Auxiliary Power Supply and Battery Systems

Inspection and Maintenance

Course 204

PARTICIPANT GUIDE

RAIL CAR TRAINING CONSORTIUM

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MODULE 1

General Inspection and Maintenance

Outline

Purpose and Objectives

The purpose of this module is to provide participants with an overview of the principles of maintenance of rail car auxiliary power supply units and batteries.

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

- Differentiate between scheduled and unscheduled maintenance
- Identify Line Replaceable Units
- Explain preventive maintenance practice
- Explain importance of keeping accurate maintenance records

Key Terms

- Computerized Maintenance Management System (CMMS)
- Line Replaceable Unit (LRU)
- Authority Having Jurisdiction (AHJ) Reactive Maintenance
- Preventive Maintenance
- Predictive Maintenance
- Portable Test Unit (PTU)

1-4 KEEPING RECORDS

Keeping records is your transit authority's official process of documenting inspection and maintenance. Each transit authority typically logs inspection, maintenance, replacement and repair records in some form of a database that can be retrieved or prepared in a report. Many agencies use a form of **computerized maintenance management system** or CMMS.

Various computerized systems are used across transit authorities. The following table presents a list of some Consortium agencies and the CMMS they use.

Transit Agency City	Maintenance Recording System
SEPTA, Philadelphia	VEMIS
RTD, Denver	MAXIMUS
GCRTA, Cleveland	UltraMain
MBTA, Boston	MCRS. Inspection discrepancy recorded on paper.
BART, San Francisco	MAXIMO

Some typical functions of a CMMS may include the following:

- Generating and prioritizing work orders.
- Tracking history of work orders by equipment, date, technician
- Tracking scheduled and unscheduled maintenance activities.
- Storing maintenance procedures by OEM warranty on equipment
- Storing manuals and other technical documentation or procedures by component.
- Storing agency-specific documentation or procedures.
- Controlling inventory so that parts can be reordered.

Figure 1.6 shows a screen shot of Denver's RTD Maximus™ software showing the history of maintenance on a specific light rail vehicle. This CMMS is capable of tracking, managing, and assigning work orders among other functions.

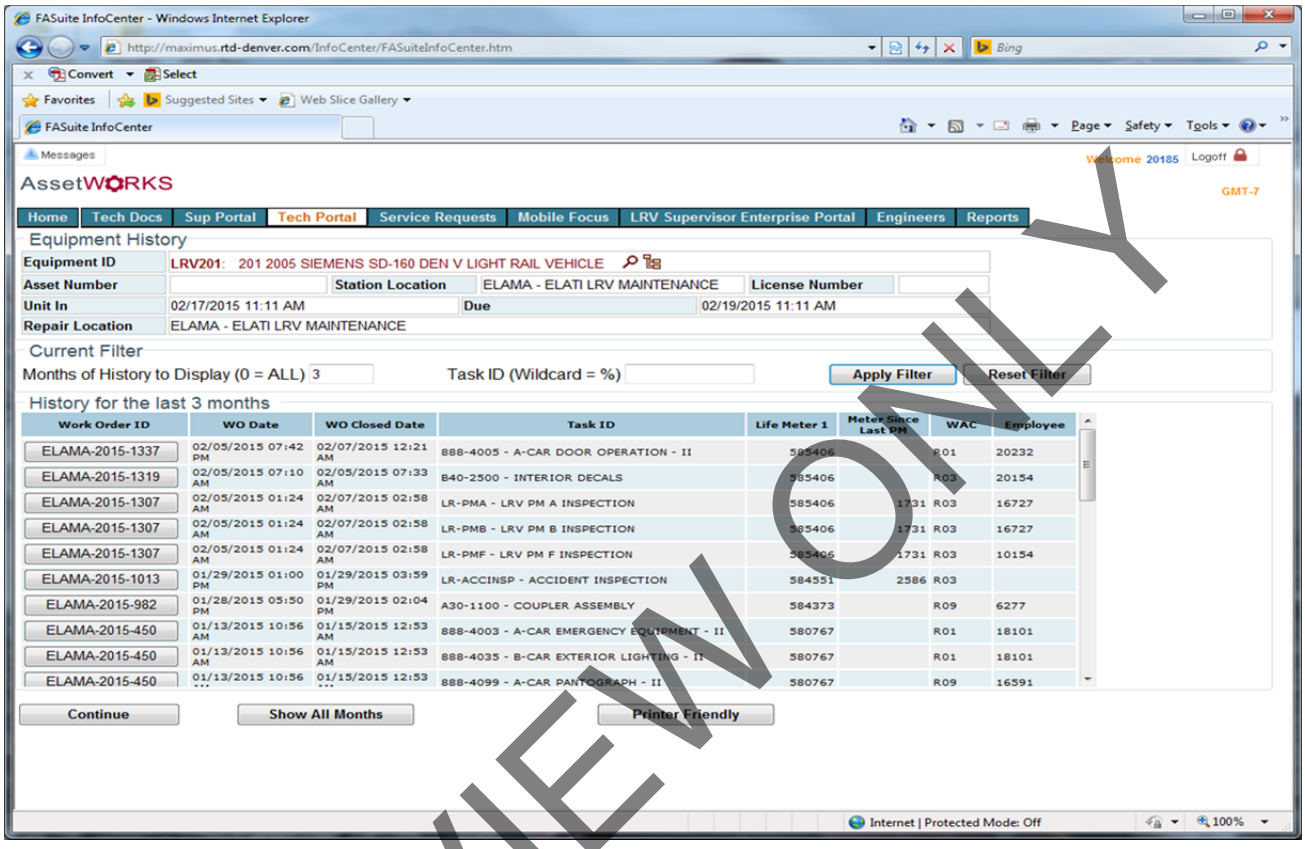


Figure 1.6 Screen Showing History of Work on Specific LRV –courtesy Denver RTD

Follow your specific transit authority procedures regarding their specific policies regarding documentation.

Activity 1.4

What are your agency's procedures for recording inspection and maintenance activities on APS units and batteries?

1-5 SUMMARY

This module differentiated between unscheduled and scheduled maintenance. The rail car technician is expected to work within both types of methods and this module emphasized the importance of scheduled maintenance not only to keep equipment working properly and to extend the life of equipment, but ultimately for the safety of those who use rail transit.

This module highlighted the importance of maintenance schedules and keeping records while giving examples of PM sheets used by several transit agencies.

MODULE 2

Auxiliary Power Supply Systems

Outline

Purpose and Objectives

The purpose of this module is to prepare participants to perform inspections and basic maintenance on the auxiliary power supply units found on many U.S. transit rail cars.

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

- Perform maintenance of APS components including:
  - Capacitors
  - Electronic Controls
  - Ventilation
  - IGBTs
- Perform function tests with portable test units
- Remove and install line replaceable units

Key Terms

- Control Boards
- Line Replaceable Unit (LRU)
- Portable Test Unit (PTU)
- Printed Circuit Board (PCB)
- Sensory Inspection
- Temperature Overload
- Temperature Sensor
- Three phase AC blower motor

2-1 OVERVIEW

Recall from Course 104: Overview and APS and Battery Systems that a rail car's auxiliary power supply unit is generally divided into three areas: the **Intermediate Voltage Power Supply (IVPS)**, the **Inverter/Three-Phase Inverter (TPINV)**, and the **Low Voltage Power Supply (LVPS)**. APS configurations vary by the original equipment manufacturer (OEM). Figure 2.1 and Figure 2.2 show two configurations of APS systems.

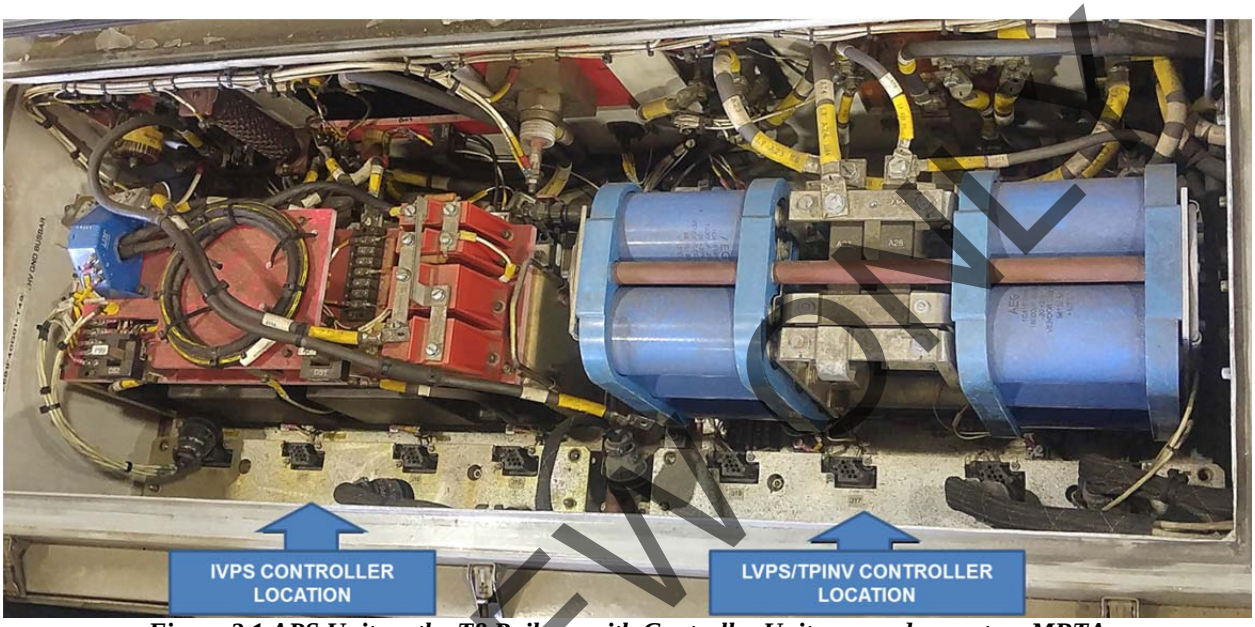


Figure 2.1 APS Unit on the T8 Rail car with Controller Unit removed –courtesy MBTA

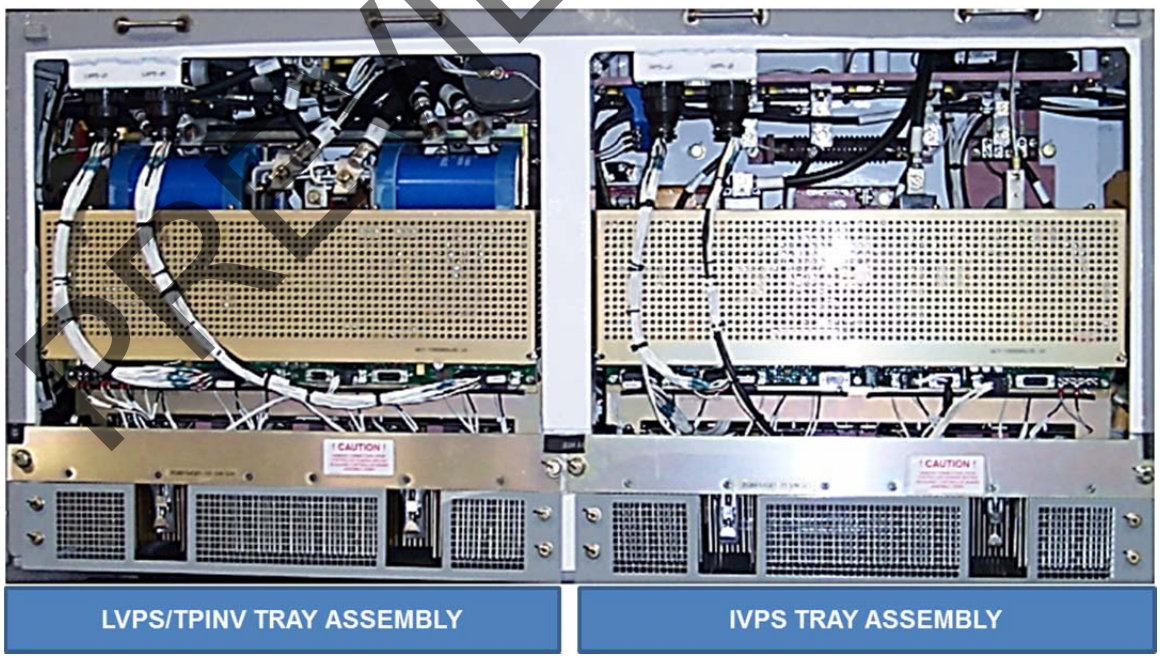
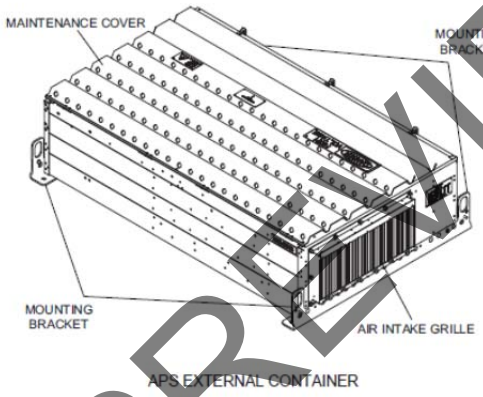


Figure 2.2 LVPS/TPINV and IVPS Tray Assemblies –courtesy BART

Each rail agency has its own established methods of inspecting and maintaining APS systems on their rail cars. In the following example, one transit agency follows OEM recommendations for inspecting and maintaining the APS unit on the outside (external) and inside (internal).

APS External Case

1. Observe all safety instructions and safety procedures.
2. Inspect the container for external damage to the maintenance cover, air intake grille and mounting brackets. Replace damaged parts if necessary.
3. Check that the two ground terminals are secured tight.
4. Clean the warning signs on the covers, using mild detergent and lint-free cloth.
5. Inspect the labels for condition and security. Defective label must be renewed.
6. Report any faults and deficiencies found to the supervisor.



APS Internal Structure

1. Observe all safety instructions and safety procedures.
2. Open maintenance cover.
3. Check gaskets for porosity and brittleness. Defective gaskets must be replaced in every case.
4. Check the complete interior of the container for ingress of dirt or water.
5. Inspect components:
   a. Check all APS's components for possible damage, such as discoloration or obviously mechanical damage. Check particularly power modules, control units, magnetic components, fans, voltage and current transducers.
   b. Faulty components must be replaced.
6. Inspect electrical connections:
   a. Check the APS's internal cable system.
   b. Check the connections of the power cables. Control the solid connection of the cable lugs.
   c. Check the Connectors (male & female part) for any corrosion, discoloring, proper electrical contact and also proper tightening of the connector's fastening screws.
7. Check control and power wiring for mechanical damage and rectify any defects noticed.
8. Check all electrical connections are secured tightly and check all electrical connections for proper contact and tightness.
9. Clean the seals before you close the container. Grease the seals with paraffin oil.
10. Close the maintenance cover.
11. Report any faults and deficiencies found to the supervisor.

Source: Light Rail Vehicle Auxiliary Power Running Maintenance and Servicing Manual, SDMTS

2-4 LVPS AND TPINV MAINTENANCE WITHIN APS

In Course 104, Introduction and Overview to APS and Battery Systems, participants learned that the APS system includes the low voltage power supply (LVPS) and three-phase inverter (TPINV) sub-systems. The participant should recall that these sub-systems supply lower voltage needed by the control equipment and charging the battery system. Much of the maintenance of an LVPS is cleaning its components. In Course 304 which follows this course, the participant will learn to troubleshoot and replace LVPS subsystems within the APS.

The following is an overview of steps to take for inspecting and cleaning the LVPS.

1. Follow safety procedures.
2. Inspect seals on all covers.
3. Lubricate rubber seals.
4. Inspect internal compartments for water ingress.
5. Inspect major electrical connections.
6. Look for broken torque seals.
7. Inspect electrolyte capacitor for oil leakage.
8. Inspect circuit board connections. If loose, secure connections.
9. Inspect and clean vents replacing filters as necessary.
10. Inspect and clean heat sinks (use compressed air).
11. Inspect and clean magnetic components for dust or dirt. Wipe and clean as necessary.
12. Inspect mounting hardware and external enclosure for corrosion and rust. Clean off rust and, where applicable, apply dielectric lubricant.
13. Connect low voltage power.
14. Download event logs using the PTU (OEM datasheet).
15. Check temperature sensor per OEM recommendation.

2-5 SUMMARY

This module guided the participant through the essential steps in performing inspection and maintenance of APS units and batteries.

MODULE 3

Batteries

Outline

Purpose and Objectives

The purpose of this module is to prepare participants to perform inspections and basic maintenance on batteries found on many U.S. transit rail cars.

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

- Perform visual and electrical tests of battery cells
- Identify good vs bad cells in batteries
- Inspect and perform maintenance of NiCd Batteries:
    - Check and verify battery specifications
    - Clean NiCd Batteries and connections
    - Check NiCd battery voltages
    - Check liquid level of cells
- Perform maintenance battery breaker disconnect
- Inspect battery breaker disconnect
- Replace battery breaker disconnect

Key Terms

- Battery Capacity
- Standard Maintenance Procedure (SMP)

Charging Voltage

- The battery is presumed to be fully charged and the charger is in the float charging mode. Check overall charging voltage. The charger should be no more than 1% from its correct float charging level.
- Check individual cell voltages. Record (if required by your SOP). The cell voltages should be quite even and must not deviate more than ± .02 volts (20mV) from the average cell voltage. In lieu of voltage readings, a visual inspection for gassing activities (bubbling) may be performed. It will require experience and good eyesight to make a meaningful observation.
- On float charge, the gassing should be minimal but even in all cells. Tiny bubbles should be present on the plate surface as well as in the 1/8" layer of oil floating on top of the electrolyte.

Dirt Accumulation

- The battery should be relatively clean and dry with no more dust accumulation than other equipment in the same enclosure. Wipe off with a damp cloth. Excessive accumulation of salts (dried KOH) on cell top could be an indication of overcharging, an insufficient amount of oil on top of electrolyte or cracked or damaged vent caps, washers and seals.
- Compressed air and, if necessary, water is recommended to remove dust and dirt, and any grayish white deposits from the battery box. Use only plain water for cleaning. A soft nonmetal brush and/or lint-free cloth may also be used.

See video on Battery Inspection, Cleaning, and Filling https://vimeo.com/186012282 Last accessed 11-03-2016

Activity 3.1

What are your agency's procedures for routine NiCd battery inspection and maintenance?

The maintenance procedure for NiCd battery systems includes the following steps:

1. Disconnect input power and unnecessary load(s).
2. Check battery box (resilient), mounting hardware and shoring/blocking in accordance with SMP.
3. Clean batteries in accordance with SMP.
4. Inspect battery casings for damage and signs of leakage or residue in accordance with SMP. Inspect for leaks, corrosion, discoloration, bulging, cracks, physical damage, leaks. Note any strong chemical smells.

Figure 3.1 Leaking Battery Cell –courtesy BART

5. Inspect individual battery cells for proper electrolyte levels (and replenish as needed) in accordance with SMP.
6. Insure batteries are fully charged in accordance with OEM instructions/SMP.
7. Check individual cells. Check for shorted cells in accordance with SMP. Measure with voltmeter.
8. Inspect inter-cell and connection (straps, link, bus bars) and all series connections in accordance with SMP.
9. Inspect mounting hardware and make sure shoring/blocking is secure.
10. Reconnect input power and load.
11. Check battery charger output charging rates (and temperature compensator if applicable) in accordance with SMP.
12. Replace components as needed that do not meet specifications.
13. Record data as required.

Safety Precautions!

Do not lay any tools or metal parts on top of battery cells as this action may cause an arc that can ignite gases.

Disposal/storage

Follow OEM and standard maintenance procedures which assure compliance with applicable federal, state, and local regulations governing hazardous waste.

Replacement programs

Upon completion of useful life cycle period, change out shall be accomplished in accordance with OEM instruction or standard maintenance procedure.

3-4 SUMMARY

This short module provided step-by-step instructions on the proper maintenance of NiCd batteries on transit rail vehicles. Topics on maintenance of battery breaker disconnect and battery maintenance schedules were also discussed.

SOURCE

1. Maintenance of Saft Railroad NICAD® Batteries. http://www.xrail.com/PDF/RRMaintManual%20SPL-SCM%2009-07.pdf. Retrieved September 28, 2016.