RAIL VEHICLE LEVEL 200
SUBJECT OVERVIEW

Module: 204 – Auxiliary Inverters & Batteries

Note: All 200 level courses should be delivered only after completion of 100 level training

About the Author: Phil Lowe

Phil Lowe, who is currently a First Class Electrical/electronic maintainer at Southeastern Pennsylvania Transportation Authority (SEPTA), has 1 year of instruction at Camden community college and over 30 years of experience in rail car operations including work in a running car house and heavy maintenance repair shop. In these positions he has been responsible for troubleshooting and repairs for the outgoing line and electrical vehicle overhaul of light rail vehicles, respectively.

Having proven abilities in a wide range of technical skills on rail vehicles, Mr. Lowe is considered a Subject Matter Expert (SME) and shares his knowledge with the industry – locally and nationally. Locally he has mentored and instructing incumbent and new employees and worked on the rail work group for the Keystone Transit Career Ladder Partnership. In this capacity he Reviewed skill gap analyses, maintained minutes for rail work group, tracked promotions and new hires in the rail department, reviewed and updated mentoring procedures, evaluate trainees, review test material with test monitors, interfaced with production staff, developed and review curriculum and courseware, reviewed classification responsibility for TWU employees and job descriptions, reviewed budgets, recommended training aids and attended project steering committee meetings.

Nationally, Mr. Lowe currently serves on two groups whose main mission is to create a nationally recognized system of training and qualifications for rail vehicle maintenance technicians: The Joint National Transit Rail Vehicle Training Standards Committee and the Transportation Cooperative Research Project's E-7 Panel.

Overview/Purpose

This material provides a general overview of rail vehicle auxiliary inverters and batteries to give technicians a basic introduction to the subject and prepare them for national qualification testing. Material presented here is intended only as a primer to rail vehicle auxiliary inverters and batteries and follows the National Training Standards established jointly by representatives from both labor and management.

As a primer additional knowledge will be needed to become fully qualified on this subject. Material presented here does not address every possible aspect of every vehicles auxiliary inverter and battery systems because these aspects vary slightly between rail car designs and manufacturers. Supplemental courseware and other resources to help technicians become qualified on this subject are listed below.

Table of Contents

Suggested Tools/Training Aids:

- power point presentations
- transparencies
- manuals
- schematics
- mock-up/live-coupler
- video/animations
- Schematics
- lap top computer
- multi-meter
- clamp-on amp meter
- oscilloscope/o-scope
- tools listed in L.O.s

Topics Covered:

Topics listed below are covered in this introduction of Couplers. A full copy of the National Training Standards from which these topics were taken is attached.

- Batteries
- Motor Alternator
- Solid State Inverter
- Battery Charger/LVPS
- Tools

Definitions, Abbreviations and Acronyms

For the purposes of this lesson, the following glossary of terms, definitions, acronyms, and abbreviations shall apply. They are not all inclusive, and the reader is encouraged to explore the text, footnotes and bibliography sources for further information.

- **ATM:** Standard Atmosphere
- **AUX:** auxiliary
- **CFM:** Cubic Feet Per Minute
- **Com:** Commutator (DC motors)
- **DC:** Direct Current
- **DMM:** Digital Multi-meter
- **GTO:** Gate Turnoff Thyristor
- **IGBT:** Insulated Gate Bi-polar Transistor
- **NiCd:** Nickel Cadmium
- **OEM:** Original Equipment Manufacturer
- **LVPS:** Low voltage power supply
- **PM:** Preventative Maintenance
- **PPE:** Personal Protection Equipment
- **RMS:** Root Means Squared
- **RPM:** revolutions per minute
- **SCR:** Silicone Controlled Rectifier
- **SG:** Specific Gravity
- **VOM:** Voltage Ohm Meter

Introductory Text by Topic Area

i. Batteries

Introduction to Batteries
Batteries are a source of **DC** power which store energy through the interaction of **positively** and **negatively** charged **poles**. The area between these poles can either be made of liquid or gel – resulting in **wet** or **dry** cell batteries, respectively. This material is **caustic** and should be handled with care. Sufficient **PPE** should be worn while dealing with batteries and batteries should always be well **ventilated** as they do give off a dangerous gas.

For transit rail vehicle systems the two most commonly used batteries are **NiCd** and **Lead Acid** Batteries – explored more below. While connected to a running rail vehicle, these batteries are generally **charged** at 1.5 to 2 volts above operating voltage. For example if 10 volts are needed to run a system, the charge being transmitted will be 11.5 to12 volts.

Single cell battery connected to form block

Batteries in transit systems come in two different types:

1. **Block style** – 5 individual cells put together in a casing(ex: car battery)
2. **Individual cells** – looks like 1/5 of a block style battery. It has the same lay out but is a different size

NiCd Battery Introduction

While Nickel Cadmium batteries (NiCd) come as both a wet and gel cell battery, **wet** cells are used by transit agencies and will therefore be the focus of this material. One example of a gel battery is the sort that you would use in an everyday camera.

Individual cell transit battery in a battery tray

Wet Cell NiCd Batteries come in two types:

1. **Single/Individual cells** – These batteries carry **1.2 volts** of DC power. In order to minimize stocking needs, most transit agencies are starting to use single cell batteries to build the battery they need. Although transit agencies differ by the equipment they use, most systems are 12, 24 or 36 volts. The battery load needed is determined by the auxiliary running circuits (tracks brakes, sanders, etc.).
2. **Mono-block** – a mono-block battery is a series of 5 single cell batteries banded together

Inspecting and Maintaining NiCd Batteries

Check and verify battery specifications
Each individual rail vehicle will have different battery specifications having to do with physical size, voltage outputs and current outputs. The specifications can be found in the Heavy maintenance manual for the specific rail vehicle. Once these specifications are found they are tested in the following ways:

1. **Physical size** – Determine if batteries fit into the allotted space – usually known as the **battery tray**. This has more to do with the current storage capability needed for the operation of the rail vehicle.
2. **Voltage Outputs** – Use a DMM digital multi-meter (or Voltage Ohm Meter (VOM)) to verify voltage.
3. **Current Outputs** – To measure the current output. You can use a clamp-on amp meter on the system while it is running or you can break the circuit and put a DMM in line with the load.

Cleaning NiCd batteries and connections

NiCd batteries will generally be cleaned under two different circumstances:

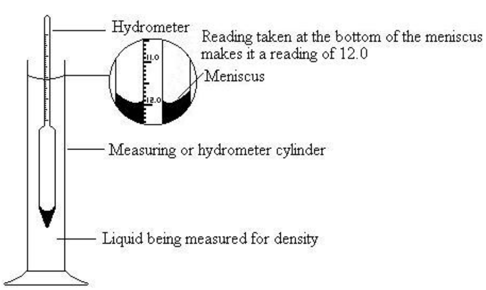
1. **Preventive Maintenance** – The system should be periodically inspected through preventative maintenance (PM). The frequency of PM examination will differ by location. During a PM examination, maintainers should inspect for **operation** and **cleanliness**. Operation is checked by making sure that all **connections** are tight. Cleanliness is determined by a **visual** inspection. Sometimes white powder will collect on the battery and battery terminals – this is a sign of **corrosion**. Corrosion is the disintegration of materials due to chemical reactions with its surroundings.

Corrosion on Batteries

2. **Service Failure/Dead Battery -** When there is a service failure and the rail vehicle will not start,(dead car) the battery circuit is the first thing that should be inspected. If there is a charge within the battery but it is not being relayed to the system the connection may be bad. In this case the connections should be checked and the terminals should be cleaned.

To clean a NiCd battery, simply use **water** and a clean dry **rag** or **dust brush**. DO NOT use a wire brush to clean a NiCd battery.

As batteries contain **electrolytes** which will **burn** your skin, take care to use sufficient **PPE** such as a **face shield** and **rubber gloves**. Also make sure the space you are working in is well ventilated and that there are no **flammable** substances nearby. Some agencies will have **designated areas** used to clean and maintain batteries.



Checking NiCd batteries specific gravities

Specific Gravity is not normally checked in the field – but upon initial manufacturing or filling in the field as the measurement changes as it is used. This is not checked on periodic inspection as it is difficult to do and can be misleading

Specific gravity (SG) is the **density** of the **electrolytes** within the wet cell of a battery as compared to the density of **water**. Optimal SG for a NiCd battery is **1.7**atm or 1.7 times as dense as water. As batteries age electrolytes **deteriorate** and the SG **decreases**. Since the electrolyte is the medium by which the two poles are separated, it is important to make sure that