Introduction and Overview to Power Distribution

Course 107

PARTICIPANT GUIDE

SIGNALS TRAINING CONSORTIUM

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Introduction and Overview to Signaling Power Distribution

Participant Guide

Signals Maintenance Training Consortium

COURSE 107

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Purpose of the Course

The purpose of the *Introduction and Overview of Signaling Power Distribution* course is to provide the participant with an introduction to signal power distribution. This introduction will include basic terminology, regulations and oversight specific to highway grade crossings, general highway grade crossing components, control circuits and warning systems.

Approach of the Book

This course begins with an outline, a statement of purpose and objectives, and a list of key terms. The *outline* will discuss the main topics to be addressed in the course. A list of *key terms* identifies important terminology that will be introduced in this course. *Learning objectives* define the basic skills, knowledge, and abilities course participants should be able to demonstrate to show that they have learned the material presented in the course. A list of *key terms* identifies important terminology that is introduced in this course. *Review exercises* conclude this course to assist the participants in reviewing key information.

Introduction & Overview to Signal Power Distribution

Outline

Outcome and Objectives:

Participants will be able to explain the principles behind power distribution for signal systems including basic terminology, regulations and oversight.

Following the completion of this module, the participant should be able to complete the exercises with an accuracy of 70% or greater:

- Identify the basic system and components for signaling power distribution
- Describe the principles of power distribution
- Explain power distribution schematics
- Explain types of backup power used in signal power distribution
- Identify and explain power phases

Key Terms

- Alternate power supply
- Alternating current (AC)
- Amperage
- Batteries
- Battery bank
- Battery Charger
- Buss bar
- Cable tray
- Cables
- Central instrument location (CIL)
- Central operation center
- Circuit breaker
- Commercial power
- Conductor
- Conduit
- Direct current (DC)
- Distribution panel
- Duct Banks
- Enclosure
- Fault
- Fiber optic cable
- Frequency converter
- Fuse
- Generator
- Ground detector
- Ground wire
- House Power
- Inverter
- Isolation Transformer
- Junction box
- Lightning arrestor
- Line loss
- Line side
- Load center
- Load side
- Mainline disconnect switch
- Manholes
- Polarity
- Pole-line cross arm
- Power fuse rack
- Power off relay (POR)
- Primary power supply
- Rectifier
- Relay rack
- Reverse Polarity
- Signal power
- Solar Chargers
- Solar panels
- Surge protector
- Tag
- Terminal board
- Three Phase Power
- Transformer
- Uninterruptable power supply (UPS)
- Utility meter
- Vaults
- Voltage
- Wires

1-1 Overview

All signal devices run on electricity. In order for signaling devices to operate as intended, a steady electrical power supply must be properly distributed and maintained for railroad operation and safety. Signal maintainers are often assigned to maintaining some equipment involved in power transmission and distribution for signal systems and related equipment.

In Course 107, Introduction and Overview of Signaling Power Distribution, signal maintainers will become acquainted with the components of power distribution, the principles of how power distribution works, the theory of operation through an examination of schematics, how to sectionalize power for maintenance and repair purposes, backup power distribution sources, power distribution safety and power distribution tools. This course will be the foundation for the later courses on inspection and maintenance as well as troubleshooting signaling power distribution.

1-2 The Signal Power Distribution Supply, System and Components

All modern rail signal systems operate by electrical power. This electrical power is either supplied by the rail agency, or as in most cases, supplied by an outside source such as a local power company and grid. Power distribution is comprised of two systems – primary and secondary or backup. **Primary power** is the normal power that is continually supplied to the system. In the event there is power interruption, the **alternate power source** designated as secondary or standby power, takes over. More on the system and theory of operation will be covered in the next section of this module.

Power distribution for signal equipment uses both **direct current** (**DC**) and **alternating current** (**AC**) power.

With a constant voltage pushing an electrical charge through a circuit and dependent upon resistance, a single direction DC current is produced. The combined constant voltage and one-way current is typically converted over to other forms of energy at some point. Most signal devices operate on DC voltages supplied by rectifiers and batteries at 30 volts or less.
AC power is what is delivered as primary power supply and mostly used for light bulbs and battery chargers. In the case of AC power, the voltage is switching polarity, or the current is switching direction back and forth. With primary power being delivered in AC voltage, in most cases for signal purposes AC voltage will need to be stepped down and current can be changed from AC to DC. This process and related components will be covered later in this section.
To better understand power distribution for signaling purposes, this section has been divided into categories that include:

- Primary Power Feed to the Signal System
- Basic Power Distribution Components
- Central Instrument Location and Wayside Cases
- Circuit and Equipment Protection

- Central Operation Center
- Solar Panels

Primary Power Feed to the Signal System

Electricity for the signal system must be delivered and maintained continuously. DC power is mostly supplied by rectifiers and batteries and will be discussed later in this module. On the other hand, AC power is typically supplied and purchased from a **commercial power company**. However, in some instances AC power is generated on-site by the rail agency.

Regardless of on-site generation or commercially supplied, AC power is transmitted by cable and wire throughout the signal system. In most agencies, the wires delivering primary AC power are above ground and delivered overhead via **pole-line crossarms**. However, some agencies receive primary AC power delivered through underground wires. Regardless of delivery method, rail agencies tap into the power where needed. The commercial power company or another department within the rail agency is usually responsible for the portion of the power supplied up to the point where power is delivered for specific signal purposes. **Transformers** (further described later in this module) are used to adjust currents and voltages to required levels.

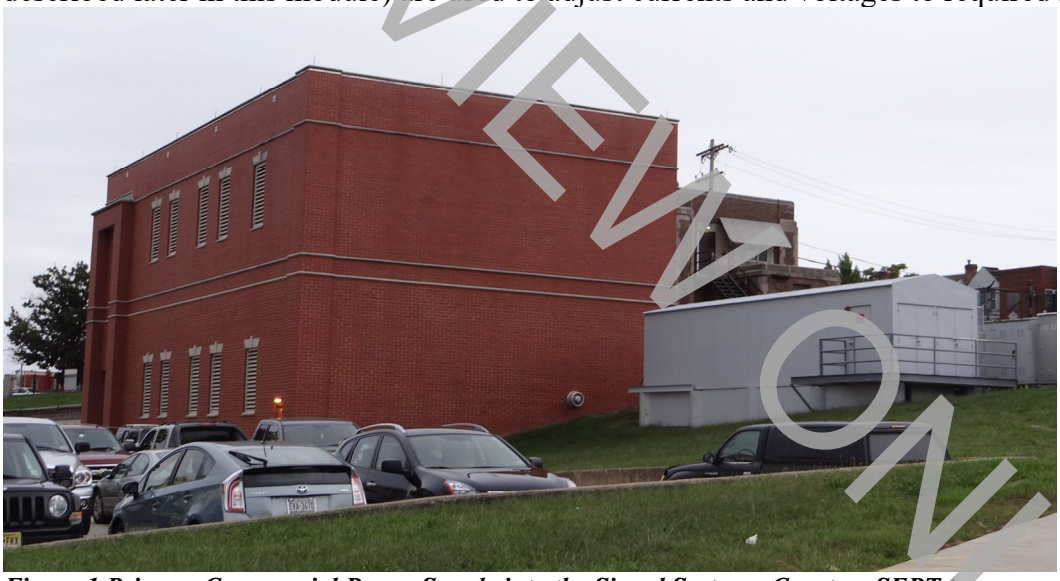

Figure 1 Primary Commercial Power Supply into the Signal System - Courtesy SEPTA

Voltage used will depend on the voltage supplied by the local power company, the distance the electricity must be transmitted and any transformer adjustment. Most AC voltages used in rail operations are 110, 220, 480, 550, and 2300 alternating at 60 cycles per second. While signaling components such as light bulbs and battery chargers operate on AC power, most signal devices operate on DC voltages lower than 30 volts. In this situation, supplied AC voltage is reduced using transformers and the current changed from AC to DC using **rectifiers**. In the space below and with help from your instructor, describe how primary power is supplied to the signal system in your agency.

