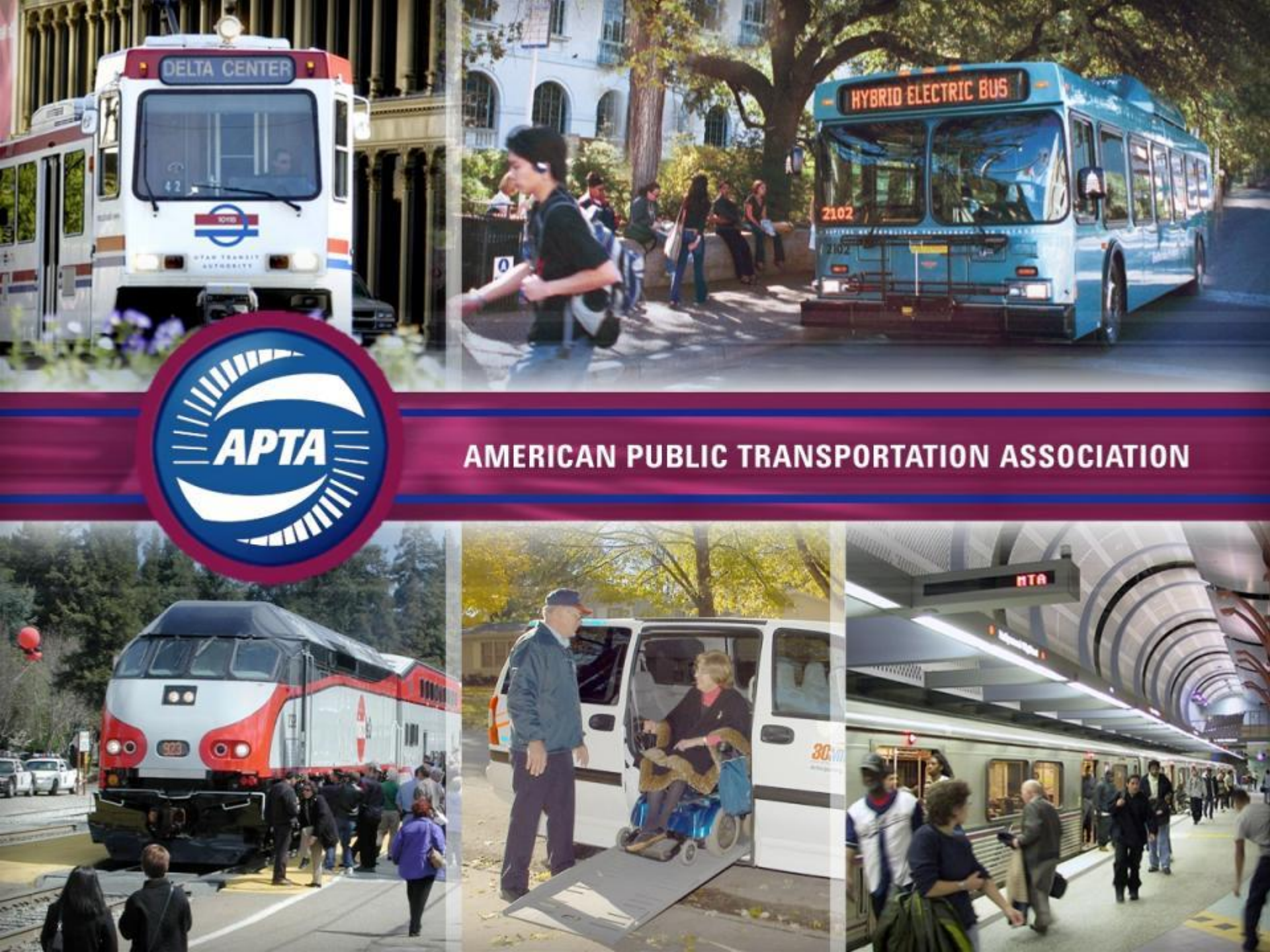
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AMERICAN PUBLIC TRANSPORTATION ASSOCIATION
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APTA Standards Quarterly Webinar Series

Presented by

APTA Brake and Chassis Working Group

Disc Brake Wheels On Inspection

January 26, 2017

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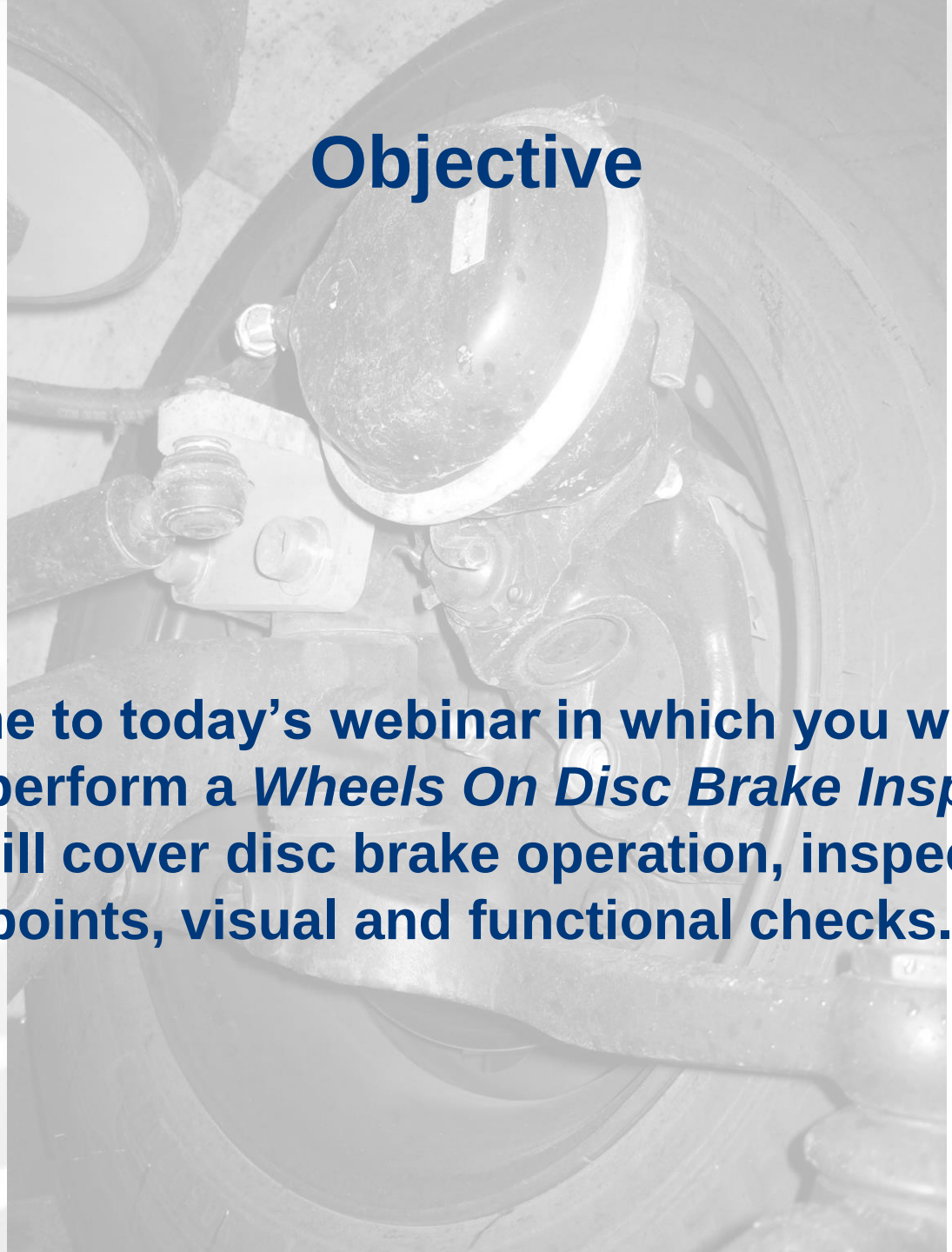
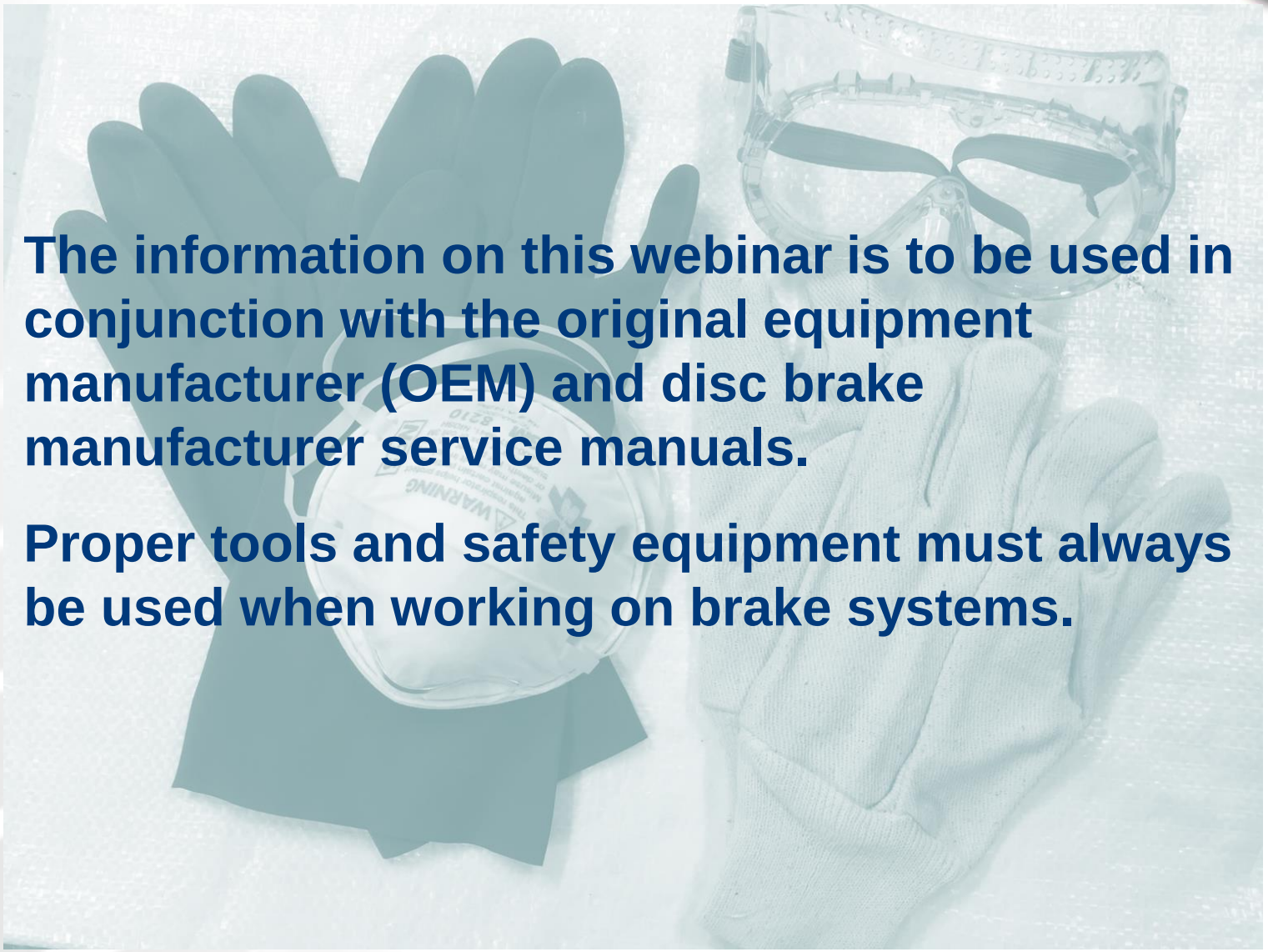
Objective



Welcome to today's webinar in which you will learn how to perform a *Wheels On Disc Brake Inspection*. We will cover disc brake operation, inspection points, visual and functional checks.

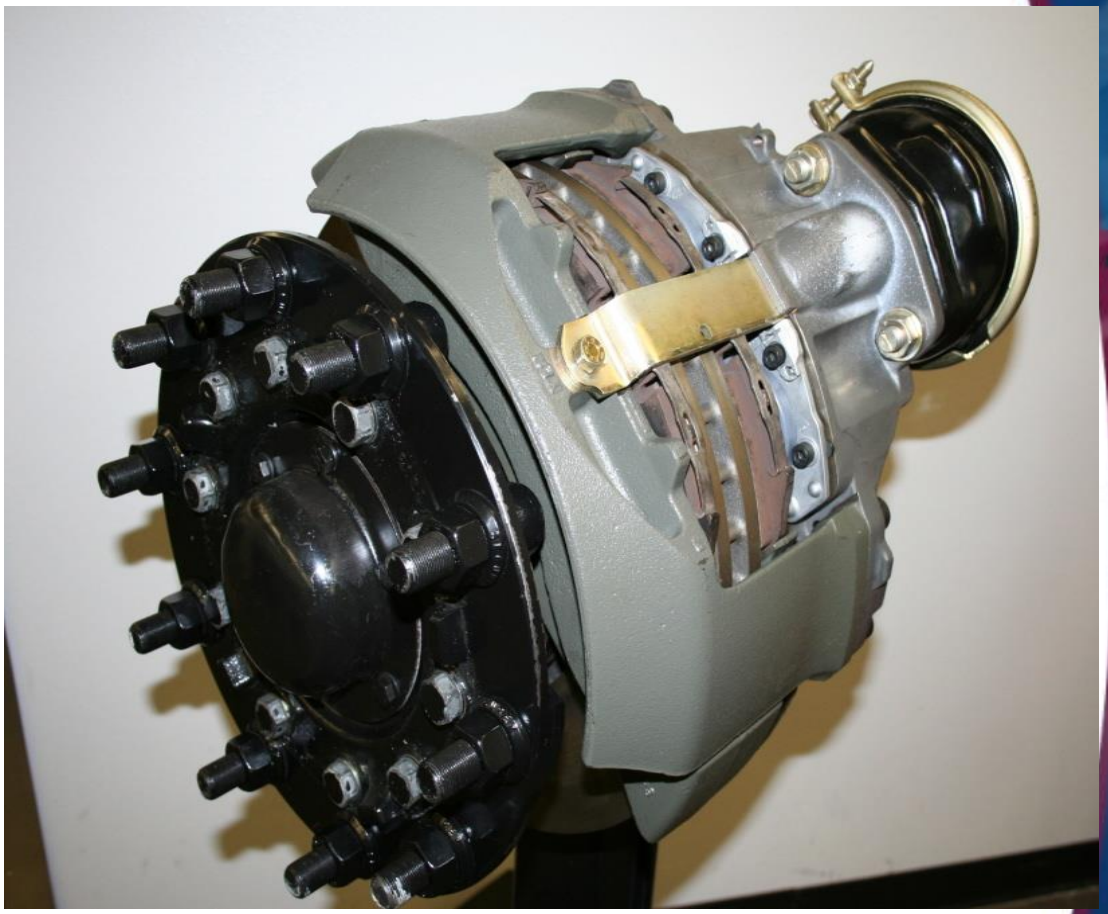
Information



- 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.

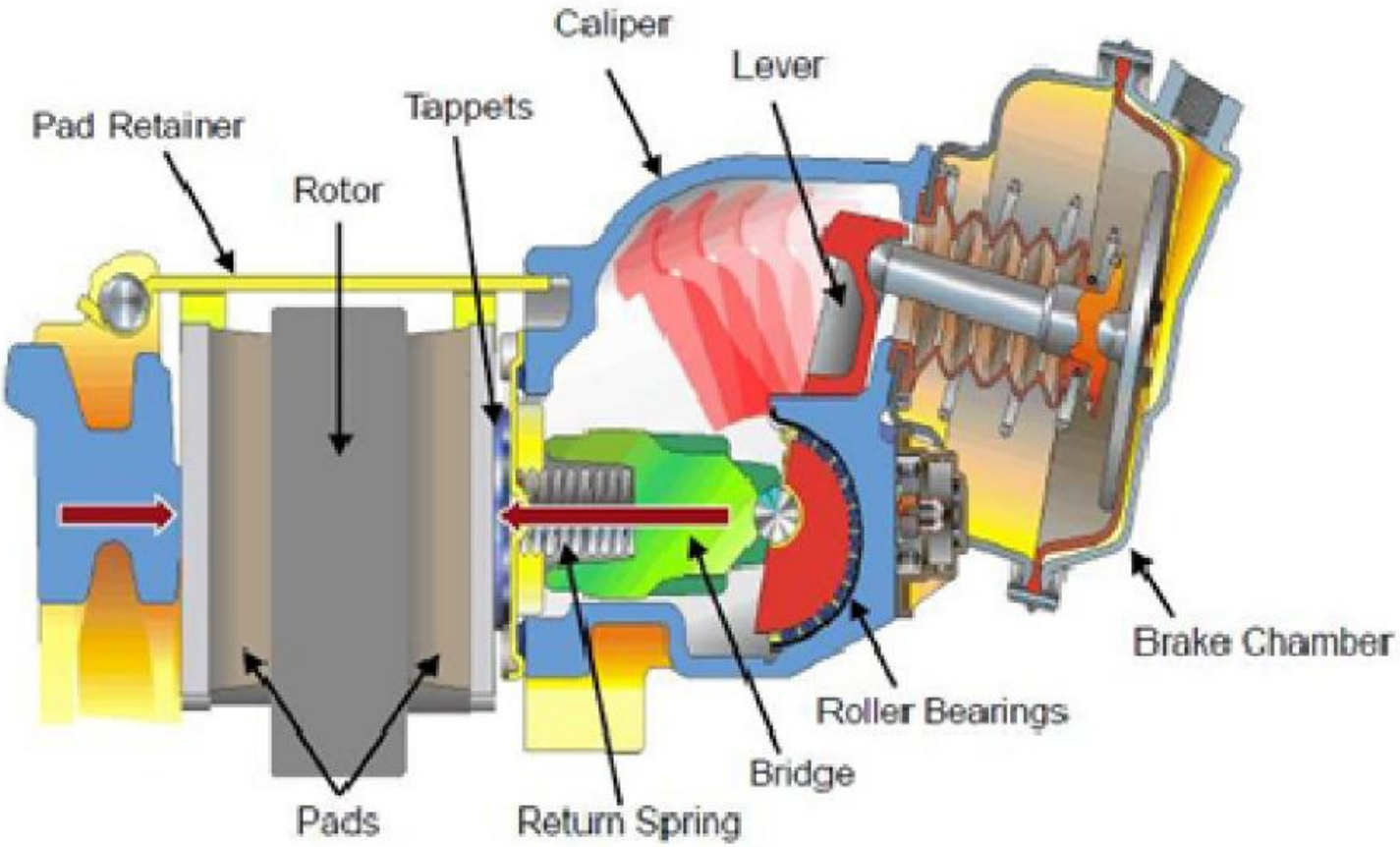
Overview

- *Nomenclature*
- *Caliper Identification*
- *Brake Pad Inspection*
- *Pad Wear Sensors*
- *Brake Wear Indicators*
- *Caliper Inspection*
- *Tappet Boots and Seals*
- *Movement and Adjuster tests*
- *Caliper Hardware Inspection*
- *Brake Rotor Inspection*
- *Brake Chamber Inspection*
- *Electronic Brake Monitoring*
- *ABS*
- *Validation*
- *Final Inspection and Test*



Nomenclature

Cross-Section of Knorr-Bremse Caliper Assembly



Nomenclature

Two mounting positions for brake chambers

Axial

Radial

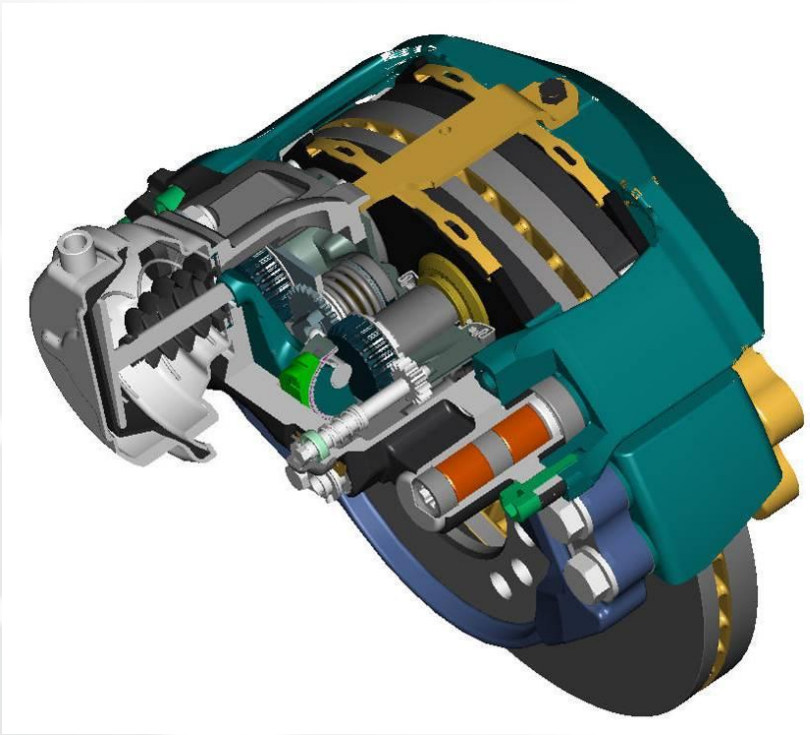
Caliper Identification

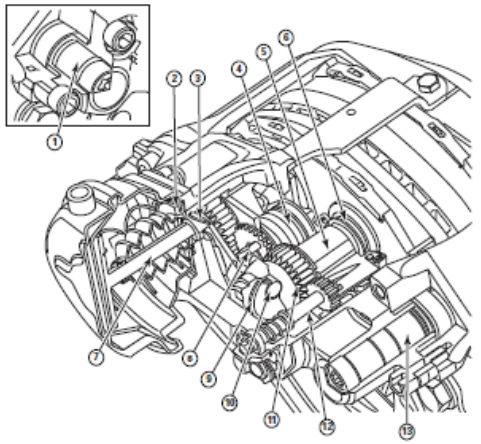
Knorr Bremse SN7 Caliper

Meritor EX225 Caliper

Caliper Identification

Meritor EX225 Caliper



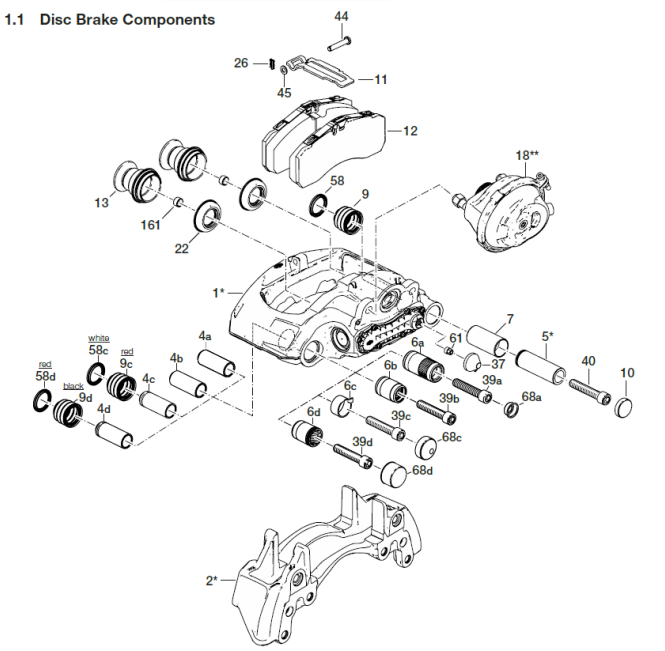


Item	Description
1	Short Slide Pin Oval Bushing
2	Housing Seal
3	Operating Shaft
4	Return Spring
5	Piston
6	Piston Head
7	Chamber Piston
8	Adjuster Shaft
9	Half Bearing
10	Roller
11	Tappet

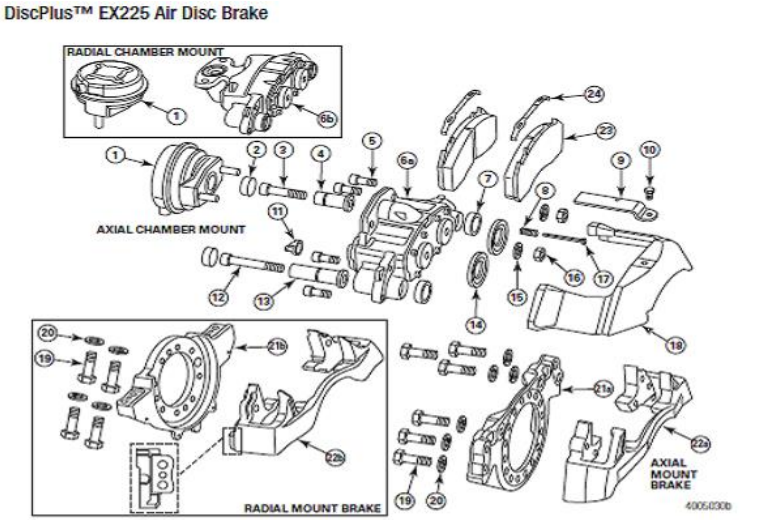
Item	Description
12	Adjuster Stem
13	Long Slide Pin Bushing

Nomenclature and Identification

Knorr SN7 exploded view



Meritor EX225 exploded view

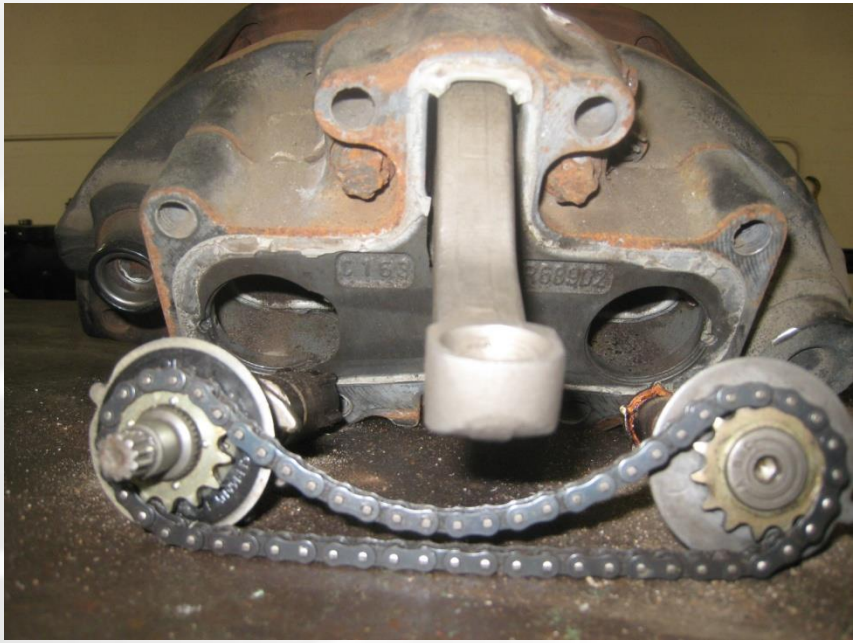


Item	Description
1	Air Chamber
2	Slide Pin Cap (2)
3	Short Slide Pin Bolt
4	Short Slide Pin
5	Bridge Bolt (4)
6a	Caliper Housing Assembly — Axial Chamber Mount
6b	Caliper Housing Assembly — Radial Chamber Mount
7	Slide Pin Boot (2)
8	Visual Wear Indicator Spring
9	Pad Retainer
10	Pad Retainer Bolt
11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

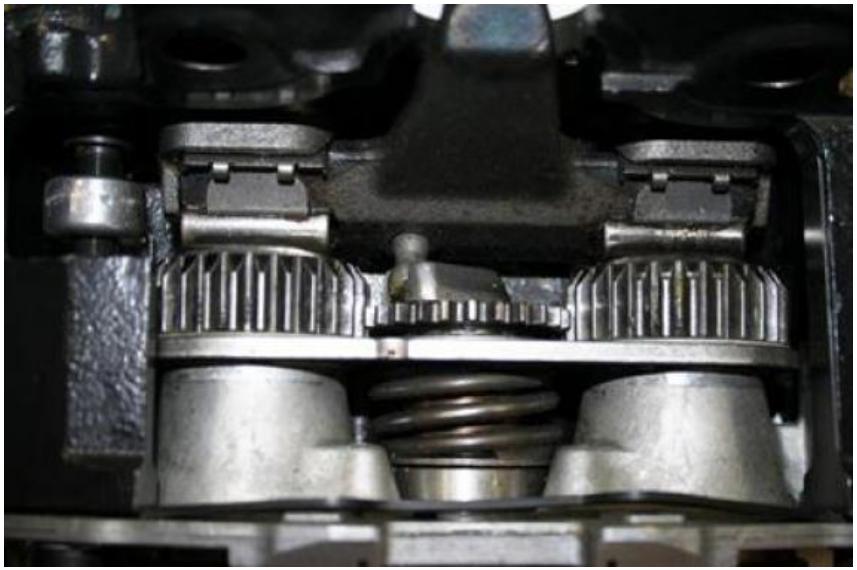
Item	Description
14	Piston Boot (2)
15	Air Chamber Washer (2)
16	Air Chamber Nut (2)
17	Visual Wear Indicator
18	Bridge
19	Carrier Bolt — EX225L (4), EX225H (5-6)
20	Washer — EX225L (4), EX225H (5-6)
21a	Torque Plate — Axial Mount
21b	Torque Plate — Radial Mount
22a	Carrier — Axial Mount
22b	Carrier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

Nomenclature

Knorr-Bremse Timing Chain



Meritor EX225 Adjuster



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

Inspection – Other types of brake assembly damage

Damage caused by a missing pad retainer strap

Damaged rim and brake chamber caused by a missing pad retainer strap

Brake Pad Inspection

- Inspect caliper for:
  - Missing brake pads
  - Loose friction material on pad backing plate
  - Brake pad thickness
  - Overheated brake pads
- Note: Brake pad thickness of 1/16 inch (1.6mm) or worn to wear sensor requires immediate reline.
- Caliper mounted wear indicator or electronic wear indicator is acceptable for measuring pad thickness.

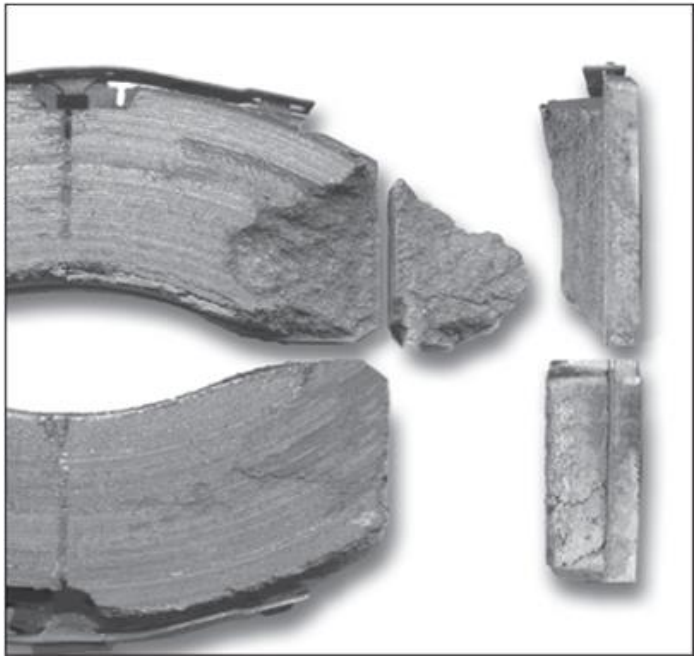
Brake Pad Inspection

Brake pads can usually be inspected using a mirror and flashlight

Brake Pad Inspection will require a mirror. Check for uneven pad wear, wear beyond tolerance, taper and broken pads.

Brake pad uneven wear (taper)

Brake pads showing unacceptable wear—note edges



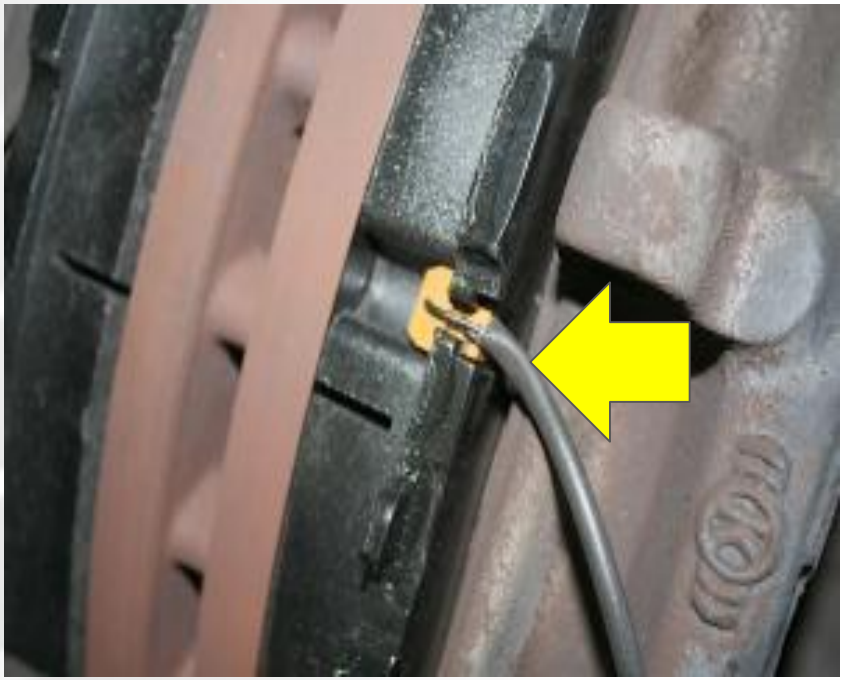
The cause of improper pad wear must be identified and corrected.

Brake Pad Wear Indicators

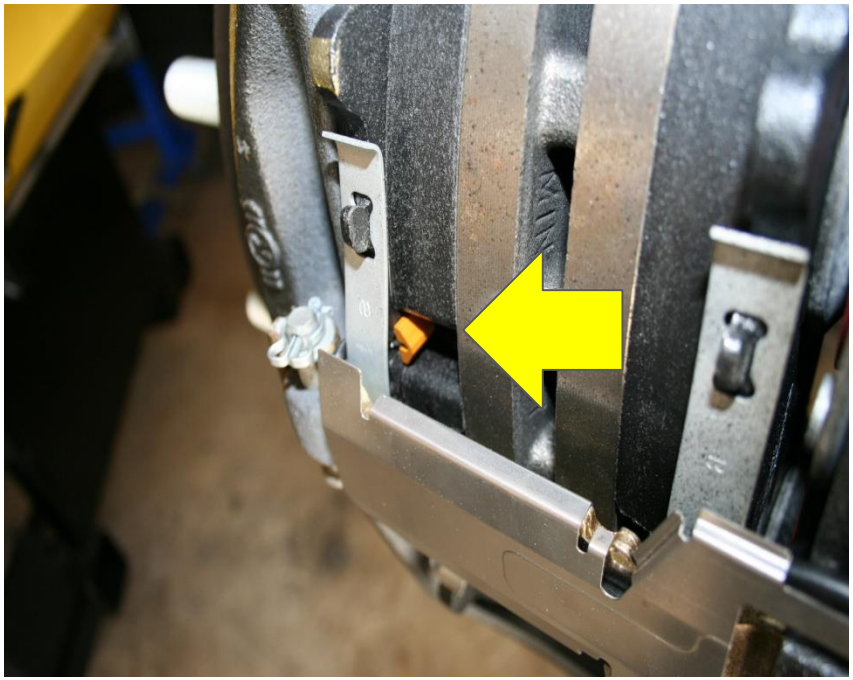
- Electronic brake pad wear indicators:
  - Warn operator prior to maximum wear limit and end of pad life
  - Account for rotor wear
- Mechanical brake pad wear indicators:
  - Measure pad thickness based on a pre-determined rotor thickness of 45 mm
  - Do not account for rotor wear

Electronic Pad Wear Sensors

In-pad wear sensor and wiring harness



In-pad wear sensor



Brake Pad Wear Sensors

- Electronic brake pad wear indicators
  - Have a sensing wire embedded in the friction material at the minimum service thickness
  - When friction material wears to minimum thickness, sensor wire contacts rotor creating a electrical path to ground and illuminates a service warning requiring further inspection
  - As the friction material wears further the sensor wire breaks creating an open circuit illuminating an end of life warning
  - Brake reline should be performed

Wear Sensor

Brake pad worn beyond tolerance—note sensor wear

Brake Pad Wear Indicators

- Mechanical brake pad wear indicators
  - Measure brake pad thickness based on caliper position and new rotor thickness of 45mm
  - As friction material and rotor wear, indicator moves providing a general reference of remaining friction material
  - Don’t compensate for rotor wear
  - Are less accurate when new pads are installed on used rotors
  - Require visual inspection of pads and rotor more frequently

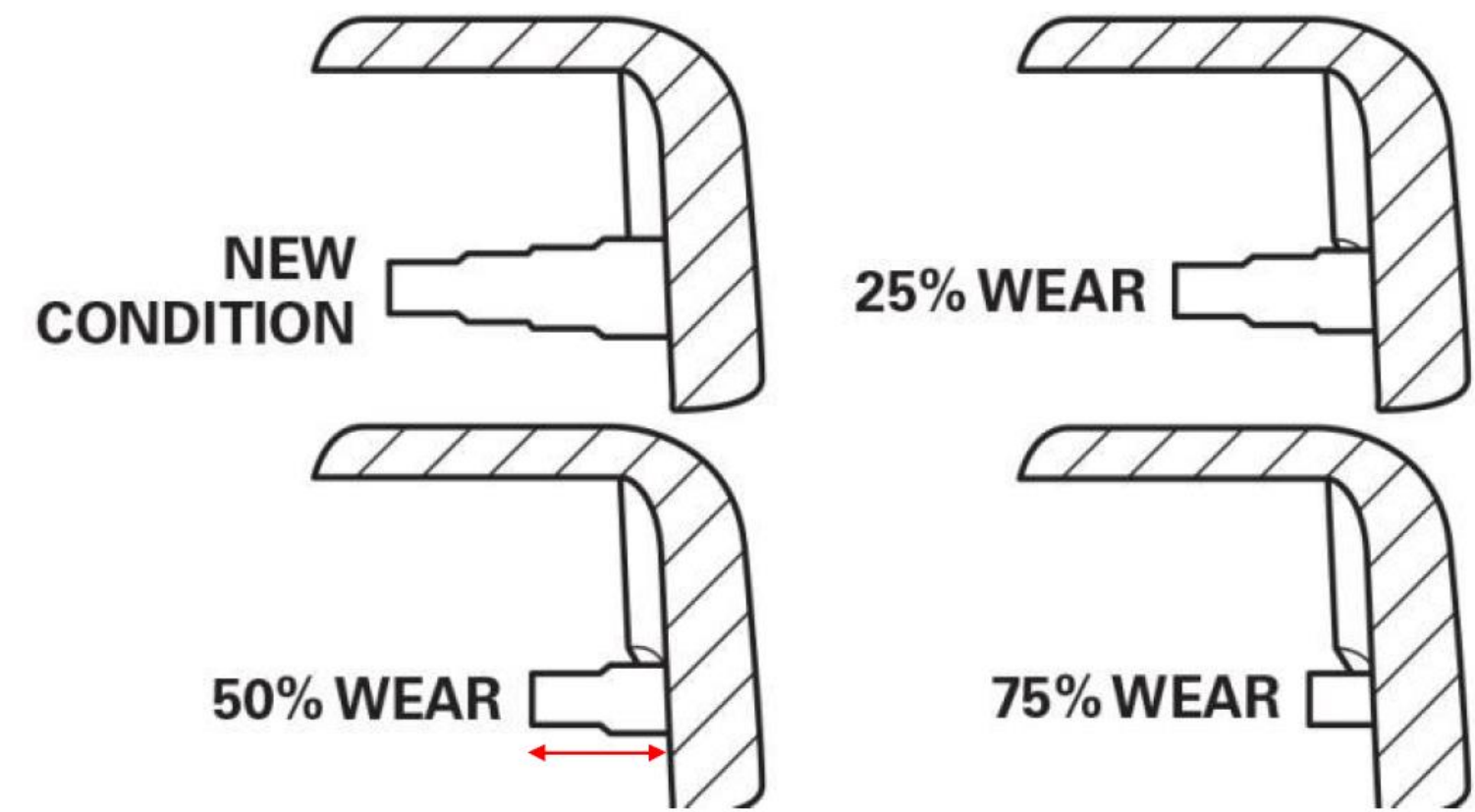
Meritor EX225 Wear Pin Inspection

The pad/rotor wear can be visually determined without removing the wheel by viewing the protrusion of the wear indicator pin. If pin protrusion is less than 0.16 inch (4mm) the pads require further inspection or replacement.

Pad wear indicator pin

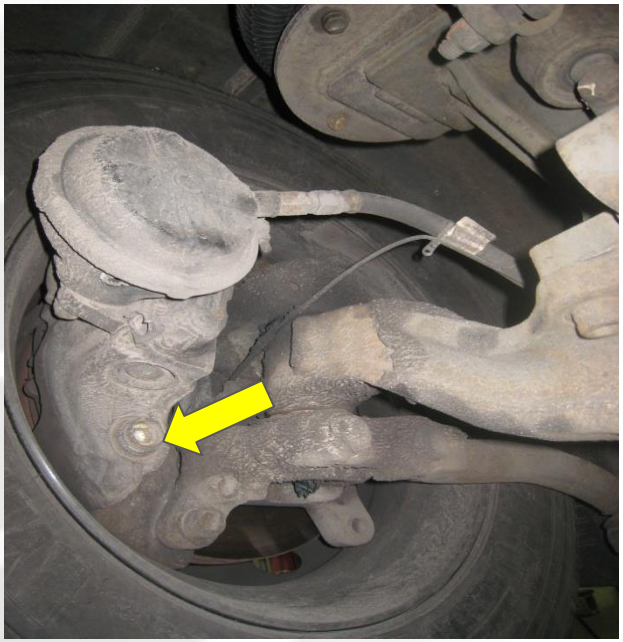
Pad wear indicator measurement using a tire tread depth gauge

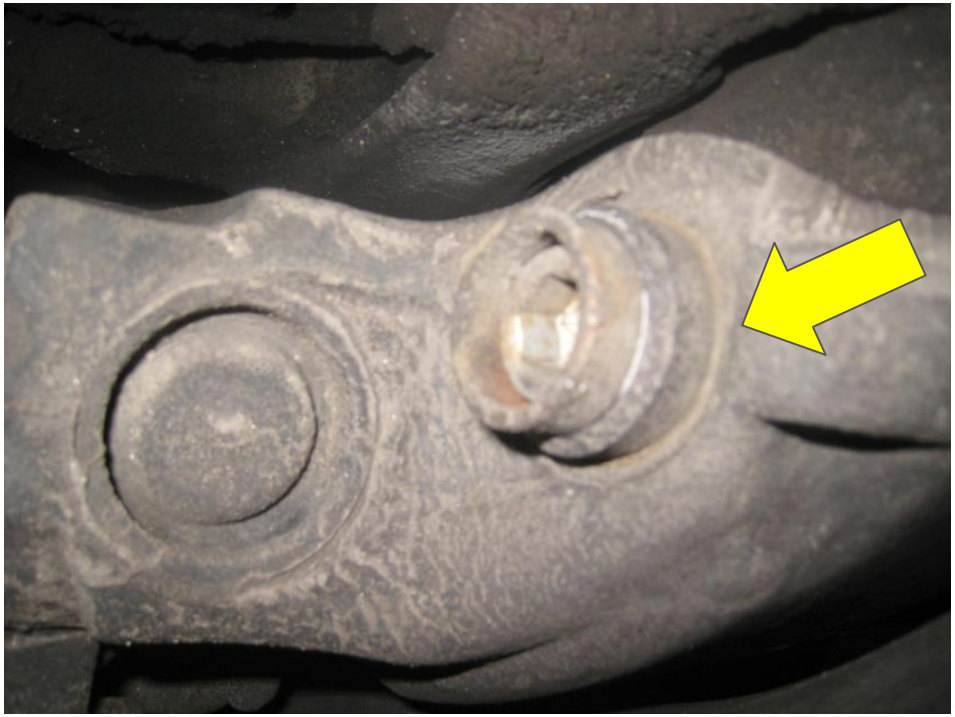
New Style Meritor Wear Indicator Pin



Knorr SN-7 Guide Pin Inspection

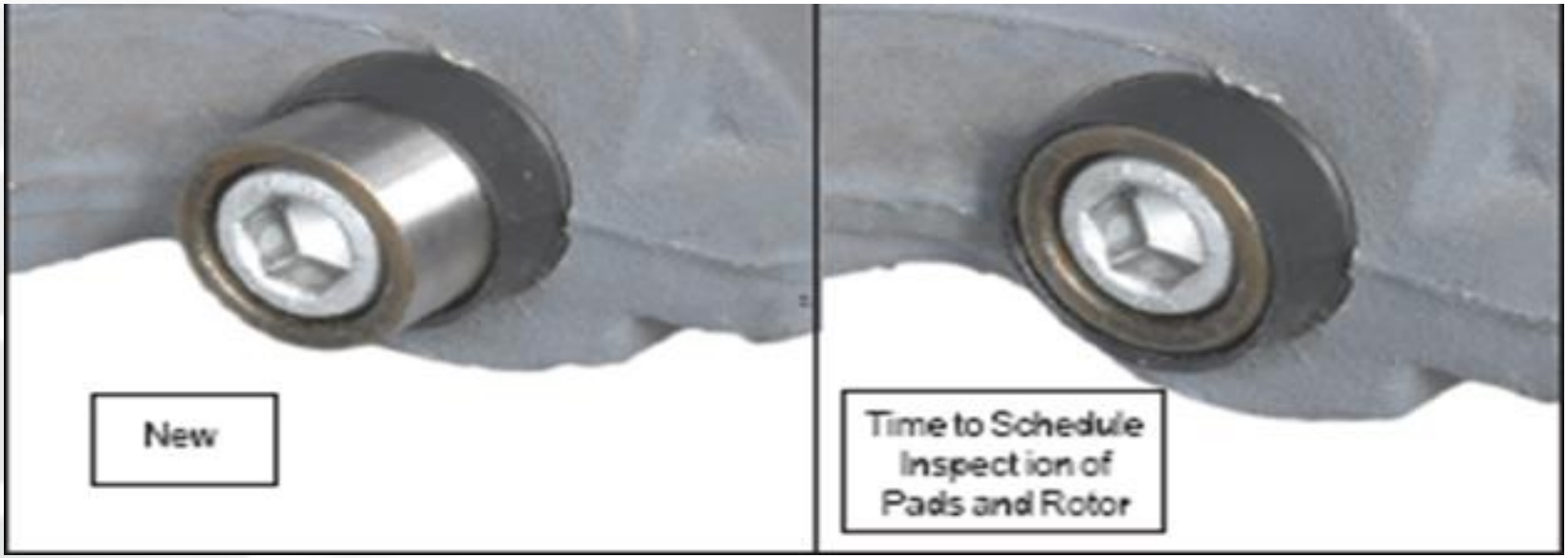
- Dirt, road salts, and debris can obstruct view of guide pin
- Care should be exercised to insure solid rubber bushing is not mistaken for stainless steel guide pin
- On early calipers, pin protrusion can be measured to track pad and rotor wear for determining fleet pad mileage/life expectations





Knorr SN-7 Guide Pine Inspection

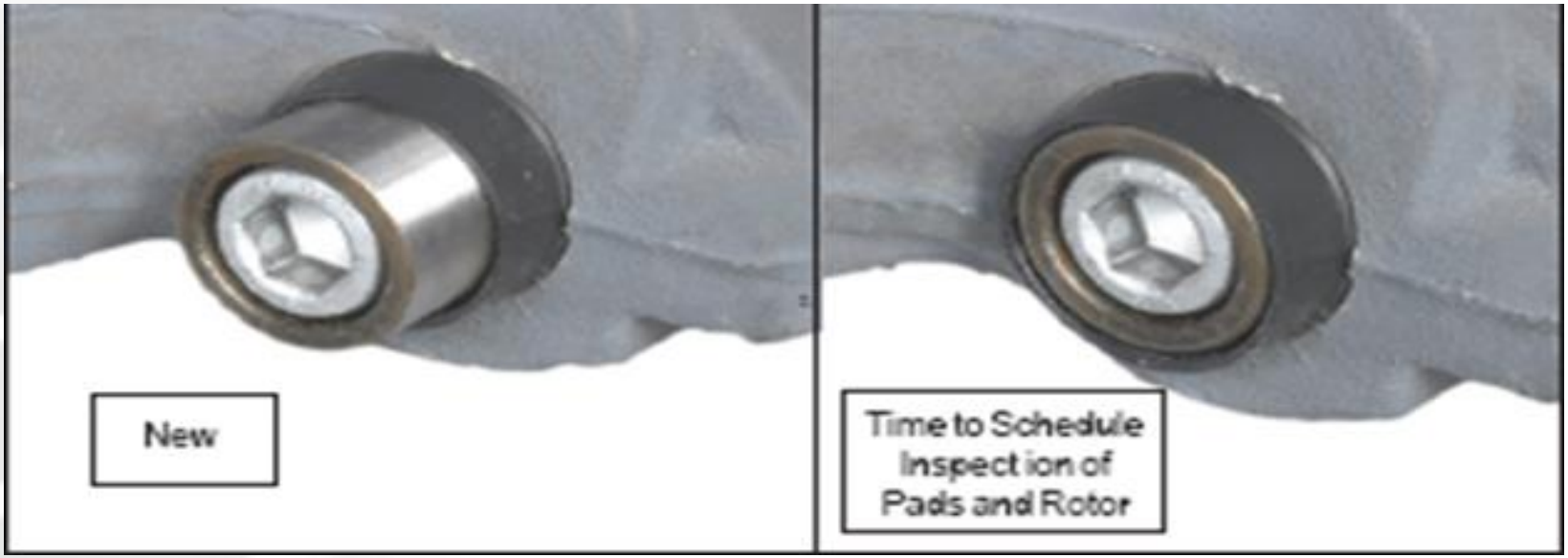
Early Knorr SN-7 Disc brakes are equipped with solid rubber bushing style wear indicators, which provide an indication of when to schedule a full wheel off brake inspection. The thicknesses of BOTH the pads/rotors will affect the wear indicator position.



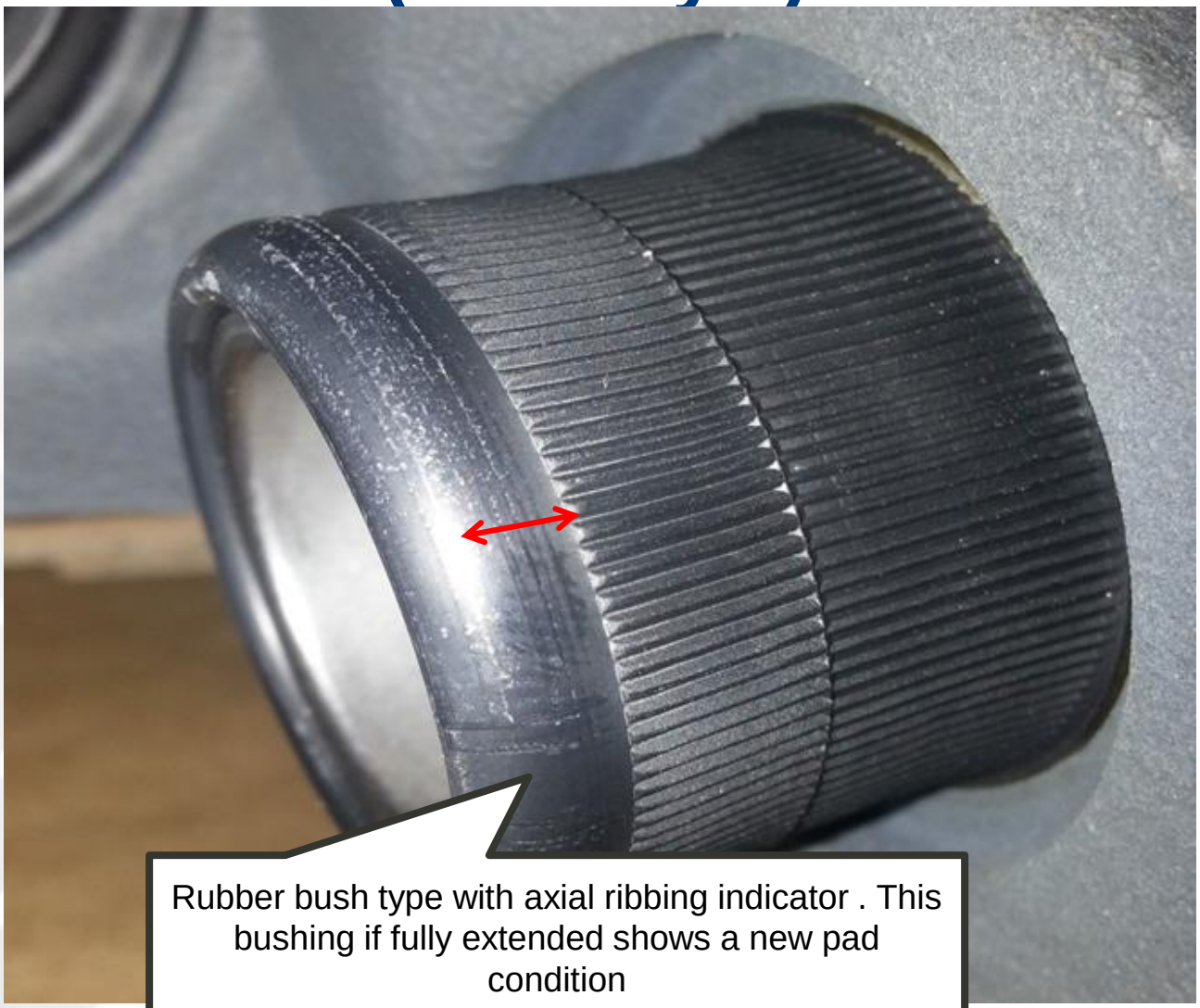
Knorr SN-7 Guide Pin Inspection

On both front and rear axle, road and curb sides, inspect the position of the guide pin compared to the solid rubber bushing.

If pad wear indicator protrudes less than 1mm (. 040"), then the wheels must be removed to measure pads and rotors on that axle (both sides).

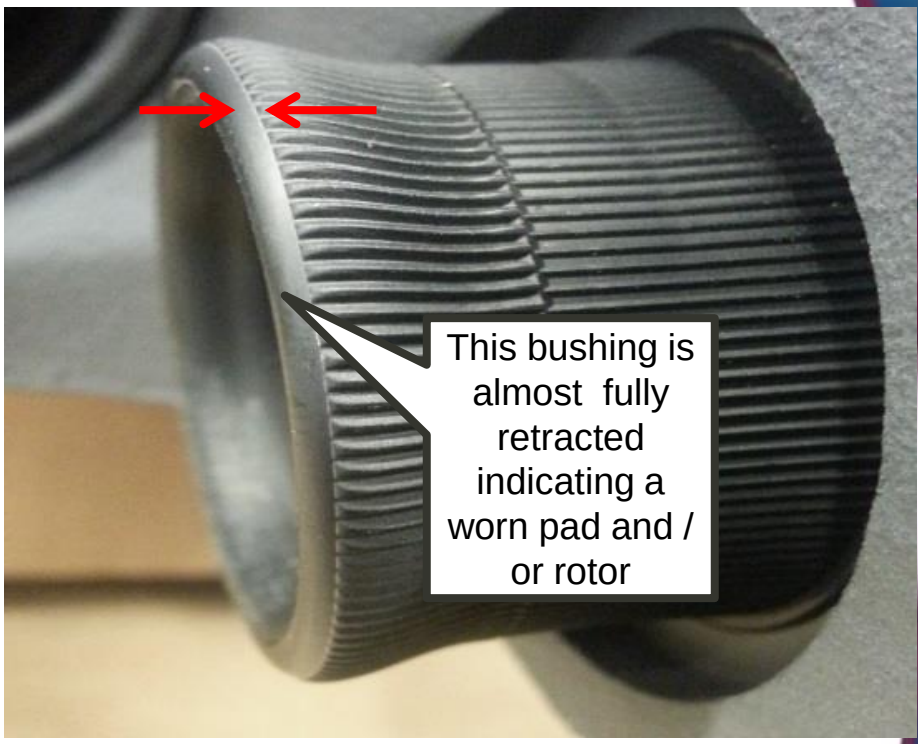


Knorr SN-7 Guide Pin Inspection (New Style)

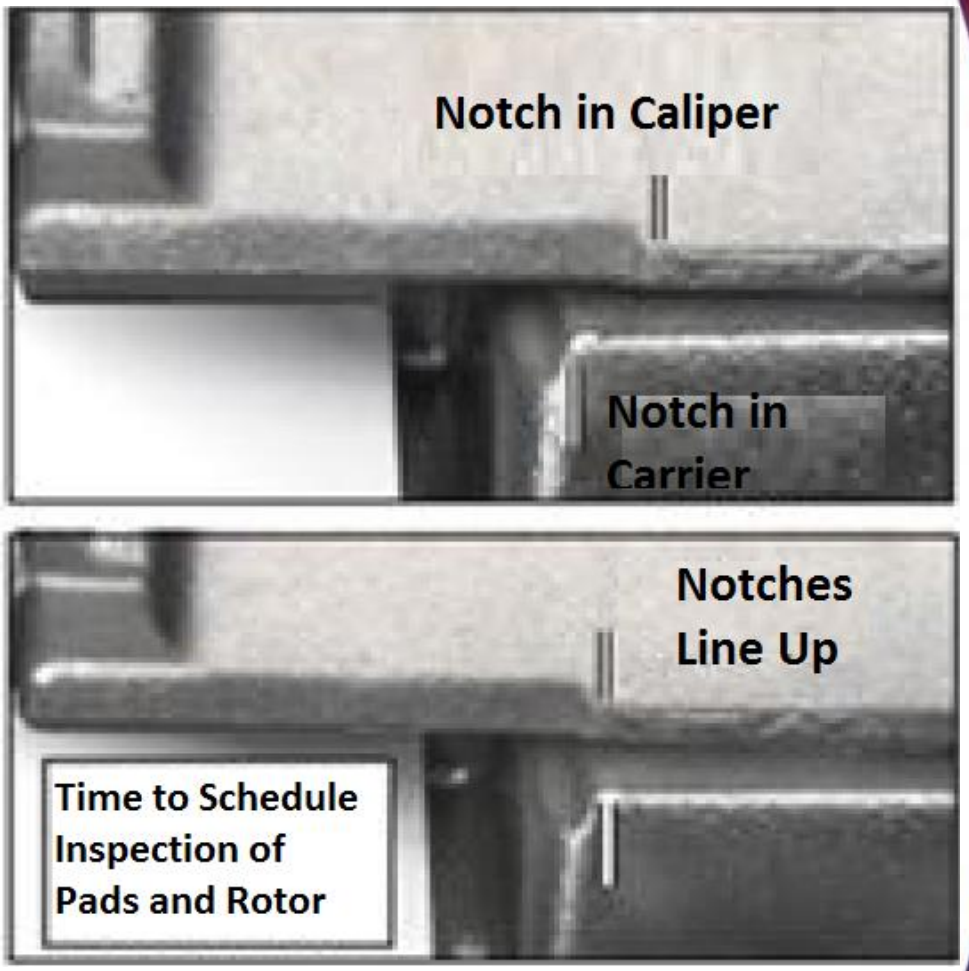


Rubber bush type with axial ribbing indicator . This bushing if fully extended shows a new pad condition

Knorr SN-7 Guide Pin Inspection (New Style)

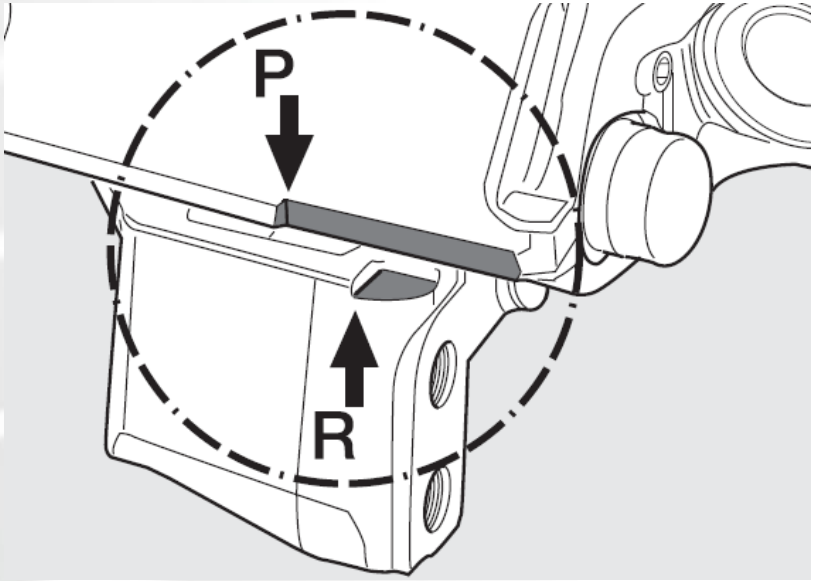


Brake Pad/Disc Wear Check Using Caliper to Caliper Position Notch

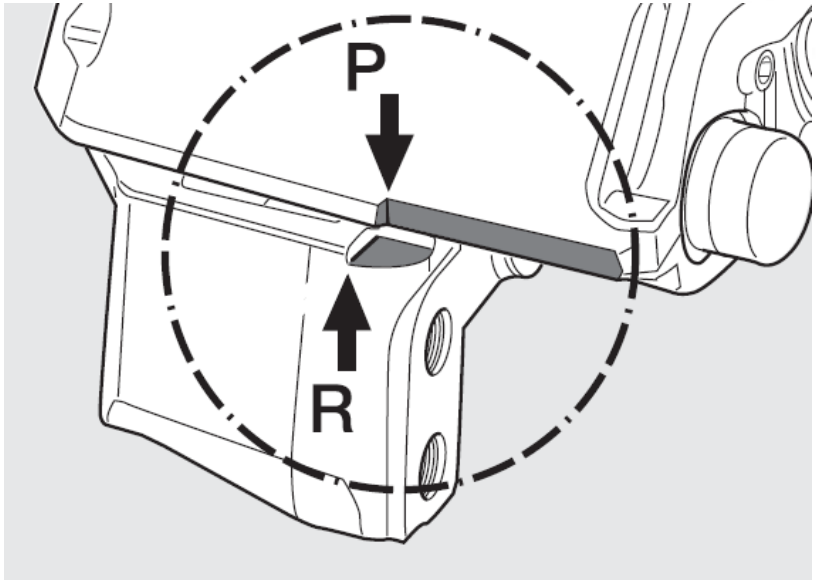


Knorr SN-7 Caliper to Carrier Notch

The pad/rotor wear can be visually determined without removing the wheel by viewing the position of the caliper position “P” compared to the carrier marking “R”



Caliper position with new pads and rotor



Caliper position when pads or rotor require further inspection

Caliper Inspection

- Inspect caliper mounting bolts for rust, movement, or signs of looseness.
- Inspect caliper for heavy rust and damage which may indicate a non-working or overheated brake
- Check slide pin and bushing wear by pushing up and down checking for excessive movement.
- Caliper should move freely along slide pins with minimum sideways or vertical movement.
- Excessive movement is a sign of worn or loose bushings and slide pins.

Caliper Inspection

Check for loose or missing mounting hardware

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

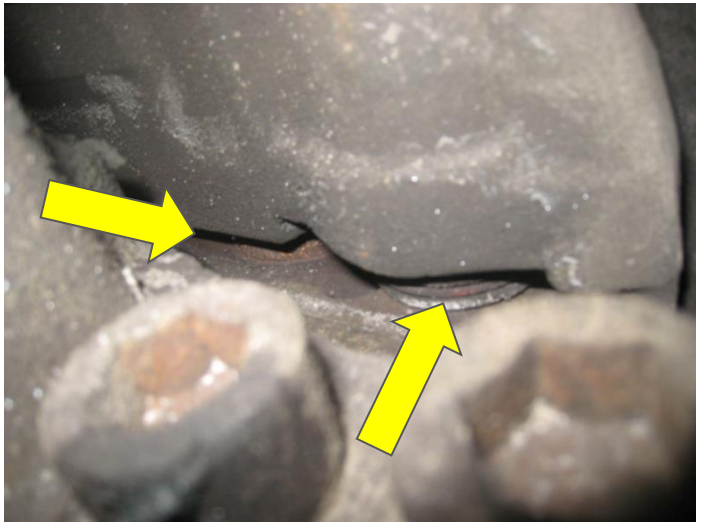
Below are examples of brake assemblies exhibiting normal operating conditions

Tappet Boots and Seals

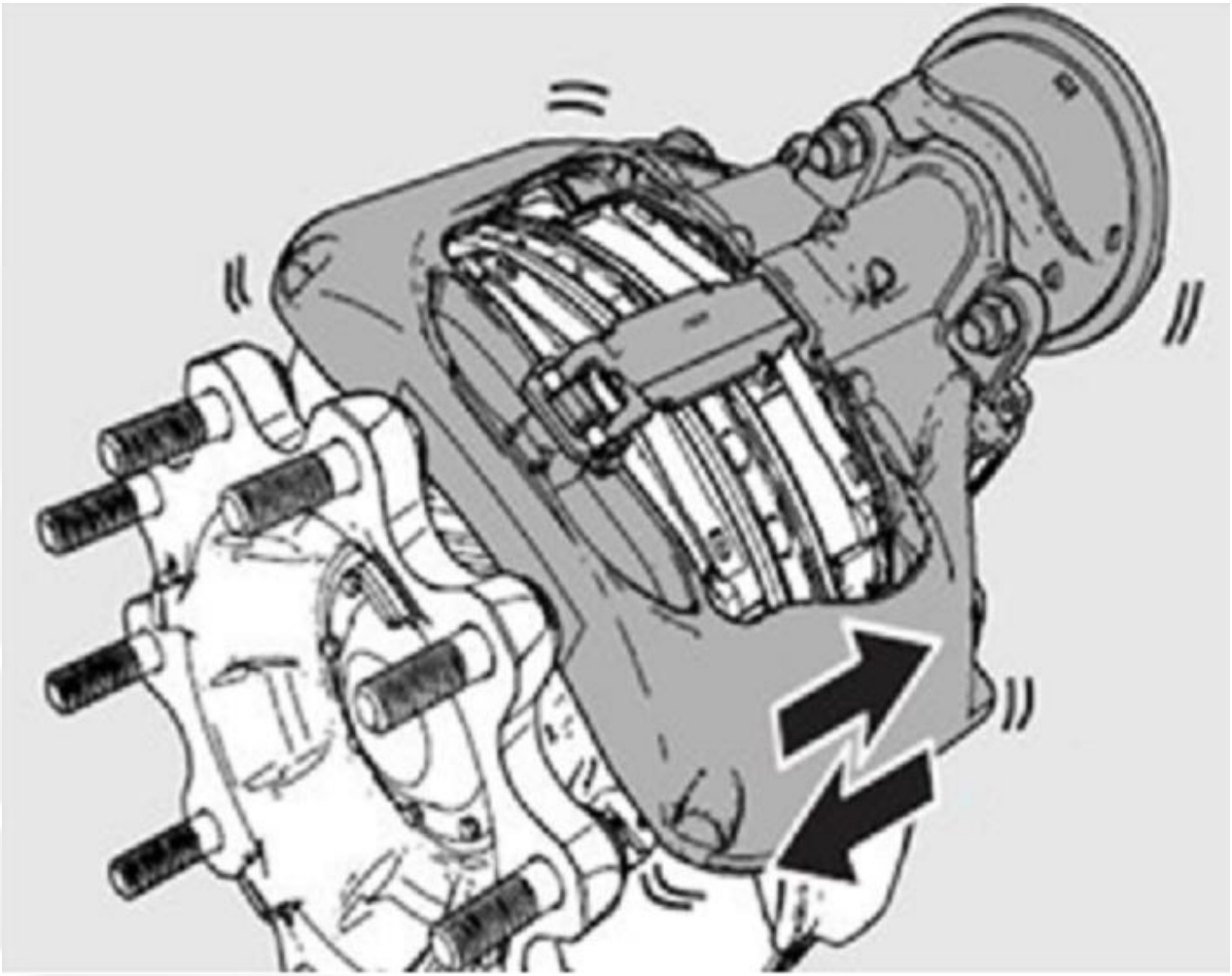
- Tappet boots and seals can be inspected using a mirror and flashlight

Tappet Boots and Seals

- Visually inspect tappet boots and slide pin seals for damage.
- Damaged boots and seals require further inspection and replacement
- 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.



Caliper Movement Test



The caliper movement test is done to make sure that the caliper slides on its pins and there is sufficient clearance between the rotor and brake pads

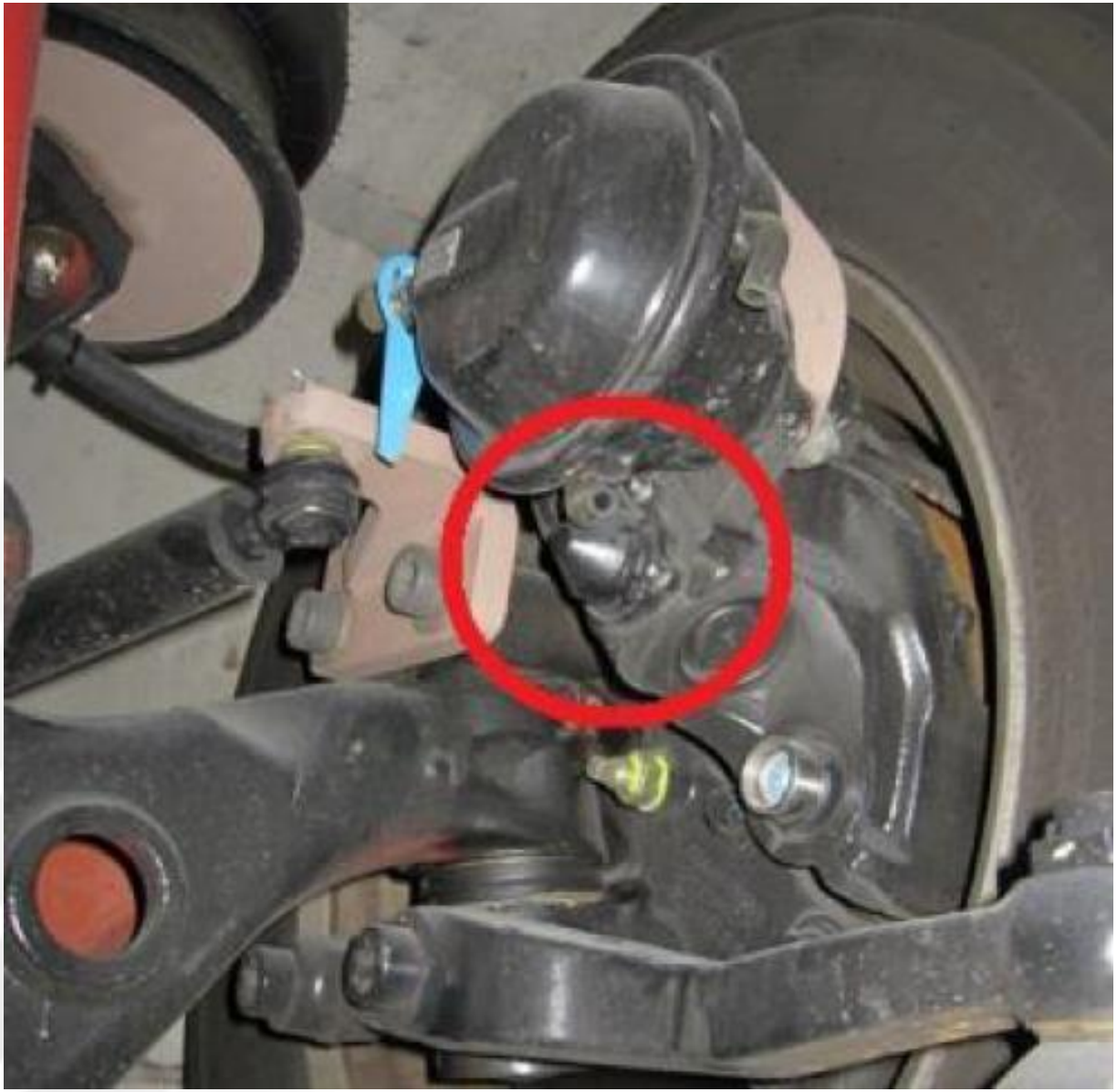
Caliper Inspection

- Caliper Adjustment
  - Attach dial indicator to torque plate or bus frame.
  - Dial indicator reading should be taken at slide pin bearing cap.
  - Check brake adjustment by sliding caliper back and forth by hand along the slide pins.
  - If caliper slides more than 0.08 inch (2mm) the brake is out of adjustment and requires further inspection or replacement.

Checking Caliper Adjustment

Also referred to as “free-running clearance”

Adjuster Location



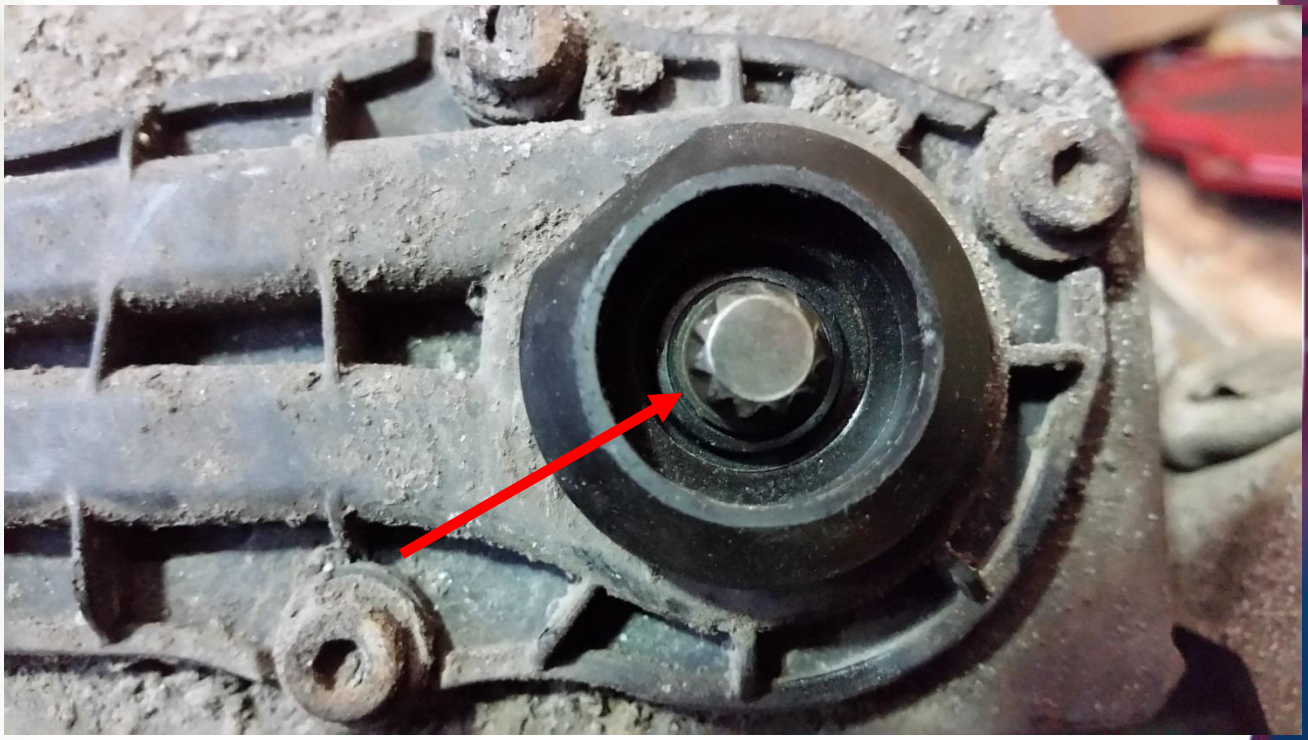
Adjusting Screw Seal and Cap

- Inspect adjusting screw cap for missing, damage and tight seal
- Visually inspect adjusting screw internal seal for damage

Adjuster Protective Cap

Knorr Bremse Shear Adapter

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



The shear adapter (above) fits over the splines on the Knorr Bremse adjuster (right)

Knorr Caliper Adjuster Test

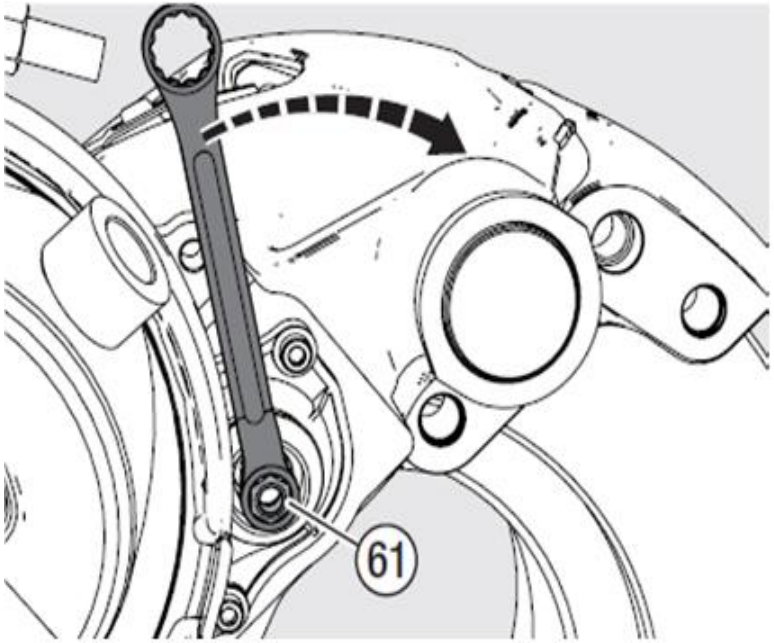
- Turn adjuster three clicks counter clockwise to back off using a box wrench or socket
- If the shear adapter fails, replace and attempt a second time
- If the shear adapter fails again, the adjuster is seized and the caliper needs to be replaced

Meritor Caliper Adjuster Test

- Turn adjuster counter clockwise to back off using a 10mm box wrench or socket
- Do not exceed 30 FT/LBS torque in either direction
- If higher torque is required. Caliper is seized and must be replaced

Caliper Adjuster Test

- Leave wrench on shear 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

Brake Pad Retaining Strap

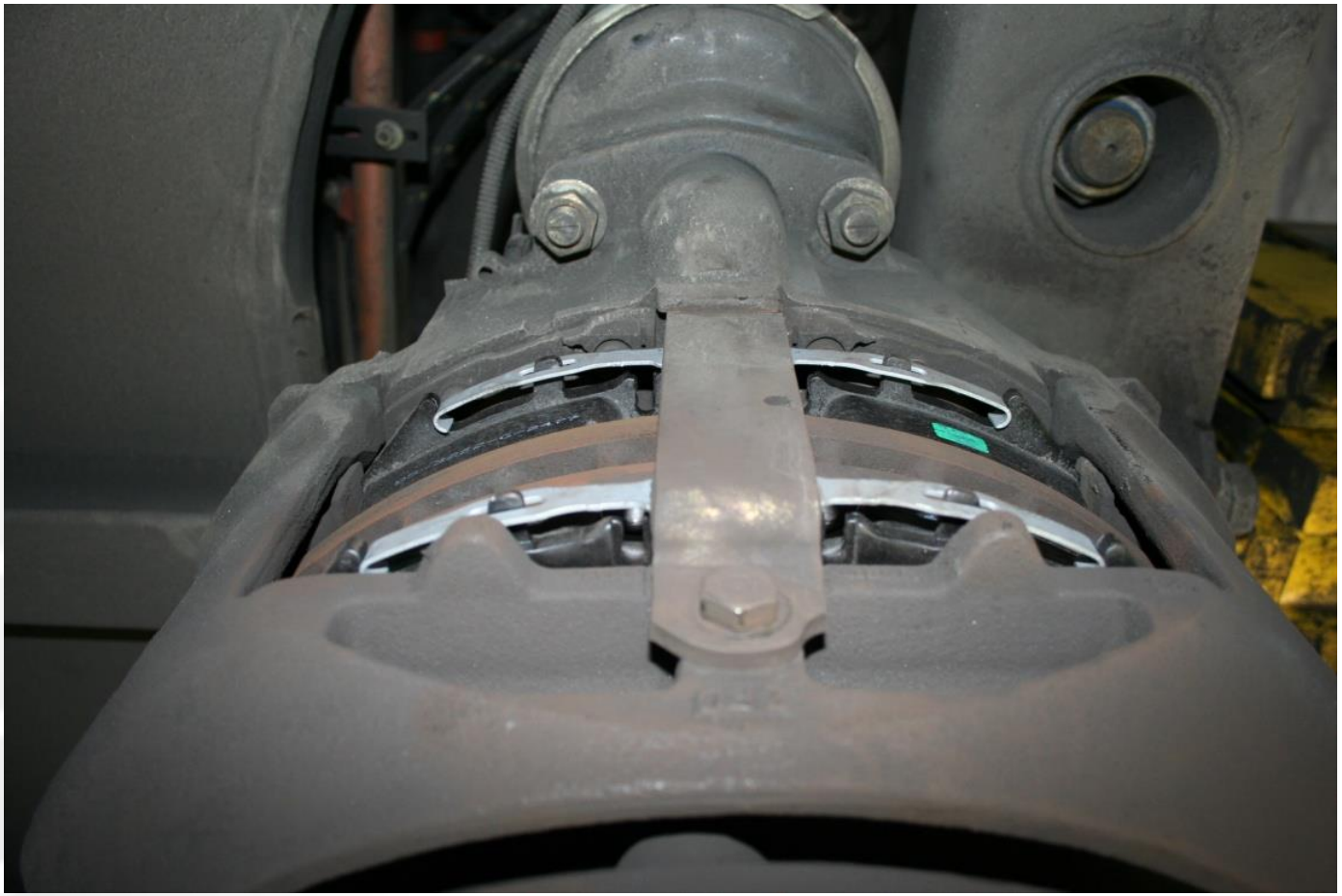
Missing brake pad retaining strap

Damaged rim and brake chamber

Missing brake pad retaining strap can allow brake pads to climb out of caliper and wear on the rim resulting in rim and brake failure.

Brake Pad Retaining Strap

Inspect caliper brake pad retaining strap and fastener.



Meritor brake pad retaining strap correctly installed with pad anti-rattle springs in place.

Brake Pad Retaining Strap

Inspect caliper brake pad retaining strap and fastener.

Knorr Bremse brake pad retaining strap correctly installed with pad anti-rattle springs in place.

Brake Rotor Inspection

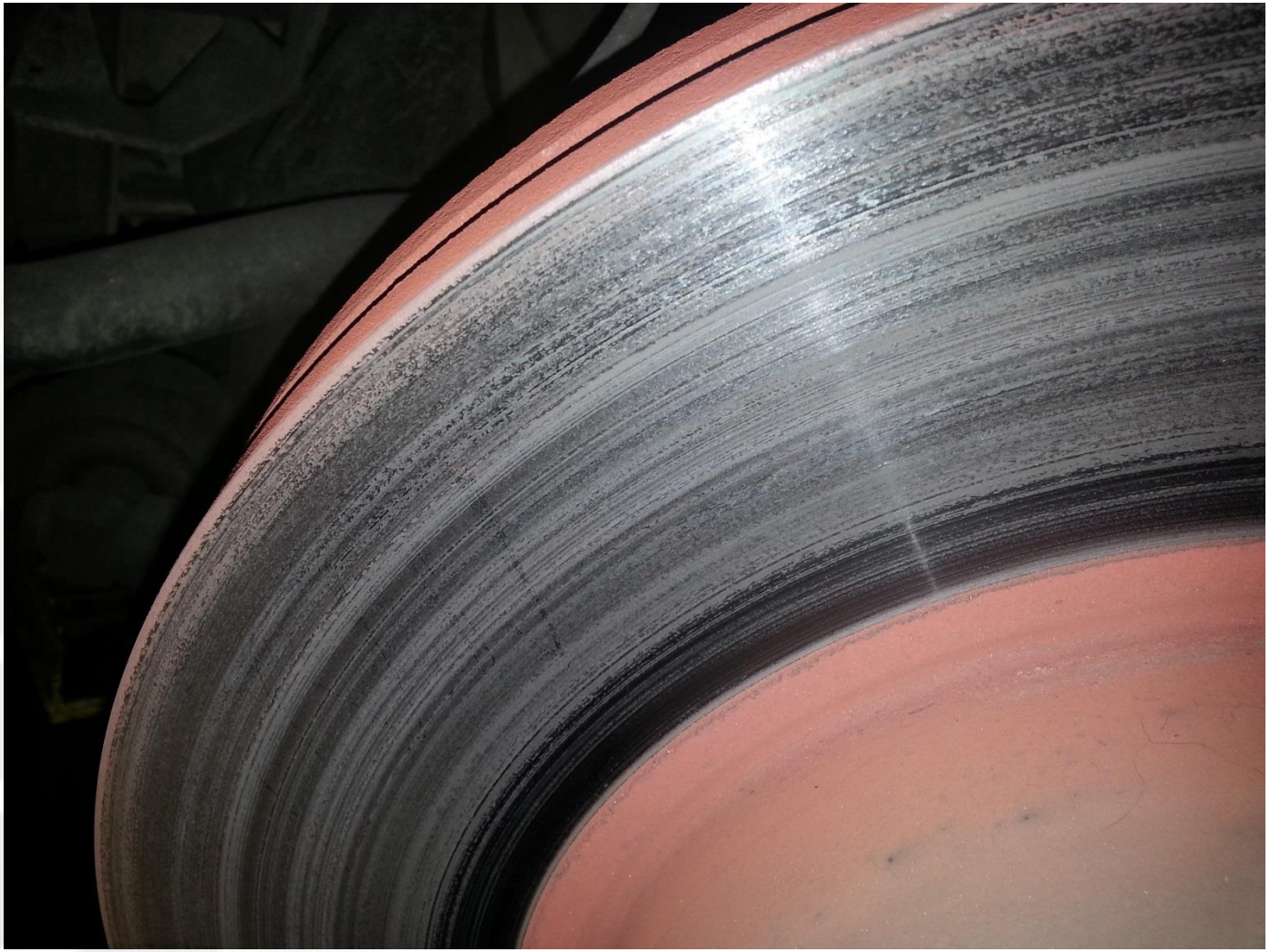
- Visually inspect rotor for:
- Wear
- Overheating
- Heat checks
- Cracks
- Grooves
- Discoloring
- Damage
- Contamination

Brake Rotor Inspection

Visually inspect swept area of rotor for defects and damage.
Only the inner side of the rotor can be easily inspected so extra care should be exercised to check as much of the rotor as possible.

Brake Rotor Inspection

Blue bands or marks indicate the rotor was very hot

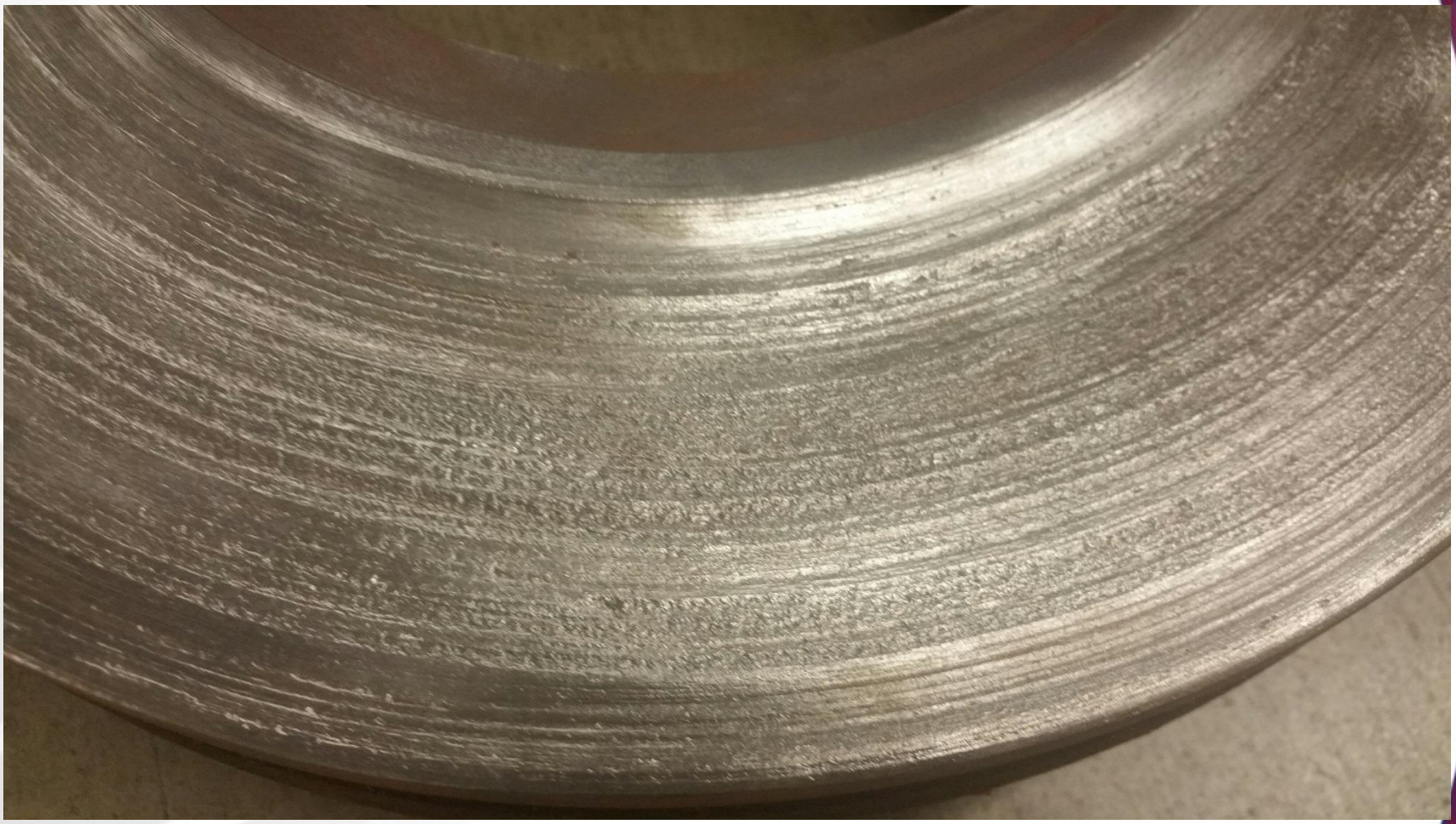


Brake Rotor Inspection

Rusting on rotor surface indicating possible inoperative brakes

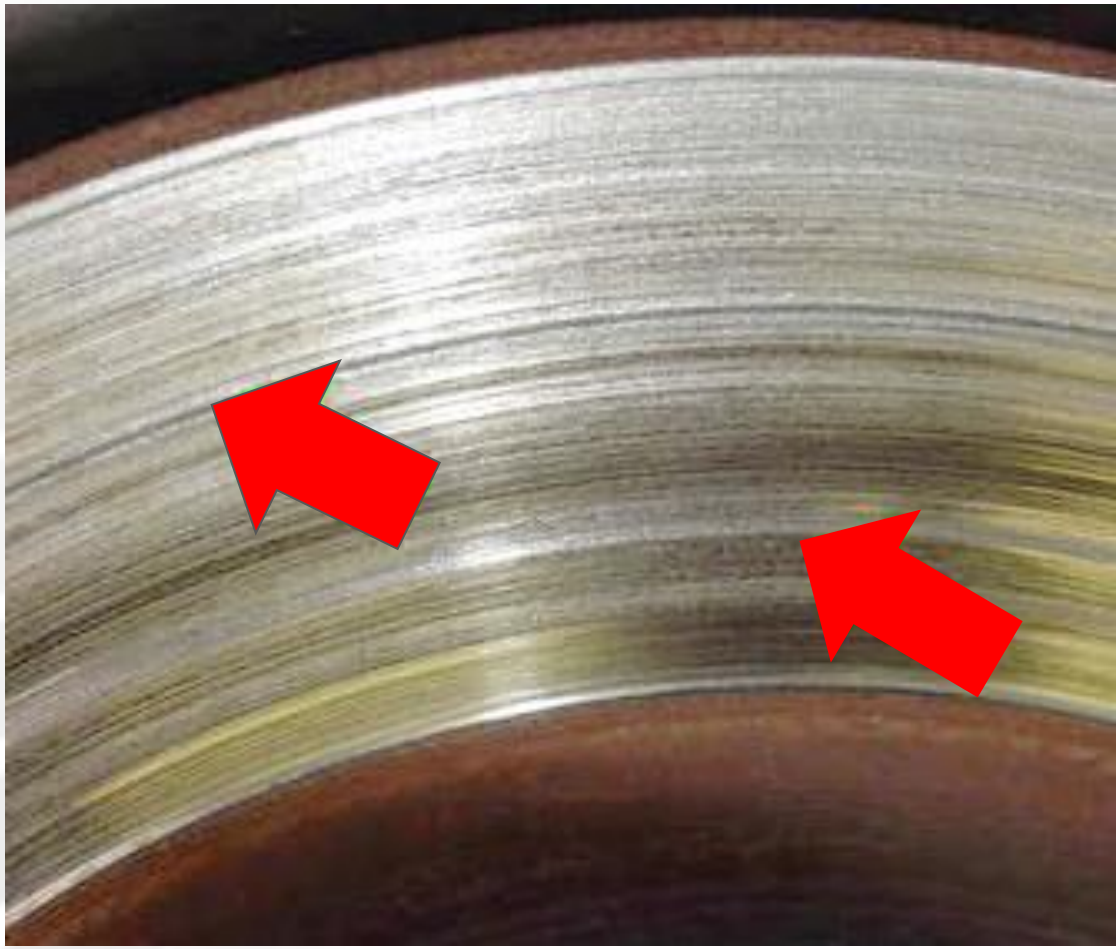
Brake Rotor Inspection

Rotor damage caused by tappet to rotor contact due to missing brake pad



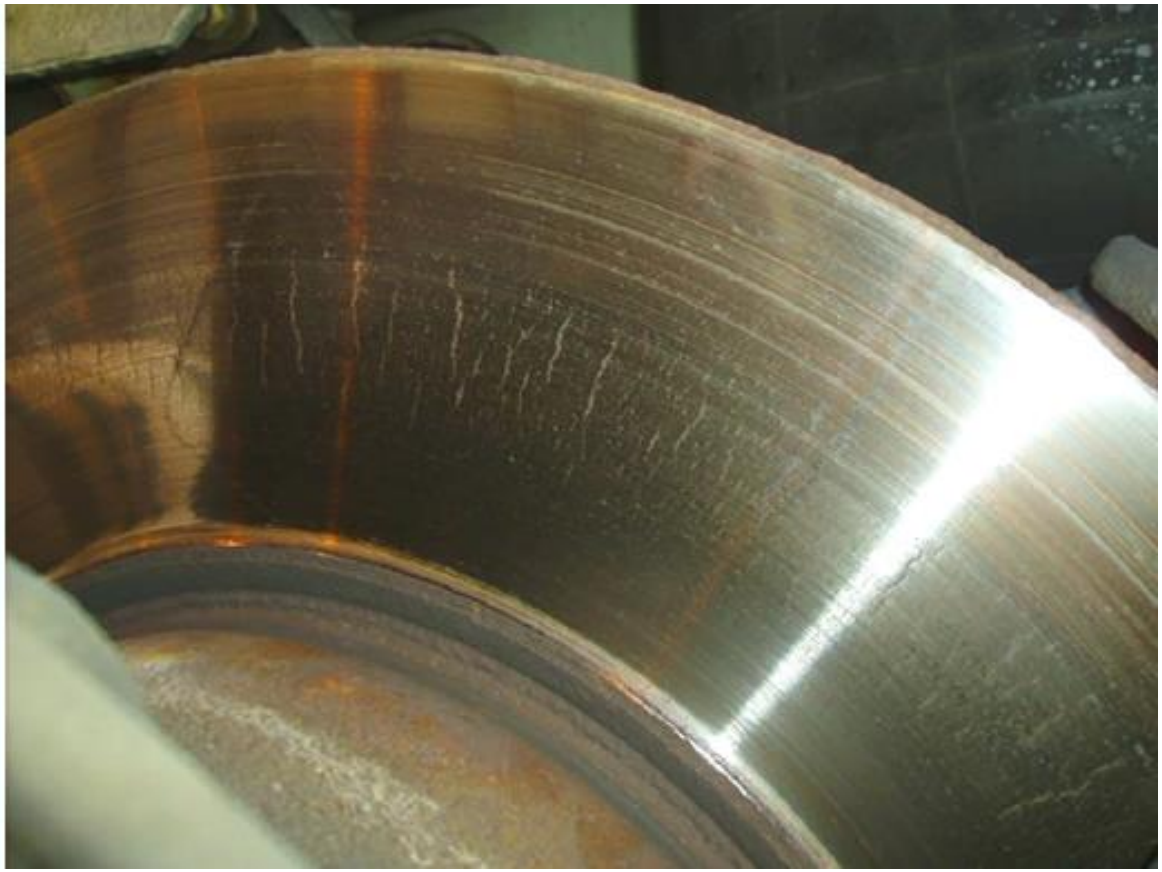
Brake Rotor Inspection

Grooves deep enough that the rotor thickness, when measured in the grooves, is thinner than the minimum allowable rotor thickness will require a rotor replacement. The cause must be identified and corrected.



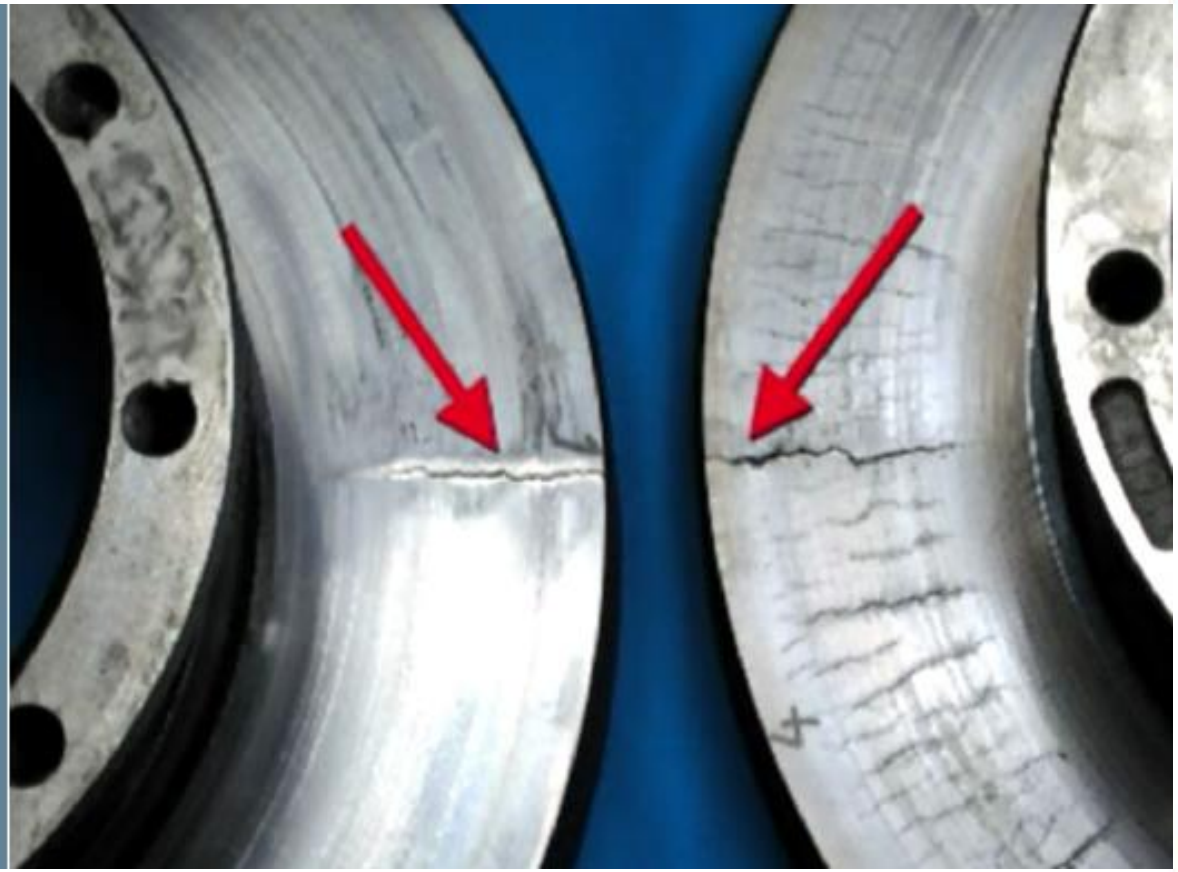
Brake Rotor Inspection

Small heat check are allowable (as shown)



Brake Rotor Inspection

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



Brake Rotor Inspection

Check rotor for damage and excessive wear

Brake Rotor Inspection

- Brake rotors should be checked for contamination from:
  - Leaking axle grease or oil seals
  - Road debris and contaminants
- Note: Oil and grease contaminated rotors should be replaced as the oil and grease can never be fully removed from the metal and will cause unbalanced brakes

Brake Rotor Inspection

Rotor contamination from grease or oil will require rotor replacement

Brake Rotor Inspection

Some Meritor rotors have different swept area thickness with the inboard swept area thinner than the outboard and should not be confused for wear. (picture for reference only)

Brake Chambers

- With the brake system at governor full cut-out, release parking brake (when applicable) then apply service brakes and listen for an air leak
- Any air leaks will deem the vehicle out of service until repairs are made
- Chambers must:

  Be same size

  Contain cage tool and sealing plug

  Display no evidence of contact with wheel, body, suspension, or frame

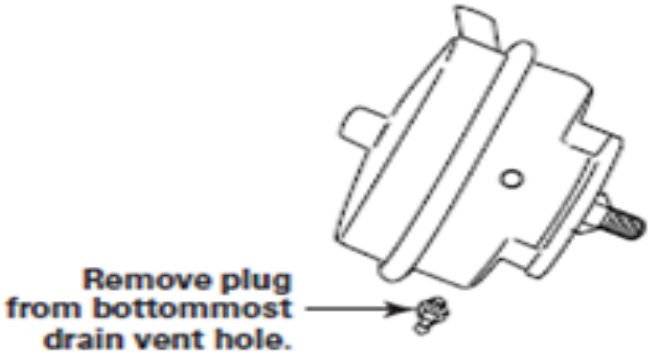
  Mounting nuts are tight and chamber is secure

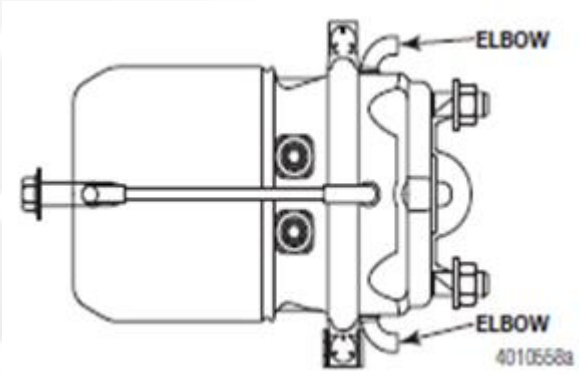
Front Service Brake Chamber

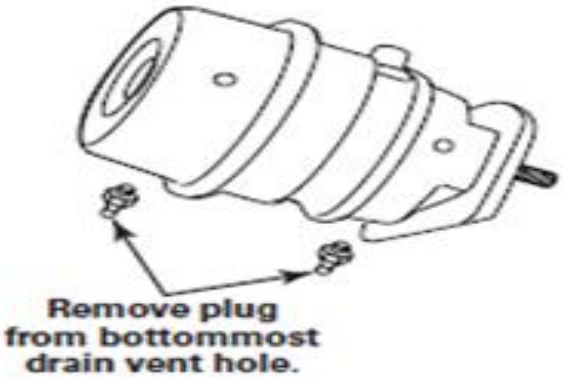
Rear Spring Brake Chamber

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





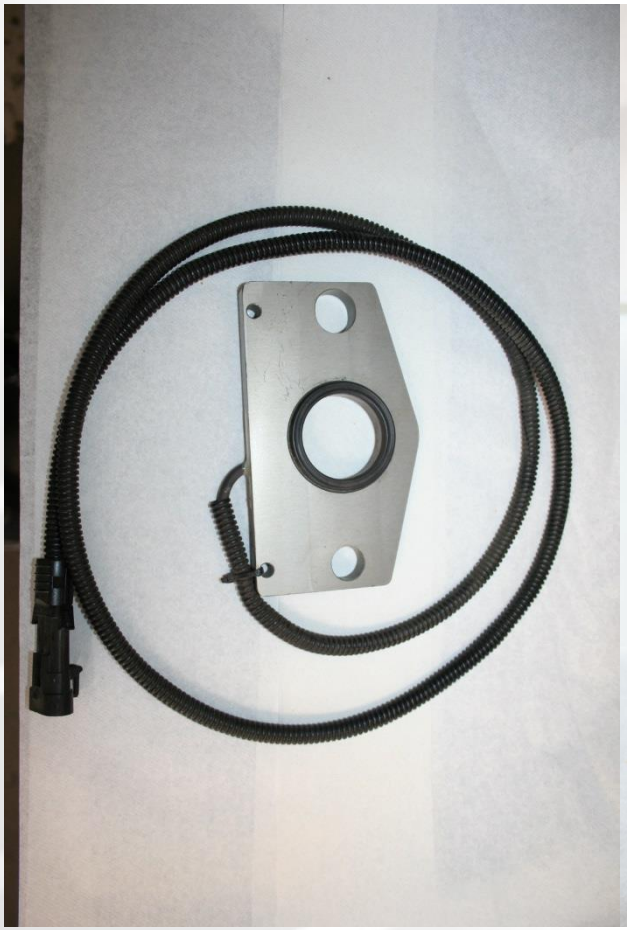


Brake Chamber Vent

Brake Chamber Vent

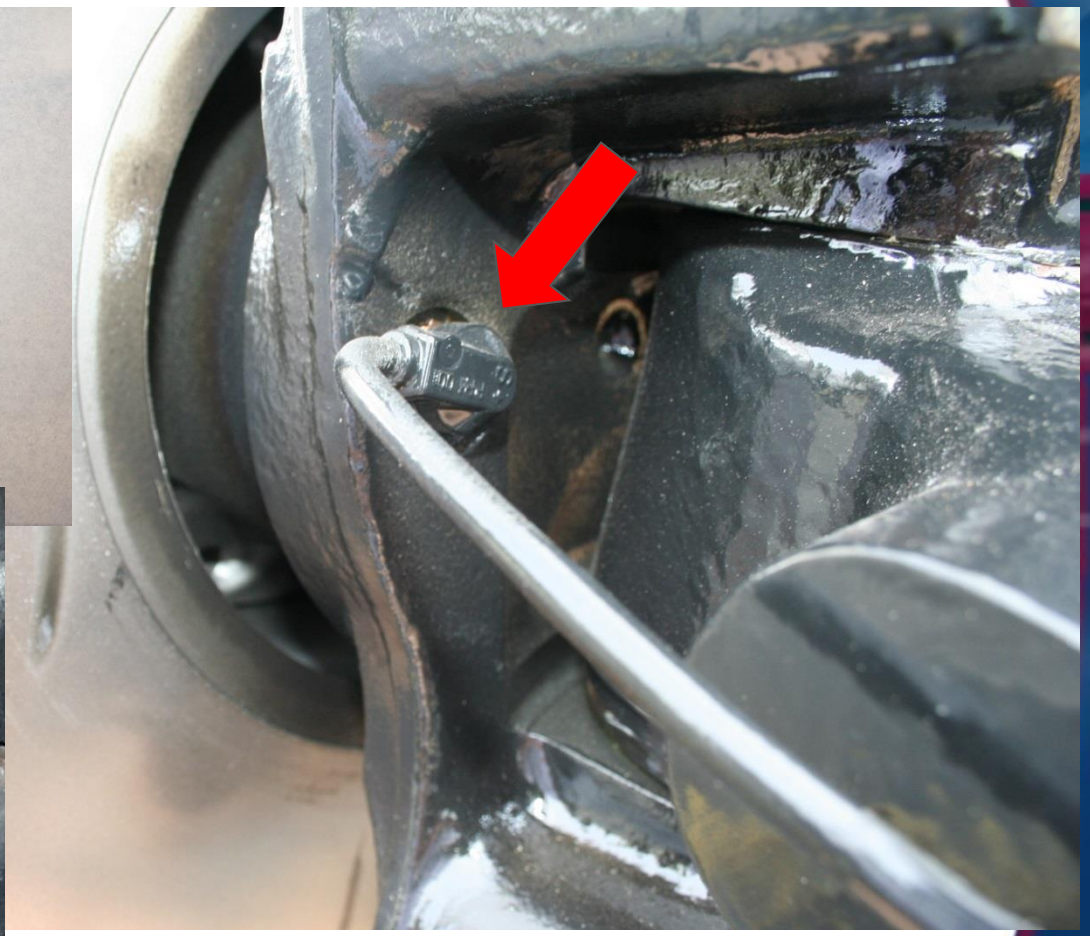
Electronic Brake Monitoring

An EBM system can be an effective maintenance tool to aid in the inspection or troubleshooting of the air brake system



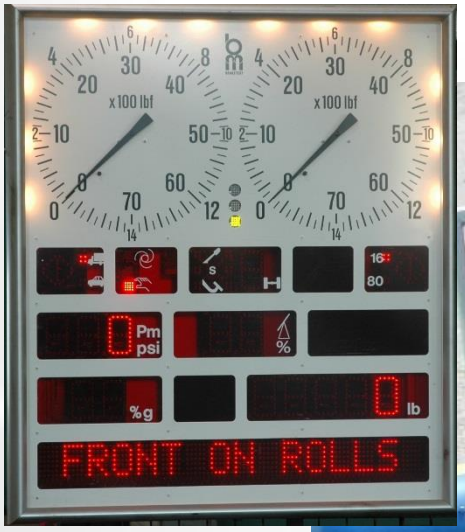
ABS Sensor

Inspect ABS sensor mounting, wiring, and adjustment. Replace as necessary.



Validation

Perform a brake performance test to verify satisfactory brake operation



Final Inspection and Test

- Perform a brake performance test to verify satisfactory brake operation
- Document inspection results
- Return bus to service if no repairs are needed
- Schedule repairs if required

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

Any Questions?

Please e-mail the questions to standards@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, drawings and technical information courtesy of MAN, ZF, Meritor, Knorr-Bremse, Bendix, LA Metro, Omnitrans, MBTA, Custom Training Aids, Link Engineering, and other members of the APTA Brake and Chassis Work Group