



# AGENDA

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## Constructing, Operating, and Maintaining Underground Distribution Systems

*Recommended CEUs 2.5/PDHs 24.75/CPEs 29.6*

*Field of Study: Specialized Knowledge*

### Day 1

**7:30 a.m. Registration**

**8:00 a.m. Introductions**

- Course Agenda and Objectives
- History of Underground Systems
- Advantages and Disadvantages of Underground Systems

**8:45 a.m. Policy and Service Guidelines**

- Cost Recovery Methods
- Joint-Use Arrangements
- Easements/Point of Ownership
- OH to UG Conversion
- Communications
- Harmonics
- Policy Development Exercise

**10:00 a.m. Break**

**10:15 a.m. Policy and Service Guidelines** *(continued)*

**Noon Lunch** *(on your own)*

**1:30 p.m. Planning & Design**

- Load Characteristics
- Planning Criteria
- Load Estimating & Diversity
- Subdivision System Design Criteria and Techniques
- Reliability Considerations
- Commercial Service Considerations
- Sectionalizing/Fault Interruption Options

*(over)*

**3:00 p.m. Break**

**3:30 p.m. Planning & Design** *(continued)*

- Planning, Design, and Layout Exercise
- Transformer Design Considerations – Loss Evaluation
- Equipment Installation Locations

**4:30 p.m. Adjourn**

## **Day 2**

**8:00 a.m. Cable Design, Application & Failure Modes**

- Cable Theory and Cable Construction
- Conductor/Insulation Types
- Mechanical/Electrical Properties
- Cable Replacement/Life Extension
- Cable Pulling Example

**9:30 a.m. Terminations & Splice Design & Operation – 200A & 600A**

- Voltage Stress Relief
- Terminations
- Splices
- Loadbreak Connections – 200A
- Deadbreak Connections – 600A

**10:00 a.m. Break**

**10:15 a.m. Terminations** *(continued)*

**Noon Lunch** *(on your own)*

**1:30 p.m. Operations and Safety**

- National Electric Safety Code
- Operation Procedures
- Inspection/Preventive Maintenance
- Clearances/Work Permits

**3:00 p.m. Break**

**3:15 p.m. Operations and Safety** *(continued)*

**4:30 p.m. Adjourn for the Day**

### **Day 3**

**8:00 a.m. Over Current Fuse Application**

- Types of Fuses
- Fuse Application & Operation
- Time-Current Curves
- Transformer & Lateral Protection
- Fuse Coordination Exercise
- Other Fuse Related Topics

**10:00 a.m. Break**

**10:15 a.m. Over Current Fuse Applications** *(continued)*

**11:30 a.m. Lunch** *(on your own)*

**1:00 p.m. Tour of Anaheim Public Utilities** *(bus boards at 12:50 p.m. outside of the hotel)*

**4:30 p.m. Return to Hotel – Adjourn for the Day**

### **Day 4**

**8:00 a.m. Lightning/Surge Protection**

**9:00 a.m. Cable Fault Location**

- Fault Cable Indicators
- Fault Location Techniques

**10:00 a.m. Break**

**10:15 a.m. Ferroresonance**

**11:30 a.m. Discussion, Course Evaluation and Wrap Up**

**Noon Adjourn**



# LEARNING OUTCOMES

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## Constructing, Operating, and Maintaining Underground Distribution Systems

*Recommended CEUs 2.5/PDHs 24.75/CPEs 29.6*

*Field of Study: Specialized Knowledge*

**Upon completion of this course, participants will be able to successfully:**

1. Analyze their own policy explain and service guidelines to provide for consistent and specific underground electric service for their electric underground customers, including such factors as point of ownership, aid to construction, joint use trench, conversion of OH to UG systems, etc.
2. Apply basic design practices for underground equipment and system fault protection devices. Fusing and fuse coordination will be discussed with examples of fuse time current curves (TCC) being provided to assist in the learning outcome. Participants will gain a basic working knowledge of fusing and fuse coordination principles.
3. Identify and apply basic theoretical and practical techniques for specifying and installing various cable accessories, including; high-voltage splices, cable termination, and elbow terminations.
4. Utilize basic, design concepts of medium voltage underground cable to properly install, operate and maintain state of the art underground distribution cable systems
5. Plan and design underground distribution systems and discuss the pros and cons of the various design options, including the factors affecting underground distribution systems, such as reliability, economics, and environmental aspects, into their planning and design work.
6. Recognize and understand the accepted standards and practices for inspection, testing, and maintenance of underground line conductors, components, equipment and structures.
7. Summarize the provisions of the current edition of the National Electric Safety Code that apply to underground distribution systems and incorporate these requirements of the NESC to the design, installation, operation, and maintenance of these systems including safe work practices associated with underground distribution systems.

8. Identify the impacts of lightning and surge events on the underground distribution system and select the techniques to mitigate the effects of such events.
9. Describe the design and operational characteristics of faulted circuit indicators and the practical application of faulted circuit indicators on distribution circuits.
10. Recognize the characteristics of ferroresonance and harmonics and apply the techniques for mitigation of these abnormal system conditions.