



# Auxiliary Power Supply and Battery Systems

## Introduction and Overview

**Course 104**

**PARTICIPANT GUIDE**

# Auxiliary Power Supply and Battery Systems

## Introduction and Overview

Course 104

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## Participant Guide

August 2016 DRAFT

Rail Car Training Consortium

# HOW TO USE THE PARTICIPANT GUIDE

## Purpose of the Course

Course 104: Introduction and Overview to Auxiliary Power Supply and Battery Systems provides participants with an overview to the principles of APS and battery systems as well as preparing to work on those systems in a transit railcar maintenance facility.

## Approach of the Book

Each course module 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 module. A list of *key terms* identifies important terminology that will be introduced in this module. *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 module. *Exercises* are built in throughout the course materials to assist the participants in learning and reviewing key information.

PREVIEW ONLY

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# MODULE 1

## General Safety Procedures

### Outline

- 1-1 Overview
- 1-2 Electrical Hazards
- 1-3 Chemical Hazards
- 1-4 Mechanical Hazards
- 1-5 Personal Protective Equipment
- 1-6 Safe Practices
- 1-7 Summary

### Purpose and Objectives

The purpose of this module is to provide participants with an overview to the electrical, chemical, and mechanical hazards that are evident in a rail vehicle maintenance facility.

Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Describe the dangers of working around high voltage
- Explain Arc Flash, Arc Blast
- List the degrees of current the human body can tolerate
- Explain Lockout/Tagout
- Explain basic OSHA High Voltage electrical standards
- Recognize safety hazards with NiCad batteries.
- Recognize safety hazards with electrolytes in batteries.
- Recognize safety hazards with moving machine parts.
- Describe PPE required practices
- Explain vehicle work area set up
- Describe the 'one hand' rule for working on electrical equipment
- Describe the human physiological reactions to electrical shock
- Identify the high voltage components and connection.

### Key Terms

- |              |                       |                              |
|--------------|-----------------------|------------------------------|
| • Acute      | • Chronic             | • Falls                      |
| • Arc flash  | • Electric shock      | • PPE                        |
| • Burns      | • Electricity Arcs    | • Sulfuric Acid              |
| • Cadmium    | • Electrocutation     | • Teratogen                  |
| • Carcinogen | • Electrolytes        | • Ventricular defibrillation |
|              | • Engineering Control | • Work Practice Control      |

# MODULE 2

## POWER COLLECTION AND SHOP POWER

### Outline

- 2-1 Overview
- 2-2 Power Collection
- 2-3 Shop Power
- 2-4 Summary

### Purpose and Objectives

The purpose of this module is to provide participants with an overview of power collection, its distribution in the rail vehicle and in the maintenance shop.

Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Identify input sources of power to a rail vehicle.
- Explain and differentiate between input and grounding.
- Recognize high and low voltage systems in a rail vehicle.
- Diagram the flow of power from high voltage to low voltage in a rail vehicle.

### Key Terms

- Catenary
- Collector Shoe
- Intermediate Voltage Power Supply (IVPS)
- Knife Switch
- Low Voltage Power Supply (LVPS)
- Pantograph
- Running rails
- Shop Power
- Stinger
- Third Rail
- Three-Phase Inverter (TPINV)

# MODULE 3

## AUXILIARY POWER SUPPLY

### Outline

- 3-1 Overview**
- 3-2 Configuration of APS**
- 3-3 Intermediate Voltage Power Supply**
- 3-4 Three-phase Inverter**
- 3-5 Low Voltage Power Supply**
- 3-6 Summary**

### Purpose and Objectives

The purpose of this module is to provide participants with an overview to the conditioning of power in the rail vehicle's auxiliary power supply system in order to supply DC and AC power to the vehicle's onboard electrical needs.

Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Discuss the concept of power conditioning with respect to the rail vehicle's auxiliary power supply system.
- Identify the three main capacities in the auxiliary power supply.
- Identify major components and devices within each main area of the auxiliary power supply.

### Key Terms

- Auxiliary Power Supply (APS)
- Chopper
- Control Circuit
- Converter
- Diode
- Fan Unit
- Gate Turn Off/On (GTO) Thyristor
- Insulated Gate Bipolar Transistor (IGBT)
- Intermediate Voltage Power Supply (IVPS)
- Inverter
- Low Voltage Power Supply (LVPS)
- Power conditioning
- Silicon Controlled Rectifier (SCR)
- Smoothing Circuit
- System Controller
- Three-Phase Inverter (TPINV)
- Thyristor
- Transformer



# MODULE 4

## BATTERIES

### Outline

- 4-1 Overview
- 4-2 Principles of Battery Operation
- 4-3 Battery Configuration
- 4-4 Battery Charger
- 4-5 Summary

### Purpose and Objectives

The purpose of this module is to provide participants with an overview to battery systems used on U.S. passenger railcars.

Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- List major components of a NiCd battery
- Specify the relationship between batteries and low voltage power supply
- Discuss purpose of batteries in a rail vehicle
- Identify principles of battery operation
- Identify battery peripherals, battery management systems, chargers, etc.
- Identify battery cells, voltage.

### Key Terms

- Anode
- Banks
- Battery box
- Cathode
- Electrode
- Electrolyte
- Interconnecting cables
- Ions
- Nickel-Cadmium (NiCd)
- Oxidation Reaction
- Pole
- Straps (links, buss bars)
- Vented cap

# MODULE 5

## TOOLS

### Outline

- 5-1 Overview
- 5-2 Meters
- 5-3 Hand Tools and Miscellaneous Materials
- 5-4 Diagnostic Tools
- 5-5 Summary

### Purpose and Objectives

The purpose of this module is to provide participants with an overview to some of the common hand and diagnostic tools used in the maintenance of auxiliary power supply and battery systems on a transit railcar.

Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Identify a multimeter and specify its use.
- Identify other tools: laptops to test and diagnose inverter systems.
- Identify other hand tools such as wrenches, sockets, screwdrivers.
- Identify electrical meter safety requirements and standards

### Key Terms

- Megohmmeter
- Micrometer
- Multimeters
- Portable Testing Unit (PTU)
- Profilometer
- Volt-Ohm Meters (VOMs)