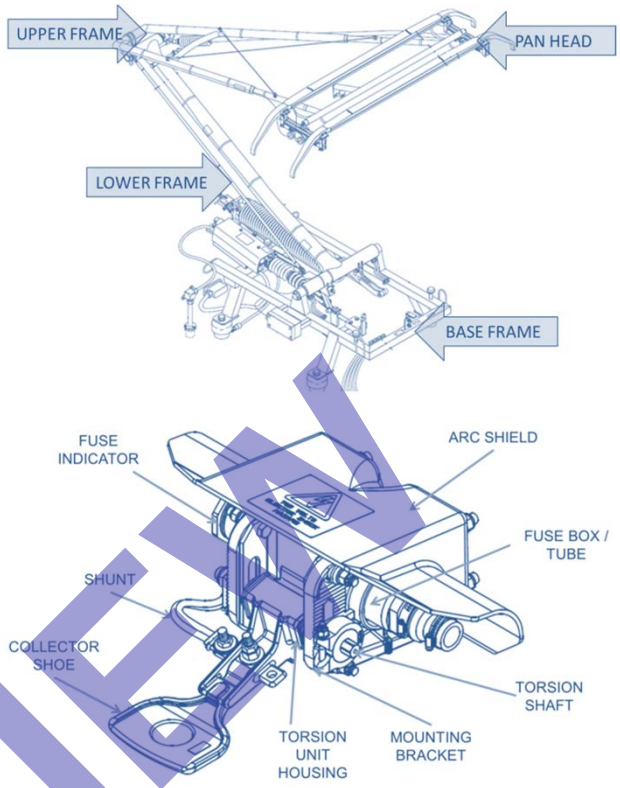
# Inspection and Maintenance of Current Collection Systems




## Course 207



# PARTICIPANT GUIDE

RAIL CAR TRAINING CONSORTIUM

Current Collection

# Inspection and Maintenance

## Course 207

## Participant Guide

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# Participant Guide



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Rail Car Training Consortium

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# MODULE 1

# *General Inspection and Maintenance*

## Outline



## Outcome and Objectives

Participants will be able to provide participants with a review of safety procedures when working on and around rail vehicles. Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Recognize safety hazards when working on current collector systems.
- Examine and compare maintenance schedules and checklists.
- Inspect and maintain the knife switch assembly.

## Abbreviations

- AHJ: Authority Having Jurisdiction
- APTA: American Public Transportation Association
- NTSB: National Transportation Safety Board
- OEM: Original Equipment Manufacturer
- OSHA: Occupational Safety and Health Administration, U.S. Department of Labor

The following is a list of the top 10 most frequently cited standards following inspections of worksites by federal Office of Safety and Health (OSHA). This list is for Fiscal Year 2017 and OSHA publishes this list to alert employers about these commonly cited standards so they can take steps to find and fix recognized hazards addressed in these and other standards before OSHA shows up. Far too many preventable injuries and illnesses occur in the workplace.

1. Fall protection.
2. Hazard communication standard – employees working around chemical hazards are notified of their hazards.
3. Scaffolding.
4. Respiratory protection.
5. Control of hazardous energy (lockout/tagout).
6. Ladders.
7. Powered industrial trucks.
8. Machinery and machine guarding.
9. Fall protection – training requirements.
10. Electrical, wiring methods, components and equipment.



## Learning Application 1A

1. Working with a partner or in a small group, list hazards specific to working on overhead catenary or third rail current collectors at the maintenance facility where you work. Use the OSHA top ten most frequently cited standards as a reference.
2. What steps are put in place to reduce or remove these hazards?
3. What are your responsibilities as far as working safely in the maintenance facility?

# MODULE 2

# *Overhead Catenary Systems*

## Outline



## Outcome and Objectives

Participants will be able to apply the steps involved in inspecting, maintaining, and testing major components of the overhead catenary power collection systems on a passenger rail vehicle.

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

- Inspect and maintain pantograph collector head
- Inspect and maintain lowering device
- Inspect and maintain raising mechanism
- Test, inspect, and maintain insulator
- Test, inspect, and maintain coupling rod
- Inspect and maintain auto drop.
- Inspect and maintain surge / lightning arrestor

## Key Terms

- Electrical Lowering Device (ELD)
- Fuse Box Assembly
- Lightning Arrester
- Shop Power
- Stinger
- Surge Arrester

# 2-1 OVERVIEW

The catenary is an overhead bare copper wire suspended from above and parallel to the running rail. The pantograph is roof-mounted on insulators. The pantograph collects electric current from the overhead catenary for the power system of the rail vehicle. Current flows from the catenary wire into the carbon strips on the pan head assembly, through the upper frame assembly, the lower frame assembly, the base frame assembly and to the vehicle electrical system from the contact plate of the base frame assembly. Copper shunts connect between the frames at the pivoting joints to direct the current around the pivot joints.

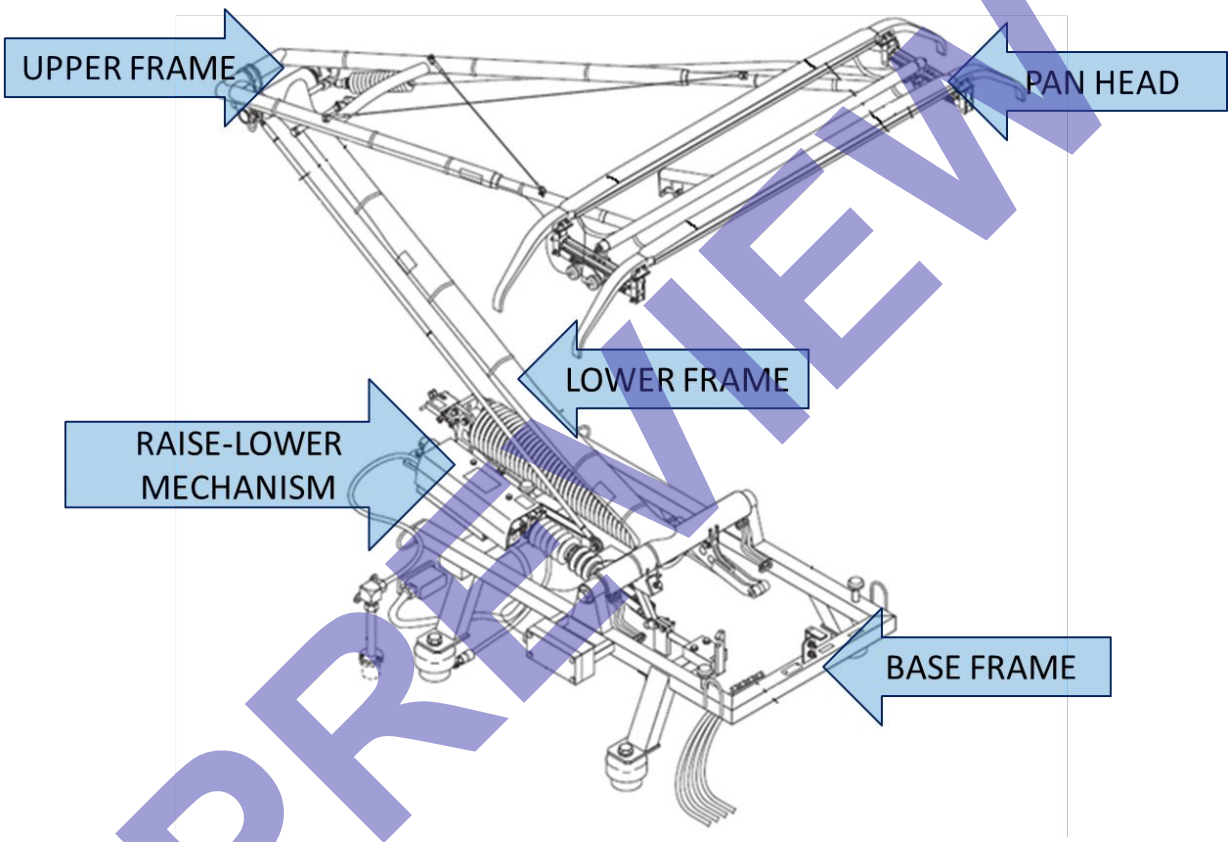


***Figure 2.1 Main Sections of Pantograph for Inspection and Maintenance***

This module presents the inspection and maintenance steps of components related to five areas of the pantograph system: pan head, upper frame, lower frame, raise-lower mechanism, and base frame. The module will also review inspection and maintenance steps involved in other major components of the pantograph system as well as identify other related maintenance tasks.

This course was developed with input from subject matter experts from several rail transportation agencies. As far as possible, the course provides the industry standard for nomenclature and components' terminology. The participant should note that their agencies might use different terms for those components.

t. Follow OEM recommendations and railroad SMP for pantograph change out. Check roof insulators for cracks and chips. Replace as necessary. Clean with approved cleaning agent.

u. Check and verify the minimum and maximum height and adjust in accordance with OEM instructions and railroad SMP.

v. Check for air leaks on automatic drop systems in accordance with OEM instructions and railroad SMP.

## Pantograph Safety

All inspection of and work on the pantograph should follow the agency's guidelines for safety.

The most important safety consideration is, of course, that the entire pantograph – pan head, upper frame, lower frame, base frame – is all energized with high voltage when the pan head is contacting a live catenary.

**WARNING: SAFETY PRECAUTION!**

When the pan head is in contact with a live catenary, the ENTIRE PANTOGRAPH is energized with high voltage.

Some important safety guidelines include:

- Persons working on the pantograph must be trained and authorized to do so.
- Before performing any maintenance procedure, lower pantograph and arrange for the removal and continuous isolation of catenary power in accordance with agency rules and standard operating procedures.
- When lowered, the pantograph should be latched and locked with a safety device designed for that purpose. An example is shown below in Figure 2.2.

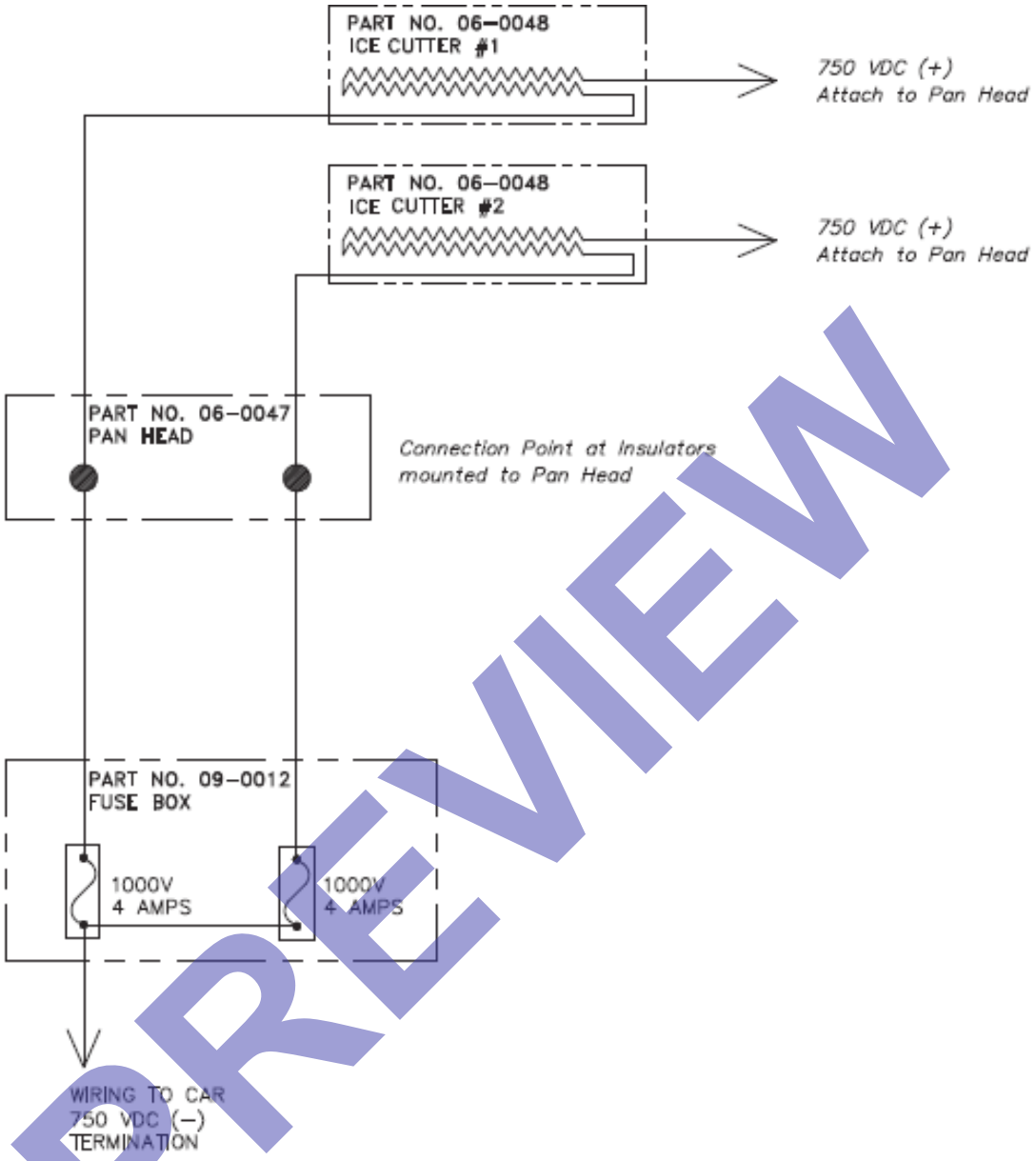


***Figure 2.5 Circuit Diagram for Ice Cutter-courtesy CATS***

### Learning Application 2G

With help from your instructor, compare the components for the upper frame assembly shown in Figure 2.6 above with the pantograph assembly on a rail vehicle at your facility. List similarities and differences taking into consideration the terms used for components. For example, what term do you use for the "diagonal cables" in Figure 2.6? Does the pantograph in your facility come equipped with a hydraulic oscillation damper (a fluid-filled shock absorber)?

## Coupling Rod Assembly

The coupling rod assembly connects between a bracket on the upper frame assembly and a bracket on the base frame assembly. On some pantograph configurations, this component may be similar in function to the **lower guide rod**.

When the pantograph is raised, the coupling rod assembly causes the upper frame assembly to pivot on its bearings and assume a raised position. Adjustments to the coupling rod therefore affect the pantograph's contact force. Inspection and maintenance tasks vary by pantograph configuration and some general steps are:

1. Inspect bolts, nuts, and connections at the upper and base frames for wear and damage. If indicated replace per OEM recommendations.
2. Adjusting the coupling rod changes the resting position of the pantograph and therefore adjustments to the coupling rod directly affect the pantograph's contact force.

### Case Study: Adjustment of Coupling Rod. CATS, Charlotte, NC

1. Lower the pantograph to its rest position.
2. Loosen hex nuts at ends of coupling rod.
3. Restrain the raising springs and adjust the length of the coupling rod by turning the tupe using a wrench on the "flats" of the tube.
4. Tighten hex nuts when done.

## Shunt Connections

Visually inspect all shunts for frayed, broken, cut, burnt or otherwise defective conditions. If any of these conditions exist, the shunt should be replaced per OEM or agency specifications. When replacing shunts, make sure the contact surfaces are clean and free from dirt or corrosion. If shunts require adjustment, make sure they do not rub against another component and that there is sufficient clearance. Visually inspect shunts for loose connections and tighten as required.

## Manual Raising and Lowering Devices

In the absence of sufficient power to the rail vehicle, the pantograph can be raised or lowered manually by a hand crank or, on some systems, by a foot pump.

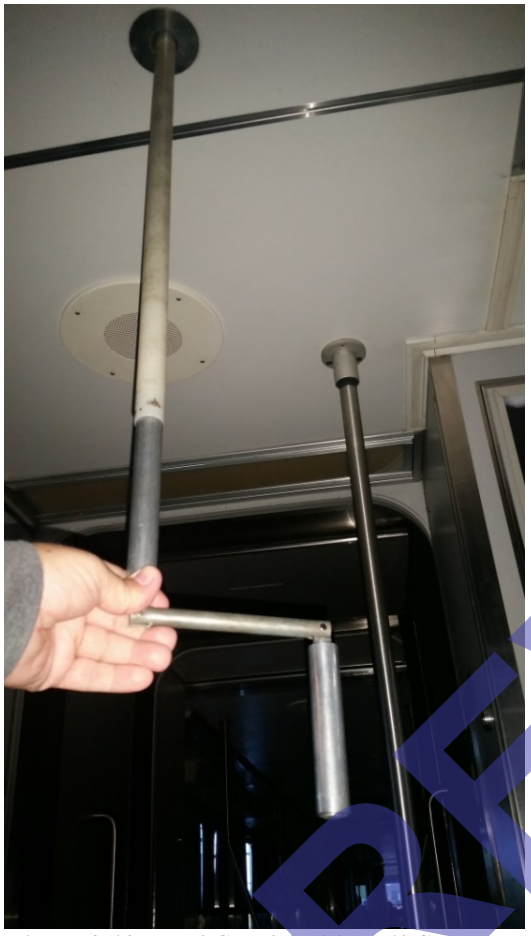

***Figure 2.10 Hand Crank inside Rail Car – courtesy DART***

***Figure 2.11 Foot Pump Used with Pantograph – courtesy G&Z Enterprises accessed on 5/25/2018***

Many rail transportation agencies follow the pantograph inspection with what some call the "post inspection checkout" where the pantograph is raised and lowered with vehicle controls. This test checks for the proper operation of the pantograph.

### Learning Application 2I

Pantograph Raising and Lowering Test

https://vimeo.com/262583536

Length: 2 minutes

# Module 3

# *Third Rail Systems*

## Outline

**3-1 Overview**

**3-2 Current Collector Assembly**

**3-3 Other Maintenance Tasks**

**3-4 Summary**

## Outcome and Objectives

Participants will be able to apply the steps involved in inspecting, maintaining, and testing major components of the third rail power collection systems on a passenger rail vehicle.

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

- Test, inspect, and maintain the current collector assembly and related components.
- Perform other related maintenance tasks.

## Abbreviations

- APS – Auxiliary Power Supply
- APTA – American Public Transportation Association
- FRP – Fiberglass-Reinforced Plastic
- HVAC – Heating, Ventilation, and Air Conditioning
- OEM – Original Equipment Manufacturer
- SMP – Standard Maintenance Practice

specifications and the railroad SMP. Inspect all shunts and cables for loose connections; tighten as required. Make sure cable routing does not result in rubbing.

NOTE: Elastic lock nuts and chemical locking compounds are not to be used to secure current-carrying components.

c. Wear indicator: Current collector shoes shall be replaced if:

- shoe is damaged;
- pad wear indicator mark is exposed; or
- shoe is worn down to the condemning limit.

d. Shoe contact: Inspect the current collector shoe pad for correct contact to the third rail. Excessive burning of pad contact area or uneven wear generally indicates improper shoe height, alignment or spring tension. If required, adjust or replace components in accordance with railroad procedures.

e. Collector free height: Inspect the current collector shoe height from top of running rail using the railroad's approved height gauge. Adjust as required.

f. Fuse condition: Inspect all ribbon or braided type fuses for burnt, separated or otherwise damaged elements, and replace as required. Inspect the trip button on the cartridge-type fuses for activation. If the button was activated, then attempt to reset, if applicable. If unable to reset, then replace the fuse.

g. Warning labels: Inspect the "Danger High Voltage" warning labels. Ensure that they are clean, legible and located as prescribed by CFR, OEM and the railroad.

h. Emergency shoe insulation: (CFR 49, Part 229.81) If applicable, ensure that each locomotive/MU car equipped with third rail collection shoes has, in good condition and sufficient supply, a device to isolate/insulate the current collection equipment from the third rail.

# 3-2 CURRENT COLLECTOR ASSEMBLY

## Gravity Type Collector Assembly

### Learning Application 3A

The following inspection steps are applied on CTA's 5000 Series rapid transit rail cars for 60-day current collector assembly inspection. How do they compare to the inspection steps for similar third rail collector assembly at your maintenance facility?

### Inspection Steps

1. Remove insulators from support assembly, pre-load devices, and current collection beam by carefully cutting and discarding self-locking cable ties.
2. Remove all dirt and old clear sealant from the current collector assembly.
3. Inspect current collector flashboard and spaces for cracks, arcing, and other damage.
4. Inspect alignment of guiding bracket that must touch upper stopping buffer on its entire surface. If required, adjust guiding bracket.
5. Visually inspect integrity of torque seal to make sure longitudinal stop mounting hardware is secure. If not, torque screws to OEM recommendation and apply torque seal.
6. Measure gap between longitudinal stops and wear plates checking for OEM recommended limit. If required, adjust to OEM recommendations.
7. Inspect lower stopping buffers for proper alignment, cracks or damage.
8. Visually inspect integrity of torque seal to make sure longitudinal stop mounting hardware is secure. If not, torque screws to OEM recommendation and apply torque seal.
9. Visually inspect integrity of torque seal to make sure spherical joint mounting hardware is secure. If not, torque nut to OEM recommendation and apply torque seal.
10. Inspect support assembly for cracks, or damage.
11. Inspect current collector beam for cracks, arcing, or other damage.
12. Inspect shoe shunts, terminals, fuse, and sleet scraper shunt for burns, fraying, or corrosion.

### Third Rail Collector Shoe Height Adjustment

1. Loosen stop nut on torsion lock.
2. Loosen stop nut securing torsion shaft until torsion lock and height adjustment washer can be disengaged from serrated teeth of collector mounting brackets.
3. Move torsion shaft and collector shoe mount up or down to attain correct height.
4. Third rail height is correctly adjusted when collector shoe rests flatly on the shoe height adjustment block that simulates the third rail.
5. Re-engage teeth of height adjustment washer and torsion lock into teeth of collector mounting brackets.
6. Tighten stop nut securing torsion shaft until snug.

### Third Rail Collector Shoe Spring Tension (Pressure) Adjustment

1. Loosen stop nuts until torsion shaft is free to rotate.
2. With spring scale attached to center of shoe, rotate torsion shaft counterclockwise until OEM-recommended shoe pressure range is obtained.
3. While maintaining load on shoe, torque stop nut per OEM recommendations.

The following instructional video demonstrates the steps a rail car technician takes to adjust the shoe height and spring tension of third rail collector shoe assemblies.

**Learning Application 3E**

Collector Shoe Height and Spring Tension Adjustment

https://vimeo.com/276918176

Length: 10 minutes



## 3-4 SUMMARY

This module provided a framework for rail car technicians to approach inspection and maintenance of the third rail current collector assemblies. The steps and recommendations in this module should be applied in conjunction with those in practice at the participant's rail transportation agency.