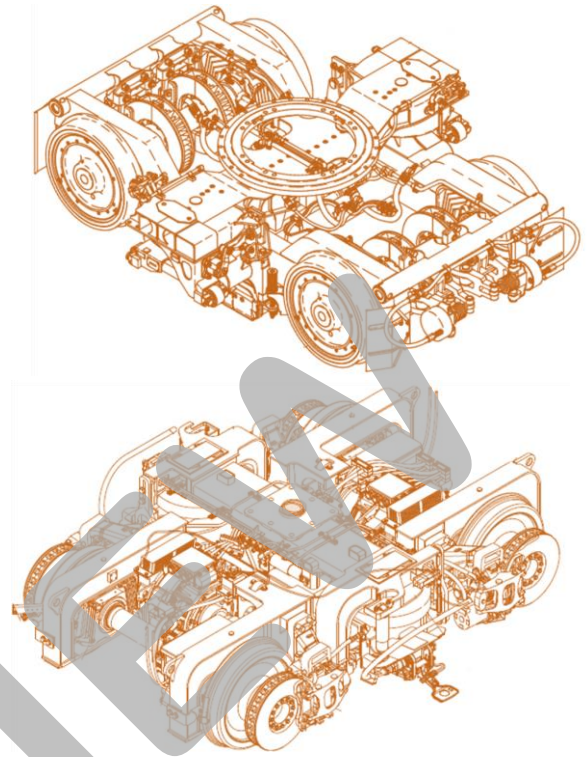


Introduction and Overview to Trucks and Axles

Course 102



PARTICIPANT GUIDE

 RAIL CAR TRAINING CONSORTIUM

Truck Systems

Introduction and Overview

Course 102

Participant Guide

Participant Guide

December 2018

Rail Car Training Consortium

REVISION INDEX

Any additions, deletions, or revisions are to be listed below.

Date	Description of Change	Revision Author
06-Feb-2019	General edits. Include updates for flange lubricator. Speed sensor.	SMEs

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HOW TO USE THE PARTICIPANT GUIDE

Purpose of the Course

Course 102: *Introduction and Overview to Trucks and Axles* provides participants with an overview to the principles of truck systems as well as preparing to work on those systems in a transit rail car maintenance facility.

Approach of the Book

Each course module begins with an outline, a statement of purpose and objectives, and a list of key terms. The outline will discuss the main topics to be addressed in the module. A list of *key terms* identifies important terminology that will be introduced in this module. *Learning objectives* define 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. *Exercises* are built in throughout the course materials to assist the participants in learning and reviewing key information.

PREVIEW

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MODULE 1

Safety and Principles of Operation

Outline

- 1-1 Overview
- 1-2 Safety Review
- 1-3 Principles of Operation of Trucks
- 1-4 Summary

Outcome and Objectives

This module reviews some safety procedures specific to working on the rail vehicle's trucks and axles as well as introduces the principles of operation of truck systems. Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Review safety guidelines.
- Identify safety hazards in the workplace.
- Describe the principle of operation of a rail car truck.
- Identified major components of a truck.

Key Terms

- Axle
- Bogie
- Running Gear
- Trailer Truck
- Unpowered Truck
- Truck
- Motor Truck
- Center Truck
- Powered Truck

Abbreviations

OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
FTA	Federal Transit Administration
LRV	Light Rail Vehicle
HRV	Heavy Rail Vehicle

COURSE 102: INTRODUCTION AND OVERVIEW OF TRUCK SYSTEMS
MODULE 1: SAFETY AND PRINCIPLES OF OPERATION

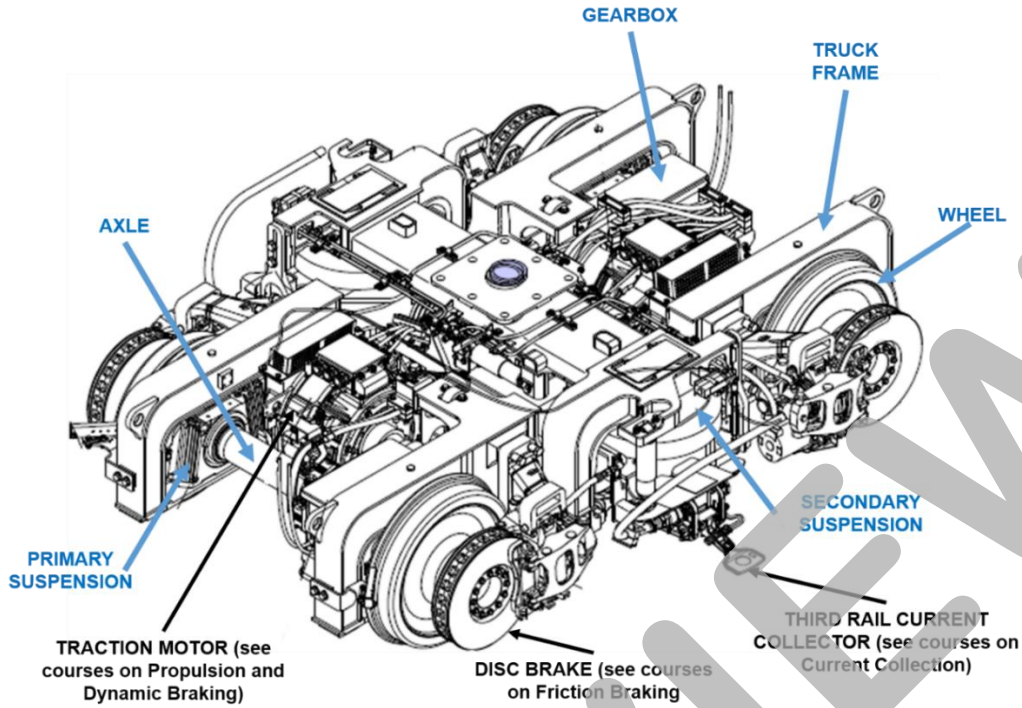


Figure 1.2 Frame, Suspension, Gearboxes, Axles on a Powered Truck Assembly –Courtesy WMATA

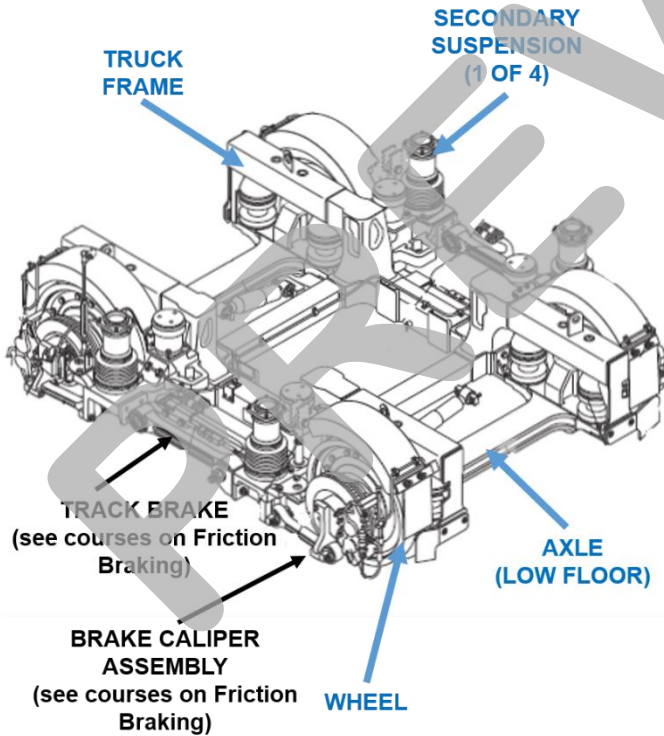


Figure 1.3 Frame, Suspension, Axles on an Unpowered Truck –Courtesy CATS

It is important to note that traction motor, brakes, and current collection subsystems are covered in other Consortium courses and as such, this course will cover the following subsystems of the rail vehicle truck:

COURSE 102: INTRODUCTION AND OVERVIEW OF TRUCK SYSTEMS
MODULE 1: SAFETY AND PRINCIPLES OF OPERATION

1. Frame and Suspension (primary and secondary) is covered in Module 2.
2. Gearbox is covered in Module 3.
3. Wheels and axles are under the topic of Wheelset Assemblies and are covered in Module 4.

Learning Application 1C



1. Watch the video below of a rail car technician pointing out the major components of a truck for a LRV at MBTA.
2. Participate in classroom activity, discussion, and knowledge checks led by your instructor.

<https://vimeo.com/297397583> Length: 7 minutes

1-4 SUMMARY

This module helped the participant review safety guidelines that are specific to working on and around trucks before describing the principles of operation of the rail vehicle truck and frame.

MODULE 2

Suspension

Outline

- 2-1 Overview
- 2-2 Primary Suspension
- 2-3 Secondary Suspension
- 2-4 Bolster
- 2-5 Summary

Outcome and Objectives

This module identifies the primary and secondary suspension systems on a rail car truck. Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Explain the principles of operation of the rail vehicle suspension system.
- List the major components of the rail vehicle suspension.
- Explain the principles of operation of the bolster.

Key Terms

- Bolster
- Damping
- Chevron Springs (Axle Springs)
- Primary Suspension
- Secondary Suspension
- Spring

Abbreviations

APTA	American Public Transportation Association
FTA	Federal Transit Administration
LRV	Light Rail Vehicle
HRV	Heavy Rail Vehicle

2-3 SECONDARY SUSPENSION

The **secondary suspension** system interconnects the car body and the truck. The main functions of the secondary suspension are:

- Provide for low vertical stiffness and therefore ride comfort for passengers.
- Buffer the car body from track irregularities, vibrations, and noise.
- Work as a vertical damper and anti-roll element.
- Keep the car body level at a constant height for all load conditions.

The arrangement of secondary suspension systems vary by rail vehicle design. Generally secondary suspension systems can be categorized by hydraulic or air. As such, some of the major components of the secondary suspension system include:

- Accumulator
- Air bag, air compressor
- Air springs
- Coil springs
- Hydraulic suspension leg
- Lateral stops (buffers) and lateral stop brackets
- Leveling sensor
- Leveling valves
- Pressure sensor
- Shock absorbers
- Vertical stop assembly

Let us examine two secondary suspension systems in the following case studies of rail vehicles used in the Charlotte, NC and Washington, DC areas.

Case Study: Hydraulic Secondary Suspension Systems on LRVs in Charlotte, NC

The light rail vehicles used in Charlotte Area Transit System in Charlotte, N.C., are supplied by Siemens Transportation Systems. The S70™ is a 70 percent low floor light rail vehicle, capable of operating at speeds up to 65 miles per hour while accommodating 236 passengers along with wheelchair accommodations. Each LRV consists of three cars, designated as A, B, and C. The A and B cars each have a powered truck and are otherwise identical, except for placement of some equipment items. The center (C) truck is not powered.



Case Study: Air Secondary Suspension Systems on HRVs in Washington, DC

One of the heavy rail vehicles used in Washington Metropolitan Area Transportation Authority in the Washington DC area is the Breda 3000 Series and refurbished by Alstom.



The maximum number of rails cars on a consist is eight cars with each rail car accommodating 175 passengers. A rail car is 75 feet long, 10 feet wide, and 11.8 feet in height and is capable of 75 miles per hour maximum operating speed. Power to these vehicles are supplied by the third rail.

On the Breda 3000 trucks, air bags are part of the secondary suspension system which uses compressed air in their suspension system.

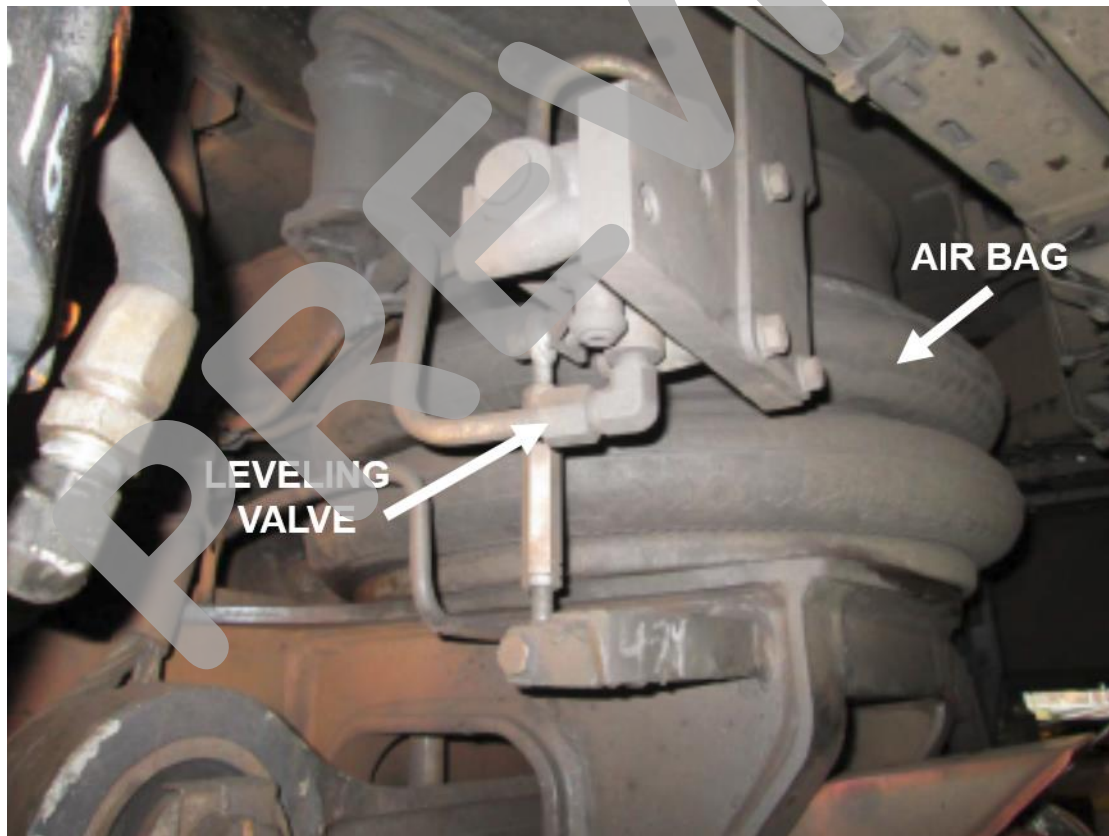


Figure 2.8 Air Bag Secondary Suspension Components on Breda® 3000 Series HRV –Courtesy WMATA

permanent, black glossy enamel on the side sill immediately adjacent to the cut-out cocks identifies their locations. Cut-out cocks are lock-wired in their normal operating position. Note that all air reservoirs provide drainage at their lowest point.

Coil Spring Secondary Suspension Systems

On some rail vehicles, secondary suspension consists of coil springs and a vertical shock absorber. The vertical shock absorbers function is to provide additional ride comfort by dampening vertical motion of the coil springs.



Figure 2.10 Secondary Suspension Springs and Shock Absorber on Siemens® SD8 Rail Car –Courtesy SDMTS

MODULE 3

Gearboxes

Outline

- 3-1 Overview
- 3-2 Major Components
- 3-3 Summary

Outcome and Objectives

This module defines the gearbox and its major components on a rail car truck. Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Explain the principles of operation of the gearbox system on a rail car truck.
- List the major components common to rail vehicle gearbox systems.

Key Terms

- Coupling
- Gear unit
- Gearbox
- Pinion and ring gear
- Rolling-element bearings (Rolling bearings)
- Shaft coupling

Abbreviations

- LRV Light Rail Vehicle
- HRV Heavy Rail Vehicle

3-2 MAJOR COMPONENTS

Please note that the topics of propulsion, dynamic braking, and traction motors are outside the scope of this course and are covered in other Rail Vehicle Training Consortium courses.

Depending on the rail vehicle type, the major components of the gear unit are discussed in the following paragraphs. The participant should note that gearbox configuration vary by rail car type and manufacturer. As the instructor leads you through this course, take notes on the relevancy, design, and layout of gearbox components for the rail vehicles at your rail transportation agency.



Learning Application 3A

With respect to Figure 3.2 and Figure 3.3, compare these gearbox, drive shaft, and traction motor arrangements with those of the rail vehicles at your agency. List similarities and differences including the nomenclature of these and related components.

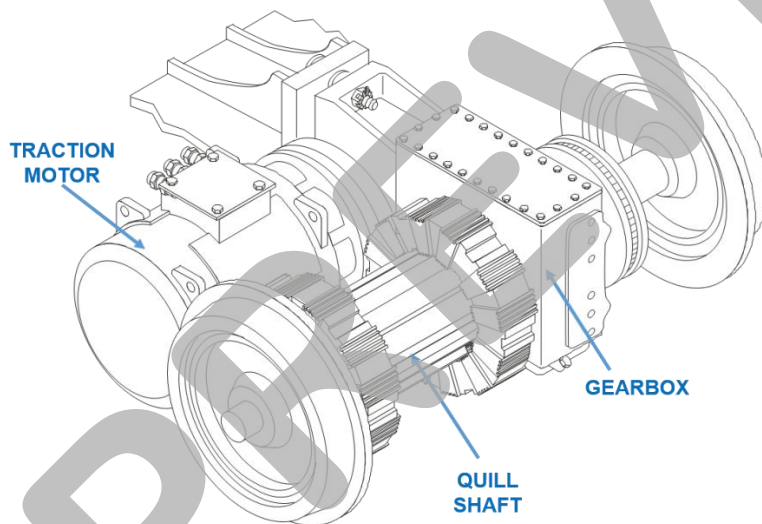


Figure 3.2 Gearbox, Quill Shaft, Traction Motor Arrangement on LRV Truck –Courtesy Denver RTD

the gearbox unit and the truck frame via rubber-metal elements. The pinion shaft and the intermediate shaft are made from case-hardened steel.

The spur gears have helical gearing and are made of case-hardened steel. The spur gears of the intermediate shaft and the hollow shaft are connected by means of tapered press fit connections. The pinion shaft is designed to be one unit.

The pinion shaft is attached by two tapered roller bearings. The intermediate shaft is attached by two cylindrical roller bearings. The hollow shaft is attached by two tapered roller bearings. The axial play at all shafts is set during assembly.

Gear lubrication is performed by means of oil bath lubrication. Oil that splashes off is gathered in oil collection troughs and fed to the bearings for lubrication. From the bearings, the oil returns to the oil sump.

Source: Heavy Repair Maintenance Manual, Transit Car “7000” Series. WMATA

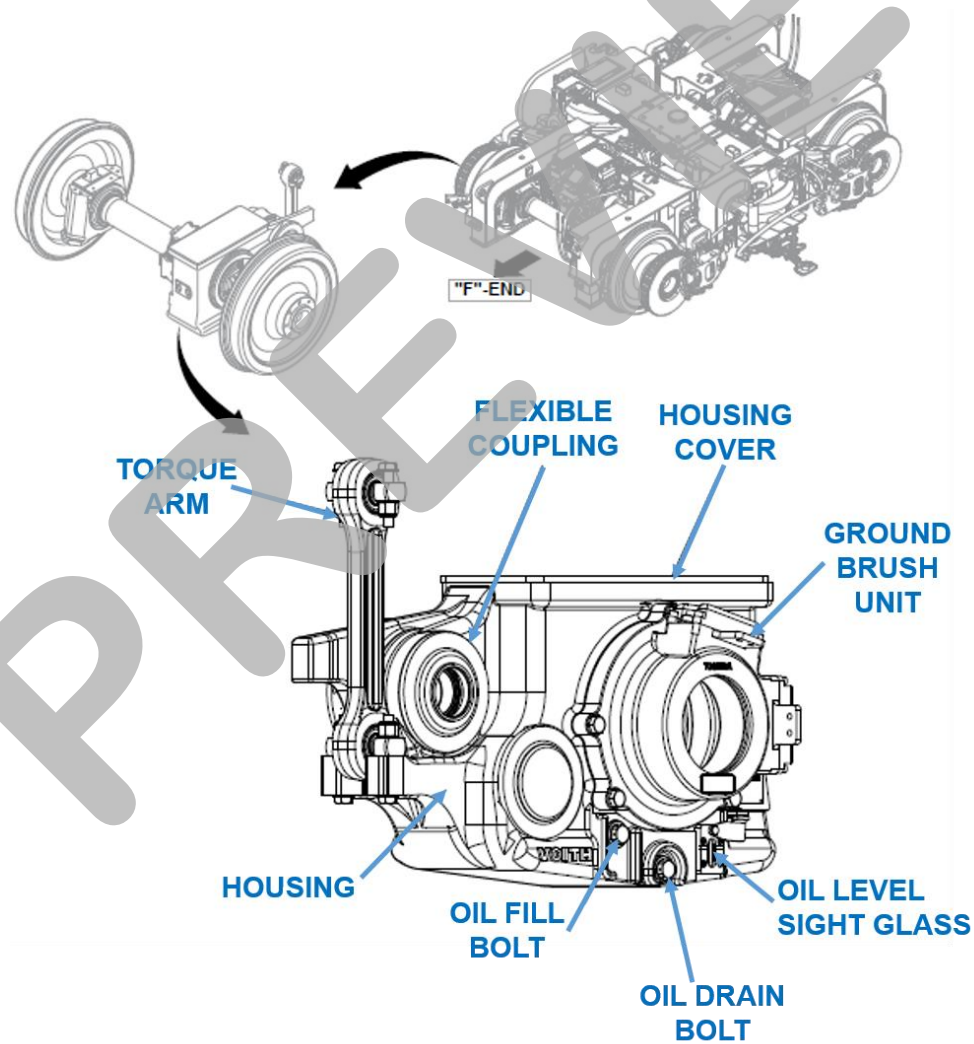


Figure 3.4 Gearbox Unit on HRV –Courtesy WMATA

Speed Sensor

The speed sensor is mounted on the gear unit to measure the speed at which the internal gear is rotating and sends a signal to the drive control unit. The speed sensors provide electrical signals utilized for propulsion control and braking control.

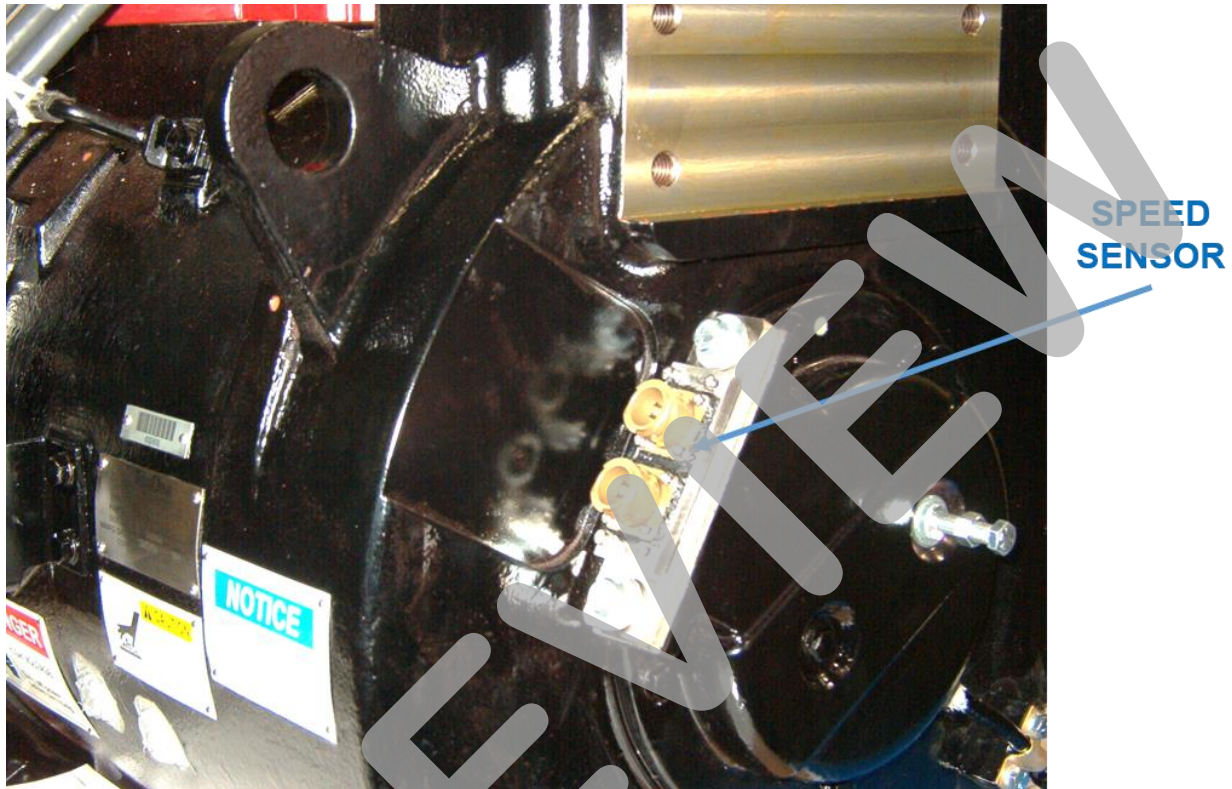


Figure 3.9 Speed Sensor Location –Courtesy DART

MODULE 4

Wheels and Axles

Outline

- 4-1 Overview
- 4-2 Axles
- 4-3 Wheels and Tires
- 4-4 Ground Brush and Journal Bearing
- 4-5 Summary

Outcome and Objectives

This module reviews the principles of operation of the truck's wheels and axles and their major components. Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Explain the principles of operation of the rail vehicle wheelset assembly.
- List the major components common to rail vehicle wheelset assembly.

Key Terms

- Axle
- Ground Brush Assembly
- Resilient Bushing
- Shunt
- Tire
- Wheel

Abbreviations

LRV	Light Rail Vehicle
HRV	Heavy Rail Vehicle
APTA	American Public Transportation Association

4-1 OVERVIEW

This module highlights the essential components and the general principles of operation of the rail truck wheelset assemblies. An example of a wheelset assembly layout is shown in Figure 4.1 below.

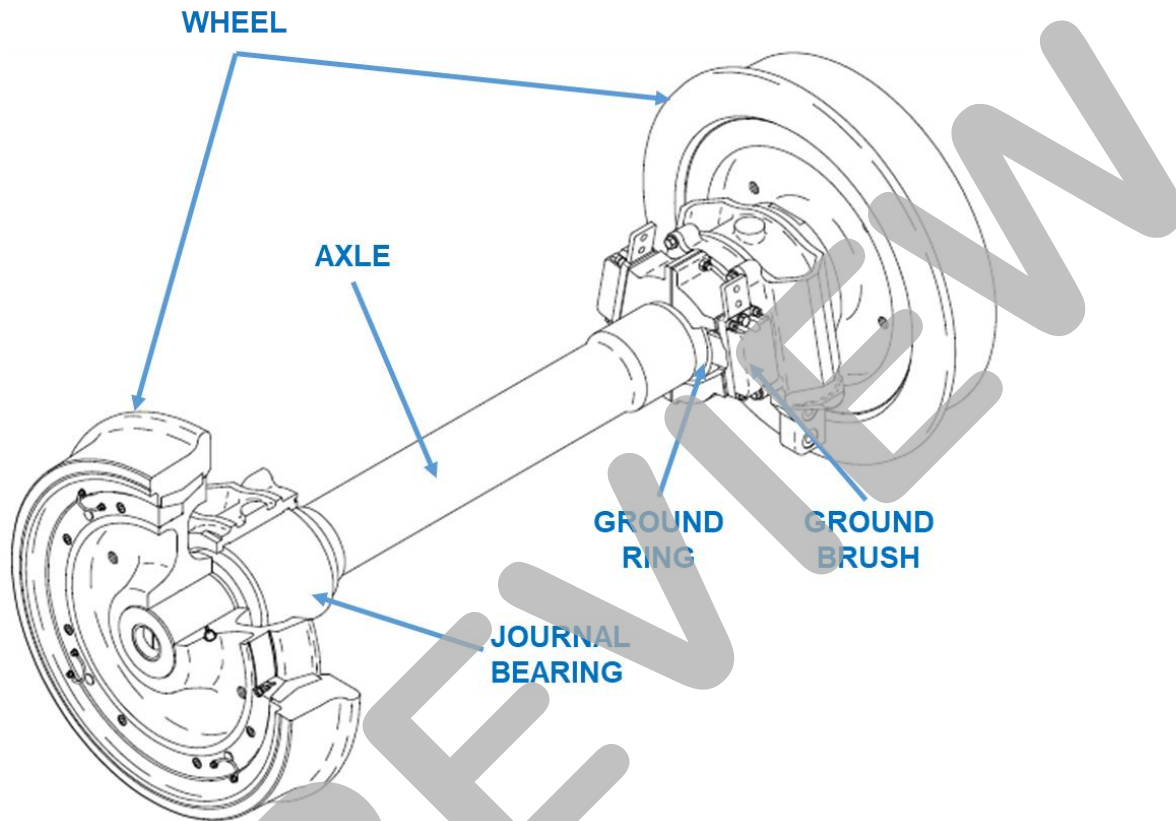


Figure 4.1 Motor Truck Wheelset Assembly on Powered Truck –Courtesy VTA

This module describes these major components of the wheelset assembly in three sections:

1. Axles,
2. Wheels and Tires, and
3. Ground Brush and Journal Bearing.

The axle, journal bearing, and wheel assembly provide the transmission of motion from the traction motor/gearbox unit assembly to the rails.

Wheelset assemblies configurations vary by vehicle type (light or heavy rail), by manufacturer, and by powered or unpowered truck. While some of the illustrations in this module are not specific to the participant's agency, the basic principles and some components are similar. The participant should be prepared to compare the systems described in this module with those systems at their respective rail transportation agencies.

4-3 WHEELS AND TIRES

Wheels guide the vehicle safely along the track. The major components of wheel assembly include:

- The **tire** is that part of the wheel assembly that meets the rail. It is mounted to the wheel.
- **Resilient bushing** (rubber block) is mounted between the tire and wheel.
- **Shunts** are connected between the tire and wheel for grounding.

Figure 4.6 shows the location of these and other components on a wheel assembly on a powered truck.

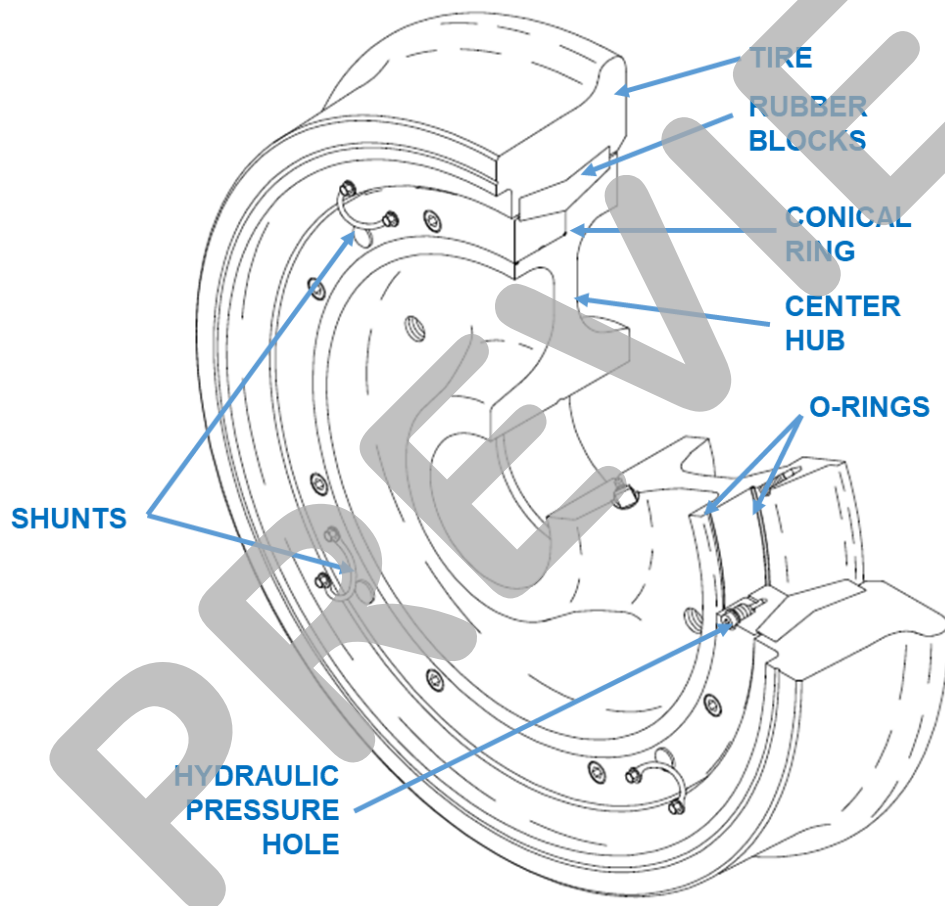


Figure 4.6 Wheel Assembly on Powered Truck –Courtesy VTA

MODULE 5

Tools

Outline

- 5-1 Overview
- 5-2 Suspension Tools and Equipment
- 5-3 Gearbox Tools and Equipment
- 5-4 Wheelset Assembly Tools and Equipment
- 5-5 Summary

Outcome and Objectives

This module reviews some basic tools the technician will likely use when working on rail vehicle trucks. Following the completion of this module, the participant should be able to complete the objectives with an accuracy of 75% or greater:

- Examine lists of specialized tools used in the inspection and maintenance of rail vehicle truck systems.

Abbreviations

APTA	American Public Transportation Association
PPE	Personal Protective Equipment
LRV	Light Rail Vehicle
HRV	Heavy Rail Vehicle

5-1 OVERVIEW

The rail car technician must use various tools for work on truck systems on the rail vehicle. This module will present some tools used across the Consortium’s rail transportation agencies.

In this module, the participant examines tools and equipment used in the inspection and maintenance of truck systems by a Consortium agency and then compares them to those used in their own agency.

5-2 SUSPENSION TOOLS AND EQUIPMENT



Learning Application 5A

With guidance from your instructor, check on the use of the following tools or equipment at your agency. Add your notes regarding that tool. Add other specialized tools that are used at your agency for inspection and maintenance of suspension components.

Component(s)	Tool, Test Equipment, or Special Equipment	Notes
Secondary Suspension Assembly	Brush	
Bolster	Bolster bushing installation tool	
	Bolster assembly table	
	Hand mill grinder	
	Bolster bushing installation tool	
	Bolster assembly table	
Truck Bolster Bushing	Truck Bolster Bushing Tool	
Lateral Shock Absorber	Vertical 5-ton press	