Vivid Learning Systems
Knowledge. Performance. Results.™

T&D POWER SKILLS

Vivid Learning Systems brings you T&D PowerSkills; which is a comprehensive, DVD / Workbook based Lineman training program that focuses on safety-related work practices that Lineworkers need to know. It is designed to help Lineworkers be efficient and safe on the job whether they are doing overhead, underground, meter, transmission or substation work. Both apprentices and journeymen Lineworkers will benefit from T&D PowerSkills training units.

INSTRUCTIONAL FEATURES

This DVD program includes up-to-date full-motion video, audio, three-dimensional graphics, animation, and simulation exercises—all to stimulate and involve the trainee in real-life procedures and experiences. Pretests and posttests can be designed by the administrator, and quizzes appear throughout each course to keep the instruction challenging.

OBJECTIVE

All T&D PowerSkills course units are arranged in a comprehensive curriculum. Important fundamentals are covered in **Maintenance Basics,** such as electrical safety and basic climbing skills, moving on to more advanced topics in **Overhead Distribution**, such as pole top equipment replacement, and transformer troubleshooting. Specialized training is offered in **Underground, Substations and Transmission**, as well.

BENEFITS

The benefits of this Instructor-Led delivery system include: reduction of learning time, consistency of delivery, better understanding of lineworker safety, Field Performance Requirements (FPR) records, increased motivation, greater retention, and ease of remedial or refresher training.

STRUCTURE

The 78 units are divided into Groups that represent major components of lineworker career tracks. One training course is described on each page of this outline. Single courses, Group-Packs, or the entire program can be purchased.

MATERIALS

Each course unit includes one DVD, one Instructor's Guide and one Student Workbook. Customization for site specific training is available upon request.

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Maintenance Basics:

INTRODUCTION TO TRANSMISSION AND DISTRIBUTION SYSTEMS

COURSE DESCRIPTION
This course explains, in general terms, how transmission and distribution systems deliver power from a power plant to customers. The course describes the major components of a typical T&D system, how they function, and how electricity flows through these components on its journey from the power plant to customers.

COURSE GOALS
Describe how transmission and distribution systems generally operate.• Identify the basic components of a transmission and distribution system and explain their functions.• Describe the flow path of electricity from a power plant, through a typical T&D system, to the customer.

SUBJECTS AND OBJECTIVES
T&D System Overview
- Explain how power grids help ensure a continuous flow of power to customers.
- State the purpose of a T&D system.
- Describe the major components of a T&D system.

Power Plants
- State the function of a power plant.
- Describe the general characteristics of atypical power plant.

Switchyards
- State the general function of switchyard.
- Describe the major components of a typical switchyard.
- Describe how the electrical flow path through a switchyard can be altered to isolate certain equipment.

Transmission Lines
- Explain the function of transmission lines in a typical T&D system.
- Describe the major components of transmission lines.

Substations
- Explain the function of a substation.
- Describe the components of a typical substation.
- Describe how the electrical flow path through a substation can be altered to isolate certain equipment.

Distribution
- Explain the function of a distribution system.
- Describe the major components of a typical distribution system.
- Explain how electricity travels through a typical distribution system to reach customers.

TRANSMISSION

COURSE DESCRIPTION

This program is designed to provide an introduction to the basic components that make up a transmission line. The program presents a basic overview of structures, conductors, and insulators commonly found on transmission lines. The program also covers the basic tasks that must be accomplished in order to build a transmission line.

COURSE GOALS

• Explain the basic purpose of a transmission system.
• Identify and explain the functions of the basic components that make up a transmission line.
• List and explain the basic tasks involved in building a transmission line.

SUBJECTS & OBJECTIVES

Overview

- Explain the purpose of the transmission portion of a T&D system.
- Identify the components that make up a typical transmission line.
- Explain the basic purpose of a power grid.

Conductors

- Explain the purpose of conductors.
- Describe some of the basic characteristics of conductors.
- Differentiate between solid, stranded, and bundled conductors.

Insulators

- Explain the purpose of insulators.
- Recognize and identify the types of insulators commonly used on transmission lines.
- Identify and describe some of the typical mounting positions for insulators on transmission lines.

Structures

- List and explain three basic classifications of structures used on transmission lines.
- List and explain some of the factors that affect the design of transmission structures.

Construction

- List and explain some of the key tasks that must be performed in order to construct a transmission line.
- Explain the basic process for stringing conductors.

DISTRIBUTION

COURSE DESCRIPTION
This course is designed to help personnel recognize the basic elements of a distribution system and to gain an understanding of how each element works. This course also introduces basic equipment such as transformers, capacitors, regulators, circuit breakers, and other types of protective devices.

COURSE GOALS
• Recognize transformers, voltage regulators, and capacitors, and in basic terms describe how these devices work.
• Identify the basic protective devices used on distribution systems to protect the system and its components from damage and its customers from power outages.
• Understand how distribution systems are laid out.

SUBJECTS AND OBJECTIVES
Introduction to Distribution Systems
- Define the term “distribution system”.
- List the basic components that make up a distribution system.
- Explain the basic difference between primary and secondary distribution voltages.

Transformers
- Define the term “transformer”.
- Explain, in general terms, how a transformer works.
- Recognize and identify pole top and pad-mounted transformers.

Voltage Regulators and Capacitors
- Define “voltage regulator”.
- Identify the electrical and physical elements that make up a typical voltage regulator.
- Explain, in general terms, how a voltage regulator works.- Define “capacitor”.- Explain, in general terms, how a capacitor works.- Describe a potential safety hazard inherent in all capacitors.

Distribution Lines and Layouts
- Explain how electrical energy flows from the substation to the consumer.
- List three categories of distribution lines and the classification of voltage carried by each line.
- List and explain three types of distribution layouts.

Protective Devices
- Explain how circuit breakers and fuses protect feeders and laterals from the effects of faults.
- Explain how reclosers and sectionalizers provide protection for a distribution system.
- Explain how sectionalizing can be accomplished to protect customers from long outages.

SUBSTATIONS AND SWITCHYARDS

COURSE DESCRIPTION

This course examines the role that substations and switchyards play in a T&D system. The course provides an overview of the purposes and functions of the major equipment used in substations and switchyards. Equipment used for protection, regulation, monitoring, and communication is introduced.

COURSE GOALS

• Explain the basic functions of substations and switchyards.
• Recognize and identify the major equipment used in substations and switchyards.
• Explain the purpose of different types of substation and switchyard equipment, and describe how this equipment works.

SUBJECTS AND OBJECTIVES

Introduction to Substations and Switchyards

- Identify the major parts of a transmission and distribution system.
- Recognize and describe the function of a substation.
- Recognize and describe the function of a switchyard.

Substations: Basic Equipment

- Recognize and identify the basic equipment found in substations.
- Describe the function of the basic equipment in a typical substation.
- Describe some general substation safety considerations.

Substations: Protective Equipment

- Recognize and identify design features and protective equipment typically used in substations.
- Describe the function of design features and protective equipment typically used in substations.

Substations: Regulation Equipment

- Recognize and identify regulation equipment found in substations.
- Describe the functions of regulation equipment found in substations.

Substation Monitoring and Communication Equipment

- Recognize and identify monitoring and communication equipment found in substations.
- Describe the functions of monitoring and communication equipment found in substations.

Switchyards

- Recognize and identify basic equipment found in switchyards.
- Describe how a switchyard is used to route power through various circuits.
- Describe basic switchyard arrangements.

BASIC ELECTRICITY THEORY

COURSE DESCRIPTION

Modern Industrial plants contain a great deal of electrical equipment that needs to be maintained and repaired. To perform electrical maintenance tasks correctly and efficiently, electricians and electrical maintenance personnel must have (1) a basic understanding of the fundamentals of electrical theory; (2) a specific knowledge of the way electrical devices operate; and (3) practical hands-on experience.

COURSE GOALS

Basic Electricity Theory reviews the fundamental principles of electrical theory as applied to electrical circuits and devices such as transformers, inductors, and capacitors. The general topics covered in this unit include the nature of electricity; basic electrical quantities and their units of measurement; electrical circuits; and electromagnetism.

SUBJECTS AND OBJECTIVES

Where Does Electricity Come From?

- Describe the structure of an atom.
- State the three characteristics of electrical charges.
- List six major sources of electricity.

Basic Electrical Quantities

- Explain what current, voltage, and resistance are.
- Describe the way in which current, voltage, and resistance are related.
- Define the terms watt and watt-hour.

Series and Parallel Circuits

- Describe the difference between a series circuit and a parallel circuit.
- Explain how current, voltage, and resistance are calculated in series circuits and in parallel circuits.

Electromagnetism

- Define electromagnetism.
- Describe the effect of a changing magnetic field on a conductor
- Define induction.
- Describe how a transformer is constructed.

Inductance and Inductors

- Define self-induction.
- Describe the characteristics of inductance.
- Describe the parts of a typical inductor and explain what an inductor does.

Capacitance and Capacitors

- Define capacitance.
- Describe a typical capacitor and explain how A capacitor stores energy.
- Explain the hazards associated with capacitors.

ALTERNATING CURRENT FUNDAMENTALS

COURSE DESCRIPTION

Most of the electrical equipment used today operates on alternating current (AC). The purpose of this training unit is to review significant terms, concepts, and principles associated with alternating current.

COURSE GOALS

Emphasis is placed on what alternating current is, how it works, and what factors affect the operation and maintenance of AC equipment such as motors, lights, and communications equipment.

SUBJECTS AND OBJECTIVES

Alternating Current

- Explain the differences between direct current and alternating current.
- Explain how current flow and polarity change in AC circuits.
- Explain what frequency is and how it is measured.
- Define peak value, peak-to-peak value, and effective value with respect to AC voltage and current.

Inductance

- Define inductance and inductive reactance.
- Explain how inductive reactance limits current flow.
- Differentiate between in-phase and our-of-phase currents and voltages.

Capacitance

- Define capacitance and capacitive reactance.
- Name the basic components of a capacitor.
- Explain the effects of capacitance o current and voltage.

AC Power

- Differentiate between true power, reactive power, and apparent power.
- Explain how power factor is used in calculating true power in AC Circuits.

Single-Phase and Three-Phase Systems

- Explain the difference between single-phase and three-phase AC systems
- Explain how a three-wire single-phase AC system supplies two different voltages.
- Differentiate between delta-connected and wye-connected three-phase AC systems.

CLIMBING WOODEN POLES

COURSE DESCRIPTION

In order to climb safely and efficiently, a lineman needs to understand and practice climbing techniques. This program introduces two methods used for climbing wooden poles. The program demonstrates proper techniques for safetying-on and off, methods of adjusting a safety strap while working on a pole, and the basic technique of maneuvering around a pole. A new section has been added describing the safe use of the popular ***BuckSqueeze*** Safety Strap.

COURSE GOALS

• Demonstrate and explain the basic techniques for free climbing and belted climbing.
• Demonstrate and explain proper techniques for safetying-on and off, adjusting a safety strap while on a pole, maneuvering around a pole, and inspecting a pole.
• Demonstrate and compare how an unqualified climber and a qualified climber install a crossarm on a bare pole.

SUBJECTS AND OBJECTIVES

Pole Climbing Equipment

- Recognize and identify the basic equipment used for climbing wooden poles.
- Demonstrate two methods of determining the proper fit of a body belt.
- Demonstrate how to determine the proper fit of climbers.
- List and explain the basic components of a safety strap.

Use, Maintenance, and Inspection of Climbing Equipment

- Demonstrate and explain the proper way to wear climbers.
- Demonstrate and explain the techniques of sharpening, gauging, and testing gaffs.
- Explain the basic considerations for inspecting equipment prior to climbing.

Basic Climbing Techniques – Part 1

- Demonstrate and explain the basic techniques for making a free ascent and a free descent.
- Demonstrate and explain what to do when a gaff gets stuck in a pole.

Basic Climbing Techniques – Part 2

- Demonstrate and explain the basic guidelines for storing and attaching a safety strap.
- Demonstrate and explain the basic techniques for belted climbing.

Basic Climbing Techniques – Part 3

- Demonstrate and explain the proper techniques for safetying-on and safetying-off.
- Demonstrate and explain the basic methods of adjusting a safety strap while working on a pole.
- Demonstrate and explain the basic technique of maneuvering around a pole.

Climbing on the Job

- Demonstrate the type of evaluation process that is used to determine if a worker is a qualified climber.
- Demonstrate and explain how to install a crossarm while working from a pole.
- Demonstrate and explain how to inspect a pole.

SAFETY IN TRANSMISSION AND DISTRIBUTION MAINTENANCE

COURSE DESCRIPTION
This course is designed to familiarize trainees with the basic safe work practices and safety equipment that are used in transmission and distribution maintenance work.

COURSE GOALS
• Identify the basic hazards encountered in T&D maintenance work.
• Describe the basic clothing and safety gear used in T&D maintenance work.
• Explain how to carry out equipment inspections, job planning, and job site preparation.
• Identify basic job hazards particular to overhead and underground line maintenance.

SUBJECTS AND OBJECTIVES

Job Hazards
- Describe the individual's role with respect to safety on the job.
- Identify hazards that may be encountered in transmission and distribution maintenance.

Protective Equipment
- Identify and describe basic clothing and personal safety equipment used in transmission and distribution work.
- Describe personal rubber gear.
- Describe hot line cover gear used to insulate energized equipment.

Safe Work Practices
- Describe how to perform a pre-use inspection on a bucket truck.
- Describe how a tailgate session is used to plan a job.
- Describe how to secure a safe work area at a typical job site.

Overhead Line Maintenance
- Describe how to test a pole before climbing it.
- Describe how to inspect pole climbing equipment.
- Describe techniques for climbing a pole.
- Describe how to apply hot line cover gear by hand and with hot sticks.

Underground Line Maintenance
- Describe how to inspect a manhole.
- Describe how to test the atmosphere under a manhole cover.
- Describe how to inspect a pad-mounted transformer.

USING TOOLS

COURSE DESCRIPTION

This program describes the basic hand and power tools commonly used in distribution work. The program presents guidelines for using manual hand tools, power hand tools, and one type of powder-actuated tool. The program also covers the safety precautions that should be followed when using each type of tool.

COURSE GOALS

• Identify several types of manual hand tools and powder-actuated tools used in power delivery work.
• Describe how manual tools and power tools are used in power delivery work.
• Describe some common safety precautions that are followed when using manual and power hand tools.

SUBJECTS AND OBJECTIVES

Manual Hand Tools – Part 1

- Describe the purpose of knives, handsaws, and other cutting tools.
- Identify the components of knives, handsaws, and cutting tools.
- Identify a brace and bit and describe how they are used.

Manual Hand Tools – Part 2

- Describe general uses for wrenches, hammers, screwdrivers, compression tools, and digging tools.
- Differentiate between adjustable wrenches, socket wrenches, and box-end wrenches.
- Describe how to use two types of manual compression tools and four types of manual digging tools.

Power Hand Tools

- Describe the safety procedures for using power hand tools.
- Identify the components of an impact wrench and a portable capstan.
- Describe how to use an impact wrench and a portable capstan.

Powder-Actuated Tools

- Describe the components of a tap connector and a powder-actuated tool.
- Explain how a powder-actuated tool is used to make a tap connection.

RIGGING – PART 1

COURSE DESCRIPTION

Line crews are constantly required to use ropes, blocks, and other special equipment to raise and lower electrical components, tools, and equipment. In order to perform these tasks safely and efficiently, a fundamental knowledge of rigging and rigging equipment is necessary. This program concentrates on the basics of overhead rigging, including safe rigging practices, ropes, knots and knot tying, the use of handlines, and the use of blocks and tackle.

COURSE GOALS

• Define rigging, and describe the basic considerations necessary for planning a rigging job.
• Identify the basic types of rope, and describe how to inspect rope.
• Describe the function of knots commonly used in overhead rigging, and demonstrate how to tie these knots.
• Describe how to hang and use a handline.
• Describe how to set up and use a block and tackle.

SUBJECTS AND OBJECTIVES

Introduction to Rigging

- Define "rigging" as it applies to overhead line work.
- List and explain three elements of safe rigging practice.

Fiber Rope

- Describe the classifications and characteristics of fiber rope.
- Explain the procedures typically used for inspecting a rope.
- Identify the parts of a rope.

Knots and Knot Tying

- Demonstrate how to coil a rope and secure it for storage.
- Demonstrate how to tie the following knots: slip knot, square knot, half hitch, and bowline.
- Describe the purpose of each knot demonstrated.
- Demonstrate how to make an eye splice.

Handlines

- Describe the purpose of a handline.
- Describe typical elements that make up a handline.
- Demonstrate various uses of a handline.

Block and Tackle

- Define mechanical advantage.
- Identify the basic components that make up a block and tackle.
- Describe how to make up a block and tackle.

Rigging on the Job

- Explain how to test rigging before starting a job.
- Explain how to rig to lift a transformer with a block and tackle.

RIGGING – PART 2

COURSE DESCRIPTION

Many jobs performed on transmission and distribution systems require heavy loads to be rigged so that they can be lifted, moved, and stabilized while work is being done. This course identifies basic rigging equipment and discusses guidelines for rigging a job safely. It also demonstrates rigging methods using different types of rigging equipment. The following procedures are covered: rigging a transformer, rigging a running corner, changing out a crossarm, and transferring secondary lines.

COURSE GOALS

• Identify the safety concerns associated with rigging.
• Describe how to use several types of rigging tools and equipment.
• Describe rigging and work methods used to replace a transformer, secure a conductor in place on a running corner, change out a crossarm, and move secondary lines.

SUBJECTS AND OBJECTIVES

Rigging Safety

- State three basic guidelines for rigging a job safely.
- Identify several types of basic rigging tools, and describe how to use them safely.

Structural Safety

- Identify three types of stress that can be created by the application of a mechanical force.
- Describe the effects of stress caused by rigging on a structure.

Transformer Rigging

- Describe the general procedure involving rigging for replacing three single-phase transformers with three larger units.

Rigging a Running Corner

- Describe the general procedure involving rigging for changing out an insulator on a running corner.

Crossarm Changeout

- Describe a general procedure involving rigging for replacing a wooden crossarm.

Transferring Secondary Lines

- Describe a general procedure involving rigging for transferring secondary lines from one dead-end utility pole to another.

ELECTRICAL SAFETY

COURSE DESCRIPTION

This course is designed to teach trainees about electrical hazards and about the protective devices and safety practices that can help prevent injuries and equipment damage on the job. The course discusses safety hazards and protective devices. It also presents a step-by-step explanation of safety practices associated with switching, tagging, testing, and protective grounding.

COURSE GOALS

- Explain the importance of following safety practices on the job.
- Describe some of the electrical hazards faced on the job.
- Identify some protective devices designed to prevent injuries to personnel and damage to electrical equipment.
- Describe how to safely switch, tag, test, and ground a circuit.

SUBJECTS AND OBJECTIVES

Introduction to Electrical Safety

- Explain why arcs, faults, and the invisibility of electricity can be dangerous.
- Describe general safety practices that apply to most electrical jobs.

Protective Devices

- Explain what a protective device is.
- Describe how fuses, circuit breakers, and reclosers can operate in an electrical system to reduce the dangers created by faults.

Switching and Tagging

- Describe the procedures of switching and tagging.
- Explain how switching and tagging help protect workers from the dangers associated with electrical hazards.

Testing

- Explain why testing is important.
- Describe how noisy testers, statiscopes, and phasing test sets are used to test circuits.

Protective Grounding

- Explain what protective grounding is.
- Describe how a de-energized line can become accidentally energized.
- Explain the difference between a ground switch and a temporary ground.
- Describe how a temporary ground can be installed.

HYDRAULIC DERRICKS

COURSE DESCRIPTION

Many tools use hydraulic power to make a job easier. Some of the common jobs on electrical systems involve lifting or digging. This program discusses the major working parts, controls, and safe operating procedures for hydraulic derricks. The program also demonstrates how to use a digger derrick to dig a hole and install a utility pole.

COURSE GOALS

- Locate and identify the major working parts and controls of digger derricks and conduct a thorough pre-trip inspection of the truck unit.
- Discuss factors to consider in order to safely operate a digger derrick.
- Describe how a digger derrick is used to dig a hole and set a utility pole.

SUBJECTS AND OBJECTIVES

Digger Derricks

- Identify the major working parts of a typical digger derrick.
- Identify the major controls of a typical digger derrick.
- List factors to be considered when operating a digger derrick.

Digger Derrick Operation

- Conduct a thorough pre-trip inspection of the truck unit.
- List factors to consider when positioning a digger derrick at a job site.
- Describe how a digger derrick is used to dig a hole.
- Describe how a digger derrick is used to install a utility pole.

Mini-Derricks

- Describe the advantages of a Mini-Derrick in rear-lot pole setting jobs.

Appendix: Pre – Trip Inspection Training

BUCKET TRUCKS – PART 1

COURSE DESCRIPTION

This program addresses some of the safety guidelines that should be followed when operating a bucket truck at the job site, including a thorough pre-trip inspection. The program reviews procedures for handling traffic conditions safely and positioning bucket trucks securely on paved, unpaved, and hilly work surfaces. The program also describes safety equipment for using bucket trucks near energized lines, and guidelines for maneuvering bucket trucks around the work area.

COURSE GOALS

• Identify basic procedures for conducting a thorough pre-trip inspection on the truck unit and for handling traffic conditions safely when using bucket trucks on the roadway.
• Describe how to position bucket trucks securely on paved, unpaved, and hilly work surfaces.
• Describe the safety equipment that is used when using a bucket truck near energized lines.
• Explain how to maneuver bucket trucks safely around the work area.

SUBJECTS AND OBJECTIVES

Introduction

- List three factors to consider when using a bucket truck on the job.
- Describe how the position of the bucket can affect the balance of the bucket truck.
- Explain how to position a bucket truck safely on a slope.
- Identify the types of work surfaces that may not withstand the weight of a bucket truck.
- Describe general safety guidelines for operating a bucket truck in a traffic area.

Bucket Truck Placement

- Describe guidelines for defining a work area that is near hazardous road conditions.
- Describe how to position a bucket truck when the work area is located near a divided highway.

Bucket Truck Operation

- Describe how to set the hydraulic system controls of a bucket truck for battery operation.
- Identify the safety equipment that linemen wear when using a bucket truck near energized equipment.
- Describe general safety guidelines for maneuvering a bucket truck to the work area.
- Describe the role of ground personnel during bucket truck operation.

Appendix: Pre – Trip Inspection Training

BUCKET TRUCKS – PART 2

COURSE DESCRIPTION

This program describes three types of outriggers used to stabilize bucket trucks. The program also demonstrates procedures for positioning and setting up a bucket truck with outriggers at a rural site, establishing a job site and setting up a bucket truck at an intersection, and maneuvering a bucket and boom around the work area.

COURSE GOALS

• Describe three types of outriggers that are used to stabilize bucket trucks.
• Describe how to use outriggers to level and stabilize a bucket truck.
• Describe basic procedures for positioning and setting up a bucket truck.
• Describe how a handline is used in bucket truck operation.

SUBJECTS AND OBJECTIVES

Outriggers

- Describe the function of outriggers.
- Describe how to use outriggers to stabilize and level bucket trucks.
- Identify three types of outriggers used on bucket trucks.
- Demonstrate how to maneuver a bucket truck through an open field.
- Demonstrate how to set up a bucket truck on an unpaved surface.

Bucket Truck Placement – Part 2

- Describe how to safely set up a bucket truck at an intersection.

Bucket Truck Operation – Part 2

- Describe how a handline is used in bucket truck operation.
- Describe how to maneuver a bucket truck safely around the work area.

SYSTEM PROTECTION AND MONITORING

COURSE DESCRIPTION

This course discusses the principles of protection and monitoring in a transmission and distribution system. The course explains the role of protective devices, system grounds, and monitoring and control equipment. Techniques for installing or replacing ground rods, arresters, and fuse links are presented. The course also describes how monitoring and control equipment is typically used in a transmission and distribution system.

COURSE GOALS

• Explain how system grounds, arresters, and fused cutouts are used to protect transmission and distribution systems, and describe how these components are installed and maintained.
• Describe the basic function and features of a SCADA (Supervisory Control and Data Acquisition) System.

SUBJECTS AND OBJECTIVES

Introduction

- In general terms, explain how system grounds, arresters, and fuses protect a T & D system.
- Briefly describe three types of monitoring and control equipment used in T & D systems.

System Grounds

- Describe factors that affect the resistance of current flow to earth.
- Describe one method for installing a ground rod.
- Describe how substations, distribution systems, and transmission systems are typically grounded.

Arresters

- Explain the principles of arrester operation.
- Describe the basic operation of a valve type arrester, a pellet type arrester, and an expulsion type arrester.
- Compare and contrast three classes of arresters.
- Describe one method for replacing a damaged arrester.

Fuses and Fuse Cutouts

- Describe the operation of an open-type fuse cutout and a door-type fuse cutout.
- Describe the operation of a fuse link.
- Explain how fuses are rated.
- Describe one method for replacing a fuse link in an open-type fuse cutout.

Monitoring and Control Systems

- Describe the functions of a monitoring and control system.
- Describe some of the important features offered by most monitoring and control systems.
- Explain the functions of the major components in a SCADA system.

Continued:

(System Protection & Monitoring, Con't)

Distribution Automation and Load Management
- Explain the function of a distribution system.
- Describe the functions of a distribution automation system and a load management system.
- Describe some of the important features offered by most distribution automation systems and load management systems.
- In general terms, explain how most distribution automation systems and load management systems operate.
- Describe the functions of the controllers in a distribution automation system and a load management system.

INTRODUCTION TO METERING

COURSE DESCRIPTION

This course is designed to present an overview of kilowatt-hour meters and meter operation. Although the program is intended to be introductory, several devices, procedures, and concepts presented assume a familiarity with basic electrical theory and distribution systems. Students without this prior training may require additional explanation or instruction.

COURSE GOALS

• Describe the basic design and operation of a modern electro-mechanical watt-hour meter.
• Identify the types of information found on a watt-hour meter nameplate, and describe what the information signifies.
• Describe single-phase and three-phase meter applications and connections.
• Identify typical signs of meter tampering.

SUBJECTS & OBJECTIVES

Basic Concepts of Metering

- Identify several early types of electro-mechanical watt-hour meters.
- Identify the basic parts of a modern eletro-mechanical watt-hour meter.
- Describe the operating principles of a modern electro-mechanical watt-hour meter.

Self-Contained Meter Application

- Explain the difference between self-contained meters and transformer-rated meters.
- List and explain some of the information typically found on meter nameplates.
- Identify the characteristics of a typical three-phase delta service and a typical three-phase wye service.

Transformer-Rated Meter Application

- Explain how an instrument transformer is connected to a transformer-rated meter.
- Identify the two main classifications of instrument transformers.
- State the function of a test switch.

Meter Testing

- Describe the basic steps for conducting a comparison test on a single-phase watt-hour meter.
- Explain the function of a standard.
- Describe how a standard is used to conduct accuracy tests.

Meterman Responsibilities

- Identify meterman responsibilities as they relate to several forms of power “theft”.

BUCKET TRUCK RESCUE

COURSE DESCRIPTION
This course demonstrates how to perform a bucket truck rescue. Trainees will see how to lower the boom in an emergency, and two ways to extract an incapacitated person from a bucket. This course also demonstrates the importance of being able to act quickly and decisively during an emergency situation.

COURSE GOALS
• Explain and demonstrate several common ways to lower the boom in the event of a bucket truck emergency.
• Describe common methods of bucket truck escape, emergency boom lowering, and bucket truck rescue.
• Demonstrate two emergency situations and show how personnel should respond.

SUBJECTS AND OBJECTIVES
Emergency Boom Lowering
- Explain how to use a bucket truck's lower controls to lower the boom in an emergency.
- Explain how to use a bucket truck's auxiliary power system to lower the boom in an emergency.
- Explain how to bleed a bucket truck's boom holding valves to lower the boom in an emergency.
- Explain how a line mechanic can use safety equipment to escape from a bucket during an emergency.

Bucket Truck Rescue – Part 1
- Describe some general considerations associated with performing a bucket truck rescue.
- Describe a basic procedure for performing a bucket truck rescue when the boom can reach the ground and the bucket truck has a quick-release device.

Bucket Truck Rescue – Part 2
- Explain what rescue blocks are and how they can be used.
- Describe a basic procedure for performing a bucket truck rescue using rescue blocks.
- Describe special circumstances that may affect a bucket truck rescue.

SAFETY IN METER WORK

COURSE DESCRIPTION
This course covers the hazards and basic safety guidelines associated with meter work and emphasizes working safely near energized equipment, using caution when approaching potentially hazardous conditions, and using protective equipment properly.

COURSE GOALS
• Describe the basic safety guidelines that apply to meter work.
• Identify the physical hazards associated with meter work and how to avoid them.
• Identify the electrical hazards associated with meter work and how to avoid them.
• Describe the safety procedures for a routine single-phase meter replacement.
• Describe the safety procedures for a routine three-phase meter installation.

SUBJECTS AND OBJECTIVES
Safety Guidelines
- State three basic safety guidelines that apply to meter work.
Physical Hazards
- Identify how to avoid the physical hazards associated with job site conditions.
Electrical Hazards
- Describe the effects of current flow on the human body.
- Describe the dangers of flash burns.
- Identify safety gear normally used for protection against electrical hazards.
Single-Phase Meter Replacement
- Describe safety procedures associated with a typical single-phase meter replacement job.
Three-Phase Meter Installation
- Describe safety procedures associated with a typical three-phase meter installation job.

SAFETY IN SUBSTATIONS AND SWITCHYARDS

COURSE DESCRIPTION

This program focuses on the basic safety principles and practices applicable to substations and switchyard maintenance work. The program describes electrical, chemical, and personal hazards that may be encountered in substations and switchyards. General procedures for responding to imminent dangers and accidents are also presented.

COURSE GOALS

• Identify hazards in substations and switchyards.
• Explain why safety practices are important.
• Recognize hazards and unsafe practices on the job.
• Describe how to respond to imminent dangers and accidents.

SUBJECTS AND OBJECTIVES

Hazards and Safety Practices

- Identify some of the safety hazards that maybe found in substations and switchyards.
- Describe some of the general safety practices that apply to most jobs in substations and switchyards.

Electrical Safety

- Identify electrical hazards that may exist in substations and switchyards.
- Define “safe working distance”.
- Identify the basic steps in making equipment electrically safe to work on.
- Explain the reason for tagging equipment.
- Identify special precautions necessary when working with capacitor banks and current transformers.

Chemical Safety

- Identify chemical hazards that may exist in substations and switchyards.
- Describe safety precautions applicable to working with insulating oil.
- Describe safety precautions applicable to working with SF_6 gas and nitrogen gas.

Personal Safety

- Identify personal hazards that may exist in substations and switchyards.
- Describe general housekeeping practices that help prevent accidents and injuries.
- Describe the proper way to lift heavy loads by hand.
- Describe the proper ways to use ladders, scaffolds, and bucket trucks for support.

Dangers and Accidents

- Describe a general procedure for responding to an imminent danger at work.
- Describe a general procedure for responding to an injury at work.
- Identify the four classes of fires and the type of extinguisher used to put out each.
- Describe a general procedure for reporting accidents.

Safety Review
- Identify violations of electrical, chemical, and personal safety practices in a series of short scenarios.
- Describe accidents that could result from the electrical, chemical, and personal safety violations presented in the video segments.

ADVANCED RIGGING

COURSE DESCRIPTION

This training program is designed to familiarize students with the various types of weights and tensions associated with rigging in line work. The safety factor for a job that includes rigging is also covered. The procedures and concepts presented assume a familiarity with basic electrical theory and transmission and distribution systems.

COURSE GOALS

• Explain the difference between static force loads and dynamic force loads.
• Explain how to determine the weight of static force loads and dynamic force loads.
• Define and explain line tension, bisect tension, and guy tension, and calculate these tensions for a given job.
• Define the term "safety factor" in terms of rigging, and apply a safety factor to plan safe rigging.

SUBJECTS AND OBJECTIVES

Rigging Forces and Tensions – Part 1

- Identify and describe two types of loads involved in rigging for line work.
- Describe how to determine the weight exerted by a conductor on an insulator.

Rigging Forces and Tensions – Part 2

- Define the term "line tension," and explain how to determine the line tension exerted by a conductor.
- Define the term "bisect tension," and describe how bisect tension can be determined by measuring distances.

Rigging Forces and the Safety Factor

- Describe how to use a bisect tension formula to determine the bisect tension exerted on a corner pole.
- Describe how to determine the approximate bisect tension exerted on a corner pole by finding the approximate angles of the line at the pole and using a "rule-of-thumb" chart.
- Define the term "guy tension," and describe how to determine the approximate guy tension required to hold against line or bisect tension.
- Define the term "safety factor" in terms of rigging for line work, and describe how to calculate the safety factor for a given job.

Weight and Tension Calculations

- Describe how conductor weight is affected when a conductor is raised or lifted to a new pole.
- Describe how to determine the weight and bisect tension exerted by conductors when they are moved to a new pole.
- Describe how to determine the guy tension needed to offset the bisect tension exerted by conductors after they are moved to a new corner pole.
- Explain how to establish a safety factor of five for the rigging used to lift a conductor and move it to a new pole.

Overhead Distribution – De-Energized

OVERHEAD DISTRIBUTION SYSTEMS

COURSE DESCRIPTION
This program covers the basic layout of overhead distribution systems. It explains how to identify circuits and equipment in the field and introduces delta- and wye-connected distribution systems. The basic theory underlying the operation of delta- and wye-connected distribution systems is also presented, and the differences between the two systems are discussed. The program also explains how to differentiate between 34.5 KV systems and 13.2 KV systems.

COURSE GOALS
• Describe the basic layout of an overhead distribution system.
• Identify circuits and equipment in the field.
• Outline the basic characteristics of delta and wye systems, and describe their distinguishing characteristics.
• Recognize and identify a 34.5 KV primary distribution system.

SUBJECTS AND OBJECTIVES
Distribution Systems Layout
- Identify the major components of a typical overhead distribution system.
- Distinguish between primary and secondary distribution systems.
- Identify common overhead distribution system layouts.
- Identify the major line sections of an overhead distribution system.

Poles, Pole Hardware, and Conductors
- Recognize and identify distribution pole hardware.
- Recognize and identify overhead distribution conductors.

Pole Top Equipment
- Recognize and identify the following types of pole top equipment: transformers, voltage regulators, capacitors, reclosers, sectionalizers, fused cutouts, surge arresters, static wires, and gang-operated air switches.

Delta and Wye Primary Systems
- Describe the winding connections for a substation transformer in a delta primary system.
- Describe the winding connections for a substation transformer in a wye primary system.
- Explain how to distinguish between delta systems and wye systems.

34.5 KV Primary System
- Recognize and identify a 34.5 KV primary distribution system.
- Explain the function of a dual voltage transformer.

SERVICE INSTALLATION – PART 1

COURSE DESCRIPTION

This course describes basic procedures for installing and connecting services. The course describes common types of service connectors, and demonstrates the basic steps involved in making a service connection. The course also demonstrates procedures for installing both overhead and underground residential services.

COURSE GOALS

• Identify common types of service connectors.
• Describe how to make a service connection.
• Describe basic procedures for installing a single-phase, overhead residential service.
• Describe basic procedures for installing a single-phase, underground residential service.

SUBJECTS AND OBJECTIVES

Types of Service Connectors

- Identify common service connectors.
- Distinguish between mechanical and compression connectors.
- Describe how a spring-action connector is used.

Making Service Connections

- Describe the factors involved in choosing the appropriate connector for making a service connection.
- Describe the four basic steps involved in making a service connection.

Installing Overhead Residential Service

- Describe the basic steps for installing a single-phase, overhead residential service.
- Describe basic procedures for making service connections at the weatherhead.
- Describe basic procedures for making service connections to the secondary mains.

Installing Underground Residential Service

- Describe the basic steps for installing a single-phase, underground residential service.
- Describe basic procedures for connecting an underground residential service to a meter box.
- Describe basic procedures for connecting an underground residential service to a transformer.

SERVICE INSTALLATION – PART 2

COURSE DESCRIPTION

This course describes three types of voltage tests that should be performed before making service connections. The course also describes procedures involved in installing a three-phase service and replacing a three-phase service without interrupting service to the customer. Typical safety practices and job preparations are also covered.

COURSE GOALS

• Describe three voltage tests that are typically performed when installing service and demonstrate how to perform each one.
• Demonstrate basic procedures for installing a three-phase service.
• Demonstrate basic procedures for replacing a three-phase service without interrupting service to the customer.

SUBJECTS AND OBJECTIVES

Testing Circuits

- Explain why it's important to perform voltage tests on a customer's circuits before installing a meter.
- Demonstrate how to test for backfeed.
- Demonstrate how to test for phase-to-ground shorts.
- Demonstrate how to test for jumpers.

Installing a Three-Phase Service

- Describe basic procedures for installing a three-phase service.

Replacing a Three-Phase Service

- Describe basic procedures for replacing a three-phase service without interrupting service to the customer.

POLE FRAMING & GUYING

COURSE DESCRIPTION

The main function of a utility pole is to support conductors. Because conductors are heavy, they can pull on a pole with a great deal of force. The equipment on a pole that supports the conductors must be constructed to withstand this force. This course describes methods used to frame a pole, that is, how to install crossarms and other conductor supports. This course also describes methods of supporting a pole using several different types of guying techniques.

COURSE GOALS

• Describe three basic types of pole construction.
• In general terms, explain the functions performed by poles and their components.
• Demonstrate how to install crossarms and insulators on utility poles.
• Identify commonly used types of guy wires.
• Demonstrate how guy wires are attached to poles and anchors.
• Demonstrate how to install anchors and guy wires.

SUBJECTS AND OBJECTIVES

Principals of Pole Construction

- Describe three basic types of pole construction.
- Describe the general functions that are performed by poles and their components.
- Describe the forces that conductors exert on poles.

Construction Types

- Describe how the three basic pole construction types can be modified to meet different needs.

Framing a Pole – Part 1

- Describe the types of cuts that can be made in a pole.
- Describe the types of bolts and other hardware used in pole framing.

Framing a Pole – Part 2

- Describe or demonstrate how individual components can be put together to frame a pole.

Guys

- Describe commonly used types of guys.
- Explain how guy wires can be attached to poles.
- Explain how guy wires can be anchored.

Guying and Grounding

- Describe or demonstrate procedures for installing anchors.
- Describe or demonstrate procedures for installing guy wires.

SETTING & REPLACING POLES

COURSE DESCRIPTION

This program presents some of the equipment and methods that can be used to set utility poles. The program describes three methods for digging holes, and outlines both power-operated and manual methods for installing poles. The program also includes guidelines for installing poles in open areas and safety considerations for installing poles around obstacles and energized lines. Additionally, this course describes basic methods for removing and replacing poles.

COURSE GOALS

• Describe three methods of digging a hole for a utility pole.
• Explain basic requirements for preparing a job site for pole setting.
• Identify the basic steps involved in rigging a pole.
• Describe how to use a digger derrick to set poles in open areas as well as in areas with obstacles and/or energized lines.
• Describe how to set poles manually in open areas as well as in areas with obstacles.
• Describe how to remove an old pole after a replacement pole has been installed.
• Describe how to lift and set a pole using pikes.
• Describe how to replace a pole with a new pole in the same hole.

SUBJECTS AND OBJECTIVES

Digging Pole Holes

- Identify basic requirements for preparing a job site for pole installation.
- Describe how to use a digger derrick, a portable power hole digger, and manual digging tools to dig a hole for a utility pole.

Setting a Pole

- Describe guidelines for rigging a utility pole before lifting it.
- Explain how to use a digger derrick to lift and set a utility pole in an open, unobstructed area.
- Explain how to use a digger derrick to lift and set a utility pole around energized lines or other obstacles.

Setting Poles Manually

- Identify some of the guidelines to follow when replacing a pole manually.
- Describe how to set a pole manually in an open area.
- Describe how to set a pole manually in an area with obstacles.

Manual Pole Removal

- Describe how an old pole may be safely removed after a replacement pole has been installed and the energized lines have been transferred.
- Identify the basic components of a typical hand-operated pole jack, and explain how it is used.

Manual Pole Setting

- Describe how a utility pole can be set by lifting and supporting it with pikes.

Manual Pole Replacement

- Describe how a replacement utility pole can be set in the same hole as the pole it is replacing by using the “cut and kick” method.
- Describe some of the rigging considerations associated with the “cut and kick” method.

SAFETY IN OVERHEAD LINE MAINTENANCE

COURSE DESCRIPTION

This course examines hazards that may be present during overhead line maintenance operations. The course also introduces protective equipment designed to create a barrier between linemen and high voltage lines and equipment, and reviews safety practices that will help ensure a safe work environment.

COURSE GOALS

• Discuss safety practices associated with overhead line maintenance.
• Identify potential electrical, structural, and climbing hazards associated with overhead line maintenance.
• Identify and discuss the function of protective equipment used during overhead line maintenance.

SUBJECTS AND OBJECTIVES

Safety Overview

- Describe the proper attitude toward safety in overhead line maintenance.
- Identify electrical hazards in overhead line maintenance.
- Identify structural hazards in overhead line maintenance.
- Describe storage procedures for equipment used in overhead line maintenance.

Care and Use of Safety Equipment

- Identify safety equipment commonly used in overhead line maintenance.
- Describe the proper testing and maintenance procedures for safety equipment.
- Explain the proper use of safety equipment.

Climbing Safety

- Explain how to store and inspect climbing equipment.
- Identify some of the most common hazards that may be found prior to climbing a pole.

Electrical Hazards

- Identify types of circuits and voltage levels.
- Identify grounds and grounded equipment.
- Describe how to create a safe work area using insulating covers.

Safety With Tools and Equipment

- Describe safe methods of using tools and equipment designed for overhead line maintenance.

Pole Top Rescue

- Describe how to safely handle an electrical shock victim when he’s on a pole.
- Explain the correct way to tie a handline to an electrical shock victim.
- Describe how to safely lower an electrical shock victim from a pole.

MULTIMETER OPERATION & USE

COURSE DESCRIPTION
In this course trainees learn the difference between analog and digital multimeters, and how to read and use both types of multimeters. Trainees can then use their knowledge of multimeters in a variety of applications.

COURSE GOALS
• Identify and describe two basic types of multimeters.
• Describe how to set up, use, read and put away a multimeter.
• Describe the proper safety precautions and procedures associated with multimeter use.
• Describe how a multimeter can be used in a variety of applications.

SUBJECTS AND OBJECTIVES
Multimeter Basics
- Identify and describe the two basic types of multimeters.
- Identify the main components of a typical multimeter.
- Identify several features that are commonly found on a digital multimeter.

Reading a Multimeter
- Describe how to read a digital multimeter.
- Describe how to read an analog multimeter.

Using a Multimeter
- Describe general safety precautions and procedures associated with using a multimeter in a substation.
- Describe how to set up a multimeter.
- Describe how to use a multimeter.
- Describe how to put a multimeter away.

Substation Applications – Part 1
- Describe how a multimeter can be used to adjust a variable resistor.
- Describe how a multimeter can be used to check continuity.
- Describe how a multimeter can be used to verify a circuit.

Substation Applications – Part 2
- Describe how a multimeter can be used to troubleshoot a communication circuit.
- Describe how a multimeter can be used to troubleshoot a DC control circuit.
- Describe how a multimeter can be used to adjust a current transducer.

USING LINE TEST EQUIPMENT

COURSE DESCRIPTION

Line test equipment includes a variety of devices used to detect and measure electrical values in transmission and distribution systems. This program presents basic information on how to use common types of line test equipment to detect amperage and voltage in the field. The program shows how to use the equipment and discusses the kinds of readings that can be expected from line test equipment.

COURSE GOALS

• Identify types of line test equipment commonly used in the field.
• Demonstrate how to use ammeters, voltmeters, and voltage testers.
• Describe the types of readings expected from ammeters, voltmeters, and voltage testers.

SUBJECTS AND OBJECTIVES

Introduction to Test Equipment

- Determine the correct testing device to use for a particular application.
- Describe how to obtain an accurate reading from a line test device.

Ammeters

- Explain how to use a clamp-on ammeter.
- Explain how to use a recording demand ammeter with a maxitran.
- State the function of a maximeter.

Voltage Testers and Voltmeters

- Describe the basic operation of a voltage test device.
- Describe how a noisy tester is used.
- Explain the difference between a needle indicating voltmeter and a digital indicating voltmeter.
- Describe how to use a phasing tool.
- Describe how to use a recording voltmeter.

Application of Voltmeters

- Describe how a lineman uses a voltmeter to troubleshoot a non-working streetlight.
- Describe how a voltage test device, a voltmeter, and a recording voltmeter are used together to troubleshoot a low voltage complaint.
- Explain how a phasing tool is used.

Rotation Indicators

- In general terms, explain how three-phase AC power is generated.
- Describe how a rotation indicator is used to indicate the direction of three-phase AC power.

Ground Resistance Test Devices

- List the parts of a typical ground resistance test device.
- Describe how a typical ground resistance test device is used to test the resistance value of a ground.

TREE TRIMMING

COURSE DESCRIPTION

Trees are common throughout the service areas covered by many utilities. When trees grow into, over, or near energized equipment, they may cause interruptions in electrical service, particularly during storms or strong winds. During an emergency, a tree crew may not be available, and it may not be possible to postpone a job. Linemen often handle small tree trimming jobs or work as part of a crew to clear large trees from power lines. This program describes basic methods of tree trimming as well as some of the hazards associated with tree trimming work and precautions that should be taken.

COURSE GOALS

• Identify safety hazards associated with tree trimming work, and describe ways to avoid them.
• Describe how to plan and perform tree trimming safely.
• Describe considerations that affect whether rigging is needed for tree trimming work.
• Identify tree cuts that are used for clearing trees and tree limbs from power lines.

SUBJECTS AND OBJECTIVES

Overview

- Identify two kinds of tree trimming jobs typically performed by a utility company.
- Describe some of the factors that influence the frequency of tree trimming and the required line clearances.

Safety Hazards

- Identify three categories of tree trimming hazards, and state some general guidelines for avoiding each.

Emergency Tree Trimming

- Identify three basic steps for planning an emergency tree trimming job, and describe how each can be accomplished.

Working Safely

- Describe how to perform tree trimming work safely from a bucket truck, from a pole, from the ground, from a ladder, and from a tree.

Controlling the Load

- Describe considerations that affect whether rigging is needed for tree trimming work.
- Identify some commonly used tree cuts, and explain when each type is used.

SAFE BUCKET TRUCK OPERATIONS

COURSE DESCRIPTION
This course covers several aspects of bucket truck safety, including how to inspect a bucket truck prior to use, how to plan a job with safety in mind, and how to avoid shock hazards associated with working on or near bucket trucks.

COURSE GOALS
• Explain how to perform a pre-use inspection on a bucket truck.
• Describe some of the basic safety considerations associated with using a bucket truck at a job site.
• Explain how personnel can protect themselves from shock hazards associated with working on or near bucket trucks.

SUBJECTS AND OBJECTIVES
Pre-Use Inspections
- Explain why a bucket truck should be inspected before it is used.
- Describe a basic procedure for inspecting a bucket truck's boom and bucket.
- Describe a basic procedure for checking a bucket truck's hydraulic system.
- Describe a basic procedure for performing an operational check on a bucket truck's boom, bucket, and hydraulic system.

Job Planning
- List factors that can affect how a bucket job is done.
- Describe safety considerations associated with setting up a bucket truck at a job site.
- Describe ways that a crew can prepare for a bucket truck related emergency.
- Describe general actions that crew members can take to ensure that a job is performed safely and efficiently.

Truck Shock Hazards
- Describe how the insulating ability of a typical boom is checked and maintained.
- Describe methods used to protect personnel from shock hazards.

WORKING ON DISTRIBUTION POLES

COURSE DESCRIPTION

This program reviews some of the factors involved in planning a distribution job, including safety guidelines and site-specific considerations. The program also describes some of the conductors commonly used in secondary construction. In addition, the program reviews the basic procedures for paralleling a service with and without the use of a jumper.

COURSE GOALS

- Identify some of the factors to consider when planning a distribution job.
- Identify some of the conductors commonly used in secondary construction.
- Describe basic procedures for paralleling a service using a jumper.
- Describe basic procedures for paralleling a service without using a jumper.

SUBJECTS AND OBJECTIVES

Planning a Distribution Job

- Describe some of the factors involved in planning a distribution job.
- Identify the safety issues that should be considered before undertaking a distribution job.

Replacing Secondary Conductors – Part 1

- Identify three common conductor arrangements commonly used in secondary construction.
- Describe the function of a payout reel.
- Describe basic procedures for pulling in and energizing triplex secondary conductors.

Replacing Secondary Conductors – Part 2

- Explain how to identify the conductors of two services that will be paralleled.
- Describe how a new service can be paralleled using a jumper.
- Describe how a new service can be paralleled without using a jumper.

Using a Temporary Crossarm

- Explain what an auxiliary crossarm is, and describe how an auxiliary crossarm can be used to support conductors while a broken crossarm is being replaced.
- Describe how a crossarm can be changed out by linemen working from the pole.

Moving Energized Conductors

- Describe a typical insulated platform.
- Describe how linemen can work from an insulated platform to move energized conductors.

Installing Floating Dead-Ends

- Explain what a floating dead-end is and what it is used for.
- Describe how linemen can work from an insulated platform to install a set of floating dead-ends.

DISTRIBUTION LINE SAFETY

COURSE DESCRIPTION
This course introduces students to the principles and techniques of single-point, or equipotential grounding. For best results, students should have a basic knowledge of electrical theory, overhead distribution systems and equipment, grounding theory, equipment, and application and common work methods and procedures used in overhead distribution line maintenance.

COURSE GOALS
• Explain the purpose of grounding an overhead line during maintenance work.
• Describe ways in which an isolated or de-energized line can become energized.
• Define the term “zone of equipotential”.
• Explain how equipotential grounding operates to safeguard linemen during a ground fault condition.
• Describe how grounding equipment is used to set up a zone for equipotential.

SUBJECTS AND OBJECTIVES
Grounding
- Define the terms “energized,” “isolated,” and “de-energized” with respect to overhead linework.
- Describe ways in which an isolated or de-energized line can become energized.
- Describe a typical procedure used to ground an isolated overhead line.

Equipotential Grounding
- Use Ohm’s law to describe current flow in a de-energized overhead line during a ground fault condition.
- Define the term “zone of equipotential”.
- Describe a method that can be used to establish a zone of equipotential.

Equipotential Grounding Connections
- Describe how grounding equipment can be used to create a zone of equipotential on a three-phase overhead line.

CARE AND TESTING OF TOOLS AND EQUIPMENT

COURSE DESCRIPTION
This program reviews the fundamentals of caring for, storing, and inspecting some of the tools and equipment used in transmission and distribution work. The program demonstrates how to perform visual inspections, field inspections, and dielectric tests on rubber protective gear, line hose, hoods, mechanical jumpers, and hot sticks.

COURSE GOALS
• Describe guidelines for the proper care, storage, and inspection of rubber goods, mechanical jumpers, and hot sticks.
• Describe the steps involved in performing dielectric tests on rubber goods, mechanical jumpers, and hot sticks.

SUBJECTS AND OBJECTIVES
Introduction
- Describe basic guidelines for keeping tools and equipment in safe operating condition.

Testing Rubber Gloves, Sleeves, and Blankets
- Describe how to perform dielectric tests on rubber gloves, sleeves, and blankets.
- Describe guidelines for visually inspecting rubber gloves, sleeves, and blankets.
- Describe guidelines for inspecting rubber gloves, sleeves, and blankets at the job site.

Testing Line Hose, Hoods, and Mechanical Jumpers
- Describe guidelines for performing dielectric tests on line hose, rubber hoods, and mechanical jumpers.
- Describe guidelines for inspecting line hose, rubber hoods, and mechanical jumpers at the job site.

Hot Sticks
- Describe the safety features common to most hot sticks.
- Describe guidelines for proper care and inspection of hot sticks.
- Describe the steps involved in performing a dielectric test on a hot stick.

POLE TOP EQUIPMENT AND REPLACEMENT – CUTOUTS & RECLOSERS

COURSE DESCRIPTION

During normal usage, pole top equipment is subjected to conditions such as heat, rain, lightning, and mechanical problems that can lead to equipment damage or failure. This course identifies some equipment used to prevent equipment damage or failure, and to provide coordinated protection for a distribution system. The course also explains how this equipment operates.

COURSE GOALS

• Identify some of the equipment used to provide coordinated protection for a distribution system.
• Explain how to replace a fuse and a damaged fused cutout.
• Describe how reclosers are classified and how they operate.

SUBJECTS AND OBJECTIVES

Introduction to Pole Top Equipment

- Describe how fused cutouts, reclosers, and sectionalizers can be used to provide coordinated protection for a distribution system.
- Describe two examples of coordinated system protection.

Cutouts

- Describe how fused cutouts are designed.
- Describe how to replace a fuse in a fused cutout.
- Describe how to safely replace a fused cutout.

Reclosers

- Describe how reclosers are classified.
- Explain the operation and operating cycles of two types of recloser control mechanisms.

POLE TOP EQUIPMENT AND REPLACEMENT – TRANSFORMERS

COURSE DESCRIPTION

This course provides an understanding of the basic procedures used to safely remove and install pole top transformers. Although specific types of transformers are used as examples, emphasis is placed on general procedures that apply to the majority of pole top transformers.

COURSE GOALS

• Identify the most common reasons for replacing transformers.
• Demonstrate how to safely de-energize a single-phase pole mounted transformer.
• Demonstrate one method of safely rigging, removing, and replacing a single-phase pole mounted transformer.
• Demonstrate how to test for the correct voltage output from a replacement transformer.
• Demonstrate how to connect and energize a replacement transformer.
• Use a boom truck to remove and install a transformer.
• Replace a completely self-protected (CSP) transformer without disrupting service.
• Demonstrate how to replace a transformer in a three-phase bank using a portable three-phase bank.

SUBJECTS AND OBJECTIVES

Removal

- Select, inspect, and properly use appropriate safety equipment that is commonly used when replacing a transformer.
- Safely de-energize and disconnect a single-phase pole top distribution transformer.
- Dismount and remove a single-phase pole top distribution transformer, using blocks and a truck-mounted winch.

Installation

- Using blocks and a truck-mounted winch, install a single-phase pole top distribution transformer with direct pole mounts.
- Safely connect a single-phase pole top distribution transformer with the secondary bus de-energized.
- Safely energize a newly-installed pole top transformer.
- Properly test a newly-installed pole top transformer.

Phasing and Tying: Removal

- Temporarily tie in a secondary distribution bus with a nearby pole top transformer to maintain customer service.
- Safely de-energize and disconnect a completely self-protected pole top distribution transformer without disrupting customer service.

Phasing and Tying: Installation

- Demonstrate how to safely rig, dismount and mount a single-phase pole top transformer.
- Safely connect and phase-in a pole top distribution transformer to an energized three-wire single-phase secondary bus.

Continued:

Three-Phase Banks: Removal
- Safely de-energize and disconnect one transformer in a three-phase bank without interrupting customer service.
- Remove a cluster-mounted pole top transformer.

Three-Phase Banks: Installation
- Install a single-phase pole top distribution transformer in a cluster-mount application.
- Safely connect, energize, and test a transformer in a three-phase bank while the secondary bus is energized.

POLE TOP EQUIPMENT AND REPLACEMENT – VOLTAGE REGULATORS

COURSE DESCRIPTION

Voltage tends to decrease along a distribution feeder. It can also fluctuate above and below acceptable levels due to changing load conditions on the system. This course covers the basic theory and operating characteristics of voltage regulators, explains how to detect problems in their operation, and demonstrates how to safety replace them.

COURSE GOALS

• Describe the basic construction and general operation of voltage regulators.
• Explain how to detect voltage regulator problems.
• Describe how to visually inspect, remove, and replace a voltage regulator.

SUBJECTS AND OBJECTIVES

Pole Top Voltage Regulators

- Describe the construction and operation of induction voltage regulators and step voltage regulators.
- Explain the operation of a voltage regulator control circuit.

Troubleshooting Pole Top Voltage

- Describe the basic parts of a step voltage regulator installed on an overhead feeder.
- Describe or demonstrate how to troubleshoot a malfunctioning step voltage regulator.

Pole Top Voltage Regulator Replacement

- Describe one method of safely zeroing and isolating a voltage regulator before change out.
- Describe or demonstrate how to safely remove a step voltage regulator from an overhead feeder and install a replacement unit.

POLE TOP EQUIPMENT AND REPLACEMENT – SWITCHING DEVICES

COURSE DESCRIPTION

This course explains how to repair and replace energized pole top equipment with a minimum of interruption to customers. It describes how to bypass and replace a recloser. It also shows how to inspect and repair one type of gang-operated switch, and how to bypass and replace a different type.

COURSE GOALS

- Describe how to bypass and replace a recloser.
- Explain how a gang-operated switch operates.
- Describe how to inspect and repair a gang-operated switch.
- Explain how to replace a one-piece gang-operated switch.

SUBJECTS AND OBJECTIVES

Recloser Replacement

- Identify the main parts of one type of electronically controlled three-phase recloser.
- Explain the importance of bypassing a recloser before replacing it.
- Describe how to replace a recloser.

Gang-Operated Switch Maintenance

- Describe the basic operation of one type of gang-operated switch.
- Identify problems typically associated with gang-operated switches.
- Describe or demonstrate how to safely inspect and troubleshoot a gang-operated switch.

Gang-Operated Switch Replacement

- Explain how a one-piece gang-operated switch is constructed.
- Describe a procedure for safely replacing one type of gang-operated switch.

POLE TOP EQUIPMENT AND REPLACEMENT – CAPACITORS

COURSE DESCRIPTION

Pole top capacitors are connected to circuits to accept and store charges. They are used to help overhead distribution feeder systems operate more efficiently and reliably. This course covers the basic theory and operating characteristics of overhead capacitors, explains how to detect problems in their operations, and demonstrates how to safely replace them when necessary.

COURSE GOALS

• Identify pole top capacitors.
• Describe the basic construction and general operation of pole top capacitors in an overhead distribution system.
• Describe how to visually inspect, remove, and replace a pole top capacitor.

SUBJECTS AND OBJECTIVES

Pole Top Capacitors

- Describe the basic construction and operation of a typical capacitor used on a distribution feeder.
- Define the term “power factor” and explain how capacitors can be used to improve power factor.

Troubleshooting Pole Top Capacitors

- Describe the basic parts of a capacitor bank installed on an overhead feeder.
- Identify typical protective devices used on a capacitor bank and describe their function.
- Identify items that should be checked during a visual inspection of a capacitor bank.

Pole Top Capacitor Replacement

- Describe or demonstrate how a pole top capacitor bank may be isolated and safely discharged.
- Describe or demonstrate how a damaged pole top capacitor bank may be safely removed and replaced.

TRANSFORMER CONNECTIONS – BASIC AND ADVANCED

COURSE DESCRIPTION

The purpose of this unit is to teach the common types of transformers and how they are connected. Basic concepts of transformers and primary systems are covered as well as single-phase connections. Single-phase distribution transformers can be interconnected to provide three-phase power in a number of different ways, providing a utility with the flexibility of meeting a variety of customer needs. This program demonstrates and explains how three-phase delta connections and three-phase wye connections are made. This program also explains how to make delta-wye, wye-delta, and open bank connections.

COURSE GOALS

• Identify the characteristics that are common to most single-phase overhead transformers.
• Explain the difference between delta and wye primary systems.
• Demonstrate how to make single-phase transformer connections.
Demonstrate how three single-phase transformers can be connected in a delta configuration on both the primary and secondary sides.
• Demonstrate how three single-phase transformers can be connected in a wye configuration on both the primary and secondary sides.
• Illustrate a three-phase, three-wire, delta secondary connection.
• Illustrate a three-phase, four-wire, delta secondary connection.
• Illustrate a three-phase, four-wire, wye secondary connection.
• Use phasor diagrams to illustrate three-phase delta-delta and three-phase wye-wye transformer connections.
Demonstrate and explain how three-phase delta-wye and wye-delta connections producing 30 degrees of angular displacement are made.
• Demonstrate and explain how open connections are made.
• Recognize and use phasor diagrams for delta-wye, wye-delta, and open connections.

SUBJECTS AND OBJECTIVES

Transformer Basics

- Define the term “transformer” and identify some common types of overhead distribution transformers.
- Describe the designations that are commonly used to identify primary and secondary bushings.
- List and explain basic information found on a transformer nameplate.

Primary Systems

- Differentiate between delta and wye primary systems.
- Recognize and explain the phasor diagrams used to illustrate delta and wye systems.
- List and explain basic requirements for connecting transformers to delta and wye systems.

Single-Phase Transformer Connections

- Demonstrate and explain how single-phase transformers can be connected to supply single-phase service.

Continued:

TRANSFORMER CONNECTIONS – BASIC AND ADVANCED (Con't)

Three-Phase Primary Connections
- Demonstrate and explain a three-phase delta primary connection using three single-phase transformers.
- Demonstrate and explain a three-phase wye primary connection using three single-phase transformers.

Delta Secondary Connections
- Demonstrate and explain how to make delta secondary connections.
- Illustrate how to connect three single-phase transformers to supply a three-phase, three-wire delta secondary.
- Illustrate how to connect three single-phase transformers to supply a three-phase, four-wire delta secondary.
- Identify some of the secondary voltages that are typically found on three-phase, three-wire and three-phase, four-wire delta-connected transformer banks.

Wye Secondary Connections
- Demonstrate and explain three-phase, four-wire, wye secondary connections.
- Identify some of the secondary voltages that can be supplied from a three-phase, four-wire, wye-wye connected bank.

Introduction To Three-Phase Banks
- Describe the basic requirements for connecting units together to form a three-phase bank.
- Explain connection principles and theory using phasor diagrams.
- Demonstrate and explain that delta-wye and wye-delta three-phase connections have angular displacements of 30 degrees.

Delta-Wye Connections
- Demonstrate and explain how a three-phase, delta-wye connection producing 30 degrees of angular displacement is made using subtractive-polarity transformers.

Wye-Delta Connections
- Demonstrate and explain how a three-phase wye-delta connection producing 30 degrees of angular displacement is made.

Alternative Connections
- Demonstrate and explain phasor diagrams and angular displacement using alternative connections.
- Demonstrate and explain how an alternative delta-delta three-phase connection producing 180 degrees of angular displacement can be made.
- Demonstrate and explain how an alternative wye-delta three-phase connection producing 210 degrees of angular displacement can be made.

Open Banks
- Demonstrate and explain an open delta-open delta connection producing 0 degrees of angular displacement.
- Demonstrate and explain an open wye-open delta, three-phase connection producing 30 degrees of angular displacement.

POWER QUALITY

COURSE DESCRIPTION

Power quality has become an important concern within the utility industry. An understanding of power quality is especially important to workers, such as field operations personnel and special services technicians, who come into contact with the public.

COURSE GOAL

This training unit describes what power quality is, discusses some basic power quality issues and how they affect customers, and looks at what a utility can do to solve power quality problems.

SUBJECTS AND OBJECTIVES

Basic Concepts

- Identify major areas of power quality.
- Identify sources of power quality problems.
- Identify causes of power quality problems and describe the effects of each.

Power Quality and the Customer

- Identify several types of power line conditioners.
- Describe residential concerns about power quality problems.
- Describe commercial concerns about power quality problems.

Power Quality and the Utility

- Describe preventive measures that utility personnel can take to help prevent power quality problems.
- Describe equipment that can be used to detect and analyze power quality problems.
- Describe how a typical power quality trouble call can be handled by utility representatives.

Overhead Distribution - Energized

DISTRIBUTION LINE INSTALLATION AND REMOVAL

COURSE DESCRIPTION
When changes are made in the area around a distribution line, for example, when a road is widened or a new road is added, it may be necessary to relocate or replace a portion of the line. This program covers job planning, safety precautions, and job site preparation as they relate to installing a new distribution line and removing the existing line.

COURSE GOALS
• Plan a distribution line installation and removal job.
• Describe basic safety considerations associated with installing a new distribution line and removing an existing line.
• Describe or demonstrate how to set new poles and reconstruct poles.
Describe or demonstrate how to install a new line.
• Describe or demonstrate how to energize and phase-in distribution circuits.
• Describe or demonstrate how to remove an existing line.

SUBJECTS AND OBJECTIVES
Planning
- Describe the basic tasks associated with the installation and removal of a distribution line.
- Identify and describe some of the equipment used in distribution line installation and removal.
Safety
- Describe the basic safety considerations associated with the four basic tasks of a distribution line installation and removal job.
Preparation
- Describe a procedure for setting a new pole.
- Describe a procedure for reconstructing an existing pole.
Installing the New Line
- Describe or demonstrate how to set a puller and a tensioner.
- Describe or demonstrate how to pull a pilot line, a bull rope, and conductors.
- Describe or demonstrate how to dead-end and sag conductors.
Energizing and Phasing-In
- Describe how to use a drawing to help determine jumper connections.
- Describe the basic tasks involved in phasing-in and energized line.
- Describe or demonstrate how to phase-in two distribution circuits with a phasing tool.
Removing Existing Line
- Describe or demonstrate how to complete a lateral line change.
- Describe or demonstrate how to remove an existing line.

DISTRIBUTION LINE REPLACEMENT

COURSE DESCRIPTION

This is the first of a two-part course that describes how to replace conductors in an existing overhead line with new conductors. The situation described is one that often occurs when it is necessary to increase the size of the conductors in a line. This course describes how to reconfigure pole framing in order to make room for the new conductors to be pulled in. It also shows how and where to set up equipment such as pilot lines, pulling rigs, and tensioners. This course also describes how to safely pull, sag, dead-end, and tie in the new conductors. Finally, you'll see one way to energize the new conductors, transfer loads from the old line to the new line, and then safely remove the old conductors.

COURSE GOALS

• Describe how to plan a distribution line replacement job.
• Demonstrate how to isolate and remove the original conductors.
• Describe how to prepare buckarm, alley arm, and dead-end poles for a reconductoring job.
• Demonstrate how to set up equipment used to install pulling ropes.
• Demonstrate how to install pulling ropes.
Describe how to ground conductors as they are pulled in.
• Demonstrate how to install replacement conductors.
• Demonstrate how to safely energize the new conductors.
• Demonstrate how to isolate and remove the original conductors.

SUBJECTS AND OBJECTIVES

Introduction

- Identify the basic tasks involved in most distribution line replacement jobs.

Pole Top Preparation

- Describe a procedure for preparing pole tops for a reconductoring job so that sufficient clearances are obtained for pulling in new conductors.

Installing Pulling Ropes

- Describe how to set up a pulling rig and a tensioner.
- Describe how to install pulling ropes.

Installing Conductors

- Describe a procedure for grounding conductors.
- Describe a procedure for installing conductors.

Energizing Conductors

- Describe a procedure for energizing new conductors.
- Describe a procedure for transferring the load from an old line to a new line.

Removing Conductors

- Describe a procedure for isolating conductors.
- Describe a procedure for removing conductors.

DISTRIBUTION LINE REPAIR – GLOVES

COURSE DESCRIPTION

To prevent interruption of service to as many customers as possible, distribution line repairs are often made while lines and equipment remain energized. Whenever work is done on energized equipment, the linemen doing the work must be insulated and isolated from all energized equipment and grounds. This training program discusses the basic principles involved in working on energized lines using insulated gloves. Work methods, communication, concentration, and safety are emphasized throughout the program.

COURSE GOALS

• Describe rubber protective equipment that is used when working on distribution lines, and explain how it is used.
• Describe how to inspect rubber protective gear.
• Describe how to install and remove rubber protective gear in a variety of job situations.

SUBJECTS AND OBJECTIVES

Rubber Protective Gear

- Describe basic rubber protective equipment used when working on overhead distribution lines.
- Describe how rubber protective gear is manufactured, sized, and stored.

Care and Inspection of Rubber Gear

- Describe problems to look for when inspecting protective gear.
- Describe general procedures for inspecting protective gear.

Replacing an In-Line Switch

- Describe how to provide a safe work area for an in-line switch replacement job.
- Describe how to remove and replace an in-line switch using the rubber glove method.
- Describe how to remove the line cover gear after completing a job.

Attaching Conductors to a New Pole

- Demonstrate how to rubber up the work area, frame out the pole, and tie in the phases of a distribution feeder to a new pole that has been set in a line.

Dead-End Insulator Change-Out

- Describe one method of safely changing out a dead-end insulator while working from an insulated platform.

DISTRIBUTION LINE REPAIR - HOT STICKS

COURSE DESCRIPTION

This program describes several types of hot-line tools that are used to work on energized lines, including hot sticks, hot stick attachments, and accessory tools. The program describes the safety-related work practices associated with storing and inspecting hot sticks, and planning for hot stick jobs. In addition, the program demonstrates basic procedures for using hot-line tools and accessories to remove and install tie wires. This program also demonstrates how to use hot sticks to move single-phase lines and to change out a dead-end insulator.

COURSE GOALS

• Describe some of the hot-line tools and equipment used to work on energized lines.
• Describe methods for the care and storage of hot sticks.
• Describe basic job planning and safety procedures for using hot sticks at the work site.
• Describe the steps involved in using hot-line tools to remove and install tie wires.
Demonstrate how to work safely on energized lines using hot sticks.
• Demonstrate how to prepare for a job that will be done using hot sticks, perform the work safely, and return the job site to a normal condition.
• Demonstrate how to move single-phase and three-phase lines and how to change out a dead-end insulator.

SUBJECTS AND OBJECTIVES

Hot-Line Tools

- Describe the function of hot-line tools.
- Identify three types of hot sticks and describe the function of each stick.
- Describe how to clean, inspect, and store hot sticks.

Planning and Safety for Hot Stick Jobs

- Explain the purpose of a tailgate session.
- Describe the basic procedures for inspecting the work site before using hot-line tools.
- Describe common safety practices to observe when using hot-line tools.

Removing and Installing Tie Wires

- Identify the hot-line tools that are commonly used when removing and installing tie wires.
- Describe basic procedures for removing and installing tie wires using hot-line tools.

Moving a Single-Phase Line

- Identify hot-line tools used to move a line by the lift method and describe the function of each tool.
- Describe a basic procedure for moving a single-phase line using the lift method.
- Identify hot-line tools used to move a line by the side method, and describe the function of each tool.
- Describe a basic procedure for moving a single-phase line using the side method.

Moving Three-Phase Lines

- Identify the hot-line tools used to move three-phase lines when using an auxiliary side arm, and describe the function of each tool.

Continued:

- Describe a basic procedure for moving three-phase lines using an auxiliary side arm.
- Identify the hot-line tools used to move three-phase lines when using an auxiliary mast arm, and describe the function of each tool.
- Describe a basic procedure for moving three-phase lines using an auxiliary mast arm. **Continued:**

DISTRIBUTION LINE REPAIR - HOT STICKS (Con't)

Changing Out a Dead-End Insulator

- Identify the hot-line tools used to change out dead-end insulators and describe the function of each tool.
- Describe a basic procedure for changing out a dead-end insulator.

TRANSFORMER TROUBLESHOOTING

COURSE DESCRIPTION

This course describes basic procedures for troubleshooting various types of transformers and transformer banks. The course begins by examining different types of transformers, transformer connections, and overcurrent and overvoltage devices that are typically used to protect transformers. The program identifies some typical causes of transformer outages and describes some general considerations involved in responding to a trouble call. The dangers associated with and the potential sources of backfeed are also covered. This course demonstrates procedures for isolating and testing single-phase transformers and three-phase transformer banks. The course also describes how to temporarily restore service in single-phase and three-phase applications.

COURSE GOALS

• Describe different types of transformers, transformer connections, and overcurrent and overvoltage protective devices.
• Identify typical causes of transformer outages.
• Describe basic procedures for responding to a trouble call.
• Describe potential sources of backfeed.

Describe how to isolate and test single-phase transformers and three-phase transformer banks.

• Describe how to temporarily restore service in single-phase and three-phase applications.

SUBJECTS AND OBJECTIVES

Introduction to Transformer Troubleshooting

- Describe different types of transformer connections.
- Describe the basic differences between CSP transformers and conventional transformers.

Protective Devices

- Describe some overcurrent protective devices that are used with transformers.
- Describe some overvoltage devices that are used with transformers.

Transformer Problems

- Describe typical causes of transformer outages.
- Describe general considerations involved in responding to a trouble call.
- Describe potential sources of backfeed.

Isolating and Testing Single-Phase Transformers – Part 1

- Describe how to isolate and test a typical wye-connected conventional transformer.
- Describe special considerations associated with isolating and testing a delta-connected conventional transformer.

Isolating and Testing Single-Phase Transformers – Part 2

- Describe how to isolate a typical CSP transformer.
- Describe how to test a typical CSP transformer.

Troubleshooting Three-Phase Banks

- Identify ways that single-phase transformers can be banked together.
- Define the following terms: pole top arcing and sympathetic tripping.
- Describe how to isolate and test a typical three-phase transformer bank.

Temporary Service Restoration

- Describe one way that temporary service can be restored in a single-phase application.
- Describe one way that temporary service can be restored in a three-phase application.

TROUBLESHOOTING OVERHEAD LINES

COURSE DESCRIPTION

This course describes methods of safely locating problems on overhead lines that result in loss of power to customers. These methods are called troubleshooting. This begins by describing the logical steps for troubleshooting, one method of troubleshooting called patrolling, common problems to look for, and safety precautions to observe when troubleshooting overhead lines. This program also describes how to locate problems on a primary line using various sectionalizing approaches. It also describes how to locate trouble on secondary lines using various testing approaches.

COURSE GOALS

• Explain the purpose of troubleshooting, and describe the steps for troubleshooting an overhead distribution system.
• Explain the purpose of patrolling, and identify problems to look for when patrolling.
• Discuss safety precautions to observe when troubleshooting overhead distribution lines.
• Describe methods for sectionalizing primary lines.
• Describe or demonstrate how to locate trouble on a line by testing secondary lines.

SUBJECTS AND OBJECTIVES

Introduction to Troubleshooting

- Explain the purpose of troubleshooting.
- Describe the logical steps for troubleshooting an overhead distribution system.

Patrolling

- Explain the purpose of patrolling overhead distribution systems.
- Identify common problems to look for when patrolling overhead distribution lines.

Troubleshooting Safety

- Describe safety precautions that should be observed when troubleshooting overhead distribution lines.

Sectionalizing Primary – Part 1

- Explain when it may be appropriate to close in a line that has tripped open.
- Describe three ways that a line can be sectionalized.

Sectionalizing Primary – Part 2

- Describe the principles for locating trouble on a primary line by sectionalizing and energizing portions of the line.

Testing Secondary – Part 1

- Describe how to locate trouble on a secondary circuit by visually checking the circuit and by testing for voltage at a customer's meter.

Testing Secondary – Part 2

- Describe how to locate trouble on a secondary circuit by testing for voltage output from a distribution transformer.
- Describe how to locate trouble on a secondary circuit by testing for voltage to a distribution transformer.

34.5 KV RUBBER GLOVE WORK

COURSE DESCRIPTION

Many companies are finding it necessary to use 34.5 KV distribution lines to keep up with customer demand for dependable, high-quality electric power. Linemen who work on these lines must be aware of the electrical hazards associated with this work. They must also be familiar with the safety equipment and procedures that enable them to perform their work safely and efficiently.

COURSE GOAL

The procedures and equipment that are used in this training program are intended only as examples. Linemen should review their company's specific procedures for working on 34.5 KV lines and learn how to use the equipment that their company provides.

SUBJECTS AND OBJECTIVES

Introduction

- Identify electrical hazards associated with working on 34.5 KV lines.
- Explain how to identify a 34.5 KV line.

Safety Equipment

- Describe how to care for and use the safety equipment typically required for working on 34.5 KV lines.

Safe Work Habits, Part 1

- Describe safety considerations associated with planning and preparing for 34.5 KV rubber glove work.

Safe Work Habits, Part 2

- Describe variations that are likely to occur between 34.5 KV rubber glove jobs.
- Describe a procedure for safely changing out a crossarm.
- Describe a procedure for safely changing out a lateral cutout on a distribution line.

TROUBLESHOOTING OVERHEAD LINES – PART 1

COURSE DESCRIPTION

Overhead systems are exposed to many hazards that can lead to a partial or total loss of power. When a problem occurs, troubleshooters are responsible for finding out what is wrong and determining how the problem can be corrected as quickly as possible. In order to locate and identify problems effectively, troubleshooters must be familiar with some basic steps of troubleshooting and know how to apply those steps to various situations. This course identifies some basic steps that can be used to troubleshoot any type of overhead system problem and describes how those steps can be applied in several different troubleshooting situations.

COURSE GOALS

• List the basic steps of troubleshooting overhead line problems.
• Describe how the steps of troubleshooting can be used to identify and correct both simple and complex problems.

SUBJECTS AND OBJECTIVES

Introduction to Troubleshooting

- Identify some basic troubleshooting steps that can be applied to any type of overhead system problem.
- Identify considerations that should be kept in mind during troubleshooting activities.
- Describe how some basic troubleshooting steps can be used to identify and correct an overhead system problem in which a single customer is affected by a partial loss of power.

Troubleshooting Applications – Part 1

- Describe how basic troubleshooting steps can be used to identify and correct an overhead system problem in which several customers are affected by a partial loss of power.

Troubleshooting Applications – Part 2

- Describe how troubleshooting steps can be used to identify and correct an overhead system problem in which several customers are affected by a total loss of power.

TROUBLESHOOTING OVERHEAD LINES – PART 2

COURSE DESCRIPTION

When damage from storms and disasters is extensive, a much larger than normal troubleshooting effort is usually required to get customers back on line as quickly as possible. To support this effort, companies often have special emergency plans in place to make sure that their employees can deal with the problems and conditions that are likely to be encountered. This course examines some of the conditions that tend to make troubleshooting overhead lines under emergency conditions different from normal troubleshooting.

COURSE GOALS

• Describe how to prepare for emergency situations.• Describe how problems are prioritized during emergencies.
• List safety considerations that should be followed during emergency troubleshooting.
• Describe how communications are handled between field personnel and the dispatcher during an emergency situation.

SUBJECTS AND OBJECTIVES

Introduction

- Identify differences between troubleshooting under emergency conditions, and troubleshooting under normal conditions.
- Describe some basic preparations that can be made prior to emergency troubleshooting.
- Describe one method used to prioritize problems during emergency troubleshooting.
- Describe basic safety precautions that should be followed during emergency troubleshooting.

Communications

- Explain why a communications center is needed during emergency conditions.
- Describe how communications to and from a communications center during emergency conditions are different from communications during normal conditions.
- Describe how the field communications group at a communications center coordinates feedback from company personnel in the field during an emergency.
- Describe how the customer communications group at a communications center coordinates information from customers during an emergency.
- Describe how the dispatcher evaluates information collected by communications center personnel and works with troublemen to deal with an emergency.

Emergency Troubleshooting

- Describe some methods for effectively dealing with the physical and electrical hazards present when troubleshooting overhead lines at night during a storm.
- Describe methods that a troubleshooter can use to help prioritize repairs and clear lines.

Underground (URD)

UNDERGROUND RESIDENTIAL SYSTEMS (URD)

COURSE DESCRIPTION
This course identifies and describes three common types of underground residential distribution (URD) systems: radial feed, loop feed, and double feed systems. URD components, cables, and terminations are also introduced and discussed. This course also describes how URD cable and equipment are installed. It describes checks performed during typical URD system maintenance inspections and how the flexibility of URD systems allows various portions of a loop feed URD system to be installed without interrupting service to customers.

COURSE GOALS
• Identify and describe three common types of URD system designs: radial feed, loop feed, and double feed.
• Identify and describe the function of various types of equipment used in URD systems.
• Describe different types of URD cables and terminations.
• Describe how URD cables and equipment are installed.
• Describe procedures for typical URD system maintenance.
• Describe how portions of a URD system can be isolated with minimum disruption of customer service.

SUBJECTS AND OBJECTIVES
Types of URD Systems
- Identify sources of power for a typical URD system.
- Describe general equipment and design considerations associated with URD systems.
- Describe radial feed, loop feed, and double feed URD system designs.

URD System Components
- Recognize and identify various types of URD system equipment.
- Describe the functions of potheads, switchgear, transformers, and protective devices commonly found on URD systems.
- Recognize the differences between pad-mounted, subsurface, and direct-buried equipment.

Cables and Terminations
- Recognize and identify different types of cable used in URD systems.
- Recognize and identify different types of cable terminators used in URD systems.

URD Equipment Installation
- Describe methods of installing URD cable.
- Describe methods of installing URD equipment above ground, subsurface, and direct-buried.

URD System Maintenance
- Describe procedures for checking equipment in an open loop URD system.

Equipment Operation
- Describe how various components of a URD system can be isolated without interrupting service to customers.

SAFETY IN UNDERGROUND LINE MAINTENANCE

COURSE DESCRIPTION
This program describes some of the common safety hazards found in URD work environments and how to minimize the effects of electrical, atmospheric, and structural hazards. The program also presents a vault emergency situation and discusses safe rescue procedures.

COURSE GOALS
To identify and describe safety hazards associated with URD line maintenance

SUBJECTS AND OBJECTIVES
Work Area Safety
- Identify safety guidelines to follow before beginning work in an underground or URD work environment.
- Describe methods for inspecting underground and URD work environments for physical hazards.

Tools and Test Equipment
- Describe how to use the following: a pocket statiscope, a phasing tool, a remote cable spear, and a remote cable cutter.

Shoring
- Identify the excavation conditions that require shoring.
- Determine when different types of shoring are required.
- Describe safety guidelines for shoring trenches.
- Identify some safe alternatives to shoring.

Atmospheric Testing
- Identify atmospheric hazards that may be found in vaults and enclosed spaces.
- Describe how to use atmospheric test devices.
- Explain how to use ventilation equipment to supply fresh air to an enclosed area.

Vault Emergency
- Describe general safety guidelines that should be followed in the event of a vault emergency.

UNDERGROUND CABLE INSTALLATION

COURSE DESCRIPTION

This program describes two methods of installing underground cable: direct-burying and pulling cable in conduit. The program demonstrates how to lay cable in an open trench and pull cable in conduit. This course also demonstrates how to use various types of equipment and tools for rigging manholes and for pulling cable in conduit.

COURSE GOALS

• Identify tools and methods for installing direct-buried URD cable.
• Describe the equipment, tools, and rigging devices that can be used for pulling cable through conduit.
• Describe the steps involved in pulling cable between two manholes.
• Describe two methods for pulling cable into buildings.

SUBJECTS AND OBJECTIVES

Direct-Buried Cable

- Describe three tools used for direct-burying URD cable.
- Identify and describe three pieces of machinery that are used to install URD cable.

URD Cable in Conduit

- Describe the steps involved in pulling URD cable in conduit.
- Identify some of the tools used for pulling URD cable in conduit.

Underground Cable Systems

- Describe the steps involved in installing cable in conduit between two manholes.
- Identify the rigging devices and equipment used to install cable in conduit between two manholes.

Pulling Cable Between Manholes

- Describe the steps involved in installing underground cable between two manholes.

Pulling Cable into Buildings

- Describe two methods for installing cable in conduit between a manhole and a building.

PAD-MOUNTED TRANSFORMERS & SWITCHGEAR

COURSE DESCRIPTION

This course discusses the basics of underground transformer operations. It presents problems that arise when operating transformers and discusses troubleshooting techniques and inspection procedures. This course also describes the general characteristics of two basic types of pad-mounted switchgear: oil-immersed disconnect switches and transclosures. This course also describes how pad-mounted switchgear can be used to sectionalize and reroute power in an underground feeder system.

COURSE GOALS

• Describe the general features of pad-mounted transformers.
• Describe typical uses for pad-mounted transformers.
• Identify four pad-mounted voltage problems and describe how to troubleshoot a three-phase transformer for these problems.
• Describe the general characteristics of oil-immersed disconnect switches and transclosures.
• Explain how pad-mounted switchgear can be used to sectionalize and reroute power in an underground feeder system.

SUBJECTS AND OBJECTIVES

Pad-Mounted Transformers

- Describe the general construction and features of a pad-mounted transformer.

Pad-Mounted Transformer Installation

- Describe an installation procedure for a three-phase pad-mounted transformer that includes the following steps: site preparation, transformer installation, and testing.

Troubleshooting a Three-Phase Transformer – Part 1

- Define “one leg open” and describe its symptoms.
- Define “ferroresonance” and describe its symptoms.
- Define “off-ratio winding” and describe its symptoms.
- Define “open neutral” and describe its symptoms.

Troubleshooting a Three-Phase Transformer – Part 2

- Describe how the troubleshooting process can be used to isolate the cause of a problem in a three-phase pad-mounted transformer.

Pad-Mounted Switchgear

- Identify two types of pad-mounted switchgear.
- Describe the use of pad-mounted switchgear to sectionalize and isolate portions of a URD system.
- Describe some typical physical and operational checks that can be performed on pad-mounted switchgear.

Pad-Mounted Switchgear Operation

- Describe the use of pad-mounted switchgear to sectionalize and isolate equipment in an underground feeder system.

CABLE SPLICING – PART 1

COURSE DESCRIPTION
Cable splicing is the process of joining two cable ends together while maintaining the cable's original design characteristics. This course focuses on cable design and preparing a cable for splicing.

COURSE GOALS
• Identify the different parts of a typical primary cable.
• Explain how cable design affects the capabilities of primary cable.
• Explain how to prepare a cable for splicing.

SUBJECTS AND OBJECTIVES
Electrical Cable
- Identify the major parts of a primary cable.
- Discuss variations in cable construction.

Voltage Stress and Stress Relief
- Explain what voltage stress is.
- Explain how a layered cable design helps to counteract the effects of voltage stress.
- Explain how a layered cable design helps to provide the relief of static charges.

Cable Preparation
- Describe one method of preparing primary cable for a tape splice.
- Identify equipment that can be used to prepare primary cable for a tape splice.

CABLE SPLICING – PART 2

COURSE DESCRIPTION
This course describes several ways to splice primary and secondary cables. It also includes instructions for using splice kits to splice primary cable.

COURSE GOALS
• Describe how to splice primary cable.
• Describe how to use splice kits.
• Describe how to splice secondary cable.

SUBJECTS AND OBJECTIVES
Primary Cable Splicing
- Explain how mechanical presses and hydraulic presses are used to install compression connectors to join conductor ends.
- Describe one method of completing a tape splice on a single-conductor, jacketed primary cable.

Splice Kits
- Describe or demonstrate how to install a molded slip-on splice on a primary cable with a concentric neutral.
- Describe or demonstrate how to install a heat-shrink splice on a primary cable with a jacketed concentric wire layer.

Secondary Cable Splicing
- Identify differences between primary and secondary cable construction.
- Describe or demonstrate how to perform a split bolt (mechanical) splice, a heat-shrink splice, a cold-shrink splice, and a rolling ring seal splice on a secondary cable.

CABLE TERMINATIONS

COURSE DESCRIPTION
Electrical cables are routinely connected to many different types of equipment. When a connection to equipment is made, the cable must be terminated, or ended, at the connection point. This course discusses different types of cable terminations, how they are installed, and how they help cables function properly. Problems associated with voltage stress and the function of stress cones are also discussed.

COURSE GOALS
• Recognize and identify typical primary cable terminations.
• Explain what voltage stress is and how terminations are built to avoid voltage stress problems.
• Describe how to install a tape termination, an elbow termination, a porcelain termination, and a rubber termination.

SUBJECTS AND OBJECTIVES
Introduction to Terminations
- Describe the function of a cable termination.
- Identify and describe three classes of terminations.

Tape Terminations
- Describe how to install a tape termination.

Elbow Terminations
- Distinguish between load-break and non-load-break elbow terminations.
- Describe how to install an elbow termination on a primary URD cable.

Porcelain Terminations
- Recognize and identify porcelain primary terminations.
- Describe how to install a porcelain termination.

Rubber Cable Terminations
- Describe how to install a molded, slip-on rubber termination.
- Describe how to install a cold-shrink rubber termination.
- Describe how to install a heat-shrink rubber termination.

LOCATING PRIMARY FAULTS

COURSE DESCRIPTION
This course is a general introduction to fault location in primary URD cable. The course covers capacitor discharge equipment, how it is used to locate faults, and a demonstration of how to locate a cable fault.

COURSE GOALS
• Describe the features, controls, and functions of the power source for one type of capacitor discharge unit.
• Describe two types of tests commonly performed on primary URD cables.
• Describe how to use capacitor discharge equipment to locate a primary cable fault.

SUBJECTS AND OBJECTIVES
Introduction
- Explain what a ground fault is.
- List the essential components contained in URD fault-locating equipment.

Capacitor Discharge Unit
- Identify and explain the purpose of the controls on a typical capacitor discharge test unit.
- Explain the function of the high potential (hipot) test.
- Explain the function of the capacitor (cap) discharge test.

Locating a Primary Cable Fault – Parts 1 & 2
- Interpret a system diagram.
- Describe how to verify that a cable is dead.
- Explain how to connect the cables on a capacitor discharge test unit so that it can be used to test for cable faults.
- Describe how to use a pickup and detector with a capacitor discharge test unit.
- Describe how to use a capacitor discharge test unit to pinpoint the location of a fault.

LOCATING SECONDARY FAULTS

COURSE DESCRIPTION
This course explains how voltage gradient equipment works and demonstrates how to use voltage gradient equipment to locate faults in secondary URD cable.

COURSE GOALS
• Explain how voltage gradient equipment works.
• Describe how to use voltage gradient equipment to locate faults in secondary URD cable.

SUBJECTS AND OBJECTIVES
Voltage Gradient Equipment
- Explain how voltage gradient equipment can be used to locate a fault in a section of secondary URD cable.
- Identify and explain the purpose of the controls on a typical voltage gradient transmitter, pickup, and detector.

Locating Secondary Fault Objectives
- Interpret a system diagram.
- Describe how to determine whether it is safe to work on a cable.
- Explain how to connect test leads on a voltage gradient transmitter.
- Describe how to use voltage gradient equipment to pinpoint the location of a fault.

URD TROUBLESHOOTING

COURSE DESCRIPTION
This course describes methods that can be used to troubleshoot two types of problems that may affect URD systems: transformer faults and cable faults.

COURSE GOALS
• Describe the layout of a typical underground residential distribution system.
• Describe methods that can be used to troubleshoot transformer faults.
• Describe methods that can be used to troubleshoot cable faults.
• Identify equipment used in the troubleshooting process.

SUBJECTS AND OBJECTIVES
Isolating Transformer Faults
- Describe the layout of a typical underground residential distribution (URD) system.
- Describe how to troubleshoot a transformer fault in which only the transformer primary fuse is blown.
- Describe how to troubleshoot a transformer fault in which the rise pole fuse is blown, but the transformer primary fuse is intact.

Isolating Cable Faults – Part 1
- Describe how to troubleshoot a cable fault in a system equipped with cable fault indicators.
- Identify three common types of cable fault indicators.
- Describe how to troubleshoot a cable fault by isolating and testing one section of cable at a time starting at the normally open point in the loop.
- Describe how to troubleshoot a cable fault by isolating and testing one section of cable at a time starting at a blown riser pole fuse.

Isolating Cable Faults – Part 2
- Describe how to troubleshoot a cable fault by re-energizing one section of cable at a time.
- Describe how the area to be isolated and tested for a cable fault in a URD system can be reduced.
- Describe the major difference between troubleshooting a transformer fault or a cable fault in a three-phase system and troubleshooting a transformer fault or a cable fault in a single-phase system.
- Describe how to troubleshoot a cable fault using a radar fault locator.

Substations:

POWER TRANSFORMERS – PART 1

COURSE DESCRIPTION
This course describes how power transformers work and introduces some of the more common types of power transformers found in substations and switchyards. This course also demonstrates how to recognize and identify specific classes of power transformers by their cooling systems and discusses how cooling systems work.

COURSE GOALS
• Describe how transformers work.
• Identify common types of transformers found in substations.
• Recognize and identify specific classes of power transformers by their cooling systems.
• Describe how different types of cooling systems work.

SUBJECTS AND OBJECTIVES
Transformer Principles
- List the main components of a transformer, and discuss the function of each part.
- Explain how a transformer fulfills the three requirements for electromagnetic induction.
- Describe how a transformer's turns ratio determines the difference between its primary and secondary voltage.

Types of Transformers
- Identify power transformers, current transformers, and potential transformers.

Cooling Systems – Part 1
- Describe the purpose of power transformer cooling systems.
- Recognize and identify a self-cooled power transformer, and describe how its cooling system works.
- Recognize and identify a self-cooled/forced-air-cooled power transformer, and describe how its cooling system works.

Cooling Systems – Part 2
- Recognize and identify a forced-oil/forced-air-cooled power transformer, and describe how the cooling system works.
- Identify and describe the functions of temperature gauges and level gauges on a power transformer.

POWER TRANSFORMERS – PART 2

COURSE DESCRIPTION
This course demonstrates how to recognize and identify specific classes of power transformers by their sealing systems and discusses how these sealing systems work.

COURSE GOALS
• Recognize and identify specific classes of power transformers by their sealing systems.
• Describe how sealing systems work.

SUBJECTS AND OBJECTIVES
Power Transformer Sealing Systems – Part 1
- State the purpose of power transformer sealing systems.
- Recognize and identify gas-sealed and conservator-type sealed power transformers.
- Describe how sealing systems work.

Power Transformer Sealing Systems – Part 2
- Recognize and identify a conservator-type sealed power transformer that has an airbag in the conservator, and describe how its sealing system works.
- Recognize and identify a gas/oil-sealed power transformer, and describe how its sealing system works.

CIRCUIT BREAKERS – PART 1

COURSE DESCRIPTION

Part one of this course provides the trainee with an overview of circuit breakers and their operating principles. It also introduces the student to the fundamental concepts of arc extinguishing and circuit interruption. At the conclusion of this course, students should be able to describe the main functions of circuit breakers and identify them by their classification. In addition, they should be able to identify air-magnetic, air-blast, oil, and vacuum circuit breakers, and briefly describe how each one operates.

COURSE GOALS

• Describe the function, purpose, and classifications of circuit breakers.
• Describe how circuit breakers work.
• Explain how the interrupting and operating mechanisms operate.
• Describe the main features and basic operation of four common types of circuit breakers.

SUBJECTS AND OBJECTIVES

Introduction to Circuit Breakers

- Discuss the two main functions of circuit breakers.
- Explain why it is important to extinguish arcs quickly.
- Discuss the roles of speed, distance, cooling, dielectric strength, and current zero in extinguishing arcs.
- Identify the dielectric mediums that are commonly used in circuit breakers to extinguish arcs.

Air-Magnetic and Air-Blast Circuit Breakers

- Describe the main arc extinguishing features of an air-magnetic circuit breaker.
- Explain how an arc is extinguished in an air-magnetic circuit breaker.
- Describe the main arc extinguishing features of an air-blast circuit breaker.
- Explain how an arc is extinguished in an air-blast circuit breaker.

Oil and Vacuum Circuit Breakers

- Describe the arc extinguishing features of an oil circuit breaker.
- Explain how an arc is extinguished in an oil circuit breaker.
- Describe the arc extinguishing features of a vacuum circuit breaker.
- Explain how an arc is extinguished in a vacuum circuit breaker.

CIRCUIT BREAKERS – PART 2

COURSE DESCRIPTION
This training program is designed to provide the student with basic information about circuit breakers that are used in substations and switchyards. The course shows how arcs are extinguished in gas-blast and gas-puffer breakers, and covers four types of breaker operating mechanisms: solenoid, motor/spring, pneumatic, and hydraulic.

COURSE GOALS
• Describe the function and purpose of circuit breakers and how their tasks are accomplished.
• Describe the main features of six common types of breaker arc interrupting mechanisms.
• Describe the four common types of breaker operating mechanisms.
• Explain how the interrupting and operating mechanisms operate.

SUBJECTS AND OBJECTIVES
Gas-Blast and Gas-Puffer Circuit Breakers
- Describe the arc extinguishing features of a gas-blast circuit breaker.
- Explain how an arc is extinguished in a gas-blast circuit breaker.
- Describe the arc extinguishing features in a gas-puffer circuit breaker.
- Explain how an arc is extinguished in a gas-puffer circuit breaker.

Solenoid and Motor/Spring Operating Mechanisms
- Describe the main features of a solenoid operating mechanism.
- Explain how a solenoid operating mechanism opens and closes circuit breaker contacts.
- Describe the main features of a motor/spring operating mechanism.
- Explain how a motor/spring operating mechanism opens and closes circuit breaker contacts.

Pneumatic Hydraulic Operating Mechanisms
- Describe the main features of a pneumatic operating mechanism.
- Explain how a pneumatic operating mechanism opens and closes circuit breaker contacts.
- Describe the main features of a hydraulic operating mechanism.
- Explain how a hydraulic operating mechanism opens and closes circuit breaker contacts.

VOLTAGE REGULATORS – PART 1

COURSE DESCRIPTION

Utilities are required to provide power to their customers within a specific range of voltages. Voltages that are outside of that range may damage equipment or cause it to operate inefficiently. One method of maintaining voltage within a specified range is by using voltage regulators. This program discusses the operation and control of substation voltage regulators.

COURSE GOALS

• Describe why voltage regulation is needed in a transmission and distribution system.
• Identify the main components of induction voltage regulators and step voltage regulators, and explain how each operates.
• Describe voltage regulator controls, and explain how each of these controls operates.

SUBJECTS AND OBJECTIVES

Voltage Regulator Operation – Part 1

- Describe the function of a voltage regulator.
- Identify the main components that enable an induction voltage regulator to adjust voltage.
- Describe how an induction voltage regulator adjusts voltage.

Voltage Regulator Operation – Part 2

- Identify the main components that enable a step voltage regulator to adjust voltage.
- Describe how a step voltage regulator adjusts voltage.

Voltage Regulator Control – Part 1

- Describe the function of a voltage detector, and explain how it works.
- Describe the function of a line drop compensator, and explain how it works.

Voltage Regulator Control – Part 2

- Describe the function of a voltage regulator time delay component.
- Describe the function of voltage regulator limit switches.
- Describe the function of a voltage regulator voltage reduction control.
- Describe the function of a voltage regulator first house voltage protector.

VOLTAGE REGULATORS – PART 2

COURSE DESCRIPTION
This program describes the general procedures for performing voltage regulator field inspections and control checks. The program also describes how to remove a voltage regulator from service and how to put a new or replacement regulator into service.

COURSE GOALS
• Describe the general procedures for performing voltage regulator field inspections and control checks.
• Describe how to remove a voltage regulator from service and how to put a new or replacement regulator into service.

SUBJECTS AND OBJECTIVES
Field Inspection
- Describe some of the common inspection steps typically performed on a voltage regulator.

Field Control Checks
- Describe control checks for a voltage regulator with solid-state control.

Regulator Replacement
- Describe how to safely remove a voltage regulator from service.
- Describe how to safely put a voltage regulator back into service.

CAPACITORS AND REACTORS

COURSE DESCRIPTION

Conditions exist in any transmission and distribution system that result in power losses in the systems and equipment that deliver power and in the systems and equipment that use power. In order to compensate for these power losses, utilities often use devices such as capacitor banks and shunt reactors.

COURSE GOALS

This training program covers the functions of substation capacitors and reactors, and how they can be safely cleared, maintained, and tested.

SUBJECTS AND OBJECTIVES

Function of Capacitors and Reactors

- Define the following terms: working power, non-working power, capacitive power, inductive power, power factor, and unity power factor.
- Describe how the relationship between working and non-working power determines the efficiency of the power produced in a T and D system.
- Explain how capacitor banks and shunt reactors are used to improve power factor.

Clearing Capacitor Banks

- Describe how to safely de-energize, isolate, and test a substation capacitor bank.
- Describe how to safely ground a substation capacitor bank using portable grounds.
- Describe how to safely ground a substation capacitor bank that is equipped with switches.

Capacitor Bank Maintenance

- Describe maintenance tasks performed on substation capacitor banks.
- Identify common problems when inspecting substation capacitor banks.
- Describe how to safely remove individual capacitors and capacitor fuses.
- Describe special precautions when handling capacitors containing PCB's

Capacitor Resistor and Insulator Testing

- Describe how to test the integrity of the internal resistor of a substation capacitor.
- Describe how to test the integrity of the insulators of a substation capacitor

Capacitor Capacitance Testing

- Describe several methods for checking the capacitance of substation capacitors,
- Describe how to check the balance of a substation capacitor bank.

Shunt Reactors

- Identify and describe two basic types of substation shunt reactors.
- Identify common problems to look for when visually inspecting a substation oil-insulated shunt reactor and an air-core shunt reactor.
- Describe how to safely de-energize, isolate, test, and ground a shunt reactor.
- Describe how to test the insulation resistance of a substation shunt reactor.

Series Reactors

- State the function of a substation series reactor and describe how a series reactor operates.

RELAYS 1

COURSE DESCRIPTION

When a fault occurs in a transmission and distribution (T&D) system, current increases and voltage decreases. The increased current causes excessive heating, which, depending on where the fault occurs, can result in a fire or an explosion. If the fault is not quickly isolated, it can damage that may result in loss of service.

T&D systems use various types of control systems to detect and isolate faults with minimum disturbance. A key component of all of these control systems is the protective relay.

COURSE GOALS

This training program examines the functions and operation of some types of protective relays that are commonly found in substations and switchyards.

Introduction to Relays

- Explain the purpose of protective relays in a T&D system.
- Describe how a protective relay is used in a T&D system.
- Describe five common relay elements and explain how they work

Overcurrent Relays

- Describe the condition that causes an overcurrent relay to operate.
- Describe the basic operating principles of overcurrent relays.

Directional Overcurrent Relays

- Identify T & D equipment typically protected by directional overcurrent relays.
- Describe the condition that causes a directional overcurrent relay to operate.
- Describe the basic operating principles of directional overcurrent relays.

Reclosing Relays

- Describe the function of reclosing relays.
- Describe the basic operating principles of reclosing relays.

Voltage Relays

- Identify the type of equipment that voltage relays typically protect.
- Describe the conditions that cause voltage relays to operate.
- Describe the basic operating principles of voltage relays.

Auxiliary Relays

- Describe the basic function of auxiliary relays.
- Describe the basic operating principles of auxiliary relays.

Solid State Relays

- Describe the basic operating principles of solid-state relays.

RELAYS 2

COURSE DESCRIPTION

An electric power system includes generators, power transformers, transmission lines, switchgear, distribution circuits, and residential and business customer equipment. At any time, severe weather, accidents, or other factors may cause part of the system to fail. If the system is not properly protected, a failure can result in personal injuries and extensive equipment damage. One of the keys to protecting equipment and personnel from failures is the use protective relays.

COURSE GOALS

This program focuses primarily on relays that are used in transmission systems. Distribution system relays are covered in Relays unit 1.

SUBJECTS AND OBJECTIVES

Introduction to Relays

- Identify five common relay elements
- Identify the functions of overcurrent, directional overcurrent, reclosing, voltage, and auxiliary relays.

Differential Relays

- Identify what differential relays typically protect.
- Describe the condition that causes a differential relay to operate.
- Describe the basic operating principles of differential relays.

Transfer Tripping

- Describe the function of transfer tripping.
- Identify the main components of a transfer tripping system.
- Identify four communication channels used for transfer tripping and explain how they work.
- Identify the main equipment associated with transfer tripping communication channels and describe the function of each type of equipment.

Distance Relays

- Identify what distance relays typically protect.
- Describe the condition that causes a distance relay to operate
- Describe the basic operating principles of distance relays.

Pilot Wire Relaying

- Describe the function of a pilot wire relaying system.
- Identify the main components of a pilot wire relaying system.
- Describe the basic operating principles of a pilot wire relaying system.

Breaker Failure Relaying

- Identify the function and the main components of a breaker failure relaying systems.
- Describe the general operation of a breaker failure relaying system.
- Describe the basic operating principles of a breaker failure relay.
- Describe the basic operating principles of a timing relay in a breaker failure relaying system.

CONTROL EQUIPMENT

COURSE DESCRIPTION

Disturbances and failures in a transmission and distribution (T&D) system can interrupt customer service and damage system equipment. Control equipment is the general name given to devices designed to minimize the effects of disturbances and failures. Control equipment helps to limit the number of customers affected by a given disturbance, as well as limit damage to the T&D system.

COURSE GOALS

This training program is designed to provide T&D system personnel with an understanding of why control equipment is needed, what equipment is used to provide control, and how the equipment works together. Although specific types of control equipment are used as examples, the emphasis is on general procedures that apply to most types of control equipment.

SUBJECTS AND OBJECTIVES

Control Functions, Modes, and Equipment

- State two basic reasons why control is needed in a substation.
- Describe how control is provided.
- Identify the equipment typically used to provide control.

Voltage Control

- State why it is necessary to control voltage.
- Describe how a simple voltage control system works.

Distribution Feeder Fault Control

- State why it is necessary to control the effects of faults.
- Describe how the effects of distribution feeder faults can be controlled using an overcurrent relay protective system and a feeder reclosing relay control system.

Transmission and Subtransmission Feeder Fault Control

- Describe how the effects of feeder faults can be controlled using an impedance relay protective system.
- Identify the difference between controlling the effects of feeder faults with an impedance system and controlling the effects of feeder faults with an overcurrent system.

Station Fault Control

- Describe how the effects of station faults can be controlled using a differential relay system
- Identify the differences between controlling the effects of station faults with a differential system and controlling the effects of station faults with an overcurrent protective system.

Source Circuit Fault Control

- Describe how the effects of source circuit faults can be controlled using a directional relay protective system.
- Describe how the effects of opens on a source circuit can be controlled using a voltage relay protective system.
- Describe how the duration of a source circuit outage can be minimized by an autoclosing relay protective system.

Routine Checks of Control Equipment

- List items typically checked during a routine inspection of substation control equipment.
- Identify what various fault indications mean.

HIGH VOLTAGE TERMINATIONS

COURSE DESCRIPTION

High-voltage cables are manufactured to exact specifications so that they can withstand a variety of mechanical and electrical stresses. When a high-voltage cable is terminated for a connection to a circuit or equipment in a substation or switchyard, the termination must also be made to exact specifications. If this is not done, the termination could become a weak point in the circuit.

COURSE GOALS

This program describes the components of high voltage terminations and demonstrates how high voltage terminations are made.

SUBJECTS AND OBJECTIVES

Cable Construction

- Describe how voltage stress can cause a cable to fail.
- Identify the main components of a high-voltage cable.
- Describe the function of each component of a high-voltage cable.

Principles of Cable Termination

- Explain how a high voltage termination provides voltage stress control
- Explain how a high voltage termination provides protection against tracking.
- Explain how a high voltage termination provides a seal to the environment

15-KV Class PILC Cable Preparation

- Identify the components of a PILC cable.
- Describe or demonstrate how to prepare a three-conductor PILC cable for termination.

15-KV Class PILC Cable Termination

- Describe or demonstrate how to build a stress cone on a three-conductor PILC cable.
- Describe or demonstrate how to attach connector stems.
- Describe or demonstrate how to install and assemble a pothead onto a cable.
- Describe or demonstrate how to seal a three-conductor PILC cable termination.

69-KV Solid Dielectric Cable Preparation

- Identify the components of a high-voltage solid dielectric cable.
- Describe or demonstrate how to prepare a single-conductor dielectric cable for a termination.

69-KV Solid Dielectric Cable Termination

- Describe or demonstrate how to apply the tapes used to make a termination on a single-conductor 69-KV solid dielectric cable.
- Describe or demonstrate how to install the insulator hoods and connector for a taped termination on a single-conductor 69-KV solid dielectric cable.

TRANSMISSION:

TRANSMISSION STRUCTURES

COURSE DESCRIPTION

Transmission lines and the structures that support them are key components to any transmission and distribution system. There are many different kinds of transmission structures, and each is designed to meet various power delivery needs and geographic considerations. Assembling and erecting a transmission structure requires planning, teamwork, and careful attention to detail.

COURSE GOAL

This training program describes the basic tasks and equipment used to assemble and erect several types of transmission structures. While transmission structures generally do not require routine servicing or maintenance, a knowledge of how they are designed and installed can be useful to anyone who works on or near transmission lines.

SUBJECTS AND OBJECTIVES

Introduction to Transmission Structures

- Identify and describe the two main types of metal structures used on transmission lines.
- Describe three types of structure configurations and explain when each type is typically used.
- Explain what a right-of-way is.
- Identify several considerations for transmission structure design.

Concrete Foundations

- Describe typical steps for preparing a job site for the installation of a concrete foundation.
- Describe basic steps for constructing and installing a concrete foundation.

Grillage Foundations

- Identify the basic parts of a grillage foundation.
- Describe the basic tasks involved in assembling and installing grillage foundations.

Lattice Tower Erection

- Describe the basic equipment and tasks commonly used to assemble and erect a lattice tower using a gin pole.
- Describe the basic equipment and tasks commonly used to assemble and erect a lattice tower using one or more cranes.

Tubular Steel Pole Erection

- Identify several common configurations of tubular steel pole structures.
- Explain how tubular steel poles can be assembled and erected using two basic pole section designs.

Structure Erection Using a Helicopter

- State two reasons for assembling a structure at a remote location.
- Describe, in general terms, how a transmission structure is installed using multiple locations and a helicopter.

TRANSMISSION LINE SAFETY

COURSE DESCRIPTION

The most important concern in transmission line work is accomplishing each job safely. Safety on the job requires making the effort necessary to control working conditions, work practices, and human actions. Personal injuries and equipment damage are minimized when safe work practices are followed and when the hazards associated with transmission line work are minimized or eliminated.

COURSE GOALS

This training unit will explore three major areas of safety associated with transmission line work: personal safety, electrical safety, and work site safety.

SUBJECTS AND OBJECTIVES

Personal Safety

- Identify and describe the types of clothing and protective equipment required for transmission line work.
- Describe how slipping, tripping, and falling hazards can be minimized.
- Describe how injuries can be avoided while loads are lifted and moved.
- Explain why attitude is important to working safely.

Electrical Safety

- Define the following terms: energized, isolated, and de-energized.
- Describe electrical hazards present in transmission line work and explain why they may be dangerous.
- Describe how an isolated or de-energized transmission line can present a hazard.
- Describe a typical procedure for grounding an isolated transmission line.

Work Site Safety

- Identify and describe general safety procedures that apply to most jobs.
- Describe steps that can be taken to ensure safety when a job involves climbing transmission structures.
- Describe steps that can be taken to ensure safety for transmission line work that involves rigging.

CLIMBING STEEL POLES & TOWERS

COURSE DESCRIPTION

Steel poles and towers used for transmission lines come in a variety of shapes, sized, and designs. Experience and practice are necessary in order to climb these structures safely and efficiently. This training unit presents a basic overview of the tools and equipment, planning, and techniques necessary for climbing steel poles and towers.

COURSE GOALS

This course will expose the student to proven safety techniques and practices for climbing steel poles and towers.

SUBJECTS AND OBJECTIVES

Climbing Equipment and Hazards

- List and explain some of the basic equipment used for climbing steel poles and towers.
- List and explain some of the typical hazards encountered on steel poles and towers.

Pre-Climb Planning and Inspection

- List and explain the purpose of the planning done at a tailgate session.
- List and explain some of the typical inspections made of equipment, tools, and structures prior to climbing.

Climbing Towers

- Describe basic techniques for ascending and descending lattice towers.

Climbing Steel Poles

- Demonstrate and explain some of the common techniques used for climbing steel poles.

Working from Steel Poles

- Demonstrate and explain the basic process for using a cable climbing belt to climb a specially equipped steel pole structure.
- Explain how ladders can be used to work from steel pole structures.

Working from Towers

- Demonstrate and explain some basic techniques for working from lattice tower structures.

TRANSMISSION LINE INSTALLATION

COURSE DESCRIPTION

Transmission line installation is a complex job that requires extensive planning, careful coordination or manpower and equipment, and a thorough mastery of construction procedures and techniques. This training program focuses on the part of that job involved with installing conductors on a structure.

COURSE GOALS

The tasks that are covered included planning the job, pulling wire, sagging wire, and clipping-in, which is the process of permanently attaching a conductor to a string of insulators.

SUBJECTS AND OBJECTIVES

Job Planning

- Explain some of the basic considerations for planning a transmission line installation job.
- Describe or demonstrate how to determine the length of wire needed for stringing, how to calculate the average span length, and how to calculate a ruling span.
- Explain what guard structures are and when they are used.

Job Preparation

- Explain the basic preparation necessary for stringing wire.
- Describe some of the basic equipment that must be assembled in preparation for stringing wire.
- Explain where the equipment necessary for stringing wire is generally placed on the section of line being strung.
- Explain why it is important to pull wire under tension.

Pulling Conductor

- Describe or demonstrate how a pilot line is pulled into position.
- Describe or demonstrate how a bull line is pulled into position.
- Describe or demonstrate how a conductor is pulled into position.
- Explain the basic concerns associated with the pulling process.

Sagging, Part 1

- Explain the purpose of sagging wire and basic considerations that must be taken into account when sagging wire.
- Explain the preparations that must be made in order to sag wire.
- Describe or demonstrate how a dynamometer can be used for sagging wire.

Sagging, Part 2

- Describe or demonstrate how a transit or a sagging scope can be used for sagging wire.
- Describe or demonstrate the stopwatch method of sagging.

Clipping-In

- Demonstrate and explain the basic process of clipping-in.
- Identify some additional items that may be installed on transmission lines.

RIGGING FOR HIGH VOLTAGE LINE WORK

COURSE DESCRIPTION

Maintenance work on transmission lines is frequently done while the lines remain energized. Working on energized lines saves money and allows for uninterrupted customer service. Live-line work is possible, in part, because of special rigging tools and equipment that have developed to allow linemen to do the work safely and efficiently.

COURSE GOALS

This training program focuses on some of the equipment and procedures used to rig for high voltage jobs. Emphasis is placed on the primary goals of rigging around high voltage equipment, and the uses of rigging techniques and equipment in practical rigging situations.

SUBJECTS AND OBJECTIVES

High Voltage Rigging Basics

- Define "safe working distance" as it applies to working around high voltage components.
- Define "load control" as it applies to rigging for high voltage work.
- Describe the three basic stages of a high voltage maintenance or repair job.
- Describe some of the basic rigging tools used for rigging around high voltage equipment.

Vertical Insulator Changeout: Tailgate Session

- Describe equipment placement and rigging that can be used to safely change out a vertical string of insulators on a wooden spar structure.
- Describe the tasks involved and the sequences of operations necessary to rig for a vertical insulator changeout.

Vertical Insulator Changeout

- Demonstrate the rigging techniques involved in safely changing out a vertical string of insulators on a wooden spar structure.

Inside "V" Insulator Changeout

- Describe the equipment placement and rigging necessary to safely change out a string of insulators in an inside "V" on a concrete "H" structure.
- Describe the tasks involved and the sequence of operations necessary to accomplish the changeout.

Running Corner Insulator Changeout

- Describe the equipment placement and rigging necessary to safely changeout a string of insulators on a running corner.
- Describe the tasks involved and the sequence of operations to accomplish the changeout.

Spar Arm Replacement

- Describe the equipment placement and rigging necessary to safely replace a spar arm on a wooden spar structure.
- Describe the tasks involved and the sequence of operations to accomplish the spar arm replacement.

WORKING ON DE-ENERGIZED TRANSMISSION LINES

COURSE DESCRIPTION

Transmission lines have characteristics that make them different from distribution lines. Because of the high voltages associated with transmission lines and the increasing use of multiple transmission lines on a given right-of-way, or even on individual structures, linemen who work on de-energized transmission lines need to be aware of some special considerations.

COURSE GOALS

This training program focuses on how to safely de-energize and isolate a transmission line. Specific attention is paid to how a de-energized transmission line can be made safe to work on, and how a transmission line can be safely restored to service.

SUBJECTS AND OBJECTIVES

De-Energizing, Isolating, and Tagging

- Describe the general procedures for de-energizing, isolating, and tagging a transmission line.

Induced Charges

- Describe how a de-energized line can become energized by magnetic induction.
- Describe how a de-energized line can become energized by electric induction.

Static Charges and Ground Systems

- Describe how a de-energized line can become energized by static electricity.
- Describe three transmission grounding systems.
- Describe how grounding minimized the dangers of induced and static charges.
- Describe how charges may continue to be present on a line at locations other than the point of grounding.

Field Clearance and Testing

- Describe the general procedures for obtaining a clearance on a transmission line.
- Describe how to test a transmission line to determine that it is de-energized.

Grounding

- Explain why it is necessary to ground a de-energized transmission line.
- Describe how to safely ground a transmission line.

Returning a Line to Normal

- Describe how to safely remove grounds from a transmission line
- Describe the general procedure for releasing a clearance.
- Describe the general procedure for switching a line back into service.

TRANSMISSION LINE REPAIR – HOT STICKS

COURSE DESCRIPTION

Taking transmission lines out of service for repairs or maintenance can be difficult and costly. For this reason, transmission lines are often worked on while they are energized. The two basic methods of working on energized lines are the bare hand method and the hot stick method. With the bare hand method, special tools and equipment allow direct contact with an energized conductor. With the hot stick method, insulated poles and other equipment are used to protect linemen from energized conductors.

COURSE GOAL

This training unit introduces the hot stick method and discusses what hot sticks are, how they are used, and how they are inspected and maintained. Emphasis is placed on safety considerations associated with the use of hot sticks.

SUBJECTS AND OBJECTIVES

Introduction to Hot Sticks

- Define "hot sticks".
- Explain the meanings of "potential", "safe working distances", and "minimum clearance" as they apply to hot sticks and hot stick safety.
- Recognize some of the basic types of hot sticks and hot stick accessories used for transmission line maintenance.

Planning the Job

- Explain the type of planning necessary to perform a job using hot sticks.
- Explain the purpose of the coating on hot sticks.
- Demonstrate and explain the basic requirements for inspecting and storing hot sticks.

Insulator Changeout (Suspension)

- Describe a basic procedure for changing out an insulator string in the suspension position on a spar pole structure.
- Identify the types of hot sticks used to change out the insulator string.
- Identify safety considerations associated with using hot sticks.

Insulator Changeout ("V" String)

- Describe a basic procedure for changing out a "V" string of insulators on a lattice tower.
- Recognize the use of basic techniques when using hot sticks to change out a "V" string of insulators.
- Identify and explain the basic considerations for safety on this type of job.

Insulator Changeout (Dead-End), Part 1

- Explain the planning considerations necessary to prepare for changing out a string of dead-end insulators on a lattice tower.
- Identify and explain the functions of the basic hot stick equipment needed to perform this type of job.
- Identify and explain the basic considerations for safety on this type of job.

Insulator Changeout (Dead-End), Part 2

- Explain the major tasks that must be accomplished in order to change out a string of dead-end insulators on a lattice tower.
- Describe the basic techniques of using hot sticks to perform these tasks.

TRANSMISSION LINE REPAIR – BARE HAND METHOD

COURSE DESCRIPTION

The increased demand for electricity in recent years has made it necessary for power companies to build more transmission lines and more extra high voltage (EHV) transmission lines. Taking these lines out of service for repairs or maintenance can be costly and difficult. As a result, lines are often worked on while they are energized. The two basic methods of working on energized lines are the hot stick method and the bare hand method. With the hot stick method, insulated poles are used to protect the linemen from energized conductors. With the bare hand method, special tools and equipment allow direct contact with an energized conductor.

COURSE GOAL

This training unit introduces the bare hand method and discusses some of the electrical theory, equipment and techniques that make bare hand work possible. Emphasis is placed on the safety considerations associated with bare hand work.

SUBJECTS AND OBJECTIVES

Introduction to the Bare Hand Method

- Explain the meaning of "potential difference" as it applies to bare hand work.
- Recognize where potential differences exist on a transmission line.
- Explain "safe working distance" (minimum clearances) as they apply to bare hand work.

Clipping In and Shunting

- Demonstrate the proper method of putting on a conductive suit to work safely on energized lines.
- Demonstrate and explain how a lineman becomes energized using the bare hand method.
- Explain how shunts are used to make a work area safe.

Planning and Inspection

- Explain the type of planning necessary to perform a job using the bare hand method.

Insulator Changeout, Part 1

- Identify and explain the basic tasks that must be accomplished on the "cold side" of the tower in preparation for changing out a "V" string of insulators.
- Identify and explain basic safety considerations that a crew follows while changing out insulators using the bare hand method.

Insulator Changeout, Part 2

- Identify and explain the basic tasks that must be accomplished on the "hot side" in order to change out a string of insulators using the bare hand method.
- Explain how a lineman comes off of an energized conductor using the bare hand method.
- Identify and explain the basic safety considerations as they apply to rigging, equipment, and personnel using the bare hand method.

Bucket Trucks and the Bare Hand Method

- Identify and explain the specialized equipment required to work from a bucket truck using the bare hand method.
- Explain the major tasks that must be accomplished and inspections that must be made on bucket trucks and bare hand equipment prior to doing a job.
- Explain how to safely energize a bucket truck.
- Identify and explain the basic tasks that must be accomplished to install or repair an armour rod from a bucket truck using the bare hand method.
- Recognize and explain some of the key safety considerations when working bare hand from a bucket truck.