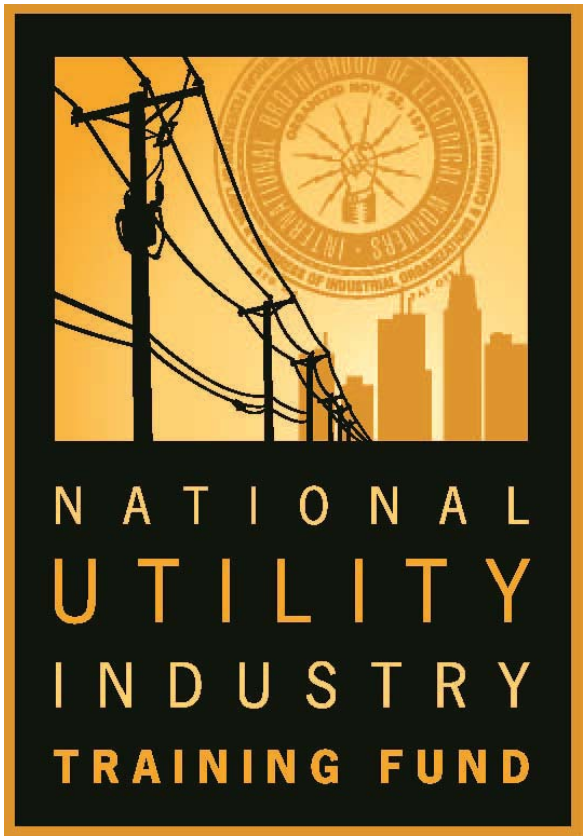
ELECTRICAL TRAINING ALLIANCE SUBSTATION APPRENTICESHIP

Third Year
Lesson Learning Objectives



signal, equipment to retrieve the communication signal, and the transmission line conductor that carries the communication signal.

Lesson Objectives

After completing this lesson, you will be able to:

1. Describe how a power line carrier system works and why it is used.
2. Identify the equipment needed for a power line carrier system.
3. Explain what function power line carrier equipment performs.

Lesson 6: Supervisory Control and Data Acquisition

Introductory Information

The United States operates on three electrical grids; one for the west coast, another for Texas, and a third for everything east of the Rocky Mountains. In order to operate these electrical grids, all the utilities and their substations must operate in sync. To maintain this operation, supervisory control and data acquisition (SCADA) equipment is used. A SCADA system allows a remote operator to monitor and control the status of the electrical equipment in a substation. The first SCADA systems were developed in the 1930s and have evolved tremendously since then. With present day developments in microcomputers, SCADA systems have become faster, smaller, and more efficient.

Lesson Objectives

After completing this lesson, you will be able to:

1. List the equipment required in a SCADA system.
2. Explain the functions of SCADA and why SCADA systems are used.
3. Describe how SCADA systems are configured.

Lesson 7: Short Circuit Analysis --- Testing for Distribution Line Faults

Introductory Information

When trouble occurs on a line, there are three steps to follow: determine the nature of the fault, locate the fault, and correct the condition. The first two of these three steps to be taken will be explained.

Lesson Objectives

After completing this lesson, you will be able to:

1. Name the three different types of line faults.
2. Explain the difference between the types of line faults.
3. Describe the methods used to locate line faults.

Lesson 8: Metering

Introductory Information

All utilities must monitor the production and sale of electricity to ensure they remain in business. Even a nonprofit cooperative must ensure enough revenue is generated from the sale of electricity to keep its

employees working and its overhead paid. Instrument transformers are used for revenue purposes or to ensure the substation remains operating within its limits. Instrument transformers include current transformers (CT) and voltage transformers (VTs or PTs).

Lesson Objectives

After completing this lesson, you will be able to:

1. Explain how metering is performed in a substation.
2. Describe the basic fundamentals of a current transformer and a voltage transformer.
3. Describe the installation practices of metering equipment.

Lesson 9: AC/DC Generators

Introductory Information

A substation control room is susceptible to outages just as the lines to customers are. The outages can be planned or due to an emergency. Either way, when the power goes out in a substation control building, the protection, communication, and control systems become powered by the substation batteries. This is acceptable for a while, but if the site is a remote or critical station that cannot be serviced in a timely fashion, a backup generator may be used to ensure that protection and control continues. A backup generator may also be used for the servicing of the station service transformer within a substation. Modern generators output AC and DC power, which makes them convenient in a substation where the AC power can run a building's heating, ventilation, and air conditioning (HVAC) while the DC can be directly wired to the station batteries.

Lesson Objectives

After completing this lesson, you will be able to:

1. Explain the basic components of a backup generator and how they perform station backups.
2. Describe the basic maintenance of a generator.

Lesson 10: UPS --- Uninterruptible Power Supplies

Introductory Information

Most industrial, commercial, and residential power distribution systems are primarily designed for lighting, HVAC, and motor loads. Information technology (IT) sites, offices, communications sites, and the general adoption of sensitive microprocessor-controlled devices have proven the need for isolating these loads from the inherently electrically "noisy" distribution system. Uninterruptible power supplies (UPSs) are sophisticated electrical devices that use utility power to synthesize a power source isolated and dedicated to the critical load equipment. When there is a power loss or severe disturbance to utility power, the UPS will continue supplying power to the critical load, drawing its energy from an alternative source until input power is restored.

UPSs range from small, single-phase units designed for use on personal computer equipment (200 VA–2 kVA) through medium-sized UPSs used for IT rooms and clusters of equipment in the office environment (5–100 kVA) to large installations such as IT sites or major facilities (200 kVA–1+ MVA).

Lesson Objectives

After completing this lesson, you will be able to:

1. Know what a UPS is.
2. Know what a UPS is for.
3. Be familiar with various types of power disturbances.
4. Be familiar with UPS types and configurations.

Lesson 11: Substations --- Batteries

Introductory Information

There are approximately 100,000 electrical substations operating in the United States, ranging in size from small rural units serving less than 100 customers to substations serving huge industrial complexes.

Most of these substations have an electrical backup system in order to operate equipment in case of a station outage. Substation DC auxiliary systems are typically used to supply loads such as relaying, supervisory, alarm, and control equipment. DC systems also supply emergency control house lighting and furnish power for circuit breaker trip and close circuits.

The batteries that provide electrical backup in substations should be studied, along with their purpose, connection, safety procedures, and maintenance.

Lesson Objectives

After completing this lesson, you will be able to:

1. State two types of load that substation batteries must support in case of a power outage.
2. List two voltages that are associated with substation batteries.
3. List three safety concerns associated with substation batteries.

Lesson 12: Substation Battery Testing

Introductory Information

Substation batteries perform a critical function in protecting substation equipment, circuits, and the continuous flow of power. The Institute of Electrical and Electronics Engineers (IEEE) has established universally-accepted standards for the testing and maintaining of substation batteries. The standards set forth by the IEEE will be discussed.

Lesson Objectives

After completing this lesson, you will be able to:

1. Explain how to complete voltage and resistance tests.
2. Explain how to complete a specific gravity test.
3. Explain how to complete integrity and capacity tests.
4. Explain how to complete an impedance test.

Lesson 13: Substation Battery Chargers

Introductory Information

A substation battery charger plays a key role in the DC control system. It converts AC power to DC and provides the normal DC power to the DC control system. It also provides the DC power necessary to maintain the substation battery at peak operating level.

Lesson Objectives

After completing this lesson, you will be able to:

1. Describe the functions and know the components of a substation battery charger.
2. Know the different types of charges available and when each type of charge is needed.
3. Explain how to conduct periodic inspections and make needed adjustments.

Lesson 14: Substation, Cell and Charger Replacement

Introductory Information

Substation DC control systems are critical to the protection of substation equipment and transmission and distribution systems. Therefore, the replacement of cells, batteries, and battery chargers is often done with the systems in service.

Lesson Objectives

After completing this lesson, you will be able to:

1. Describe how to replace a cell while continuing to provide DC protection to the system.
2. Explain how to replace a battery while continuing to provide DC protection to the system.
3. Describe how to replace a battery charger while continuing to provide DC protection to the system.

Lesson 15: Commissioning a Substation

Introductory Information

Before a new or expanded substation can be put into service, many tests must be performed. The term used to cover the necessary testing is “commissioning a substation.” Commissioning a substation can consist of numerous tests, from visual inspections to ensuring relays operate when a fault occurs. This is a good opportunity to test equipment before it enters service in order to establish baseline criteria against which to compare future testing data.

Lesson Objectives

After completing this lesson, you will be able to:

1. Understand why and when commissioning is performed.
2. List the equipment in a substation that requires commissioning.
3. Explain how to commission the supervisory control and data acquisition (SCADA) system.