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
| At least one copy of NFPA 70B, Recommended Practice for Electrical Equipment Maintenance |
| Power Line Worker Level Three: Substation PowerPoint® Presentation Slides |
| Hot stick and attachments |
| Insulating mats |
| Computer |
| Insulating covers |
| Whiteboard/chalkboard |
| Grounding clamps |
| Markers/chalk |
| Grounding cables |
| Pencils and paper |
| Open-loop ammeter |
| Appropriate personal protective equipment |
| Portable ground tester |
| Electrical safety analysis |
| Module Examinations* |
| Personal protective grounds |
| Performance Profile Sheets* |
| Lockout/tagout equipment |

* 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


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


Codebook City, source for NEC® explanations.
http://www.codebookcity.com/codearticles/nec/index.htm

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


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.

### 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
- Markers/chalk
- Power Line Worker Level Three: Substation PowerPoint® Presentation Slides
- Pencils and paper
- Sufficient sets of structural drawings
- Sufficient number of contour drawings
- Module Examinations*
- Performance Profile Sheets*
- Computer
- Whiteboard/chalkboard

* 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.

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.

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<td>B. Substation Construction Plans</td>
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<td>1. Plan Set Contents</td>
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<td>A. Architectural Drawings</td>
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<td>1. Site Plans</td>
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<td><strong>Session III. Structural Drawings</strong></td>
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<td>A. Structural Drawings</td>
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<td>2. Framing Plans</td>
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<td>B. Laboratory</td>
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<tr>
<td>Have trainees point out and explain common components of structural drawings.</td>
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<td><strong>Session IV. Mechanical Drawings; Details and Sections</strong></td>
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<td>A. Mechanical Drawings</td>
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<td>2. Plumbing Systems</td>
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<td>B. Details and Sections</td>
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<td><strong>Sessions V and VI. Electrical Drawings</strong></td>
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<td>A. Electrical Drawings</td>
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<tr>
<td>1. Legends, Symbols, and Numbers</td>
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<td>2. Notes</td>
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<td>3. Grid Reference Numbers</td>
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<td>4. Schematic and Wiring Diagrams</td>
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<td>B. PT/Laboratory</td>
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<tr>
<td>Have trainees identify three specific components on a schematic provided by the instructor. This laboratory corresponds to Performance Task 1.</td>
<td></td>
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<tr>
<td><strong>Session VII. General Arrangement Drawings</strong></td>
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<tr>
<td>A. General Arrangement Drawings</td>
<td>____________</td>
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<tr>
<td>B. PT/Laboratory</td>
<td>____________</td>
</tr>
<tr>
<td>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.</td>
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</tbody>
</table>
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:

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 Power Point® Presentation Slides
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 following 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.

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<th>Topic</th>
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<td>B. Corona</td>
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<td>1. The Effects of Corona</td>
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<td>2. Corona Prevention</td>
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<td><strong>Session II. Installing Rigid Bus and Support Insulators</strong></td>
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<td>A. Installing Rigid Bus and Support Insulators</td>
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<td>1. Assembling Rigid Aluminum Bus</td>
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<td>2. Installing Support Insulators</td>
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<td><strong>Session III. Installing Disconnects and Circuit Switchers</strong></td>
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<td>A. Installing Disconnects and Circuit Switchers</td>
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<tr>
<td>1. Hook Switch Disconnects</td>
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<td>2. Circuit Interrupters</td>
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<td><strong>Sessions IV–V. Installing Power Transformers</strong></td>
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<td>A. Installing Power Transformers</td>
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<td>1. Receiving Transformers</td>
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<td>2. Lifting and Handling</td>
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<td>3. Storage</td>
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<td>4. Tank Access and External Radiators</td>
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<td>5. Wiring</td>
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<tr>
<td>B. PT/Laboratory</td>
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<tr>
<td>Have the trainees create a step-by-step plan for the installation of a transformer. This laboratory corresponds to Performance Task 1.</td>
<td></td>
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</tbody>
</table>
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
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](http://www.cdtechno.com).

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.

<table>
<thead>
<tr>
<th>Topic</th>
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<td><strong>Sessions I and II. Introduction; Control House Configurations; Typical Site-Built Control House Construction; PCM Equipment Installation</strong></td>
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<tr>
<td>A. Introduction</td>
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<td>B. Control House Configurations</td>
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<td>C. Typical Site-Built Control House Construction</td>
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<td>1. Foundations</td>
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<td>2. Floors</td>
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<td>3. Building Structure</td>
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<td>4. HVAC Equipment</td>
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<td>5. Plumbing</td>
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<td>6. Cableways</td>
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<td>D. PCM Equipment Installation</td>
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<td><strong>Session III. Auxiliary AC Service Power and DC Control Power Systems</strong></td>
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<tr>
<td>A. Auxiliary AC Service Power and DC Control Power Systems</td>
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<tr>
<td>1. Auxiliary AC Station Service</td>
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<tr>
<td>2. Auxiliary DC Control Power System</td>
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<td>3. Battery Bank</td>
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<tr>
<td>4. Batteries</td>
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<td>5. Battery Chargers</td>
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<tr>
<td><strong>Session IV. Fire Protection Equipment; Communication Systems</strong></td>
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<td>A. Fire Protection Equipment</td>
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<td>1. Gaseous Direct and Indirect Systems</td>
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<td>2. Automatic Gaseous Flooding Systems</td>
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<td>3. Gaseous Fire Suppression Agents</td>
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<td>4. Aerosol Flooding Systems</td>
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<td>B. Communication Systems</td>
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<td><strong>Session V. Laboratory</strong></td>
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<tr>
<td>A. Laboratory</td>
<td>____________</td>
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<tr>
<td>1. Have the trainees practice laying out a control panel.</td>
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<tr>
<td>2. Have the trainees practice building a DC circuit.</td>
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<tr>
<td><strong>Sessions VI and VII. PT/Laboratory</strong></td>
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<tr>
<td>A. PT/Laboratory</td>
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<tr>
<td>1. Have the trainees lay out a control or relay panel. This laboratory corresponds to Performance Task 1.</td>
<td>____________</td>
</tr>
<tr>
<td>2. Have the trainees build a DC circuit. This laboratory corresponds to Performance Task 2.</td>
<td>____________</td>
</tr>
</tbody>
</table>
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
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.


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.

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<td>B. Insulated Power Cables</td>
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<td>2. Insulation</td>
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<td>3. Insulation Shield System</td>
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<td>4. Jacket</td>
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<td><strong>Session II. Cable Splices</strong></td>
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<td>A. Cable Splices</td>
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<td>1. Preparing the Surface</td>
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<td>2. Joining the Conductors with Connectors</td>
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<td>3. Reinsulating</td>
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<td>4. Reshielding</td>
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<td>B. Terminating Substation Power Conductors</td>
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<td>1. Terminations</td>
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<td>2. Bolted Connections</td>
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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
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

* 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.


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*
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.

<table>
<thead>
<tr>
<th>Topic</th>
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<td>A. Introduction</td>
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<td>B. Tools and Test Equipment</td>
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<tr>
<td>1. Electrical Tools and Equipment</td>
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<td>2. Other Test Equipment</td>
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<td><strong>Sessions II and III. Battery System Testing and Maintenance; Disconnect and Switch Maintenance</strong></td>
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<td>2. Battery Chargers</td>
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<td>3. Battery Maintenance Schedules</td>
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<td>4. Battery Maintenance and Test Procedures</td>
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<td>B. Disconnect and Switch Maintenance</td>
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<td>1. Switch Inspection Guidelines</td>
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<td>2. DLRO Testing</td>
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<td><strong>Sessions IV and V. Potential Device Testing; Capacitor and Reactor Inspection Testing</strong></td>
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<td>2. VT Testing</td>
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<td>B. Capacitor and Reactor Inspection and Testing</td>
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<td>7. Oil Circuit Breaker Maintenance</td>
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<td>8. Air-Magnetic and Vacuum Circuit Breakers</td>
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<td>9. Gas and Air-Blast Breakers</td>
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</tbody>
</table>
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
- 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.

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.

<table>
<thead>
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<th>Topic</th>
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<td>A. Introduction</td>
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<td>3. Transformer Dielectric Protection</td>
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<td><strong>Session II. System Protective Devices; Protective Device Coordination; Basic Feeder Diagrams</strong></td>
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<td>A. System Protective Devices</td>
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<td>3. Reclosers</td>
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<td>2. Cold-Load Pickup</td>
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<td>3. Applying Protective Device Coordination</td>
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<td>A. Transmission-Level Protection and Monitoring</td>
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<td>2. SCADA Systems</td>
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<td>3. Zone Relay Protection</td>
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<tr>
<td>B. PT/Laboratory</td>
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<tr>
<td>1. Have the trainees draw a basic trip and close circuit. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td>2. Have the trainees identify the components used in system protection and control. This laboratory corresponds to Performance Task 2.</td>
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</table>
Session V. Review and Testing

A. Review

B. Module Examination

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

C. Performance Testing

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

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*
- 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

*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.

- NCCER Publications:
  - *Your Role in the Green Environment*
  - *Sustainable Construction Supervisor*
- Occupational Safety and Health Administration (OSHA), www.osha.gov.
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.

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<td>2. Impact of Technology</td>
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<td>4. Sexual Harassment</td>
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<td>5. Gender and Minority Discrimination</td>
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<td>C. Business Organizations</td>
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<td>1. Division of Responsibility</td>
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<td>2. Authority, Responsibility, and Accountability</td>
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<td>3. Job Descriptions</td>
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<td>B. The Shift in Work Activities</td>
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<td>C. Becoming a Leader</td>
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<td>1. Characteristics of a Leader</td>
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<td>2. Functions of a Leader</td>
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<td>3. Leadership Styles</td>
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<td>4. Ethics in Leadership</td>
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<td>D. Communication</td>
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<td>3. Written or Visual Communication</td>
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<td>E. Motivation</td>
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<td>1. Successful Teams</td>
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<td>2. Building Successful Teams</td>
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Session III. Section Two – Leadership Skills, Part Two
Section Three – Safety, Part One

A. Getting the Job Done
   1. Delegating
   2. Implementing Policies and Procedures
B. Problem Solving and Decision Making
   1. Decision Making vs. Problems Solving
   2. Types of Decisions
   3. Problem Solving
   4. Special Leadership Problems
C. Safety Overview
   1. Accident Statistics
D. Costs of Accidents
   1. Insured Costs
   2. Uninsured Costs
E. Safety Regulations
   1. Workplace Inspections
   2. Penalties for Violations

Session IV. Section Three – Safety, Part Two

A. Employer Safety Responsibilities
   1. Safety Program
B. Crew Leader Involvement in Safety
   1. Safety Training Sessions
   2. Inspections
   3. First Aid
   4. Fire Protection and Prevention
   5. Substance Abuse
   6. Job-Related Accident Investigations
C. Promoting Safety
   1. Safety Training Sessions
   2. Safety Contests
   3. Incentives and Awards
   4. Publicity

Session V. Section Four – Project Control, Part One

A. Project Control Overview
   1. Development Phase
   2. Planning Phase
   3. Construction Phase
B. Project Delivery Systems
   1. General Contracting
   2. Design-Build
   3. Construction Management
C. Cost Estimating and Budgeting
   1. The Estimating Process
D. PT/Laboratory
   Have the trainees develop an estimate for the work activity. This laboratory corresponds to Performance Task 1.
Session VI. Section Four – Project Control, Part Two

A. Planning
   1. Why Plan?
   2. Stages of Planning

B. PT/Laboratory
   Have the trainees develop and present a look-ahead schedule based on one of the plans. This laboratory corresponds to Performance Task 2.

C. The Planning Process
   1. Establish a Goal
   2. Identify the Work to Be Done
   3. Identify Tasks to Be Performed
   4. Communicating Responsibilities
   5. Follow-Up Activities

D. Planning Resources
   1. Safety Planning
   2. Materials Planning
   3. Site Planning
   4. Equipment Planning
   5. Tool Planning
   6. Labor Planning

Session VII. Section Four – Project Control, Part Three

A. Scheduling
   1. The Scheduling Process
   2. Bar Chart Schedule
   3. Network Schedule
   4. Short-Term Scheduling
   5. Updating a Schedule

B. Cost Control
   1. Assessing Cost Performance
   2. Field Reporting System
   3. Crew Leader’s Role in Cost Control

C. Resource Control
   1. Materials Control
   2. Equipment Control
   3. Tool Control
   4. Labor Control

D. Production and Productivity

Session VIII. 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.

C. Performance Testing
   1. Trainee must perform each task to the satisfaction of the instructor to receive recognition from NCCER.
   2. Record the training results on Training Report Form 200, and submit the results to the Training Program Sponsor.