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**RECOMMENDED PRACTICE**
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Bus Brake and Chassis Working Group

# Troubleshooting Common Transit Bus S-Cam and Air Brake Complaints

**Abstract:** This document establishes a recommended practice for troubleshooting common braking-related complaints on transit buses equipped with S-cam brakes. Individual operating agencies may modify these guidelines to accommodate their specific equipment and mode of operation. Test results must meet or exceed federal, state or other local regulatory agency requirements if different from the recommendations outlined in this document.

**Keywords:** brake performance, brakes, bus brake, deceleration, PBBT, stopping, transit bus

**Summary:** This document establishes a recommended practice for transit bus front/rear axle S-cam brake reline. Individual operating agencies should modify these guidelines to accommodate their specific equipment and mode of operation. The following recommended practices and guidelines assume that the end users have sufficient skills and knowledge to repair and maintain the related systems at a journeyman level. These skills and knowledge must also include a fluent understanding of safe shop working practices, not only for the agency but also OSHA/CCOHS/provincial/federal/state and local safety standards. A familiarity with applicable industries, component/system suppliers, and vehicle manufacturers is also assumed.

> **NOTE:** The purpose of this disclaimer is to minimize the need for constant explanations/reminders to end users of basic shop processes and safe working practices to prevent injuries.

**Scope and purpose:** This recommended practice provides troubleshooting guidelines for heavy-duty transit buses equipped with air drum brakes equipped with S-cam type brakes. It covers only the most probable causes of the most common braking-related complaints. It does not cover all possible reasons or complaints. The purpose of this recommended practice is to provide a uniform method and criteria for troubleshooting the most probable cause of the most common braking related complaints.

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## Introduction

*This introduction is not part of APTA BTS-BC-RP-005-10, Rev. 2, "Troubleshooting Common Transit Bus S-cam and Air Brake Complaints."*

APTA recommends the use of this document by:

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

# Troubleshooting Common Transit Bus S-Cam and Air Brake Complaints

## 1. Safety

It is the technician's responsibility to ensure that the bus is safe to operate before performing the tests in this document. This should include the following:

- visual inspection
- an on-site test drive in a safe, controlled area

## 2. Common brake-related complaints

The following sections contain common brake problems and their likely causes. See **Figure 1** for a flow chart depicting the brake troubleshooting process.

### 2.1 Slack (soft) brakes

#### 2.1.1 Definition

Slack or soft brakes refers to the vehicle not slowing or stopping effectively when the brakes are applied.

> **SAFETY NOTE:** It is important to treat every slack brake with extreme caution. Complaints can be verified by a road test (subjective) or a decel test (objective). It is also important to validate all repairs by performing a brake deceleration test, as outlined in Section 3.2.5.

#### 2.1.2 Typical causes of slack (soft) brakes

Brakes out of adjustment:

- Excessive push rod travel:
  - Automatic brake adjuster malfunction or improper setup
  - Worn foundation components (yoke, clevis, bushing, camshaft, etc.)
- Tight camshaft (poor lubrication)
- Broken parts, brake adjuster, chamber bracket, park brake spring
- Push rod and brake adjuster alignment

Brake assembly differences:

- Incorrect chamber size and type
- Incorrect brake adjuster length
- Brake adjuster applied angle

Brake lining and drum condition:

- Glazed or polished lining:
  - Imbalanced brake (one axle doing a disproportionate amount of the braking force)
  - Mismatched friction material
  - Regenerative braking

    - Brake not reaching optimal operating temperature
    - Dragging brake
    - Incorrect lining for application
    - New shoes installed on a non-resurfaced drum
- Poor choice of friction material
- Contaminated lining (typically oil or grease)
- Worn brake lining, cracked or loose block
- Insufficient brake lining to drum contact

Air system malfunctioning:
- Air leaks and/or restrictions in application delivery system
- Contaminated or worn air system components
- Contamination in reservoirs, lines and components
- Improper or malfunctioning applications and relay valves (crack pressure)

## 2.2 Brake noise

### 2.2.1 Definition

Brake noise refers to an unwanted sound created when the brakes are applied or while the vehicle is moving.

### 2.2.2 Factors to consider when diagnosing brake noises

- The type, pitch, volume and location of noise
- Whether the brakes are warm or cold when the noise happens
- At what brake application pressure the noise occurs
- Whether the noise occurs at higher vehicle speeds or toward the end of the brake application
- If the noise changes throughout the braking application
- Brake noise before or after brake burnish

### 2.2.3 Typical causes of a squealing noise when the brakes are applied

- Glazed/polished surfaces on the lining and/or the drum
- Lining loose on shoe
- Worn foundation:
    - Anchor pin, bushings
    - Camshaft, bushing, support bracket
    - Brake return springs
- Foundation brake parts not meeting OEM specifications:
    - Brake drum design and weight
    - Wrong lining for the application
- Poor lining-to-drum contact:
    - Improper spider alignment
    - Bell mouthing drum
    - Improper machining (arc)
    - Worn foundation parts
- Imbalanced brake (one axle doing a disproportionate amount of the braking force)
- Dragging brakes:
    - Brakes not releasing
    - Contaminated air system
    - Sticking camshaft
    - Misadjusted brake adjuster
    - Broken spring brake chamber return spring

- Shoe table or backing plate rubbing against drum
- Improper finish on the lining and/or drum

### 2.2.4 Typical causes of a grinding noise when the brakes are applied

- Damaged or contaminated lining (foreign material embedded in friction material)
- Metal-to-metal contact between brake shoe and brake drum
- Foundation part failure (return spring failure, roller or cam-over condition)

## 2.3 Pulling (brake steer)

### 2.3.1 Definition

Pulling refers to an unintended directional change, left or right, that occurs during brake application.

### 2.3.2 Typical causes of pulling brakes

- Braking-related:
    - Contaminated lining (typically oil or grease)
    - Uneven lining to drum clearance
    - Uneven push rod travel
    - Glazed (polished) or rough drums surface and/or lining
    - Different lining formulation or burnish condition, right to left
    - Inoperative brake
    - Mismatched, defective or worn foundation parts (slack length, air chamber size/type)
    - S-cam mismatched (some manufactures utilize a special cam to adjust brake torque)
    - Damaged or restricted brake hoses
    - Modifying air system from original configuration
- Steering-related:
    - Alignment
    - Loose and/or worn steering linkage (tie rods, drag link, etc.)
    - Loose and/or wheel end components (wheel bearing, king pins, etc.)
- Tire-related:
    - Improper inflation
    - Mismatched tire size or type
- Suspension-related:
    - Radius rod or torque rod damage (bent) and/or bushing wear
    - Ride height control imbalance
    - Axles out of alignment front to rear (thrust angle)

**NOTE:** Altering the brake balance from rear to front can exaggerate pulling.

## 2.4 Smelly (hot) brakes

### 2.4.1 Definition

Smelly brakes are those that have an unusual odor, which is typically the result of higher-than-normal brake temperatures.

### 2.4.2 Typical causes of smelly brakes

Newly relined brakes:

- The release of vapors caused by heat generated during the break-in process is normal. See APTA BT-RP-001-05, “Transit Bus In-Service Brake System Performance Testing,” for the proper burnishing procedure.

Overheated brakes:

- Dragging brakes:
  - Worn foundation brake components (broken return spring, binding S-cam, etc.)
  - Improper setup (brake adjusters, lining-to-drum clearance, machining, etc.)
  - Malfunctioning air system valve (application, relay, quick release, air restriction, interlocks, etc.)
  - Spring brake not fully released (broken or weak spring, air leak, insufficient hold-off pressure)
- Slow release (worn foundation brake components, binding shoe, minimal anchor pin/shoe clearance)
- An underperforming brake or axle foundation, causing other foundation brakes to be overworked:
  - Mismatched foundation brakes (chambers size/type, friction material)
  - Poor lining-to-drum contact
  - Glazed or polished drum or lining surface

Contaminated lining/drum:

- Leaking wheel seal
- Over-greased S-cam/anchor pin

**NOTE:** Contaminated linings must be replaced, never cleaned or reconditioned.

## 2.5 Poor brake mileage performance

### 2.5.1 Definition

Poor brake mileage performance refers to the mileage between relines not achieving established baseline goals.

### 2.5.2 Establish baseline goals

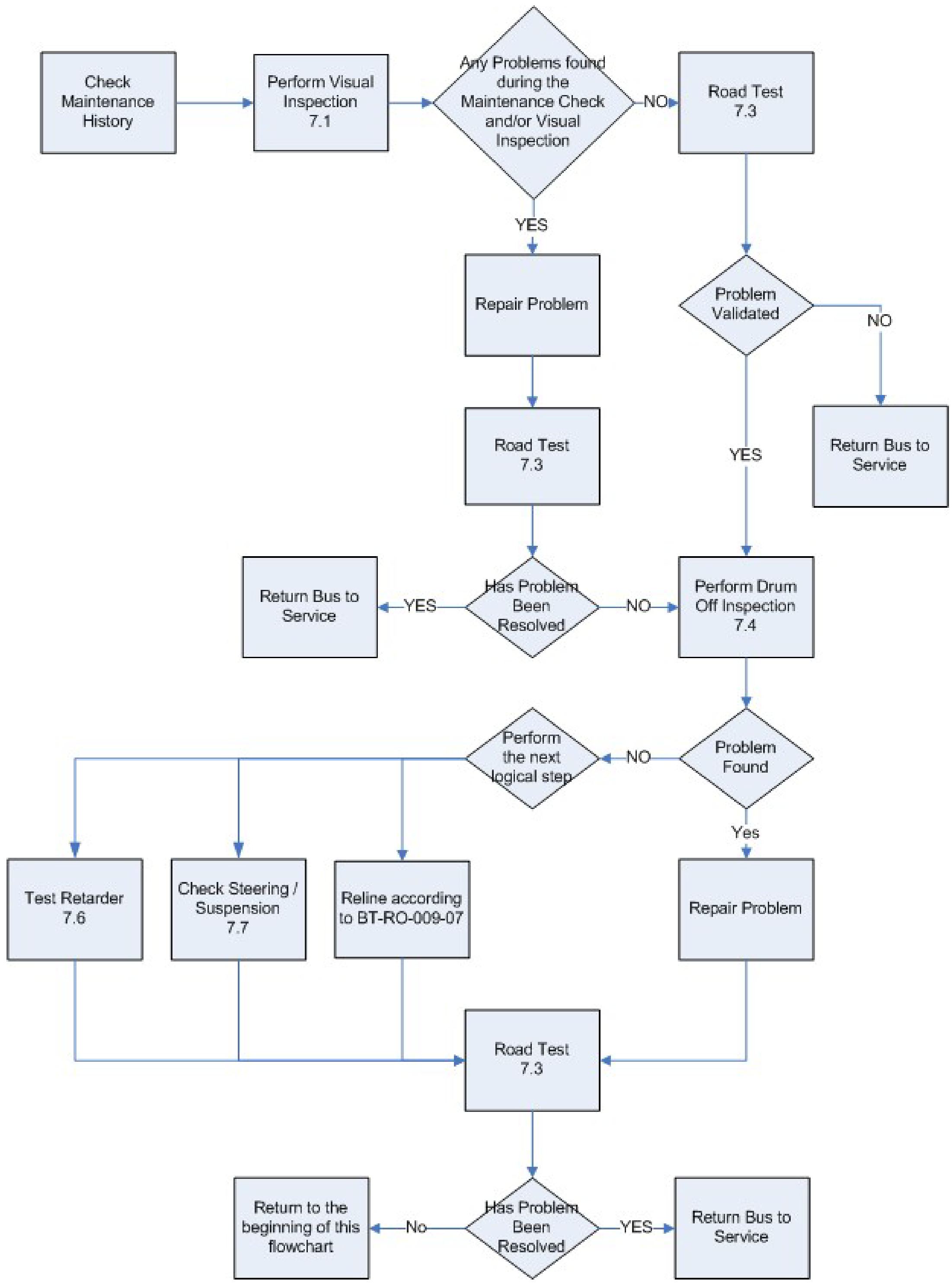
This document focuses on individual buses within a fleet and not a fleetwide problem. It is necessary to establish a fleet average, for each series of coach, after all axles are using the agency's preferred lining. Any coach that varies outside the normal reline interval (for example, 20%) should be inspected. Each depot and agency will need to establish its own baseline.

### 2.5.3 Typical causes of poor brake mileage performance

- The reuse of worn foundation parts
- Improper brake burnishing after reline (see Section 3.2.4)
- Dragging brakes (see Section 2.4.2)
- Excessive braking imbalance, side-to-side and/or axle to axle:
  - Improper setup
  - Improper or mismatched foundation or air system components
  - Contaminated or worn air system components
  - Glazed or polished drum or lining at one axle, generally due to one axle performing the majority of the work
- Malfunctioning supplemental braking system (retarder, engine brake, braking regen, etc.)

**FIGURE 1**
Brake Troubleshooting Flow Chart



# 3. Test descriptions

## 3.1 Review of maintenance records

Troubleshooting of a brake system–related problem can often be simplified or resolved by examining the maintenance history of a vehicle. Historical data must be accurate and updated to include most recent activities to be of value to troubleshooting. Agencies that have maintenance data collection systems and reports available will benefit by incorporating specific information as described herein. Those that do not have maintenance data systems in place should review any maintenance files and records to the extent available.

A review of maintenance records for the problem bus should include the following:

- The most recent brake reline date and mileage traveled since that date
- Drum size on axles at last reline
- History of bus mileage between brake relines for the last two or three intervals
- Repairs and technician comments relating to the brake system, auxiliary braking system, suspension, steering system and air supply system since the last reline date
- Scheduled maintenance and inspection completion
- Road call or operator reports
- History of similar complaints on this bus
- Brake test data from APTA BT-RP-001-05, "Transit Bus In-Service Brake System Performance Testing"

In conducting this review, a technician is looking for a variety of factors that could point toward the problem area. These include recent repairs that may have introduced a problem or failed to solve a previous problem. It is important to check for deteriorating performance on an axle or wheel, or missed scheduled maintenance.

## 3.2 Preliminary inspection

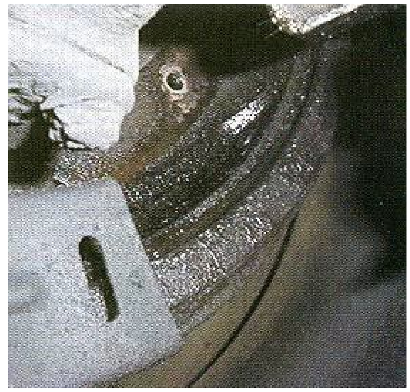
### 3.2.1 Visual inspection

Look for loose, missing or damaged hardware. Thoroughly inspect the foundation brake system, which includes the brake block, drums, brake chambers, mounting fasteners, anchor pins, return springs, rollers, brake adjusters and other system parts.

- Lining/shoe (**Figure 2**):
  - Check that the block is not worn to the wear line or less than ¼ in. as measured at the center of the shoe. At no time should rivets or bolts touch the drum.
  - Check that there is no movement between the brake block and the shoe.
  - Check for missing segments of brake block.
  - Check the brake blocks for cracks, hardness and glazing.
  - Inspect for signs of block contamination, i.e., oil or grease.
  - Check shoes for damage, broken welds, worn roller pockets and/or broken shoes.
  - Make sure all components are appropriate for the application (proper length pushrod, proper brake chamber size, etc.).

**FIGURE 2**
Brake Lining Problems


Cracked lining


Contaminated lining

- Brake actuator (chamber):
  - During pushrod travel measurements, listen for air leaks in the brake chambers or other foundation brake components.
  - Inspect for dents, bends, misalignment, leaks, pushrod return, corrosion and missing caps.
- Air hoses:
  - Inspect for cracks, kinks, routing, leaking, chafing and deterioration.
  - Check for proper size and material.
  - Check for different configurations side to side (different fittings, hose size and routing, etc.).
- Hardware:
  - Check the condition of the clevis, pin and yoke.
  - Check for broken or missing return springs.
  - Check brake return spring for proper installation.
  - Check drums for excessive wear or cracks (**Figure 3**).
  - Check S-cams and rollers (wear, flat spots, lift).

**FIGURE 3**
Brake Drum Problems


Cracked brake drum

- Steering suspension:
  - Worn, damaged or misaligned steering/suspension components can cause a vehicle to pull or drift during braking. Carefully inspect the tires, torque rod bushings, drag links, air bags, tie-rod ends, king pins and shock absorbers.

### 3.2.2 Brake power stroke measurement

The measurement procedure may be modified for each agency's requirements but should contain the following steps:

1. Measure and record the distance from the brake chamber face to the center of the clevis pin with the brakes fully released. Repeat at all wheel locations.
2. Increase or decrease reservoir pressure to 100 psi, and turn off engine.
3. Make and hold a full service brake application.
4. While holding the application, measure and record the distance from the brake chamber face to the center of the clevis pin. Repeat at all wheel locations.
5. Subtract the measurements between the brakes applied and brakes released to determine power stroke.

If the power stroke exceeds the allowable stroke for the chamber size, the cause of the overstroke condition must be identified and corrected. If the vehicle is equipped with automatic brake adjusters and measurements exceed the power stroke limits in **Table 1**, then follow the manufacturer's recommendations to repair deficiencies. The power stroke should then be retested to confirm compliance.

**TABLE 1**
Power Stroke Limits

| Chamber size | Stroke limit (in.) | Stroke limit (mm) |
|---|---|---|
| 20 | 1¾ | 45 |
| 20LS | 2 | 51 |
| 24 | 1¾ | 45 |
| 24L | 2 | 51 |
| 24LS | 2½ | 64 |
| 30 | 2 | 51 |
| 30LS | 2½ | 64 |
| 30 DD3 | 2¼ | 57 |
| 36 | 2¼ | 57 |

**CAUTION:** Find and repair the cause of an overstroke condition. Do not manually adjust automatic brake adjusters as a means to repair.

### 3.2.3 Road testing

It is the technician's responsibility to ensure that the bus is safe to operate before performing a road test on public roads. The test may include a visual inspection and/or test drive in a safe area within the agency's property. Each property may have different safety requirements before a vehicle is road-tested. Be sure to comply with agency road-testing procedures.

The purpose of the road test is to verify the complaint as well as isolate the origin. To accomplish this, it is important to replicate the circumstances that caused the original complaint as closely as possible, paying close attention to the temperature of the brakes, road conditions and rate of deceleration.

The use of testing devices may help replicate the conditions and isolate the problem.

### 3.2.4 Burnish brakes and measure temperatures at all wheel ends

Temperatures should be within 50° F side to side on the same axle, 100° F from steer to drive and center axle. Burnish procedures may be modified for each agency's requirements but should be similar to the following steps:

1. Using the service brake, slow the vehicle from 20 mph to 5 mph at approximately 0.3 g deceleration, or a moderate brake application.
2. Repeat this process 10 times (snubs) at regular intervals of approximately 500 ft or 0.1 mi without stopping the vehicle.

   **CAUTION:** Do not permit wheel lockup.

3. After the 10th brake application (snub), make one complete stop from 20 mph to 0 mph.
4. Compare drum temperature differential immediately after burnishing. Any drum that is significantly cooler (approximately 50° F side to side, 100° F front to center/rear) than the others indicates a lack of braking effort. Inspect the vehicle for brake defects and perform necessary repair. After repairs have been made, repeat burnishing.

### 3.2.5 Brake deceleration testing procedure

**SAFETY NOTE:** Testing area should be clear of all traffic and in a location with good visibility.

The following is a general procedure for performing a brake deceleration test. Consult the operator's manual of the testing equipment being used for the specific procedure. Each operating agency may determine the number of tests used and the pass/fail criteria for the road deceleration test.

Newly installed friction components can produce inconsistent results when performing deceleration tests. For that reason, it is recommended that the following tests be performed only on brakes with some service history:

1. Position the vehicle on a level, dry surface free of debris.

   **NOTE:** If testing brake performance on a wet or low coefficient road surface, the value of the test may be limited.

2. Build air system pressure to OEM cut-out specification.
3. Calibrate the testing equipment.
4. Accelerate to approximately 20 mph.
5. Bring the vehicle to a complete stop with a full brake application.
6. Record results from the test.
7. Repeat as necessary per agency standards.

If deceleration capability of the service brake system is tested with a mechanical deceleration measurement device (**Figure 4**), the peak efficiency of 60% (0.6 g) should be achieved from an initial speed of approximately 20 mph.

If the deceleration capability of the service brake system is tested with an electronic deceleration measurement device (**Figure 4**), an average in-stop deceleration rate of at least 0.528 g should be achieved from a speed of 20 mph to a complete stop.

**FIGURE 4**
Brake System Testers


Typical mechanical tester | Typical electronic tester | Performance-based brake tester

Vehicles may pass the deceleration requirements, but other conditions may affect the total stopping distance, such as the following:

- **Application delay timing:** A brake pedal sensor triggering device can be used to determine the delay time of the brake application, which may vary due to changes in the pneumatic or foundation brake systems. Application delay time is defined as the amount of time from when the brake pedal sensor is triggered until the vehicle reaches the set point deceleration. Comparison of the delay time within similar model buses and the delay time obtained during the test may provide an indication of the status of the air system.
- **ABS system faults:** Crossed wheel sensors, modulator valves, or apply and hold wiring of the modulator valves can all increase stopping distances and not trigger fault codes. Care should be taken to check for these problems as well as addressing recognized faults.

### 3.2.6 Performance-based brake tester (PBBT)

A PBBT may be used to measure the brake force (or performance) at each wheel end, allowing the user to objectively diagnose brake problems. Either a roller brake tester (**Figure 4**) or a flat plate tester may be used. When using a PBBT, a brake system test must be conducted in accordance with the testing procedure outlined in the PBBT OEM technical manual. For additional information on performance brake testing, refer to APTA BP-RP-001-07, "Transit Bus Brake Shoe Rebuild," and 49 CFR-393, "Parts and Accessories Necessary for Safe Operation."

### 3.2.7 Infrared temperature measurement

The use of an infrared tester or similar device to measure brake temperatures is an effective tool for isolating faults. It is important for the accuracy of this test that the technician record the temperatures on the same location of each wheel end (lug nuts, drum, wheel flange, etc.). The temperature difference should not exceed approximately 50 °F from side to side, or 100 °F front to center/rear.

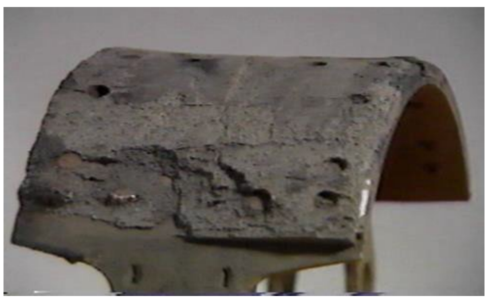
## 3.3 Drum off inspection

Remove the brake drums to perform the following inspections (**Figure 5**).

- Drum:
  - Inspect drum for abnormal wear patterns, such as bell mouthing, scoring, glazing, etc.
  - Inspect for cracks that go through the entire drum wall.
  - Inspect mounting surface for cracks and oblong or deformed mounting holes.
  - Inspect for excessive heat checking (cracks beyond the rebore limits). Minor heat checking is normal.
  - Check for evidence of excessive heat such as bluing, hard spots, etc.
  - Measure the inside diameter. Check that it doesn't exceed the maximum diameter cast into the drum, or is close enough that the drum will wear past its specification before the next inspection.
- Brake lining:
  - Inspect contact area for at least 80% contact.
  - Check for abnormal wear patterns caused by a bell-mouthed drum, bent spider, oversized drum or stretched shoe.
  - Check for glazed lining.
  - Check for excessive heat.
  - Check for broken or missing segments.
  - Check for contraindicated brake block.
  - Check for loose brake block.
- Brake shoe:
  - Check for shoe stretch and broken welds.
  - Check for elongation of anchor pin or roller seats.
  - Check table thickness of steel shoes.
- Brake adjuster:
  - Check for broken splines.
  - Check for a missing clevis pin.
  - Check integrity of exterior bracketing or linkage.
  - Check for loose or missing parts.
  - Check for a broken housing.
- Hardware kit/mounting:
  - Check for missing/broken/stretched return springs.
  - Ensure proper lubrication throughout foundation brakes.
  - Check for a bent spider.
  - Check roller for binding and flat spots.
  - Check anchor pins, bushings, set screws and safety wire.
- Camshaft/roller:
  - Check for broken or twisted splines.
  - Check for a worn camshaft shaft (flat spots, brinelling).
  - Check camshaft radial play. If play exceeds 0.03 in., check for worn bushings and camshaft journal.
  - Check for worn or undersized roller pins.

**FIGURE 5**
Drum-Off Inspection

Excessive drum crack



Heat damage

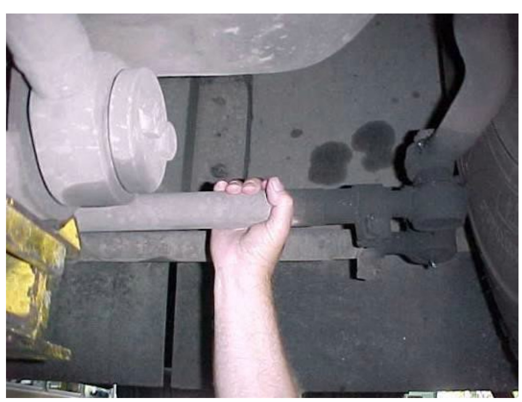
Damaged S-cam

## 3.4 Steering, suspension and wheel-end inspection

The following is a typical inspection of the steering/suspension components. Individual manufacturers may require special testing.

- Check wheel bearings for free, smooth, movement and excessive end play (greater than 0.005 in.). If excessive play is found, have a co-worker apply the brakes to isolate the wheel bearing from the king pin end play.
- Check king pins for excessive movement laterally and vertically.
- Using hand pressure, check the tie-rod ends and pitman arms for excessive play (**Figure 6**).

**FIGURE 6**
Checking Tie Rod Ends



- Check tires:
    - Evidence of scuffing (feathered), cupping or one-sided wear can indicate worn or damaged steering/suspension or a vehicle out of alignment.
    - Improper inflation can affect tire wear as well as vehicle drivability.
- Check steering shafts and miter box for excessive play or binding.
- Check axles for signs of damage that may affect chassis alignment.
- Check the condition of the air bags (air springs). Air bags that have different lifting force will affect ride height and drivability. Check ride height.
- Check shocks for excessive leaks, damage, binding and loose bushings. Shocks that have different compression/rebound characteristics can affect drivability.
- Use a short pry bar to check for movement in the torque rod/bushing. Excessive movement is an indication of wear or damage to the torque rod and/or bushing.
- Check that the power steering pitman arm is in the center position. Check with OEM for verification on proper arm location.
- Check chassis alignment (caster, camber, toe, thrust angle, offset, etc.).
- Check proper backlash in the power steering gear against manufacturing adjustment procedures.
- Inspect the undercarriage:
    - Check the front and rear axle suspension for loose connections.
    - Make sure suspension U-bolts and connections are secure and properly torqued.
    - Check for damage (cracks, dents or bent components).
- Lubrication:
    - Grease axle and all available suspension locations.
- Check for any binding articulation points.

## 3.5 Air system inspection

### 3.5.1 Check governor cut-in and cut-out pressure

Compressor cut-out pressure is typically between 120 and 125 psi on transit buses. Cut-in pressure is 15 to 20 psi below cut-out. Minimum allowable cut-in pressure for transit buses is 85 psi. Cut-in pressure is nonadjustable. If it is out of tolerance, the governor will need to be replaced.

### 3.5.2 Check for air leaks

- **Static test:** With the system at cut-out pressure, the engine off, spring brakes applied and service brakes released, the system should not lose more than 2 psi per minute, when observed at the dash gauges.
- **Brake applied test:** With the system at cut-out pressure, the engine off, spring brakes released and service brakes fully applied, the system should not lose more than 3 psi per minute when observed at the dash gauges.

If the bus fails either of the tests, check the following areas for leaks:

- application, relay valves
- hoses, air lines and fittings
- brake actuator
- air drier
- reservoirs

### 3.5.3 Check reservoir for excess liquids

Slowly open the drain valve and check for contamination. Contamination is detrimental to the entire air system and must be kept to a minimum.

Excessive water is typically caused by one of the following:

- improper draining intervals
- malfunctioning air drier
- excessive air compressor duty cycle (over 25%)
- frozen air drier purge valve
- high inlet air temperature to the air drier
- malfunctioning air compressor (head gasket, cracked head)

Excessive oil is typically caused by one of the following:

- improper drain intervals
- malfunctioning air compressor
- restriction on the air inlet side of the air compressor
- excessive air compressor duty cycle (over 25%)
- high inlet air temperature to the air drier

### 3.5.4 Check compressor build time

Pressure in the primary and secondary reservoirs must increase from 85 psi to 100 psi within 25 seconds with the engine at governed RPM. Excessive compressor buildup time is typically caused by one of the following:

- worn or malfunctioning air compressor
- restriction on the air inlet side of the air compressor
- excessive air leaks
- loose or slipping drive belt
- malfunctioning unloader valves

### 3.5.5 Check air system pressure balance front to rear

Install a duplex gauge to the service side of a front and rear air brake chamber. Apply the service brake in 10 psi increments (10 psi, 20 psi, 30 psi, etc.). The pressure difference between the front and rear brakes should not exceed 2 psi. Unbalanced brake pressures are typically caused by one of the following:

- malfunctioning relay valves
- malfunctioning brake application valve
- kinked or restricted lines

## Related APTA standards

**APTA BTS-SS-RP-001-05,** "Transit Bus In-Service Brake System Performance Testing"
**APTA BTS-SS-RP-002-05,** "Transit Bus Foundation Brake Lining Classification"
**APTA BTS-BC-RP-003-07,** "Transit Bus Brake Shoe Rebuild"
**APTA BTS-BC-RP-004-07,** "Transit Bus Front and Rear Axle S-Cam Brake Reline"

## References

Code of Federal Regulations, 49 CFR 571.121, Title 49: Volume 5, Part 571, Federal Motor Vehicle Safety Standards, Section 121, "Air Brake Systems," 2002.

Commercial Vehicle Safety Alliance (CVSA), Out-of-Service (OOS) Criteria, Truck Maintenance Council (TMC).

DOT Federal Motor Vehicle Carrier Safety Administration, Title 49, Part 393, published in the Code of Federal Regulations.

Motor Vehicle Safety Standards Section 121 "Air Brake Systems" 2002.

## Definitions

**brake actuator:** A brake chamber or brake cans.

**brake adjuster:** automatic slack adjuster (ASA).

**lining:** Brake block or friction material.

## Abbreviations and acronyms

| | |
|---|---|
| **ASA** | automatic slack adjuster |
| **CFR** | Code of Federal Regulations |
| **CVSA** | Commercial Vehicle Safety Alliance |
| **NATSA** | North American Transportation Services Association |
| **OEM** | original equipment manufacturer |
| **PBBT** | performance-based brake testers |
| **psi** | pounds per square inch |

## Summary of document changes

- Updates from 2016

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