

Module Overview

This module introduces the trainees to the equipment and methods used to ground de-energized high-voltage circuits during maintenance activities. An understanding of these principles is essential to the safety of electrical maintenance workers.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum*; *Industrial Maintenance E & I Technician Level One*; *Industrial Maintenance E & I Technician Level Two*; and *Industrial Maintenance E & I Technician Level Three*, Modules 40301-09 through 40307-09.

Objectives

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

1. Explain the purpose of temporary grounding.
2. Explain requirements associated with temporary grounding devices.
3. Identify and explain temporary grounding equipment.
4. Explain how to install and remove temporary grounding devices.

Performance Tasks

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

1. Apply temporary grounding for a given application with correct PPE, tools, and parts.
2. Demonstrate inspection and storage of temporary grounding components.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Three: Substation
PowerPoint® Presentation Slides
(ISBN 978-0-13-257181-4)

Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Appropriate personal protective equipment
Electrical safety analysis
Personal protective grounds
Lockout/tagout equipment

At least one copy of *NFPA 70B, Recommended Practice for Electrical Equipment Maintenance*
Hot stick and attachments
Insulating mats
Insulating covers
Grounding clamps
Grounding cables
Open-loop ammeter
Portable ground tester
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.

Note

NFPA 70®, *National Electrical Code®*, and *NEC®* are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All *National Electrical Code®* and *NEC®* references in this module refer to the 2008 edition of the *National Electrical 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 shop safety procedures. Emphasize any special safety precautions associated with working on or near high-voltage equipment and circuits. Review the different hazards that could cause voltage to be present on a de-energized circuit. Explain that grounding of the circuit being worked on will prevent such hazards. Review the requirements for an electrically safe work condition.

Additional Resources

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

OSHA Standard 1910.269, Electric Power Generation, Transmission, and Distribution

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9868

ANSI/IEEE C2-2007 (National Electrical Safety Code). New York, NY: Institute of Electrical and Electronic Engineers.

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

NFPA 70B (Recommended Practice for Electrical Equipment Maintenance)

<http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70B>

NFPA 70E (Standard for Electrical Safety in the Workplace)

<http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70E>

Hubbell Power Systems, Inc., source for products and training. <http://www.hubbellpowersystems.com>

Codebook City, source for *NEC®* explanations.

<http://www.codebookcity.com/codearticles/nec/index.htm>

US Department of the Interior, Bureau of Reclamation, Denver, Colorado.

Offers a variety of manuals covering several maintenance-related career fields, including a *Facilities Instructions, Standards, and Techniques Manual, Volume 5-1 (FIST 5-1)*, which covers Personal Protective Grounding for Electric Power Facilities and Power Lines, 2005.

http://www.usbr.gov/power/data/fist_pub.html

ASTM F855-04, Standard Specifications for Temporary Protective Grounds to Be Used on De-Energized Electric Power Lines and Equipment, 2004. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959.

ASTM F2249-03 Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-Energized Electric Power Lines and Equipment, 2003. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959.

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 *Temporary Grounding*. You will need to adjust the time required for testing based on your class size and resources. There are no performance tasks for this module. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Safety Analysis; Purpose of Temporary Grounding	
A. Introduction	_____
B. Electrical Safety Analyses	_____
C. Purpose of Temporary Grounding	_____
Session II. Temporary Grounding Terms; Sources of Hazardous Energy	
A. Terms	_____
B. Sources of Hazardous Energy	_____
1. Stored Energy	_____
2. Static Buildup	_____
3. Backfeeding	_____
4. Faulted Equipment	_____
5. Induced-Voltage Areas	_____
6. High-Voltage Testing	_____
Session III. Temporary Grounding Preparations; Requirements for Temporary Grounding Devices	
A. Temporary Grounding Preparation	_____
B. Requirements for Temporary Grounding Devices	_____
1. General Requirements	_____
2. Specific Requirements	_____
3. Installation Requirements	_____
Session IV. Selection and Evaluation of Temporary Grounding Devices; Installation and Removal of Temporary Grounding Devices	
A. Ground Cable Assemblies	_____
B. Insulation Devices	_____
C. Specialized Grounding and Testing Devices	_____
D. Evaluating Ground Cable Assemblies	_____
1. Cables	_____
2. Ferrules and Clamps	_____
E. Evaluating Hot Sticks and Attachments	_____
F. Ground Tester Equipment	_____
G. Installation of Temporary Grounding Devices	_____
H. Removing PPGs	_____

Session V. Laboratory

A. Laboratory

Have trainees practice installing temporary grounding equipment.
This laboratory corresponds to Performance Task 1.

Session VI. Laboratory; Review and Testing

A. Laboratory

Have trainees practice inspecting and storing temporary grounding equipment. This laboratory corresponds to Performance Task 2.

B. Module Review

C. Module Examination

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

D. Performance Testing

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

Module Overview

This module introduces the trainee to advanced drawings and how to read and interpret them. The trainees will learn to recognize the functions of various kinds of structural drawings, the component symbols, and the numbering systems used.

Objectives

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

1. Identify and interpret common construction drawings.
2. Read and interpret schematic and wiring diagrams.
3. Read and interpret schedules and general arrangement drawings.

Performance Tasks

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

1. Identify three specific components on a schematic diagram provided by the instructor.
2. Locate the types and placement of equipment according to a general arrangement drawing provided by the instructor.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Three: Substation
PowerPoint® Presentation Slides
(ISBN 978-0-13-257181-4)
Computer
Whiteboard/chalkboard

Markers/chalk
Pencils and paper
Sufficient sets of structural drawings
Sufficient number of contour drawings
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. 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.

Blueprint Reading for Construction, 2nd edition. James A. S. Fatzinger. Prentice Hall.

Teaching Time for This Module

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

Topic	Planned Time
Session I. Introduction; Substation Construction Plans	
A. Introduction	_____
B. Substation Construction Plans	_____
1. Plan Set Contents	_____
2. Initial Review of Substation Drawings	_____
Session II. Architectural Drawings	
A. Architectural Drawings	_____
1. Site Plans	_____
2. Floor and Roof Plans	_____
Session III. Structural Drawings	
A. Structural Drawings	_____
1. Foundation Plans	_____
2. Framing Plans	_____
B. Laboratory	_____
Have trainees point out and explain common components of structural drawings.	
Session IV. Mechanical Drawings; Details and Sections	
A. Mechanical Drawings	_____
1. HVAC Systems	_____
2. Plumbing Systems	_____
B. Details and Sections	_____
Sessions V and VI. Electrical Drawings	
A. Electrical Drawings	_____
1. Legends, Symbols, and Numbers	_____
2. Notes	_____
3. Grid Reference Numbers	_____
4. Schematic and Wiring Diagrams	_____
B. PT/Laboratory	_____
Have trainees identify three specific components on a schematic provided by the instructor. This laboratory corresponds to Performance Task 1.	
Session VII. General Arrangement Drawings	
A. General Arrangement Drawings	_____
B. PT/Laboratory	_____
Have trainees locate the types and placement of equipment according to a general arrangement drawing provided by the instructor. This laboratory corresponds to Performance Task 2.	

Session VIII. Review and Testing

A. Review

B. Module Examination

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

C. Performance Testing

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

Module Overview

This module introduces the trainee to the types and functions of medium- and high-voltage electrical equipment. The trainees will learn the different configurations of this equipment and its purpose in a substation.

Objectives

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

1. Define *corona* and describe techniques for its prevention.
2. Explain how to install various types of rigid buses and support insulators.
3. Explain how to install various types of disconnects and circuit switchers.
4. Explain how to install and wire a power transformer.
5. Explain how to install various types of circuit breakers.
6. Explain how to install capacitor banks and reactors.

Performance Tasks

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

1. Create a step-by-step plan for the installation of a transformer.
2. Locate instructor-requested information in an installation manual for at least one of the following components:
 - Disconnect switches
 - Circuit breakers
 - Capacitor banks
 - Reactors

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Three: Substation
PowerPoint® Presentation Slides
(ISBN 978-0-13-257181-4)
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Selection of weldments
Selection of bolted and mechanical aluminum
bus fittings
Selection of washers

Set of manufacturer's installation instructions for
large power transformer
Transformer liquid level gauge
Transformer wiring diagram
Capacitor bank wiring diagram
Installation manual for at least one of the follow-
ing components:
Disconnect switches
Circuit breakers
Capacitor banks
Reactors
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 for working with medium- and high-voltage electrical equipment. 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 25 hours are suggested to cover *Medium- and High-Voltage Equipment Installation*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Corona	
A. Introduction	_____
B. Corona	_____
1. The Effects of Corona	_____
2. Corona Prevention	_____
Session II. Installing Rigid Bus and Support Insulators	
A. Installing Rigid Bus and Support Insulators	_____
1. Assembling Rigid Aluminum Bus	_____
2. Installing Support Insulators	_____
Session III. Installing Disconnects and Circuit Switchers	
A. Installing Disconnects and Circuit Switchers	_____
1. Hook Switch Disconnects	_____
2. Circuit Interrupters	_____
Sessions IV–V. Installing Power Transformers	
A. Installing Power Transformers	_____
1. Receiving Transformers	_____
2. Lifting and Handling	_____
3. Storage	_____
4. Tank Access and External Radiators	_____
5. Wiring	_____
B. PT/Laboratory	_____
Have the trainees create a step-by-step plan for the installation of a transformer. This laboratory corresponds to Performance Task 1.	

Sessions VII–IX. Installing Circuit Breakers; Installing Capacitor Banks and Reactors

A. Installing Circuit Breakers

1. SF6 Gas
2. Installing Outdoor Circuit Breakers
3. Installing Rack-Mounted Indoor Circuit Breakers

B. Installing Capacitor Banks and Reactors

1. Installing Capacitors and Capacitor Banks
2. Installing Reactors

C. PT/Laboratory

Have trainees locate instructor-requested information in an installation manual for at least one of the following components:

- Disconnect switches
- Circuit breakers
- Capacitor banks
- Reactors

This laboratory corresponds to Performance Task 2.

Session X. 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 trainee to the components and systems in control houses. Trainees will learn to build a DC circuit and lay out a control panel.

Objectives

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

1. Identify and explain the uses of components in DC battery systems.
2. Explain and identify the systems and system components in station services.
3. Describe the systems used to monitor a substation.
4. Describe control house types and general construction.
5. Describe fire protection systems.

Performance Tasks

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

1. Lay out a control or relay panel.
2. Build a DC circuit.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Three: Substation
PowerPoint® Presentation Slides
(ISBN 978-0-13-257181-4)
Computer
Whiteboard/chalkboard
Markers/chalk

Pencils and paper
Materials and tools for laying out a control or relay panel
Materials and tools for building a DC circuit
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 for working with the batteries and equipment found in control houses. 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.

C & D Technologies; systems for the power conversion and storage of electrical power, including industrial batteries and electronics. www.cdtechno.com.

Modern Solutions for Protection, Control, and Monitoring of Electric Power Systems, 2010. Pullman, WA: Schweitzer Engineering Laboratories, Inc.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *Control House*. 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
Sessions I and II. Introduction; Control House Configurations; Typical Site-Built Control House Construction; PCM Equipment Installation	
A. Introduction	_____
B. Control House Configurations	_____
C. Typical Site-Built Control House Construction	_____
1. Foundations	_____
2. Floors	_____
3. Building Structure	_____
4. HVAC Equipment	_____
5. Plumbing	_____
6. Cableways	_____
D. PCM Equipment Installation	_____
Session III. Auxiliary AC Service Power and DC Control Power Systems	
A. Auxiliary AC Service Power and DC Control Power Systems	_____
1. Auxiliary AC Station Service	_____
2. Auxiliary DC Control Power System	_____
3. Battery Bank	_____
4. Batteries	_____
5. Battery Chargers	_____
Session IV. Fire Protection Equipment; Communication Systems	
A. Fire Protection Equipment	_____
1. Gaseous Direct and Indirect Systems	_____
2. Automatic Gaseous Flooding Systems	_____
3. Gaseous Fire Suppression Agents	_____
4. Aerosol Flooding Systems	_____
B. Communication Systems	_____
Session V. Laboratory	
A. Laboratory	_____
1. Have the trainees practice laying out a control panel.	_____
2. Have the trainees practice building a DC circuit.	_____
Sessions VI and VII. PT/Laboratory	
A. PT/Laboratory	_____
1. Have the trainees lay out a control or relay panel. This laboratory corresponds to Performance Task 1.	
2. Have the trainees build a DC circuit. This laboratory corresponds to Performance Task 2.	

Session VIII. Review and Testing

A. Review

B. Module Examination

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

C. Performance Testing

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

Module Overview

This module introduces the trainee to the tools and equipment needed to make cable terminations and splices. Trainees will make terminations and splices, learn to recognize acceptable and unacceptable work, perform hi-pot tests, and use a hydraulic press on a connector.

Objectives

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

1. Explain how to prepare an insulated cable for terminations and splices.
2. Explain how to prepare a non-insulated cable for terminations and splices.
3. Describe how to complete cable assembly terminations and splices.
4. Explain the inspecting and testing process for medium- and high-voltage terminations and splices.

Performance Tasks

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

1. Properly make a medium/high-voltage cable termination or splice with a termination kit.
2. Test a termination or splice with a hi-pot.
3. Use a hydraulic press (greater than 15 tons) on a connector.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Three: Substation
PowerPoint® Presentation Slides
(ISBN 978-0-13-257181-4)
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
Selection of power cables
Sections of insulation shield
Sufficient short lengths of cable and tools for removing layers

Constant and high-MA crimping tools, appropriate cable, and connectors
Samples of acceptable and unacceptable crimps
Selection of terminal blocks, conductors, and necessary tools for installing wires
Sufficient termination kits
Hydraulic press (greater than 15 tons) and sufficient connectors
Hi-pot tester and sufficient terminations or splices
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 for working with connectors, conductor terminations, and splices. 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.

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

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover *Connectors, 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
Session I. Introduction; Insulated Power Cables	
A. Introduction	_____
B. Insulated Power Cables	_____
1. Strand Shielding	_____
2. Insulation	_____
3. Insulation Shield System	_____
4. Jacket	_____
Session II. Cable Splices	
A. Cable Splices	_____
1. Preparing the Surface	_____
2. Joining the Conductors with Connectors	_____
3. Reinsulating	_____
4. Reshielding	_____
5. Rejacketing	_____
6. Cold-Splice Kits	_____
7. Paper-Insulated Cable Splices	_____
Sessions III and IV. Cable Terminations; Terminating Substation Power Conductors	
A. Cable Terminations	_____
1. Stress Control	_____
2. External Leakage Insulation	_____
3. Sealing to the External Environment	_____
4. Grounding Shield Ends	_____
B. Terminating Substation Power Conductors	_____
1. Terminations	_____
2. Bolted Connections	_____

Sessions V and VI. Low-Voltage and Control Wiring

A. Low-Voltage and Control Wiring

1. Stripping and Cleaning Conductors
2. Heat-Shrink Insulators
3. Low-Voltage Connectors and Terminals
4. Installing Compression Connectors
5. Installing Control and Signal/Cable Conductors
6. Termination Inspection
7. Terminal Block Connections
8. Cable/Conductor Routing and Inspection Considerations

B. PT/Laboratory

Have trainees properly make a medium/high-voltage cable termination or splice with a termination kit. This laboratory corresponds to Performance Task 1.

Session VII. Bending Cable and Training Conductors; High-Potential (Hi-Pot) Testing

A. Bending Cable and Training Conductors

B. High-Potential (Hi-Pot) Testing

1. Method of Application
2. Selective Guard Circuits
3. Connections
4. Selective Guard Service Connections
5. Corona Guard Ring and Guard Shield
6. Go/No-Go Testing
7. Insulation Resistance Measurements

Sessions VIII and IX. PT/Laboratory

A. PT/Laboratory

1. Have the trainees use a hydraulic press (greater than 15 tons) on a connector. This laboratory corresponds to Performance Task 3.
2. Have the trainees test a termination or splice with a hi-pot. This laboratory corresponds to Performance Task 2.

Session X. 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 trainee to the tools and equipment needed to maintain batteries, switches, disconnects, potential devices, capacitors and reactors, circuit breakers, and transformers. The trainee will also learn to test batteries; maintain disconnects, switches, and circuit breakers; check capacitors, capacitor banks, and reactors; and perform control cabinet checks and DLRO and dielectric tests.

Objectives

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

1. Explain how to test and maintain batteries.
2. Explain how to test and maintain disconnects, switches, and circuit switchers.
3. Explain how to test and maintain potential devices.
4. Explain how to test and maintain capacitors and reactors.
5. Explain how to test and maintain circuit breakers.
6. Explain how to test and maintain transformers.

Performance Tasks

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

1. Perform the following tests on a battery:
 - Confirm the battery voltage readings.
 - Confirm cell voltage readings.
 - Record the specific gravity reading.
 - Adjust the electrolyte.
 - Clean and neutralize the battery casing.
 - Adjust the battery charger.
2. Perform the following tasks on disconnects, switches, or circuit switchers:
 - Clean and lubricate.
 - Exercise the switch.
 - Adjust for proper engagement of the contact surfaces.
 - Perform a DLRO test.
3. Perform the following tasks on a capacitor, capacitor bank, or reactor:
 - Check capacitance value.
 - Check the integrity of the reactors.
4. Perform the following tasks on a circuit breaker:
 - Make control cabinet measurements and checks.
 - Perform a DLRO test.
 - Perform a dielectric test.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Three: Substation
PowerPoint® Presentation Slides
(ISBN 978-0-13-257181-4)
Computer
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
As many high-voltage detectors and meters as possible for the trainees to examine and use:
Phasing sticks
Megohmmeter
Hi-pot tester
Digital low-resistance ohmmeter
Transformer turns ratio tester

Other test equipment as feasible:
Liquid dielectric test equipment
SF₆ test equipment
Vacuum bottle testing
Access to substation equipment, including batteries, switches and disconnects, potential devices, capacitors and reactors, circuit breakers, and transformers
Access to test equipment, gauges, and sampling devices
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 for working with test equipment and performing electrical maintenance. 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.

Electrical Power Equipment Maintenance and Testing, Second Edition. Paul Gill. CRC Press.

ASTM Standard D923-07: Standard Practices for Sampling Electrical Insulating Liquids. ASTM International. www.astm.org

ASTM Standard D877-02(2007): Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes. ASTM International. www.astm.org

ASTM Standard D1816-04: Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes. ASTM International. www.astm.org

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

Topic	Planned Time
Session I. Introduction; Tools and Test Equipment	
A. Introduction	_____
B. Tools and Test Equipment	_____
1. Electrical Tools and Equipment	_____
2. Other Test Equipment	_____
Sessions II and III. Battery System Testing and Maintenance; Disconnect and Switch Maintenance	
A. Battery System Testing and Maintenance	_____
1. Substation Batteries	_____
2. Battery Chargers	_____
3. Battery Maintenance Schedules	_____
4. Battery Maintenance and Test Procedures	_____
B. Disconnect and Switch Maintenance	_____
1. Switch Inspection Guidelines	_____
2. DLRO Testing	_____
Sessions IV and V. Potential Device Testing; Capacitor and Reactor Inspection Testing	
A. Potential Device Setting	_____
1. CT Tests	_____
2. VT Testing	_____
B. Capacitor and Reactor Inspection and Testing	_____
1. Capacitor Inspection and Testing	_____
2. Series Reactor Inspection	_____
Session VI. Circuit Breaker Maintenance and Testing	
A. Circuit Breaker Maintenance and Testing	_____
1. Visual Inspections	_____
2. Removing a Circuit Breaker from Service	_____
3. Inspecting Control Panels	_____
4. Operating Mechanisms	_____
5. Circuit Breaker DLRO Testing	_____
6. Time-Travel Testing	_____
7. Oil Circuit Breaker Maintenance	_____
8. Air-Magnetic and Vacuum Circuit Breakers	_____
9. Gas and Air-Blast Breakers	_____

Session VII. Power Transformer Inspection and Maintenance

A. Power Transformer Inspection and Maintenance

- 1. Transformer Operating Inspections
- 2. Oil Sampling
- 3. Transformer Testing

Session VIII. PT/Laboratory

A. PT/Laboratory

Have the trainees perform the following tests on a battery:

- Confirm the battery voltage readings.
- Confirm cell voltage readings.
- Record the specific gravity reading.
- Adjust the electrolyte.
- Clean and neutralize the battery casing.
- Adjust the battery charger.

This activity corresponds to Performance Task 1.

Sessions IX–XI. PT/Laboratory

A. PT/Laboratory

1. Have the trainees perform the following tasks on disconnects, switches, or circuit breakers:

- Clean and lubricate.
- Exercise the switch.
- Adjust for proper engagement of the contact surfaces.
- Perform a DLRO test.

This activity corresponds to Performance Task 2.

2. Have trainees perform the following tasks on a capacitor, capacitor bank, or reactor:

- Check capacitance value.
- Check the integrity of the reactors.

This activity corresponds to Performance Task 3.

3. Have trainees perform the following tasks on a circuit breaker:

- Make control cabinet measurements and checks.
- Perform a DLRO test.
- Perform a dielectric test.

This activity corresponds to Performance Task 4.

Session XII. 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 trainee to protective devices and how they are coordinated to handle faults and interruptions in electrical distribution systems. The trainees will learn to recognize the protective components and relay schemes.

Objectives

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

1. Explain the function of system protection and control.
2. Identify the components used in system protection and control.
3. Describe the basic types of relay schemes.

Performance Tasks

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

1. Draw a basic trip and close circuit.
2. Identify the components used in system protection and control.

Materials and Equipment

Multimedia projector and screen
Power Line Worker Level Three: Substation
PowerPoint® Presentation Slides
(ISBN 978-0-13-257181-4)
Computer
Whiteboard/chalkboard
Markers/chalk

Pencils and paper
Access to substation-class protective devices and equipment
Substation three-line diagrams
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 for working with system protection for electrical distribution systems. 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.

Protective Relaying: Principles and Applications, Third Edition. J. Lewis Blackburn and Thomas J. Domin. CRC Press.

Modern Solutions for Protection, Control, and Monitoring of Electric Power Systems, Schweitzer Engineering Laboratories, Inc. Quality Books, Inc.

Power System Protection. Paul M. Anderson. Wiley-IEEE Press.

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

Topic	Planned Time
Session I. Introduction; System Monitoring	
A. Introduction	_____
B. System Monitoring	_____
1. Instrument Transformers	_____
2. Protective Relays	_____
3. Transformer Dielectric Protection	_____
Session II. System Protective Devices; Protective Device Coordination; Basic Feeder Diagrams	
A. System Protective Devices	_____
1. Fuses	_____
2. Circuit Breakers	_____
3. Reclosers	_____
B. Protective Device Coordination	_____
1. Coordinating Points of a Feeder	_____
2. Cold-Load Pickup	_____
3. Applying Protective Device Coordination	_____
C. Basic Feeder Diagrams	_____
1. Feeder Designs	_____
Sessions III and IV. Transmission-Level Protection and Monitoring	
A. Transmission-Level Protection and Monitoring	_____
1. Energy Control Centers	_____
2. SCADA Systems	_____
3. Zone Relay Protection	_____
B. PT/Laboratory	_____
1. Have the trainees draw a basic trip and close circuit. This laboratory corresponds to Performance Task 1.	
2. Have the trainees identify the components used in system protection and control. This laboratory corresponds to Performance Task 2.	

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

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

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

Prerequisites

There are no prerequisites for this course.

Objectives

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

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

Performance Tasks

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

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

Industry Recognized Credentials

If you're training through an NCCER-accredited sponsor you may be eligible for credentials from NCCER's Registry. The ID number for this module is 46101-11. Note that this module may have been used in other NCCER curricula and may apply to other level completions. Contact NCCER's Registry at 888.622.3720 or go to nccer.org for more information.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Power Line Worker Level Three: Distribution
PowerPoint® Presentation Slides
(ISBN 978-0-13-294912-5)
Multimedia projector and screen
Computer
Several construction job descriptions, including
one that is very vague and one that is overly
detailed
Several MSDSs appropriate to the craft
Original and as-built drawings of the same
project
A redline drawing
Sufficient copies of a roofing formwork detail
drawing
Sufficient copies of the worksheet with entries

Examples of schedules:*

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

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

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

Set of construction drawings
Module Examinations**
Performance Profile Sheets**

* Because this module may be used for different industries, materials such as project schedules should be appropriate to the craft where possible.

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

Additional Resources

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

Aging Workforce News, www.agingworkforcenews.com.

American Society for Training and Development (ASTD), www.astd.org.

Architecture, Engineering, and Construction Industry (AEC), www.aecinfo.com.

CIT Group, www.citgroup.com.

Equal Employment Opportunity Commission (EEOC), www.eeoc.gov.

National Association of Women in Construction (NAWIC), www.nawic.org.

National Census of Fatal Occupational Injuries (NCFI), www.bls.gov.

National Center for Construction Education and Research, www.nccer.org.

National Institute of Occupational Safety and Health (NIOSH), www.cdc.gov/niosh.

National Safety Council, www.nsc.org.

NCCER Publications:

- *Your Role in the Green Environment*
- *Sustainable Construction Supervisor*

Occupational Safety and Health Administration (OSHA), www.osha.gov.

Society for Human Resources Management (SHRM), www.shrm.org.

United States Census Bureau, www.census.gov.

United States Department of Labor, www.dol.gov.

USA Today, www.usatoday.com.

Teaching Time for This Module

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

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

