



RECOMMENDED PRACTICE

American Public Transportation Association
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Signal Training Joint Steering
Committee

Rail Signals Maintenance Training Content and Standards

Abstract: This *Recommended Practice* establishes standards for a program of rail signals maintenance training.

Keywords: rail signals, training

Summary: The safe and efficient operation of transit rail systems is highly dependent on reliable rail signals to control train operations. Rail signals 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 rail signals 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 training practices.

Scope and purpose: The labor-management subject matter experts on the Signal 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.



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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 rail signals to control train operations. Rail signals maintenance has been identified by APTA and unions representing transit workers as a craft with a shortage of practitioners. The inadequate numbers of rail signals 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 signal maintainers. The difficulty in recruiting new entrants into the field is exacerbated by sometimes unfavorable outdoor and confined working conditions and changes in signal technology.

In response to the need for rail signals 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 training practices. The development of these training guidelines was supported through grants from the U.S. Department of Labor, the Federal Transit Administration and the TCRP. In addition, APTA is supporting programs to develop computer-based short courses of study using the recommended 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 country. **Table 1** lists the agencies and unions involved.

TABLE 1
Signal 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
Pennsylvania	Pittsburgh	Port Authority	ATU 85
New Jersey	Newark	New Jersey Transit	ATU 819
North Carolina	Charlotte	Charlotte Area Transit Systems	
Texas	Dallas	DART	ATU 1338
Washington		Central Puget Sound Regional Transit Authority	ATU 757
Other participants: Brotherhood of Rail Road Signalmen, 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 signals maintainers.
- Determined the skills, knowledge and abilities required to successfully execute the job responsibilities and tasks of the signals maintenance craft.
- Developed a program of training and order of instruction for classroom and on the job training for signals maintainers.
- Determined the learning objectives associated with each phase of the training process to develop signals maintainers.

1.1.1 Meeting dates

The Signal Training Joint Steering Committee met on the following dates:

- November 14, 2006
- January 23, 2007
- February 13, 2007
- March 1, 2007
- June 20, 2007
- September 26, 2007
- January 28, 2008
- September 3, 2008
- March 27, 2009

2. Rail Signals Training Guidelines

Rail signals maintenance training guidelines are organized into nine subject areas corresponding to the different job responsibilities of a rail signal maintenance technician. These subject areas:

1. Comprehensive overview of rail train operations and safety
2. Train detection and control
3. Switches
4. Grade crossings
5. Power distribution
6. Signals
7. Train stops
8. Interlockings
9. Control panels and human-machine interfaces

The nine areas of the curriculum include content and learning objectives at various levels of difficulty. 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 rail signal 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 signal technicians and journeyman to execute all of the job responsibilities required of a typical signal maintainer. The training guideline also includes an advanced 400-level component that would apply to the maintenance and troubleshooting skills of an advanced technician.

The labor-management subject matter experts on the Signal 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 Signals Overview (two modules, levels 100 and 200)

100. Overview

- **100-1. History and Purpose of Signal Systems**
 - 100-1-1. Describe how signals are used to maximize capacity of limited track safely
 - 100-1-2. Describe different failures that caused something to be done to improve the system
 - 100-1-3. Describe different systems that have been used throughout history
- **100-2. Fail safe Principles of Signals**
 - 100-2-1. Describe the importance of train order/time tables
 - 100-2-2. Describe how continuous refinements make the system more fail safe
 - 100-2-3. Explain why system has to fail in a safe manner
- **100-3. Introduction to Track Circuits**
 - 100-3-1. Describe normally energized relays on track circuits
 - 100-3-2. Describe normally de-energized relays on track circuits
 - 100-3-3. Explain how most restrictive aspects/a signal set at “danger”
 - 100-3-4. Define and describe the uses of vital relays
 - 100-3-5. Explain reasons for regular inspection and testing of vital relays
 - 100-3-6. Inspect/test vital relays
 - 100-3-7. Perform vital relay testing
- **100-4. Safety Principles**
 - 100-4-1. Describe process of moving people safely
 - 100-4-2. Explain the how the purpose of system is to keep trains from colliding
- **100-5. Rail Roadway Worker Protection**
- **100-6. Safe Train Operation/Expedited Train Movement**
 - 100-6-1. Demonstrate ability to coordinate track related activities with central dispatch
 - 100-6-2. Describe how individuals responsible for own safety
 - 100-6-3. Describe importance of maintaining awareness of your environment
 - 100-6-4. Describe that human communication is a *vital* part of the process; cannot lose sight of those working on the tracks
 - 100-6-5. Describe the importance of human communications to central control to train mechanics to operators and all staff
 - 100-6-6. Describe the overall layout of your system to reduce your personal risk/injury
 - 100-6-7. Describe why there is a need for more reliable system to track the whereabouts of those working on the tracks for safety reasons
 - 100-6-8. Explain function of permissive proceed signal and how it is unique to each system
 - 100-6-9. Explain purpose of slow zone/work zone
 - 100-6-10. Explain results of failure to comply (high risks and dangers)
 - 100-6-11. Explain rules, policy and procedures at your organization
 - 100-6-12. Explain why there is no room for human error
- **100-7. Regulatory/Regulations (Importance of Testing)**
 - 100-7-1. Demonstrate awareness and comply with rules and regulations
 - 100-7-2. Describe different levels of rules and regulations (company, FRA, FTA, levels of government) and the jurisdiction of each
- **100-8. Signal System Operation**

- 100-8-1. Demonstrate ability to refer to glossary of terms/nomenclature)
- **100-9. Special Tools**
 - 100-9-1. Explain the use and purpose of preventive maintenance and standard operating procedures at your agency
 - 100-9-2. Explain the use of an access vehicle
- **100-10. Test Equipment**
 - NOTE:** Generally these will be specific to individual agencies.
 - 100-10-1. Demonstrate ability to use switch obstruction gauge
 - 100-10-2. Demonstrate ability to use oscilloscope/spectrum analyzer
 - 100-10-3. Demonstrate ability to use shunt strap/shunt cord
 - 100-10-4. Demonstrate ability to use RR volt/ohm meters
 - 100-10-5. Demonstrate ability to use automatic train stop test equipment
 - 100-10-6. Demonstrate ability to use frequency specific volt meters
 - 100-10-7. Demonstrate ability to use IJ checker
 - 100-10-8. Demonstrate ability to use Megger
 - 100-10-9. Demonstrate ability to use relay testers
 - 100-10-10. Demonstrate ability to clamp on amp meter (both AC and DC)
 - 100-10-11. Demonstrate use of surge coils
 - 100-10-12. Demonstrate ability to use stopwatches
- **100-11. Function and purpose of signal equipment and defining nomenclature**
 - 100-11-1. Explain FRA nomenclature
 - 100-11-2. Explain AREMA nomenclature
 - 100-11-3. Explain IEEE nomenclature (developing CBTC)
 - 100-11-4. Explaining the use of barcodes
 - 100-11-5. Explain signal nomenclature
 - 100-11-6. Explain access and use of APTA standards and recommended best practices
- **100-12. Advanced Test Equipment**
 - 100-12-1. Demonstrate ability to maintain, calibrate and care for test equipment
 - 100-12-2. Maintain laptops, software and PTE (portable test equipment)
 - 100-12-3. Maintain packet checker
 - 100-12-4. Demonstrate ability to use clamp-on amp meter (both AC and DC)
 - 100-12-5. Demonstrate ability to use surge coils

200. Overview

- **200-1. Test Equipment (Specialized Testing Equipment)**
 - 200-1-1. Demonstrate ability to maintain, calibrate and care for test equipment
 - 200-1-2. Perform maintenance on test equipment
 - 200-1-3. Demonstrate ability to use and maintain laptops, software and PTE
 - 200-1-4. Perform maintenance on laptops, software and PTE
 - 200-1-5. Perform maintenance on packet checker
- **200-2. Power**
 - 200-2-1. Verify operation of power supply
 - 200-2-2. Check and verify power supply
 - 200-2-3. Check input/output using prints

2.2 Train Control (four modules, levels 100 through 400)

101. Train Control (Intro and Overview)

- **101-1. The fundamentals of DC track circuits**
 - 101-1-1. Understand circuit principles and operations of a DC track circuit
 - 101-1-2. Identify track components
 - 101-1-3. Inspect and perform preventive maintenance on a DC track circuit
- **101-2. Reading track circuit prints and documentation**
 - 101-2-1. Demonstrate ability to use aspect charts
 - 101-2-2. Demonstrate ability to use track plans
 - 101-2-3. Demonstrate ability to use train markers
 - 101-2-4. Demonstrate ability to use electrical prints
 - 101-2-5. Identify equipment location (rack)
 - 101-2-6. Identify control lines
- **101-3. DC Track Circuits and Related Components**
 - 101-3-1. Describe signals and aspects
 - 101-3-2. Demonstrate ability to read schematics
 - 101-3-3. Describe traffic direction
 - 101-3-4. Identify and understand function of rectifier/battery
 - 101-3-5. Identify and understand function of the resistor
 - 101-3-6. Identify and understand function of track fuse
 - 101-3-7. Identify and understand function of down the rail
 - 101-3-8. Identify and understand function of fuse on the relay end
 - 101-3-9. Identify and understand function of 1-to-1 transformer
 - 101-3-10. Identify and understand function of relay
- **101-4. Coded Track Circuits**
 - 101-4-1. Describe how code is transmitted to the rail
 - 101-4-2. Identify components of a coded AC track circuit
 - 101-4-3. Describe difference between train detection and cab signals

201. Train Control (Inspection and Maintenance)

- **201-1. DC Track Circuits Inspection and Maintenance**
 - 201-1-1. Understand function of all DC Track circuit components
 - 201-1-2. Perform an inspection and basic maintenance of full circuit, including:
 - 201-1-3. Demonstrate ability to do track profiles for AC and DC (performance profiles)
 - 201-1-4. Perform shunt test
 - 201-1-5. Demonstrate ability to do polarity check (that polarity is different from one track to the next)
 - 201-1-6. Set up base reference
 - 201-1-7. Inspect and maintain rectifier/battery
 - 201-1-8. Inspect and maintain the resistor
 - 201-1-9. Inspect and maintain track fuse
 - 201-1-10. Inspect and maintain down the rail
 - 201-1-11. Inspect and maintain fuse on the relay end
 - 201-1-12. Inspect and maintain 1-to-1 transformer
 - 201-1-13. Inspect and maintain relay
 - 201-1-14. Inspect and maintain automatic block system

- 201-1-15. Inspect and maintain switch circuit controllers
- 201-1-16. Inspect and maintain repair relay and relay logic circuits
- **201-2. DC track Circuits Basic Troubleshooting**
 - 201-2-1. Identify and correct basic common faults in DC track circuits
 - 201-2-2. Check track voltage at the receive end in the house
 - 201-2-3. Check track voltage at feed end, same as in the house
 - 201-2-4. Inspect for broken rail and wires
 - 201-2-5. Check integrity of insulated joints
- **201-3. AC Track Circuits Inspection and Maintenance**
 - 201-3-1. Understand function of all AC track circuit components
 - 201-3-2. Perform an inspection and basic maintenance of full circuit
 - 201-3-3. Inspect and maintain fuse
 - 201-3-4. Inspect and maintain transformer
 - 201-3-5. Inspect and maintain primary fuse
 - 201-3-6. Inspect and maintain secondary fuse
 - 201-3-7. Inspect and maintain variable resistor
 - 201-3-8. Inspect and maintain track fuse
 - 201-3-9. Inspect and maintain rail
 - 201-3-10. Inspect and maintain bond wires
 - 201-3-11. Inspect and maintain track leads
 - 201-3-12. Inspect and maintain insulated joints
 - 201-3-13. Inspect and maintain fuse on the relay end
 - 201-3-14. Inspect and maintain adjustable resistor
 - 201-3-15. Inspect and maintain isolation transformer (on single-rail track circuits)
 - 201-3-16. Inspect and maintain frequency (60 Hz/100 Hz)
 - 201-3-17. Inspect and maintain impedance bonds
 - 201-3-18. Inspect and maintain narrow and broad band shunts
 - 201-3-19. Inspect and maintain single rail/double rail
 - 201-3-20. Inspect and maintain AC vane relays
 - 201-3-21. Inspect and maintain DC-to-AC code converters
 - 201-3-22. Inspect negative return bonds
- **201-4. AC Track Circuits Basic Troubleshooting**
 - 201-4-1. Identify and correct basic common faults in AC track circuits
 - 201-4-2. Check track voltage at the receive end in the house
 - 201-4-3. Check track voltage at feed end, same as in the house
 - 201-4-4. Inspect rail bonds and for broken rail and wires
 - 201-4-5. Check integrity of insulated joints
 - 201-4-6. Determine whether phase angles are correct
 - 201-4-7. Determine whether a problem is due to a ground or DC propulsion current
- **201-5. Track Circuit Protective Devices Inspection and Maintenance**
 - 201-5-1. Inspect and maintain surge suppressors
 - 201-5-2. Inspect and maintain ground fault detectors
 - 201-5-3. Inspect and maintain lightning arrestors
 - 201-5-4. Inspect and maintain equalizers
 - 201-5-5. Inspect and maintain fuses

- **201-6. Audio Frequency Overlay (AFO) Train Detection Systems Inspection and Maintenance**
 - 201-6-1. Inspect and maintain carrier frequency
 - 201-6-2. Inspect and maintain track frequency
 - 201-6-3. Inspect and maintain power levels
 - 201-6-4. Inspect and maintain transmitters, receivers, transceivers
 - 201-6-5. Inspect and maintain frequency compatibility “for harmonics”
 - 201-6-6. Inspect and maintain common usage areas for overrun circuits
 - 201-6-7. Inspect and maintain transmitter
 - 201-6-8. Inspect and maintain audio frequency overlay
 - 201-6-9. Inspect and maintain phase shift overlay
 - 201-6-10. Inspect and maintain modulated track frequency
 - 201-6-11. Inspect and maintain indicating track occupancy (no train means the relay is up)
 - 201-6-12. Inspect and maintain modulated train/cab frequency (transmitted only when train is present)
 - 201-6-13. Demonstrate ability to transmit speed information
 - 201-6-14. Inspect and maintain twisted pair
 - 201-6-15. Inspect and maintain transmitting mini bond
 - 201-6-16. Inspect and maintain running rail
 - 201-6-17. Inspect and maintain receiving mini bond (tuned to receive signal from the transmitter [frequency selective])
 - 201-6-18. Inspect and maintain receiver
 - 201-6-19. Put out DC voltage to energize the relay
 - 201-6-20. Inspect and maintain track relay (vital relay)
- **201-7. AFO Train Detection Systems Basic Troubleshooting**
 - 201-7-1. Check transmit voltage at test points
 - 201-7-2. Check train transmit voltage and frequency
 - 201-7-3. Check receive voltage at test points
 - 201-7-4. Check track receive voltage
 - 201-7-5. Check voltage input to receive board
 - 201-7-6. Check receive level
 - 201-7-7. Check rail and components
 - 201-7-8. Check track frequency
- **201-8. Coded Track Circuits Inspection and Maintenance**
 - 201-8-1. Inspect and maintain coded track circuit
 - 201-8-2. Inspect and maintain code transmitting and following relays
 - 201-8-3. Inspect and maintain AC coded track

301. Train Control (Troubleshooting and Repair)

- **301-1. DC Track Circuits Troubleshooting**
 - 301-1-1. Follow general troubleshooting process including:
 - Check status; is it working or not?
 - Check for presence of a grounded circuit
 - Check voltage in/out
 - Check relays
 - Check insulated joints
 - Check bonds

- Understand and check track schematics
- Verify rail integrity
- Check feed and relay resistors
- Check feed and relay fuse
- Check track connections and terminations
- Check fouling wires
- Check train transmit voltage and frequency
- 301-1-2. Troubleshoot, adjust or repair 1-to-1 transformer
- 301-1-3. Troubleshoot, adjust or repair fuse on the relay end
- 301-1-4. Troubleshoot, adjust or repair relay
- 301-1-5. Troubleshoot, adjust or repair the rectifier/battery
- 301-1-6. Troubleshoot, adjust or repair the resistor
- 301-1-7. Troubleshoot and repair interlocking (verify request/response)
- 301-1-8. Troubleshoot and repair automatic block system
- 301-1-9. Troubleshoot and repair switch circuit controllers
- 301-1-10. Troubleshoot and repair relay and relay logic circuits
- 301-1-11. Troubleshoot and repair track circuit
- 301-1-12. Troubleshoot and repair a circuit ground
- **301-2. AC Track Circuits Troubleshooting**
 - 301-2-1. Troubleshoot, adjust or repair adjustable resistor
 - 301-2-2. Troubleshoot, adjust or repair frequency (60 Hz/100 Hz)
 - 301-2-3. Troubleshoot, adjust or repair fuse on the relay end
 - 301-2-4. Troubleshoot, adjust or repair insulated joints
 - 301-2-5. Troubleshoot, adjust or repair isolation transformer (on single-rail track circuits)
 - 301-2-6. Troubleshoot, adjust or repair track leads
 - 301-2-7. Troubleshoot, adjust or repair bond wires
 - 301-2-8. Troubleshoot, adjust or repair fuse
 - 301-2-9. Troubleshoot, adjust or repair primary fuse
 - 301-2-10. Troubleshoot, adjust or repair secondary fuse
 - 301-2-11. Troubleshoot, adjust or repair track fuse
 - 301-2-12. Troubleshoot, adjust or repair transformer
 - 301-2-13. Troubleshoot, adjust or repair variable resistor
 - 301-2-14. Troubleshoot, adjust or repair AC vane relays
 - 301-2-15. Troubleshoot, adjust or repair DC-to-AC code converters
 - 301-2-16. Troubleshoot, adjust or repair impedance bonds
 - 301-2-17. Troubleshoot, adjust or repair narrow and broad band shunts
 - 301-2-18. Troubleshoot, adjust or repair single rail/double rail
 - 301-2-19. Test voltage on secondary transformer
 - 301-2-20. Troubleshoot and repair a circuit ground
- **301-3. Track Circuit Protective Devices Troubleshooting**
 - 301-3-1. Troubleshoot, adjust or repair equalizers
 - 301-3-2. Troubleshoot, adjust or repair fuses
 - 301-3-3. Troubleshoot, adjust or repair ground fault detectors
 - 301-3-4. Troubleshoot, adjust or repair lightning arrestors
 - 301-3-5. Troubleshoot, adjust or repair surge suppressors
- **301-4. AFO Train Detection Systems Troubleshooting**

301-4-1. Follow general troubleshooting process including:

- Adjust transmit voltage and receive voltage
- Use of frequency selective (or specific) voltmeter

301-4-2. Troubleshoot, adjust or repair carrier frequency

301-4-3. Troubleshoot, adjust or repair common usage areas for overrun circuits

301-4-4. Troubleshoot, adjust or repair frequency compatibility “for harmonics”

301-4-5. Troubleshoot, adjust or repair power levels

301-4-6. Troubleshoot, adjust or repair track frequency

301-4-7. Troubleshoot, adjust or repair transmitter

301-4-8. Troubleshoot, adjust or repair transmitters, receivers, transceivers

301-4-9. Troubleshoot, adjust or repair modulated train/cab frequency

301-4-10. Troubleshoot, adjust or repair audio frequency overlay

301-4-11. Troubleshoot, adjust or repair indicating track occupancy

301-4-12. Troubleshoot, adjust or repair modulated track frequency

301-4-13. Troubleshoot, adjust or repair phase shift overlay

301-4-14. Troubleshoot, adjust or repair receiver

301-4-15. Troubleshoot, adjust or repair receiving mini bond

301-4-16. Troubleshoot, adjust or repair track relay (vital relay)

301-4-17. Troubleshoot, adjust or repair transmitting mini bond

301-4-18. Troubleshoot, adjust or repair twisted pair

301-4-19. Put out DC voltage to energize the relay

301-4-20. Replace circuit board with proper frequency

- **301-5. Interlocking Troubleshooting**

301-5-1. Describe how interlocking may be controlled by automatic, remote or local control

301-5-2. Describe how interlocking may be controlled by all three, one at a time

301-5-3. Troubleshoot and repair event recorders

- **301-6. Using Frequency Shift Key (FSK)**

- **301-7. Coded Track Circuit Troubleshooting**

301-7-1. Troubleshoot, adjust or repair AC coded track

301-7-2. Troubleshoot, adjust or repair code transmitting and following relays

301-7-3. Troubleshoot, adjust or repair coded track circuit

- **301-8. Advanced Track Circuit and Transmission/Receiving Troubleshooting**

301-8-1. Check train transmit voltage and frequency

401. Train Control (Installation, Rebuild, Setup and Testing)

- **401-1. DC Track Circuits Installation, Rebuild and Testing**

401-1-1. Install, replace, rebuild, set up or test 1-to-1 transformer

401-1-2. Install, replace, rebuild, set up or test fuse on the relay end

401-1-3. Install, replace, rebuild, set up or test relay

401-1-4. Install, replace, rebuild, set up or test the rectifier/battery

401-1-5. Install, replace, rebuild, set up or test the resistor

- **401-2. AC Track Circuits Installation, Rebuild and Testing**

401-2-1. Install, replace, rebuild, set up or test AC vane relays

401-2-2. Install, replace, rebuild, set up or test DC-to-AC code converters

401-2-3. Install, replace, rebuild, set up or test impedance bonds

401-2-4. Install, replace, rebuild, set up or test narrow and broad band shunts

401-2-5. Install, replace, rebuild, set up or test single rail/double rail

- 401-2-6. Install, replace, rebuild, set up or test adjustable resistor
- 401-2-7. Install, replace, rebuild, set up or test frequency (60 Hz/100 Hz)
- 401-2-8. Install, replace, rebuild, set up or test fuse on the relay end
- 401-2-9. Install, replace, rebuild, set up or test insulated joints
- 401-2-10. Install, replace, rebuild, set up or test isolation transformer (on single-rail track circuits)
- 401-2-11. Install, replace, rebuild, set up or test track leads
- 401-2-12. Install, replace, rebuild, set up or test bond wires
- 401-2-13. Install, replace, rebuild, set up or test fuse
- 401-2-14. Install, replace, rebuild, set up or test primary fuse
- 401-2-15. Install, replace, rebuild, set up or test secondary fuse
- 401-2-16. Install, replace, rebuild, set up or test track fuse
- 401-2-17. Install, replace, rebuild, set up or test transformer
- 401-2-18. Install, replace, rebuild, set up or test variable resistor
- **401-3. Audio Frequency Overlay Installation, Rebuild and Testing**
 - 401-3-1. Install, replace, rebuild, set up or test modulated train/cab frequency
 - 401-3-2. Install, replace, rebuild, set up or test audio frequency overlay
 - 401-3-3. Install, replace, rebuild, set up or test indicating track occupancy
 - 401-3-4. Install, replace, rebuild, set up or test modulated track frequency
 - 401-3-5. Install, replace, rebuild, set up or test phase shift overlay
 - 401-3-6. Install, replace, rebuild, set up or test receiver
 - 401-3-7. Install, replace, rebuild, set up or test receiving mini bond
 - 401-3-8. Install, replace, rebuild, set up or test track relay (vital relay)
 - 401-3-9. Install, replace, rebuild, set up or test transmitting mini bond
 - 401-3-10. Install, replace, rebuild, set up or test twisted pair
 - 401-3-11. Put out DC voltage to energize the relay
 - Install DC voltage to energize the relay
 - 401-3-12. Install, replace, rebuild, set up or test carrier frequency
 - 401-3-13. Install, replace, rebuild, set up or test common usage areas for overrun circuits
 - 401-3-14. Install, replace, rebuild, set up or test frequency compatibility “for harmonics”
 - 401-3-15. Install, replace, rebuild, set up or test power levels
 - 401-3-16. Install, replace, rebuild, set up or test track frequency
 - 401-3-17. Install, replace, rebuild, set up or test transmitter
 - 401-3-18. Install, replace, rebuild, set up or test transmitters, receivers, transceivers
- **401-4. Coded Track Circuits Installation, Rebuild and Testing**
 - 401-4-1. Install, replace, rebuild, set up or test AC coded track
 - 401-4-2. Install, replace, rebuild, set up or test code transmitting and following relays
 - 401-4-3. Install, replace, rebuild, set up or test coded track circuit
- **401-5. Track Circuit Protective Devices Installation, Rebuild and Testing**
 - 401-5-1. Install, replace, rebuild, set up or test equalizers
 - 401-5-2. Install, replace, rebuild, set up or test fuses
 - 401-5-3. Install, replace, rebuild, set up or test ground fault detectors
 - 401-5-4. Install, replace, rebuild, set up or test lightning arrestors
 - 401-5-5. Install, replace, rebuild, set up or test surge suppressors

2.3 Turnouts/Switches (four modules, levels 100 through 400)

102. Turnouts (Intro and Overview)

- **102-1. Turnout Layout and Components**
 - 102-1-1. Describe theory of operation and purpose of turnouts
 - 102-1-2. Overview of turnout prints
 - 102-1-3. Describe turnout components: rail, frogs, points, etc.
 - 102-1-4. Describe purpose and components of point detection
 - 102-1-5. Describe purpose and components of electric/mechanical locks
- **102-2. Types of Switches**
 - 102-2-1. Describe theory of operation; how do switches work?
 - 102-2-2. Describe main features of various types of switches

202. Turnouts (Inspection and Maintenance)

- **202-1. Understanding Layout prints**
 - 202-1-1. Demonstrate ability to read switch layout prints (specs, dimensions and tolerances)
 - 202-1-2. Demonstrate ability to read and understand diagrams, prints and schematics
- **202-2. Switch Layout and Components, Inspection and Maintenance**
 - 202-2-1. Perform inspection (maintenance and adjustment)
 - 202-2-2. Perform obstruction tests
 - 202-2-3. Inspect/test and maintain detector rods (indication rod)
 - 202-2-4. Inspect/test and maintain electric switch lock
 - 202-2-5. Inspect/test and maintain lock rod
 - 202-2-6. Inspect/test and maintain switch circuit controller and/or external circuit controller
 - 202-2-7. Inspect/test and maintain switch layout
 - 202-2-8. Inspect/test and maintain throw rod
 - 202-2-9. Inspect/test and maintain track components (rail, frogs, points)
 - 202-2-10. Reference fouling wires and circuits (from other modules)
 - 202-2-11. Explain relationship between various turnout components
 - 202-2-12. Inspect/test and maintain bonds
 - 202-2-13. Inspect/test and maintain fouling wires and circuits
 - 202-2-14. Perform preventive maintenance tasks according to regulations or manufacturer's specifications
- **202-3. Power Switch Inspection and Maintenance**
 - 202-3-1. Perform inspection (maintenance and adjustment)
 - 202-3-2. Inspect/test and maintain air source
 - 202-3-3. Inspect/test and maintain hydraulic switch
 - 202-3-4. Inspect/test and maintain electric (AC/DC) switch machines
 - 202-3-5. Inspect/test and maintain pneumatic switch
 - 202-3-6. Inspect/test and maintain solenoid switch
 - 202-3-7. Inspect/test and maintain switch heaters/snow melters
- **202-4. Hand Throw Switches Inspection and Maintenance**
 - 202-4-1. Inspect/test and maintain electric/mechanical locks
 - 202-4-2. Inspect/test and maintain spring switch
 - 202-4-3. Inspect/test and maintain slap switch or variable point switch

302. Turnouts (Troubleshooting and Repair)

- **302-1. Switch Layout and Components Troubleshooting**

- 302-1-1. Troubleshoot, adjust or repair connecting rods
- 302-1-2. Troubleshoot, adjust or repair detector rods (indication rod)
- 302-1-3. Troubleshoot, adjust or repair electric switch lock
- 302-1-4. Troubleshoot, adjust or repair lock rod
- 302-1-5. Troubleshoot, adjust or repair switch circuit controller
- 302-1-6. Troubleshoot, adjust or repair switch layout
- 302-1-7. Troubleshoot, adjust or repair throw rod
- 302-1-8. Troubleshoot, adjust or repair track components (rail, frogs, points)
- **302-2. Power Switch Troubleshooting**
 - 302-2-1. Troubleshoot, adjust or repair electric/mechanical locks
 - 302-2-2. Troubleshoot, adjust or repair hydraulic switch
 - 302-2-3. Troubleshoot, adjust or repair motor AC/DC
 - 302-2-4. Troubleshoot, adjust or repair pneumatic switch
 - 302-2-5. Troubleshoot, adjust or repair power (electric) switch
 - 302-2-6. Troubleshoot, adjust or repair solenoid switch
 - 302-2-7. Troubleshoot, adjust or repair spring switch
 - 302-2-8. Troubleshoot, adjust or repair switch circuit controller
 - 302-2-9. Troubleshoot, adjust or repair switch heaters/snow melters

402. Turnouts (Installation, Rebuild, Setup and Advanced Testing)

- **402-1. Switch Layout and Components Installation, Rebuild and Testing**
 - 402-1-1. Install, replace, rebuild, set up and/or test connecting rods
 - 402-1-2. Install, replace, rebuild, set up and/or test detector rods (indication rod)
 - 402-1-3. Install, replace, rebuild, set up and/or test electric switch lock
 - 402-1-4. Install, replace, rebuild, set up and/or test hydraulic switch
 - 402-1-5. Install, replace, rebuild, set up and/or test lock rod
 - 402-1-6. Install, replace, rebuild, set up and/or test switch circuit controller
 - 402-1-7. Install, replace, rebuild, set up and/or test switch layout
 - 402-1-8. Install, replace, rebuild, set up and/or test throw rod
 - 402-1-9. Install, replace, rebuild, set up and/or test track components (rail, frogs, points)
- **402-2. Power Switch Installation, Rebuild and Testing**
 - 402-2-1. Install, replace, rebuild, set up and/or test electric/mechanical locks
 - 402-2-2. Install, replace, rebuild, set up and/or test hydraulic switch
 - 402-2-3. Install, replace, rebuild, set up and/or test motor AC/DC
 - 402-2-4. Install, replace, rebuild, set up and/or test pneumatic switch
 - 402-2-5. Install, replace, rebuild, set up and/or test power (electric) switch
 - 402-2-6. Install, replace, rebuild, set up and/or test solenoid switch
 - 402-2-7. Install, replace, rebuild, set up and/or test spring switch
 - 402-2-8. Install, replace, rebuild, set up and/or test switch heaters/snow melters

2.4 Grade Crossing (four modules, levels 100 through 400)

103. Grade Crossing (Intro and Overview)

- **103-1. Grade Crossing Warning System Theory and Operation**
 - 103-1-1. Describe grade crossing warning systems history
 - 103-1-2. Describe equipment, circuits and warning devices
 - 103-1-3. Describe grade crossing types, (gated and non-gated) and levels of protection

103-1-4. Describe types of warning systems, constant warning time vs. fixed distance warning

103-1-5. Describe regulations pertaining to grade crossings

103-1-6. Describe types and operation of gate mechanisms

203. Grade Crossing (Inspection and Maintenance)

- **203-1. Grade Crossing Inspection and Maintenance**

203-1-1. Perform preventive maintenance tasks according to regulations or manufacturer's specs, including items below:

203-1-2. Inspect and maintain warning devices (gates, warning lights, signage, bells and grade)

203-1-3. Inspect and maintain grade crossing controls (prediction/protection)

203-1-4. Inspect and maintain crossing structures

203-1-5. Inspect and maintain crossing signage

203-1-6. Inspect and maintain barriers/gate arm

203-1-7. Inspect and maintain gate mechanisms

203-1-8. Inspect and maintain approach and island circuits

203-1-9. Inspect and maintain non-gated grade crossing

203-1-10. Inspect and maintain event recorders/monitoring equipment

203-1-11. Inspect and maintain quad gates

203-1-12. Inspect and maintain traffic signal interface (preemption)

203-1-13. Perform a post accident inspection

303. Grade Crossing (Troubleshooting and Repair)

- **303-1. Grade Crossing Warning System Troubleshooting and Repair**

303-1-1. Troubleshoot causes of false activations and activation failures

303-1-2. Explain processes for if a warning system cannot be repaired promptly

303-1-3. Troubleshoot, adjust or repair warning devices (gates, warning lights, signage, bells and grade)

303-1-4. Troubleshoot, adjust or repair grade crossing controls (prediction/protection)

303-1-5. Troubleshoot, adjust or repair crossing structures

303-1-6. Troubleshoot, adjust or repair crossing signage

303-1-7. Troubleshoot, adjust or repair barriers/gate arm

303-1-8. Troubleshoot, adjust or repair gate mechanisms

303-1-9. Troubleshoot, adjust or repair approach and island circuits

303-1-10. Troubleshoot, adjust or repair non gated grade crossing

303-1-11. Troubleshoot, adjust or repair event recorders/monitoring equipment

303-1-12. Troubleshoot, adjust or repair quad gates

303-1-13. Troubleshoot, adjust or repair traffic signal interface (preemption)

403. Grade Crossing (Installation, Rebuild, Setup and Testing)

- **403-1. Grade Crossing Warning System Installation, Rebuild, Setup and Testing**

403-1-1. Explain how to safely disable a crossing to facilitate emergency repairs

403-1-2. Demonstrate track circuit frequency selection for grade crossing repairs

403-1-3. Install, replace, set up or test warning devices (gates, warning lights, signage, bells and grade)

403-1-4. Install, replace, set up or test grade crossing controls (prediction/protection)

- 403-1-5. Install, replace, set up or test crossing structures
- 403-1-6. Install, replace, set up or test crossing signage
- 403-1-7. Install, replace, set up or test barriers/gate arm
- 403-1-8. Install, replace, set up or test gate mechanisms
- 403-1-9. Install, replace, set up or test approach and island circuits
- 403-1-10. Install, replace, set up or test non gated grade crossing
- 403-1-11. Install, replace, set up or test event recorders/monitoring equipment
- 403-1-12. Install, replace, set up or test quad gates

2.5 Power Distribution (four modules, levels 100 through 400)

104. Power Distribution (Intro and Overview)

- **104-1. Power Distribution Theory and Operation**
 - 104-1-1. Describe theory of operation of local power distribution system
- **104-2. Primary Power Sources and System Components**
 - 104-2-1. Demonstrate ability to read schematics
 - 104-2-2. Describe how incoming power comes from utilities, the types of power and its uses for signaling systems
 - 104-2-3. Describe operation of breakers
 - 104-2-4. Describe power source
 - 104-2-5. Explain how to sectionalize power sources for testing and troubleshooting and repair on low and high tension
 - 104-2-6. Explain how to properly phase different power sources
 - 104-2-7. Explain how to use voltage tester and phasing tester
 - 104-2-8. Explain how to perform insulation testing and cable fault testing on low and high tension sources
 - 104-2-9. Describe theory of operation of pneumatic power distribution system
 - 104-2-10. Explain how to sectionalize power sources for testing and troubleshooting and repair on pneumatic systems

204. Power Distribution (Inspection and Maintenance)

- **204-1. Primary Power Sources, Inspection and Maintenance**
 - 204-1-1. Demonstrate ability to troubleshoot using a meter
 - 204-1-2. Inspect and maintain DC power rectified
 - 204-1-3. Inspect and maintain frequency converters
 - 204-1-4. Inspect and maintain rectifiers
 - 204-1-5. Inspect and maintain solar panels
 - 204-1-6. Inspect and maintain Transfer switches
 - 204-1-7. Inspect and maintain transformer, circuit breakers, cables
 - 204-1-8. Inspect and maintain pneumatic supplies and allied equipment
- **204-2. Secondary power sources inspection and maintenance**
 - 204-2-1. Demonstrate ability to troubleshoot using a meter
 - 204-2-2. Inspect and maintain batteries
 - 204-2-3. Inspect and maintain chargers
 - 204-2-4. Inspect and maintain inverters
 - 204-2-5. Inspect and maintain rectifiers
 - 204-2-6. Inspect and maintain secondary power

- 204-2-7. Inspect and maintain solar panels
- 204-2-8. Inspect and maintain UPS (emergency or standby power)
- **204-3. Power Distribution System Inspection and Maintenance**
 - 204-3-1. Demonstrate ability to troubleshoot using a meter
 - 204-3-2. Inspect and maintain AC power
 - 204-3-3. Inspect and maintain batteries
 - 204-3-4. Inspect and maintain chargers
 - 204-3-5. Inspect and maintain DC power rectified
 - 204-3-6. Inspect and maintain primary power
 - 204-3-7. Inspect and maintain rectifiers
 - 204-3-8. Inspect and maintain solar panels
 - 204-3-9. Inspect and maintain transfer switches
 - 204-3-10. Inspect and maintain transformer, circuit breakers, cables
 - 204-3-11. Inspect and maintain UPS (emergency or standby power)

304. Power Distribution (Troubleshooting and Repair)

- **304-1. Primary Power Sources, Troubleshooting**
 - 304-1-1. Troubleshoot, adjust or repair AC power
 - 304-1-2. Troubleshoot, adjust or repair DC power rectified
 - 304-1-3. Troubleshoot, adjust or repair rectifiers
 - 304-1-4. Troubleshoot, adjust or repair transformer, circuit breakers, cables
 - 304-1-5. Troubleshoot, adjust or repair grounds; determine what type of ground is present
 - 304-1-6. Replace a rectifier
- **304-2. Secondary Power Sources Troubleshooting**
 - 304-2-1. Troubleshoot and replace batteries
 - 304-2-2. Troubleshoot and replace chargers
 - 304-2-3. Troubleshoot and replace inverters
 - 304-2-4. Troubleshoot, adjust or repair secondary power
 - 304-2-5. Troubleshoot, adjust or repair UPS (emergency or standby power)
- **304-3. Power Distribution System Troubleshooting**
 - 304-3-1. Troubleshoot, adjust or repair AC power
 - 304-3-2. Troubleshoot and replace batteries
 - 304-3-3. Troubleshoot and replace chargers
 - 304-3-4. Troubleshoot and replace frequency converters
 - 304-3-5. Troubleshoot and replace inverters
 - 304-3-6. Troubleshoot, adjust or repair primary power
 - 304-3-7. Troubleshoot, adjust or repair rectifiers
 - 304-3-8. Troubleshoot, adjust or repair transfer switches
 - 304-3-9. Troubleshoot, adjust or repair transformer, circuit breakers, cables
 - 304-3-10. Troubleshoot, adjust or repair UPS (emergency or standby power)
 - 304-3-11. Troubleshoot, adjust, or repair air equipment, such as pneumatic train stops and switches. Sectionalize air mains
 - 304-3-12. Perform ground detection testing

404. Power Distribution (Installation, Rebuild, Setup and Testing)

- **404-1. Primary Power Sources Installation**
 - 404-1-1. Install, replace, rebuild, set up or test AC power

- 404-1-2. Install, replace, rebuild, set up or test batteries
- 404-1-3. Install, replace, rebuild, set up or test chargers
- 404-1-4. Install, replace, rebuild, set up or test DC power rectified
- 404-1-5. Install, replace, rebuild, set up or test frequency converters
- 404-1-6. Install, replace, rebuild, or set up inverters
- 404-1-7. Install, replace, rebuild, set up or test primary power
- 404-1-8. Install, replace, rebuild, set up or test rectifiers
- 404-1-9. Install, replace, rebuild, set up or test transfer switches
- 404-1-10. Install, replace, rebuild, set up or test transformer, circuit breakers, cables
- 404-1-11. Install, replace, rebuild, set up or test UPS (emergency or standby power)
- **404-2. Secondary Power Source Installation**
 - 404-2-1. Install, replace, rebuild, set up or test AC power
 - 404-2-2. Install, replace, rebuild, set up or test frequency converters
 - 404-2-3. Install, replace, rebuild, set up or test meter
 - 404-2-4. Install, replace, rebuild, set up or test transfer switches
 - 404-2-5. Install, replace, rebuild, set up or test transformer, circuit breakers, cables
- **404-3. Power Distribution System Installation**
 - 404-3-1. Install, replace, rebuild, set up or test batteries
 - 404-3-2. Install, replace, rebuild, set up or test chargers
 - 404-3-3. Install, replace, rebuild, set up or test inverters
 - 404-3-4. Install, replace, rebuild, set up or test secondary power
 - 404-3-5. Install, replace, rebuild, set up or test UPS (emergency or standby power)

2.6 Signals (three modules, levels 200 through 400)

205. Signals (Inspection and Maintenance)

- **205-1. Signaling Systems Inspection and Maintenance**
 - 205-1-1. Inspect/test and maintain automatic train protection (ATP)
 - 205-1-2. Inspect/test and maintain automatic train operation (ATO)
 - 205-1-3. Inspect/test and maintain automatic train supervision (ATS)
- **205-2. Wayside Signaling Inspection and Maintenance**
 - 205-2-1. Inspect/test and maintain automatic block system (ABS)
 - 205-2-2. Inspect/test and maintain wayside signaling
 - 205-2-3. Inspect/test and maintain interlocking signal system
- **205-3. Train Wayside Communication (TWC) Inspection and Maintenance**
 - 205-3-1. Inspect/test and maintain movable block
 - 205-3-2. Inspect/test and maintain communication-based train control (CBTC)
 - 205-3-3. Inspect/test and maintain positive train separation (PTS)
 - 205-3-4. Inspect/test and maintain automatic train control (ATC)

305. Signals (Troubleshooting and Repair)

- **305-1. Signaling Systems Troubleshooting**
 - 305-1-1. Troubleshoot, adjust and/or repair automatic train protection (ATP)
 - 305-1-2. Troubleshoot, adjust and/or repair automatic train operation (ATO)
 - 305-1-3. Troubleshoot, adjust and/or repair automatic train supervision (ATS)
 - 305-1-4. Troubleshoot, adjust and/or repair centralized traffic control
 - 305-1-5. Troubleshoot, adjust and/or repair advanced train control system (ATCS)
 - 305-1-6. Troubleshoot, adjust and/or repair advanced automatic train control (AATC)

- **305-2. Wayside Signaling Troubleshooting**
 - 305-2-1. Troubleshoot, adjust and/or repair automatic block system (ABS)
 - 305-2-2. Troubleshoot, adjust and/or repair wayside signaling
 - 305-2-3. Troubleshoot, adjust and/or repair interlocking signal system
- **305-3. Train Wayside Communication (TWC) Troubleshooting**
 - 305-3-1. Troubleshoot, adjust and/or repair movable Block
 - 305-3-2. Troubleshoot, adjust and/or repair communication-based train control (CBTC)
 - 305-3-3. Troubleshoot, adjust and/or repair positive train separation (PTS)
 - 305-3-4. Troubleshoot, adjust and/or repair automatic train control (ATC)

405. Signals (Installation, Rebuild, Setup and Advanced Testing)

- **405-1. Signaling Systems Installation, Rebuild and Setup**
 - 405-1-1. Install, rebuild, set up and/or test automatic train protection (ATP)
 - 405-1-2. Install, rebuild, set up and/or test automatic train operation (ATO)
 - 405-1-3. Install, rebuild, set up and/or test automatic train supervision (ATS)
 - 405-1-4. Install, rebuild, set up and/or test centralized traffic control
 - 405-1-5. Install, rebuild, set up and/or test advanced train control system (ATCS)
 - 405-1-6. Install, rebuild, set up and/or test advanced automatic train control (AATC)
- **405-2. Wayside Signaling Installation, Rebuild and Setup**
 - 405-2-1. Install, rebuild, set up and/or test automatic block system (ABS)
 - 405-2-2. Install, rebuild, set up and/or test interlocking signal system
- **405-3. Train Wayside Communication (TWC) Installation, Rebuild and Setup**
 - 405-3-1. Install, rebuild, set up and/or test movable block
 - 405-3-2. Install, rebuild, set up and/or test communication-based train control (CBTC)
 - 405-3-3. Install, rebuild, set up and/or test positive train separation (PTS)
 - 405-3-4. Install, rebuild, set up and/or test automatic train control (ATC)

2.7 Train Stops (three modules, levels 200 through 400)

206. Train Stops (Inspection and Maintenance)

- **206-1. Mechanical**
 - 206-1-1. Demonstrate ability to understand electrical prints and ground equipment diagrams
 - 206-1-2. Explain operation of train stops
 - 206-1-3. Inspect/test and maintain mechanical parts
 - 206-1-4. Inspect/test/maintain speed enforcement system (wheel detector)
- **206-2. Magnetics**
 - 206-2-1. Inspect/test and maintain magnetic stops
- **206-3. Wheel Pickups**
 - 206-3-1. Inspect/test and maintain wheel pickups
- **206-4. De-rail**
 - 206-4-1. Inspect/test and maintain de-rail

306. Train Stops (Troubleshooting and Repair)

- **306-1. Mechanical**
 - 306-1-1. Troubleshoot, adjust or repair mechanical parts
 - 306-1-2. Identify which modules interface with the trip stop
- **306-2. Magnetics**
 - 306-2-1. Troubleshoot, adjust or repair magnetic stops

- **306-3. Wheel Pickups**
306-3-1. Troubleshoot, adjust or repair wheel pickups
- **306-4. De-rail**
306-4-1. Troubleshoot, adjust or repair de-rail

406. Train Stops (Installation, Rebuild, Setup and Advanced Testing)

- **406-1. De-rail**
406-1-1. Install, rebuild, or set up de-rail
- **406-2. Magnetics**
406-2-1. Install, rebuild, or set up magnetic stops
- **406-3. Mechanical**
406-3-1. Use track install diagram
406-3-2. Install, replace, rebuild, or set up mechanical parts
- **406-4. Wheel Pickups**
406-4-1. Install, rebuild or set up wheel pickups

2.8 Interlocking (two modules, levels 100 and 200)

107. Interlocking (Intro and Overview)

- **107-1. Explain Concepts of Interlocking Operation**

207. Interlocking (Inspection and Maintenance)

- **207-1 Interlocking**
207-1-1. Inspect and maintain manual interlocking
207-1-2. Inspect and maintain automatic interlocking

307. Interlocking (Troubleshooting and Repair)

- **307-1. Troubleshooting Interlocks**
307-1-1. Perform route locking test
307-1-2. Perform approach locking test
307-1-3. Perform time locking test
307-1-4. Perform traffic locking test
307-1-5. Perform indication locking test
307-1-6. Download and read event reports

2.9 Control Panels (three modules, levels 200 through 400)

208. Control Panels (Inspection and Maintenance)

- **208-1. Local Control Panels/Human-Machine Interfaces (HMI)**
208-1-1. Inspect and maintain components
208-1-2. Inspect and maintain safety tool
208-1-3. Inspect and maintain communication-based train control (GPS)
208-1-4. Demonstrate ability to read control panel schematics
208-1-5. Identify functions of each light, button or key
208-1-6. Explain each panels function as it relates to interlocking
208-1-7. Replace light indicators and switches
- **208-2. New Technology**
208-2-1. Inspect and maintain electronic track circuit
208-2-2. Inspect and maintain programmable logic controllers

- 208-2-3. Inspect and maintain solid state interlocking
- 208-2-4. Inspect and maintain computer based interlocking

308 Control Panels (Troubleshooting and Repair)

- **308-1. Local Control Panels/Human-Machine Interfaces (HMI)**
 - 308-1-1. Troubleshoot, adjust or repair control panel components
 - 308-1-2. Use control panel to troubleshoot the interlocking
 - 308-1-3. Troubleshoot, adjust or repair communication-based train control (GPS)
- **308-2. New Technology**
 - 308-2-1. Troubleshoot, adjust or repair electronic track circuit
 - 308-2-2. Troubleshoot and repair PLCs (programmable logic controllers)
 - 308-2-3. Troubleshoot and repair solid state interlocking
 - 308-2-4. Troubleshoot and repair solid computer based interlocking

408 Control Panels (Installation, Rebuild, Setup and Testing)

- **408-1. Local Control Panels/Human-Machine Interfaces (HMI)**
 - 408-1-1. Fulfilling testing requirements
 - 408-1-2. Install or replace control panels
 - 408-1-3. Perform simulations to test interlocking
- **408-2. New Technology**
 - 408-2-1. Install, replace, rebuild, set up or test electronic track circuit

References

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

Abbreviations and acronyms

AATC	advanced automatic train control
APTA	American Public Transportation Association
ABS	automatic block system
AC	alternating current
AFO	audio frequency overlay
AREMA	American Railway Engineering and Maintenance-of-Way Association
ATC	automatic train control
ATCS	advanced train control system
ATO	automatic train operation
ATP	automatic train protection
ATS	Automatic Train Supervision
ATU	Amalgamated Transit Union
CBTC	communication-based train control
CTA	Chicago Transit Authority
DC	direct current
FRA	Federal Railroad Administration
FSK	frequency shift key
FTA	Federal Transit Administration
GPS	Global Positioning System
HMI	human-machine interfaces
Hz	hertz
IBEW	International Brotherhood of Electrical Workers
IEEE	Institute of Electrical and Electronic Engineers
LACMTA	Los Angeles County Metropolitan Transportation Authority
MTS	Metropolitan Transit System (San Diego)
PLC	programmable logic controllers
PTE	portable test equipment
PTS	positive train separation
TCRP	Transit Cooperative Research Program
TWC	train wayside communication
UPS	uninterruptable power supply