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Recommended Practice for Transit Bus Front and Rear Axle S-Cam Brake Reline

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APTA Bus Brake Working Group

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APTA Bus Standards Committee

Abstract: This recommended practice provides guidelines for performing a complete brake reline on the front and rear axle of a bus with S-cam brakes. The practice includes the disassembly, cleaning, inspection and assembly. This recommended practice is to be used in conjunction with the manufacturer's service manual.

It is recommended that all components be replaced equally on both wheel ends of the axle. Failure to do so may affect braking performance.

Keywords: Anchor pins, brake shoes, S-cam bushings, brake adjuster, wheel bearings, spider, return spring, wheel seals, brake shoe rollers, brake rebuild, brake reline, brake maintenance

Introduction

This Recommended Practice for Transit Bus Front/Rear Axle Brake Reline reflects the consensus of the APTA Bus Standards Program members on the items, methods, and procedures that have provided the best performance record based on the experiences of those present and participating in meetings of the Program Task Forces and Working Groups. Recommended practices are voluntary, industry-developed, and consensus-based practices that assist equipment suppliers, vehicle and component manufacturers, and maintenance personnel in the construction, assembly, operation, and maintenance of transit bus vehicles. Recommended practices may include test methodologies and informational documents. Recommended practices are non-exclusive and voluntary; they are intended to neither endorse nor discourage the use of any product or procedure. **All areas and items included therein are subject to OEM's and manufacturers' supplemental or superseding recommendations**. APTA recognizes that for certain applications, the practices, as implemented by operating agencies, may be either more or less restrictive than those given in this document.

This document is recommended for:

- Individuals or organizations that inspect and maintain transit buses
- Individuals or organizations that contract with others for the inspection and maintenance of transit buses
- Individuals or organizations that influence how transit buses are inspected and maintained

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1. Overview

This document establishes a recommended practice for transit bus Front/Rear axle brake reline. Individual operating agencies should modify these guidelines to accommodate their specific equipment and mode of operation.

1.1 Scope

This recommended practice provides guidelines for disassembly, preparation, inspection, and reassembly of the typical heavy-duty transit bus s-cam brakes. The components may be different than pictured and some procedures will vary.

1.2 Purpose

The purpose of this document is to provide a uniform standard for heavy duty transit bus brake reline.

2. References

This recommended practice is to be used in conjunction with the original equipment manufacturer (OEM) and brake manufacturer service manuals.

3. Definitions, abbreviations and acronyms

3.1 Definitions

Brake Shoe Assembly – consists of the brake shoe and the brake block
MSDS - Material Safety Data Sheet.
OSHA – Occupational Safety and Health Administration
NIOSH – National Institute for Occupational Safety and Health
MSHA – Mine Safety and Health Administration
HEPA – High Efficiency Particulate Air
NLGI – National Lubricating Grease Institute

3.2 These terms are interchangeable:

Brake Block – friction material, brake lining
Brake adjuster – slack adjuster
S-cam – camshaft
Bearing cups—bearing races

Brake chamber—air chamber
Machining – turning, reboring, grinding, sanding, and cutting
Pushrod travel—air chamber power stroke

4. Hazardous material warning

Most brake linings no longer contain asbestos fibers. However, if working with any component that does contain asbestos, take all the necessary precautions prescribed by OSHA, and follow all federal, provincial/state, and local safety requirements. The health impact of non-asbestos fibers (e.g., brake block with glass, mineral wool, ceramic, aramid, carbon etc.) is not specifically covered under current OSHA regulations. Although medical experts do not agree about the possible long-term risks of working with, and breathing, non-asbestos fibers, some experts believe that long-term exposure could cause pneumoconiosis, fibrosis, and cancer. Therefore, it is recommended that workers avoid dust when working on brakes that contain non-asbestos materials.

Brake block may also contain crystalline silica, lead, antimony, phenol, and other possibly hazardous materials. Refer to the material's MSDS for all necessary precautions. Follow the general safety procedures listed below when working with braking components.

- Whenever possible, work on brakes in a separate area away from other operations.
- Always wear a respirator approved by NIOSH or MSHA during all brake service procedures.
- NEVER use compressed air or dry brushing to clean brake parts or assemblies. OSHA recommends that you use cylinders that enclose the brake. The cylinders have vacuums with HEPA filters and arm sleeves. If such equipment is not available, carefully clean parts and assemblies in the open air.
- During disassembly, carefully place all parts on the floor or in a suitable cleaning station to avoid getting dust into the air. After vacuum cleaning, any remaining dust should be removed using a rag soaked in water and then wrung until nearly dry.
- If it is necessary to grind or machine brake linings, additional precautions should be taken because contact with fiber dust is higher during these operations. In addition to wearing an approved respirator, such work should be done in an area with exhaust ventilation.

- NEVER use compressed air or dry sweeping to clean the work area. Use an industrial vacuum with HEPA filters and rags soaked in water and wrung until nearly dry. Used rags should be disposed of with care to avoid getting dust into the air. Use an approved respirator when emptying vacuum cleaners and handling used rags.

- Workers should wash their hands before eating, drinking, or smoking. Work clothes should not be worn home, but should be vacuumed after use and then laundered separately, without shaking, to prevent dust from getting into the air.

5. Initial inspection

In cases where components such as brake adjusters, brake chambers and camshafts are not scheduled for replacement during the reline, each property should establish a schedule for replacing these components based on the local operating conditions and usage history.

5.1 Vehicle brake and maintenance history

This Recommended Practice for Front/Rear axle brake reline and maintenance also applies to components of the system that do not have wear indications but are inspected visually or require disassembly.

To determine a proactive replacement schedule, use the manufacturers' recommendations for component replacement/rebuild and/or the agency's component history. These may be based on mileage, brake cycles, or time. They may include variables such as climatic considerations, unique operating parameters or a combination of both. The replacement schedules will vary from agency to agency.

Any historical data must be accurate, updated as required and meet the challenge of consistent performance, reliability and repeatability. Agencies that have the expertise of data collection, evaluation and mechanical knowledge can use this historical data to schedule brake system component replacement/rebuild intervals. If historical data is unavailable a program of data collection should be implemented for future needs.

However, scheduled replacement/rebuild intervals MUST NOT exceed the manufactures recommendations.

5.2 Overall Performance Based Brake Test

A Performance Based Brake Test can be used as part of the inspection process to assess the efficiency of the brake system and its assemblies prior to scheduled repairs. A test can measure the operator input, (application control line air pressure), and the brake output, (delivered brake torque through the wheels). An individual brake assembly or axle may lose its effectiveness and not be detected before the brake block is worn to the normal replacement level. An ineffective brake can cause side-to-side or axle-to-axle imbalances of the total brake system. When identified, an ineffective brake assembly can be repaired or replaced in addition to the already scheduled repairs.

5.2.1 Retarder operation

Service brakes are designed to stop a vehicle in a safe and controlled manner; however for enhanced drivability and extended brake life, some buses are equipped with supplemental braking systems. Apparent brake problems could be problems associated with these supplemental brakes. Because of the many different applications (transmission retarder, engine brake, driveline retarder) and configurations (auto apply, electronic controlled, air controlled), consult the OEM manual for proper testing procedures.

5.3 Visual inspection

Removal of wheels or other components will prevent the inspection of selected brake components. Prior to the disassembly of the foundation brake and related wheel/brake components, thoroughly inspect the foundation brake system, which includes the automatic brake adjuster, brake block, drums, brake chambers, mounting fasteners and other system parts.

Safely raise and support the bus by the axles at an appropriate working height.

5.3.1 Confirm need for reline in accordance with agency policies and procedures.

5.3.2 Visually inspect the brake block

- Check for wear: block should not be worn into the wear line (if equipped) or less than 1/4 inch (for ¼ inch bolt) and 3/8 inch (for 3/8 inch bolt) as measured at the center of the shoe. At no time should rivets or bolts touch the drum.
- Check for movement: there should be no movement between the brake block and the shoe.
- Look for cracks: no cracks should have a void greater than 1/16 inch or longer than 1

½ inch long.

- Check for missing segments that expose a fastener.
- Inspect for signs of block contamination i.e. oil or grease.

5.3.3 Make sure all components are appropriate for the application; i.e. proper length brake adjusters, proper brake chamber size, etc.

5.3.4 Dragging/tight wheels. With all four wheels elevated from the ground, rotate each wheel to find dragging or tight brakes.

5.3.5 Pushrod travel

- Measure pushrod travel at each brake per CVSA standards. Pushrod travel should be within ¼ inch measurement from left to right wheel on the same axle. Excessive pushrod travel may be cause to replace the brake adjuster or other foundation brake parts as required to meet new or original specification.
- During pushrod travel measurements, check camshaft for excessive movement and for normal return of the foundation brake during release.

5.3.6 Brake Chamber

- During pushrod travel measurements, listen for air leaks in the brake chambers or other foundation brake components. Additional or extended application of the brake system may be needed to meet DOT standards for air system leak tests.
- Inspect for dents, bends, alignment, leaks, pushrod return, corrosion, and missing caps.

- Hardware
  - Check the condition of the clevis, pin and yoke.
  - Check the integrity of the return springs.
- Lining wear/cam position
- The position of the roller on the cam should be closely checked at every brake inspection. The position of the roller on the s-cam is directly related to brake block and drum wear. Other factors such as stretched shoes and worn cam bushings may also affect cam to roller position. Care must be taken when inspecting the brakes to ensure that the roller on the s-cam will not lock or allow the s-cam to "cam over" before the block wears out.
- Air hoses
- Inspect for cracks, kinks, routing, leaking, chafing, deterioration, proper size and material.
- Visual Inspection of suspension/steering components
- Some braking complaints can be caused by steering and/or suspension problems. Worn, damaged or misaligned steering/suspension components can cause a vehicle to pull or drift

during braking. Carefully inspect the torque rod bushings, drag links, tie-rod ends, king-pins, and shock absorbers as part of every pre-reline inspection. In many cases it's more efficient to replace/repair these parts during the reline because the wheel assemblies are removed.

5.4 Automatic brake adjuster maintenance, inspection and testing

Clean and inspect per manufacturer's recommendation or replace.

Caution: Do not submerge brake adjusters in solvent, water, or hot tank.

All Automatic Brake Adjusters require inspection at periodic intervals. This should be done at your normal preventative maintenance inspection. At these times you should do the following:

- Measure and record the brake chamber pushrod travel with reservoir pressure between 90 and 100 psi and brakes fully applied.
- Grease each brake adjuster.
- Inspect each brake adjuster for integrity and connection points at the clevis and brackets, if used.
- Check for a difference in the stroke length between the left and right side of the axle. There should be no more than ¼" difference.
- If the stroke exceeds the CVSA or DOT maximum allowances, do not manually adjust the automatic brake adjuster. Follow the manufacturer's procedure to determine the cause of the excessive stroke.

Note: Some brake adjusters use special grease while others use normal chassis grease. It is important to use the proper grade of grease per manufacturer's recommendation.

Note: Not all automatic brake adjusters require the same maintenance procedures. Be sure to follow the specifications of the manufacturer.

6. Removal of the wheels, hubs and drums

6.1 Front wheels, hubs and drums

- Back off the brake adjuster until there is enough clearance between the shoes and drum to allow the drum to be removed.

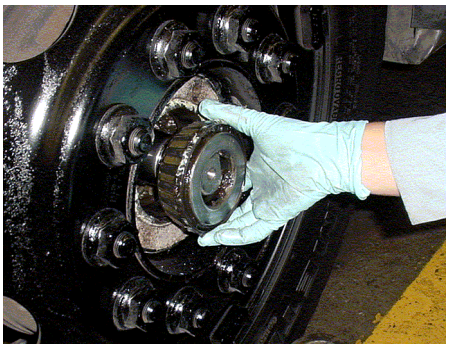
Caution: Do not use impact wrench on the brake adjuster.

Note: The procedure used to back off the brake adjuster will depend on the type of brake adjuster used. Check with the manufacturer for a detailed procedure.

- Check the hubcap for leaks or damage.
- If the bus uses oil-lubricated bearings, drain the oil into an appropriate container and dispose of the oil in accordance with local regulations or company policy.
- Remove the cap screws from the hubcap.
- Remove the hubcap and discard if damaged. Remove and discard the gasket.
- Bend the tab of the lock washer away from the flat on the lock nut.
- Remove the lock nut, lock washer, pierced locking ring and adjusting nut.

Caution: Always use the proper size socket when tightening or loosening the lock nuts. Do not use a hammer and chisel to loosen and remove the nut.

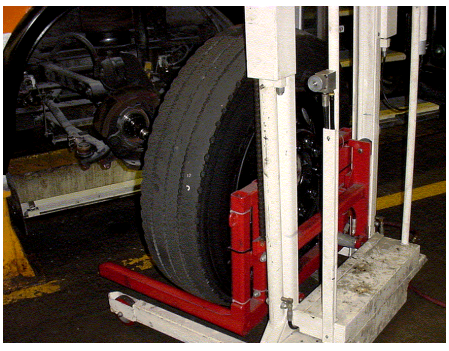
Note: The procedure above is typical of an adjusting nut, lock mechanism, and lock nut arrangement. There are also single nut adjusting and locking arrangements. If necessary, consult the maintenance manual for the correct procedures and tools.



- Remove the outer wheel-bearing cone.

Note: Proper bearing maintenance must be maintained to assure safe and reliable bearing performance.

- Keep the bearing cup and cone as a matched set.
- Replace bearing cups and cones as an assembly.
- If bearing is dropped the cup and cone must be replaced.
- Do not “spin dry” the bearing with compressed air.
- Use a wheel dolly to remove the wheel, drum, and hub as an assembly.



- Remove the front inner wheel seal and wheel bearing. Discard the seal.

Caution: Use a seal removal tool that does not put pressure on the bearing or damage the hub seal bore.

- Wipe all excess grease or oil from spindle.

Warning: Do not use compressed air to remove the brake dust.

6.2 Rear wheels, hub and drum

- Attach shop air to the bus and release the parking brake. Ensure the spring brake (parking brake) is fully released. If the spring brake is not releasing or will not stay released, the brake will need to be caged or the chamber replaced.
- Loosen the brake adjuster until there is enough clearance between the shoes and drum to allow the drum to be slid over the shoes and removed.

Caution: Do not use impact wrench on brake adjuster.

Note: The procedure used to back off the brake adjuster will depend on the type of brake adjuster used. Check with the manufacturer for a detailed procedure.

- Loosen the axle nuts.
- There are multiple methods for removing the axle:
  - Jack screws
  - Axle shaft puller-0po889
  - Cover the raised boss on the center of the axle flange and strike with hammer
- After breaking the axle loose, remove the nuts, washers, and alignment dowels.
- Remove the axle shaft from the housing.

NOTE: The street side and curbside shafts may differ. Make sure they get reinstalled on the same side as they were removed.

- Remove and discard any seals and gaskets.

- Remove the lock nut, lock washer and pierced locking ring.
- Remove the outer bearing cone from the wheel hub.

Caution: Always use the proper size socket when tightening or loosening the lock nuts. Do not use a hammer and chisel to loosen and remove the nut.

Note: The procedure described above is typical of an adjusting nut, locking mechanism, and lock nut arrangement. There are also single nut adjusting and locking arrangements. If necessary, consult the maintenance manual for the correct procedures and tools.

Proper bearing maintenance must be maintained to assure safe and reliable bearing performance.

- Keep the bearing cup and cone as a matched set.
- Replace bearing cups and cones as an assembly.
- If bearing is dropped the cup and cone must be replaced.
- Do not "spin dry" the bearing with compressed air.

- Place a wheel dolly under the dual rear wheel. Use the wheel dolly to carry the weight of the rear wheels. Remove the wheels, drum and hub as an assembly.
- If the inside wheel seal uses an oil seal wiper sleeve, remove it by hitting the oil seal wiper with

a hammer to loosen it. Use a punch or chisel to drive the oil wiper sleeve off the housing; then discard.

- If the bus is equipped with an outside wheel seal using an oil seal wiper sleeve, use a punch to remove the oil seal wiper and cork assembly; then discard.
- To replace inner wheel seal, remove the screws attaching the inner seal retainer to the hub.
- Remove the inner seal retainer assembly and gasket along with the inner wheel-bearing cone.
- Discard the gasket.

- Using a soft punch, drive the seal from the retainer, taking care not to damage the sealing surface of the retainer.
- Thoroughly clean all grease from the wheel and hub.

7. Foundation brake disassembly

7.1 Inspect brake shoes before removal

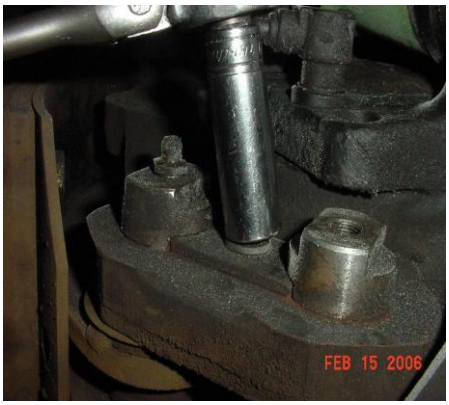
The way the brake block has worn can help determine the condition of the foundation brake. Look for unusual patterns such as, the angle of wear, uneven lining wear and the condition of the brake block. See Appendix D for examples of abnormal brake block wear and the likely cause. When disassembling the brakes for reline, note the condition of each brake component before disposing.

7.2 Disassemble the foundation brake

On steer axles, turn the spindle to the fully locked position to gain access to the anchor pin locks.

7.2.1 Remove the brake shoes

Removal the anchor pins



- Remove the anchor pin locking fasteners (bolts, snap ring, anchor pin bracket).
- Use a soft drift and drive the anchor pins out.

Note: Anchor pins may be difficult to remove. Take care to avoid bending the spider when removing the anchor pins. Frozen anchor pins should always be removed with a press.

Note: Anchor pins should be replaced as part of every brake reline.

Removal of the brake shoes

- With the anchor pins removed, use a pry bar or suitable tool to remove the return springs. Take care not to drop the shoe assemblies when removing the return springs.
- Remove the brake shoes from the spider and discard the return spring(s).

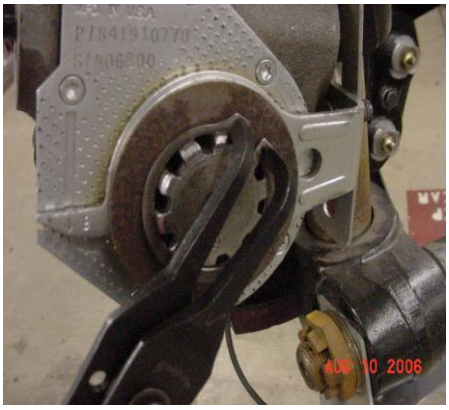
7.3 Remove the brake adjuster, S-cam and bushings

On steer axles, turn the spindle to the fully locked position to gain access to the anchor pin locks.

Clean any buildup of dirt and grease from the end of the S-cam and brake adjuster.

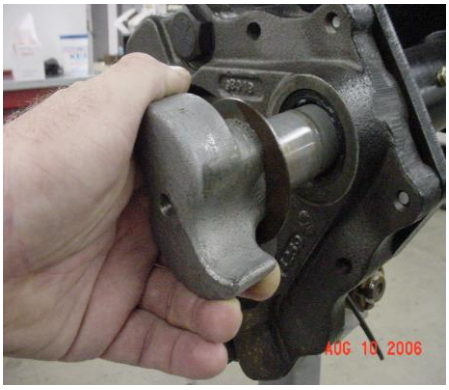
7.3.1 Remove the brake adjuster

- Remove and discard cotter pin. Remove clevis pin and inspect for wear. Replace as necessary.
- Inspect the yoke and brake adjuster bushing for wear. Replace parts as necessary.
- Remove the snap-ring or retaining bolt and washer from the end of the s-cam.
- If equipped, disconnect the brake adjuster adjustment bracket.
- Remove the brake adjuster and the spacing washers.
- Inspect all parts and replace as necessary.



7.3.2 Remove S-cam and bushings

Once the brake adjuster and brake shoes have been removed, the S-cam can be slid out towards the outside of the bus.

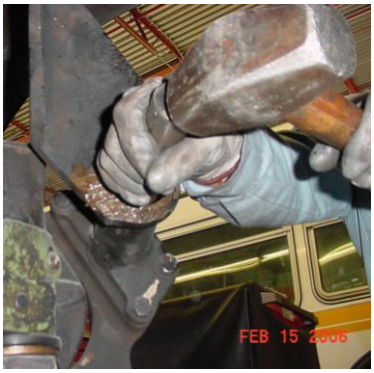


Remove and discard camshaft bushings at every reline. Camshaft bushings keep the cam and brake shoe assemblies centered in the brake drum. As the bushings wear, they allow the camshaft to fall off center, creating unequal drum clearance between the top and bottom shoes. This can affect pushrod travel, braking torque, and braking performance.

To remove the bushings, use a tool specifically designed for bushing removal or a soft driver such as a brass or aluminum punch. Drive the inner S-cam bushing out towards the center of the bus.

Remove the outer bushing using the procedure above, driving the bushing from the center of the bus towards the outside.

Note: There is a ridge in the center of the spider that prevents the bushings from being removed or installed in any manner other than what is described in this document.



8. Cleaning and inspection

8.1 Spider, spindle, and axle tube

Thoroughly clean the axle tube, spindle and spider assembly. Use a cleaner that complies with local safety and environmental regulations and agency policy.

Warning: Do not use compressed air to remove the dirt and dust from the brake assembly.

After the spider has been cleaned, check for:

- Cracks
- Worn anchor pin holes
- Loose fasteners
- Bent spider (brake shoe anchor pins must hold the shoe and lining assemblies parallel to the brake drum surface).

After the spindle / axle tube has been cleaned, check for:

- Cracks
- Damaged threads
- Damaged seal surface
- Damaged bearing seats

8.2 Checking the spider alignment

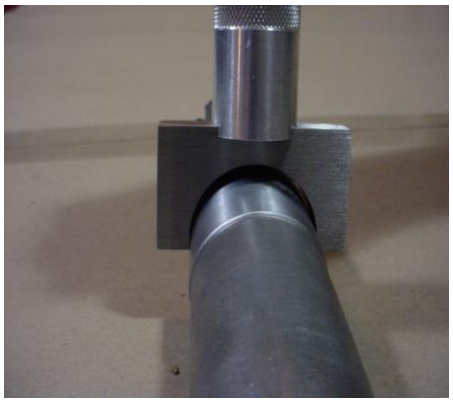
Proper spider alignment is determined by making sure the axle tube is parallel to the anchor pin holes. To use this tool, tighten the clamp section around the axle tube, insert the pin into the anchor pin hole and tighten the knurled nut that holds the

pin. If the spider is not bent, the pin will slide all the way through the anchor pinhole. If the spider is bent, the pin will not slide into the anchor pinhole or will only slide in part way.

If alignment is not correct replace spider and recheck.

8.3 S-Cam inspection

Check the camshaft splines, head and journals for cracks, wear and corrosion.



Check the journal areas of the camshaft for wear using a "go-no-go" gauge. When checking the journal area, check it in several locations because the journal will not wear evenly.

Replace worn or damaged camshafts.

Note: Do not dress or regrind camshaft.

8.4 Springs and rollers

Replace brake shoe return springs and rollers at each reline.

8.5 Brake shoes

Refer to APTA BT-RP-005-07 Brake Shoe Rebuild for disassembly, cleaning, inspecting and rebuilding.

8.6 Wheel bearing inspection

Roller bearings should be cleaned according to manufacturer's recommendation and inspected.

It is important to keep bearing cups and cones matched. Remove all the old lubricant using a cleaner that complies with local safety and environmental regulations and agency policy. Do not spin dry the bearings with compressed air. Inspect the cup, the cone, the rollers and cage of all bearings. See Appendix E for examples of bearing wear and damage. Also assure that the cup does not move in hub.

8.7 Drum

Be sure that drum is free of grease and debris. Measure to determine useful life. The drum should not exceed OEMs maximum diameter specifications during the life of the reline, (maximum diameter is normally cast into the drum). Check for cracks, bell mouth, hard spots, hot spots, heat checks, glazing and blue areas. See Appendix F for examples of abnormal drum wear and the likely cause.

8.8 Hub/ABS tone ring

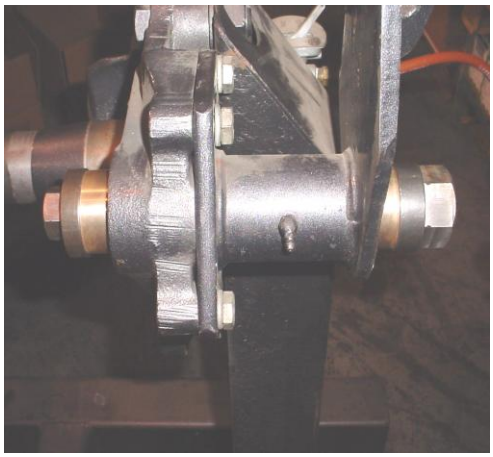
Inspect the ABS tone ring for damage. Be sure that hub is free of grease and debris.

- Inspect seal bore for scoring or damage.
- Check that the bearing cups are secure in the bore.
- Check wheel studs for damage.

9. Assembling the foundation brake

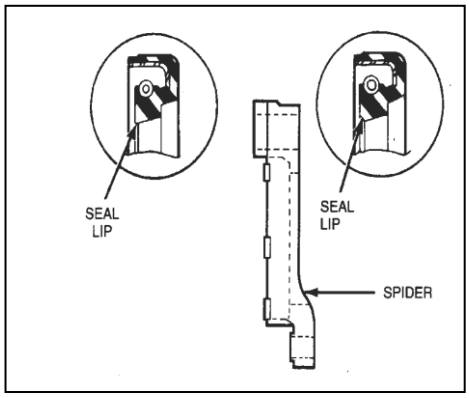
9.1 Install S-cam bushings

Install camshaft bushings with a tool specifically designed for installation to assure proper fit and to avoid distortion to the brake spider. Press the bushings until the outer edge is flush with the bottom of the seal bore.



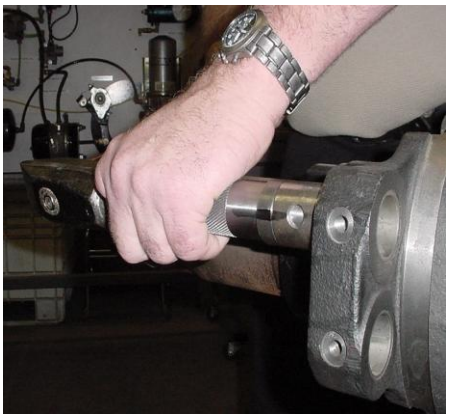
9.2 Install S-cam seals

Use the appropriate driver to install the camshaft seals. Install both seals with seal lips facing the brake adjuster. Drive them until they are flush with the bore. Lightly lubricate seal lips, bushings, and camshaft.



9.3 Install anchor pin bushing

Mark lock-bolt hole on spider and bushing as shown. Align marks to properly locate new bushing. Use appropriate tool to drive out old bushing while installing new bushing.



9.4 Install S-cam

Install the cam head washer (one only), lightly lube the bearing area with a 12-hydroxy lithium stearate chassis

grease, NLGI grade 1 or 2 and slide the S-cam in place. Take care not to damage the seals while installing the camshaft.

Check S-cam for proper fit, clearance and 360° rotation.

9.5 Install brake adjusters

Install the correct OEM spacer washer between the spider and the brake adjuster, lubricate the cam shaft spines with a temperature resistant anti-seize. Slide the brake adjuster onto the S-cam. Install the shim pack removed earlier and snap ring or retaining washer and bolt.

Check for .030" to .060" lateral movement of the brake adjuster. It may be necessary to reposition the shims or select different thicknesses of shims to achieve this result.

Ensure there is no interference between pushrod and the brake chamber and the brake adjuster aligns with the clevis.

9.6 Install brake shoes

When using combination lining install primary and secondary shoe assemblies in proper location per manufacturer's recommendations.

- Lubricate the anchor pins with a NLGI Grade #1 or equivalent grease. The grease must handle the high temperatures without flowing and remain soft under normal service. Consult the manufacturer's manual for the correct lubricant.
- Slide the anchor pins through the brake shoes, spider and any necessary spacers or washers taking care that the grease fittings on the anchor pins are at the backside of the spider and easily accessible for routine maintenance. Install the locking hardware. Check that the shoes rotate freely on the anchor pin.
- Lubricate anchor pins through grease fitting until clean grease is visible between the shoe and washer. Wipe away any excessive grease.

Note: Do not get grease on the brake shoe lining.

- Install brake shoe return spring(s), ensuring they do not interfere with adjacent components (s-cam, shoes, hub, etc.).

CAUTION: Consult manufacturer's manual for specific brake type or configurations.

- If the brake rollers have not been installed, lubricate the roller pockets of the brake shoe with a NLGI grade #1 or equivalent grease (the grease must handle the high temperatures without flowing and remain soft under normal service.)
- Spread the brake shoes apart and install the brake shoe rollers. Let the shoes snap against the S-cam to make sure the rollers are seated equally and fully in the brake shoes and the S-cam pockets.

Note: Ensure there is no lubricant on the contact surfaces between the rollers and S-cam head.

9.7 Install brake adjuster hardware

- Rotate the brake adjuster arm into the yoke by turning adjusting hex nut clockwise. Lubricate and install clevis pin and new cotter pin.
- If equipped, install and adjust brake adjuster control arm bracket or other connections as necessary per manufacturer's recommendations.
- Lubricate all remaining grease fittings.

Ensure proper installation of all components before installing tire, hub and drum.

9.8 Install front wheel bearings, seals and hub assembly

9.8.1 Grease- lubricated bearings

- Place the cleaned wheel bearings in the grease packer. Pack the bearings with grease until it comes out all sides.
- Lightly lubricate the spindle with the same grease used to pack the wheel bearing.
- Fill the hub cavity level to the bearing cups with wheel bearing grease.
- Lightly coat the bearing races (cups) with grease.
- Place the inner wheel bearing in the inner race.
- Clean all grease from the seal mounting area.

Note: Some seal drivers are designed to have the seal and bearing mounted onto the tool for installation.

9.8.2 Oil-lubricated bearings

Caution: Do not grease pack oil-lubricated wheel bearings

- Lightly coat the inner wheel bearing in oil.
- Lightly coat the bearing races (cups) with oil.
- Place the inner wheel bearing in the inner race.
- Clean all oil from the seal mounting area.

Note: Some seal drivers are designed to have the seal and bearing mounted onto the tool for installation.

9.8.3 Install the wheel seal

- Tip the tire/wheel assembly against a solid surface.
- Using the seal manufactures approved seal driver or equivalent; gently tap the seal into place with the lip facing the inside of the hub. Listen for the sound changing indicating the seal is seated properly.
- If recommended by seal manufacturer apply a coating of lubricant to the inner seal lip or sealing surface.

9.8.4 Preset the ABS and speedometer sensors (If equipped)

If bus is equipped with a wheel-end speedometer sensor, it is normally located on the left side (street side) front tire. However, there are many variations, so refer to OEMs recommendations for service and adjusting.

For either the ABS or speedometer to function properly, the sensors must be in good condition and adjusted properly. Service on both sensors is the same. Inspect the sensors and wiring for damage. Replace as necessary.

Set pre-adjustment by pushing the sensors fully outboard. When the wheel/hub assembly and bearings are correctly installed, the air gap for the sensors will properly position itself automatically.

9.8.5 Install front hub, drum and wheel

- Carefully slide the hub (or complete wheel end assembly) over the spindle, supporting it to avoid damaging the wheel seal and ABS sensor.
- Lightly coat the wheel-bearing cone with grease or oil depending on application and slide the outer wheel-bearing cone over the spindle and into place.
- Install the adjusting nut on the spindle and adjust finger tight.
- Install the drum and the wheel (if not already installed).
- Tighten the adjusting nut to a torque of 200 ft. lbs while rotating the wheel.
- Back off the adjusting nut one full turn.
- Tighten the adjusting nut to 50 ft. lbs while rotating the wheel.
- Back off the (inner) adjusting nut ½ turn.
- Install lock washer and/or tab type washer
- Install the locking nut and torque to 300-400 ft. lbs.
- Use a dial indicator to verify a final endplay of .001-.005 inch.

Refer to appendix G for complete text of TCM RP 618 wheel bearing adjustment procedure.

- Install a new gasket, hubcap and bolts. Tighten the hubcap bolts 20-30 ft lbs.

Note: For oil-lubricated bearings add appropriate oil per manufacturer's recommendations.

9.9 Install rear wheel bearings, seals and hub assembly

If equipped, use an appropriate driver to install inner seal wiper.

9.9.1 Grease-lubricated bearings

- For grease-lubricated bearings, place the cleaned wheel bearings in the grease packer. Pack the bearings with grease until it comes out all sides
- Lightly lubricate the axle tube with the same grease used to pack the wheel bearing.
- Fill the hub cavity level to the bearing cups with wheel bearing grease.
- Lightly coat the bearing races (cups) with grease.
- Place the inner wheel bearing in the inner race.

9.9.2 Oil-lubricated bearings

Caution: Do not grease pack oil-lubricated wheel bearings

- Lightly coat the inner wheel bearing in oil.
- Lightly coat the bearing races (cups) with oil.
- Place the inner wheel bearing in the inner race.

9.9.3 Install the wheel seal

- Using the seal manufactures approved seal driver or equivalent; gently tap the seal into the seal retainer. Listen for the sound changing indicating the seal is seated properly.
- Lightly coat the lip seal with the same lubricant used on the bearings.
- Replace the seal retainer gasket; install seal retainer and torque fasteners to 20–30 ft lbs.

9.9.4 Preset the ABS sensors (If equipped)

For the ABS or speedometer to function properly, sensors must be in good condition and adjusted properly. Inspect the sensors and wiring for damage. Replace as necessary.

Set pre-adjustment by pushing the sensors fully outboard. When the wheel/hub assembly and bearings are correctly installed, the air gap for the sensors will properly position itself automatically.

9.9.5 Install hub, drum and wheel

- Use a wheel dolly to install the wheel / drum and hub as an assembly. Take care not to damage the wheel seal while installing the assembly.
- For oil lubricated bearings, fill hub with same type lubricant used in the axle sump or hub assembly.
- Ensure there is a light coat of lubricant on the outer wheel bearing.
- Install the outer bearing cone onto the axle housing tube.
- Install the adjustment nut and tighten the adjusting nut to a torque of 200 ft. lbs while rotating the wheel.
- Back off the adjusting nut one full turn.
- Tighten the adjusting nut to a final torque of 50 ft. lbs while rotating the wheel.
- Back off adjusting nut ¼ turn.
- Install lock washer and / or tab type washer.
- Install the locking nut and torque to 300-400 ft. lbs for dowel style washers or 200-275 for tab style washers.
- Use a dial indicator to verify a final endplay of .001-.005 inch.

Refer to appendix G for complete text of TCM RP 618 wheel bearing adjustment procedure.

- Install new gaskets and/or seal on hub.
- Install the axle shafts in the correct side of the housing.
- Install the dowels, washers, and nuts. Torque to manufactures recommendations using a cross tightening sequence.

9.10 Brake adjustment

Brake adjuster manufacturers very in their adjustment procedure, so it is important to follow

their recommended practice. However the general rule is to tighten the brake adjuster until the block touches the drum and then back off the brake adjuster ½ to ¾ turn.

CAUTION: This is not the final brake adjustment and any final testing at this point will be invalid. The brake adjusters will continue to automatically adjust to their home position through brake applications during the burnishing process and road test.

Lower the bus and use a torque wrench to tighten the lug nuts to the appropriate value in the manufacturer recommended sequence.

Note: Recheck wheel lug nut torque after the bus has been in service between 200 and 500 miles.

10. Burnishing, testing, and final inspection

10.1 Burnishing

Burnishing procedures may be modified for each agency's requirements, but should be similar to the following steps:

a) Turn the retarder off, if possible, until the burnishing procedure is complete.

b) Use the service brake to slow the vehicle from 20 to 5 mph at approximately 0.3 g deceleration, or a moderate brake application (snubbing). Repeat this snubbing process a minimum of 10 times at regular intervals of approximately 500 ft. or 0.1 mile without stopping the vehicle.

CAUTION: Do not permit wheel lock up.

c) After completing the snubbing process in "b", make one complete stop from 20 to 0 MPH.

d) Immediately after burnishing, compare brake temperatures measured in the exact same location at each wheel (example, on the drum or wheel stud). Any significant temperature differential (approximately 50°F side to side, 100°F front to rear) indicates a braking problem. Inspect the vehicle for brake defects and repair as necessary. After repairs have been made, repeat burnishing process.

10.2 Performance test

Test the vehicle using APTA Recommended Practice for In-Service Brake Testing, BT-RP-001-05. Verify that the vehicle meets your agency or government regulations.

10.3 Final inspection

Visually check brakes for:

- Loose or broken components
- Leaks (oil, air, and grease)

Measure push rod travel at each wheel. Refer to the CVSA Brake Adjustment Limit listed below.

Clamp Type Brake Chamber

Type	Brake Adjustment Limit	Type	Brake Adjustment Limit
9	1 3/8"	24	1 3/4"
12	1 3/8"	30	2"
16	1 3/4"	36	2 1/4"
20	1 3/4"	DD3	2 1/4"

Long Stroke Type Brake Chamber

Type	Brake Adjustment Limit	Type	Brake Adjustment Limit
16L	2"	24L3*	2 1/2"
20L	2"	30L3*	2 1/2"
24L	2"		

* Not yet added to CVSA criteria

APPENDIX A - Background

The function of brakes is to stop the vehicle, control speed and hold it stationary. The action of applying the brakes sets up a force effective at the road surface, which acts in the opposite direction to the motion of the vehicle causing it to slow down or decelerate. The ability of the brakes to perform their function is known as braking efficiency and can be measured. There are legal regulations that require all vehicles to have an efficient braking system.

FMVSS 121 requires vehicle manufacturers to have a braking system capable of achieving a specific minimum deceleration. If correctly maintained and operated within its designed load limits the braking system will achieve the minimum braking efficiency required. Brakes are designed to a specific geometry. If any part of the foundation brake assembly is bent or distorted, brake performance may become erratic and unpredictable. Always replace bent or distorted parts in order to make sure the brakes function correctly. The key to good brake maintenance is consistency. Both material and procedures must be the same each time a reline is done. Consistent procedures and standard component replacement contribute to reliable brake performance.

APPENDIX B - Brake Adjusters

Brake adjusters are the link between the brake chamber and the foundation brake. The length of adjuster arm affects the force transmitted to the brake by the air chamber. The longer the brake adjuster length the higher the force leveraged to the brake. This is normally referred to as the AL (Area times Length) factor.

The purpose of a brake adjuster is to provide an acceptable shoe-to-drum clearance in the brake. Increased shoe-to-drum clearance will result in increased air chamber stroke. Excessive shoe-to-drum clearance can result in decreased braking power and increase stopping distances. Excessive air chamber stroke may be related to worn components in the foundation brake including the brake adjuster.

Total air chamber stroke is established by three elements when the brakes are applied.

- Free stroke – the rotation of the cam shaft closing the shoe-to-drum clearance.
- Foundation brake parts binding to each other to close tolerances.
- Foundation brake elasticity [aka stretch], includes cam-shaft wrap, wing bracket movement and brake drum stretch.

Manual Brake Adjusters are common on vehicles manufactured prior to October 1994 with S-cam drum brakes. These adjusters require periodic manual adjustment to maintain proper shoe-to-drum clearance in the brake. Manual brake adjusters contain a locking ring and adjustment nut to adjust the brake. The need to perform brake adjustments will vary widely depending on the severity of service.

Automatic brake adjusters are required on vehicles manufactured after October 1994 with S-cam drum brakes. Automatic brake adjusters perform the same function as manual brake adjusters; however they're able to do it without the need for periodic manual adjustment. Some of the benefits of the automatic brake adjuster are:

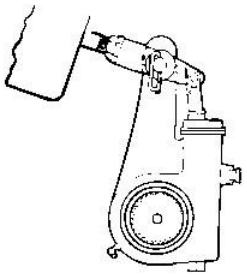
- Automatic brake adjustment
- Reduced down time and maintenance cost
- Improved brake balance and performance
- Reduced air chamber travel and less air consumption
- Higher margin of braking safety

Automatic brake adjusters do require attention during routine maintenance inspections but are not intended to be adjusted manually to improve braking performance.

Brake Adjuster Angle and Pushrod Length

Brake adjuster angles are determined by the length of the pushrod with yoke attached. The

angle of the adjuster [as determined by brake engineers] when the air chamber is fully caged [released] sets the operation of the adjuster to perform properly.



Pushrod length is measured from the face of the air chamber to the center of the clevis pin when the air chamber is fully caged. This measurement is determined by the brake manufacture and/or the bus OE to set up the correct angle of the brake adjuster between the air chamber pushrod and cam shaft. Brake adjuster performance is determined by the angle of the automatic brake adjuster set by the brake designer. Changes to shorten or extend the pushrod length of a "stroke-sensing adjuster" may cause the brake adjuster to over or under adjust.

Some types of automatic brake adjusters have an additional connecting rod from the yoke to the adjuster. The correct pushrod length is designed to activate the point of adjustment on the applied stroke. Maintaining the correct pushrod length is important for all automatic brake adjusters for maximum braking performance .

The 90 degree rule – This rule was commonly used when manual brake adjusters where the norm. The brake adjuster should not exceed a 90 degree angle in the brake applied position. By properly setting the pushrod length and adjusting the brake, the angle would not exceed the 90 degree position. The theory is to maximize braking force. This rule was never adopted into written law but was referred to in numerous documents to visually determine the re-adjustment limit of a manual brake adjuster.

Today's design criteria allow the adjuster to operate from 85 degrees to 105 degrees to provide proper input torque to the brake. In some cases, designers start the automatic brake adjuster at a 90 position to provide proper input torque to the brake. This condition must not be changed. The 90 degree rule hence becomes subject to degrees of interpretation as opposed to intended brake design.

Free Stroke – Checking or measuring free stroke is most beneficial when checking the brakes with the vehicle wheels on the ground. Determine free stroke movement by measuring the distance of movement of the pushrod when using a pry bar or specially designed tool to manually apply the brakes. An average distance of 1/2 inch is considered acceptable. If free stroke is less than 3/8 inch, check for a dragging brake. Use a feeler gauge between the brake drum and brake shoe or elevate and rotate the wheel to determine a

dragging brake.

Power Stroke – Power stroke is determined by measuring the total travel distance of the pushrod from any point along the rod using 90-100 psi reservoir brake pressure.

Power stroke meeting CVSA maximums should be considered an out-of-service brake and a sign of improper brake operation. **Adjustment to the automatic brake adjuster without a repair is considered an unsafe practice.** Identify the cause of the problem and make the necessary repairs to bring the braking system back into proper condition.

APPENDIX C.-.Reline Check List

BRAKE RELINE CHECK OFF LIST

Remove the wheels and drum assembly.	road side: _____ curb side: _____
Clean and inspect bearings.	road side: _____ curb side: _____
Clean hubs.	road side: _____ curb side: _____
Remove brake shoes.	road side: _____ curb side: _____
Remove and replace bushings, wipers & seals.	road side: _____ curb side: _____
Remove and clean the brake adjuster.	road side: _____ curb side: _____
Install and adjust the brake adjuster.	road side: _____ curb side: _____
Install shoes springs and rollers	road side: _____ curb side: _____
Pack bearings and install inner wheel seal.	road side: _____ curb side: _____
Install wheel and drum assembly.	road side: _____ curb side: _____
Adjust wheel bearings end play.	road side: _____ curb side: _____
Install gasket, seal and hardware.	road side: _____ curb side: _____
Burnish and performance test.	road side: _____ curb side: _____

QUALITY CONTROL CHECK LIST

TASK	**SIGN OFF**
Remove wheels and drums	
Clean and inspect bearings	
Clean hubs	
Remove brake shoes	
Remove and replace bushings	
Remove and replace wipers	
Remove brake adjuster and S-cam	

TASK	SIGN OFF
Retrieve a set of turned brake drums	
Retrieve reline kit from inventory	

TASK	SIGN OFF
Install brake adjuster and S-cam	
Install shoes, springs and rollers	
Pack bearings and install inner wheel seal	
Install wheel and drum assembly	
Adjust wheel bearing end play	
Install gaskets, seals, axles and hardware	
Burnish and performance test	

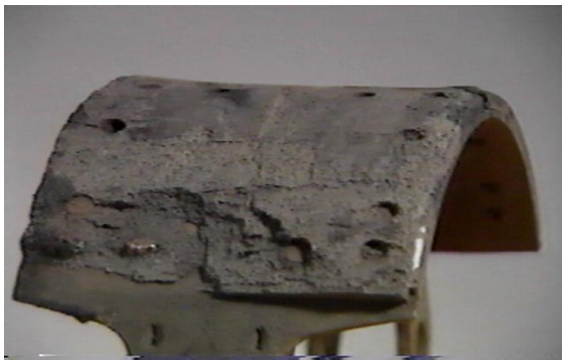
APPENDIX D - Inspection of Brake Shoes

For additional information and examples refer to TMC RP 607B.

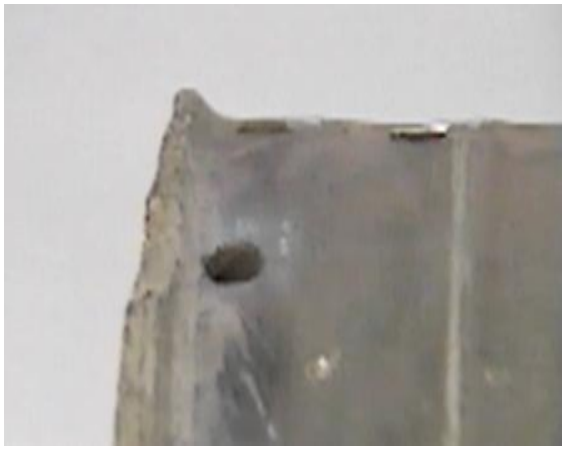
The following pictures are examples of commonly found brake wear problems.

This is an example of excessive heat that could have been caused by:

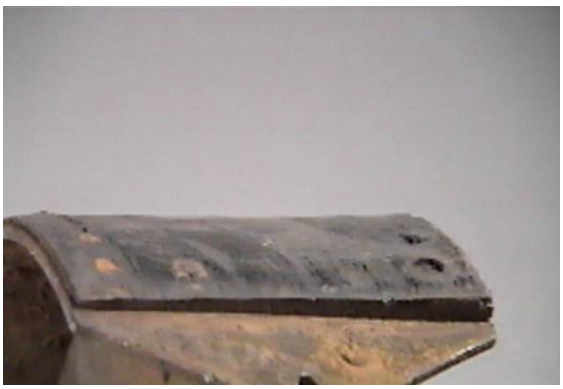
- Overworking of the brakes.
- Weak return spring (if lower shoe only).
- Brakes adjusted too tight.
- Wrong friction material for the application.



This is an example of wear caused by a bent or misaligned spider.



This is an example of a bell mouth drum.



This is an example of an oversize drum.

This is an example of cracked lining that could be caused by:

- Bent shoe table
- Improper installation of brake block
- Improper brake block for application.

This is an example of a missing or broken segment.

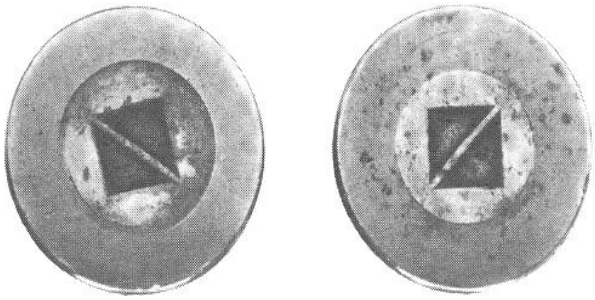
APPENDIX E - Inspect Wheel Bearings

For additional information and examples refer to TMC RP 607B.

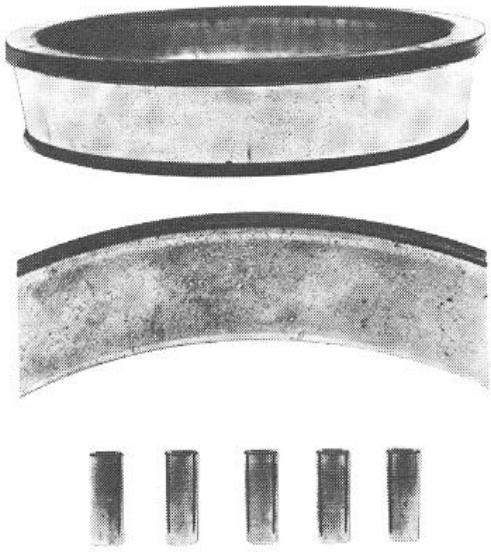
Remove all lubricant from the bearings.

Inspect the cup, the cone, the rollers and cage of all bearings. If any of the following conditions exist, the bearing MUST be replaced.

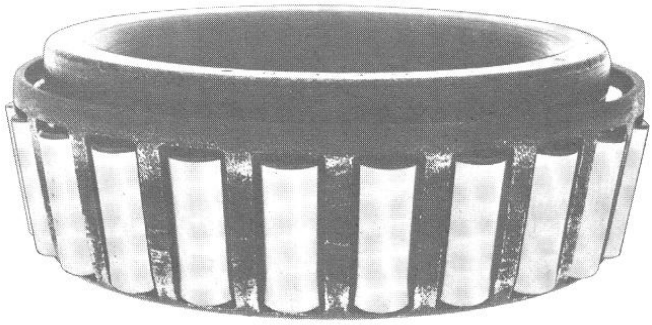
- The center of the large diameter end of the rollers is worn level or below the outer surface.



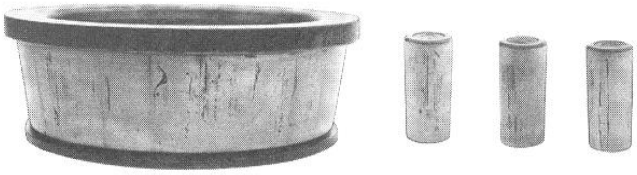
- The radius at the large diameter end of the rollers is worn to a sharp edge.
- A visible roller groove in the cup or the cone inner race surfaces. The groove can be seen at either the small or large diameter end of both parts.
- Deep cracks or breaks in the cup, the cone inner race or the roller surfaces.



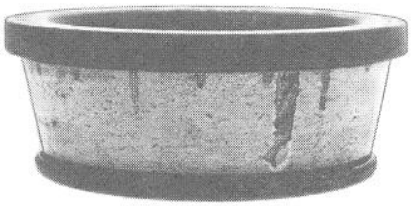
- Bright wear marks on the outer surface of the roller cage.



- damage on the rollers and on the surfaces of the cup and the cone inner race that touches the rollers.



- damage on the cup and the cone inner surfaces that touch the rollers.



Appendix F.-.Inspection of Brake Drums

To achieve maximum drum life and optimum performance, proper brake maintenance and brake balance are essential. Consult your bus manufacturer's maintenance manual for proper maintenance of the braking mechanism.

The following procedures are suggested as a means of obtaining maximum service and to determine the need for replacement.

NOTICE: When replacing lining or brake drum on one end of the axle, replace the same components on the other end of the axle. This will maintain proper braking load on the axle.

A1. Inspection of Brake Drums

When relining brakes, the brake drum should be cleaned and inspected. To be suitable for further service, the brake drum should pass the following checks:

A. The braking surface should be free of scoring, excessive heat checks and free of cracks.

B. The braking surface diameter should be within the maximum diameter cast or stamped on the drum or minimum thickness cast or stamped on the rotor.

C. The mounting holes and pilot must be round and true.

D. The mounting surface must be clean and flat.

CAUTION: If any of the above conditions are not met, the brake drum should be replaced.

NOTICE: Brake drums should be replaced in pairs to achieve the same braking power on the axle.

A2. Machining the Brake Surface

It may be desirable to turn or resurface the braking surface to remove small heat checks or other surface defects. The following should be noted when turning:

When resurfacing a drum, allow a margin under the maximum diameter for additional wear depending on agency experiences.

Example: For a wear allowance of 0.040 the drum may be machined a total of 0.290" over the brake surface diameter of a new brake drum with a nominal diameter of 14.500".

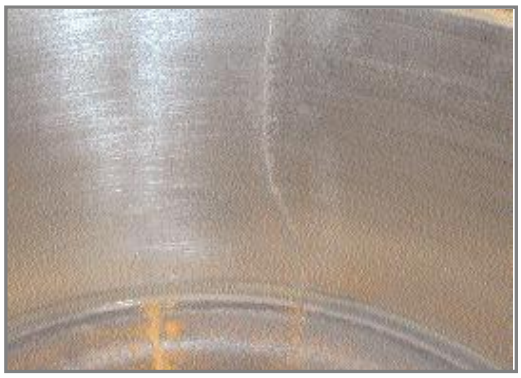
	Maximum Diameter	14.830
	Wear Margin	0.040
Machining Allowance	0.290	
	New Drum Diameter	14.500

WARNING: DO NOT WEAR A BRAKE DRUM BEYOND THE MAXIMUM

DIAMETER STAMPED OR CAST ON THE BRAKE DRUM.

The maximum diameter or discard diameter is the maximum diameter to which the brake drum may be worn, and still be usable. If any portion of the brake surface exceeds the maximum diameter it must be discarded. The maximum diameter cast into the back plate portions of the brake drum supersedes all published information.

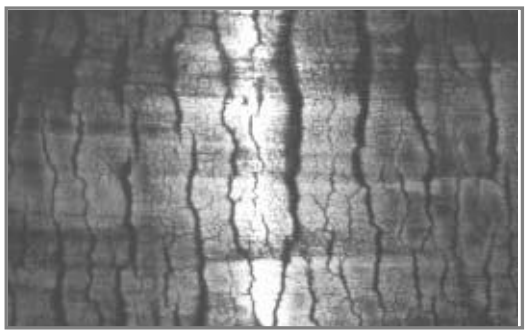
A3. Brake Drum Wear Information



A-Cracked

A. Cracked Brake Drums		
Problem	**Cause**	**Solution**
1. If drum is new	Mishandling	Replace brake drum
2. If drum is used (see picture at left)	Heat checks connect together and grow through drum	Replace brake drum. Check brake balance and brake system. (see Heavy Heat Check.
3. If used and low mileage	Improper shoe contact	Replace brake drum. Shoes must contact the drum at the center of the shoe.

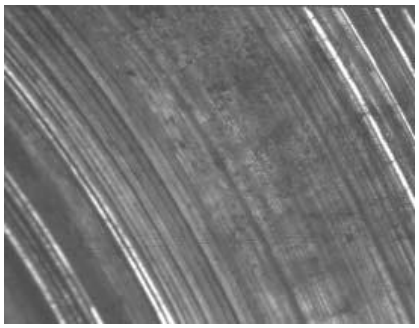
B. Heat Checked Drums		
Problem	**Cause**	**Solution**
1. Light	Normal condition	Does not impair brake performance. Brake drum may be turned within normal limits
2. Heavy	Imbalanced brake system, dragging brakes or driver abuse. It is caused by constant heating and cooling of brake surface	Replace brake drum. Check brake balance, brake return springs, brake adjustment, and lining type within vehicle combination.
3. Used, low mileage	Improper shoe contact	Replace brake drum. Shoes must contact the drum at the center of the shoe.



B1-Heat Check-Light

B2-Heat Check-Heavy

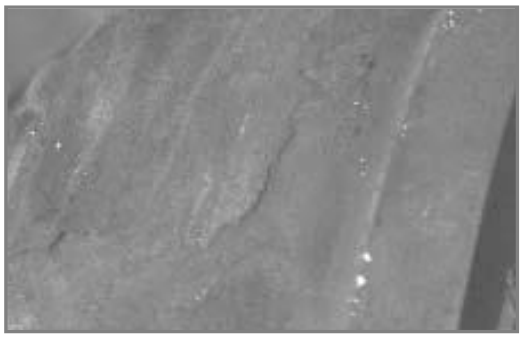
C. Grooved Drums		
Problem	**Probable Cause**	**Solution**
1.Fine Grooving	Abrasive foreign material or poor quality brake lining	Rebore brake drum within normal limits or replace the drum and lining
2. Grooves along edges of lining	Abrasive foreign material collecting at edges of lining	Dust shield may cause or cure this problem
3. Grooves coincide with rivet holes	Loose rivets, bolts or foreign material collecting in rivet or bolt holes	Rebore brake drum within normal limits or replace. Use rivet hole plugs



C1-Grooving-Fine Grooves

C2-Grooving-Grooves along edges of lining

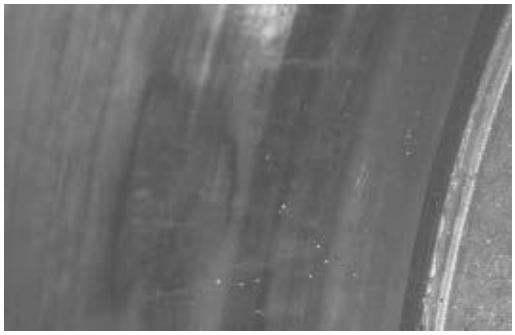
D. Miscellaneous Drum Wear		
Problem	**Probable Cause**	**Solution**
1. Blue or discolored braking surface	Excessive heat	Rebore brake drum within normal limits or replace
2. Scale on outside	Excessive heat	Check brake balance, weak or broken return springs, brake adjustment and lining.
3. Grooves coincide with rivet holes	Loose rivets, bolts or foreign material collecting in rivet or bolt holes	Rebore brake drum within normal limits or replace. Use rivet hole plugs.
4 Excessive wear	Abrasive foreign material or poor quality lining	.Check maximum diameter and rebore within limit or replace.



D1-Blue or Discolored Brake

D2–Scale On Outside

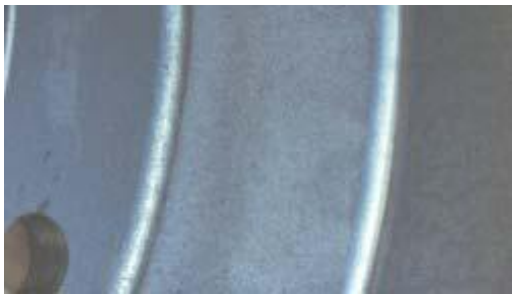
D. Miscellaneous Drum Wear		
Problem	**Probable Cause**	**Solution**
5. Heat spotted or hard spots in brake surface	Highly localized heating and cooling cycles	Grind hard spot and re-bore brake drum within normal limits
6. Greased Stained Drums	Leaking oil seal; improper lubrication of brake components	Repair source of oil or grease leak; clean the brake drum and replace linings
7. Faded or diminished brake power	High temperature in brake system, improperly adjusted brakes or inferior brake lining	Check brake drum, brake lining condition, brake adjustment, and brake balance. Avoid operation conditions or loads which create excessive brake temperature.
8. Noise, chatter or pulsating during brake application	Heat spotted drums, greased-stained drums, loose brake drum, or brake components	The bake drums should be removed and checked for one or more of these conditions and the appropriate action taken to resolve the condition.



D5-Heat spotted or Hard Spots

D6-Greased Stained Drums

D. Miscellaneous Drum Wear		
Problem	**Probable Cause**	**Solution**
9. Polished Brake Surface		
a. Non-asbestos lining	Normal condition	
b. Glazed surface	Insufficient braking input force, (i.e. overly aggressive retarder or lining material, improper brake balance)	Remove glaze with emery cloth or rebore drum within normal limits.



D9-Polished / Glazed Braking Surface

E. Out-of-round		
Problem	**Probable Cause**	**Solution**
1. Balance	Balance weight has fallen off or a balanced drum was not specified	Specify balanced brake drums when ordering.
2. Variation in diameter	Heat distortion	Rebore brake drum within normal limits or replace.
3. Concentricity	Improper fit to pilot or improper seating on wheel or hub	Clean all mounting surfaces check for correct fit and clearance to wheel.

Appendix G - Wheel bearing Adjustment

Recommended Practice

RP 618 **VMRS 018**

WHEEL BEARING ADJUSTMENT PROCEDURES

PREFACE
The following Recommended Practice is subject to the Disclaimer at the front of TMC's *Recommended Maintenance Practices Manual.* Users are urged to read the Disclaimer before considering adoption of any portion of this Recommended Practice.

OBJECTIVE
The goal of this Recommended Procedure is to achieve a verifiable wheel bearing end play of 0.001" to 0.005" (0.025 mm to 0.127 mm).

SCOPE
The following service procedures apply to steer, drive, and trailer axle assemblies using conventional double nut or single nut systems. Follow these service procedures carefully to prevent premature wheel end component failure and increase seal and bearing life.

ABS (anti-lock braking systems) and traction control systems with wheel end sensing require precise bearing adjustment to function properly.

This Recommended Practice details proper service procedures for D-type, bendable-type, and dowel-type spindle nut washers.

NOTE: For single nut self-locking systems, consult manufacturers' instructions.

If you have a system that differs from what is indicated in this procedure, consult the vehicle manufacturer's recommended procedure.

WARNING: Never work under a unit supported by only a jack. Always support the vehicle with stands. Block the wheels and make sure the unit will not roll before releasing brakes.

CAUTION: If your axle is equipped with spoke wheels and the rim clamps have been disassembled to remove the tire and rim assembly, the tire and rim assembly must be reinstalled and the rim clamps properly torqued BEFORE adjusting the wheel bearings. Failure to do this may result in improper wheel bearing adjustment.

REFERENCES
TMC RP 622, *Wheel Seal and Bearing Removal, Installation and Maintenance.*

PROCEDURES
Step 1: Lubricate the bearing with clean axle lubricant of the same type used in the axle sump or hub assembly.

IMPORTANT
(a) In oil bath systems that rely on differential fill to provide lubricant to the wheel seals, do not pack bearings with grease before installation. Grease will temporarily restrict or prevent the proper circulation of axle lubricant and may contribute to wheel seal failure.

(b) Never use an impact wrench to adjust wheel bearings.

Step 2: After the wheel hub and bearings are assembled on the spindle or axle tube, torque the inner (adjusting) nut to 200 lbf• ft (271 N•m) while rotating the wheel hub assembly. Refer to **Table 1** at the end of this Recommended Practice.

Step 3: Back off the inner (adjusting) nut one full turn. Rotate the wheel.

Step 4: Re-torque the inner (adjusting) nut to 50 lbf• ft (68 N•m) while rotating the wheel hub assembly. Refer to **Table 1** at the end of this Recommended Practice.

Step 5: Back off the inner (adjusting) nut. Refer to **Table 1** at the end of this Recommended Practice for the proper back-off amount.

Step 6: Install the locking washer.

If dowel pin and washer (or washer tang and nut flat) are not aligned, remove the washer, turn it over and reinstall. If required, loosen the inner (adjusting) nut just enough for alignment.

IMPORTANT
Never tighten the inner (adjusting) nut for alignment at this point of the procedure. This may pre-load the bearing and cause premature failure.

Step 7: Install and torque the outer (jam) nut. Refer to **Table 1** at the end of this Recommended Practice for proper torque values.

NOTE: This adjustment allows the wheel to rotate freely with 0.001" to 0.005" (0.025 mm to 0.0127 mm) end play.

Step 8: Verify end play with a dial indicator. Wheel end play is the free movement of the tire and wheel assembly along the spindle axis.

(a) Make sure the brake drum-to-hub fasteners are tightened to the manufacturers' specifications.

(b) Attach a dial indicator with its magnetic base to the hub or brake drum.

(c) Adjust the dial indicator so that its plunger or pointer is against the end of the spindle with its line of action approximately parallel to the axis of the spindle. See **Fig. 1.**

(d) Grasp the wheel assembly at the 3 o'clock and 9 o'clock positions. Push the wheel assembly in and out while oscillating it to seat the bearings. Read bearing end play as the total indicator movement.

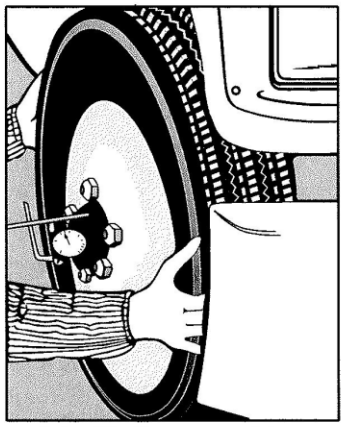
NOTE: If end play is not within specification, readjustment is required.

Step 9: RE-ADJUSTMENT PROCEDURE

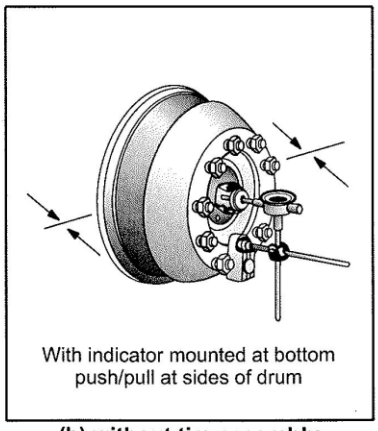
Excessive End Play
If end play is too loose, remove the outer (jam) nut and pull the washer away from the inner (adjusting) nut, but not off the spindle. Tighten the inner (adjusting) nut to the next alignment hole of the washer. Reassemble the washer and re-torque the outer (jam) nut. Refer to **Table 1** for torque values. Verify end play with a dial indicator.

Insufficient End Play
If end play is not present, remove the outer (jam) nut and pull the washer away from the inner (adjusting) nut, but not off the spindle. Loosen the inner (adjusting) nut to the next alignment hole of the washer. Reassemble the washer and re-torque the outer (jam) nut. Refer to **Table 1** for torque values. Verify end play with a dial indicator.

FINE TUNING THE ADJUSTMENT
If, after performing the readjustment procedures, end play is 0.004" - 0.005" (0.102 mm - 0.127 mm) range, repeat the appropriate procedures, removing the washer from the spindle, tighten or loosen



(a) with tire assembly



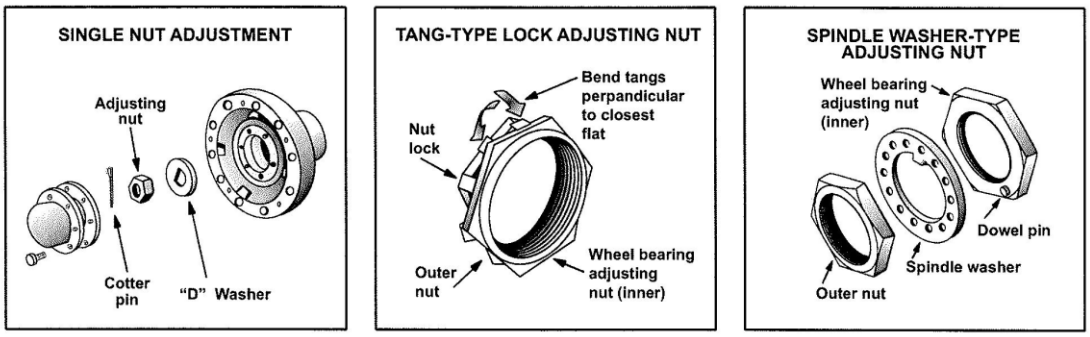
(b) without tire assembly

Fig. 1: Dial Indicator Set-Up

the inner adjusting nut the equivalent of 1/2 of an alignment hole of the washer, or reversing the alignment washer, and reinstalling it onto the spindle. Reassemble and re-torque the outer (jam) nut. Refer to **Table 1** for torque values. Verify end play with a dial indicator.

NOTE: Bendable-type washer lock only: Secure nuts by bending one wheel nut washer tang over the inner and outer nut. Bend the tangs over the closest flap perpendicular to the tang. See Fig. 2.

CAUTION: Before operating the unit, the wheel hub cavities and bearings must be lubricated to prevent failure. For final wheel end assembly refer to TMC RP 622.



"D" Type "Tang" Type "Dowel" Type

Fig. 2: Adjusting Nut Identification and Installation

TABLE 1

WHEEL BEARING ADJUSTMENT PROCEDURE

STEP 1: Lubricate the wheel bearing with clean axle lubricant of the same type used in the axle sump or hub assembly.
Note: Never use an impact wrench when tightening or loosening lug nuts or bolts during the procedure.

INITIAL ADJUSTING NUT TORQUE	INITIAL BACK OFF	FINAL ADJUSTING NUT TORQUE	BACK OFF			JAM NUT TORQUE		ACCEPTABLE END PLAY
			AXLE TYPE	THREADS PER INCH	FINAL BACK OFF	NUT SIZE	TORQUE SPECIFICATIONS	
STEP 2	STEP 3	STEP 4		STEP 5	STEP 6	STEP 7		STEP 8
200 lb•ft (271 N•m) While Rotating Wheel	One Full Turn	50 lb•ft (68 N•m) While Rotating Wheels	Steer (Front) Non-Drive	12	1/6 Turn *	Install Cotter Pin to Lock Axle Nut in Position		0.001"-0.005" (.025-.127 mm)
				18	1/4 Turn *			
				14	1/2 Turn	Less Than 2-5/8" (66.7 mm)	200-300 lb•ft (271-407 N•m)	
				18				
			Drive	12	1/4 Turn	Dowel Type Washer	300-400 lb•ft (407-542 N•m)	As Measured Per Procedure With Dial Indicator
				16		Tang Type Washer **	200-275 lb•ft (271-373 N•m)	
			Trailer	12	1/4 Turn	2-5/8" (66.7 mm) and over	300-400 lb•ft (407-542 N•m)	
				16				

* If dowel pin and washer (or washer tang and nut flat) are not aligned, remove the washer, turn it over, and reinstall. If required, loosen the inner (adjusting) nut just enough for alignment.
** Bendable type washer lock only: Secure nuts by bending one wheel nut washer tang over the inner and outer nut. Bend the tangs over the closest flat perpendicular to the tang.