Module One (26301-17) explains how to calculate branch circuit and feeder loads for residential and commercial applications. It also covers various derating factors.

### Objectives

#### Learning Objective 1
- Calculate branch circuit loads.
  a. Calculate branch circuit ratings.
  b. Apply derating factors.
  c. Calculate branch circuit ampacity.

#### Learning Objective 2
- Identify residential branch circuit requirements.
  a. Calculate lighting loads.
  b. Calculate receptacle loads.
  c. Calculate small appliance loads.
  d. Calculate laundry circuit loads.
  e. Calculate cooking appliance loads.
  f. Calculate water heater loads.
  g. Calculate electric heating loads.
  h. Calculate air conditioning loads.

### Learning Objective 3
- Calculate commercial loads.
  a. Calculate the loads on multi-outlet assemblies.
  b. Calculate show window loads.
  c. Calculate sign loads.
  d. Calculate loads for heavy-duty lamp holder outlets.
  e. Calculate commercial kitchen equipment loads.
  f. Calculate motor loads.
  g. Calculate welder loads.

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

### Note
NFPA 70®, National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

### Teaching Time: 17.5 hours
(Seven 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on branch and feeder circuit load calculations. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.

Classroom Equipment and Materials
- Whiteboard and markers
- Pencils and paper
- *Electrical Level Three PowerPoint® Presentation*
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Module Review answer key
- Module Examinations
- Module Examination answer key (for paper-based exams)

Safety Considerations
This module covers material that relates to trainees working with and around electrical branch and feeder circuits used in residential and commercial applications. Safety must be emphasized at all times. Any trainees in an electrical environment should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees. Any practice sessions and Performance Tasks must be completed under your direct supervision.
Session Outline for Module 26301-17

LOAD CALCULATIONS – BRANCH AND FEEDER CIRCUITS

The Lesson Plan for this module is divided into seven 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSIONS ONE & TWO**

Sessions One and Two cover Sections 1.0.0 through 1.3.0 and describe how to calculate branch circuit loads.

1. Show the Sessions One and Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with calculating branch circuit loads.
3. Explain how to calculate branch circuit ratings.
4. Explain how to apply derating factors.
5. Explain how to calculate branch circuit ampacity.

**SESSIONS THREE & FOUR**

Sessions Three and Four cover Sections 2.0.0 through 2.8.0 and describe how to identify residential branch circuit requirements.

1. Show the Sessions Three and Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with identifying residential branch circuit requirements.
3. Explain how to calculate lighting loads.
4. Explain how to calculate receptacle loads.
5. Explain how to calculate small appliance loads.
6. Explain how to calculate laundry circuit loads.
7. Explain how to calculate cooking appliance loads.
8. Explain how to calculate water heater loads.
9. Explain how to calculate electric heating loads.
10. Explain how to calculate air conditioning loads.

**SESSIONS FIVE & SIX**

Sessions Five and Six cover Sections 3.0.0 through 3.7.0 and describe how to calculate commercial loads.

1. Show the Sessions Five and Six PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with calculating commercial loads.
3. Explain how to calculate the loads on multi-outlet assemblies.
4. Explain how to calculate show window loads.
5. Explain how to calculate sign loads.
6. Explain how to calculate loads for heavy-duty lamp holder outlets.
7. Explain how to calculate commercial kitchen equipment loads.
8. Explain how to calculate motor loads.
9. Explain how to calculate welder loads.

**SESSION SEVEN**

Session Seven is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination.
2. Record the testing results as required for paper-based exams. The results for exams administered through online testing systems are recorded automatically in the Registry System.
Module Two (26302-17) explains how to select conductors for different applications and size conductors based on the expected load and voltage drop.

### Objectives

**Learning Objective 1**
- Select conductors for various applications.
  a. Identify overcurrent protection for branch circuits and feeders.
  b. Identify the properties of conductors.

**Learning Objective 2**
- Size conductors based on expected load and voltage drop.
  a. Calculate wire sizes based on resistance.
  b. Calculate conductor resistances.
  c. Calculate voltage drops for various applications.

### Performance Tasks

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

### Note

NFPA 70®, National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

### Teaching Time: 15 hours

(Six 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module covers material that relates to trainees working with and around conductors used in residential and commercial applications. Safety must be emphasized at all times. Any trainees in an electrical environment should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees. Any practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard and markers
Pencils and paper
Electrical Level Three PowerPoint® Presentation
DVD player
LCD projector and screen
Computer
Internet access during class
Stranded conductors
Bare and coated copper wire
Module Review answer key
Module Examinations

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


Online resources are available for trainees who would like more information on conductor selection and calculations. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26302-17

CONDUCTOR SELECTION AND CALCULATIONS

The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSIONS ONE THROUGH THREE

Sessions One through Three cover Sections 1.0.0 through 1.2.2 and describe how to select conductors for various branch applications.

1. Show the Sessions One through Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with conductor materials and types.
3. Explain how to identify overcurrent protection for branch circuits and feeders.
4. Explain how to identify the properties of conductors.

SESSIONS FOUR & FIVE

Sessions Four and Five cover Sections 2.0.0 through 2.3.2 and describe how to size conductors based on the expected load and voltage drop.

1. Show the Sessions Four and Five PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with calculating conductor resistance and voltage drop.
3. Explain how to calculate wire sizes based on resistance.
4. Explain how to calculate conductor resistances.
5. Explain how to calculate voltage drops for various applications.

SESSION SIX

Session Six is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination.
2. Record the testing results as required for paper-based exams. The results for exams administered through online testing systems are recorded automatically in the Registry System.
Module Two (26302-17) explains how to identify lamps and lighting systems, and how to select lighting systems for various applications.

### Objectives

#### Learning Objective 1
- Identify lamps and lighting fixtures.
  - Classify lighting by type of service and location.
  - Identify types of lighting fixtures.

#### Learning Objective 2
- Select lighting systems for various applications.
  - Identify types of lighting for various applications.
  - Identify special-purpose wiring systems.
  - Select dimmer systems for various applications.

### Performance Tasks

#### Performance Task 1 (Learning Objective 1)
- Using manufacturers’ catalogs, select the appropriate lighting fixtures for specific lighting situations.

#### Performance Task 2 (Learning Objective 2)
- While touring selected structures to observe their lighting systems:
  - Identify the various types of lighting fixtures used.
  - Explain the specific purpose(s) served by the different fixtures.
  - Identify the lighting system class of service.

### Note

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### Teaching Time: 12.5 hours
(Five 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations
This module covers material that involves working with and around electrical lighting fixtures and circuits used in residential, commercial, and industrial applications. Safety must be emphasized at all times. When working in an electrical environment, instructors must ensure that trainees wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees. Practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
Whiteboard and markers
Pencils and paper
*Electrical Level Three PowerPoint® Presentation Slides*
DVD player
LCD projector and screen
Computer
Internet access during class (optional)
Specific PPE required by the site
Various lighting manufacturers’ catalogs
Common examples of the following types of lighting fixtures:
- Incandescent
- Fluorescent
- HID
- Outdoor
- LED
- Vandal resistant
Common dimmer controls
Module Review answer key
Module Examinations
Performance Profile sheets

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


There are a number of online resources available for trainees who would like more information on lighting fixtures and their applications. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26303-17

PRACTICAL APPLICATIONS OF LIGHTING

The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE
Session One covers Sections 1.0.0 through 1.2.5 and identifies lamps and lighting fixtures.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with different types and advantages of LED lighting for various applications.
3. Explain how lighting is classified by type of service and location.
4. Explain how to identify types of lighting fixtures.

SESSION TWO
Session Two covers Sections 2.0.0 through 2.3.5 and describes how to select lighting systems for various applications.
1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with factors that must be considered when selecting a lighting system for a specific application.
3. Explain how to identify types of lighting for various applications.
4. Explain how to identify special-purpose wiring systems.
5. Explain how to select dimmer systems for various applications.

SESSIONS THREE AND FOUR
Sessions Three and Four are set aside for lab work needed to satisfy the module Performance Tasks. You can allocate lab time for these activities based on class size and available facilities. One approach would be to have some trainees complete one performance task while other trainees work on the other performance task.
1. Using manufacturers’ catalogs, select the appropriate lighting fixtures for specific lighting situations.
2. While touring selected structures to observe their lighting systems:
   • Identify the various types of lighting fixtures used.
   • Explain the specific purpose(s) served by the different fixtures.
   • Identify the lighting system class of service.

Upon completion of the lab work, ask the trainees to complete the Module Review questions and Supplemental Exercises before the upcoming review and testing session.

SESSION FIVE
Session Five is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.
Module Four (26304-17) describes the NEC® classifications and requirements for hazardous locations.

**Objectives**

**Learning Objective 1**
- Identify hazardous locations.
  - Identify Class I locations.
  - Identify Class II locations.
  - Identify Class III locations.
  - Locate NEC® requirements for hazardous locations.

**Learning Objective 2**
- Prevent ignitions and explosions in hazardous locations.
  - Identify sources of ignitions.
  - Select and install explosion-proof equipment and seals.

**Performance Task**

**Performance Task 1 (Learning Objective 2)**
- Using two rigid metal conduit nipples, a sealing fitting, three pieces of No. 12 THHN conductors, and a packing fiber/sealing kit, perform the following operations:
  - Secure one conduit nipple in each end of the seal.
  - Make sure the required number of threads are engaged.
  - Pull the three THHN conductors through the nipples and seal so that about 6" (150 mm) is protruding from each nipple.
  - Pack the fiber as per the instructions furnished with the sealing kit.
  - Mix the sealing compound.
  - Position the unit in the required location and pour in the sealing compound.

**Note**

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**Teaching Time: 15 hours**
(Six 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Before You Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations
This module covers material that may involve working in and around hazardous locations. Safety must be emphasized at all times. When working in an electrical environment, instructors must ensure that trainees wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees. Practice sessions and Performance Tasks must be completed under your direct supervision.

Equipment, Materials, and Resources
Whiteboard and markers
Pencils and paper
Electrical Level Three PowerPoint® Presentation
DVD player
LCD projector and screen
Computer
Internet access during class (optional)
Specific PPE required by the site
Various types of explosion-proof equipment, including:
  Conduit junction boxes
  Conduit fittings
Flexible connectors
Packing fiber/sealing kits
Rigid metal conduit nipples
Sealing fittings
Three sections of No. 12 THHN conductors
Packing fiber/sealing kits
Module Review answer key
Module Examinations
Copies of the Performance Profile sheets

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


There are a number of online resources available for trainees who would like more information on NEC® classifications and requirements for hazardous locations. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26304-17
HAZARDOUS LOCATIONS

The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**Session One**

Session One covers Sections 1.0.0 through 1.4.4 and identifies hazardous locations.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with hazardous location classifications.
3. Explain how to identify Class I locations.
4. Explain how to identify Class II locations.
5. Explain how to identify Class III locations.
6. Explain how to locate NEC® requirements for hazardous locations.

**Sessions Three Through Five**

Sessions Three through Five are set aside for lab work needed to satisfy the module Performance Task. You can allocate lab time for these activities based on class size and available facilities. One approach would be to have trainees working at multiple work stations.

1. Using two rigid metal conduit nipples, a sealing fitting, three pieces of No. 12 THHN conductors, and a packing fiber/sealing kit, perform the following operations:
   - Secure 1 conduit nipple in each end of the seal.
   - Make sure the required number of threads are engaged.
   - Pull the three THHN conductors through the nipples and seal so that about 6" (150 mm) is protruding from each nipple.
   - Pack the fiber as per the instructions furnished with the sealing kit.
   - Mix the sealing compound.
   - Position the unit in the required location and pour in the sealing compound.

Upon completion of the lab work, ask the trainees to complete the Module Review questions and Supplemental Exercises before the review and testing session.

**Session Six**

Session Six is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing
2. Submit the results to your Training Program Sponsor through the Registry System.
# Lesson Plans for Module 26305-17

**Overcurrent Protection**

Module Five (26305-17) explains how to size and select circuit breakers and fuses for various applications. It also covers short circuit calculations and troubleshooting.

## Objectives

### Learning Objective 1
- Recognize overcurrent conditions.
  - a. Identify overload conditions.
  - b. Identify short circuit conditions.
  - c. Identify ground faults.
  - d. Identify arc faults.

### Learning Objective 2
- Identify fuses and their applications.
  - a. Identify fuse ratings.
  - b. Identify types of fuses and their operating characteristics.
  - c. Identify fuse classes and applications.

### Learning Objective 3
- Identify circuit breakers and their applications.
  - a. Identify circuit breaker classifications.
  - b. Identify circuit breaker interrupting capacity ratings.

### Learning Objective 4
- Size and select overcurrent devices.
  - a. Select overcurrent devices for various applications.
  - b. Apply short circuit calculations.

### Learning Objective 5
- Test and troubleshoot circuit breakers and fuses.
  - a. Test and troubleshoot circuit breakers.
  - b. Test and troubleshoot fuses.

## Performance Tasks

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

## Note

NFPA 70®, National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

## Teaching Time: 25 hours

(Ten 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

## Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentation and Performance Profile Sheets from www.nccerinc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module covers material that relates to trainees working with and around electrical circuit breakers and fuses used in residential and commercial applications. Safety must be emphasized at all times. Any trainees in an electrical environment should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees. Any practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
- Whiteboard and markers
- Pencils and paper
- Electrical Level Three PowerPoint® Presentation
- DVD player
- LCD projector and screen
- Computer
- Internet access during class
- Various types of fuses, including Class H and Class R
- Examples of fuse rejection clips
- Various types of circuit breakers
- Module Review answer key
- Module Examinations

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


There are a number of online resources available for trainees who would like more information on circuit breakers and fuses. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26305-17
OVERCURRENT PROTECTION

The Lesson Plan for this module is divided into ten 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.4.0 and describes how to recognize overcurrent conditions.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with problems that can cause overcurrent conditions.
3. Explain how to identify overload conditions.
4. Explain how to identify short circuit conditions.
5. Explain how to identify ground faults.
6. Explain how to identify arc faults.

**SESSIONS FOUR & FIVE**

Sessions Four and Five cover Sections 3.0.0 through 3.2.0 and describe how to identify circuit breakers and their applications.

1. Show the Sessions Four and Five PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with circuit breakers used in residential, commercial, and industrial applications.
3. Explain how to identify circuit breaker classifications.
4. Explain how to identify circuit breaker interrupting capacity ratings.

**SESSIONS TWO & THREE**

Sessions Two and Three cover Sections 2.0.0 through 2.3.5 and describe how to identify fuses and their applications.

1. Show the Sessions Two and Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with fuse ratings.
3. Explain how to identify fuse ratings.
4. Explain how to identify fuses and their operating characteristics.
5. Explain how to identify fuse classes and applications.

**SESSIONS SIX & SEVEN**

Sessions Six and Seven cover Sections 4.0.0 through 4.2.3 and describe how to size and select overcurrent devices.

1. Show the Sessions Six and Seven PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the importance of using protective devices for short circuits and overload conditions.
3. Explain how to select overcurrent devices for various applications.
4. Explain how to apply short circuit calculations.
# Lesson Plans for Module 26306-17

## DISTRIBUTION EQUIPMENT

Module Six (26306-17) examines switchboards and switchgear, including NEC® requirements for installation, grounding, and maintenance. It also covers ground fault relay testing.

### Objectives

#### Learning Objective 1
- Identify electrical distribution system components.
  - a. Identify switchboard components and installation requirements.
  - b. Identify switchgear components and installation requirements.
  - c. Identify the operation and applications of high-voltage limiting (HVL) switches.
  - d. Identify the operation and applications of bolted pressure switches.
  - e. Identify various transformers and their applications.
  - f. Identify panelboard arrangements for various applications.

#### Learning Objective 2
- Identify the installation requirements for distribution equipment.
  - a. Identify the NEC® requirements for distribution equipment.
  - b. Interpret electrical diagrams related to the installation of distribution equipment.

#### Learning Objective 3
- Test and maintain switchgear.
  - a. Describe the general maintenance guidelines for switchboards and switchgear.
  - b. List the test guidelines for switchboards and switchgear.
  - c. Identify the devices used to monitor power distribution systems for ground faults.

### Performance Tasks

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

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**Note**

NFPA 70®, National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

**Teaching Time: 12.5 hours**

(Five 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Before You Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
**Safety Considerations**

This module covers material that involves working with and around electrical distribution equipment in commercial and industrial applications. Safety must be emphasized at all times. When working in an electrical environment, instructors must ensure that trainees wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees.

**Classroom Equipment and Materials**

- Whiteboard and markers
- Pencils and paper
- *Electrical Level Three PowerPoint®* Presentation
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Copies of the *NFPA 70E®, Standard for Electrical Safety in the Workplace*, Latest Edition
- Module Review answer key
- Module Examinations

**Additional Resources**

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


There are a number of online resources available for trainees who would like more information on electrical distribution equipment. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the *PowerPoint®* presentations throughout the program.
Session Outline for Module 26306-17

**DISTRIBUTION EQUIPMENT**

The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

### Session One

Session One covers Sections 1.0.0 through 1.6.5 and identifies electrical distribution system components.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the basic layout and components of an electrical distribution system.
3. Identify switchboard components and installation requirements.
4. Identify switchgear components and installation requirements.
5. Describe the operation and applications of high-voltage limiting (HVL) switches.
6. Describe the operation and applications of bolted pressure switches.
7. Identify various transformers and their applications.
8. Identify panelboard arrangements for various applications.

### Session Two

Session Two covers Sections 2.0.0 through 2.2.7 and identifies the installation requirements for distribution equipment.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the NEC® requirements that pertain to the installation of distribution equipment.
3. Identify the NEC® requirements for distribution equipment.
4. Explain how to interpret electrical diagrams related to the installation of distribution equipment.

### Sessions Three and Four

Sessions Three and Four cover Sections 3.0.0 through 3.3.7 and describe how to test and maintain switchgear.

1. Show the Sessions Three and Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the use of infrared thermography for detecting temperature abnormalities in electrical equipment.
3. Describe the general maintenance guidelines for switchboards and switchgear.
4. List the test guidelines for switchboards and switchgear.
5. Identify the devices used to monitor power distribution systems for ground faults.

### Session Five

Session Five is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

Administer the Module Examination and submit the results to your Training Program Sponsor through the Registry System.
# Lesson Plans for Module 26307-17

## Transformers

Module Seven (26307-17) describes the construction, operation, and applications of various transformers. It also covers transformer connections and grounding requirements.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Learning Objective 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning Objective 1</strong></td>
<td>• Troubleshoot and maintain transformers.</td>
</tr>
<tr>
<td>• Identify the construction and operation of a transformer.</td>
<td>a. Identify common transformer problems.</td>
</tr>
<tr>
<td>a. Explain the operation of a typical transformer.</td>
<td>b. Perform transformer testing and maintenance.</td>
</tr>
<tr>
<td>b. Describe the construction of a typical transformer.</td>
<td></td>
</tr>
<tr>
<td>c. Make transformer connections for various applications.</td>
<td></td>
</tr>
<tr>
<td><strong>Learning Objective 2</strong></td>
<td></td>
</tr>
<tr>
<td>• Apply the NEC® requirements for transformers and capacitors.</td>
<td><strong>Performance Tasks</strong></td>
</tr>
<tr>
<td>a. Identify the NEC® requirements for transformers.</td>
<td>This is a knowledge-based module. There are no Performance Tasks.</td>
</tr>
<tr>
<td>b. Identify the NEC® requirements for capacitors.</td>
<td></td>
</tr>
<tr>
<td>c. Identify the NEC® requirements for resistors and reactors.</td>
<td></td>
</tr>
</tbody>
</table>

## Objectives

### Learning Objective 1
- Identify the construction and operation of a transformer.
  - a. Explain the operation of a typical transformer.
  - b. Describe the construction of a typical transformer.
  - c. Make transformer connections for various applications.

### Learning Objective 2
- Apply the NEC® requirements for transformers and capacitors.
  - a. Identify the NEC® requirements for transformers.
  - b. Identify the NEC® requirements for capacitors.
  - c. Identify the NEC® requirements for resistors and reactors.

### Learning Objective 3
- Troubleshoot and maintain transformers.
  - a. Identify common transformer problems.
  - b. Perform transformer testing and maintenance.

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

### Note
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### Teaching Time: 12.5 hours
(Five 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Additional Resources

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


There are a number of online resources available for trainees who would like more information on transformers and related equipment. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.

Safety Considerations

This module covers material that relates to trainees working with and around transformers and related equipment in commercial and industrial applications. Safety must be emphasized at all times. Any trainees in an electrical environment should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees. Any practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- Electrical Level Three PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class
- Module Review answer key
- Module Examinations
- Module Examination answer key

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Session Outline for Module 26307-17
TRANSFORMERS

The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE
Session One covers Sections 1.0.0 through 1.3.9 and identifies the construction and operation of a transformer.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the basic construction and operation of a transformer.
3. Explain the operation of a typical transformer.
4. Describe the construction of a typical transformer.
5. Discuss how to make transformer connections for various applications.

SESSION TWO
Session Two covers Sections 2.0.0 through 2.3.0 and explains how to apply the NEC® requirements for transformers and capacitors.
1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the four-letter designations that indicate how the internal medium of a transformer is cooled.
3. Identify the NEC® requirements for transformers.
4. Identify the NEC® requirements for capacitors.
5. Identify the NEC® requirements for resistors and reactors.

SESSION THREE & FOUR
Sessions Three and Four cover Sections 3.0.0 through 3.2.2 and describe how to troubleshoot and maintain transformers.
1. Show the Sessions Three and Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the importance of transformer testing and maintenance.
3. Identify common transformer problems.
4. Discuss how to perform transformer testing and maintenance.

SESSION FIVE
Session Five is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.
1. Have trainees complete the written examination.
2. Record the testing results as required for paper-based exams. The results for exams administered through online testing systems are recorded automatically in the Registry System.
Lesson Plans for Module 26308-17

COMMERCIAL ELECTRICAL SERVICES

Module Eight (26308-17) describes the components, installation considerations, and NEC® requirements for commercial electrical services.

Objectives

Learning Objective 1
• Identify installation considerations for commercial services.
  a. Identify service components.
  b. Locate NEC® requirements for commercial services.

Learning Objective 2
• Install commercial services.
  a. Install overhead services.
  b. Install underground services.
  c. Install switchgear.
  d. Install multi-family services.

Performance Tasks
• This is a knowledge-based module; there are no Performance Tasks.

Note
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Teaching Time: 10 hours
(Four 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
**Safety Considerations**

This module covers material that involves working with and around commercial electrical services. Safety must be emphasized at all times. When working in an electrical environment, instructors must ensure that trainees wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical circuits and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees.

**Classroom Equipment and Materials**

<table>
<thead>
<tr>
<th>Item</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiteboard and markers</td>
<td>Internet access during class (optional)</td>
</tr>
<tr>
<td><em>Electrical Level Three</em> PowerPoint® Presentation</td>
<td>Module Review answer key</td>
</tr>
<tr>
<td>DVD player</td>
<td>Module Examinations</td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td></td>
</tr>
<tr>
<td>Computer</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Resources**

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


There are a number of online resources available for trainees who would like more information on commercial electrical services. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**
Session One covers Sections 1.0.0 through 1.2.4 and identifies installation considerations for commercial services.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with components common to a typical commercial service.
3. Identify and discuss service components.
4. Locate and discuss NEC® requirements for commercial services.

**SESSION TWO AND THREE**
Sessions Two and Three cover Sections 2.0.0 through 2.4.0. They explain how to install commercial services.
1. Show the Sessions Two and Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the general procedures involved in installing commercial services.
3. Discuss how to install overhead services.
4. Discuss how to install underground services.
5. Discuss how to install switchgear.
6. Discuss how to install multi-family services.

**SESSION FOUR**
Session Four is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.
Administer the Module Examination and submit the results to your Training Program Sponsor through the Registry System.
Lesson Plans for Module 26309-17

MOTOR CALCULATIONS

Module Nine (26309-17) describes the calculations required to size the conductors and overcurrent protection required for motor applications.

Objectives

Learning Objective 1
- Identify motor connections and operating characteristics.
  a. Calculate synchronous speed.
  b. Identify stator windings.

Learning Objective 2
- Size motor circuit conductors.
  a. Calculate conductor ampacities for a typical motor control center.
  b. Calculate conductor ampacities for other motor applications.

Learning Objective 3
- Size motor protective devices.
  a. Size fuses for short circuit protection.
  b. Size overcurrent protection for oversized motors.
  c. Size motor overload protection.
  d. Size short circuit protection for use with motor starters.
  e. Size protective devices for multi-motor branch circuits.
  f. Size equipment grounding conductors.
  g. Install capacitors for power factor correction.

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

Note
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Teaching Time: 12.5 hours
(Five 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module covers material that relates to trainees working with and around electrical motors and motor control centers. Safety must be emphasized at all times. Any trainees in an electrical environment should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to unseen hazards related to electrical motors, circuits, and equipment. Any deficiencies must be corrected to ensure the future safety of all trainees. Any practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials
- Whiteboard and markers
- Pencils and paper
- Various online resources for trainees interested in electric motors and ampacity calculations associated with sizing electrical conductors and devices. A search for additional information may be assigned as homework.
- Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.
- Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.

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

- There are a number of online resources available for trainees who would like more information on electric motors and ampacity calculations associated with sizing electrical conductors and devices. A search for additional information may be assigned as homework to interested trainees.
- Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.
- Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26309-17

MOTOR CALCULATIONS

The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.2.2 and identifies motor connections and operating characteristics.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the principles and benefits of three-phase electricity and its use in motors.
3. Explain how to calculate synchronous speed.
4. Identify and discuss stator windings.

**SESSION TWO**

Session Two covers Sections 2.0.0 through 2.2.3 and explains how to size motor circuit conductors.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the proper sequence of steps involved in sizing motor circuit conductors.
3. Discuss how to calculate conductor ampacities for a typical motor control center.
4. Discuss how to calculate conductor ampacities for other motor applications.

**SESSIONS THREE & FOUR**

Sessions Three and Four cover Sections 3.0.0 through 3.7.0 and explain how to size motor protective devices.

1. Show the Sessions Three and Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with short circuits and overloads and devices used to protect motors from these conditions.
3. Discuss how to size fuses for short circuit protection.
4. Discuss how to size overcurrent protection for oversized motors.
5. Discuss how to size motor overload protection.
6. Discuss how to size short circuit protection for use with motor starters.
7. Discuss how to size protective devices for multi-motor branch circuits.
8. Discuss how to size equipment grounding conductors.
9. Discuss how to install capacitors for power factor correction.
Session Outline for Module 26309-17

MOTOR CALCULATIONS

SESSION FIVE

Session Five is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination.

2. Record the testing results as required for paper-based exams. The results for exams administered through online testing systems are recorded automatically in the Registry System.
Module Ten (26310-17) covers the installation, termination, and testing of voice, data, and video cabling systems.

Objectives

**Learning Objective 1**
- Install structured cabling systems.
  a. Install campus backbone subsystems.
  b. Install equipment/telecom room subsystems.
  c. Install riser subsystems.
  d. Install horizontal subsystems.
  e. Install work area subsystems.

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

**Learning Objective 2**
- Install and terminate various types of cable.
  a. Terminate UTP jacks and plugs.
  b. Terminate RG6 F-type coaxial cable.
  c. Install fiber-optic cable.
  d. Ground and test VDV systems.

Note
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**Teaching Time: 10 hours**
(Four 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
**Safety Considerations**

This module provides an overview of the procedures used to install, terminate, and test voice, data, and video cabling systems. Instructors must ensure that trainees understand the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present when performing these tasks. Any deficiencies must be corrected to ensure the future safety of all trainees. Point out that the safety procedures on each job site may be more stringent than OSHA or NEC® requirements.

**Classroom Equipment and Materials**

- Whiteboard and markers
- Pencils and paper
- *Electrical Level Three* PowerPoint® Presentation
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Stripping tool and connectors
- Module Review answer key
- Module Examinations

**Additional Resources**

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


There are a number of online resources available for trainees who would like more information on voice, data, and video cabling systems. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

### Session Outline for Module 26310-17

**Voice, Data, and Video**

**Session One**

Session One covers Sections 1.0.0 through 1.5.4 and describes how to install structured cabling systems.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to consider the benefits of properly designed and installed structured cabling.
3. Describe how to install campus backbone subsystems.
4. Describe how to install equipment/telecom room subsystems.
5. Describe how to install riser subsystems.
6. Describe how to install horizontal subsystems.
7. Describe how to install work area subsystems.

**Session Two**

Session Two covers Sections 2.0.0 through 2.2.0 and describes how to terminate unshielded twisted pair (UTP) and coaxial cable.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to familiarize trainees with the range of tools that may typically be used when terminating UTP and coaxial cable.
3. Describe how to terminate UTP jacks and plugs.
4. Describe how to terminate RG6 F-type coaxial cable.

**Session Three**

Session Three covers Sections 2.3.0 through 2.4.2 and describes how to install fiber-optic cable.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the basic composition and capabilities of optical fiber.
3. Describe how to install fiber-optic cable in trays and ducts.
4. Describe how to install fiber-optic cable in conduit.
5. Describe how to install fiber-optic system components.

**Session Four**

Session Four is a review and testing session. Have trainees complete the Module Review questions and Supplemental Exercises. Alternatively, these may be assigned as homework at the end of Session Three. Go over the Module Review questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

Administer the Module Examination and submit the results to your Training Program Sponsor through the Registry System.
Module Eleven (26311-17) provides information on selecting, sizing, and installing motor controllers. It also covers control circuit pilot devices and basic relay logic.

**Objectives**

**Learning Objective 1**
- Identify relays and contactors.
  - a. Identify electromechanical relays.
  - b. Identify magnetic contactors.
  - c. Identify types of motor overload protection.

**Learning Objective 2**
- Select magnetic and manual motor starters.
  - a. Select NEMA magnetic contactors/motor starters.
  - b. Select IEC magnetic contactors/motor starters.
  - c. Identify contactor/motor starter accessories.

**Learning Objective 3**
- Identify control transformers and pilot devices.
  - a. Identify control transformers.
  - b. Identify switches, sensors, and pilot lights.

**Learning Objective 4**
- Identify installation considerations for motor controls.
  - a. Select motor enclosures.
  - b. Interpret installation diagrams.
  - c. Identify NEC® regulations for motor control circuits.
  - d. Connect motor controllers for specific applications.

**Performance Task**

**Performance Task 1 (Learning Objective 4)**
- Make all connections for a magnetic motor controller, controlled by two pushbutton stations, including the connections for holding the circuit interlock.

**Note**
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**Teaching Time: 12.5 hours**
(Five 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations

This module provides an overview of motor controls, control circuit pilot devices, and basic relay logic. Instructors must ensure that trainees understand the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present when working with or in the vicinity of motors and motor controllers. Any deficiencies must be corrected to ensure the future safety of all trainees. Point out that the safety procedures on each job site may be more stringent than OSHA or NEC® requirements. Practice sessions and Performance Tasks must be completed under your direct supervision.

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- *Electrical Level Three* PowerPoint® presentation
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Specific PPE required by the site
- Power relays
- Mechanical contactors (including one for disassembly)
- Overload relays (including a melting-alloy overload relay and a bimetallic overload relay for disassembly)
- Magnetic and manual motor starters
- Contactor/motor starter accessories
- Control transformers
- Pushbutton switches (including one for disassembly)
- Selector switches (including joystick-operated types)
- Pushbutton stations
- Pilot lights/pilot light assemblies
- Temperature switches
- Pressure switches
- Limit switches
- Flow switches
- Float switches
- Foot switches
- Jogging and plugging switches
- Proximity switches/sensors
- Photoelectric switches/sensors
- Drum switches
- NEMA enclosures
- Several magnetic motor controllers, each of which is controlled by two pushbutton stations
- Tools and connections needed for making all connections for each magnetic motor controller, including the connections for holding the circuit interlock
- Module Review answer key
- Module Examinations
- Performance Profile Sheets

Additional Resources

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


There are a number of online resources available for trainees who would like more information on motor controls and basic relay logic. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26311-17

MOTOR CONTROLS

The Lesson Plan for this module is divided into five 2.5-hour sessions.
This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.3.3 and describes how to identify relays and contactors.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with electromechanical relays and how they operate.
3. Describe how to identify electromechanical relays.
4. Describe how to identify magnetic contactors.
5. Describe how to identify types of motor overload protection.

**SESSION TWO**

Session Two covers Sections 2.0.0 through 3.2.5. It describes how to select magnetic and manual motor starters and begins a discussion of how to identify control transformers and pilot devices.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with magnetic motor starters and how they operate.
3. Describe how to select NEMA magnetic contactors/motor starters.
4. Describe how to select IEC magnetic contactors/motor starters.
5. Describe how to identify contactor/motor starter accessories.
6. Identify and describe control transformers.
7. Identify and describe the following: pushbutton switches, selector switches, pushbutton stations, pilot lights, temperature switches, and pressure switches.

**SESSION THREE**

Session Three covers Sections 3.2.6 through 3.2.12 and concludes the discussion of how to identify control transformers and pilot devices.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to review the pilot devices that were covered in Session Two and encourage trainees to familiarize themselves with several additional switches/sensors that are used in motor control circuits.
3. Identify and describe the following types of switches: limit switches, flow switches, float switches, foot switches, jogging and plugging switches, proximity switches/sensors, photoelectric switches/sensors, and drum switches.
Session Outline for Module 26311-17

MOTOR CONTROLS

SESSION FOUR

Session Four covers Sections 4.0.0 through 4.4.6 and describes how to identify installation considerations for motor controls. The session ends with a lab exercise to satisfy the module performance task.

1. Show the Session Four PowerPoint® presentation.
2. Use the Kickoff Activity to engage trainees in considering the consequences of inadequate planning when installing motor controllers.
3. Explain how to select motor enclosures.
4. Explain how to interpret installation diagrams.
5. Identify NEC® regulations for motor control circuits.
6. Describe how to connect motor controllers for specific applications.
7. Demonstrate how to make connections for a magnetic motor controller controlled by two pushbutton stations, including the connections for holding the circuit interlock.
8. Have the trainees demonstrate how to make all connections for a magnetic motor controller controlled by two pushbutton stations, including the connections for holding the circuit interlock. This laboratory corresponds to Performance Task 1.
9. Have the trainees review the entire module and complete the Module Review questions and Supplemental Exercises before the upcoming review and testing session.

SESSION FIVE

Session Five is a review and testing session. Go over the Module Review questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing.
2. Submit the results to your Training Program Sponsor through the Registry System.