PARTICIPANT GUIDE: Course 101

Overview, General Safety and Regulations 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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MODULE 1

History and Overview of Traction Power Systems

Outline

1-1 Overview

1-2 History of Traction Power Systems

1-3 Traction Power Basics

1-4 Health and Safety

1-5 Summary

Learning Outcomes

This module gives an overview of the principles of operation in a traction power system as well 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 Recall the history and functions of traction power leading up to the 21st century.

101-1-2 Identify basic functions and features of each mode of traction power system.

101-1-3 Recall basic health and safety features of working with traction power systems

Key Terms

• Traction power system	• Overhead Catenary
• Overhead line system	• Rigid Overhead Conductor System
• Third rail electrification systems	• Third Rail
• Overhead Contact	• Traction Power substations

Abbreviations

TPSS Traction Power Substations
TPTC Traction Power Training Consortium

1-1 OVERVIEW

One major function of rail electrification system—or **traction power system—**is to safely transport people via electrified traction lines. To carry out this function, vehicles using a traction power system require a safe, reliable, and uninterrupted supply of power. This module outlines the ways in which traction power is generated, transmitted, and distributed to the point where the rail vehicle can collect and use this power to operate. This module outlines the history, the functions and modes of traction power, the governing bodies known as regulatory agencies and the tools often used for traction power work.

1-2 HISTORY OF TRACTION POWER SYSTEMS

A Brief History of Traction Power Systems

Historically, traction power systems have been around for nearly 100 years, with the first systems being built at the turn of the 1900s. However, these systems were often limited by the means and technology available during the time frame it was established. It was during this period of the early 20th century when the structure and layout for traction power systems really started to pick up steam in North America. This culminated into several of the primary systems that we still use today: *contact systems* and *third rail systems*.

The first **overhead line system** (known back then as a tram) was showcased at the 1881 International Electric Exposition in Paris, presented by a German electrical engineer named Ernst Werner Siemens. Siemens was a figurehead in the field of electric and telecommunications. Siemens was also the founder of the widely known Siemens conglomerate, and the unit of electrical conductance—*siemens*—was adopted in his honor.

By 1883, the first permanent tram service was established with overhead lines in Austria. A simpler overhead wire was used in conjunction with a pantograph used along the vehicle, created by Frank J. Sprague in 1888. (Source: https://en.wikipedia.org/wiki/Overhead_line)

By the turn of the 20th century and into the early 1900s, however, overhead systems were starting to increase in popularity in the North American region as more systems began to appear as the practical applications of electrification of railways found to fare better for regional and long-distance travel using overhead systems than typical transportation means available at the time. Electric traction also began replacing steam-powered transit (cable and small locomotives) and horse-drawn carriers within the developing urban sprawl.

Figure 1 Werner von Siemens
Source:https://en.wikipedia.org/wiki/Werner_von_Siemens

It was only in the last 20 years or so that the exponential growth of technology and breakthroughs in science that traction power systems really changed the rail transportation norms of the past century.

Figure 2 Frank J. Sprague Source: https://en.wikipedia.org/wiki/Frank_J._Sprague

Third rail electrification systems are one of the oldest forms for supplying power to trains using their own rails. The first instances of third rail being used come from the Berlin Industrial Exposition of 1879, with the first line to use a centralized third rail operation was the Bessbrook and Newry Tramway located in Ireland circa 1885.

Third rail power supply began to emerge in the North American urban public transportation field during the 1880s. The first systems were implemented and tested in Cleveland (1884) and Denver (1885). Big American tram hub networks such as New York, Washington D.C., and Chicago followed suit around by the early 1900s, as this method system fell out of favor in European networks, primarily due to issues with weather. As expansion and industrialization continued long into the 20th century, many agencies began to shift away from using third rail powered travel in favor of overhead lines for both regional and long-distance travel.

(Source: https://en.wikipedia.org/wiki/Third_rail#History)

As means of electric traction-powered transportation showed increases in efficiency, power and speed, it unleashed a mass outcry for its implementation throughout urban streets. This led to the development of more heavy, load (passenger or package) carrying cars in one system that operated at street level.

However, once the 1940s arrived the rapid influx of (predominantly) light rail methods would start to see a decline as advancements made in personal motor vehicles (such as motorcycles and motor cars) began to more crowded public transit that would often make stops? This created a shift between the needs of public transit methods mainly in the interurban areas with a higher population density that often could not capitalize on its people having personal vehicles.

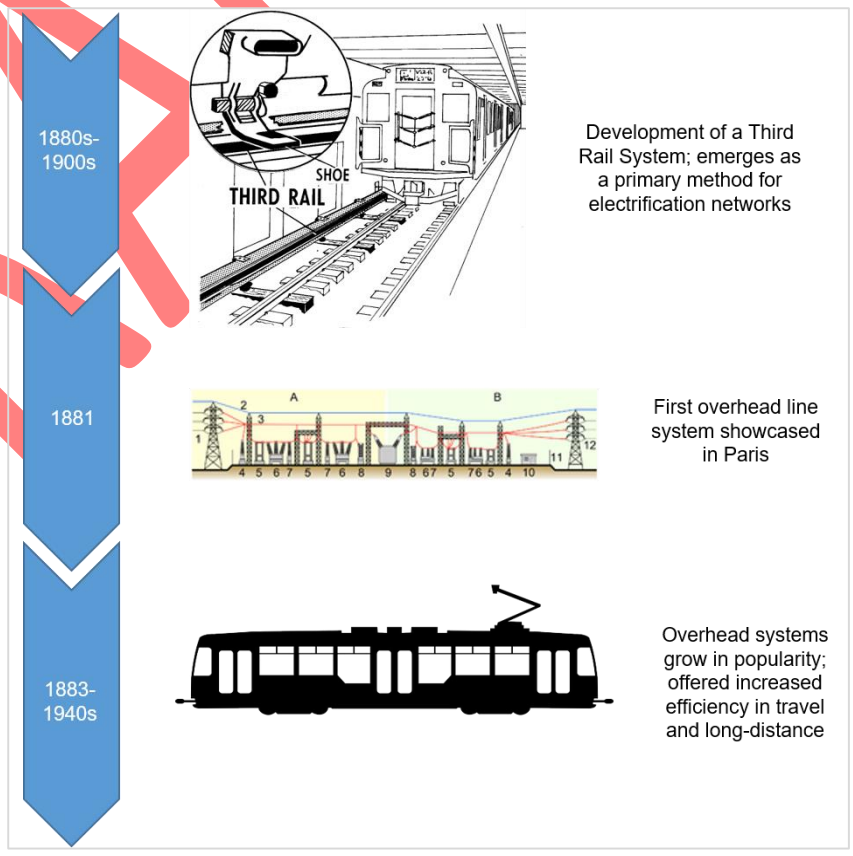

Figure 3 Timeline summary of Traction Power

Learning Application 1A

On your own (or with a partner), answer the following prompts. Consult with your instructor if you are unsure or need help.

1. How have overhead line systems developed or changed at your agency?

2. How have third rail systems developed or changed at your agency?

1-3 TRACTION POWER BASICS

The basis of rail electrification system is the process of supplying a form of energy—in this instance electric power--that powers the rail vehicle. Electric energy is generated in large quantities at local utility companies or an agency's own power stations. Using one or multiple forms of traction power distribution, power is then distributed to the rail vehicles. Each mode will be explored in-depth in later Traction Power Consortium courses.

Modes of Traction Power

With traction power there are several modes of providing electric power to the rail vehicles. wire lines are needed to deliver power to the rail vehicles. For the purpose of this set of courses covering traction power we will focus on two categories: Overhead Systems and Third Rail. 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 [see Figure 4]

Figure 4 Overhead Contact system

Figure 5 Overhead Catenary system

- **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 [see Figure 5]

- **Rigid Overhead Conductor System**: Similar structure to Overhead Contact with added benefits of less chance of tension snaps and no catenary wire needed [see Figure 6]

Figure 6 Rigid Overhead Conductor System

Figure 7 Third Rail system

- **Third Rail**: A semi-conductible rail place 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 [see Figure 7]

Traction power substations (TPSS) are also a critical component of the rail electrification process. These substations are the facilities that receive electricity from a source and convert it into a useable power supply for the rail vehicle. These methods of electric power conversion and distribution apply to many modes of transportation, such as rail vehicles, trams/streetcars and trolley buses. Substations will be covered in-depth in Course 103.

There are a few agencies with the Traction Power Training Consortium (TPTC), each of which has one or multiple modes of traction power systems in use at Consortium properties. The table below shows the list of TPTC agency members of the national Traction Power Training Consortium and their corresponding mode of traction power system.

Property	**Mode**
NFTA Buffalo, NY	Overhead Catenary
DART Dallas, TX	Overhead Catenary, Overhead Contact
SacRT	Overhead Catenary, Overhead Contact
GCRTA	Overhead Catenary, Overhead Contact
Metro Transit	Overhead Catenary, Overhead Contact
SEPTA	Third Rail, Overhead Catenary, Overhead Contact
VTA	
Sound Transit	Overhead Catenary

Learning Application 1B

Use the space below to write down what system(s) your agency currently has in use for traction power systems. Write down any identifying features of that systems and any unique components or areas you think are important. You can work as a class or small groups. Consult your instructor if you are unsure or need help.

1-4 HEALTH AND SAFETY NOTICE

There are many safety guidelines and protocols that one must follow when dealing with any form of electric/traction power or rail equipment, and it is vital to follow any and all related safety proctors related to traction power inspection, maintenance and troubleshooting for your own safety, as well as the health and safety of your fellow workers.

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.

1-5 SUMMARY

Rail electrification systems, or rather traction power, have had a huge influence on the rail transit industry. From its beginnings in the late 19th century to modern day traction power is still relied on today for public transit and contributes to the urban development process of the local agency. Though this module was short and offered a lot of information, the key takeaways are listed below:

- Traction power (overhead and third rail) has a lengthy history that has developed a long way since its inception, especially in the last 20 years.
- There are four basic modes of traction power: Overhead contact, overhead catenary, Rigid Overhead Conductor system and Third rail systems

- Each agency may have different or a combination of traction power modes that have varied requirements for safety and health of its traction power workers. Always consult your supervisor, manuals or training materials for reference.