



Course 304

Auxiliary Power Supply and Battery Systems Troubleshooting and Repair

Module 2: Troubleshooting APS Systems

INSTRUCTOR GUIDE

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PREVIEW ONLY

Checklist for Instruction

- ✓ Confirm the training dates, location, and number of participants.
- ✓ Ensure you have all materials listed in the section **Materials for Instruction**.
- ✓ Read and study the Instructor Guide, PowerPoint presentation, as well as any manuals pertaining to troubleshooting batteries at your rail transportation agency.
- ✓ If using case studies, review ahead of time and select the most appropriate cases studies for your audience.
- ✓ Familiarize yourself with the Participant Guide or coursebook.
- ✓ Collaborate with local host/coordinator to determine who will print the following (available on website):
- ✓ Certification of completion for each participant.

Supplies, Audio-Visual Equipment, Internet Access

The following is important for the adequate delivery of this course:

- ✓ LCD projector compatible with a notebook computer and cables for proper connection
- ✓ Computer with software to run Microsoft PowerPoint
- ✓ Electronic remote device to advance slides in PowerPoint presentation, if available
- ✓ Projection screen (at least 6' x 6')
- ✓ Pointer (preferably laser type)
- ✓ Twenty-foot or longer extension cord
- ✓ Dry erase board with dry erase markers and eraser, if available
- ✓ Flip chart with markers
- ✓ Supplies such as pencils, note pads, markers, highlighters.
- ✓ You may need Internet access.

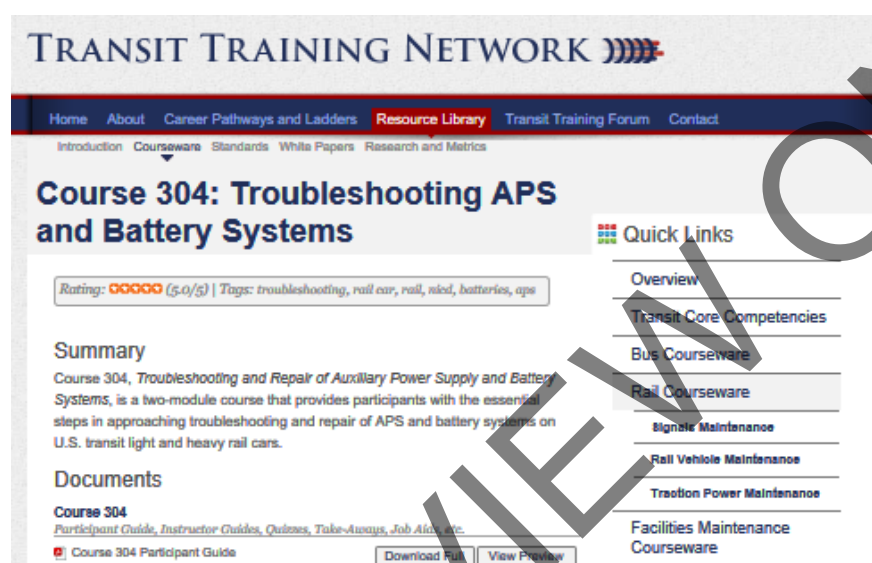
All equipment should be placed and tested in the room. The instructor should check at least one hour prior to the first day of the course.

Follow these steps to download all instruction materials for this course.

All materials can be downloaded from www.transittraining.net. Click this [link](#).

- Click on the **Resource Library** tab.
- In lower right under **Useful & Helpful Links** click on **Courseware**.
- In middle right under **Quick Links** click on **Rail Courseware**.
- Click on **Rail Vehicle Maintenance**.
- Scroll down to **Course 304: Troubleshooting APS and Battery Systems**

Follow relevant links to download files.



1 Screen Print of Transit Training Network

Overview to Module 2

- Duration of this module: 142 minutes (2 hours 22 minutes)
- PowerPoint slides: 16
- This module has a quiz for participants.
- At the end of this module, participants need to complete the **Post-course Assessment**. This helps gauge their progress. Please return their responses to the Transportation Learning Center, attn.: Xinge Wang. xwang@transportcenter.org

Learning Objectives for Module 2

Following the completion of this module, the rail car technician should be able to:

- Apply troubleshooting principles to the battery charger and LVPS
- Identify probable causes of NiCd battery malfunction and repair NiCd Batteries
 - Replace NiCd batteries
 - Charge NiCd batteries
 - Troubleshoot shorted cells
 - Diagnose charging rates and non-charging rates


Outline of PowerPoint Presentation for Module 2

Topic Title	Slides	Duration (Minutes)
Overview	1-4	7
Troubleshooting Common Reported Problems	5-10	80
Troubleshooting Reduced Battery Performance	11-13	30
Summary and Quiz	14-16	25
		142 Minutes


Slide 5

Troubleshooting and Repair of APS and Battery Systems

Common Reported Problems



- Emergency lighting activation
- Ground fault
- Under voltage
- Low current output
- Erratic output
- Weak battery
- Water consumption – excessive as well as insufficient
- Continuous heavy gassing
- Battery Overheating Indication (sensor supplied)
- Electrolyte leakage
- Corrosion of equipment or metallic parts close to battery
- Short-circuited battery and battery cell

 RAIL CAR TRAINING CONSORTIUM

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INSTRUCTIONAL EVENT: Recall prior knowledge

TIME: 10 minutes

SAY: Here are some common reported problems that are associated with the LVPS and battery system on the rail car.

DO: Ask for a volunteer (someone who has not responded in class before) to read the problems as they appear on this slide. As the volunteer reads each problem, ask them to pause then encourage discussion by asking if anyone can figure out what is the root cause of that problem.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: 25

Instructor Notes

Slide 7



INSTRUCTIONAL EVENT: Present new content. Provide learning activities.

TIME: 30 minutes

SAY: Let us spend some time together looking at this document from APTA. Anyone knows what APTA stands for? APTA is the abbreviation for the American Public Transportation Association and our transit agency is a member of APTA. Let's divide up in two teams. Each team will select read the APTA Emergency Lighting Design document then come up the correct answers on the worksheet. You will have 10 minutes to read the APTA document and 10 minutes to prepare all the answers in the worksheet. Let's see which team can come up with the correct answers in the shortest amount of time. Bonus points for teams giving the Section number and pages from which they drew the answers!

DO: Allow participants to divide themselves in two teams. Give each participant a copy of APTA Emergency Lighting Exercise. In this packet are two pages of a worksheet in which participants will fill in the answers. They can look up the answers in the accompanying APTA Rail Standard for emergency lighting activation. Give participants at least ten minutes to read the APTA document. Then all each team another ten minutes to discuss and decide on the correct answers. Call time after 20 minutes. The team that finishes first should present their answers to the entire group first. The other team can respond with "Agree", "Disagree" or "Agree with condition" to the first team's responses. Encourage discussion.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: 22

TAKEAWAY: Give each participant a copy of APTA Emergency Lighting Exercise which includes a 2-page worksheet and a 10-page document on APTA's Emergency Lighting System Design for Rail Transit Vehicles.

Instructor Notes

Slide 10

Troubleshooting and Repair of APS and Battery Systems		
Common Reported Problems		
Excessive Water Consumption by Battery		
Problem	Likely causes	What to do
Excessive water consumption	Charge voltage too high	Check charger output to battery. Recalibrate charging system. Top up electrolyte per OEM recommendation.
	One or more cells shorted causing a higher charging voltage on rest of cells in battery	Check for cells with zero voltage. Remove battery and replace defective cell per OEM recommendation.
	Small leak or cracks causing cell to dry out	Check for wetness in battery box, battery. Using a voltmeter check which parts of the battery has lowest potential to ground. Clean and dry battery and battery box per OEM recommendation.
	Elevated outside temperature and/or no compensation on charging voltage	Top up electrolyte levels per OEM recommendation. Check charging system.
RAIL CAR TRAINING CONSORTIUM		

INSTRUCTIONAL EVENT: Recall from past experience. Present new content.

TIME: 10 minutes

SAY: OK, these are likely causes when the problem is excessive water consumption by the rail car battery system. This time I am going to ask a volunteer to read the likely cause and the rest of you will respond with the corresponding solution in the “What to Do” column.

DO: Ask a volunteer to read the first likely cause “Charge voltage too high” then lead the rest of the class with “Check charger output to battery. Recalibrate charging system. Top up electrolyte per OEM recommendation” before moving on to the next likely cause. Repeat this for the next four likely causes. If time allows, expand on these based on your own experience and knowledge of battery systems.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: 29

Instructor Notes

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Troubleshooting and Repair of APS and Battery Systems

Match the Probable Cause with the Corrective Action!

1. Rupture of several internal cell connections	a. Commission battery. Clean and dry battery and battery box.
2. Ruptured cell(s), tube(s), connection(s)	b. Replace cell(s)/battery. Commission battery. Clean and dry battery and battery box.
3. Metallization, performance, or oxidation of separators	c. Replace damaged cell(s). Commission battery. Clean and dry battery and battery box.
4. Severe shorts of separator missing	d. Check charging system. Refer to OEM recommendation. Some transit agencies charge the battery on car continuously for at least 8 hours prior to train departure.
5. Hydrogen ignites outside cell(s) due to presence of flame or spark	e. Replace damaged cell(s). Commission battery. Clean and dry battery and battery box.
6. Open circuit due to cell(s) dry out or internal connection due to use of acid or other water containing materials	f. Replace cell(s)/battery/components if damaged as per OEM recommendation. Commission battery. Clean and dry battery and battery box.
7. Open circuit due to damaged lower connection(s) between cells or crates	g. Recharge specification. If needed, contact OEM or battery service supplier.
8. Shorted cell(s) and/or metallic particles inside cell(s)	h. Replace damaged cell(s). Commission battery. Clean and dry battery and battery box.
9. Overfill/overflowing of electrolyte level(s) causing short(s)	i. Replace damaged connection(s), apply torque values to all connection nuts/pole bolts per OEM recommendations. Commission battery. Clean and dry battery and battery box.
10. Mechanical contact between cell(s) and/or battery box	j. Replace damaged cell(s). Commission battery. Clean and dry battery and battery box. Check for correct polarity connections.
11. Battery not well charged and/or temperature compensation lacking	k. Replace damaged cell(s), tube(s) or connection(s). Commission battery. Clean and dry battery and battery box.
12. Electrolyte missing / ruptured cell(s) or electrolyte leakage	l. Replace battery. Commission battery. Clean and dry battery and battery box.
13. Maximum / minimum temperature beyond OEM specification	m. A cell(s) with partial or complete short-circuit will consume less or no water than others. Let cell(s) remain in circuit until a replacement is made available. Topping-up remaining cells may be more frequent. Remove battery and replace defective cell(s)/crate(s). Commission battery. Clean and dry battery and battery box.
14. Cell(s) battery aging or end of life	n. Check battery connections. Replace any damaged cable assemblies, cell(s), and battery components. Commission battery. Clean and dry battery and battery box.

RAIL CAR TRAINING CONSORTIUM

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INSTRUCTIONAL EVENT: Recall from past experience. Present new content. Application feedback.

TIME: 20 minutes

SAY: OK, ready? **[CLICK to display two columns]** Each team should match the accurate Probable Cause in the left column with its corresponding Corrective Action in the right column. Let me give you an example. The Corrective Action for Probable Cause Number 1 ("Rupture of several internal cell connections") is J ("Replace damaged cell(s). Commission battery. Clean and dry battery and battery box. Check for correct polarity connections.") Ready to play? Now, I have some warnings. There are three Corrective Actions that are identical and they apply to different Probable Causes. What questions do you have?

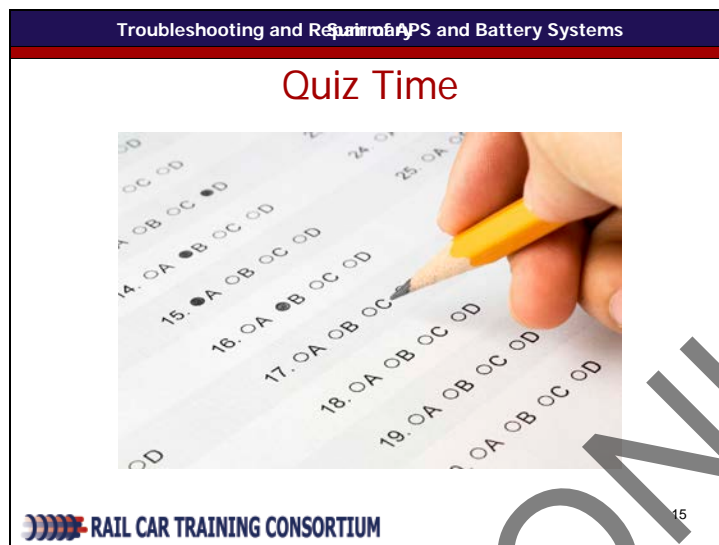
DO: Respond to questions from participants. Once everyone is ready to play, give them 10 minutes to come up with the right answers. **[CLICK to remove arrow and Answer is 1j from display]** Leave the columns up on display. Call time after 10 minutes. Let the team who came in second in the previous team exercise go first. Encourage discussion by asking the other team if they have the similar answer. If their answer is different ask them which corrective action they chose and why they chose that answer. Once the game is over, ask participants to open their coursebooks to Pages 30-31 and check their answers against the ones in the table. Encourage discussion. Consult with document GAME – Probable Cause and Corrective Actions Table

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: 30-31

NOTE: The source of the table, Reduced Peak Performance – Probable Causes and Correction Actions, is from the SAFT Batteries Manual used by the Charlotte Area Transit System.

Instructor Notes

Slide 15



INSTRUCTIONAL EVENT: Assess learning.

TIME: 10 minutes

SAY: I hope you enjoyed this class as well as learn something new about troubleshooting rail transit vehicle batteries. Let's assess what you learned today with a short quiz.

DO: Give quiz to each participant. Allow time to complete. Collect quizzes and correct and distribute the corrected quizzes to each participant.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: 22

Instructor Notes