



APTA STANDARDS DEVELOPMENT PROGRAM  
**RECOMMENDED PRACTICE**

American Public Transportation Association  
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Traction Power Training Joint  
Steering Committee

# Traction Power Maintenance Training Standards

**Abstract:** This *Recommended Practice* establishes standards for a program of traction power maintenance training.

**Keywords:** traction power, training,

**Summary:** The safe and efficient operation of transit rail systems is highly dependent on reliable traction power to allow train operations. Traction power maintenance has been identified by APTA and unions representing transit workers as a craft with a shortage of practitioners. In response to the need for traction power maintenance training, the Transportation Learning Center has partnered with APTA, transit agencies and unions representing transit workers to develop joint labor-management training guidelines and recommended practices for this craft.

**Scope and purpose:** The labor-management subject matter experts on the Traction Power Training Joint Steering Committee developed the training curriculum and guidelines with the expectation that training would be instructor led and include on-the-job training under the supervision of an experienced and qualified journeyman or technician. Completion of Level 100 to 300 learning objectives would typically require a three-year period, though these guidelines do not include instructional hour and on-the-job hours recommendations.

This Recommended Practice represents a common viewpoint of those parties concerned with its provisions, namely, transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any standards, practices or guidelines contained herein is voluntary. In some cases, federal and/or state regulations govern portions of a rail transit system's operations. In those cases, the government regulations take precedence over this standard. APTA recognizes that for certain applications, the standards or practices, as implemented by individual rail transit agencies, may be either more or less restrictive than those given in this document.



## Participants

The American Public Transportation Association greatly appreciates the contributions of the **Traction Power Training Joint Steering Committee**, who provided the primary effort in the drafting of this *Recommended Practice*:

*Co-Chairs:*

**Jim Lindsay** (ATU Local 1277)  
**Cam Beach** (Beach Consulting)

**Atlanta (ATU Local 689)**  
 Terry Mark

**Boston (MBTA/IBEW Local 103)**  
 George Kuers  
 Jim O'Connell

**Chicago (CTA/IBEW Local 9)**  
 Robert Burns  
 Gus Nouti  
 John Burkard

**Connecticut (URS Corporation)**  
 Alex Goff

**Dallas (DART)**  
 Rocky Rogers

**Los Angeles (LACMTA/ATU Local 1277)**  
 Stephen Norton  
 Forrest Belmont

**New York City (TWU Local 100)**  
 Joe Ayala

**Northern California (BART)**  
 Don Allen

**Pittsburgh (ATU Local 85)**  
 Teddy Ault  
 Scott Davis

**Sacramento (Sacramento Regional Transit/IBEW Local 1245)**  
 Mike Cormiaie  
 John Anders

**San Diego (MTS/IBEW Local 465)**  
 Joe Petito  
 Don Estep

**St. Louis (Metro)**  
 Suzanne Whitehead

**Washington, D.C. (ATU Local 689)**  
 James Madaras

**ATU International/APTA**  
 Bob Hykaway  
 John Remark  
 Pam Boswell

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## 1. Objective of this standard

Public transportation faces a technical skills shortage driven by changing technologies, shifting workforce demographics, record-breaking growth in ridership and the continuing expansion of transit systems and users. Industry leaders acknowledge that the pace of technological change has surpassed the capacity of most agencies to train skilled technicians and new entrants/employees in the effective diagnosis, repair and maintenance of advanced capital equipment. To address many of these issues, labor-management partnerships have been advocated in a number of blue-ribbon reports (see References) from the Transportation Research Board and its Transit Cooperative Research Program (TCRP) as well as from the American Public Transportation Association (APTA).

The safe and efficient operation of transit rail systems is highly dependent on reliable traction power to allow train operations. Traction power maintenance has been identified by APTA and unions representing transit workers as a craft with a shortage of practitioners. The inadequate numbers of traction power maintainers is attributed to several factors, including the pending retirement of incumbent workers, the continued expansion of rail transit systems nationwide and inadequate recruitment and training of traction power maintainers. The difficulty recruiting new entrants into the field is exacerbated by sometimes having to work in unfavorable weather, confined spaces and other less-desirable working conditions.

In response to the need for traction power maintenance training, the Transportation Learning Center has partnered with APTA, transit agencies and unions representing transit workers to develop joint labor-management training guidelines and recommended practices for this craft. The development of these training guidelines was supported through grants from the U.S. Department of Labor, the Federal Transit Administration and the Transit Cooperative Research Program. In addition, APTA is supporting programs to develop computer-based short courses of study using the training guidelines developed with the Center.

### 1.1 The Steering Committee

The development of recommended training guidelines was coordinated through a joint labor-management Steering Committee of subject-matter experts drawn from rail transit agencies across the United States.

**Table 1** lists the participants.

**TABLE 1**  
Traction Power Training Joint Steering Committee Members

State	City	Agency	Union
California	Los Angeles	LACMTA	ATU 1277
California	Sacramento	Sacramento RTD	IBEW 465
California	San Diego	San Diego MTS	IBEW 465
Illinois	Chicago	CTA	IBEW 9
Massachusetts	Boston	MTA	IBEW 103
Missouri	St. Louis	Metro	ATU 788
Pennsylvania	Philadelphia	SEPTA	TWU 234
Pennsylvania	Pittsburgh	Port Authority	ATU 85
New Jersey	Newark	New Jersey Transit	ATU 819
Oregon	Portland		ATU 757
Texas	Dallas	DART	
<b>Other participants:</b> Beach Consulting, Charlotte Area Training Systems GE Transportation, Washington Group			

Meeting over a period of two and one-half years, this committee of management and labor subject matter experts:

- Determined the job responsibilities and related tasks required of traction power maintainers.
- Determined the skills, knowledge and abilities required to successfully execute the job responsibilities and tasks of the traction power maintenance craft.
- Developed a program of training and order of instruction for classroom and on the job training for traction power maintainers.
- Determined the learning objectives associated with each phase of the training process to develop traction power maintainers.

### 1.1.1 Meeting dates

The Traction Power Training Joint Steering Committee met on the following dates:

- June 21, 2007
- September 27, 2007
- January 29, 2008
- September 4, 2008
- March 26, 2009

## 2. Traction power training guidelines

Traction power maintenance training guidelines are organized into 10 subject areas corresponding to the different job responsibilities of a traction power maintenance technician. These subject areas:

1. Comprehensive overview of train operations, safety and history of traction power systems
2. Traction power security related procedures and regulatory agency authority.
3. Specialized traction power tools and test equipment
4. Theory of power distribution (contact, catenary and third rail)
5. Theory, operation and maintenance of substations
6. Grounding
7. ANSI system, symbology
8. Battery backup power systems and emergency power
9. Incoming utility sources and management of utility power.
10. Electronics, relays and programmable logic circuits

The 10 areas of the curriculum include content and learning objectives at various levels of difficulty.

The committee identified several prerequisites candidates should have before starting the 100 level curriculum: basic print reading, basic electrical safety, AC and DC power, test meter reading, and computers. Level 100 training modules are introductory content and may overlap with other crafts that share a core of basic mechanical, electrical and electronic knowledge. Level 200 training areas are specific to traction power maintenance and build on the foundation technical knowledge, skills and abilities developed in the level 100 training areas. Level 300 training modules are the more advanced learning objectives imparting skills, knowledge and abilities required for traction power technicians and journeymen to execute all of the job responsibilities required of a traction power maintainer. Identical course titles may appear in more than one level. This indicates that the class is on the same subject but presented at an increased level of complexity.

The labor-management subject matter experts on the Traction Power Training Joint Steering Committee developed the training curriculum and guidelines with the expectation that training would be instructor led and include on-the-job training under the supervision of an experienced and qualified journeyman or

technician. Completion of Level 100 to 300 learning objectives would typically require a three-year period, though these guidelines do not include instructional hour and on-the-job hours recommendations.

## 2.1 100-level courses

### 100. Introduction to Traction Power (Safety, Security, History)

- **100-1. Understanding History of Traction Power Systems**
- **100-2. Understanding and following Traction Power Safety Practices**
  - 100-2-1. Reference to FRA standards as appropriate
  - 100-2-2. Explain principles and demonstrate ability to refer to NEC and NFPA 70E
  - 100-2-3. Review Hazard Risk Assessment (part of NFPA 70E)
  - 100-2-4. Describe process of interfacing with public safety agencies
  - 100-2-5. Describe railway safety procedures
    - 100-2-5-1. Demonstrate process of referring to agency rail roadway worker protection procedures pertaining to track safety
  - 100-2-6. Explain the risk of working with an energized vs. de-energized system
  - 100-2-7. Describe principle of grounding of distribution system
  - 100-2-8. Describe grounding of OCS procedure
  - 100-2-9. Identify voltage classification of system related to federal, state and agency safety procedures
  - 100-2-10. Identify safety tools
  - 100-2-11. Describe purpose of lock-out/tagout and power securing procedures
    - 100-2-11-1. Describe consequences of an unexpected release of hazardous energy
  - 100-2-12. Describe automatic ground
  - 100-2-13. Describe state and federal requirements for lock-out/tag-out and power securing procedures
  - 100-2-14. Describe process of referring to agency regulations pertaining to lock-out/tag-out
  - 100-2-15. Describe process of referring to agency regulations pertaining to power securing procedures
  - 100-2-16. Demonstrate proper use of personal protective equipment
  - 100-2-17. Explain the remote control capabilities related to substation operation
  - 100-2-18. Explain and demonstrate safety procedures and safety equipment at your property
  - 100-2-19. Explain and demonstrate safety procedures for working at heights and fall protection (for OCS properties)
  - 100-2-20. Explain and demonstrate safety procedures for working in confined spaces
  - 100-2-21. Explain and demonstrate safety procedures for pole climbing
- **100-3. Understanding Traction Power Security Related Procedures**
  - 100-3-1. Explain limited access to substations
  - 100-3-2. Explain TSA recommended procedures for dealing with suspicious packages
  - 100-3-3. Explain processes for observing people
- **100-4. Understanding Regulatory Agency Authority**
  - 100-4-1. Describe state and federal regulation related to traction power systems
- **100-5. Understanding ANSI System**
  - 100-5-1. Explain design of traction power system includes ANSI and IEEE standards
- **100-6. Using Specialized Traction Power Tools**
  - 100-6-1. Demonstrate ability to use hot stick
  - 100-6-2. Demonstrate ability to use meters; multimeters, DVM
  - 100-6-3. Demonstrate ability to use various hand and power tools, and explain reasons for using double insulated tools and identify tool requirements at your location
  - 100-6-4. Describe specialized tools for maintaining substations and distributions (refer to substation and distribution for tool lists)
  - 100-6-5. Properly use tools for substation maintenance

100-6-6. Describe the use of Hi-Pot testing

100-6-7. Procedures for testing and calibrating test equipment listed above

## 102 Power Distribution (Intro and Overview of Theory and Operation)

- **102-1. Purpose and Methods of Power Distribution**
  - 102-1-1. Explain purpose and methods of power distribution
  - 102-1-2. Explain history of power distribution
  - 102-1-3. Describe the varying operating voltages
  - 102-1-4. Describe differences in systems between rail systems
- **102-2. How a Traction Power System Works**
  - 102-2-1. Follow and describe the local functional order of a traction power system, including:
    - Utility, through circuit breaker, to transformer
    - AC switchgear
    - Rectifier transformer
    - Rectifier
    - DC switchgear
    - Distribution to OCS/third rail
  - 102-2-2. Describe traction power control systems
  - 102-2-3. Describe how traction power system works
  - 102-2-4. Explain DC positive feed and its components
  - 102-2-5. Describe negative return and its components
  - 102-2-6. Describe concept of parallel negative return
  - 102-2-7. Describe traction power in context of track circuit
  - 102-2-8. Describe negative feeder cables
  - 102-2-9. Describe operation of battery backup power systems (UPS)
  - 102-2-10. Describe fault annunciation
  - 102-2-11. Describe transfer trip
- **102-3. Describe Function and Components of Substations**
  - 102-3-1. Explain history of substations
  - 102-3-2. Describe the varying operating voltages for substations
  - 102-3-3. Describe differences in systems between rail systems
  - 102-3-4. Describe purpose of automatic reclose of breakers
- **102-4. Describe Function and Components of Overhead Contact Systems**
  - 102-4-1. Describe difference between overhead contact system and overhead catenary system
  - 102-4-2. Explain how overhead contact systems works
  - 102-4-3. Identify components of overhead contact system and their purpose
  - 102-4-4. Describe process of determining whether energized vs. de-energized (sectioning wiring)
- **102-5. Describe Function and Components of Overhead Catenary System**
  - 102-5-1. Describe difference between overhead catenary system and overhead contact system
  - 102-5-2. Explain how overhead catenary systems works
  - 102-5-3. Identify components of overhead catenary system and their purpose
  - 102-5-4. Describe process of determining whether energized vs. de-energized (sectioning wiring)
- **102-6. Describe Function and Components of Third Rail Systems**
  - 102-6-1. Describe impedance bonds
  - 102-6-2. Describe sectionalization
  - 102-6-3. Explain energized vs. de-energized
  - 102-6-4. Describe differences between third rail power and overhead power systems
  - 102-6-5. Weld third rail feed cables
- **102-7. DC Theory and Power Components**
  - 102-7-1. Demonstrate process of isolating system by opening or closing DC switchgear

- 102-7-2. Demonstrate process of verifying load and no load situation with disconnect switches
- **102-8. Power Distribution Systems**
  - 102-8-1. Describe operations and components of an overhead contact system
  - 102-8-2. Describe operations and components of an overhead catenary system
  - 102-8-3. Describe operations and components of a third rail powered system
- **102-9. Bond Types and Methods**
  - 102-9-1. Describe types of bonds (impedance bonds and power bonds)
  - 102-9-2. Describe methods of bond attachment (cadweld, spot weld, arc weld, mechanical, structure)
  - 102-9-3. Describe effect of improper bonding on rail metallurgy and broken rail
  - 102-9-4. Weld extensions to the structure; create structure bonds
- **102-10. Impedance Bonds**
  - 102-10-1. Describe traction power in context of the track circuit
  - 102-10-2. Describe purpose of impedance bonds
- **102-11. Circuit Breakers and Protective Devices**
  - 102-11-1. Explain use and purpose of circuit breakers and protective devices
  - 102-11-2. Demonstrate process of verifying circuit breaker is disconnected before performing maintenance on breakers that can be isolated
  - 102-11-3. Demonstrate how to use personal protective equipment when working on circuit breakers that cannot be disconnected from traction power before performing maintenance
- **102-12. Understand Source of Power for Switch Heaters/Snow Melters**
- **102-13. Understanding Cathodic Protection**
  - 102-13-1. Define cathodic protection principles
  - 102-13-2. Describe principle of stray current

## 108. Linear induction

### 2.2 200-level courses

#### 200. Understanding and Following PM Programs

- **200-1. Add content from agency specific PM programs**
- **200-2. Teach general best practices and concepts of preventive maintenance**

#### 202 Power Distribution and Control Systems (Inspection and Maintenance)

- **202-1. AC Power Systems (Inspection and Maintenance)**
  - 202-1-1. Review of AC theory
  - 202-1-2. Describe and maintain instrument transformers
  - 202-1-3. Maintain circuit breakers and protective devices
  - 202-1-4. Maintain AC switchgear
  - 202-1-5. Maintain disconnect switches (load and non-load)
  - 202-1-6. Explain circuit breakers and protective devices
  - 202-1-7. Explain traction rectifier transformer (6 pulse vs. 12 pulse)
  - 202-1-8. Explain and maintain rectifier
  - 202-1-9. Maintain auxiliary transformers
- **202-2. DC Power Systems (Inspection and Maintenance)**
  - 202-2-1. Review of DC theory
  - 202-2-2. Describe and maintain instrument transformers
  - 202-2-3. Maintain circuit breakers and protective devices
  - 202-2-4. Maintain DC switchgear
  - 202-2-5. Maintain disconnect switches (load and non-load)
  - 202-2-6. Explain and maintain rectifier
  - 202-2-7. Maintain auxiliary transformers

- **202-3 Bond types and methods**
  - 202-3-1. Perform cadweld bonding
  - 202-3-2. Perform spot weld bonding
  - 202-3-3. Perform arc weld bonding
  - 202-3-4. Perform mechanical bonding
  - 202-3-5. Perform impedance bonds

### **203 Substations (Inspection and Maintenance)**

- **203-1. Read and Interpret Circuit Prints**
  - 203-1-1. Explain ANSI/IEEE nomenclature
  - 203-1-2. Explain and interpret local prints
- **203-2. Inspect and Maintain Substation Components**
  - 203-2-1. Inspect and maintain transformers
  - 203-2-2. Inspect and maintain rectifiers
  - 203-2-3. Inspect and maintain AC breakers
  - 203-2-4. Inspect and maintain DC breakers
  - 203-2-5. Inspect and maintain protective relays
  - 203-2-6. Inspect and maintain UPS and station battery banks
  - 203-2-7. Inspect auxiliary relay contacts
- **203-3. Describe and Follow Prescribed Substation PM Procedures**

### **204 Overhead Contact System (Inspection and Maintenance)**

- **204-1. Preparing to Work on Overhead Contact System**
  - 204-1-1. Describe and explain safety procedures for working at heights and fall protection
  - 204-1-2. Describe sectionalization
  - 204-1-3. Explain energized vs. de-energized
- **204-2. Demonstrate Process of Determining Whether Energized vs. De-energized (Sectioning Wiring)**
  - 204-2-1. Verify whether OCS is de-energized
  - 204-2-2. Demonstrate proper application of a ground strap
- **204-3. Inspecting and Maintaining Overhead Contact System Components**
  - 204-3-1. Inspect and maintain contact cable (applying local parameters)
  - 204-3-2. Inspect and maintain supporting structure
  - 204-3-3. Maintain/repair supporting structure
  - 204-3-4. Inspect all insulators
  - 204-3-5. Inspect insulation and wash as applicable
  - 204-3-6. Inspect, maintain and replace contact cable
  - 204-3-7. Inspect and maintain overhead line feeder cable
  - 204-3-8. Inspect and maintain hangers
  - 204-3-9. Inspect and replace equalizing jumper cable
  - 204-3-10. Inspect and maintain poles
  - 204-9. Inspect and maintain back guy (expand on various types)
- **204-4. Check Section Insulation (Various Types)**
  - 204-1-1. Check arc horns
  - 204-1-2. Check rumses
  - 204-1-3. Check support structure
- **204-5. Inspect and Maintain Overhead System**
  - 204-5-1. Tighten and adjust cable
  - 204-5-2. Grease wheels on auto tension system where applicable
- **204-6. Describe and follow prescribed overhead contact system PM procedures**



## 205 Overhead Catenary System (Inspection and Maintenance)

- **205-1. Preparing to Work on Overhead Catenary System**
  - 205-1-1. Understand and follow safety procedures for working at heights and fall protection
  - 205-1-2. Describe sectionalization
  - 205-1-3. Explain energized vs. de-energized
- **205-2 Inspecting and Maintaining Overhead Catenary System**
  - 205-2-1. Measure and install messenger wire, staggering contact wire to prevent wear on pantograph
  - 205-2-2. Inspect and maintain hangers
  - 205-2-3. Inspect and maintain overhead line feeder wire
  - 205-2-4. Inspect and maintain poles
  - 205-2-5. Check and adjust wire tension
  - 205-2-6. Check and adjust fixed tension wires
  - 205-2-7. Check and adjust auto (constant) tension
  - 205-2-8. Inspect and maintain snow and ice removal equipment
  - 205-2-9. Inspect all insulators
  - 205-2-10. Inspect and maintain contact wire
- **205-3. Check Section Insulation (Various Types)**
  - 205-3-1. Check arc horns
  - 205-3-2. Check rums
  - 205-3-3. Check support structure
- **205-4. Describe and Follow Prescribed Overhead Catenary System PM Procedures**

## 206 Third Rail Systems (Inspection and Maintenance)

- **206-1. Inspecting and Maintaining Third Rail and Components**
  - 206-1-1. Inspect bonds
  - 206-1-2. Perform cable bonding
  - 206-1-3. Maintain third rail feed cables
  - 206-1-4. Inspect and replace third rail insulators
  - 206-1-5. Inspect third rail structure and conditions for wear or any abnormality
  - 206-1-6. Inspection and condition of third rail gaps and inclines
  - 206-1-7. Inspect and replace third rail joints
  - 206-1-8. Inspect third rail feeder cable
  - 206-1-9. Cable splicing and insulation
- **206-2. Inspecting and Maintaining Snow and Ice Removal Equipment**
- **206-3. Inspecting and Maintaining Cables**
  - 206-3-1. Explain and demonstrate the routing of cables through ducts
  - 206-3-2. Perform duct rodding
  - 206-3-3. Perform work on manholes
  - 206-3-4. Read duct and manhole prints
  - 206-3-5. Explain and demonstrate processes and equipment used to pull cable
  - 206-3-6. Explain and demonstrate processes for cable fault location

## 207. HVAC and Lighting

**NOTE:** Include equipment that is relevant to traction power maintainers in a given property.

## 208. Understanding Low Resistance Groundings vs. High Resistance Groundings

## 2.3 300-level courses

### **300 Incoming Utility (Service Power) Sources and Basic Diagnosis**

- **300-1. Explain Operation of Equipment**
- **300-2. Describe Primary Power Distribution**
- **300-3. Determine Voltage**
- **300-4. Identify Whether AC or DC**
- **300-5. Locate and Utilize Disconnect Switch**
- **300-6. Describe Isolation of Circuits**
- **300-7. Demonstrate Ability to Read Single-Line Blueprints**
- **300-8. Describe How Metering System Works**
- **300-9. Use and Maintain Portable Generators**
  - 300-9-1. Safely set up portable generators
  - 300-9-2. Demonstrate various hookups
  - 300-9-3. Check phasing
  - 300-9-4. Select correct voltage

### **301 Traction Power Control Systems (Troubleshooting, Adjustment and Repair)**

- **301-1. Describe Various Points of Control of Substations and Distribution Network**
- **301-2. Define and Describe Supervisory Control and Data Acquisition System (SCADA)**
  - 301-2-1. Fiber optics and communication systems
- **301-3. Use SCADA to Troubleshoot and Improve System Performance**

### **302 Power Distribution Systems (Troubleshooting, Adjustment and Repair)**

- **302-1. Power Isolation**
  - 302-1-1. Identify section of rail where power needs to be turned off to perform maintenance
  - 302-1-2. Read and interpret rail feeder and return drawings
  - 302-1-3. Identify power sections on rail feeder and return drawings
  - 302-1-4. Communicate with power control center to isolate power in appropriate section
  - 302-1-5. Field confirm power isolation with a voltage tester
  - 302-1-6. Remove taps and open switches as applicable
  - 302-1-7. Communicate with power control center to restore power
  - 302-1-8. Follow agency safety precautions and procedures
- **302-2 AC Power Systems (Troubleshooting and Repair)**
  - 302-2-1. Troubleshoot, repair and replace Instrument Transformers
  - 302-2-2. Troubleshoot, repair and replace Circuit breakers and protective devices
  - 302-2-3. Troubleshoot and repair Traction rectifier transformer (6 pulse vs. 12 pulse)
  - 302-2-4. Troubleshoot and repair rectifier
  - 302-2-5. Troubleshoot and repair no-load disconnect
  - 302-2-6. Troubleshoot and repair auxiliary transformers
- **302-3 DC Power Systems (Troubleshooting and Repair)**
  - 302-3-1. Troubleshoot and repair instrument transformers
  - 302-3-2. Troubleshoot and repair circuit breakers and protective devices
  - 302-3-3. Troubleshoot and repair rectifier
  - 302-3-4. Demonstrate proper method to replace diodes
  - 302-3-5. Troubleshoot and repair no-load disconnect
  - 302-3-6. Troubleshoot and repair auxiliary transformers

### **303 Substations (Troubleshooting, Adjustment and Repair)**

- **303-1 Troubleshooting Methods and Best Practices**

- 303-1-1. Using OEM manuals in troubleshooting
- 303-1-2. Read and interpret circuit prints to discover and repair problems
- 303-1-3. Describe and demonstrate linear troubleshooting method
- 303-1-4. Describe and demonstrate half split troubleshooting method
- 303-1-5. Explain when to use each method

- **303-2. Substation Components Troubleshooting and Repair**

- 303-2-1. Troubleshoot and replace transformers
- 303-2-2. Troubleshoot and replace rectifiers
- 303-2-3. Troubleshoot and replace breakers (AC and DC)
- 303-2-4. Troubleshoot and replace protective relays
- 303-2-5. Troubleshoot and replace UPS
- 303-2-6. Troubleshoot and replace station battery banks

### **304 Overhead Contact Systems (Troubleshooting, Adjustment and Repair)**

- **304-1. Troubleshooting and Repairing Overhead Contact System Components**

- 304-1-1. Repair contact cable (applying local parameters)
- 304-1-2. Repair supporting structure
- 304-1-3. Replace and splice contact cable
- 304-1-4. Maintain/repair supporting structure

- **304-2. Troubleshoot and Repair Contact Cable Defects**

- **304-3. Troubleshoot and Repair Hangers**

- **304-4. Troubleshoot and Repair Poles**

- **304-5. Check and Adjust Cable Tension**

- 304-5-1. Check and adjust fixed tension cables
- 304-5-2. Check and adjust auto (constant) tension

- **304-6. Repair and Replace Section Insulation (Various Types)**

- 304-6-1. Repair and replace arc horns
- 304-6-2. Repair and replace rumes
- 304-6-3. Repair and replace support structure

- **304-7. Troubleshoot and Repair Back Guy**

### **305 Overhead Catenary Systems (Troubleshooting, Adjustment and Repair)**

- **305-1. Troubleshooting and Repairing Overhead Catenary System**

- 305-1-1. Troubleshoot and repair contact wire
- 305-1-2. Troubleshoot, adjust and repair hangers
- 305-1-3. Troubleshoot, adjust and repair poles
- 305-1-4. Check and adjust wire tension
- 305-1-5. Check and adjust fixed tension wires
- 305-1-6. Check and adjust auto (constant) tension
- 305-1-7. Troubleshoot and repair snow and ice removal equipment
- 305-1-8. Repair and replace down guy
- 305-1-9. Repair and replace span wire

- **305-2 Repair and Replace Section Insulation (Various Types)**

- 305-2-1. Repair and replace arc horns
- 305-2-2. Repair and replace rumes
- 305-2-3. Repair and replace support structure

### **306 Third Rail Systems (Troubleshooting, Adjustment and Repair)**

- **306-1. Troubleshoot and Repair Third Rail and Components**
- **306-2. Troubleshoot and Repair Third Rail Structure**

- **306-3. Troubleshoot and Repair Snow and Ice Removal Equipment**
- **306-4. Measure a Curved Radius for Rail Installation and Replacement**

## References

Transportation Learning Center, “People Make the Hardware Work: Transit Experts Call for Labor-Management Training Partnerships,” 2007.

## Abbreviations and acronyms

<b>AC</b>	alternating current
<b>ANSI</b>	American National Standards Institute
<b>APTA</b>	American Public Transportation Association
<b>ATU</b>	Amalgamated Transit Union
<b>BART</b>	Bay Area Rapid Transit
<b>CTA</b>	Chicago Transit Authority
<b>DART</b>	Dallas Area Rapid Transit
<b>DC</b>	direct current
<b>DVM</b>	digital volt meter
<b>FRA</b>	Federal Railroad Administration
<b>HVAC</b>	heating, ventilation, air conditioning
<b>IBEW</b>	International Brotherhood of Electrical Workers
<b>IEEE</b>	Institute of Electrical and Electronic Engineers
<b>LACMTA</b>	Los Angeles County Metropolitan Transportation Authority
<b>MBTA</b>	Massachusetts Bay Transportation Authority
<b>MTS</b>	Metropolitan Transit System (San Diego)
<b>NEC</b>	National Electrical Code
<b>NFPA</b>	National Fire Prevention Association
<b>OCS</b>	overhead catenary system
<b>OEM</b>	original equipment manufacturer
<b>PM</b>	preventative maintenance
<b>SCADA</b>	supervisory control and data acquisition system
<b>SEPTA</b>	Southeastern Pennsylvania Transportation Authority
<b>TSA</b>	Transportation Security Administration
<b>TWU</b>	Transport Workers Union of America
<b>UPS</b>	uninterruptible power supply