



# **PARTICIPANT GUIDE:**

## **Course 200**

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# **Preparing for Inspection and Maintenance of Traction Power Systems**

 **TRACTION POWER TRAINING CONSORTIUM**



## REVISION INDEX

Additions, deletions, or revisions are listed in the table below.

| Date | Module and Section | Description of Change | Revision Author |
|------|--------------------|-----------------------|-----------------|
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**Disclaimer:** This course is intended to educate employees of public transportation systems that have agreed to voluntarily participate in the Traction Power Training Consortium. It is intended only as informal guidance on the matters addressed, and should not be relied upon as the only method or manner for performing the tasks or work outlined in the materials. Anyone using this document or information provided in the associated training program should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of care in any given circumstances. These materials are based on compendiums of knowledge from transit employees, manufacturers and outside consultants, each of whom may approach a repair, update, or maintenance in their own unique way. Always follow the safety and maintenance procedures from your own agency, union, relevant OEM(s) and/or regulatory organizations. In addition, the course materials include examples from member agencies, nomenclature, procedures, and configurations which can vary from one transit location to another. The document that you are now referencing may have been modified by the Consortium member. For the original versions, please go to [www.TransitTraining.net](http://www.TransitTraining.net) or contact the Transportation Learning Center.

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**Note:** All images contained within this document were contributed by Traction Power Training Consortium members unless otherwise noted.

## TRACTION POWER TRAINING CONSORTIUM

The national Traction Power Training Consortium (TPTC) is a group of public transportation agencies that are members of the American Public Transportation Association (APTA). Each participating agency assigns two subject matter experts to advise instruction designers and help shape the Consortium courses. As of June 2020, the following agencies have agreed to work with the Transportation Learning Center on the TPTC.

| AGENCY                           | UNION     | LOCATION         |
|----------------------------------|-----------|------------------|
| <b>BART</b>                      | SEIU 1021 | Oakland, CA      |
| <b>DART</b>                      | ATU 1338  | Dallas, TX       |
| <b>GCRTA</b>                     | ATU 268   | Cleveland, OH    |
| <b>Metro Transit</b>             | ATU 1005  | Minneapolis, MN  |
| <b>NFTA</b>                      | ATU 1342  | Buffalo, NY      |
| <b>SacRT</b>                     | IBEW 1245 | Sacramento, CA   |
| <b>SEPTA</b>                     | TWU 234   | Philadelphia, PA |
| <b>Tacoma Link Sound Transit</b> |           | Tacoma, WA       |
| <b>VTA</b>                       | ATU 2665  | Santa Clara, CA  |

As of April 2020, the Consortium identified 16 courses that are distributed over three levels designed to upskill new and experienced traction power maintainers. Each agency assigns two subject matter experts (SMEs) who have been working with the Center's skilled instructional system designers (ISDs) to build courses on traction power maintenance

| Topic Areas        | Course No. | 100 LEVEL<br>Introduction and Overview                              | Course No. | 200 LEVEL<br>Inspection and Maintenance           | Course No. | 300 LEVEL<br>Troubleshooting, Adjustment and Repair      |
|--------------------|------------|---|------------|---|------------|--|
| Overview           | 100        | Overview, General Safety, and Regulations of Traction Power Systems | 200        | Prep for Insp and Maint of Traction Power Systems | 300        | Principles of Troubleshooting Traction Power Systems     |
| Power Distribution | 101        | Introduction to Traction Power Dist and Control Systems             | 201        | Insp and Maint of Power Dist and Control Systems  | 202        | Troub, Adjust & Repair of Power Dist and Control Systems |
| Substations        | 102        | Introduction to Substations   | 202        | Insp and Maint of Substations                     | 302        | Troub, Adjust & Repair of Substations                    |
| Overhead Systems   | 103        | Introduction to Overhead Systems                                    | 203        | Insp and Maint of Overhead Systems                | 303        | Troub, Adjust & Repair of Overhead Systems               |
| Third Rail         | 104        | Introduction to Third Rail Systems                                  | 204        | Insp and Maint of Third Rail Systems              | 304        | Troub, Adjust & Repair of Third Rail Systems             |

## HOW TO USE THE PARTICIPANT GUIDE

### Purpose of the Course

Course 200, *Preparing for Inspection and Maintenance of Traction Power Systems*, offers participants with an overview of the inspection and maintenance materials, approaches and equipment requirements necessary prior to beginning work for inspecting and maintaining traction power systems.

### Approach of the Course

Each course module begins with an outline, a learning outcome statement, a list of key terms, and a list of acronyms. The outline will discuss the main topics to be addressed in the module. The *Learning Outcome* lists the basic skills, knowledge, and abilities course participants should be able to demonstrate to show that they have learned the material presented in the module. A list of *key terms* identifies important terminology that will be introduced in this module. *Exercises* are built in throughout the course materials to assist the participants in learning and reviewing key information.

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**\*Indicates this section can be revised to reflect agency-specific content and materials**

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# MODULE 1

## *What is Inspection & Maintenance?*

### Outline

- 1-1 Overview
- 1-2 Health & Safety Reminder
- 1-3 What is Inspection & Maintenance?
- 1-4 Prerequisite Knowledge, Training and Licenses
- 1-5 Summary

### Learning Outcomes

This module gives an overview of the principles of operation in a traction power system as well as describes its major components. Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- 101-1-1 Outline the process of inspection and maintenance for traction power systems
- 101-1-2 Recognize common varieties of maintenance schedule or inspection sheets
- 101-1-3 Identify agency prerequisites for traction power inspection and maintenance

### Key Terms

|   |  |
|---|--|
| <ul style="list-style-type: none"><li>• Inspection</li></ul>                    | <ul style="list-style-type: none"><li>• Inspection sheet</li></ul> |
| <ul style="list-style-type: none"><li>• Maintenance</li></ul>                   | <ul style="list-style-type: none"><li>•</li></ul>                  |
| <ul style="list-style-type: none"><li>• Preventive Maintenance sheets</li></ul> | <ul style="list-style-type: none"><li>•</li></ul>                  |
| <ul style="list-style-type: none"><li>• Maintenance schedule</li></ul>          | <ul style="list-style-type: none"><li>•</li></ul>                  |

### Abbreviations

TPSS            Traction Power substations

## 1-1 OVERVIEW

**This course follows up on TP Courses 100 and 101.**

In the previous course, *Course 100 Overview, General Safety and Regulations of Traction Power Systems*, you were introduced to the basics of traction power systems, reviewed the highly crucial safety aspects and practices, and identified typical traction power tools. The next level of this training, *Course 200 Preparing for Inspection and Maintenance of Traction Power Systems*, is designed to help the participant hone essential skills for inspecting and maintaining track circuits. In doing so, this module supplements and enhances on-the-job, classroom, and other training the traction power maintainer will receive from their public transit agency.

Every rail transportation system adheres to strict record-keeping and timetables for inspection and maintenance. These practices ensure the safety of rail passengers, workers, and properties. With traction power inspection, maintenance and troubleshooting, an overemphasis on safety *must* be taken into consideration. In the field, safety procedures and practices can make the difference between a life-or-death situation, and can prevent tragedies from occurring.

Safety regulation and procedures can vary between agencies, but all take into account oversight from federal and state regulation. At a local level, each agency can have differences in the manner in which they operate, and have different systems in place that warrant another approach for inspection, maintenance and troubleshooting.



*Figure 1 A maintainer examines a substation cabinet*

Source:

<https://ggwash.org/view/62548/breakfast-links-metro-and-the-union-square-off>

### Modes of Traction Power

There are variations within each category, and this includes:

- **Overhead Contact:** A system of simple, non-curving wires used to distribute power to rail vehicles which use a pantograph to connect the rail vehicle to wire system; Different types can include trolleys and streetcars (Module 1-3, page 4)
- **Overhead Catenary:** With a setup like the Overhead Contact; Has a messenger wire which is what contact wire is suspended from and uses a pantograph to collect power (Module 1-3, page 4)
- **Rigid Overhead Conductor System:** Similar structure to Overhead Contact with added benefits of less chance of tension snaps and no catenary wire needed (Module 1-3, page 5)



- **Third Rail:** A semi-conductible rail placed above, below or beside an amount of rail track to connect with the wheels or rail vehicle to provide electricity; this method always uses DC electricity (Module 1-3, page 5)

Each agency may vary in their definition of what their overhead/third rail line systems boundaries are, so it is important to check with your supervisor or guidelines to determine where your area of work will begin and end.

Traction power substations (TPSS) are also a critical component of the rail electrification process. These processes of electric power conversion and distribution apply to many modes of transportation, and will be covered in-depth in Traction Power Course 103.

## **Traction Power Tools**

Maintenance of traction power systems requires quite a few tools to keep functioning properly. In Course 100, we reviewed several of the common tools that traction power maintainers often use, such as:

- Digital and DC Voltmeter (Module 4-2, page 41-42)
- Hot Stick (Module 4-2, page 42)
- Grounding/Cable wires (Module 4-2, page 43)
- HI-Pot testing (Module 4-2, page 43)
- Digital Low Resistance Ohmmeter [DLRO] (Module 4-2, page 44)

## **Regulatory Authority & Publications**

A regulatory agency is often a federal or government agency that provides oversight and creates the legal authority that public transit agencies abide by. Some of the regulatory agencies you may deal with might include (but are not limited to):

Some common acronyms are used throughout this course are:

- APTA The American Public Transportation Association
- AREMA American Railway Engineering and Maintenance-of-Way Association
- FRA Federal Railroad Administration
- FTA Federal Transportation Administration.
- OSHA Occupational Safety and Health Administration
- PPE Personal Protective Equipment
- RTS Rail transportation system

Regulatory agencies often publish publications that provide important rules and guidelines that are vital as maintainers continue to go out into the field and deal with maintenance and troubleshooting firsthand. These additional resources are not limited to, but include the list below:

[National Electric Code 70E v.2018](#)

[ANSI Essential Requirements: Due Process for American National Standards](#)

[California Code of Regulations: Electrical Safety Orders](#)

*(Your instructor will have a to these documents if you want to review a copy)*

## 1-2 HEALTH & SAFETY REMINDER

Each agency has their own local procedures for handling safety when it comes to traction power inspection, maintenance and troubleshooting. You should always refer to your local guidelines and ask your supervisor for clarification on a specific procedure or operation you are performing for traction power inspection, maintenance and/or troubleshooting.

*It should be noted that not every agency has the same modes and/or setup for traction power networks and thus may not need to consider certain information such as specific safety protocols or procedures. Each agency may not use or have the same set of tools used for traction power inspection, maintenance and troubleshooting tasks. Each agency may have a variation of names for a specific tool and can vary from agency to agency.*

### Standard Safety Practices

Make sure you review your agencies' operating procedures when it comes to safety with traction power processes. Each agency may have different terms or styles of precautions, and should always come before heading out to test, inspect, troubleshoot or repair any components. If you need a reminder of how each operates there is a reference and page number for *TP Course 100* in the parentheses as indicated by the symbol ( ).

Some common practices include (but are not limited to):

- Electrical & High voltage safety (Module 2-2; Module 2-3, page 10-14)
- Arc Flash/Burn safety & prevention (Module 2-4, page 14-16)
- Emergency response and preparedness (Module 2-5, page 17-19)
- Removing power & zero energy systems (Module 2-6, page 19-21)
- Lock Out/Tag Out [LOTO] (Module 2-6, page 22-23)
- Bucket truck & equipment safety (Module 2-6, page 23-24)
- Fall and injury protection (Module 2-6, page 24)
- PPE Selection and use (Module 2-7, page 25-28)

- Electrical Hazard rating/analysis (Module 27, page 26)
- Arc Flash/Approach Boundary Levels (Module 2-7, page 29-30)

## 1-3 WHAT IS INSPECTION AND MAINTENANCE?

For our purposes, this course is intended to introduce those who may not have had prior experience with inspection and maintenance at transit agencies. **Inspection** is considered an act or process that allows someone to look carefully, examine closely and/or critically to ensure proper functioning. The American Public Transportation Association (APTA) defines **maintenance** as

“...the upkeep of vehicles, plant, machinery, and equipment. [Maintenance] may be scheduled, planned, progressive, or periodic based on pre-established intervals of time, hour, or mileage and employing pre-printed checklists or it may be unscheduled or corrective, generally not interval based.”

Inspection and maintenance for the public transit field is the process by which one examines or observes a part or process and provides repair and upkeep service to keep that part or service operational and safe. As traction power maintainers and workmen, it is your duty to regularly check and service the components in the traction power system.



### Learning Application 1A- [Intro to I&M]

Watch the video: TBD. Once you're finished, answer the following questions. If required, your instructor will give you a password.

1. Sample question posed here?
  2. Sample question posed here?
- 

## Record Keeping: Maintenance Schedules & Inspection Sheets\*

This section introduces the idea of record keeping. This includes using PM sheets, maintenance scheduling and inspection sheets. We will outline the necessary preparation, procedures and requirements you will need prior to performing any inspection and maintenance work on traction power systems. All rail transportation systems have their maintenance staff complete some iteration of **Preventive Maintenance (PM) sheets** on all jobs or work/maintenance orders done on the traction power system. This is usually observed by the supervisor and/or analysts to keep track of any and all maintenance and inspections. Every public transit agency adheres to strict record-keeping and timetables for inspection and maintenance. These practices ensure the safety of rail passengers, workers, and properties. The FRA mandates that all tests, maintenance, repair, and replacement of any track circuit component be recorded and stored electronically. This is open for variance in the operations at each agency.

Many agencies also utilize a logbook system where maintainers manually add and communicate any and all work, materials and PM checks. Other agencies will initially fill out PM sheets manually and convert those to a digital format at some point later. Some will use an electronic file to fill in data and check off maintenance steps as the work is performed, thus allowing the record keeping to be updated instantly. This helps maintainers when future work or maintenance orders are requested and troubleshooting is required. Thus, agencies will complete record keeping manually, electronic or digitally, or some combination of the two methods. Any records completed will be kept on file for a certain amount of time, dependent on the type of maintenance and procedures in place.

A **maintenance schedule** is a plan to conduct regular checks for any change in the operations of systems and to perform preventive maintenance to return dysfunctional or worn-down components to an optimum state. The schedule typically lists the standard tasks that need to be completed in order to keep the traction power systems operating at optimum performance.

An **inspection sheet** is a document that helps maintainers to record and input data and/or information when inspecting and performing maintenance that can be reviewed and stored for later use. Below are several examples of one agency's type of inspection sheets and maintenance forms

Substation Defect Inspection List

Date \_\_\_\_\_

Maintainer \_\_\_\_\_

Substation \_\_\_\_\_

\_\_\_\_\_ 1. Check and replace all A/C and D/C switchgear lamps / LED's.

\_\_\_\_\_ 2. Check and replace L.A.P. lamps.

\_\_\_\_\_ 3. Check all fluorescent lighting.

\_\_\_\_\_ 4. Perform visual inspection of 150/151 over current relay if applicable.

\_\_\_\_\_ 5. Perform visual inspection of the 182/183 relay if applicable.

**Figure 3** Substation Defect Inspection list [courtesy of DART]

TPSS Light Maintenance Duties  
(Siemens Substation)

Work Order # \_\_\_\_\_

Substation: \_\_\_\_\_

Date: \_\_\_/\_\_\_/\_\_\_

Follow on WO #:

Light Maintenance, which includes:

| Date | Hour(s) | Maintainer | Job | Description                                   |
|------|---------|------------|-----|---|
|      |         |            | 1   | PM fluorescent fixtures                       |
|      |         |            | 2   | PM all wall mounted & free standing equipment |
|      |         |            | 3   | PM PCR interior                               |
|      |         |            | 4   | PM exterior of AC & DC switchgear             |
|      |         |            | 5   | PM interior of AC switchgear cubicle          |

**Figure 4** TPSS light maintenance duties [courtesy of DART]

