

Rail Traction Power Training Content and Standards
Revised in response to APTA comments

ID	<u>Module Title</u>	
		<i>Responsibilities / Course Content</i>
		<i>Tasks / Learning Objectives</i>
100 Level Modules -- Traction Power Systems Introduction and Overview		
100	<i>Introduction to Traction Power (Safety, Security, History)</i>	
100-1	<i>Understanding History of Traction Power Systems</i>	
100-2	<i>Understanding and following Traction Power Safety Practices</i>	
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. deenergized 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 (Sacto)	
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	<i>Understanding Traction Power Security Related Procedures</i>	
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	<i>Understanding Regulatory agency authority</i>	
100-4-1	Describe state and federal regulation related to traction power systems	
100-5	<i>Understanding ANSI System</i>	
100-5-1	Explain design of traction power system includes ANSI and IEEE standards	
100-6	<i>Using specialized Traction Power tools</i>	
100-6-1	Demonstrate ability to use hot stick	
100-6-2	Demonstrate ability to use meters - multimeters, DVM	

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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	<i>Power Distribution (Intro and Overview of Theory and Operation)</i>	
102-1	<i>Purpose and methods of power distribution</i>	
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	<i>How a traction power system works</i>	
102-2-1	Follow and describe the local functional order of a traction power system, including:	
	Utility, through circuitbreaker, 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	

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102-2-8		Describe negative feeder cables
102-2-9		Describe operation of Battery Back-up Power systems (UPS)
102-2-10		Describe fault annunciation
102-2-11		Describe transfer trip
102-3	<i>Describe function and components of substations</i>	
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	<i>Describe function and components of overhead contact system</i>	
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. deenergized (sectioning wiring)
102-5	<i>Describe function and components of overhead catenary system</i>	
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. deenergized (sectioning wiring)
102-6	<i>Describe function and components of third rail systems</i>	
102-6-1		Describe impedance bonds
102-6-2		Describe sectionalization
102-6-3		Explain energized vs. deenergized

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102-6-4		Describe differences between third rail power and overhead power systems
102-6-5		Weld third rail feed cables
102-7		<i>DC Theory and power components</i>
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		<i>Power Distribution Systems</i>
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		<i>Bond types and methods</i>
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 extentsions to the structure; create structure bonds
102-10		<i>Impedance bonds</i>
102-10-1		Describe traction power in context of the track circuit
102-10-2		Describe purpose of impedance bonds
102-11		<i>Circuit breakers and protective devices</i>
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		<i>Understand source of power for switch heaters / snow melters</i>
102-13		<i>Understanding Cathodic Protection</i>
102-13-1		Define cathodic protection principles
102-13-2		Describe principle of stray current
108		<u>Linear induction</u>

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200 Level Modules -- Traction Power Systems Inspection and Maintenance		
200	<u>Understanding and Following PM Programs</u>	
200-1		<i>Add content from agency specific PM programs</i>
200-2		<i>Teach general best practices and concepts of Preventive maintenance</i>
202	<u>Power Distribution and control Systems (Inspection and Maintenance)</u>	
202-1	<i>AC Power systems (Inspection and Maintenance)</i>	
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	<i>DC Power systems (Inspection and Maintenance)</i>	
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	<i>Bond types and methods</i>	
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	<u>Substations (Inspection and Maintenance)</u>	
203-1	<i>Read and interpret circuit prints</i>	
203-1-1		Explain ANSI/IEEE nomenclature
203-1-2		Explain and interpret local prints
203-2	<i>Inspect and maintain substation components</i>	
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

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		<i>Responsibilities / Course Content</i>
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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		<i>Describe and follow prescribed substation PM procedures</i>
204	<u>Overhead Contact System (Inspection and Maintenance)</u>	
204-1		<i>Preparing to work on Overhead Contact system</i>
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. deenergized
204-2		<i>Demonstrate process of determining whether energized vs. deenergized (sectioning wiring)</i>
204-2-1		Verify whether OCS is de-energized
204-2-2		Demonstrate proper application of a ground strap
204-3		<i>Inspecting and maintaining overhead contact system components</i>
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		<i>Check section insulation (various types)</i>
204-1-1		Check arc horns
204-1-2		Check rumes
204-1-3		Check support structure
204-5		<i>Inspect and maintain overhead system</i>
204-5-1		Tighten and adjust cable
204-5-2		Grease wheels on auto tension system where applicable
204-6		<i>Describe and follow prescribed Overhead Contact system PM procedures</i>
205	<u>Overhead Catenary System (Inspection and Maintenance)</u>	
205-1		<i>Preparing to work on Overhead Catenary system</i>
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. deenergized

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		<i>Responsibilities / Course Content</i>
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205-2		<i>Inspecting and maintaining overhead catenary system</i>
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		<i>Check section insulation (various types)</i>
205-3-1		Check arc horns
205-3-2		Check rums
205-3-3		Check support structure
205-4		<i>Describe and follow prescribed Overhead Catenary system PM procedures</i>
206		<u>Third Rail Systems (Inspection and Maintenance)</u>
206-1		<i>Inspecting and maintaining third rail and components</i>
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		<i>Inspecting and maintaining snow and ice removal equipment</i>
206-3		<i>Inspecting and maintaining cables</i>
		Explain and demonstrate the routing of cables through ducts
		Perform duct rodding
		Perform work in manholes

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		Read duct and manhole prints
		Explain and demonstrate processes and equipment used to pull cable
		Explain and demonstrate processes for cable fault location
207	<i>HVAC & Lighting</i>	
		(include equipment that is relevant to Traction Power maintainers in a given property)
208	<i>Understanding Low Resistance Groundings vs. High Resistance Groundings</i>	

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300 Level Modules -- Traction Power Systems Troubleshooting and Repair		
300	<i>Incoming Utility (service power) Sources and Basic Diagnosis</i>	
300-1		<i>Explain operation of equipment</i>
300-2		<i>Describe primary power distribution</i>
300-3		<i>Determine voltage</i>
300-4		<i>Identify whether AC or DC</i>
300-5		<i>Locate and utilize disconnect switch</i>
300-6		<i>Describe isolation of circuits</i>
300-7		<i>Demonstrate ability to read single line blue prints</i>
300-8		<i>Describe how metering system works</i>
300-9		<i>Use and maintaing portable generators</i>
		<i>Safely set up portable generators</i>
		<i>Demonstrate various hookups</i>
		<i>Check phasing</i>
		<i>Select correct voltage</i>
301	<i>Traction Power Control Systems (Troubleshooting, Adjustment and Repair)</i>	
301-1		<i>Describe various points of control of substations and distribution network</i>
301-2		<i>Define and describe Supervisory Control and Data Acquisition system (SCADA)</i>
301-2-1		<i>Fiber Optics and communication systems</i>
301-3		<i>Use SCADA to Troubleshoot and improve system performance</i>
302	<i>Power Distribution Systems (Troubleshooting, Adjustment and Repair)</i>	

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302-1	<i>Power Isolation</i>	
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	<i>AC Power systems (Troubleshooting and Repair)</i>	
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

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302-2-6		Troubleshoot and repair Auxiliary transformers
302-3		<i>DC Power systems (Troubleshooting and Repair)</i>
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		<i>Substations (Troubleshooting, Adjustment and Repair)</i>
303-1		<i>Troubleshooting methods and best practices</i>
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		<i>Substation Components troubleshooting and repair</i>
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		<i>Overhead Contact Systems (Troubleshooting, Adjustment and Repair)</i>
304-1		<i>Troubleshooting and repairing overhead contact system components</i>
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		<i>Troubleshoot and repair contact cable defects</i>
304-3		<i>Troubleshoot and repair hangers</i>
304-4		<i>Troubleshoot and repair poles</i>
304-5		<i>Check and adjust cable tension</i>
304-5-1		Check and adjust fixed tension cables
304-5-2		Check and adjust auto (constant) tension
304-6		<i>Repair and replace section insulation (various types)</i>
304-6-1		Repair and replace arc horns
304-6-2		Repair and replace rumes
304-6-3		Repair and replace support structure

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304-7		<i>Troubleshoot and repair back guy</i>
305	<i>Overhead Catenary Systems (Troubleshooting, Adjustment and Repair)</i>	
305-1		<i>Troubleshooting and Repairing overhead catenary system</i>
305-1-1		<i>Troubleshoot and repair contact wire</i>
305-1-2		<i>Troubleshoot, adjust and repair hangers</i>
305-1-3		<i>Troubleshoot, adjust and repair poles</i>
305-1-4		<i>Check and adjust wire tension</i>
305-1-5		<i>Check and adjust fixed tension wires</i>
305-1-6		<i>Check and adjust auto (constant) tension</i>
305-1-8		<i>Troubleshoot and repair snow and ice removal equipment</i>
305-1-9		<i>Repair and replace down guy</i>
305-1-10		<i>Repair and replace span wire</i>
305-2		<i>Repair and replace section insulation (various types)</i>
305-2-1		<i>Repair and replace arc horns</i>
305-2-2		<i>Repair and replace rumes</i>
305-2-3		<i>Repair and replace support structure</i>
306	<i>Third Rail Systems (Troubleshooting, Adjustment and Repair)</i>	
306-1		<i>Troubleshoot and repair third rail and components</i>
306-2		<i>Troubleshoot and repair third rail structure</i>
306-3		<i>Troubleshoot and repair snow and ice removal equipment</i>
306-4		<i>Measure a curved radius for rail installation and replacement</i>