APTA STANDARDS PROGRAM

RECOMMENDED PRACTICE

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Vehicle Inspection and Maintenance Working Group

Truck Systems Periodic Inspection and Maintenance

Abstract: This recommended practice provides the framework for developing minimum inspection, maintenance, testing and alignment procedures to maintain rail transit trucks in a safe and reliable operating condition.

Keywords: bearings, cracks, gearboxes, leveling, lubricants, trucks, wear, wheels

Summary: This recommended practice is intended to provide a template for developing system-specific transit vehicle truck inspection and maintenance procedures that incorporate best practices. These practices address design details found in a wide sampling of transit vehicle truck designs. Rail transit agencies should select recommendations that are applicable to the configuration of their specific equipment.

Foreword

The American Public Transportation Association is a standards development organization in North America. The process of developing standards is managed by the APTA Standards Program's Standards Development Oversight Council (SDOC). These activities are carried out through several standards policy and planning committees that have been established to address specific transportation modes, safety and security requirements, interoperability, and other topics.

APTA used a consensus-based process to develop this document and its continued maintenance, which is detailed in the manual for the APTA Standards Program. This document was drafted in accordance with the approval criteria and editorial policy as described. Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

This document was prepared by the Vehicle Inspection and Maintenance Working Group, as directed by the Rail Standards Policy and Planning Committee.

This document 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 recommended practices or guidelines contained herein is voluntary. APTA standards are mandatory to the extent incorporated by an applicable statute or regulation. In some cases, federal and/or state regulations govern portions of a transit agency's operations. In cases where there is a conflict or contradiction between an applicable law or regulation and this document, consult with a legal adviser to determine which document takes precedence.

This document supersedes APTA RT-VIM-RP-019-03, Rev. 2, which has been revised. Below is a summary of changes from the previous document version:

- Removed section titled "Note on alternate practices."
- Removed Table 1 that contained mileage and time intervals for inspection and maintenance.
- Combined and updated sections on materials, tools and safety/personal protective equipment.
- Removed section previously titled "2.6 Correction of deficiencies."
- Added guidance on wheelset back-to-back measurement and reference to APTA RT-WRI-WP-001-23, "Rail Vehicle Wheelset Back-to-Back Distance Measurement and Monitoring Practices.

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Participants

The American Public Transportation Association greatly appreciates the contributions of the **Vehicle Inspection and Maintenance Working Group**, which provided the primary effort in the drafting of this document.

At the time this standard was completed, the working group included the following members:

Michael Kunkle, *Pittsburgh Regional Transit (PRT)*, Chair
Claire Patrigeon, *Toronto Transit Commission*, Vice Chair
Austin Scioli, *WSP*, Secretary

Pamela Alexander, *Hatch*
Jose Ballesteros, *King County Metro*
Casey Blaze, *Greater Cleveland RTA*
Bruce Bloomster, *Bohr Electronics*
Stephen Bonina, *WSP*
K'Moy Daye, *Metro-North Railroad*
Paul Denison, *Sound Transit*
John Deppen, *Amsted Rail*
Floyd D'Souza, *Metrolinx (GO Transit)*
Sebastian Durzynski, *TDG International*
Carlos Flores, *LA Metro*
Frank Fowler, *NFTA Metro*
Tom Freeman, *International Name Plate Supplies*
Silvester Fulmore, *Charlotte Area Transit System*
Marc Gagne, *TDG International*
Deepika Gangwani, *Toronto Transit Commission*
Russell Gaus, *GFT*
Christian Gschnitzer-Baernthaler, *Stadler US*
Tina Hall, *Charlotte Area Transit System*
Juan Hernandez, *Mott MacDonald*
Joseph Hopfner, *Regional Transportation District*
Michael Hubbell, *Lone Star TAM*
Reid Hunt, *Knorr-Bremse*
Robert Jacks, *Charlotte Area Transit System*
Robert Jones, *Stadler Rheintal AG*
Srinivas Katreddi, *WSP*
Paul Kovacs, *Lea+Elliott*
Stephen Land, *Houston Metro*
Daniel Lanoix, *Independent Consultant*
Marc Laughlin, *Charlotte Area Transit System*
Robert Lawless, *SEPTA*
Brian Ley, *WSP*
Martin Lortie, *Alstom*
John MacEwen, *SEPTA*
Eloy Martinez, *HNTB*
William McClellan, *ACI*
Shawn Merchant, *T.Y. Lin International*
Thomas Muehlbauer, *Stadler US*
Jim Neddo
Pat O'Byrne, *Bosch Engineering GmbH*
Nicolas Pepper, *Maryland Transit Administration*
Matt Pieters, *OC Transpo/City of Ottawa*
Anand Prabhakaran, *Sharma & Associates*
Shushil Ramnaress, *WMATA*
Brandon Reilly-Evans, *Hatch*
Michelle Rodriguez, *SEPTA*
Richard Seaton, *TDG International*
Sean Shim, *NJ Transit*
Jonathan Stark, *ISC Applied Systems*
Talon Turner, *Charlotte Area Transit System*
Raj Wagley, *U.S. Department of Transportation*
Jia Wei, *Houston Metro*
Michael Wetherell, *McKissack & McKissack*
Kenneth Williams, *Hartsfield-Jackson Airport*
Michael Yates, *WSP*

Project team
Bryan Sooter *American Public Transportation Association*
Tytus Suchotinunt, *American Public Transportation Association*
Terasa Importico, Hatch
Benjamin Spears, Hatch

Introduction

This introduction is not part of APTA RT-VIM-RP-019-03, "Truck Systems Periodic Inspection and Maintenance."

This document describes the basic maintenance and inspection requirements for rail transit vehicle truck systems. APTA recommends the use of this document by:

- individuals or organizations that operate rail transit systems;
- individuals or organizations that contract with others for the operation of rail transit systems; and
- individuals or organizations that influence how rail transit systems are operated (including but not limited to consultants, designers and contractors).

Scope and purpose

This recommended practice applies to rail transit vehicles. It is intended to be applied, as applicable, by rail transit agencies for periodic inspection and maintenance. These procedures specifically address wheels, axles, drives, primary suspensions, truck frames, secondary suspensions, truck-to-car-body connections and ride controls. This document should be used in conjunction with rail transit agency instructions and OEM recommendations.

Truck Systems Periodic Inspection and Maintenance

1. Frequency of conduct

Periodic inspection and maintenance tasks on truck systems should be performed on a regular schedule as determined by the rail transit agency. The frequency of any task contained within this recommended practice shall comply with all applicable federal, state and local regulations. Further, in the conduct of the agency's periodic inspection and maintenance programs, the frequencies for individual tasks should be established based on a number of additional factors, including but not limited to the following:

- OEM-recommended intervals
- industry experience
- operating environment/conditions
- historical data
- performance requirements
- failure analysis
- rail transit agency's testing and experience
- reliability-centered maintenance programs.

NOTE: In the absence of experience, recommendations or history, initial inspection intervals should be no longer than 30 days or 3,000 to 5,000 miles.

2. Requirements and specific tasks

WARNING: Before commencing inspection and maintenance work, set up the required lockout/tagout procedures so that the equipment will not be energized or moved unexpectedly.

WARNING: After completing truck inspection and repairs, verify that truck brake cutout devices are returned to the normal operating position and brakes applied. If brake cutout devices are left in the cut out position, tag cutout devices and then follow appropriate rail transit agency operating procedures for moving vehicles with brakes cut out.

2.1 Materials, tools and safety/personal protective equipment

The following materials are normally required for truck inspection and maintenance:

- OEM-recommended or agency-approved lubricants and corrosion protection materials
- torque seal
- additional materials referenced in OEM maintenance manuals, agency service bulletins or instructions

In addition to the standard tools carried by maintenance personnel, the following specialized equipment may be required:

- acoustical listening device and torque wrench*
- specialized gauges*
- nondestructive testing equipment

NOTE: Tools marked with an asterisk (*) require periodic calibration as specified by the rail transit agency's practices.

Appropriate personal protective equipment meeting minimum American National Standards Institute standards, and as required by the rail transit agency, should be worn at all times in the performance of maintenance tasks.

Agency-established safety practices, rules and procedures should be followed at all times in the performance of these inspections and tests, in addition to any task-specific OEM safety recommendations.

2.2 Training requirements

The rail transit agency and/or its maintenance contractors should develop and execute training programs that provide employees with the fundamental technical knowledge and skills necessary to safely and effectively perform the tasks outlined in this recommended practice.

In addition to the fundamental technical skills required of these employees, maintenance workers who inspect and maintain rail transit vehicle trucks should have received detailed, formal and on-the job training for inspecting and maintaining each truck configuration they may encounter in the course of their work.

2.3 Inspection and maintenance procedures

For consistency, maintenance workers should work from standard check sheets that guide the work. Each inspection element should be checked off as it is completed in order to provide accountability for the completeness of procedures performed. The practice also provides maintenance workers and their supervisors with a record of inspection progress for continuity if the work is passed to other maintenance workers or shifts. Deficiencies discovered during the inspection should be documented in the rail transit agency's maintenance management system.

Any repairs or adjustments completed during the inspection should be recorded on the inspection form and signed off as completed by the maintenance worker performing the work. If deficiencies are not acknowledged as having been corrected on the inspection forms, the disposition of each incomplete item should be noted on the inspection forms (i.e., reinspected and found serviceable or converted to a work order number). A maintenance supervisor or a rail transit agency designee should review each completed inspection and ensure that all deficiencies are addressed.

NOTE: It is important to develop a system that tracks deferred repairs until those repairs are completed.

Corrosion (rust) should be removed before it propagates, and corrosion protection agents should be applied as required.

Trucks that are stored should have the wheels rotated at a minimum every six months to prevent damage to the bearings.

2.3.1 Wheels and axles

2.3.1.1 Wheels

Measure flange and tread wear using gauges appropriate for the wheel profile being inspected. If measuring gauges are used (rather than go/no-go gauges) record flange height and thickness, rim thickness, or the wheel diameter calculated from a rim reference groove. Record measured dimensions on inspection records to maintain wheel wear history. For dc motor current balance and effective spin/slide detection, maintain propulsion and brake system manufacturer recommendations for wheel diameter matching. Maintain precise wheel diameter matching in accordance with the propulsion, braking and onboard signaling systems' OEM recommendations.

Severity of wheel defects discovered and their disposition should be determined by rail transit agency guidelines or the AAR Wheels and Axles manual. Inspect wheel plates and hubs for cracks, gouges and arc burns. Wheels with hub, plate or rim defects that may cause stress concentrations are to be removed from service. Inspect wheel treads for slide flats, spalling, shelling and thermal cracking. Check rims and plates for discoloration due to overheating.

For ring-damped wheels, inspect the ring for damage.

For resilient wheels, inspect external shunts connecting the tire to the hubs or cheek plates. Use inspection methods on internal shunt resilient wheels that confirm that the ground path impedance across each tire and hub is uniform. Check that tires have not shifted on the hub of two-piece wheels.

Wheel truing should be used to address wheel defects, and wheels with condemning defects that cannot be removed by wheel truing should be replaced. Use manufacturer or AAR guidelines to define a minimum diameter wheel and minimum rim thickness.

Rail agencies should obtain and follow locomotive/car manufacturer(s) indicated procedures and time intervals for wheelset back-to-back measurements. Refer to APTA RT-WRI-WP-001-23, Rail Vehicle Wheelset Back-to-Back Distance Measurement and Monitoring Practices for more information.

2.3.1.2 Axles

Disposition of axle defects should be determined by rail transit agency guidelines and/or the AAR Wheels and Axle manual.

Visually inspect axles for grooves, nicks or arc burning. Remove indications by polishing, but replace axles with nicks, gouges, arc burns, overheating or circumferential scoring that may become a stress concentration point.

2.3.1.3 Journal bearings

Visually inspect grease-lubricated journal bearings for evidence of purging. Use bearing manufacturer guidelines for monitoring lubricant purging that may include lubricant replenishment or bearing replacement. Check oil level in the reservoir of oil-lubricated journal bearings. Where equipped, check serviceability of temperature sensors installed in axles to detect overheated journal bearings. If bearings are removed, replace with new or recertified bearings.

2.3.2 Truck-mounted systems

Inspect all truck-mounted hardware for wear, damage and missing components in accordance with rail transit agency instructions, and repair or replace.

2.3.2.1 Ground brush boxes

Remove, clean and inspect each ground brush, and inspect the springs and the brush guide. Verify that each brush slides freely and is retained tightly against its slip ring. Inspect the slip ring for damage, defects and shifting. Inspect car body to ground brush housing cables. Replace cables that have torn stranding. Replace ground brushes that are shorter than a wear limit witness mark or the wear limit established by the rail transit agency. Replace ground brushes with evidence of burning, discoloration or shunt damage.

2.3.2.2 Flange lubricators

Where equipped, inspect truck-mounted solid lubricant blocks and holders. Replace lubricant blocks worn to manufacturer or rail transit agency limits. Ensure that blocks slide freely within their holders and maintain constant contact with the throat of the flange and/or in the restraining rail contact zone on the back of the flange.

Where equipped, inspect oil or grease lubricant delivery systems. Refill lubricant reservoirs as required to the specified level with lubricants designated by the OEM or the RTA as appropriate for the lubricator being serviced and actuate the controls. Verify that the lubricant is dispensed to the throat of the wheel flange.

2.3.2.3 Sanding equipment

Where equipped, verify that truck-mounted sand nozzles deliver sand to the head of the rail. Clean or replace plugged or damaged sand delivery nozzles. Refill sand boxes as required in accordance with rail transit agency instructions. Where equipped, verify that sand nozzle heaters are operable.

2.3.2.4 Trip cocks

Inspect the emergency pipe trip cock for proper attachment and operation. Gauge and adjust as required.

2.3.2.5 Antennas and receiver coils

Inspect truck-mounted antennas and receiver coils for proper attachment. Inspect cable insulation for splits and cuts, and verify that connectors are secure.

2.3.3 Drives

2.3.3.1 Gearboxes

Visually inspect the gearbox for damage or missing components. Check and maintain the oil level in each gearbox. Use OEM guidelines for determining and maintaining proper gearbox oil levels. Use oil designated by the OEM or the rail transit agency as appropriate for the gear drive being serviced. Record the amount of make-up oil added. Check for unusual or excessive oil leakage.

> **NOTE:** Use oil consumption records to identify gearboxes that leak oil excessively.

Replace gearbox oil at scheduled intervals or based on sampled oil or environmental conditions.

The following predictive inspection techniques may be incorporated into the periodic inspection cycle:

- gearbox backlash
- contaminant detection
- noise monitoring
- temperature monitoring

NOTE: The rail transit agency should develop baseline comparison standards, established for its equipment and local operating environment. Baseline conditions should represent a known serviceable drive system standard.

2.3.3.2 Resilient and flexible couplings

Inspect traction motor flexible couplings for evidence of grease or oil slinging. Check flexible coupling components for excessive lost motion. Gauge the coupling halves for proper alignment. Where equipped, inspect output quill to axle resilient couplings for compressed, sheared and torn rubber elements and cracked or missing spider components. Inspect for age-related surface cracks or bulging in elastomer coupling elements that are an indication of loss of resilience. Add lubricant and secure fittings, adhering to OEM or rail transit agency guidelines. Remove and replace defective couplings.

2.3.3.3 Drive component suspension

Inspect traction motor and gear unit suspension elements. Inspect horizontal stabilizers and gear drive to traction motor resilient mounting bushings. Inspect drive component safety blocks, cables and hangers. In accordance with OEM guidelines, verify that all safety restraint components are in the correct position; verify that all fasteners are secured and in place with a locking device where required; and replace elastomeric components. Inspect elastomeric pads and bushings, and replace any that are deformed, are torn, exhibit initiation of bond failure or are cracked with obvious compression set.

NOTE: Elastomeric components have a finite shelf life.

2.3.3.4 Speed sensors

Inspect speed sensor housings for impact damage that has distorted or cracked the body. In accordance with OEM guidelines, verify that speed sensor mounting hardware is secured. Tighten or replace speed sensors, mounting hardware and brackets as required. Check that cables are secured and are not chafing. Inspect open generator gears (usually found on non-powered axles) for damage and accumulations of metal-laden debris that may impede accurate pulse counts. If required, clean the sensor face in accordance with rail transit agency maintenance guidelines.

2.3.4 Primary suspension

Replace primary suspension components in matched sets only. It is important to replace springs in matched sets to ensure the vehicle weight distribution, spring life and wheel load equalization are maintained per design. Matched sets are typically required across the same wheelset or truck. Matched sets are typically color coded or similar and shipped as a matched set.

2.3.4.1 Steel springs, equalizer beams and journal bearing adapters

Inspect coil spring sets for alignment with witness marks (if equipped), damage and excessive rust pitting. Replace damaged spring seats and worn journal bearing adapters when springs are replaced. Inspect for pedestal liner wear that allows excessive journal adapter lateral and longitudinal movement. Replace missing or damaged components.

2.3.4.2 Shock rings and bonded rubber chevrons

Inspect linear or conical bonded rubber primary suspension elements for deformation or degradation. In shock ring applications, inspect for bulging, pinched and deformed elastomer between the axle cap and the journal bearing housing.

2.3.5 Secondary suspensions

2.3.5.1 Steel springs

Inspect springs for breaks and cracks and rust pitting. Inspect spring pockets for accumulations of dirt and debris that retain moisture. Replace springs that are broken or corroded in excess of specifications. Replace secondary springs in matched sets only. Inspect condition of resilient pads located in spring pockets, and replace if damaged. Check car-leveling heights and adjust as required in accordance with rail transit agency instructions.

2.3.5.2 Air springs

Inspect bellows for air leaks at the bead rings. Look for bulges in the outer ply. Look for abrasion of the plies between convolutions. Replace leaking or physically damaged air bellows. Inspect air bellows shrouds for physical damage that may impede operation of the air spring. After changing a damaged bellow, verify car leveling in accordance with rail transit agency guidelines.

> **NOTE:** A vehicle leveling workstation should be established with known, minimal track surface and cross level deviation. All vehicle leveling checks should be performed at the vehicle leveling workstation in order to factor out track structure variables.

> **NOTE:** Inspect shutoff valves to ensure valves open and close freely without leaking, and service shutoff valves in accordance with OEM procedures.

2.3.6 Truck frames and bolsters/slewing rings

2.3.6.1 Truck frames

Inspect truck frames for propagating cracks and points of contact that result in mechanical wear. Inspect welds and the heat-affected zones adjacent to welds for stress-induced cracks. Inspect the attachments for brake equipment, stabilizer or radius rods and the transom attachment points used for articulated side frame arrangements. Inspect and lubricate transom spherical bearings where equipped.

2.3.6.2 Dampers

Inspect shock absorbers (also referred to as a snubber) for fluid leaks and secure attachment as well as hydrobushings. Using OEM or rail transit agency guidelines, replace leaking shock absorbers and check that shock absorber mounting hardware is secure.

2.3.6.3 Tie rods and tie rod ends

Inspect tie rods and tie rod ends for proper attachment and freedom of motion. Adjust tie rod length to allow the full range of motion required by the attached shock absorber. Replace worn, loose tie rod ends. Lubricate tie rod ends using OEM and rail transit agency guidelines.

2.3.7 Truck/car body bolsters, spring planks

Inspect bolsters and spring plank/swing hangers for propagating cracks and points of contact that result in mechanical wear. Inspect the stabilizer or radius rod attachment points and shock absorber attachment brackets for cracks.

Inspect center pin receptacle liner and bolster longitudinal, lateral and vertical stop wear surfaces for clearances exceeding tolerance limits in accordance with OEM and rail transit agency guidelines. Inspect side bearing contact surfaces, and replace accessible contact pads or plan truck replacement for renewal of wear liners, contact pads or bushings to restore manufacturer or agency clearance limits. Inspect ground cables and

shunts, and replace frayed shunt straps and torn conductors. Check ground cable and shunt attachment hardware for securement and corrosion.

Inspect rubber bushings in accordance with agency instructions and replace as required.

2.3.7.1 Slewing rings

Inspect slewing rings using OEM or rail transit agency guidelines. Lubricate bearing elements based on manufacturer recommendations and the local operating environment.

2.3.8 Truck-to-car-body connections

2.3.8.1 Radius/torsion rods

Inspect radius rod resilient pads at the truck/bolster anchor and at the car body anchor. Inspect radius rod securing hardware. Replace radius rod resilient pads that are separating from the bonded metal backing plate, have taken a permanent compression set or are cracked. Replace radius rod resilient pads in truck sets. Use recommended and approved methods to measure radius rods' length. Use approved methods to ensure that radius rods are adjusted to maintain car body and truck bolster alignment.

Inspect torsion rod bushings for cracks and other signs of wear. Inspect mounting hardware for securement. Lubricate and/or replace as required in accordance with rail transit agency instructions.

2.3.8.2 Pipes, hoses and cables, cleats, and clamps

Visually inspect all air hoses, cables and pneumatic/hydraulic pipes for damaged or loose cleats and clamps. Repair or secure as required. Check flexible connections and hoses for damage of chafing. Redress hoses and cables that are being damaged by contact with truck and car body equipment or by abrading each other. Inspect that cleats are effective in securing and routing hoses, and replace or repair as required.

2.3.8.3 Cables and chains

Inspect hand/parking brake cables, chains, rods and links for evidence of fouling and security of attachment. Repair or replace as required. Adjust chains and cables so that parking brakes can be applied and released without interference. Lubricate as required.

3. Recordkeeping

Recordkeeping and internal audits should be performed in accordance with rail transit agency procedures.

References

Association of American Railroads, “AAR Manual of Standards and Recommended Practices,” Section G, Part II, Wheels and Axles.

APTA RT-WRI-WP-001-23 Rail Vehicle Wheelset Back-to-Back Distance Measurement and Monitoring Practices.

Definitions

acoustical listening device: A vibration monitor that transforms the minute impacts from mismatched or distressed rolling and sliding elements into audible pressure waves that can be heard through an air tube stethoscope or seen by observing the plot of electrical signals generated by a transducer monitoring the same energy.

baseline noise and vibration signature: The displacement response frequency from vibrations generated by mechanical rolling and sliding contact. Vibration characteristics can be recorded by plotting the displacement amplitude and frequency or when in an audible range, by characteristic sounds. The baseline signature is a record of the characteristics recorded from a new, rebuilt or predetermined, known serviceable truck and is used as the basis for comparison.

slewing rings: A rotational rolling-element bearing that typically supports heavy, slow-turning, or slowly oscillating loads and is generally located between the truck and the car body.

snubber: A friction or hydraulic device used to damp oscillations, also known as a shock absorber or damper (e.g., truck-to-bolster yaw oscillations).

spin test: A diagnostic procedure typically used to detect anomalies that are not apparent when inspecting stationary motors, gear drives and wheel sets. Wheel sets are jacked off the running rail and rotated under no-load conditions (or “spun”) either through resistance control of traction power line voltage or by utilizing a testing device supplying low voltage or low frequency.

torque stripe/seal: Registration mark painted across a fastener and an adjacent stationary reference surface immediately after the specified tightening torque has been applied. Marks subsequently found out of registration indicate relative motion, probable loosening and reduced clamping forces.

wheel profile gauges: Instruments for determining the deviation of the observed, actual wheel profile from the new or ideal wheel profile.

Abbreviations and acronyms

ac	alternating current
AAR	Association of American Railroads
dc	direct current
OEM	original equipment manufacturer

Document history

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