit  
Lengths of 8" pipe  
10" sample obstructions  
Bending charts to match mechanical, electrical,  
and hydraulic benders  
PVC solvent cements and MSDSs  
End plugs for PVC conduit  
Pipe reamer  
Shop towels  
Brushes

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

\* Located at the back of this module.

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

## Safety Considerations

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

## Additional Resources

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

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

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

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

## Teaching Time for This Module

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

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

**Topic**

**Planned Time**

**Session VI. Review and Testing**

A. Module Review

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B. Module Examination

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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

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1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.

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



## Module Overview

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

## Prerequisites

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

## Objectives

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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

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

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

## Materials and Equipment

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<i>Electrical Level Two</i> PowerPoint® Presentation	Setscrew cable grips
Slides (ISBN 978-0-13-257132-6)	Swivel rope clevis
Multimedia projector and screen	Basket grips
Computer	Cable cutters/stripping tools
Appropriate personal protective equipment	Self-contained hand-crank wire puller
Whiteboard/chalkboard	Fish tape
Markers/chalk	Power blower/vacuum fish tape system
Pencils and scratch paper	Electrical cable puller
Scientific calculator	Cable grips
Copy of the latest edition of the <i>National Electrical Code</i> ®	Clamps for supporting conductors
Several lengths of cable from No. 12 through 4/0 AWG	Cable supports
Wire lubricant	Manufacturers' catalogs for cable supports
Several types of pulling ropes	Cable manufacturers' literature
Several different types and lengths of conductors	Quick Quiz*
Measuring tape	Module Examinations**
	Performance Profile Sheet**

\* Located at the back of this module.

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

## Safety Considerations

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

## Additional Resources

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

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

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

## Teaching Time for this Module

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

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

**Topic**

**Planned Time**

**Session IV. Review and Testing**

A. Module Review

\_\_\_\_\_

B. Module Examination

\_\_\_\_\_

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

C. Performance Testing

\_\_\_\_\_

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





## Module Overview

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

## Prerequisites

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

## Objectives

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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*<sup>®</sup> (*NEC*<sup>®</sup>) requirements for making cable terminations and splices.
5. Demonstrate crimping techniques.
6. Select the proper lug or connector for the job.

## Performance Tasks

---

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

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

## Materials and Equipment

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*Electrical Level Two* PowerPoint<sup>®</sup> Presentation  
Slides (ISBN 978-0-13-257132-6)  
Multimedia projector and screen  
Computer  
Appropriate personal protective equipment  
Whiteboard/chalkboard  
Markers/chalk  
Pencils and scratch paper  
Copy of the latest edition of the *National Electrical Code*<sup>®</sup>  
Wire strippers  
Heavy-duty strippers  
Ratchet-type cable cutters  
Assorted sizes and types of wire and cable  
Crimp-type and mechanical compression connectors  
Heat-shrink insulators

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

\* Located at the back of this module.

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

## Safety Considerations

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

## Additional Resources

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

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

## Teaching Time for this Module

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

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

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

A. Taping Electrical Joints

\_\_\_\_\_

B. Motor Connection Kits

\_\_\_\_\_

C. PT/Laboratory

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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

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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

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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

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Multimedia projector and screen  
*Power Line Worker Level Two: Substation*  
PowerPoint® Presentation Slides  
(ISBN 978-0-13-296747-1)  
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

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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.

*Electric Power Substations Engineering*, 2nd Edition. Boca Raton, FL: CRC Press.

*IEEE Guide for Safety in AC Substation Grounding*, 3rd Edition. New York, NY: Institute of Electrical & Electronic Engineers (IEEE).

## Teaching Time for This Module

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

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

## 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

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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

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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

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Markers/chalk	Construction plans including topographical and grade information
Pencils and scratch paper	Leveling rods
Whiteboard/chalkboard	Sight level
<i>Heavy Equipment Operations Level One</i>	Automatic level
PowerPoint® Presentation Slides (ISBN 978-0-13-292167-1)	Laser level
Multimedia projector and screen	Tripod
Computer	Pocket leveling rod
Appropriate personal protective equipment	Hand level
Samples of marked surveyor stakes:	Measuring tape
Center line stakes	18" rulers
Offset stakes	String
Grade stakes	Trade Terms Quiz*
Slope stakes	Module Examinations**
Edge of pavement stakes	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

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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

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

*Site Layout* Levels 1 and 2, Latest Edition. NCCER. Upper Saddle River, NJ: Pearson Education Inc.

## Teaching Time for This Module

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

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

## Session VI. Review and Testing

A. Review

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B. Module Examination

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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

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



### Module Overview

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This module introduces the trainee to 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

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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

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Multimedia projector and screen  
*Power Line Worker Level Two: Substation*  
PowerPoint® Presentation Slides  
(ISBN 978-0-13-296747-1)  
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

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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

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

American Concrete Institute (ACI). [www.concrete.org](http://www.concrete.org).

Cement Association of Canada. [www.cement.ca](http://www.cement.ca).

Portland Cement Association. [www.cement.org](http://www.cement.org).

*Principles and Practices of Commercial Construction*, 7<sup>th</sup> Edition. Cameron C. Andres. Upper Saddle River, NJ: Prentice Hall.

*Steel Construction Manual*, 13<sup>th</sup> Edition. Chicago, IL: American Institute of Steel Construction.

## Teaching Time for This Module

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

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

**Session VI. Rebar**

A. Rebar

- 1. Reinforcing Bars
- 2. Fabrication
- 3. Bar Supports
- 4. Welded-Wire Fabric

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**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

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**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.

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**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.

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**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.

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### Module Overview

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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

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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

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Multimedia projector and screen  
*Power Line Worker Level Two: Substation*  
PowerPoint® Presentation Slides  
(ISBN 978-0-13-296747-1)  
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

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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

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

*ANSI/NEMA CC 1-2009, Electric Power Connections for Substations.*  
[www.nema.org](http://www.nema.org)

## Teaching Time for This Module

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An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 17½ hours are suggested to cover *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.

Topic	Planned Time
<b>Session I. Introduction; Safety; Steel Assembly and Erection</b>	
A. Introduction	_____
B. Safety	_____
1. Fall Protection	_____
2. Electrical Safety	_____
3. Welding Safety	_____
C. Steel Assembly and Erection	_____
1. Drawings	_____
2. Materials	_____
<b>Session II. Support Types; Components</b>	
A. Support Types	_____
1. Lattice Structures	_____
2. Dead End	_____
3. A-Frame	_____
4. Lightning Masts	_____
B. Components	_____
1. Insulators	_____
2. Lightning Arresters	_____
3. Switches, Disconnects, and Circuit Breakers	_____
<b>Session III. Structural Steel Threaded Fasteners</b>	
A. Structural Steel Threaded Fasteners	_____
1. Thread Standards	_____
2. Bolts for Structural Steel	_____
3. Care of Bolts	_____

## **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

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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

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

## Objectives

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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

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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

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Multimedia projector and screen  
*Basic Rigger / Intermediate Rigger / Advanced Rigger*  
PowerPoint® Presentation Slides  
(ISBN 978-0-13-257363-4)

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

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Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires trainees to work with hand tools and slings. Ensure that trainees are briefed on shop safety policies and hand tool safety.

## Additional Resources

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

*Bob's Rigging and Crane Handbook*, Latest Edition. Leawood KS: Pellow Engineering Services.

*Crane Safety on Construction Sites*, 1998. Task Committee on Crane Safety on Construction Sites. Reston, VA: ASCE.

*Occupational Safety and Health Standards for the Construction Industry, 29 CFR Part 1926*. Washington, DC: OSHA Department of Labor, U.S. Government Printing Office.

*Rigging Handbook*, 2003. Jerry A. Klinke. Stevensville, MI: ACRA Enterprises, Inc.

## Teaching Time for This Module

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

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

### **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.

