APTA

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

APTA Bus Technical Maintenance Committee Webinar Series

Presents

Disc Brake Wheels Off Inspection and Reline

January 21, 2015

Introduction

- Welcome to today's webinar in which we will cover a wheels off inspection and reline of the bus disc brake system
- My name is John Brundage and I will be the moderator for this webinar
- The information on this webinar is to be used in conjunction with the original equipment manufacturer (OEM) and disc brake manufacturer service manuals
- Proper tools and safety equipment must always be used when working on brake systems

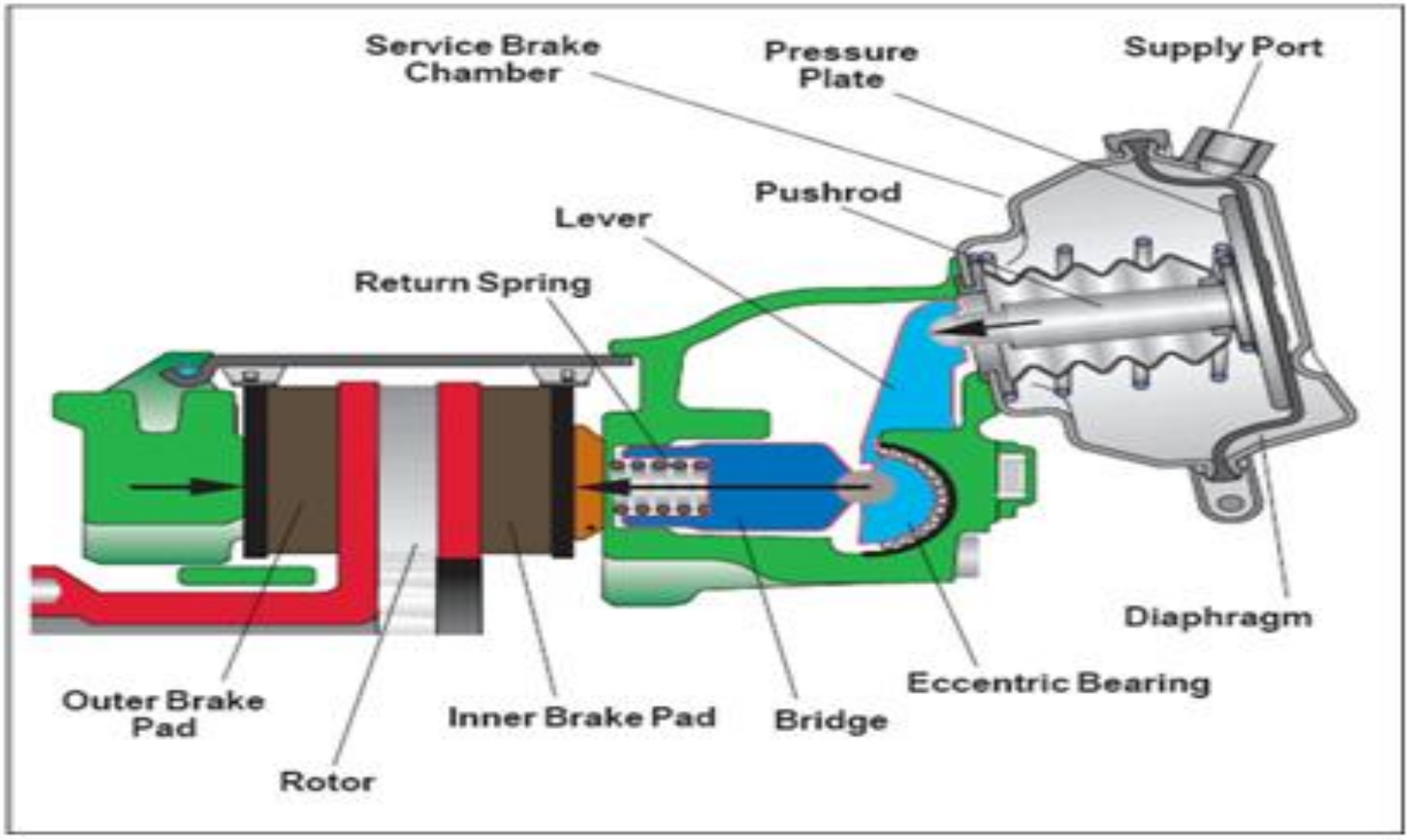
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Overview

- *Nomenclature*
- *Brake Chambers*
- *Caliper Movement Test*
- *Caliper Adjuster Test*
- *Thermal Overload*
- *Brake Pad Removal*
- *Brake Pad Inspection*
- *Pad Abutment Inspection*
- *Caliper Guide/Slide Pin Inspection*
- *Tappet Boots and Seals*
- *Brake Rotor Inspection*
- *Resurface Brake Rotor*
- *Brake Pad Installation and Adjustment*
- *Final Inspection and Test*

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

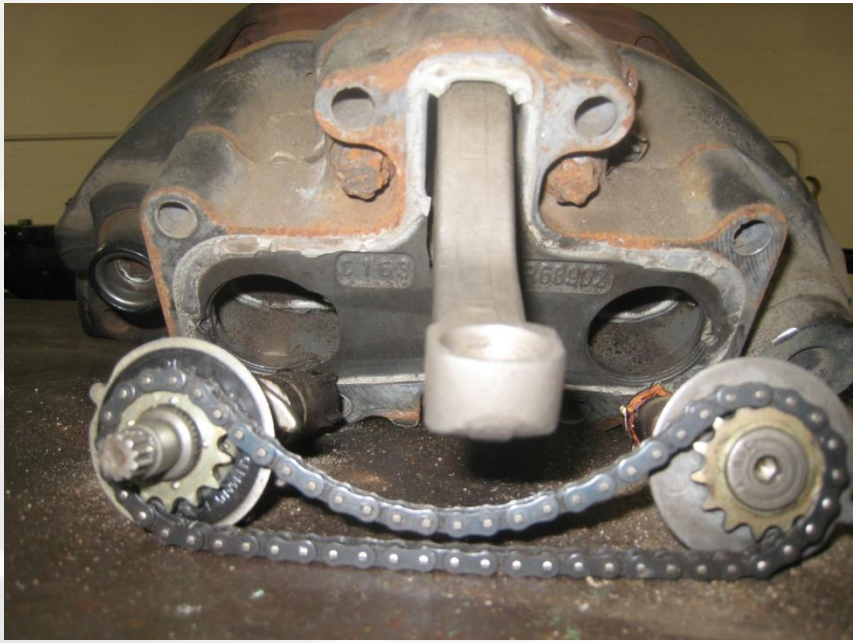
Nomenclature



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Nomenclature

Knorr timing chain and lever

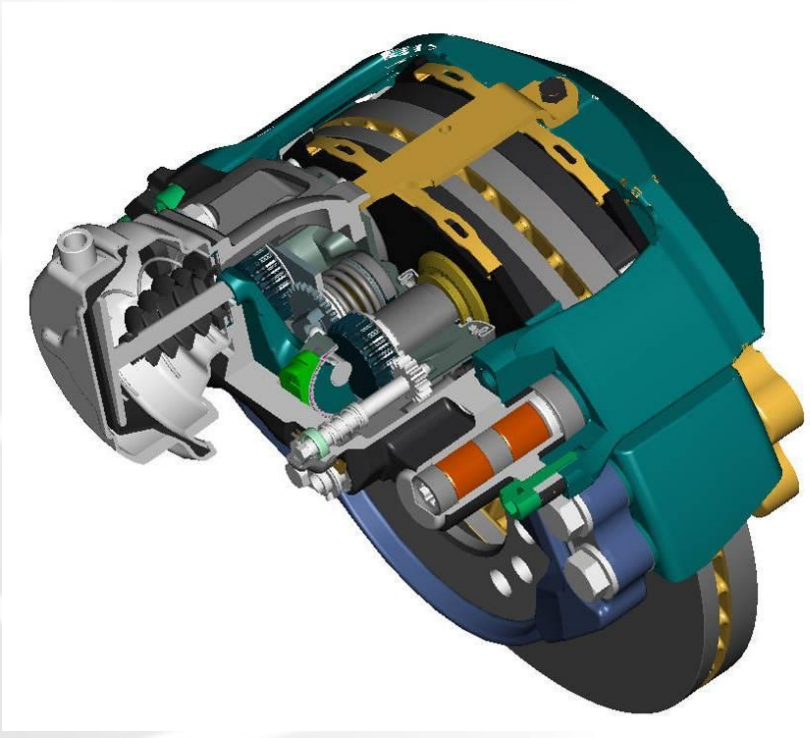


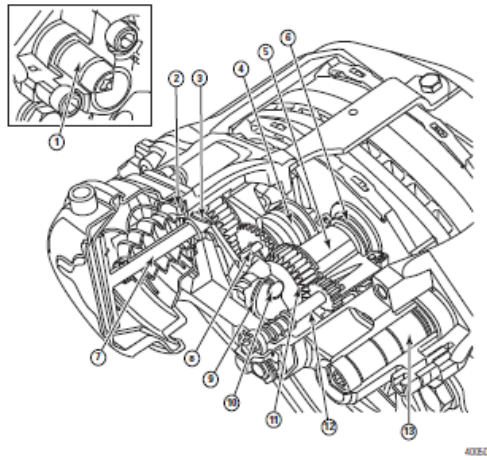
For illustration purposes only. Do not disassemble. Not serviceable.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Nomenclature

Meritor EX225 Caliper





Item	Description
1	Short Slide Pin Oval Bushing
2	Housing Seal
3	Operating Shaft
4	Return Spring
5	Piston
6	Piston Head
7	Chamber Piston
8	Adjuster Shaft
9	Half Bearing
10	Roller
11	Tappet

Item	Description
12	Adjuster Stem
13	Long Slide Pin Bushing

Nomenclature

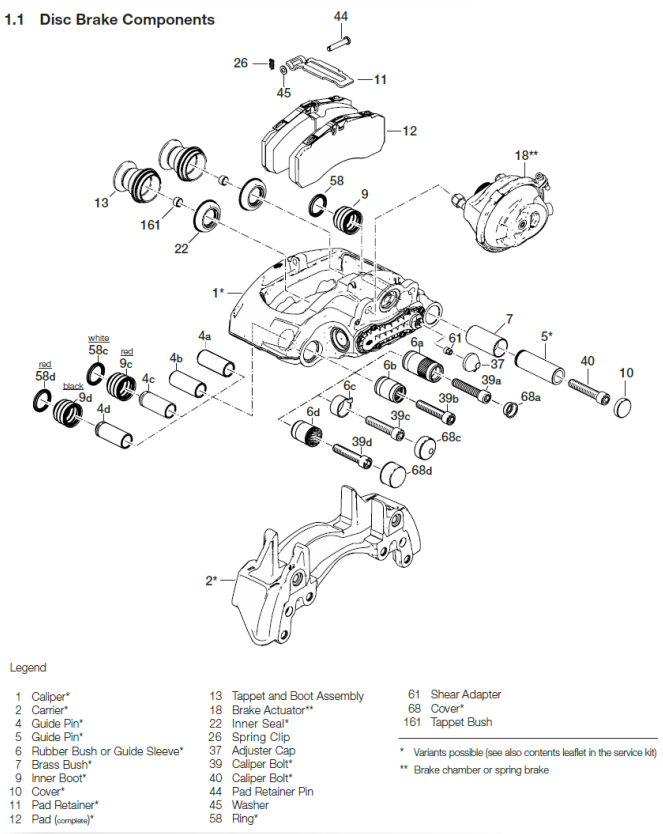
Knorr SN7 Caliper

Meritor EX225 Caliper

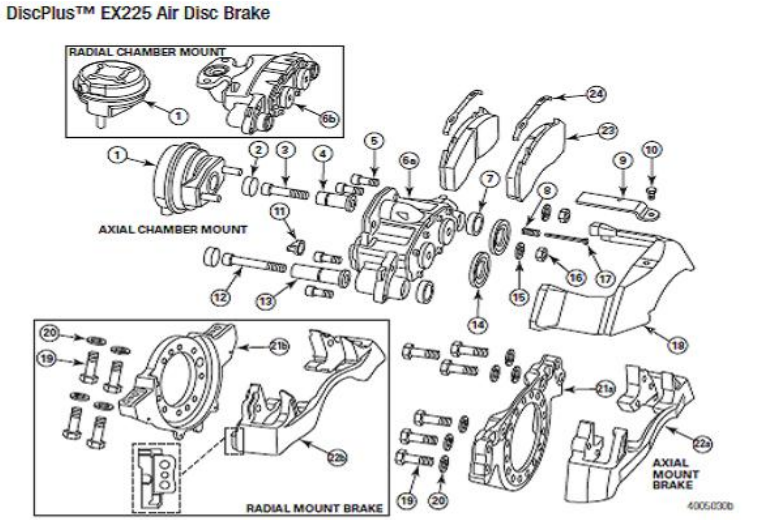
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Nomenclature

Knorr SN7 exploded view



Meritor EX225 exploded view



Item	Description
1	Air Chamber
2	Slide Pin Cap (2)
3	Short Slide Pin Bolt
4	Short Slide Pin
5	Bridge Bolt (4)
6a	Caliper Housing Assembly — Axial Chamber Mount
6b	Caliper Housing Assembly — Radial Chamber Mount
7	Slide Pin Boot (2)
8	Visual Wear Indicator Spring
9	Pad Retainer
10	Pad Retainer Bolt
11	Adjuster Cover
12	Long Slide Pin Bolt
13	Long Slide Pin

Item	Description
14	Piston Boot (2)
15	Air Chamber Washer (2)
16	Air Chamber Nut (2)
17	Visual Wear Indicator
18	Bridge
19	Carrier Bolt — EX225L (4), EX225H (5-6)
20	Washer — EX225L (4), EX225H (5-6)
21a	Torque Plate — Axial Mount
21b	Torque Plate — Radial Mount
22a	Carrier — Axial Mount
22b	Carrier — Radial Mount
23	Brake Pad (2)
24	Pad Spring (2)

Brake Chambers

Two mounting positions for brake chambers

Axial

Radial

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Chambers

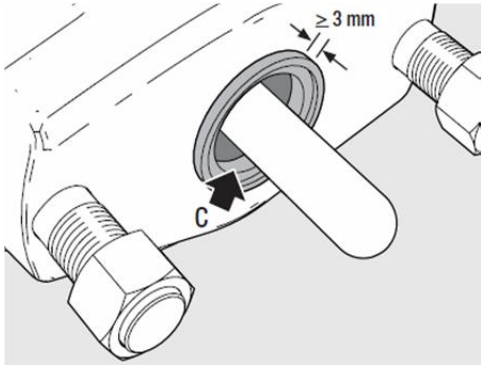
Front brake chamber

Rear spring brake chamber

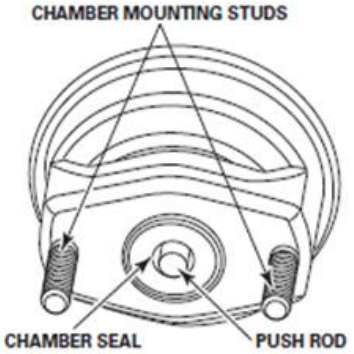
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Chambers

- With the brake system at governor full cut-out, release parking brake (when applicable) then apply service brakes and listen for air leak
- Any air leaks will deem the vehicle out of service until repairs are made
- When removing spring brake chambers, follow the manufacturer's instructions to completely cage and release the brake
- When the chamber is removed for inspection or replacement, check for mounting stud damage, push rod protrusion, and signs of water intrusion into the caliper
- Knorr / Bendix calipers rely solely on the brake chamber seal to prevent water and contaminant intrusion
- Meritor calipers use a seal in the caliper and another seal on the brake chamber
- If the brake chamber seals have failed, the chambers must be replaced
- If water or contamination is found in the caliper, the caliper will need to be replaced. Caliper seals should be inspected and replaced as needed



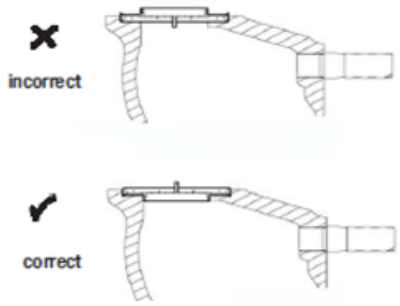
Knorr chamber



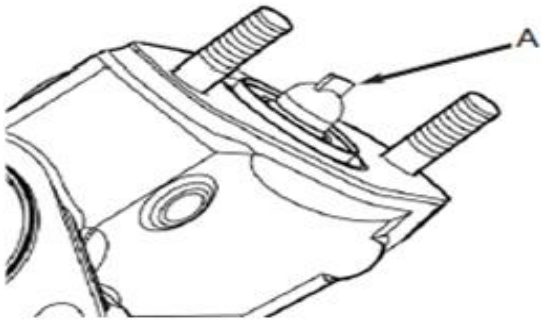
Meritor chamber

Brake Chambers

- Meritor caliper seals need to be inspected and replaced as necessary
- Water intrusion into the caliper will require caliper replacement
- New Meritor chambers are shipped with a transit plug and should not be confused with the caliper seal
- The transit (shipping) plug must be removed before the chamber is installed



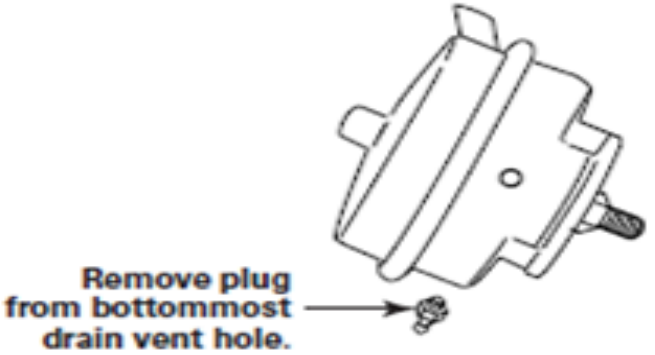
Meritor caliper seal

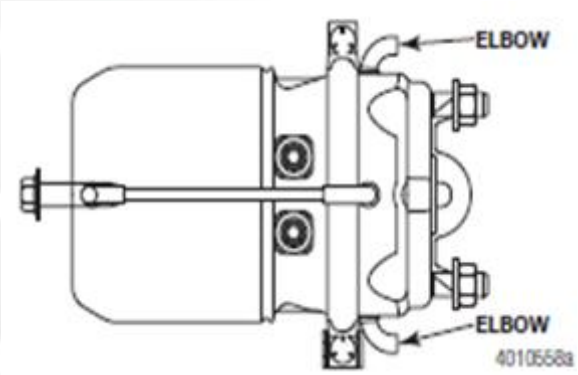


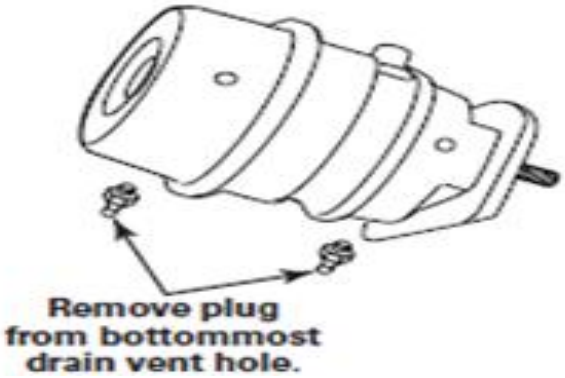
Meritor shipping plug

Brake Chambers

- Ensure the bottommost housing plug is removed
- Failure to remove a plug from the non-pressure housing will cause a slow releasing, dragging brake
- For brake chambers equipped with elbows, the chamber must be oriented in such a way that the two elbows will easily allow water and contaminants to drain from the chamber

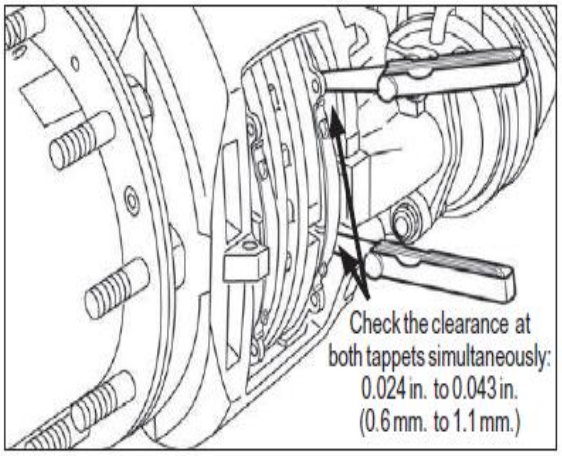




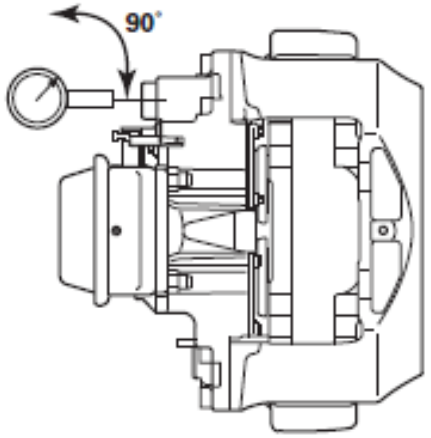


Caliper Movement Test

- For Knorr calipers, with the brakes in a cool down condition, push the inboard pad away from the tappets
- Use two long feeler gauges to measure between the whole tappet surface and pad backplate
- For Meritor EX225 calipers, attach a magnetic dial indicator to the to the torque plate or axle, with the indicator parallel to the slide pin near the center of the caliper
- Slide the caliper back and forth by hand and note the reading. If the reading exceeds .080” the brake is out of adjustment and requires further attention
- Meritor EX225 brakes have a .030” running clearance
- Gap too large can cause brake failure
- Gap too small can cause brake overheating
- Any defect must be corrected



Knorr pictured above



Meritor EX225 pictured above

Knorr Bremse Sheer Adapter

The Knorr Bremse sheer adapter is designed to sheer if excessive torque is required to turn the adjuster.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Caliper Adjuster Test

- Inspect adjusting screw cap for missing, damage and a tight seal
- Visually inspect adjusting screw internal seal for damage
- Remove cap for Caliper Adjuster Test

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

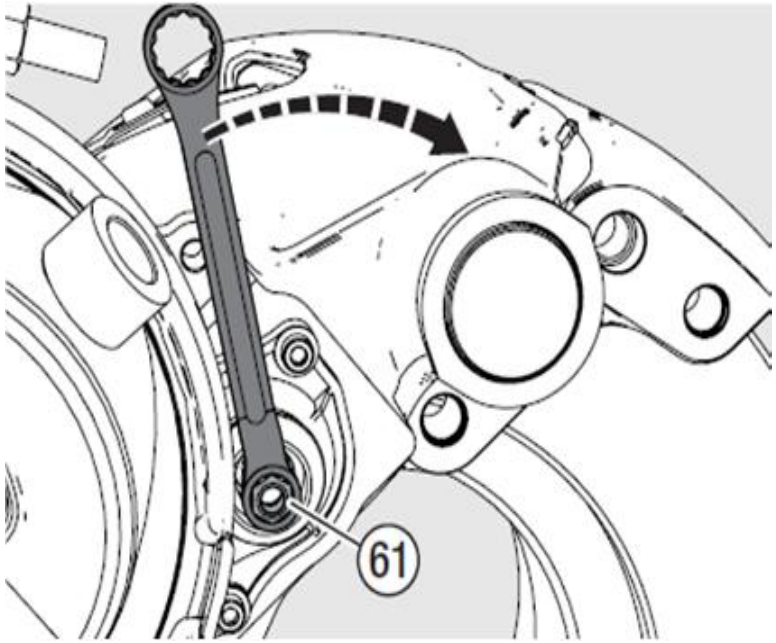
Caliper Adjuster Test

- Turn adjuster three clicks counter clockwise to back off using a box wrench or socket
- If the sheer adapter fails, replace and attempt a second time
- If the sheer adapter fails again, the adjuster is seized and the caliper needs to be replaced

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Caliper Adjuster Test

- Leave wrench on sheer adapter (Knorr) or adjuster (Meritor)
- Make sure wrench is positioned so that it can move clockwise without obstruction
- Apply brakes with about 2 bar (30 psi) air pressure five to ten times
- The wrench should turn clockwise
- If the wrench does not turn, turns only on first application, or turns forward and backward with every application, the adjuster has failed and the caliper must be replaced



Knorr Bremse pictured above

Meritor pictured to the left

Thermal Overload

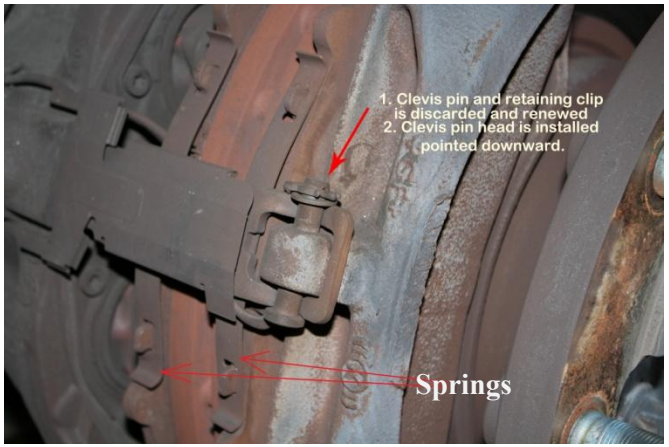
Below are examples of Thermal Overload which is an indication of excessive heat caused by dragging brakes. The cause must be identified and corrected.

Below are examples of brake assemblies exhibiting normal operating conditions.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Pad Removal

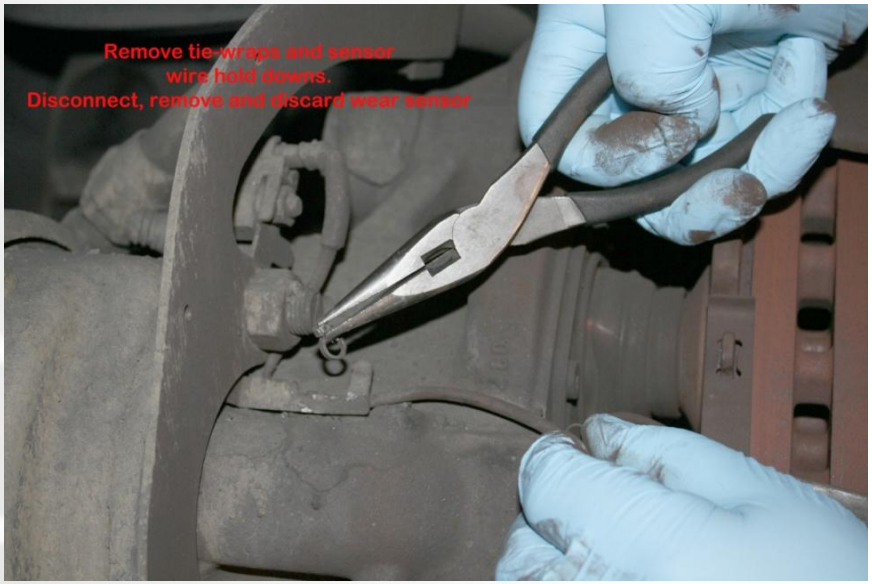
- Release or cage spring brake as required
- Remove bolt or clevis pin on pad retainer
- Visually inspect pad retainer for bending or wear
- Remove brake pad springs (some are permanently affixed)



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Pad Removal

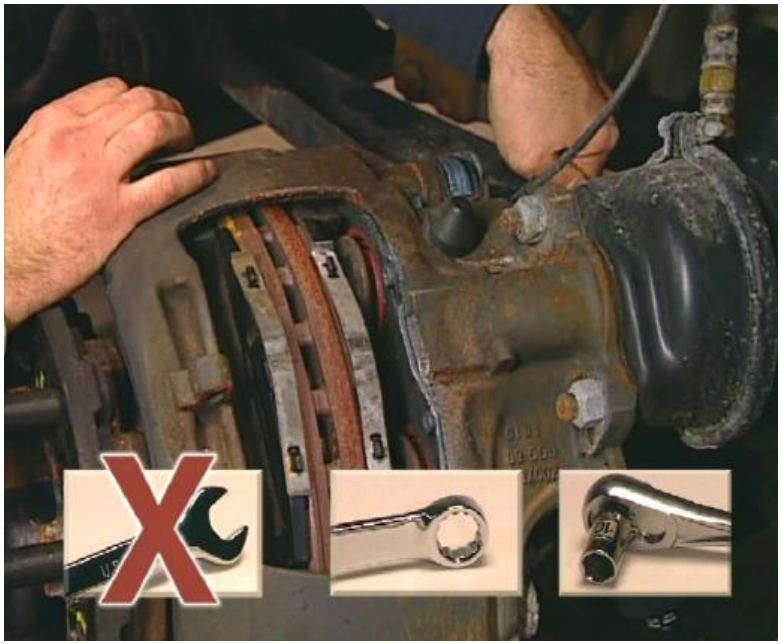
If equipped, disconnect wear sensor

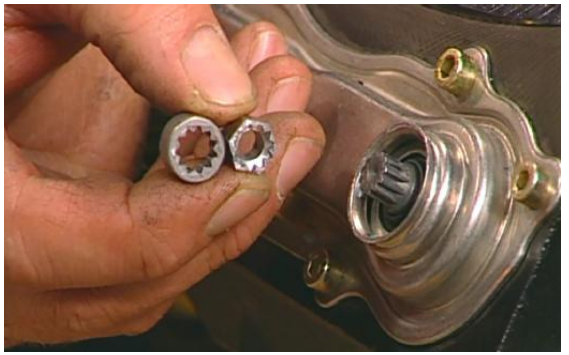


AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Pad Removal

- Deadjust brakes using a shear adapter (Knorr) or 10mm wrench (Meritor)
- Turn the adjuster counterclockwise to deadjust
- Back off until you feel the adjuster stem stop turning
- Deadjustment requires more force than adjustment
- For Meritor calipers, do not exceed 30lb-ft (40nm) torque
- For Knorr calipers, using the wrong wrench or continuing to torque after the tappets are fully retracted will cause the shear adapter to fail
- Remove brake pads

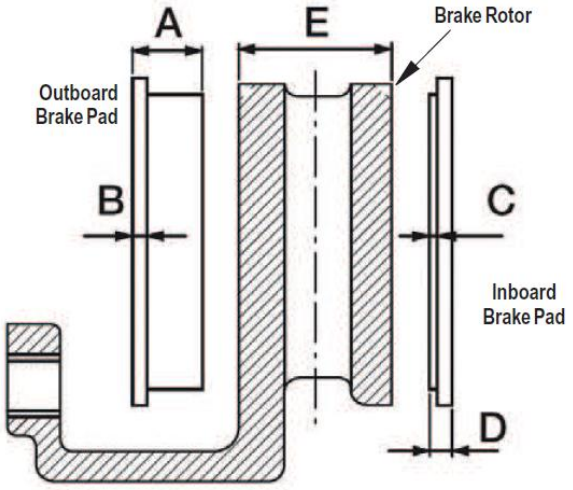




AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

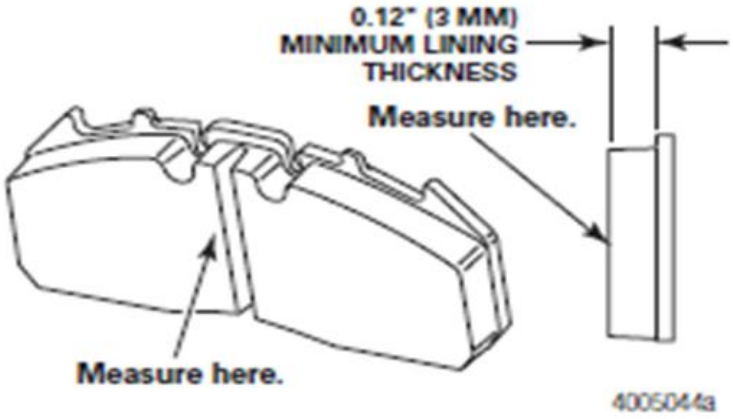
Brake Pad Inspection

Knorr SN7 brake pad and rotor dimensions



A	Thickness of a new pad (1.181 in.) (30 mm.).
B	Backing plate thickness (0.360 in.) (9 mm.)
C	Minimum thickness of friction material (0.080 in.) (2 mm.)
D	Minimum thickness of a worn pad (0.433 in.) (11 mm.); replace pads.
E	Thickness of a new rotor (1.77 in.) (45 mm.). Minimum rotor thickness (1.46 in.) (37 mm.)

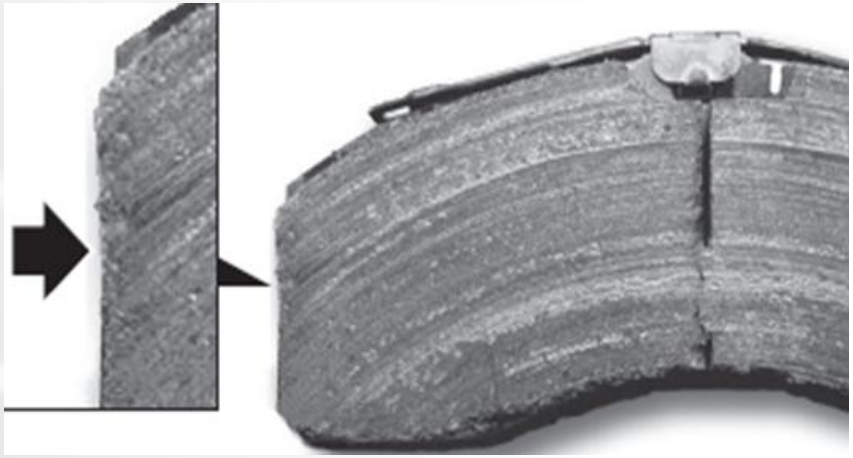
Meritor brake pad dimensions



Check for pad thickness and uneven wear. Always refer to the brake, axle, or manufacturer's manual for specifications.

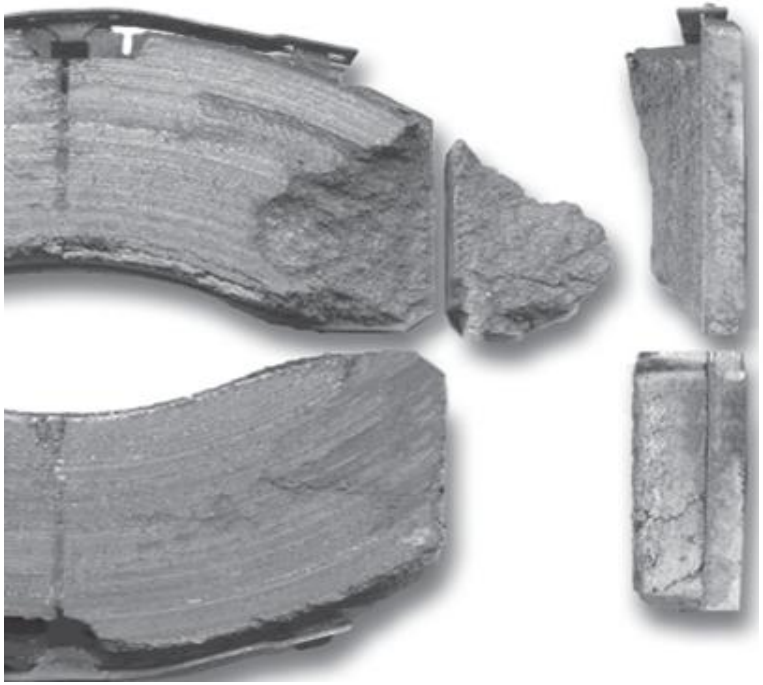
Brake Pad Inspection

Pad with minor wear patterns (re-use permitted)



Minor damage at edges is permitted. Replacement of pads is required if major damage is present or the pads are worn to an unacceptable level.

Pad with major damage (re-use not permitted)



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Pad Inspection

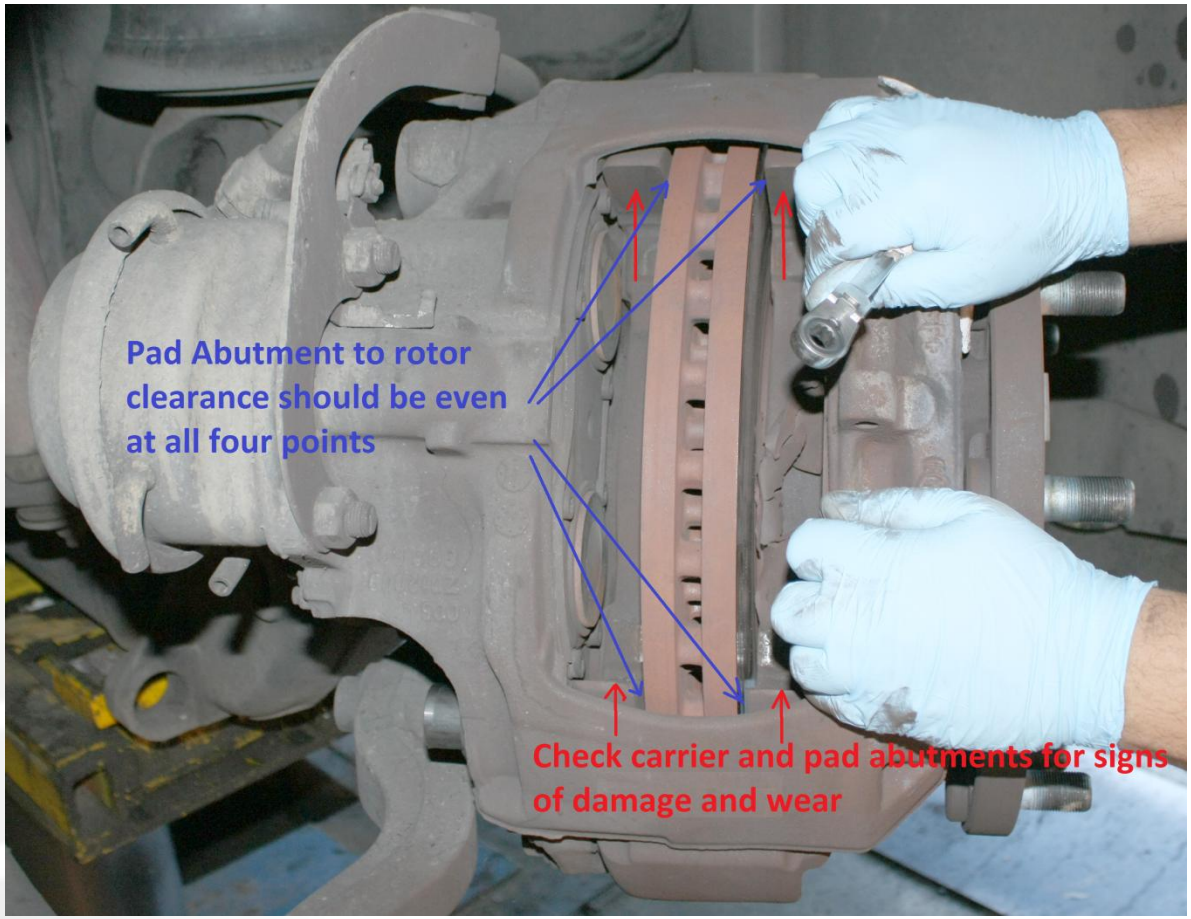
Outer pad with taper

Inner pad with taper

The cause of the tapered wear must be identified and corrected.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Pad Abutment Inspection



Minor abutment wear is normal. Wear that will cause the pads to hang up will require carrier replacement.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

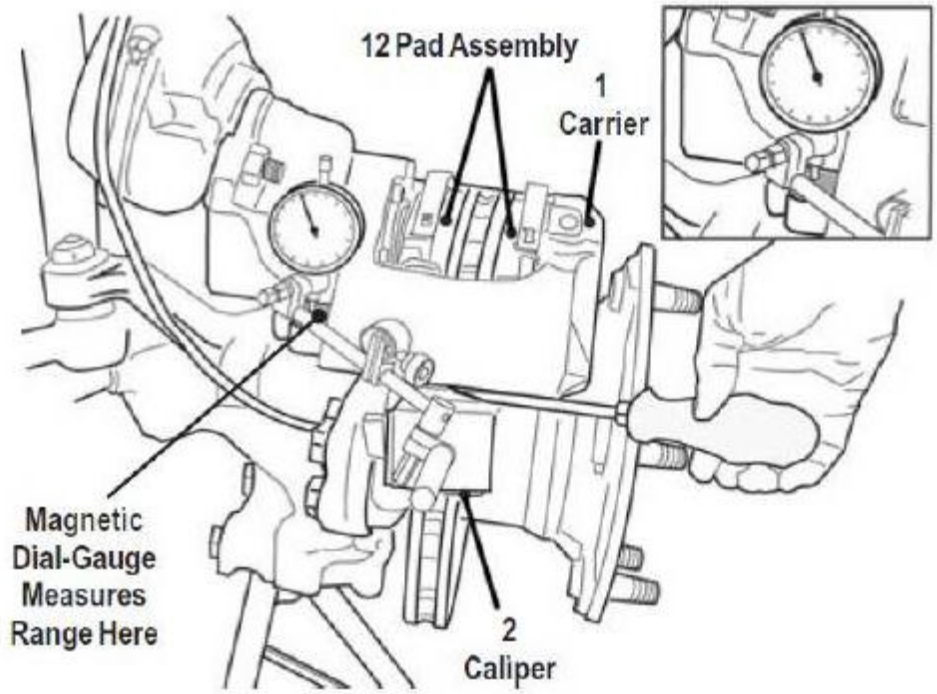
Caliper Guide/Slide Pin Check

Using hand pressure only, with the brake pads removed, make sure the caliper slides freely along the whole length of the guide pins.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Caliper Guide Pin Inspection

Place a flat-blade screwdriver between carrier and caliper forcing them in opposite directions, then read the maximum value on the dial-gauge

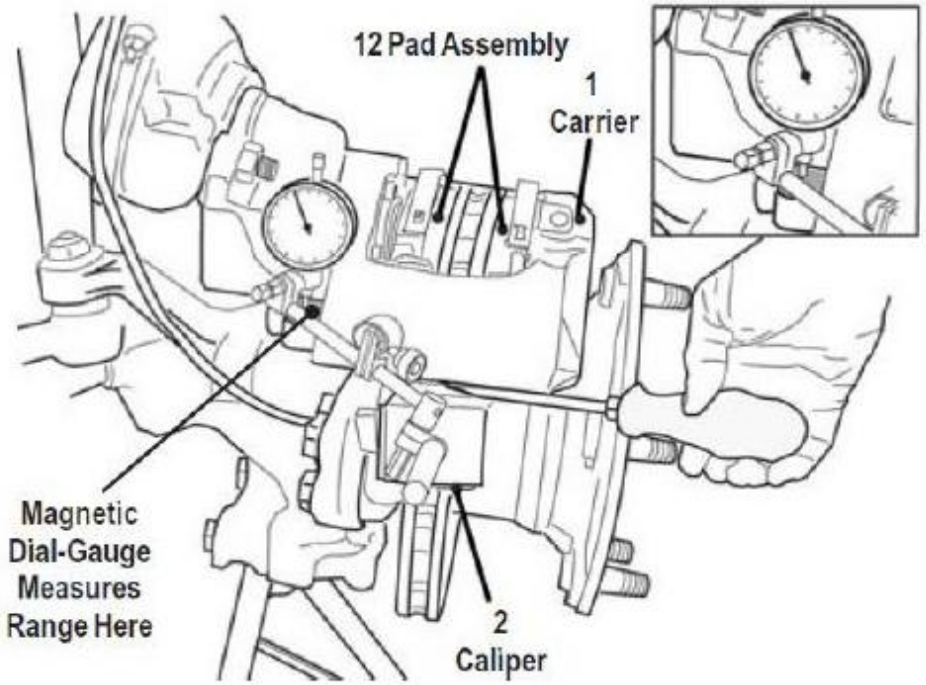


Knorr-Bremse guide pin inspection. Mount a dial indicator as shown. If the caliper is removed, guide pins, bushings and seals should be replaced. The SB caliper version uses rubber bushings. Refer to the manual for specifications.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Caliper Guide Pin Inspection

If the value is greater than 0.078 in. (2.0 mm), replace the guide pin bushings or replace the caliper/carrier assembly



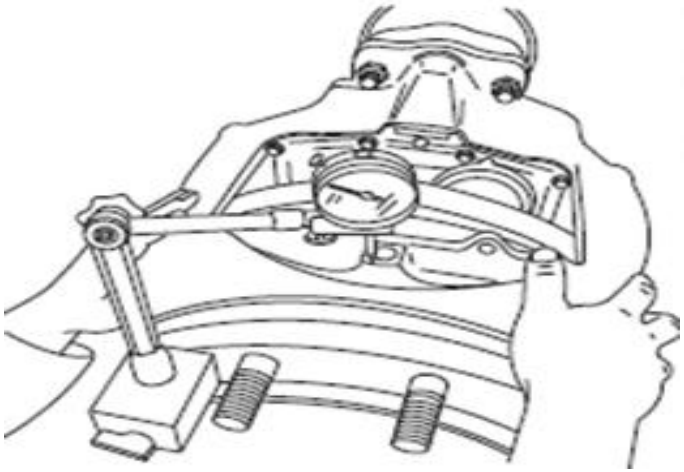
Knorr-Bremse guide pin inspection. Mount a dial indicator as shown. If the caliper is removed, guide pins, bushings and seals should be replaced. The SB caliper version uses rubber bushings. Refer to the manual for specifications.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Caliper Guide/Slide Pin Inspection

- Mount a dial indicator as show with the caliper in the middle position on the slides with the brake pads removed
- Push the caliper and down and set the dial indicator to “0”
- Next, pull up on the caliper as far as possible without allowing the caliper to slide and note the measurement
- If the reading is more than .078” (2mm), replace the bushings and slide pins

Meritor Radial Test

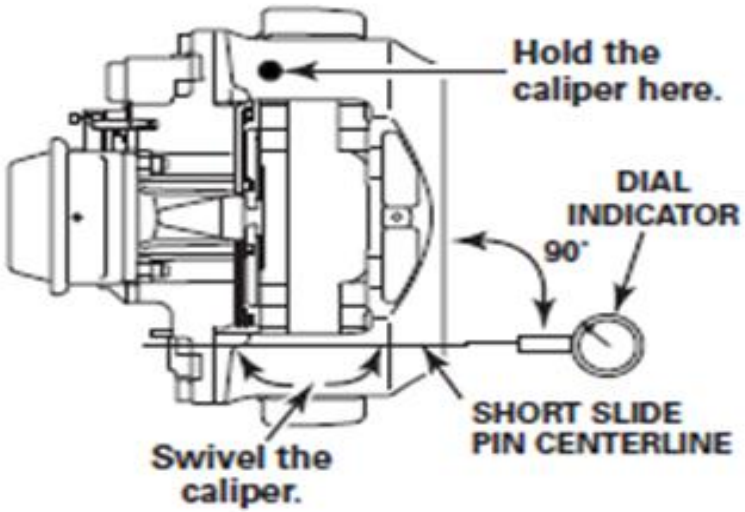


If the caliper is removed, slide pins, bushings, seals and mounting hardware should be replaced.

Caliper Guide/Slide Pin Inspection

- Mount a dial indicator to the hub so that it is in line with the centerline of the short slide pin as show with the caliper in the middle position on the slides with the brake pads removed
- Hold the caliper so that it cannot move
- Swivel the caliper until it stops in one direction and set the gauge to “0”
- Move the housing in the opposite direction until it stops and note the reading
- If the reading is more than .118” (3mm) replace the bushings, slide pins, or caliper assembly

Meritor Tangential Test



If the caliper is removed, slide pins, bushings, seals and mounting hardware should be replaced.

Caliper Guide/Slide Pin Inspection

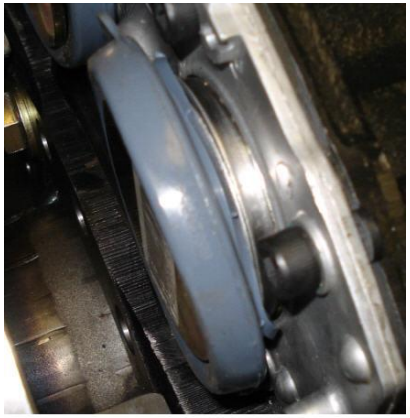
Check guide/slide pin boots and replace as needed and when guide pins and bushings are replaced.

All slide pin boots must be free from damage and be properly seated.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Tappet Boots and Seals

- Inspect tappets and seals anytime the wheels are removed
- Damaged, improperly seated, loose or worn boots and seals can allow moisture to enter the caliper
- Rust and contamination of the internal caliper mechanism can cause the caliper to malfunction and not adjust or release, resulting in dragging or slack brakes
- Damaged boots and seals must be replaced before the brake pads are installed



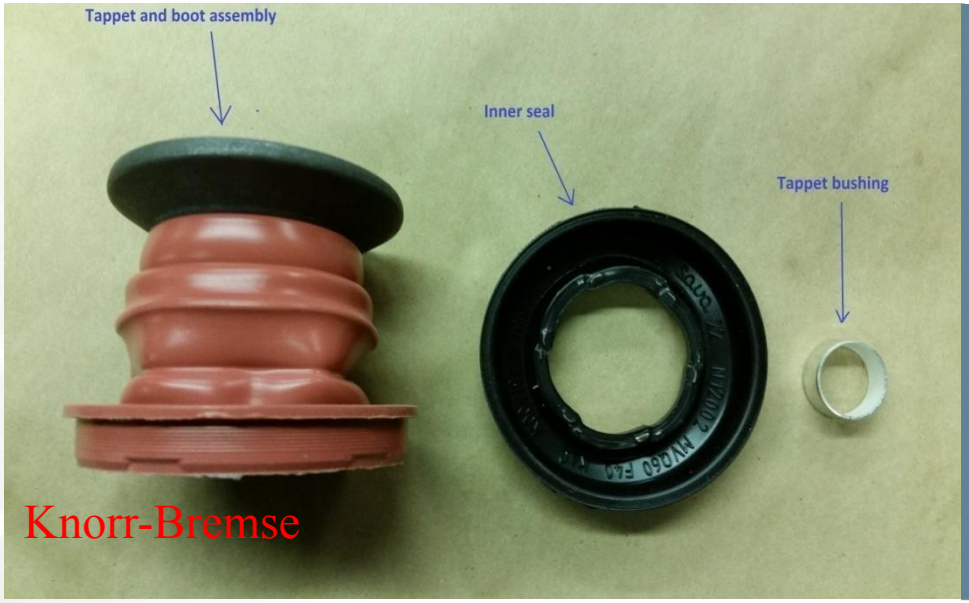
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Tappet Boots and Seals

- Clean tappet pad contact surfaces
- Use a straight edge, measure tappet height to ensure both tappets are at equal height
- If tappet height is uneven, the caliper must be replaced

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Tappet Boots and Seals



Inspect tappets and seals any time the wheels are removed

They can be replaced without removing the caliper, but special tools are required

To optimize caliper life, consideration should be given for proactive preventative replacement of tappet seals and boots.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

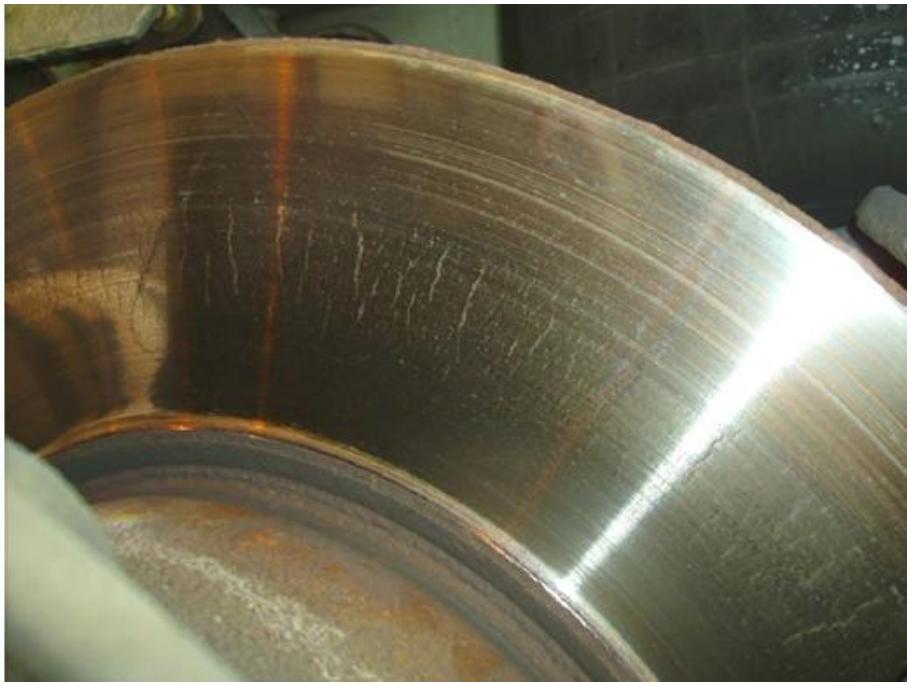
Brake Rotor Inspection

Check rotor for damage and excessive wear

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Rotor Inspection

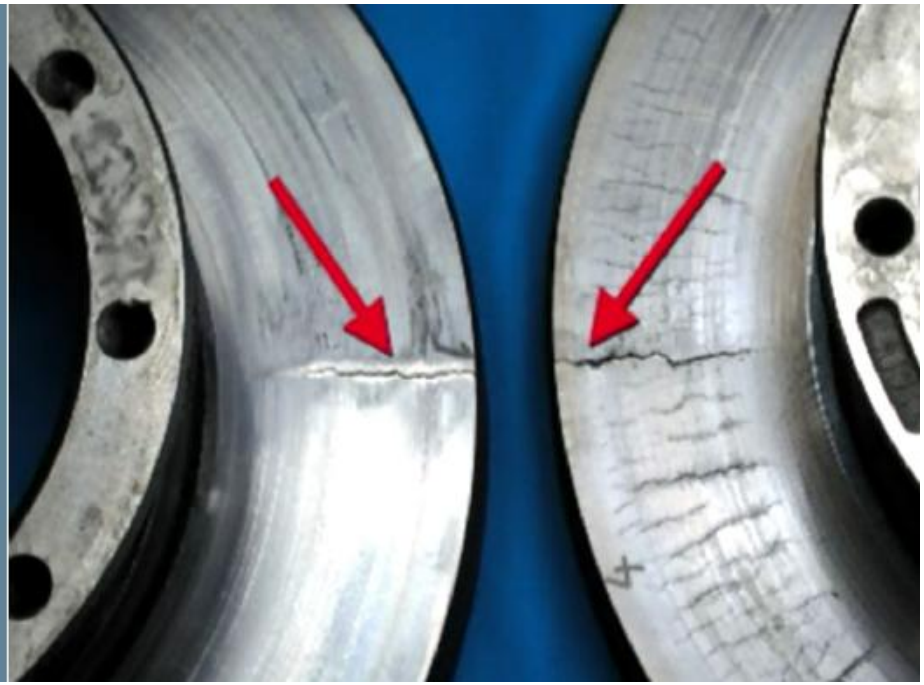
Small heat check are allowable (as shown)



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Rotor Inspection

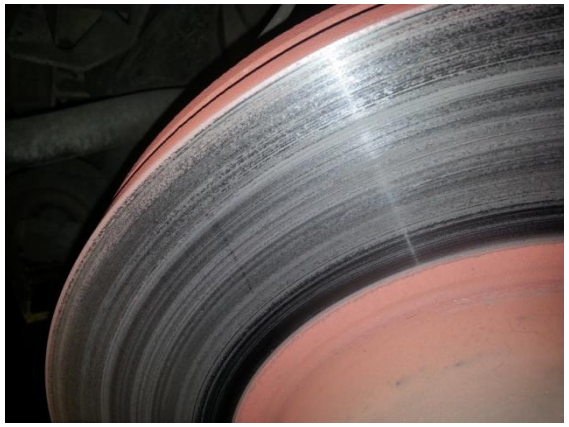
Large cracks creating a split in the rotor is not acceptable and requires rotor replacement



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Rotor Inspection

- Blue bands or marks indicate that the rotor was very hot
- Determine the cause and correct. Replace the rotors and pads
- If the rotor thickness measured across any groove is less than the minimum discard thickness found on the rotor casting, discard and replace the rotor

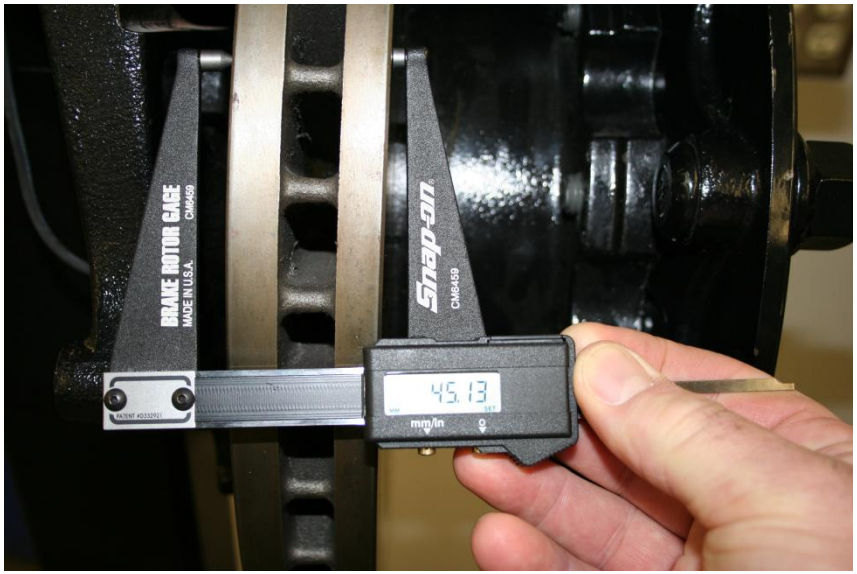


AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Rotor Inspection

Use a micrometer to measure thickness at 90 degree intervals.

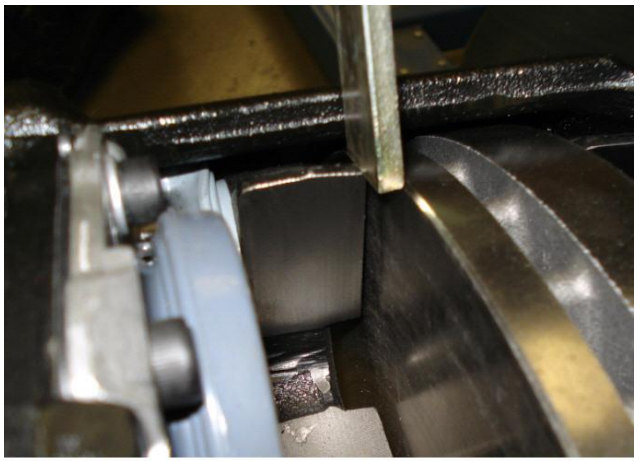
Typical new rotor thickness is 45mm. The discard measurement is found on the rotor casting and is usually 37mm.



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Rotor Inspection

- Some Meritor rotors have different swept area thickness
- For the Meritor EX225, you can utilize the pad retainer strap as a thickness gauge to assist in determining the minimum thickness of the brake rotor and uneven rotor wear
- Refer to the axle, brake, or vehicle manufacturers manuals to determine if this is applicable



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Rotor Inspection

- Attach a dial indicator as shown. The measurement should be taken at the center of the braking surface
- Rotate the rotor slowly by hand one full revolution and note the measurement
- If the run out exceeds .008” check the wheel bearing adjustment

Measuring lateral brake rotor run out. Refer to the brake, axle, or vehicle manufacturer’s manuals for specifications.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

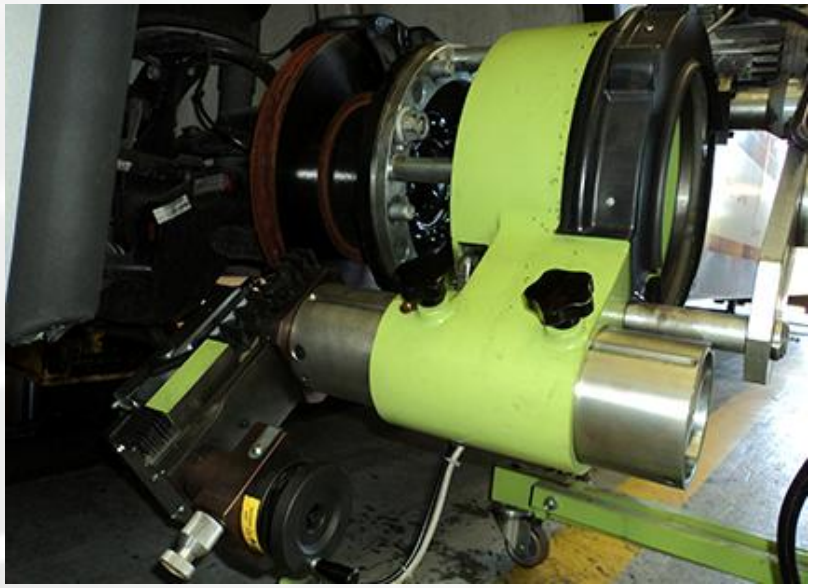
Brake Rotor Inspection

- *Rotor discard thickness is frequently cast into the rotor hat flange and is the minimum thickness the rotor can be worn to before the rotor is no longer considered safe for operation*
- *Consideration should be taken as brake rotors wear over the course of brake pad life*
- *Wear rates can be calculated by first installing and measuring new rotors and pads. Then measure both when the pads are worn to their minimum thickness*
- *It is not recommended to install brake pads if rotor wear rates would cause rotor thickness to wear below discard limits during the expected life of the brake pads*
- *Rotors can be resurfaced to acceptable conditions providing that all other specifications are met*

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Resurfacing of Brake Rotor

On Vehicle



Off Vehicle

Options exist for resurfacing the rotors both on and off the vehicle.

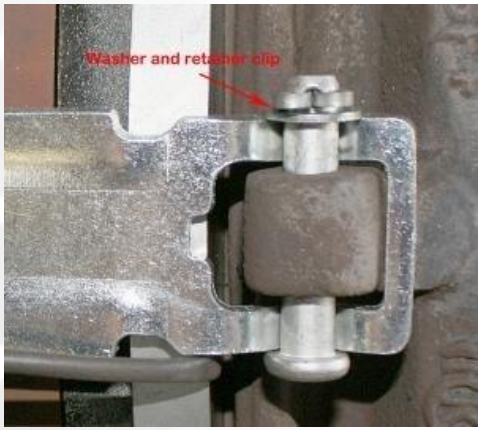
Brake Pad Installation and Adjustment

- Make sure the tappets are fully retracted and all surfaces are clean
- Brake pads must be changed as an axle set and NOT individually
- Install new pads with new retainers and hardware
- If equipped, fit and connect wear sensors

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

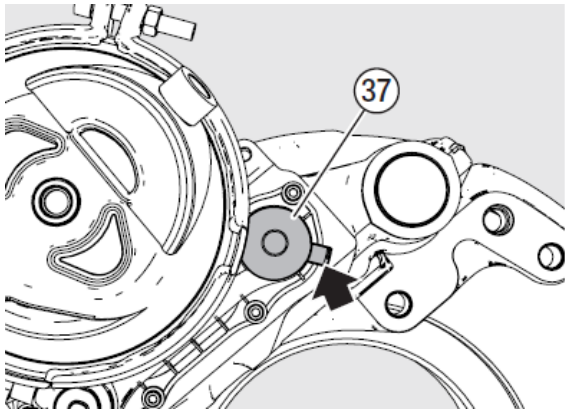
Brake Pad Installation and Adjustment

- Install new pad retainers and hardware
- Make sure sensor harnesses are secure per the manufacturer's recommendations to prevent chafing



Brake Pad Installation and Adjustment

- For Knorr/Bendix calipers, turn the shear adapter clockwise until the pads come in contact with the rotor
- Then back off the adjuster three clicks and check the running clearance. Clearance should be between .024” and .043” (.6mm and 1.1mm)
- Apply and release the brake making sure the hub turns easily by hand
- Install the adjuster stem cap noting the orientation of the tab



AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Brake Pad Installation and Adjustment

- To set the initial running clearance on Meritor calipers, use a 10mm socket and turn the adjuster clockwise until both pads contact the rotor
- Turn the adjuster back ½ turn to create a running clearance
- Apply the brakes five times to set the correct running clearance
- Check that the rotor is free to turn and confirm the brake pad to rotor clearance is within specification
- Nominal pad-to-rotor clearance should be .030” (.75mm)
- Install the adjuster stem cap

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Final Inspection and Test

- Complete a final visual inspection
- Install tires
- Burnish brakes
- Perform a brake performance test to verify satisfactory brake operation

Frequency of wheel off inspections will vary depending on the operating environment but should not be limited to pad change intervals.

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

Any Questions?

Please e-mail the questions to

Jeff Hiott ***Jhiott@apta.com***

Saahir Brewington ***SBrewington@apta.com***

The APTA Brake and Chassis Work Group and the APTA Bus Standards Committee would like to thank you for joining our Webinar.

Pictures and drawings and technical information courtesy of MAN, ZF, Meritor, Knorr-Bremse, Bendix, Omnitrans, Custom Training Aids, MBTA, and other members of the APTA Brake and Chassis Work Group