

Disc Brake System Description and Operation

System Component Description

The disc brake system consists of the following components:

Brake Pads

Mechanical output force from the brake caliper is applied to the brake pads which make contact with friction surfaces of the brake rotor.

Brake Rotors

Mechanical output force is applied to the brake rotor friction surfaces by the brake pads to slow the rotation speed of the tyre and wheel assembly.

Brake Caliper Anchor Plate (Except HSV)

Provides a secure mounting surface for the brake caliper to the steering knuckle while enabling the brake caliper to align correct with the brake rotor.

Brake Caliper (Except HSV)

The front and rear brake calipers are a single aluminium housing unit. The front brake caliper incorporates two hydraulic pistons and the rear brake caliper incorporates one hydraulic piston. Both front and rear brake calipers have one bleed valve. Each hydraulic piston has a fluid seal and a dust seal.

Brake Caliper (HSV)

The front and rear brake calipers are made up of two aluminium halves retained together by bolts. The hydraulic chambers on the brake caliper halves are linked by a bridge pipe with each half incorporating its own bleed valve. The front and rear brake calipers incorporate four hydraulic pistons. Each hydraulic piston has a fluid seal and a dust seal.

System Operation (Except HSV)

Mechanical output force is applied from the hydraulic brake caliper pistons to the inner brake pad. As the brake caliper pistons press the inner brake pad towards the inner friction surface or the brake rotor, the brake caliper slides away from the brake rotor pulling the outer brake pad onto the outer friction surface of the brake rotor. This allows the output force to be equally distributed. The force applied to the friction surfaces of the brake disc rotor slows the rotation of the tyre and wheel assemblies. The correct function of both the brake pad and brake anchor plate is essential for even distribution of braking force.

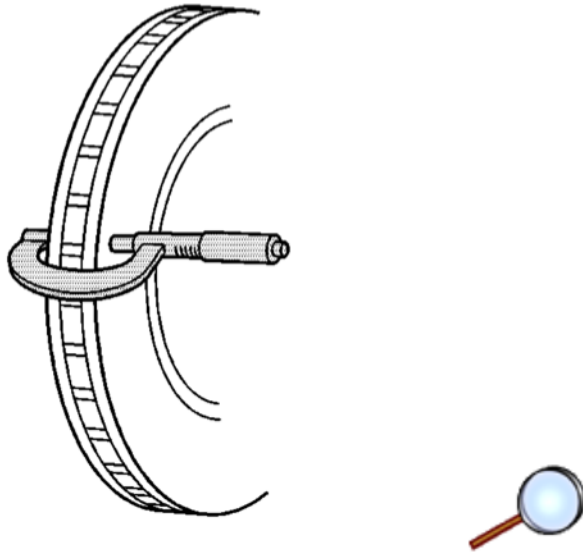
System Operation (HSV)

Mechanical output force is applied by the hydraulic brake caliper inboard and outboard pistons to the inner and outer brake pads. The brake calipers are a fixed opposed-piston design allowing the output force to be equally applied through the distribution of the pressurized brake fluid within the caliper. The brake pads apply the output force to the friction surfaces on the brake rotors, which slow the rotation of the tire and wheel assembly. The correct function of the brake pad hardware and of the brake caliper inboard and outboard pistons is essential for even distribution of braking force.

Brake Rotor Thickness Measurement

Warning: Refer to [Brake Dust Warning](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the wheels. Refer to [Tire and Wheel Removal and Installation](#).
3. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.



4. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the thickness of the brake disc at 4 points, evenly spaced around the brake disc.
5. Make sure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the brake disc, about 13 mm ($\frac{1}{2}$ in), for each measurement.
6. Compare the lowest thickness measurement recorded to the specifications. Refer to [Disc Brake Component Specifications](#).
7. If the lowest thickness measurement of the brake disc is above the minimum allowable thickness after refinishing specification, the brake disc may be able to be refinished, depending upon surface and wear conditions which may be present.
8. If the lowest thickness measurement of the brake disc is at or below the minimum allowable thickness after refinishing specification, the brake disc may not be refinished.
9. If the lowest thickness measurement of the brake disc is at or below the discard thickness specification, the brake disc requires replacement.

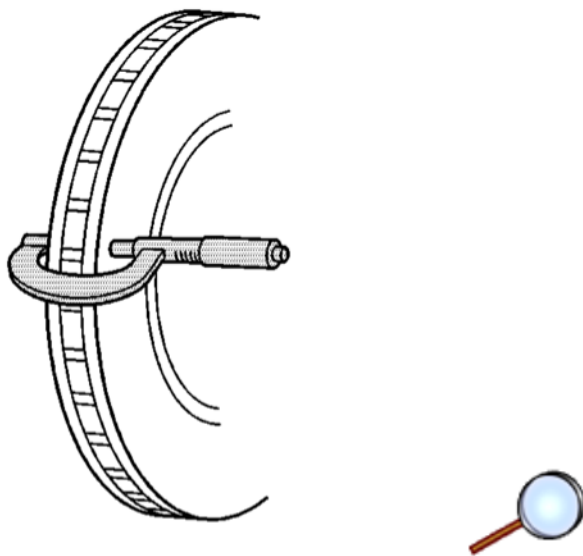
Brake Rotor Thickness Variation Measurement

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the wheels assembly. Refer to [Tire and Wheel Removal and Installation](#).
3. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.



4. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the thickness of the brake disc at 4 points, evenly spaced around the brake disc.
5. Make sure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the brake disc, about 13 mm ($\frac{1}{2}$ in), for each measurement.
6. Calculate the difference between the highest and lowest thickness measurements recorded to obtain the amount of thickness variation.
7. Compare the thickness variation measurement to the specifications. Refer to [Disc Brake Component Specifications](#).

Note: Whenever a brake disc is refinished or replaced, the assembled lateral runout (LRO) of the brake disc must be measured to make sure optimum performance of the disc brakes.

8. If the brake disc thickness variation measurement exceeds the specification, the brake disc requires refinishing or replacement.

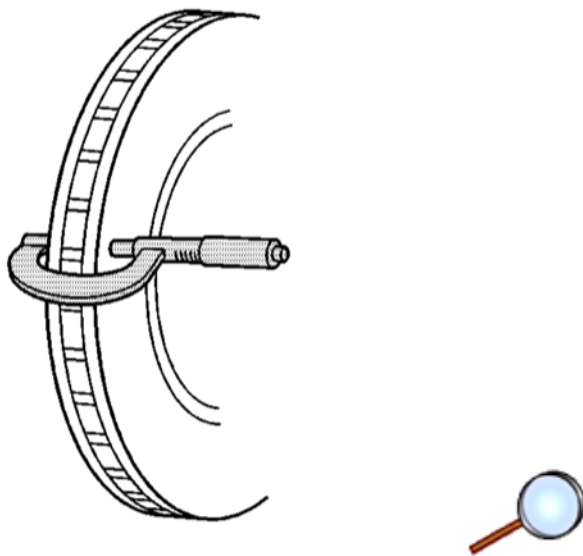
Brake Rotor Surface and Wear Inspection

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the wheels. Refer to [Tire and Wheel Removal and Installation](#).
3. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.
4. Inspect the friction surfaces of the brake disc for the following Braking Surface Conditions:
 - Heavy rust and/or pitting
Light surface rust can be removed with an abrasive disc. Heavy surface rust and/or pitting must be removed by refinishing the brake disc.
 - Cracks and/or heat spots
 - Too much blueing, discoloration
5. If the friction surfaces of the brake disc exhibit one or more of the Braking Surface Conditions, the brake disc requires refinishing or replacement.



6. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the scoring depth of any grooves present on the brake disc friction surfaces.
7. Compare the groove scoring depth recorded to the specifications. Refer to [Disc Brake Component Specifications](#).
8. If the brake disc scoring depth exceeds the specification, or if too much scoring is present, the brake disc requires refinishing or replacement.

Brake Rotor Assembled Lateral Runout Measurement

Special Tools

- J-23738-A Hand Vacuum Pump
- J 26900-12 Dial Indicator
- J 26900-13 Magnetic Indicator Base

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Note:

- Brake disc assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake disc over time, usually between 10,000–20,000 km (6,200–12,400 mi).
- Brake disc thickness variation MUST be inspected BEFORE inspecting for assembled LRO. Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to [Brake Rotor Thickness Variation Measurement](#).

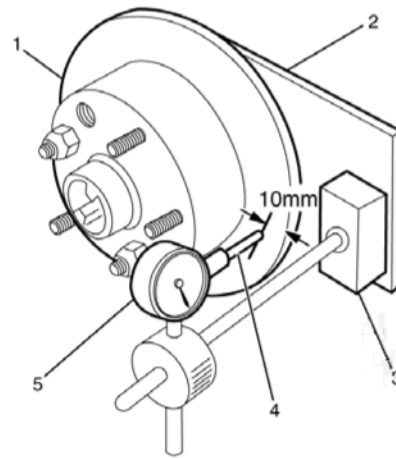
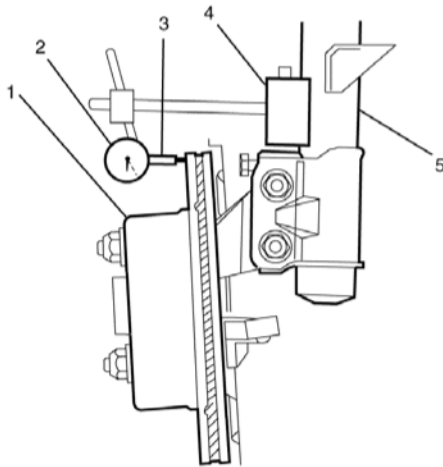
1. Matchmark the position of the brake disc to the wheel studs.

Note: Whenever the brake disc has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in too much assembled LRO of the brake disc, which may lead to brake pulsation.

2. Inspect the mating surface of the hub/axle flange and the brake disc to make sure that there is no corrosion, foreign particles, rust, or debris. If the wheel hub/axle flange and/or brake disc mating surfaces exhibit these conditions, perform the following steps:
 - 2.1. Remove the brake disc from the vehicle. Refer to [Front Brake Rotor Replacement](#) or [Rear Brake Rotor Replacement](#).
 - 2.2. Clean any rust or corrosion from the mating surface of the hub/axle flange.
 - 2.3. Clean any rust or corrosion from the mating surface of the brake disc.
 - 2.4. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.
3. Install the disc to the hub/axle flange using the matchmark made prior to removal.

Note: Install the wheel nuts in reverse avoid damage to the tapers.
4. Install 2 wheel nuts in reverse to opposite wheel studs to retain the brake disc to the hub.

5. Mount a dial indicator and position the indicator button so it contacts the brake disc friction surface at a 90 degree angle, approximately 10 mm ($\frac{3}{8}$ in) from the outer edge of the brake disc.



Note: The dial indicator's magnetic mounting base (4) must be securely mounted to the front strut unit (5).

- To measure the front brake disc assembled LRO (View A), set up a dial indicator (2) on a magnetic mounting base (4) and attach to the front strut unit (5) above the brake disc (1).

Note: The dial indicator's magnetic mounting base (3) must be securely mounted to the dial indicator plate (2).

- To measure the rear brake disc assembled LRO (View B), bolt the dial indicator plate (2) to the brake caliper attaching points on the rear knuckle. Set up a dial indicator (4) on a magnetic mounting base (3) and attach to the dial indicator plate (2). Refer to Dial Indicator Plate in Special Tools for dial indicator plate details.

6. Measure and record the assembled LRO of the brake disc:

- 6.1. Rotate the brake disc until the lowest reading is displayed on the indicator dial, then set the dial to zero.
- 6.2. Rotate the brake disc until the highest reading is displayed on the dial.
- 6.3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
- 6.4. Measure and record the amount of assembled LRO.

7. Compare the brake disc assembled LRO to the specifications. Refer to [Disc Brake Component Specifications](#).

8. If the brake disc assembled LRO measurement exceeds the specification, refer to [Brake Rotor Assembled Lateral Runout Correction](#).

9. If the brake disc assembled LRO measurement is within specification, install the brake caliper and depress the brake pedal several times to secure the brake disc in place before removing the wheel nuts.

Brake Pad Inspection (Except HSV)

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

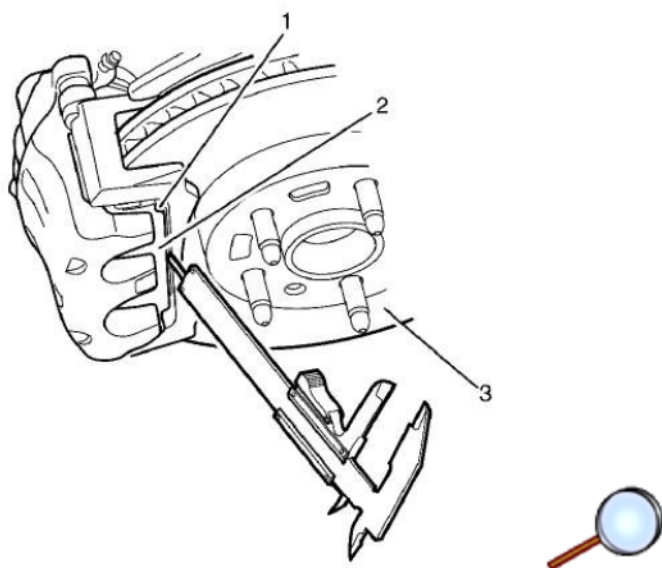
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

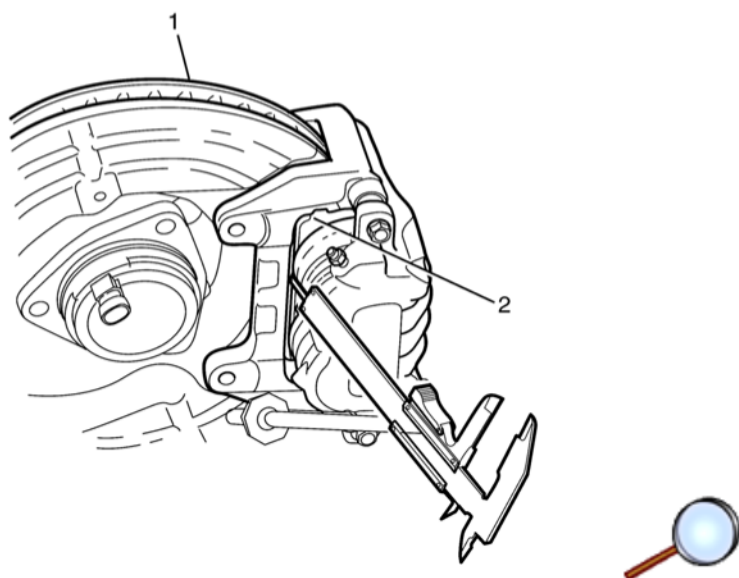
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

Note: This procedure references the right front wheel. Brake pad inspection for the other wheels are similar.

2. Remove the wheel. Refer to [Tire and Wheel Removal and Installation](#).
3. Carry out a visual inspection of the brake assembly.
4. Install 2 opposite wheel nuts with the flat side of the wheel nut against the brake rotor to retain the brake rotor to the wheel hub.
5. With the aid of an assistant or a brake pedal holding bar, apply and hold the foot brake.



6. Using a vernier caliper measure and record the distance from the outer brake pad backing plate outer edge (2) to the disc rotor (1).



7. Using a vernier caliper measure and record the distance from the inner brake pad backing plate outer edge (2) to the disc rotor (1).
8. Replace the brake pad if:
 - Either reading is 10 mm or less (this equates to 3 mm lining material remaining on the brake pad).
 - If there is more than 2 mm variation between the inner and outer brake pad. This may be caused by the caliper binding. Refer to [Brake Caliper Inspection](#).
9. Remove the brake pedal holding bar.
10. Remove the 2 wheel nuts (1) from the wheel studs.
11. Install the wheel. Refer to [Tire and Wheel Removal and Installation](#).
12. Lower the vehicle to the ground.

Brake Pad Inspection (HSV)

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

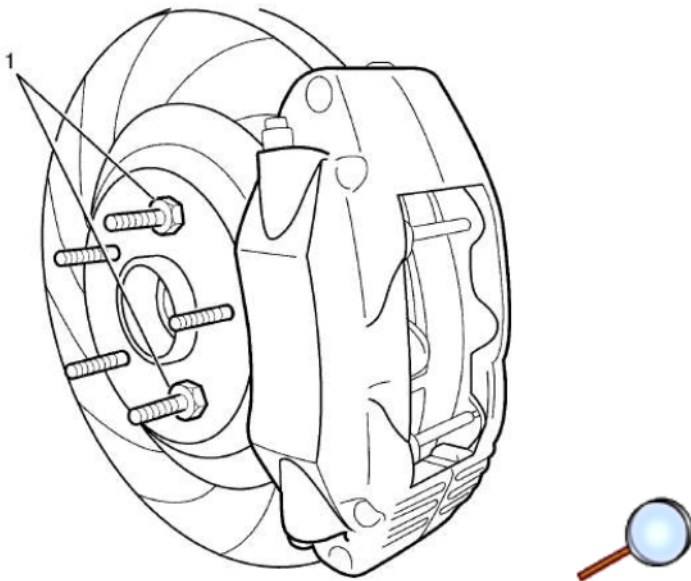
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

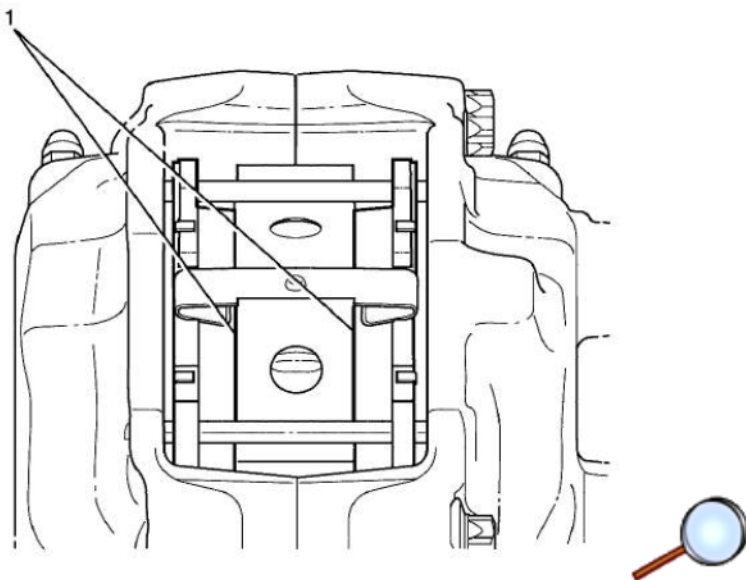
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

Note: This procedure references the left front wheel. Brake pad inspection for the other wheels are similar.

2. Remove the wheel. Refer to [Tire and Wheel Removal and Installation](#).

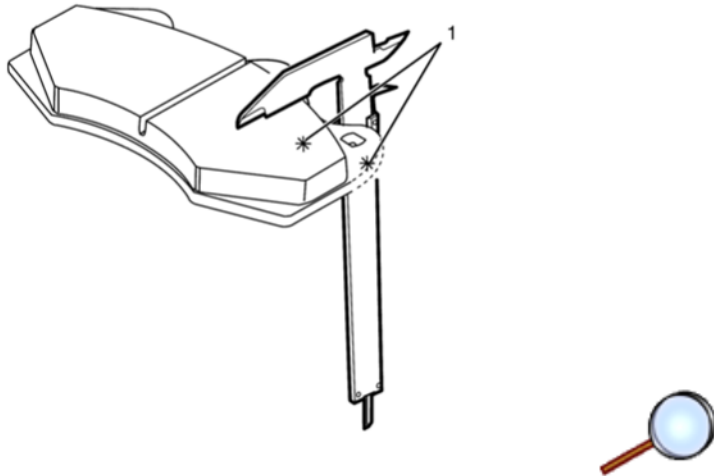


3. Install 2 opposite wheel nuts (1), with the flat side of the wheel nut against the brake rotor to retain the brake rotor to the wheel hub.

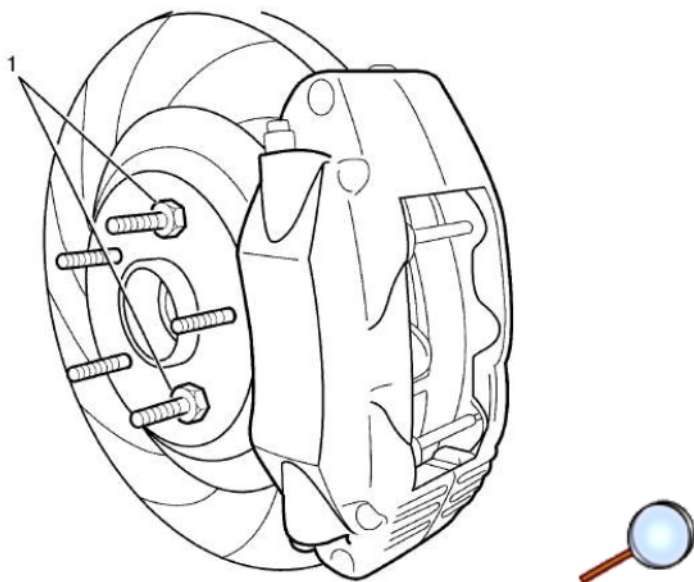


4. Carry out a visual inspection of the brake pads.
 - Inspect the brake pad shims.
 - Inspect the thickness of the brake pad friction surfaces (1).

5. If the brake pads appears worn or further inspection is required, remove the brake pads. Refer to:
- [Front Disc Brake Pads Replacement.](#)
 - [Rear Disc Brake Pads Replacement.](#)



6. Using a vernier caliper measure the thickness of the outer brake pad between the friction surface and the backing plate (1).
7. Using a vernier caliper measure the thickness of the inner brake pad between the friction surface and the backing plate (1).
8. Replace the brake pads if:
- Either of the brake pad measurement is 3.0 mm or less.
 - If there is more than 2.0 mm variation between the inner and outer brake pad reading.
 - If there is more than 2.0 mm difference between the leading and trailing edge of the same brake pad.
 - If the brake pads friction surfaces has, cracks, fractures, or damage.
9. Verify that the brake pad shims are not damaged or corroded and firmly attached to the brake pads.
10. Replace damaged or corroded brake pad shims.
11. Install the brake pads. Refer to:
- [Front Disc Brake Pads Replacement.](#)
 - [Rear Disc Brake Pads Replacement.](#)



12. Remove the 2 wheel nuts (1) from the wheel studs.
13. Install the wheel. Refer to [Tire and Wheel Removal and Installation](#).
14. Lower the vehicle to the ground.

Brake Caliper Inspection (Except HSV Front)

Special Tools

J-23738-A Hand Vacuum Pump

1. Inspect the brake fluid level in the brake master cylinder reservoir.

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Note: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

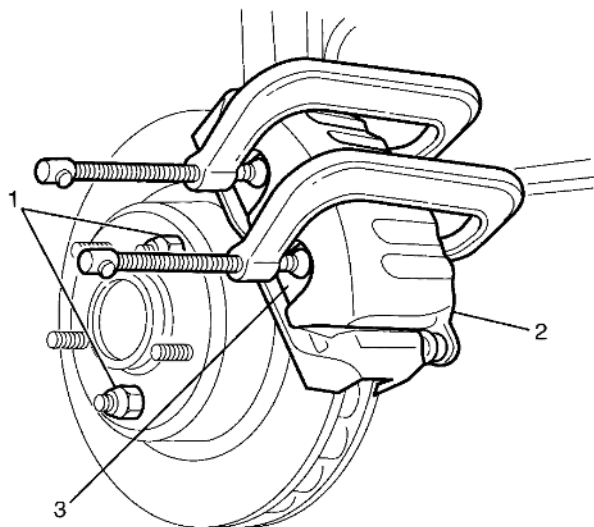
Note: The brake fluid level must be midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

2. If required, use J-23738-A hand vacuum pump to remove some brake fluid until the brake fluid level is midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).



5. Install 2 wheel nuts (1) in reverse, to opposing wheel studs so that the front brake rotor is retained to the front wheel hub assembly.

Note: Position the ends of the G-clamps against the rear of the front brake caliper (2) and against the outboard brake pad (3).

6. Install a large G-clamp over the body of the front brake caliper (2).

Note: The front brake caliper piston should slide smoothly into the front brake caliper bore. Overhaul or replace the front brake caliper assembly if the front brake caliper piston is frozen or the front brake caliper piston does not bottom out smoothly.

7. Tighten the G-clamps until the front brake caliper pistons bottom out in the front brake caliper bores.

8. Remove the G-clamps from the front brake caliper (2).

Note: Minimal freeplay should exist between the front brake caliper (2) and the anchor bracket. If too much free play exists, the front brake caliper guide pins and anchor bracket requires further inspection.

9. Grasp the front brake caliper (2) and move the front brake caliper (2) up and down.

Note: The front brake caliper (2) should slide smoothly along the front brake caliper guide pins with minimal force. If the movement of the front brake caliper (2) along the guide pins are not smooth, the front brake caliper guide pins and anchor bracket requires further inspection.

10. Grasp the front brake caliper (2) and move the front brake caliper (2) in and out along the front brake caliper guide pins.

Note: DO NOT disconnect the hydraulic brake flexible hose from the front brake caliper. Failure to comply will require that the brake system be bleed.

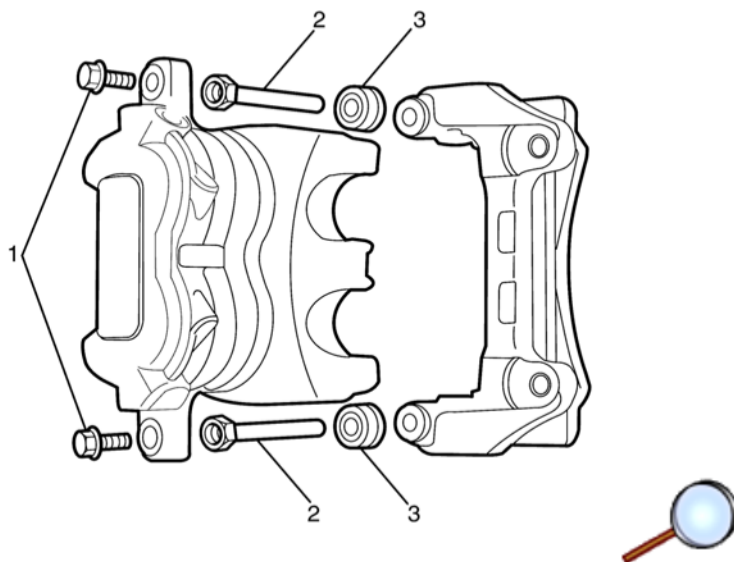
11. Remove the front brake caliper. Refer to [Front Brake Caliper Replacement](#).

Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

12. Inspect the front brake caliper to steering knuckle retaining bolts for the following:

- Bent or damaged front brake caliper to steering knuckle retaining bolts
- Binding
- Corrosion
- Seizing in the knuckle

13. If any of the conditions listed are found, replace the front brake caliper to steering knuckle retaining bolts.



14. Remove the front brake caliper lower guide pin retaining bolts (1) and inspect for the following:

- Bent or damage
- Binding
- Corrosion
- Seizing

15. If any of the above conditions are found, replace the front brake caliper lower guide pin retaining bolts (1)

Note: Do not disengaging the guide pins from the front brake caliper boots (3) at this stage.

16. Gently slide the front brake caliper guide pins (2) in and out of the anchor bracket and inspect front brake caliper guide pins (2) for the following:

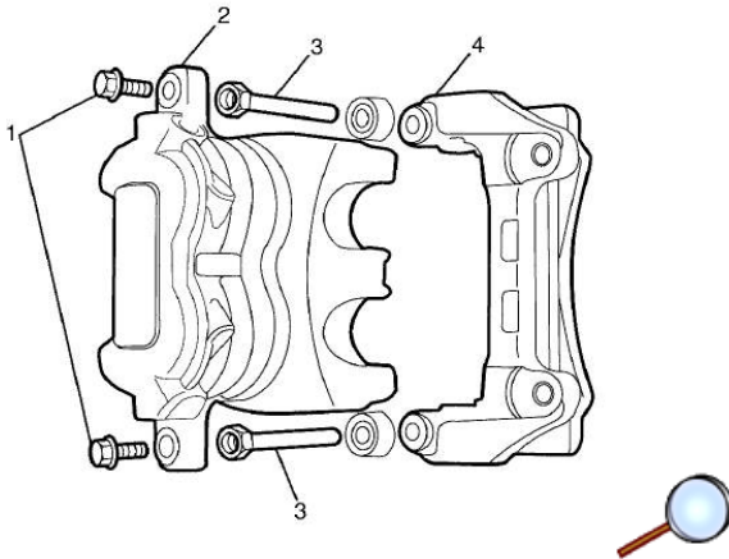
- Bent or damage
- Binding
- Corrosion
- Seizing

17. If any of the conditions listed above are found, replace the front brake caliper guide pins (2).

18. Inspect the front brake caliper boots (3) for the following:

- Missing front brake caliper boots
- Cracked or torn front brake caliper boots
- Deteriorated front brake caliper boots

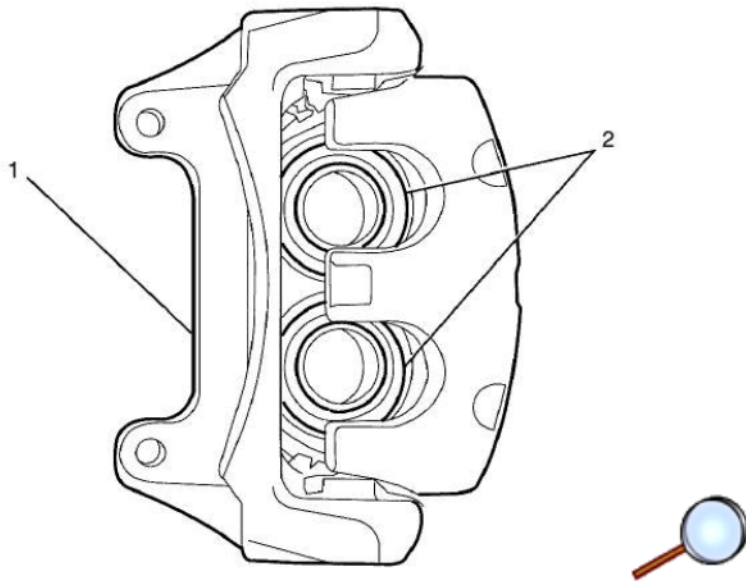
19. If any of the conditions listed above are found, replace the front brake caliper boots (3).



20. Inspect the front brake caliper (2) and front brake caliper anchor plate (4) for the following:

- Bent or damaged front brake caliper anchor plate (4)
- Excessive play between the front brake caliper guide pins (3) and the front brake caliper anchor plate (4)
- Excessive play between the front brake caliper guide pin bolts (1) and the front brake caliper (2)
- Corrosion
- Cracks
- Damage

21. If any of the conditions listed above are found, replace or overhaul the front brake caliper assembly.



22. Inspect the front brake caliper piston dust boot seals (2) for the following:

- Cracks
- Tears
- Cuts
- Deterioration
- Incorrect seating of the front brake caliper piston dust boot seals (2) in the front brake caliper (1)
- Brake fluid leakage around the front brake caliper piston dust boot seals (2)

23. If any of the conditions listed above are found, overhaul the front brake caliper [Front Brake Caliper Overhaul](#) or replace the front brake caliper [Front Brake Caliper Replacement](#).

24. Install the front brake caliper. Refer to [Front Brake Caliper Replacement](#).

25. Remove the 2 wheel nuts (1), from the wheel studs.

26. Install the front wheels. Refer to [Tire and Wheel Removal and Installation](#).

27. Lower the vehicle to the ground.

28. With the ignition off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.

29. Repeat the previous step until a firm brake pedal application is obtained.

30. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).

31. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

Brake Caliper Inspection (HSV Front)

Special Tools

J-23738-A Hand Vacuum Pump

1. Inspect the brake fluid level in the brake master cylinder reservoir.

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Note: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

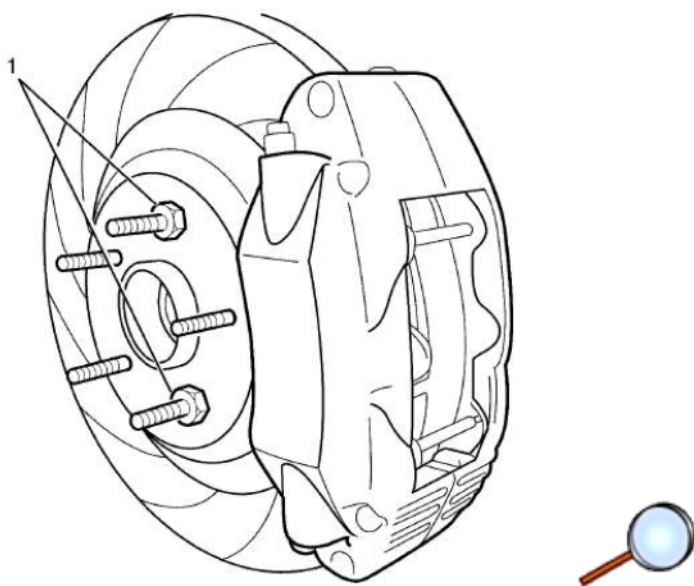
Note: The brake fluid level must be midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

2. If required, use J-23738-A hand vacuum pump to remove some brake fluid until the brake fluid level is midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

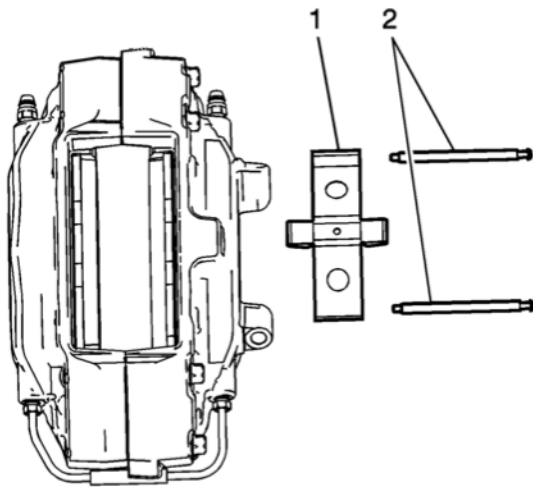
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

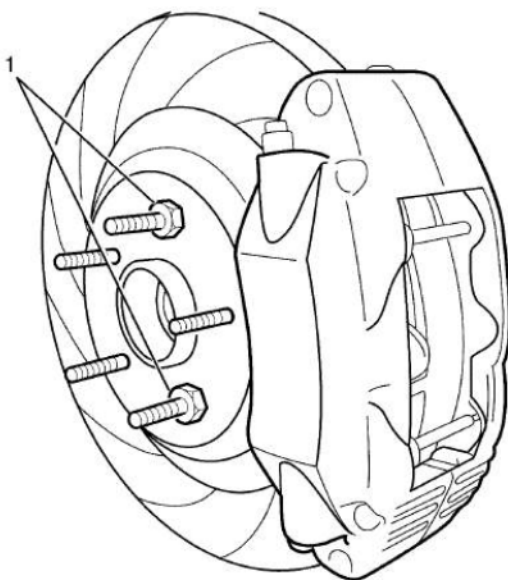
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).



5. Install 2 opposite wheel nuts (1), with the flat side of the wheel nut against the brake rotor to retain the brake rotor to the wheel hub.
6. Remove the front brake pads. Refer to [Front Disc Brake Pads Replacement](#).



7. Inspect the brake pad retainer (1) and front brake caliper guide pins (2) for the following:
 - Bent, worn or damaged front brake caliper guide pins (2)
 - Cracks, excessive wear or damage
 - Excessive corrosion
 - Looseness of the disc brake pads
 - Missing brake pad retainers (1) or front brake caliper guide pins (2)
8. If any of the conditions listed above are found, replace the affected components.
9. Inspect the front brake caliper for the following:
 - Cracks, excessive wear or damage to the housing
 - Torn, cracked, incorrectly seated or deteriorated dust boot seals
 - Brake fluid leakage around the front brake caliper dust boot seals and on the brake pads
10. If any of the conditions listed above are found, overhaul the front brake caliper [Front Brake Caliper Overhaul](#) or replace the front brake caliper [Front Brake Caliper Replacement](#).



11. Install the front brake pads. Refer to [Front Disc Brake Pads Replacement](#).
12. Remove the 2 wheel nuts (1), from the wheel studs.
13. Install the front wheels. Refer to [Tire and Wheel Removal and Installation](#).
14. Lower the vehicle to the ground.

15. With the Ignition Off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
16. Repeat the previous step until a firm brake pedal application is obtained.
17. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).
18. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

Brake Caliper Inspection (Except HSV Rear)

Special Tools

J-23738-A Hand Vacuum Pump

1. Inspect the brake fluid level in the brake master cylinder reservoir.

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Note: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

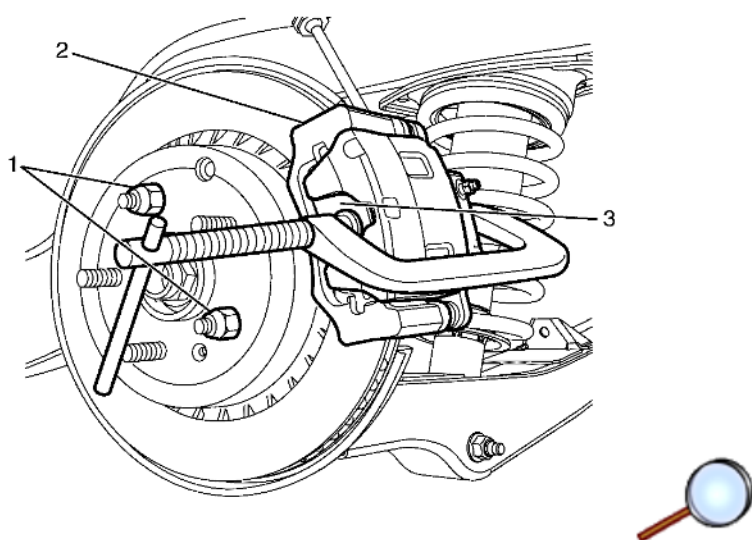
Note: The brake fluid level must be midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

2. If required, use J-23738-A hand vacuum pump to remove some brake fluid until the brake fluid level is midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

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Warning: Refer to [Safety Glasses Warning](#).

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).



5. Install 2 wheel nuts (1) in reverse, to opposing wheel studs so that the front brake rotor is retained to the front wheel hub assembly.

Warning: Refer to [Brake Dust Warning](#).

Note: Position the ends of the G-clamp against the rear of the rear brake caliper (2) and against the outboard brake pad (3).

6. Install a large G-clamp over the body of the rear brake caliper (2).

Note: The rear brake caliper pistons should slide smoothly into the rear brake caliper bores. Overhaul or replace the rear brake caliper assembly if the rear brake caliper piston is frozen or the rear brake caliper piston does not bottom out smoothly.

7. Tighten the G-clamp until the rear brake caliper piston bottoms out in the rear brake caliper bore.

8. Remove the G-clamp from the rear brake caliper (2).

Note: Minimal freeplay should exist between the rear brake caliper (2) and the anchor bracket. If too much free play exists, the rear brake caliper guide pins and anchor bracket requires further inspection.

9. Grasp the rear brake caliper (2) and move the rear brake caliper (2) up and down.

Note: The rear brake caliper (2) should slide smoothly along the rear brake caliper guide pins with minimal force. If the movement of the rear brake caliper (2) along the guide pins are not smooth, the rear brake caliper guide pins and anchor bracket requires further inspection.

10. Grasp the rear brake caliper (2) and move the rear brake caliper (2) in and out along the rear brake caliper guide pins.

Note: DO NOT disconnect the hydraulic brake flexible hose from the rear brake caliper. Failure to comply will require that the brake system be bleed.

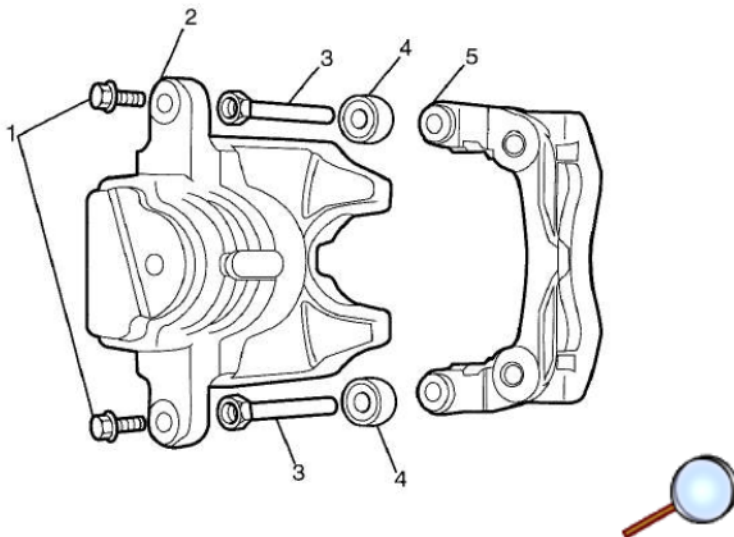
11. Remove the rear brake caliper. Refer to [Rear Brake Caliper Replacement](#).

Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

12. Inspect the rear brake caliper to knuckle retaining bolts for the following:

- Bent or damage
- Binding
- Corrosion
- Seizing in the knuckle

13. If any of the conditions listed above are found, replace the rear brake caliper to knuckle retaining bolts.



14. Remove the rear brake caliper lower guide pin retaining bolts (1) and inspect for the following:

- Bent or damage
- Binding
- Corrosion
- Seizing

15. If any of the above conditions are found, replace the rear brake caliper lower guide pin retaining bolts (1)

Note: Do not disengaging the guide pins from the rear brake caliper boots (4) at this stage.

16. Gently slide the rear brake caliper guide pins (3) in and out of the anchor bracket (5) and inspect rear brake caliper guide pins (3) for the following:

- Bent or damage
- Binding
- Corrosion
- Seizing

17. If any of the conditions listed above are found, replace the rear brake caliper guide pins (3).

18. Inspect the rear brake caliper boots (4) for the following:

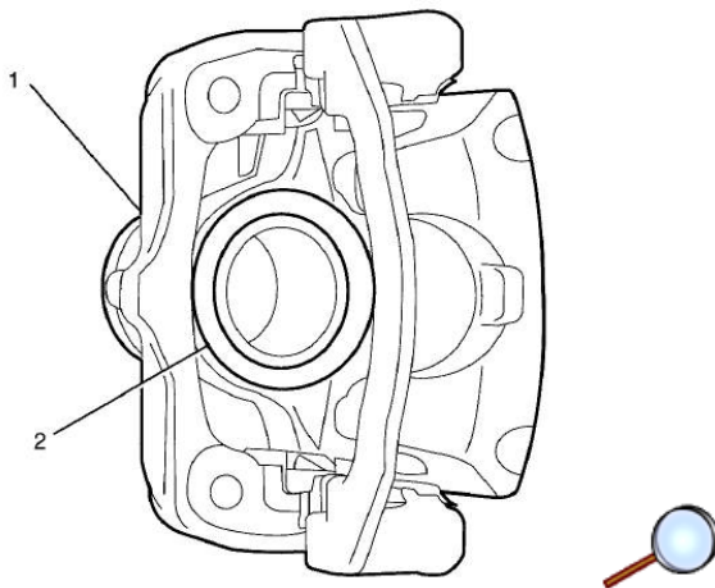
- Missing rear brake caliper boots (4)
- Cracked or torn rear brake caliper boots (4)

19. If any of the conditions listed above are found, replace the rear brake caliper boots (4).

20. Inspect the rear brake caliper (2) and rear brake caliper anchor plate (5) for the following:

- Bent or damaged rear brake caliper anchor plate (5)
- Excessive play between the rear brake caliper guide pins (3) and the rear brake caliper anchor plate (5)
- Excessive play between the rear brake caliper guide pin bolts (1) and the rear brake caliper (2)
- Corrosion
- Cracks
- Damage

21. If any of the conditions listed above are found, replace or overhaul the rear brake caliper assembly.



22. Inspect the rear brake caliper piston dust boot seals (2) for the following:

- Cracks
- Tears
- Cuts
- Deterioration
- Incorrect seating of the rear brake caliper piston dust boot seals (2) in the rear brake caliper (1)
- Brake fluid leakage around the rear brake caliper piston dust boot seals (2)

23. If any of the conditions listed above are found, replace or overhaul the rear brake caliper assembly.

24. Install the rear brake caliper. Refer to [Rear Brake Caliper Replacement](#).

25. Remove the 2 wheel nuts (1) from the wheel studs.

26. Install the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).

27. Lower the vehicle to the ground.
28. With the Ignition Off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
29. Repeat the previous step until a firm brake pedal application is obtained.
30. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).
31. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

Brake Caliper Inspection (HSV Rear)

Special Tools

J-23738-A Hand Vacuum Pump

1. Inspect the brake fluid level in the brake master cylinder reservoir.

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Note: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

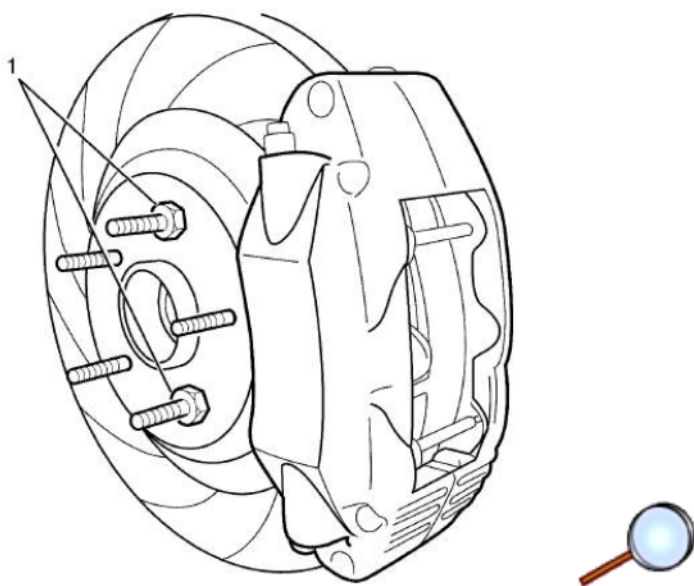
Note: The brake fluid level must be midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

2. If required, use J-23738-A hand vacuum pump to remove some brake fluid until the brake fluid level is midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

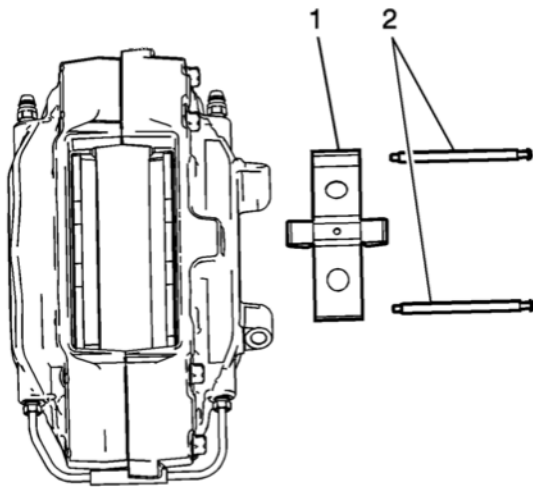
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

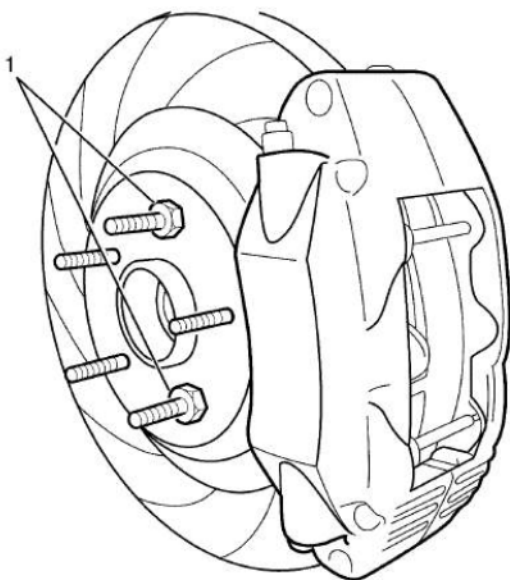
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).



5. Install 2 opposite wheel nuts (1), with the flat side of the wheel nut against the brake rotor to retain the brake rotor to the wheel hub.
6. Remove the rear brake pads. Refer to [Rear Disc Brake Pads Replacement](#).



7. Inspect the brake pad retainer (1) and rear brake caliper guide pins (2) for the following:
 - Bent, worn or damaged rear brake caliper guide pins (2)
 - Cracks, excessive wear or damage
 - Excessive corrosion
 - Looseness of the disc brake pads
 - Missing brake pad retainers (1) or rear brake caliper guide pins (2)
8. If any of the conditions listed above are found, replace the affected components.
9. Inspect the rear brake caliper for the following:
 - Cracks, excessive wear or damage to the housing
 - Torn, cracked, incorrectly seated or deteriorated dust boot seals
 - Brake fluid leakage around the rear brake caliper dust boot seals and on the brake pads
10. If any of the conditions listed above are found, overhaul the rear brake caliper [Rear Brake Caliper Overhaul](#) or replace the rear brake caliper [Rear Brake Caliper Replacement](#).



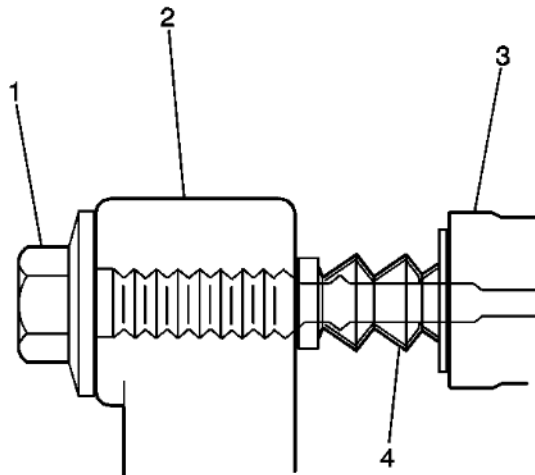
11. Install the rear brake pads. Refer to [Rear Disc Brake Pads Replacement](#).
12. Remove the 2 wheel nuts (1) from the wheel studs.
13. Install the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).
14. Lower the vehicle to the ground.

15. With the Ignition Off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
16. Repeat the previous step until a firm brake pedal application is obtained.
17. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).
18. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

Front Disc Brake Mounting and Hardware Inspection

Warning: Refer to [Brake Dust Warning](#).

1. Inspect the fluid level in the brake master cylinder reservoir.
 2. If the brake fluid level is midway between the maximum–full point and the minimum allowable level then no brake fluid needs to be removed from the reservoir before proceeding.
 3. If the brake fluid level is higher than midway between the maximum–full point and the minimum allowable level then remove brake fluid to the midway point before proceeding.
 4. Raise and support the vehicle. Refer [Lifting and Jacking the Vehicle](#).
 5. Remove the tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
 6. Grasp the brake caliper housing and try to move the brake caliper housing up/down and forward/reverse in relation to the brake caliper mounting bracket. If excessive looseness is observed the brake caliper bracket bushings and/or the brake caliper mounting bolts may need to be replaced.
 7. Compress the front caliper pistons.
 - Install a large C-clamp over the top of the caliper housing and against the back of the outboard pad.
 - Slowly tighten the C-clamp until the pistons are pushed completely into the caliper bores.
 - Remove the C-clamp from the caliper.
 8. With the pistons compressed into the caliper bores, grasp the brake caliper housing and slide it back and forth on the brake caliper mounting bolts. Check for smooth operation. If the brake caliper housing slide force is high or the brake caliper housing does not slide smoothly, inspect the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings for wear or damage. If wear or damage conditions are found, replacement of the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings is necessary.
 9. Remove the brake caliper mounting bolts from the brake caliper mounting bracket and support the brake caliper using heavy mechanics wire. Do Not remove the hydraulic brake hose from the caliper. Refer to [Front Brake Caliper Replacement](#).
- Note:** When replacing the disc brake pads, maintain the same disc brake pad wear sensor orientation.
10. Remove the disc brake pads from the brake caliper mounting bracket.
 11. Inspect the disc brake pad mounting hardware for the following:
 - Missing mounting hardware
 - Excessive corrosion
 - Bent mounting tabs
 - Looseness at the brake caliper mounting bracket
 - Looseness at the disc brake pads
 - Excessive contaminants in the brake caliper mounting bracket surface and threads.
 12. If any of the conditions listed are found, the disc brake pad mounting hardware requires replacement.
 13. Ensure the disc brake pads are held firmly in place on the brake caliper mounting bracket, yet slide easily on the mounting hardware without binding.



14. Inspect the brake caliper guide pin bolt (1), brake caliper (2), caliper bracket (3), and the guide pin seal (4) for the following:
- Binding
 - Seizing
 - Looseness in the brake caliper mounting bracket
 - Bent or damaged brake caliper mounting bolts
 - Cracked or torn boots
 - Missing boots
 - Bent or damaged brake caliper mounting bracket
15. If any of the conditions listed are found then the brake caliper mounting hardware requires replacement.
16. Install the disc brake pads to the brake caliper mounting bracket.
17. Install the disc brake caliper to the brake caliper mounting bracket. Refer to [Front Brake Caliper Replacement](#).

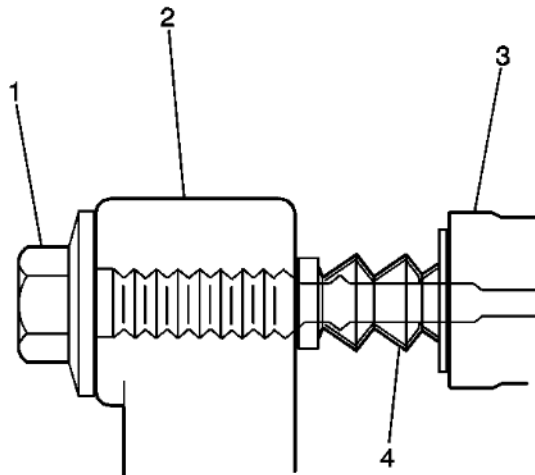
Rear Disc Brake Mounting and Hardware Inspection

Warning: Refer to [Brake Dust Warning](#).

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum–full point and the minimum allowable level then no brake fluid needs to be removed from the reservoir before proceeding.
3. If the brake fluid level is higher than midway between the maximum–full point and the minimum allowable level then remove brake fluid to the midway point before proceeding.

Danger: Do not use a service jack in locations other than those specified to lift this vehicle. Lifting the vehicle with a jack in those other locations could cause the vehicle to slip off the jack and roll; this could cause injury or death.

4. Raise and support the vehicle. Refer [Lifting and Jacking the Vehicle](#).
5. Remove the tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
6. Grasp the brake caliper housing and try to move the brake caliper housing up/down and forward/reverse in relation to the brake caliper mounting bracket. If excessive looseness is observed the brake caliper bracket bushings and/or the brake caliper mounting bolts may need to be replaced.
7. Compress the rear caliper piston.
 - Install a large C-clamp over the top of the caliper housing and against the back of the outboard pad.
 - Slowly tighten the C-clamp until the piston is pushed completely into the caliper bores.
 - Remove the C-clamp from the caliper.
8. With the piston compressed into the caliper bore, grasp the brake caliper housing and slide it back and forth on the brake caliper mounting bolts. Check for smooth operation. If the brake caliper housing slide force is high or the brake caliper housing does not slide smoothly, inspect the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings for wear or damage. If wear or damage conditions are found, replacement of the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings is necessary.
9. Remove the brake caliper mounting bolts from the brake caliper mounting bracket and support the brake caliper using heavy mechanics wire. Do not disconnect the hydraulic brake hose from the caliper. Refer to [Rear Brake Caliper Replacement](#).
10. Remove the disc brake pads from the brake caliper mounting bracket.
11. Inspect the disc brake pad mounting hardware for the following:
 - Missing mounting hardware
 - Excessive corrosion
 - Bent mounting tabs
 - Looseness at the brake caliper mounting bracket
 - Looseness at the disc brake pads
 - Excessive contaminants in the brake caliper mounting bracket surface and threads.
12. If any of the conditions listed are found, the disc brake pad mounting hardware requires replacement.
13. Ensure the disc brake pads are held firmly in place on the brake caliper mounting bracket, yet slide easily on the mounting hardware without binding.



14. Inspect the caliper bolts (1) for the following:

- Binding
- Seizing
- Looseness in the brake caliper mounting bracket (3)
- Bent or damaged brake caliper mounting bolts
- Cracked or torn boots (4)
- Missing boots
- Bent or damaged brake caliper mounting bracket (3)

15. If any of the conditions listed are found then the brake caliper mounting hardware requires replacement.

16. Install the disc brake pads to the brake caliper mounting bracket.

17. Install the disc brake caliper to the brake caliper mounting bracket. Refer to [Rear Brake Caliper Replacement](#).

Front Disc Brake Pads Replacement (Except HSV)

Special Tools

J-23738-A Hand Vacuum Pump

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

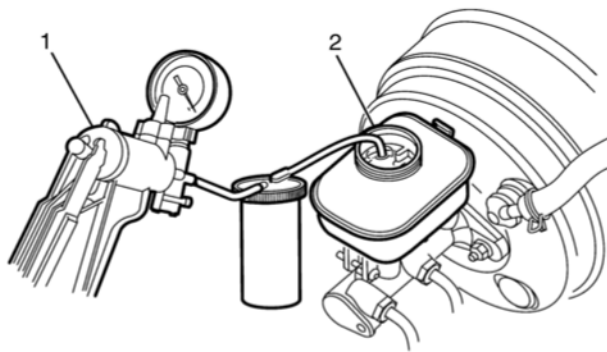
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



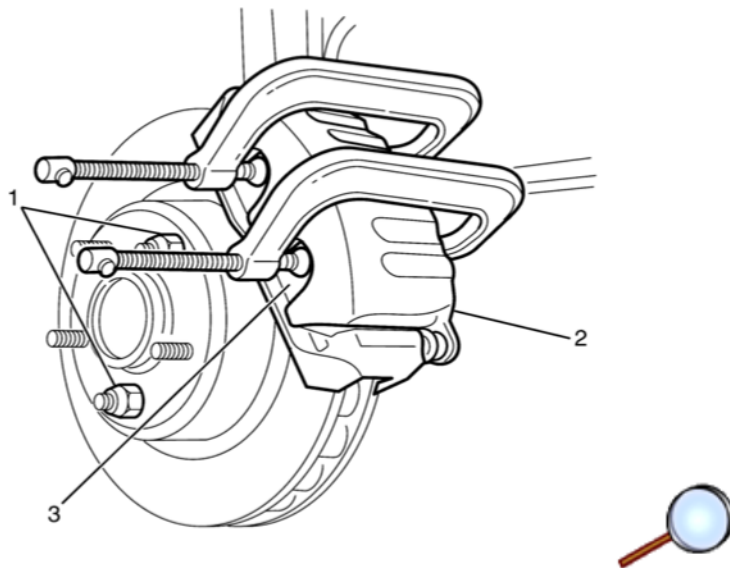
1. Inspect the fluid level in the master cylinder reservoir (2).

- If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Note: DO NOT re use the removed fluid.

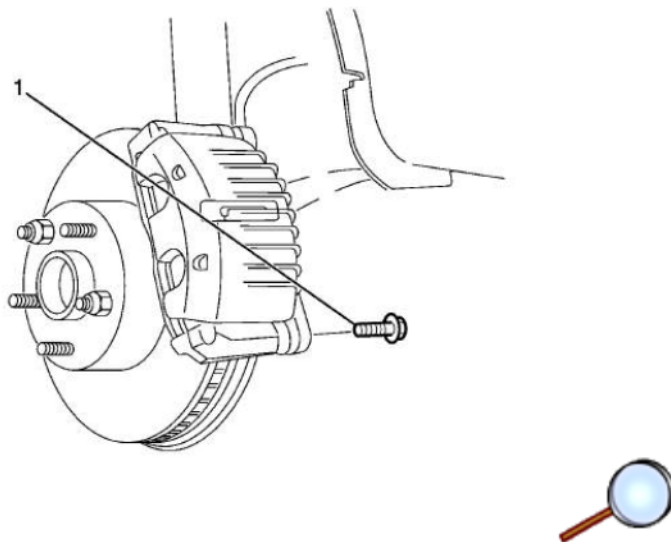
- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, using a hand vacuum pump (1) syphon the brake fluid to the midway point before proceeding.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
 3. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).



4. Install two wheel nuts (1) in reverse to opposite wheel studs to retain the brake disc to the hub.

Note: Position the ends of the G-clamps against the rear of the brake caliper (2) and against the outboard brake pad (3).

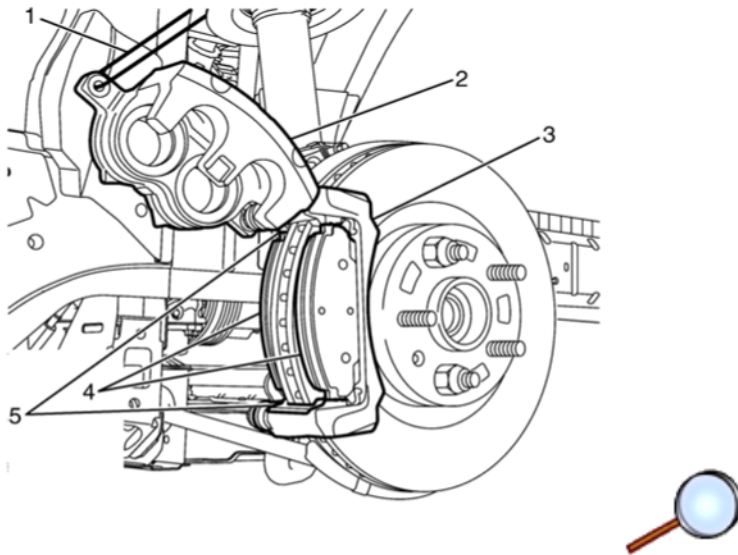
5. Install large G-clamps over the body of the brake caliper (2).
6. Tighten the G-clamps evenly until the brake caliper pistons bottom out in each brake caliper bore.
7. Remove the G-clamps from the brake caliper (2).



Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Note: Make sure the bolt hole is thoroughly cleaned and all micro-encapsulated thread sealant is removed.

8. Remove the brake caliper lower guide pin bolt (1).
Discard the bolt.
Clean the bolt hole.



Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

Note: DO NOT disconnect the brake hose from the brake caliper (2).

9. Pivot the brake caliper (2) upward and secure with heavy mechanics wire (1), or equivalent.
10. Remove the brake pads (4) from the brake caliper anchor plate (3).
11. Remove the brake pad retainers (5) from the brake caliper anchor plate (3).
12. Clean the brake pad brake pad retainer surfaces of the brake caliper anchor plate (3).

Note: Inspect the brake caliper guide pins for freedom of movement and the condition of the guide pin boots. This is achieved by moving the guide pins inboard and outboard within the brake caliper anchor plate (3) bores, without disengaging the slides from the boots.

13. Inspect the brake caliper guide pins and boots for the following conditions:
 - Restricted brake caliper guide pin movement.
 - Too much brake caliper guide pin play in the brake caliper anchor plate (3).
 - Seized or binding brake caliper guide pins.
 - Split or torn boots.
14. If any of the conditions listed are found, overhaul or replace the brake caliper (2).

Installation Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

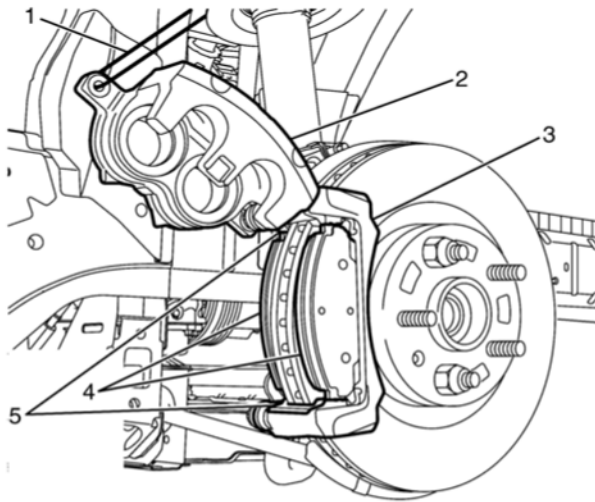
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Clean the piston to brake pad contact faces as required.



2. Install the new brake pad retainers (5) to the brake caliper anchor plate (3).

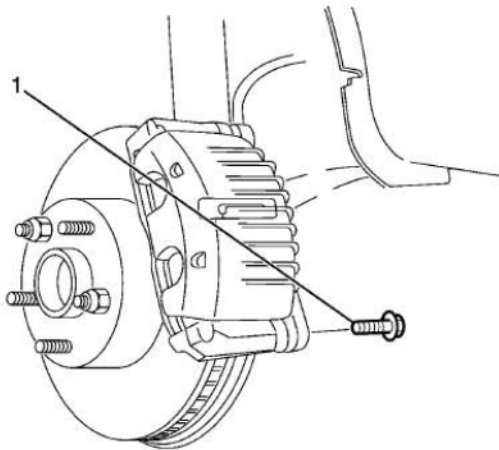
Note: The brake pads (4) are marked as inner and outer only. Failure to install the brake pads (4) in their correct position will cause the brake pads (4) not to seat correctly in the brake caliper (2).

3. Install the brake pads (4) to the brake caliper anchor plate (3).

Note: Make sure the brake hose is correctly located in its mounting bracket.

Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

4. Remove the mechanics wire or equivalent (1), and rotate the brake caliper (2) into position over the brake pads (4) and to the brake caliper anchor plate (3).



Caution: Refer to [Fastener Caution](#).

5. Install the NEW lower brake caliper guide pin to brake caliper anchor plate retaining bolt (1) and tighten to **42 N•m (31 lb ft)**.
6. Remove the wheel nuts retaining the brake disc to the hub.
7. Install the front wheels. Refer to [Tire and Wheel Removal and Installation](#).
8. Lower the vehicle to the ground.
9. With the engine off, gradually apply the brake pedal approximately 2/3 of its travel distance.
10. Slowly release the brake pedal.
11. Repeat steps 9 and 10 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.

12. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
13. Burnish (bed in) the brake pads and brake discs. Refer to [Brake Pad and Rotor Burnishing](#).

Front Disc Brake Pads Replacement (HSV)

Special Tools

J-23738-A Hand Vacuum Pump

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

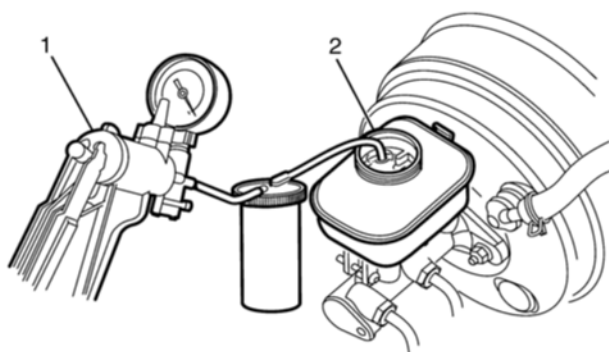
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.



1. Inspect the fluid level in the master cylinder reservoir (2).

- If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

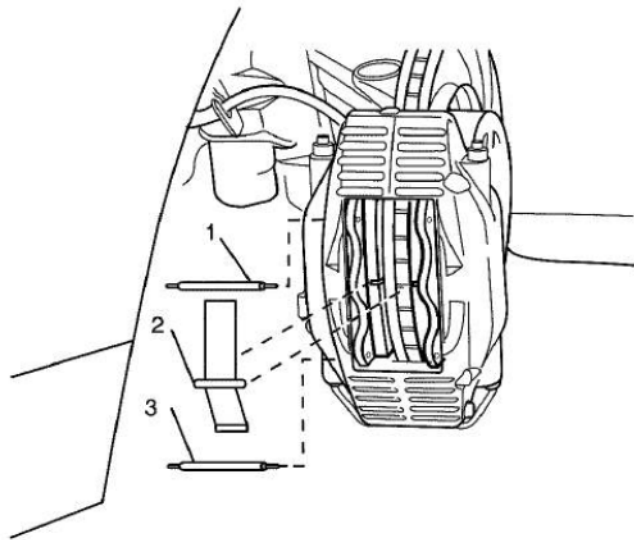
Note: DO NOT re-use the removed fluid.

- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.

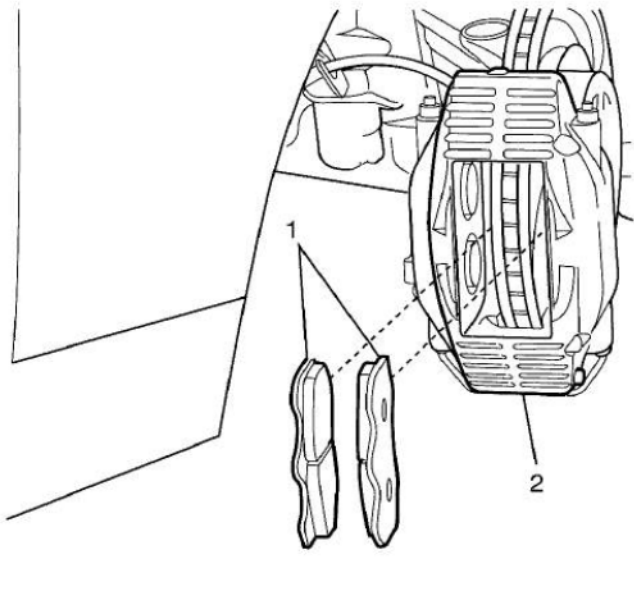
Note: Brake pads should always be replaced in axle sets.

2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

3. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).



4. Use a suitable tool to remove the upper retaining pin (1), lower retaining pin (3) and anti-rattle clip (2) from the brake caliper.

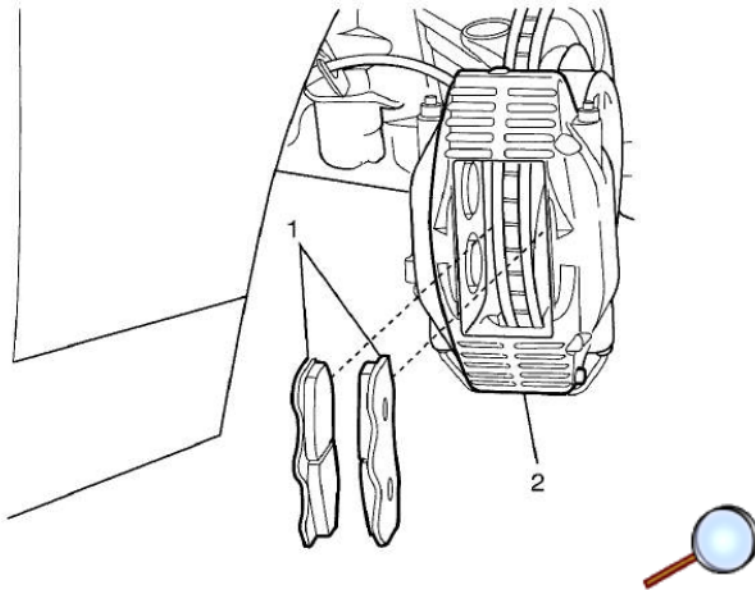


5. Remove the brake pads (1) from the brake caliper (2).
6. Clean the contact surfaces of the brake caliper pistons with denatured alcohol before pushing the pistons fully back into the brake caliper.

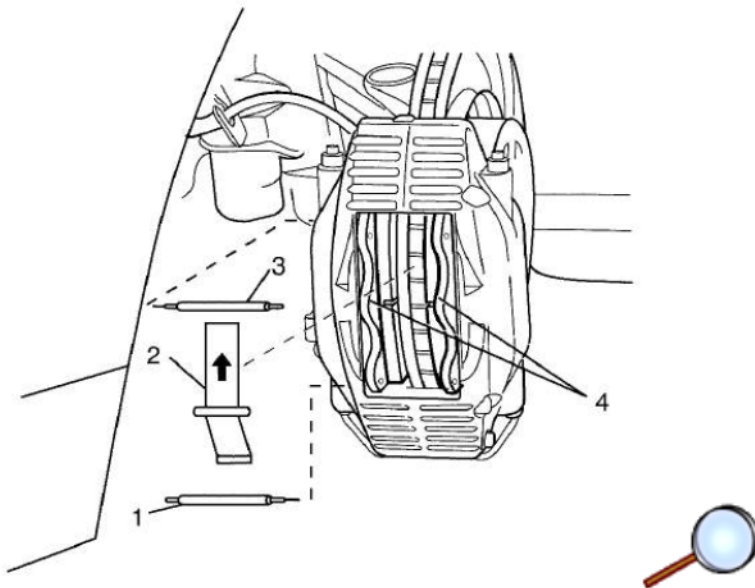
Installation Procedure

Note: Make sure shims are securely affixed to backing plate of the brake pads.

1. Clean the piston to brake pad contact faces as required.



2. Install the brake pads (1) into the brake caliper (2) against the caliper pistons.



3. Install the lower retaining pin (1) into the caliper body through both brake pads (4) .

Note: Arrow located on anti-rattle clip indicates direction of disc rotation. Make sure correct installation of the anti-rattle clip.

4. Install the anti-rattle clip (2) behind the lower retaining pin (1).

5. While bending the anti-rattle clip (2) inwards, install the upper retaining pin (3) into the caliper body and through both brake pads (4).

6. Install the front wheels. Refer to [Tire and Wheel Removal and Installation](#).

7. Lower the vehicle to the ground.

8. With the Ignition Off, gradually apply the brake pedal approximately 2/3 of its travel distance.

9. Slowly release the brake pedal.

10. Repeat steps 10 and 11 until a firm brake pedal application is obtained. This will correctly seat the brake caliper pistons and brake pads.

11. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

12. Burnish (bed in) the brake pads and brake rotors. Refer to [Brake Pad and Rotor Burnishing](#).

Front Disc Brake Pads Replacement (Redline)

Special Tools

CH-23738-A Hand Vacuum Pump

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

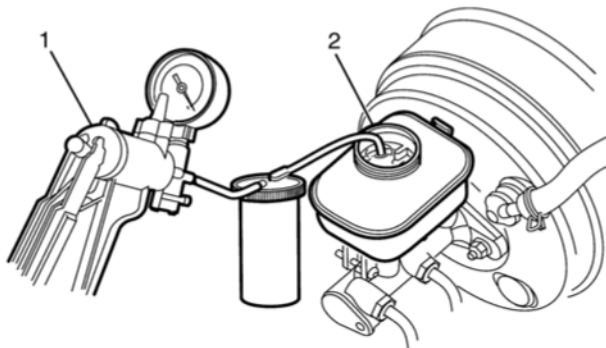
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Note: Always replace disc brake pads in axle sets.



1. Inspect the fluid level in the master cylinder reservoir (2).

- If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

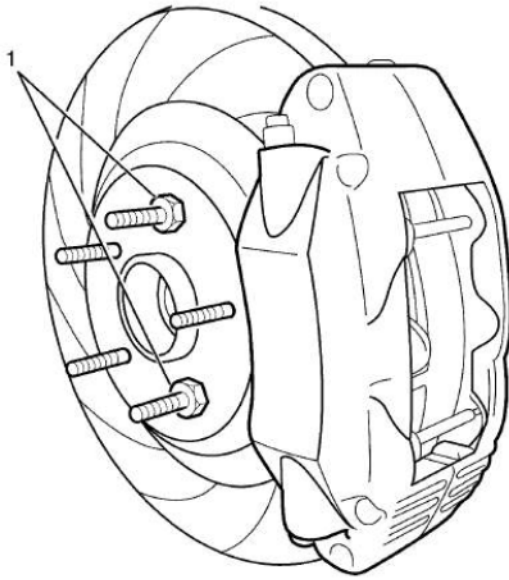
Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Note: DO NOT re use the removed fluid.

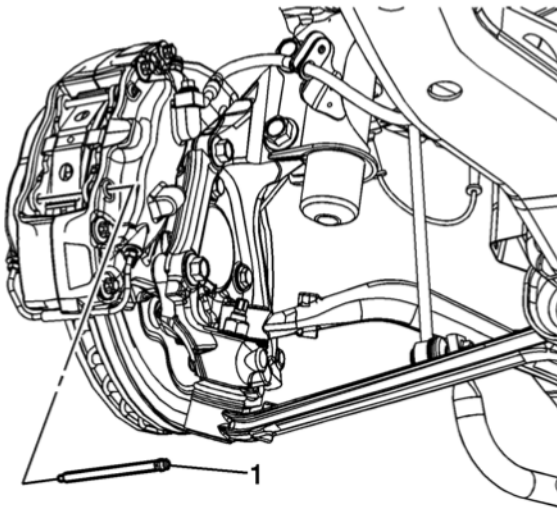
- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, use the CH-23738-A Hand Vacuum Pump (1) to syphon the brake fluid out until it is at the midway point before proceeding.

2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

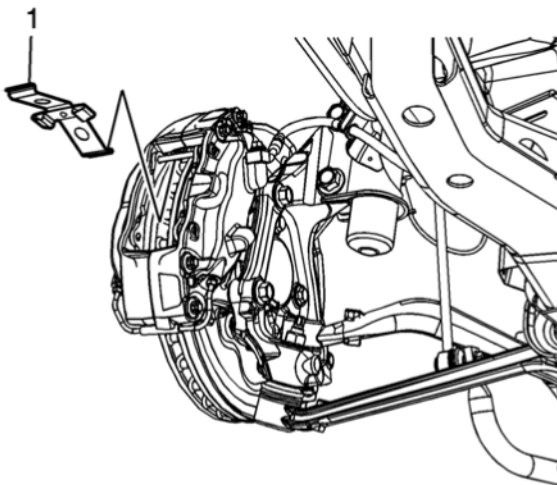
3. Remove the tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).



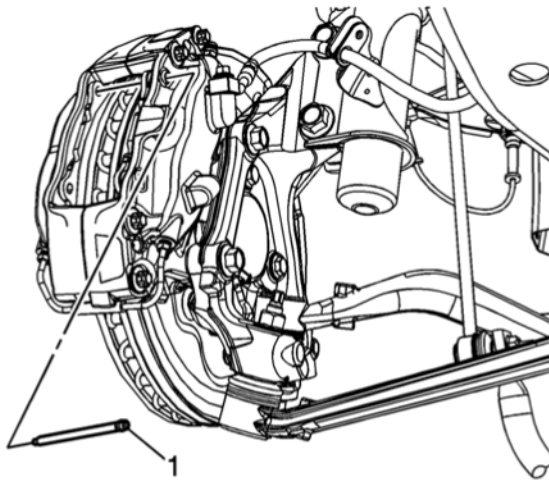
4. Install two opposite wheel nuts (1), with the flat side of the wheel nut against the brake rotor to retain the brake rotor to the wheel hub.



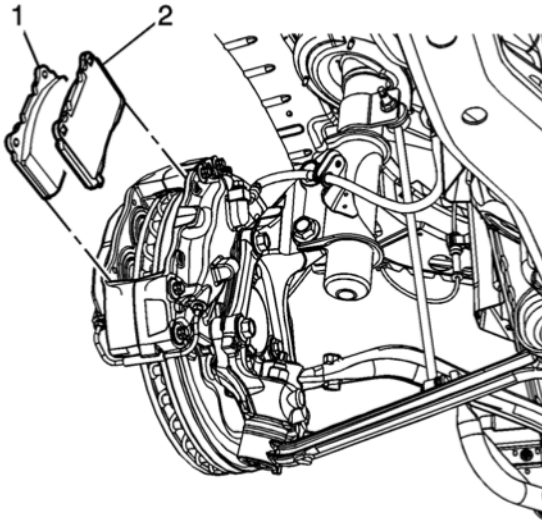
5. Hold the end of the brake pad spring down and carefully drive out the lower brake caliper pin (1) from the brake caliper.



6. Remove the brake pad spring (1).



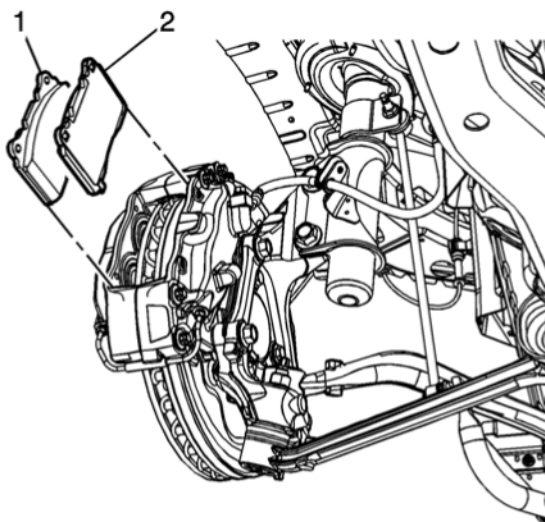
7. Carefully drive out the upper brake pad pin (1) from the brake caliper.
8. Using a spreader tool, carefully push the brake caliper pistons into the caliper bores until fully seated.



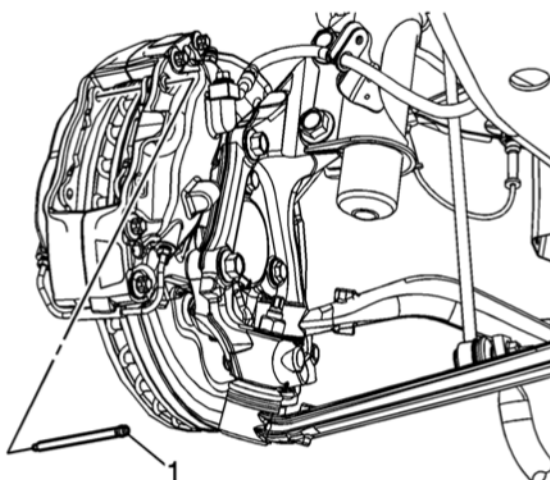
9. Remove the outer brake pad (1).
10. Remove the inner brake pad (2), noting the location of the brake pad wear sensor.

Installation Procedure

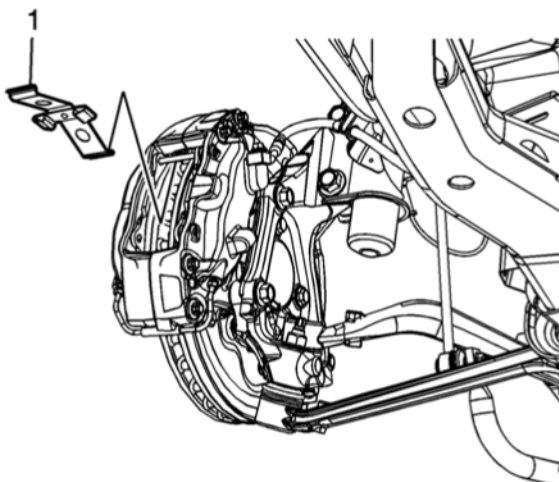
1. Inspect the brake caliper pins and brake pad springs for damage or excessive corrosion and replace, if necessary.



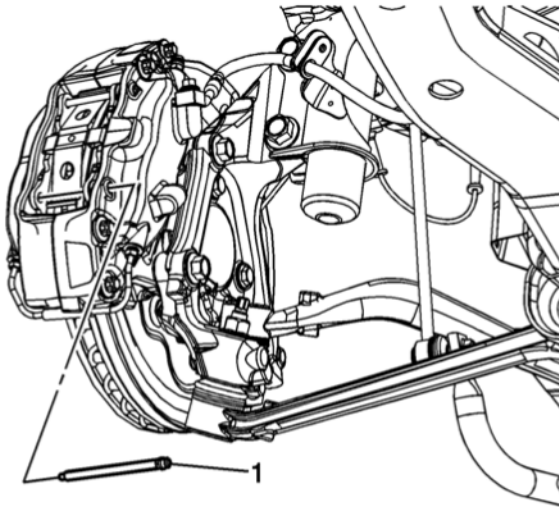
2. Install the outer brake pad (1).
3. Install the inner brake pad (2), noting the location of the brake pad wear sensor.



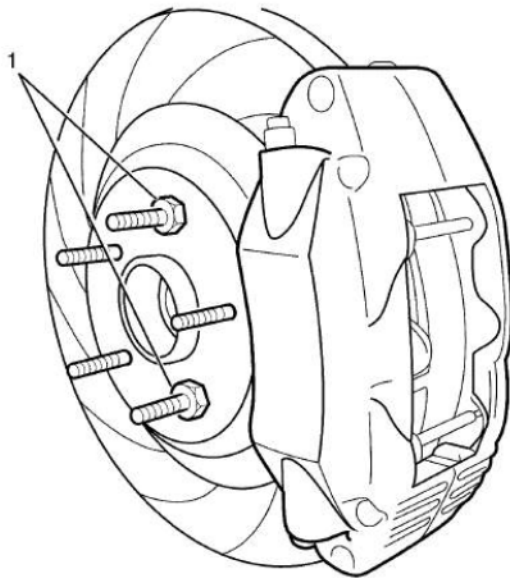
4. Carefully drive the upper brake caliper pin (1) into the brake caliper.
5. Ensure the brake caliper pin is fully seated in the brake caliper.



6. Install the brake pad spring (1).



7. Hold the end of the brake pad spring down and carefully drive the lower brake caliper pin (1) into the brake caliper.
8. Ensure the brake caliper pin is fully seated in the brake caliper.



9. Remove the wheel nuts (1) retaining the brake rotor to the wheel hub.
10. Install the tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
11. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
12. Slowly release the brake pedal.
13. Wait 15 seconds, then repeat steps 11 and 12 until a firm brake pedal apply is obtained. This will properly seat the brake caliper pistons and brake pads.
14. Fill the brake master cylinder reservoir to the proper level. Refer to [Master Cylinder Reservoir Filling](#).
15. Burnish the brake pads and rotors. Refer to [Brake Pad and Rotor Burnishing](#).

Rear Disc Brake Pads Replacement (Except HSV)

Special Tools

J-23738-A Hand Vacuum Pump

Removal Procedure

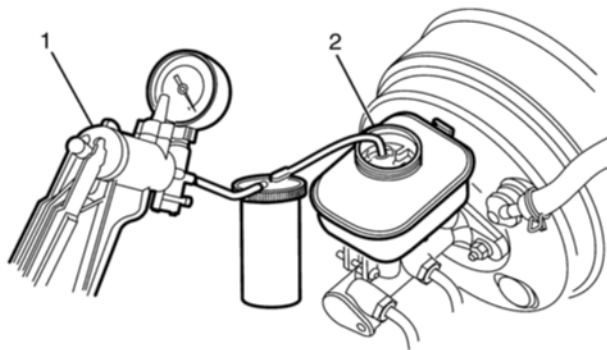
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

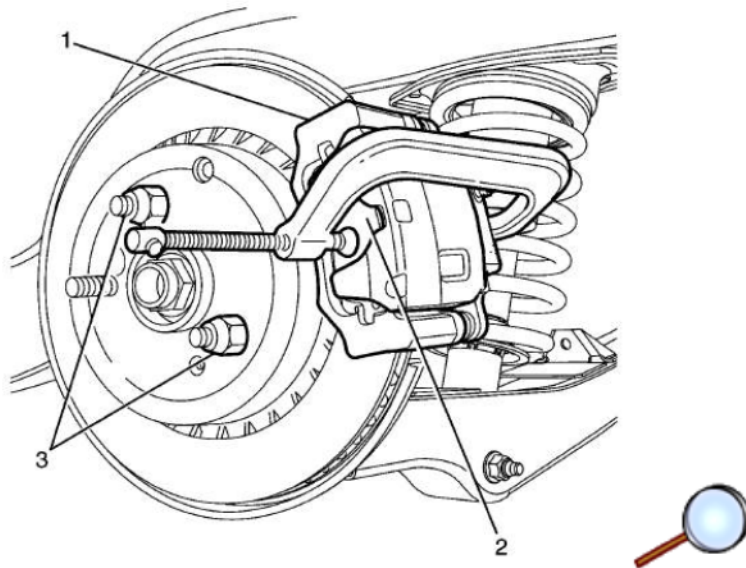
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).
 - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

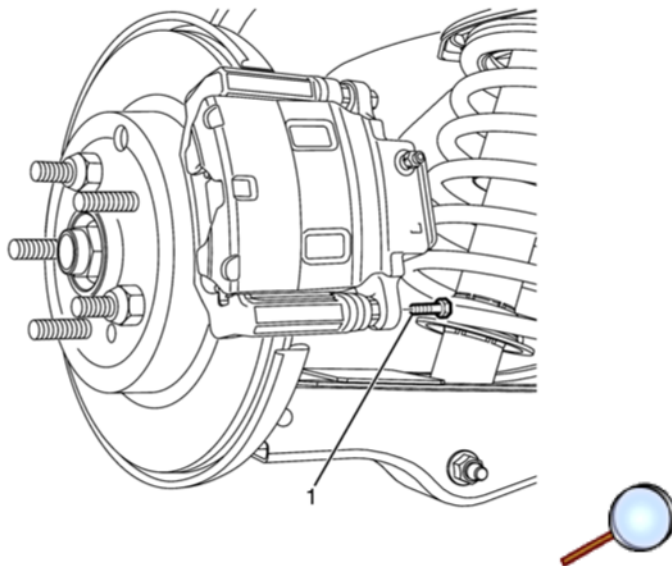
Note: DO NOT re use the removed fluid.
 - If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.
- Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.
- Warning:** Refer to [Safety Glasses Warning](#).
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).



4. Install 2 wheel nuts (3) in reverse to opposite wheel studs to retain the brake disc to the hub.

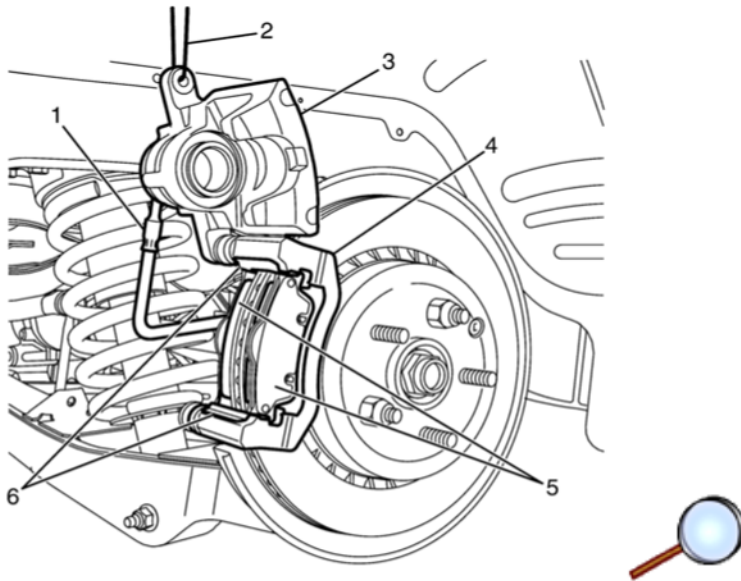
Note: Position the ends of the G-clamp against the rear of the rear brake caliper (1) and against the outboard brake pad (2).

5. Install a large G-clamp over the body of the rear brake caliper (1).
6. Tighten the G-clamp until the rear brake caliper piston bottoms out in the rear brake caliper bore.
7. Remove the G-clamps from the rear brake caliper (1).



Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

8. Remove the rear brake caliper to rear brake caliper lower guide pin retaining bolt (1) and discard.

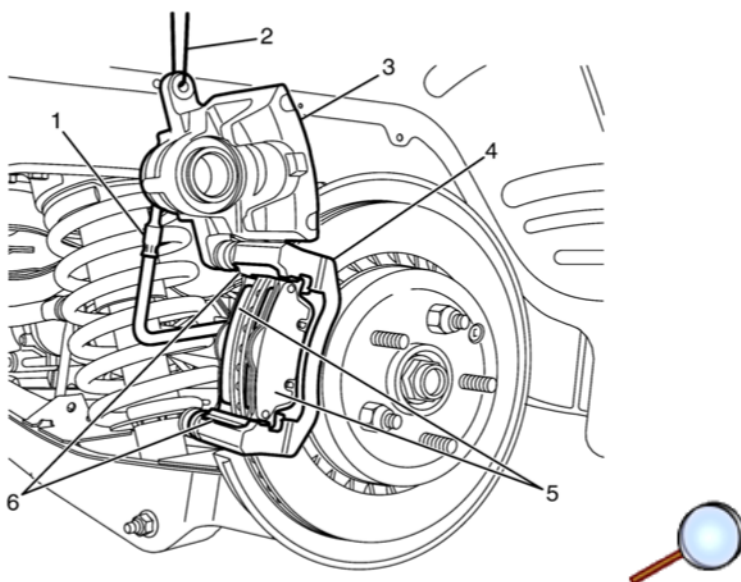


Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

Note: DO NOT disconnect the brake hose (1) from the rear brake caliper (3).

9. Pivot the rear brake caliper (3) upward and secure with heavy mechanics wire (2), or equivalent.
10. Remove the rear disk brake pads (5) from the rear brake caliper anchor plate (4).
11. Remove the rear disk brake pad retainers (6) from the rear brake caliper anchor plate (4).
12. Clean the rear brake disk pad retainer mating surfaces of the rear brake caliper anchor plate (4).
13. Inspect the rear brake caliper guide pins and boots for the following conditions:
 - Restricted rear brake caliper guide pin movement
 - Excessive rear brake caliper guide pin play in the rear brake caliper anchor plate (4)
 - Seized or binding rear brake caliper guide pins
 - Split or torn rear brake caliper guide pin boots
14. If any of the conditions listed are found, overhaul or replace the rear brake caliper (3).

Installation Procedure



Note: DO NOT use petrol to clean the rear brake caliper piston as this may damage the rear brake caliper piston seals.

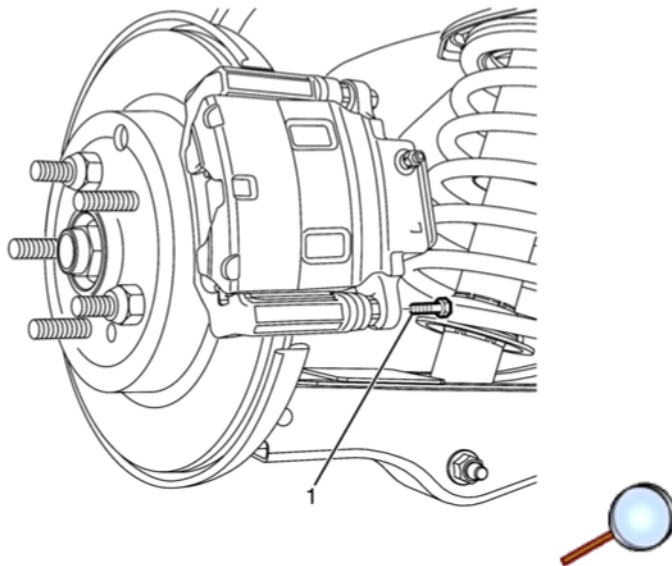
1. Thoroughly clean the rear brake caliper surfaces which make contact with the rear disk brake pads (5).
2. Install the rear disk brake pad retainers (6) to the rear brake caliper anchor plate (4).

Note: The rear disk brake pads (5) are directional and marked as left hand inner and right hand inner and must only be fitted to their respective positions or brake pad life and performance will be reduced.

3. Install the rear disk brake pads (5) to the rear brake caliper anchor plate (4).

Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

4. Remove the mechanics wire (2) or equivalent , and rotate the rear brake caliper (3) into position over the rear disk brake pads (5). and to the rear brake caliper anchor plate (4).



5. Align the rear brake caliper with the rear brake caliper guide pin.

Caution: Refer to [Fastener Caution](#).

6. Install the NEW rear brake caliper to rear brake caliper lower guide pin retaining bolt (1) and tighten to **42 N·m (31 lb ft)**.
7. Remove the wheel nuts retaining the brake disc to the hub.
8. Install the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
9. Lower the vehicle to the ground.
10. With the Ignition Off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
11. Repeat the previous step until a firm brake pedal application is obtained.
12. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).
13. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
14. Burnish the brake pads and brake discs if required. Refer to [Brake Pad and Rotor Burnishing](#).

Rear Disc Brake Pads Replacement (HSV)

Special Tools

J-23738-A Hand Vacuum Pump

Removal Procedure

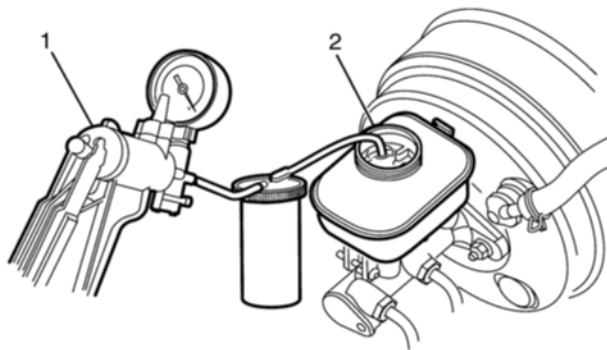
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).

- If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

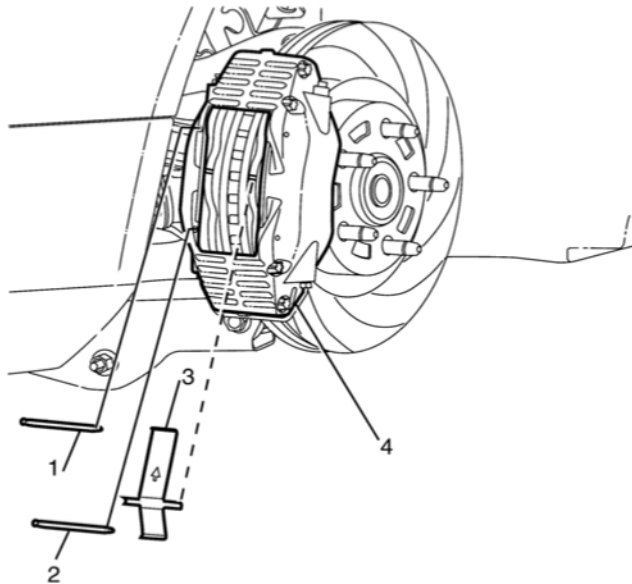
Note: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.

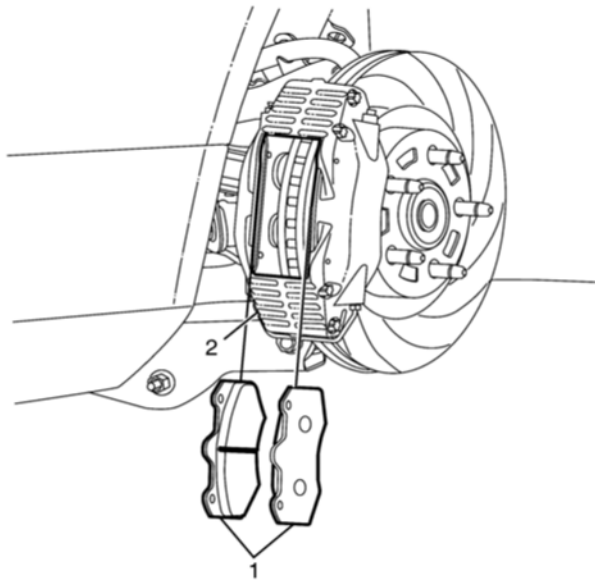
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).



4. Use a suitable tool to remove the upper retaining pin (1), lower retaining pin (2) and anti-rattle clip (3) from the rear brake caliper (4).

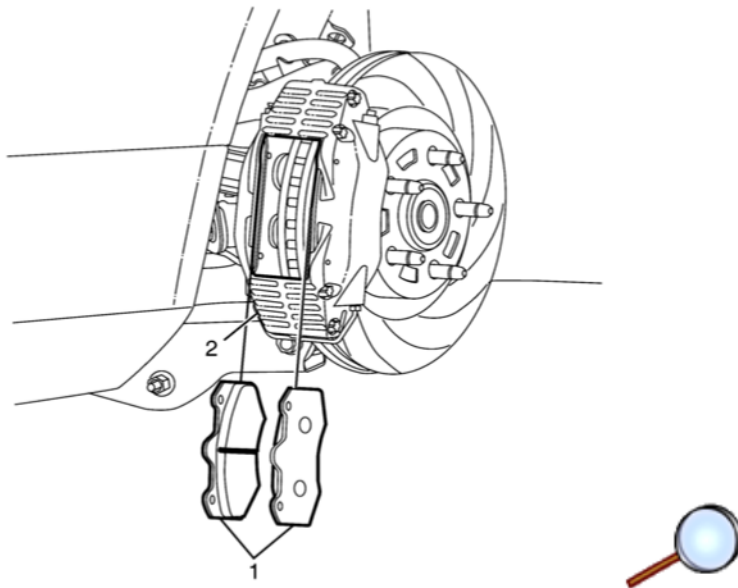


5. Using an appropriate retractor tool slowly push the rear brake caliper pistons back into the rear brake caliper (2).
6. Remove the rear disk brake pads (1) from the rear brake caliper (2).

Note: DO NOT use petrol to clean the rear brake caliper pistons as this may damage the rear brake caliper piston seals.

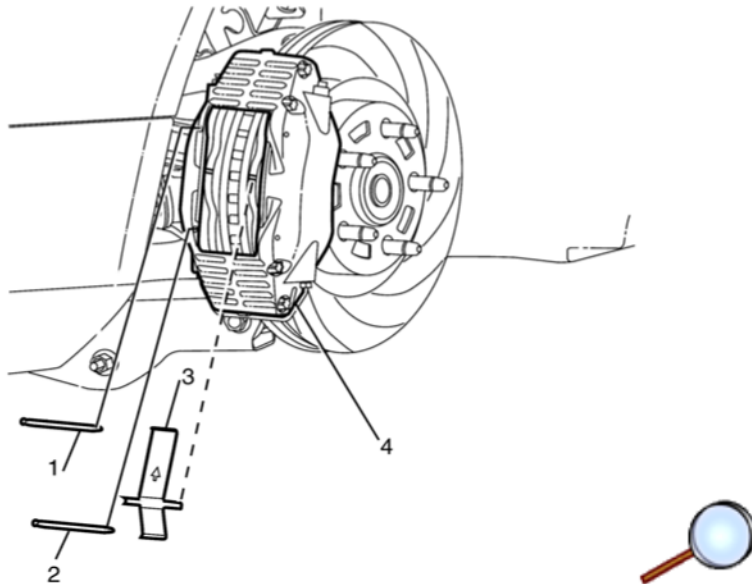
7. Clean the contact surfaces of the brake rear brake caliper pistons with denatured alcohol.

Installation Procedure



Note: Make sure rear disk brake pad shims are securely attached to the rear disk brake pads (1).

1. Install the rear disk brake pads (1) to the rear brake caliper (2).



2. Install the rear disc brake pad upper retaining pin (2) to the rear brake caliper (4) making sure it has securely engaged both rear disk brake pads.

Note: The anti-rattle clip must be installed with the arrow pointing in the forward direction of disc rotation.

3. Insert the anti-rattle clip (3) behind the rear brake pad upper retaining pin (2).
4. Push the anti-rattle clip down towards the rear disk rotor and install the rear disk brake pad lower retaining pin (1) into the rear brake caliper (4) making sure it has securely engaged both rear disk brake pads.
5. Install the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).
6. Lower the vehicle to the ground.
7. With the Ignition Off, gradually apply the brake pedal approximately 2/3 of its travel distance.
8. Slowly release the brake pedal.
9. Repeat steps 9 and 10 until a firm brake pedal application is obtained. This will correctly seat the rear brake caliper pistons and brake pads.
10. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

11. Burnish (bed in) the brake pads and brake rotors. Refer to [Brake Pad and Rotor Burnishing](#).

Brake Pad and Rotor Burnishing

Warning: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

Burnishing the brake pads and brake rotors is necessary in order to ensure that the braking surfaces are properly prepared after service has been performed on the disc brake system.

This procedure should be performed whenever the disc brake rotors have been refinished or replaced, and/or whenever the disc brake pads have been replaced.

1. Select a smooth road with little or no traffic.
2. Accelerate the vehicle to 48 km/h (30 mph).

Note: Use care to avoid overheating the brakes while performing this step.

3. Using moderate to firm pressure, apply the brakes to bring the vehicle to a stop. Do not allow the brakes to lock.
4. Repeat steps 2 and 3 until approximately 20 stops have been completed. Allow sufficient cooling periods between stops in order to properly burnish the brake pads and rotors.

Front Brake Caliper Replacement (HSV)

Special Tools

GE-23738-A Hand Vacuum Pump

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

Warning: Refer to [Brake Dust Warning](#).

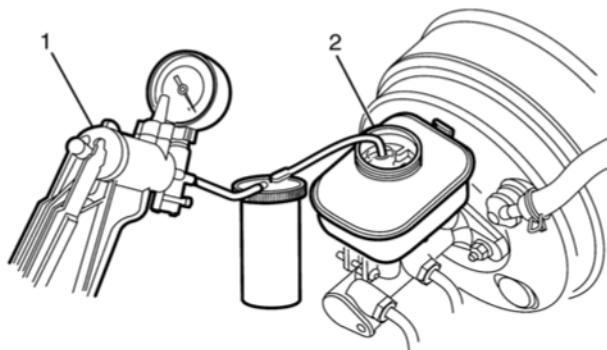
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).
2. If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

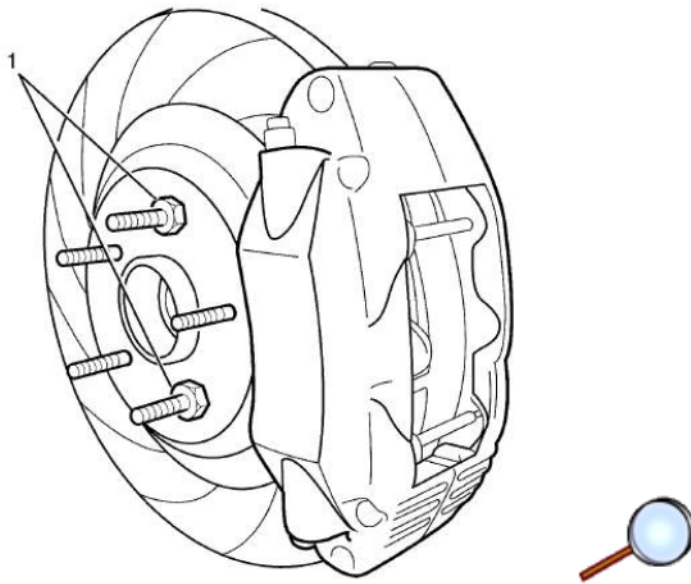
Note: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Note: DO NOT reuse the removed brake fluid.

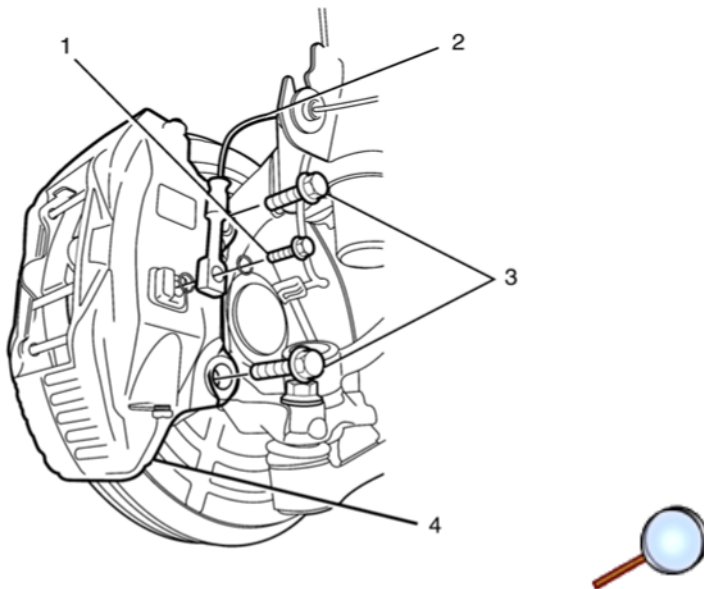
3. If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, remove brake fluid to the midway point using the GE-23738-A Hand Vacuum Pump (1) before proceeding.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).



6. Install 2 wheel nuts (1) in reverse to opposite wheel studs to retain the brake rotor to the wheel hub.
7. Remove the front disc brake pads. Refer to [Front Disc Brake Pads Replacement](#).
8. Inspect the front disc brake pads. Refer to [Brake Pad Inspection](#).
9. Place a drain tray under the front brake caliper.

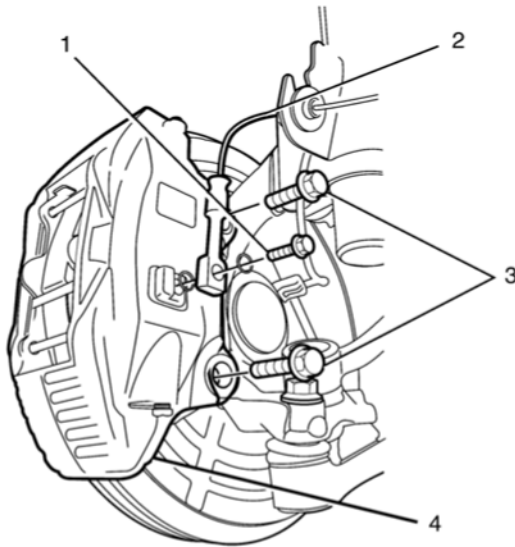


10. Remove the front brake hose to front brake caliper retaining banjo bolt (1).
11. Remove the front brake hose (2) from the front brake caliper (4).
12. Cap the brake hose fitting to prevent brake fluid loss and contamination.
Note: Do not reuse the brake hose fitting gaskets.
13. Discard the brake hose fitting gaskets.
14. Gently warm the front brake caliper to steering knuckle retaining bolts (3) with a heat gun to soften the micro encapsulated adhesive on the bolts.
Note: Do not reuse the front brake caliper to steering knuckle retaining bolts.
15. Remove and discard the front brake caliper to steering knuckle retaining bolts (3).
16. Remove the front brake caliper (4).

Installation Procedure

1. Clean the brake caliper threaded mounting holes with a M12x2.0 thread chaser to remove any remaining threadlocker.

2. Clean the front brake caliper mounting surfaces and front brake caliper mounting threads using brake cleaner or equivalent.



Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

3. Position the front brake caliper over the front brake rotor and align the front brake caliper with the steering knuckle.

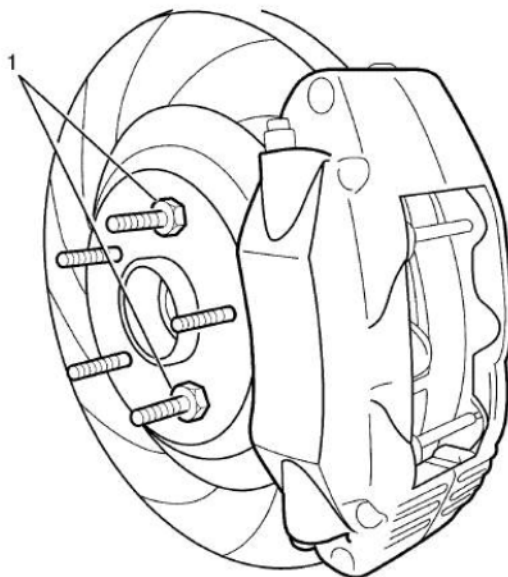
Caution: Refer to [Fastener Caution](#).

Note: Under no circumstances is an impact wrench to be used on caliper mounting bolts.

4. Install the NEW front brake caliper to steering knuckle retaining bolts (3) and tighten to **160 N•m (118 lb ft)**.

Note: Install new brake hose fitting gaskets.

5. Assemble the front brake hose fitting gaskets and the front brake hose to front brake caliper retaining banjo bolt (1) to the front brake hose (2).
6. Install the front brake hose to front brake caliper retaining banjo bolt (1) to the front brake caliper (4) and tighten to **35 N•m (26 lb ft)**.
7. Install the front disc brake pads. Refer to [Front Disc Brake Pads Replacement](#).
8. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).



9. Remove the 2 wheel nuts (1) from the wheel studs.
10. Install the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).

11. With the ignition OFF, gradually apply and release the brake pedal to approximately 2/3 of its travel distance.
12. Repeat step 11 until a firm brake pedal application is obtained.
13. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
14. Burnish the brake pads and brake rotors if required. Refer to [Brake Pad and Rotor Burnishing](#).

Front Brake Caliper Replacement (Except HSV)

Special Tools

CH-23738-A Hand Vacuum Pump

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

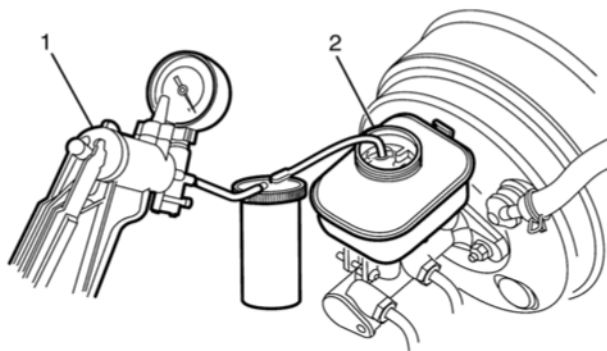
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the master cylinder reservoir (2).

- If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

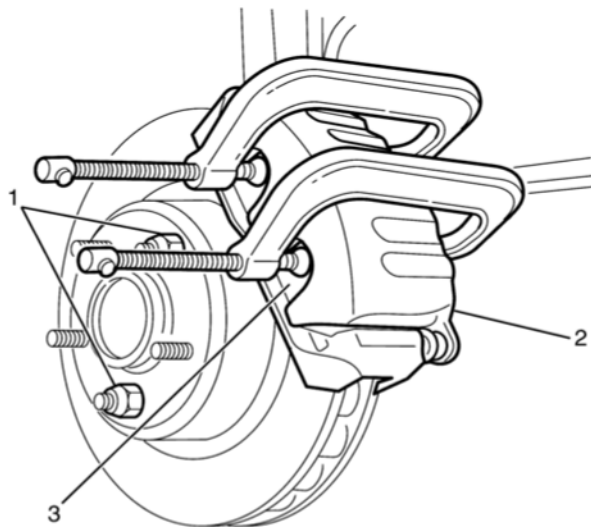
Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Note: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, use the CH-23738-A Hand Vacuum Pump (1) to syphon the brake fluid out until it is at the midway point before proceeding.

2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

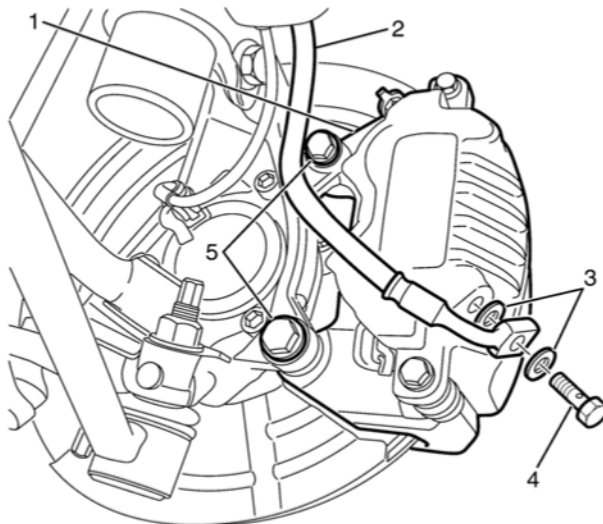
3. Remove the front wheel. Refer to [Tire and Wheel Removal and Installation](#).



4. Install 2 wheel nuts (1) in reverse to opposite wheel studs to retain the brake disc to the hub.

Note: Position the ends of the G-clamps against the rear of the front brake caliper (2) and against the outboard brake pad (3).

5. Install large G-clamps over the body of the front brake caliper (2).
6. Tighten the G-clamps evenly until the front brake caliper pistons bottom in each front brake caliper bore.
7. Remove the G-clamps from the front brake caliper (2).
8. Place a clean suitable container under the front brake caliper.



9. Remove the front brake hose to front brake caliper retaining banjo bolt (4).

Note: Install a rubber cap or plug on the exposed brake hose end in order to prevent fluid loss and contamination.

10. Separate the brake hose to front brake caliper retaining banjo bolt (4) from the brake hose (2).

Note: The front brake caliper copper brake hose sealing washers (3) are single use components. They must be discarded after removal.

11. Remove and discard the copper brake hose sealing washers (3).

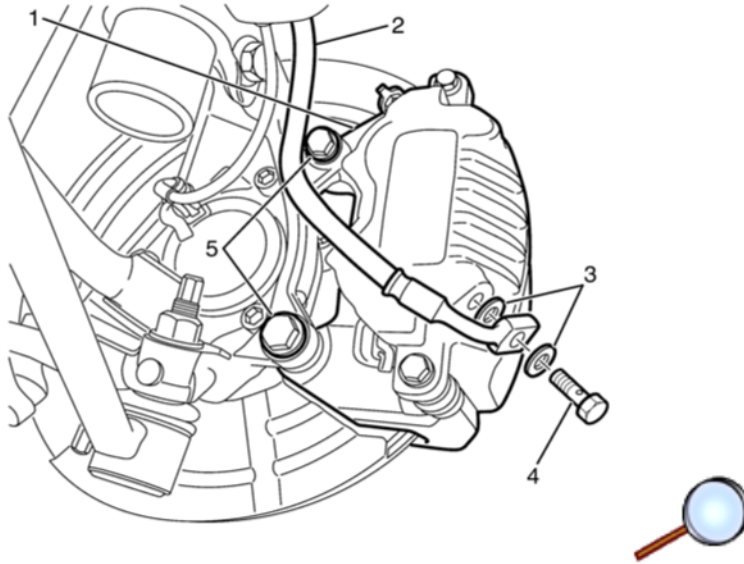
Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

12. Remove the front brake caliper anchor plate to steering knuckle retaining bolts (5) and discard.

13. Remove the front brake caliper (1) from the steering knuckle.
14. Clean the front brake caliper anchor plate mounting surfaces on the steering knuckle.
15. Check the serviceability of the front brake pads [Brake Pad Inspection](#).

Installation Procedure

1. Install the existing or NEW brake pads as required. Refer to [Front Disc Brake Pads Replacement](#).
2. Press the inner brake pad by using a suitable tool to make sure the front brake caliper pistons bottom out in each front brake caliper bore.



Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

3. Position the front brake caliper over the front brake rotor and align the front brake caliper with the steering knuckle.

Caution: Refer to [Fastener Caution](#).

4. Install the NEW front brake caliper anchor plate to steering knuckle retaining bolts (5) and tighten to **40 N·m + 90 degrees (30 lb ft + 90 degrees)**.

Note: Install NEW copper brake hose sealing washers.

5. Assemble the front brake hose sealing washers (3) and the front brake hose to front brake caliper retaining banjo bolt (4) to the front brake hose (2).
6. Install the front brake hose to front brake caliper retaining banjo bolt (4) to the front brake caliper (1) and tighten to **35 N·m (25 lb ft)**.
7. Bleed the braking system. Refer to [Hydraulic Brake System Bleeding](#).
8. Remove the 2 wheel nuts retaining the brake disc to the hub.
9. Install the front wheel. Refer to [Tire and Wheel Removal and Installation](#).
10. Lower the vehicle to the ground.
11. With the Ignition OFF, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
12. Repeat step 11 until a firm brake pedal application is obtained.
13. If a firm brake pedal application can not be obtained, bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).
14. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
15. Burnish the brake pads and brake discs if required. Refer to [Brake Pad and Rotor Burnishing](#).

Front Brake Caliper Replacement (Redline)

Special Tools

CH-23738-A Hand Vacuum Pump

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

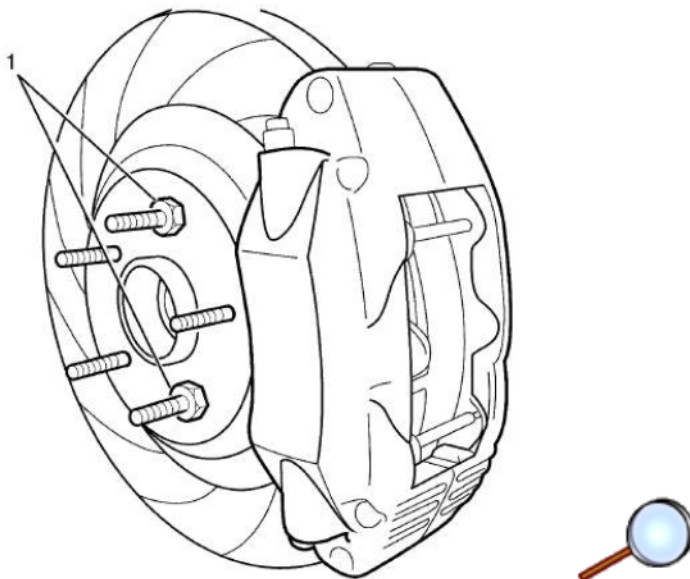
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

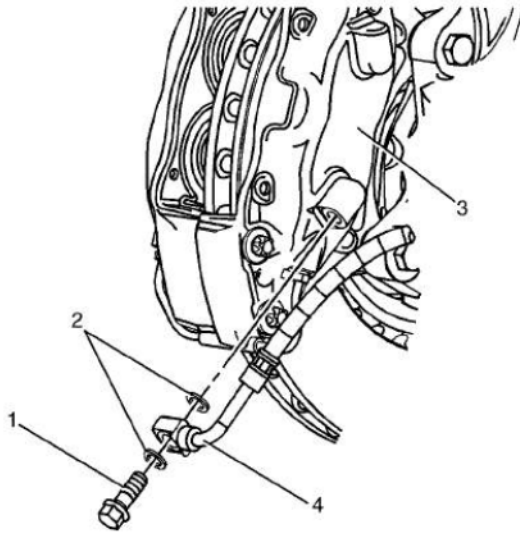
Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Inspect the brake fluid level in the brake master cylinder reservoir.
2. If required, use CH-23738-A Hand Vacuum Pump to remove some brake fluid until the brake fluid level is midway between the maximum brake fluid level marking and the minimum brake fluid level marking.
 - Do not completely empty the brake master cylinder reservoir.
 - The brake fluid level must be midway between the maximum brake fluid level marking and the minimum brake fluid level marking.
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).



5. Install two opposite wheel nuts (1), with the flat side of the wheel nut against the brake rotor to retain the brake rotor to the wheel hub.



6. Remove the front disc brake pads. Refer to [Front Disc Brake Pads Replacement](#).

7. Remove the brake hose to brake caliper banjo bolt (1).

8. Remove the brake hose (4) from the brake caliper (3).

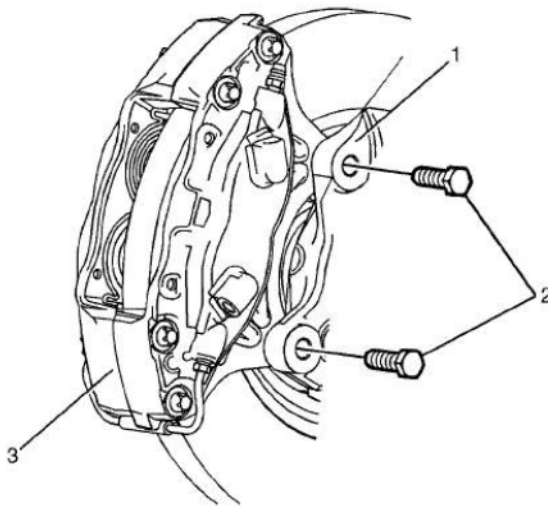
Note: Plug the exposed end of the brake hose (4) in order to prevent fluid loss and contamination.

9. Plug the exposed end of the brake hose (4).

Note: Plug the exposed brake hose hole of the brake caliper (3) in order to prevent contamination.

10. Plug the exposed brake hose hole of the brake caliper (3).

11. Discard the brake caliper banjo bolt (1) and copper washers (2).



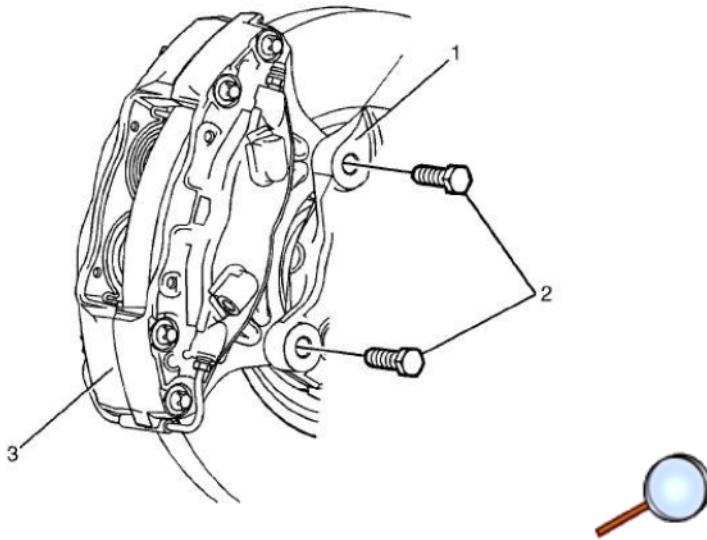
Note: The brake caliper to knuckle mounting bolts are single-use, and must be replaced whenever they are removed.

12. Remove the brake caliper to knuckle mounting bolts (2) and discard.

Note: If the brake pads are to be removed from the brake caliper, make sure that the brake pads are installed in their original positions. Failure to comply will cause the brake pads to be seated incorrectly and may effect the braking efficiency.

13. Remove the brake caliper (3) from the steering knuckle (1).

[Installation Procedure](#)

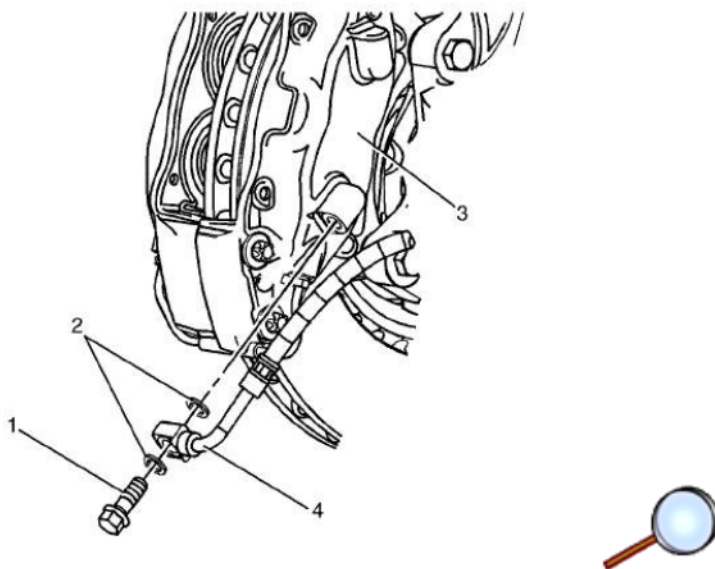


1. Install the brake caliper (3) to the steering knuckle (1).

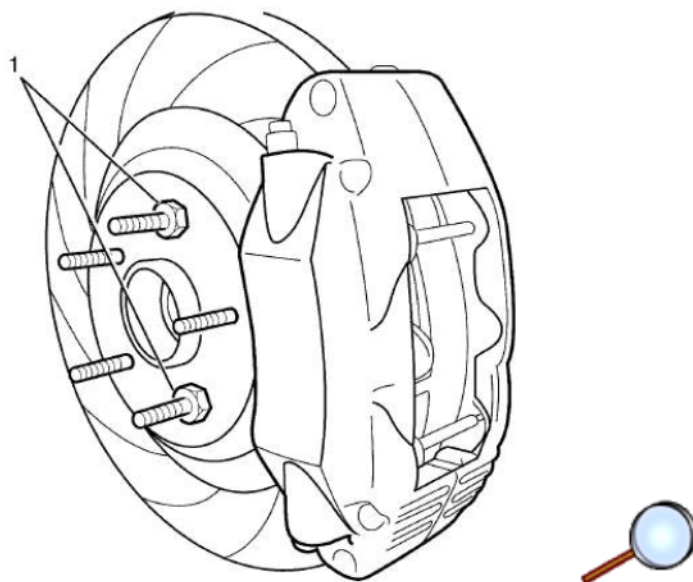
Caution: Refer to [Fastener Caution](#).

Note: Do not use an impact wrench to tighten the brake caliper to steering knuckle mounting bolts (2). Failure to comply may cause damage to the brake caliper to steering knuckle mounting bolts (2).

2. Install the NEW brake caliper anchor plate to front steering knuckle mounting bolts (2) and tighten to **40 N·m + 90 degrees (30 lb ft + 90 degrees)**.
3. Check the serviceability of the brake pads. Refer to [Brake Pad Inspection](#).
4. Install the NEW brake pads to the brake caliper if required. Refer to [Front Disc Brake Pads Replacement](#).



5. Remove the plug from the brake hose hole of the brake caliper (3).
6. Remove the plug from the exposed end of the brake hose (4).
7. Assemble the NEW brake caliper banjo bolt (1) and the NEW copper washers (2) to the brake hose (4).
8. Install the brake caliper banjo bolt, brake hose, and washer assembly to the brake caliper (3) and tighten the brake caliper banjo bolt to **35 N·m (25 lb ft)**.
9. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).
10. With the Ignition OFF, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
11. Repeat step 10 until a firm brake pedal application is obtained.



12. Remove the 2 opposite wheel nuts (1), from the wheel studs.
13. Install the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
14. Burnish the brake pads and rotors if required. Refer to [Brake Pad and Rotor Burnishing](#).

Rear Brake Caliper Replacement (Except HSV)

Special Tools

J-23738-A Hand Vacuum Pump

Removal Procedure

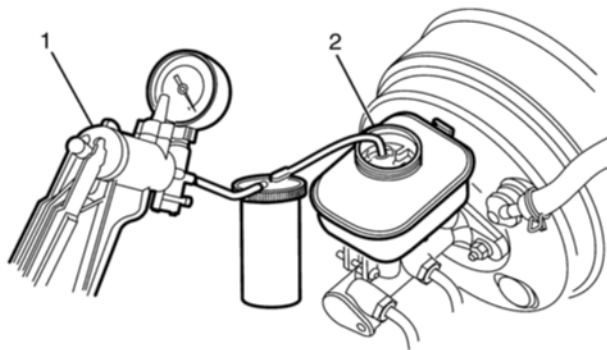
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

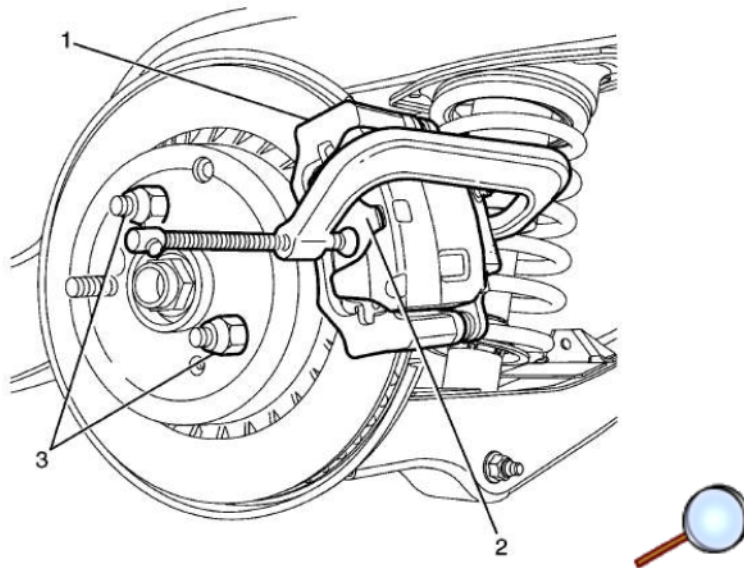
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).
 - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

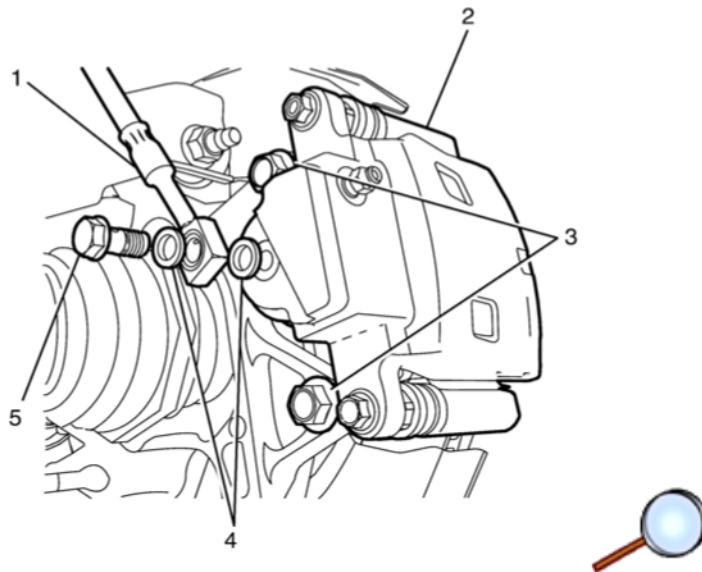
Note: DO NOT re use the removed fluid.
 - If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.
- Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.
- Warning:** Refer to [Safety Glasses Warning](#).
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).



4. Install 2 wheel nuts (3) in reverse to opposite wheel studs to retain the brake disc to the hub.

Note: Position the ends of the G-clamp against the rear of the rear brake caliper (1) and against the outboard brake pad (2).

5. Install a large G-clamp over the body of the rear brake caliper (1).
6. Tighten the G-clamp until the rear brake caliper piston bottoms out in the rear brake caliper bore.
7. Remove the G-clamps from the rear brake caliper (1).
8. Place a drain tray beneath the rear brake caliper .



9. Remove the brake hose to rear brake caliper retaining banjo bolt (5).

Note: Install a rubber cap or plug on the exposed brake hose end in order to prevent fluid loss and contamination.

10. Separate the brake hose to rear brake caliper retaining banjo bolt (5) from the brake hose (1).

Note: The rear brake caliper copper brake hose sealing washers (4) are single use components. They must be discarded after removal.

11. Remove and discard the copper brake hose sealing washers (4).

Note: Inspect the brake caliper anchor plate to knuckle retaining bolts (2) for damage. Discard any damaged bolts.

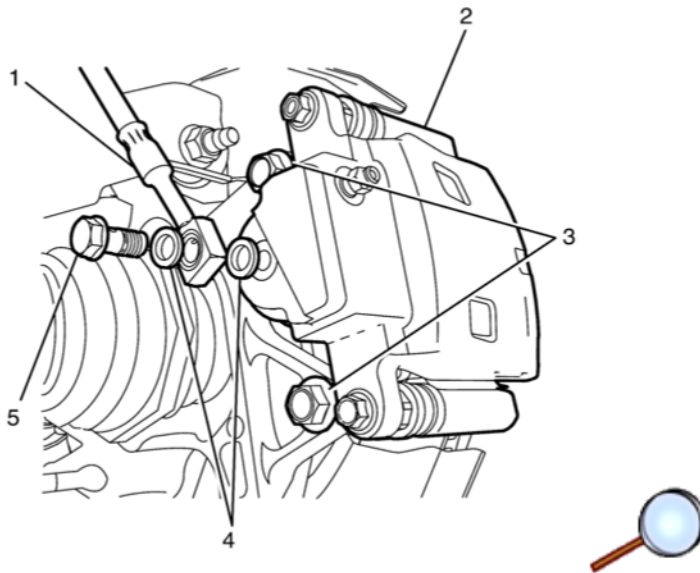
Note: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

12. Remove the rear brake caliper anchor plate to rear knuckle retaining bolts (3).

- Clean and inspect the bolts.
 - Clean the bolt holes.
13. Remove the rear brake caliper (2) from the vehicle.
 14. Clean the rear brake caliper anchor plate mounting surfaces on the rear knuckle.
 15. Check the serviceability of the brake pads. Refer to [Brake Pad Inspection](#).

Installation Procedure

1. Install the existing or NEW brake pads as required. Refer to [Rear Disc Brake Pads Replacement](#).
2. Press the inner brake pad by using a suitable tool to make sure the rear brake caliper piston bottoms out in the rear brake caliper bore.



Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

3. Position the rear brake caliper over the rear brake rotor and align the rear brake caliper with the rear knuckle.
4. Apply Loctite® 243 to the brake caliper anchor plate to knuckle bolts (3).

5. Install the rear brake caliper anchor plate to rear knuckle retaining bolts (3) and tighten to **110N·m (81 lb ft)**.

Note: Install NEW copper brake hose sealing washers.

6. Assemble the rear brake hose sealing washers (4) and the rear brake hose to rear brake caliper retaining banjo bolt (5) to the rear brake hose (1).
7. Install the rear brake hose to rear brake caliper retaining banjo bolt (5) to the rear brake caliper (2) and tighten to **35N·m (26 lb ft)**.
8. Bleed the braking system. Refer to [Hydraulic Brake System Bleeding](#).
9. Remove the 2 wheel nuts retaining the brake disc to the hub.
10. Install the rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
11. Lower the vehicle to the ground.
12. With the Ignition Off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
13. Repeat the previous step until a firm brake pedal application is obtained.
14. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).
15. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

16. Burnish the brake pads and brake discs if required. Refer to [Brake Pad and Rotor Burnishing](#).

Rear Brake Caliper Replacement (HSV)

Special Tools

GE-23738-A Hand Vacuum Pump

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

Warning: Refer to [Brake Dust Warning](#).

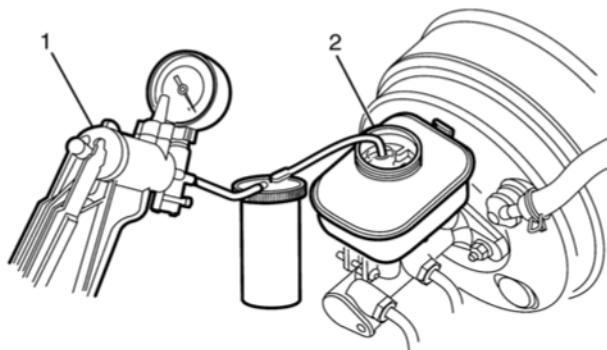
Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).
2. If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

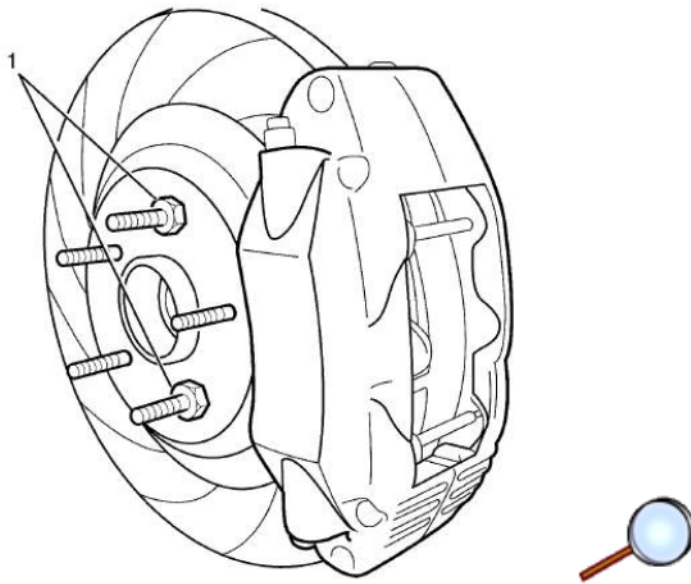
Note: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Note: DO NOT reuse the removed brake fluid.

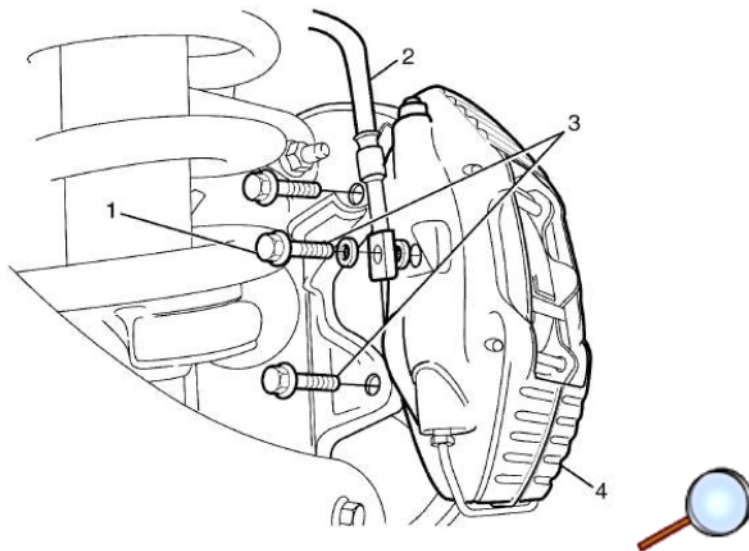
3. If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, remove brake fluid to the midway point using the GE-23738-A Hand Vacuum Pump (1) before proceeding.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the rear tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).



6. Install 2 wheel nuts (1) in reverse to opposite wheel studs to retain the brake rotor to the wheel hub.
7. Remove the rear disc brake pads. Refer to [Rear Disc Brake Pads Replacement](#).
8. Inspect the rear disc brake pads. Refer to [Brake Pad Inspection](#).
9. Place a drain tray under the rear brake caliper.

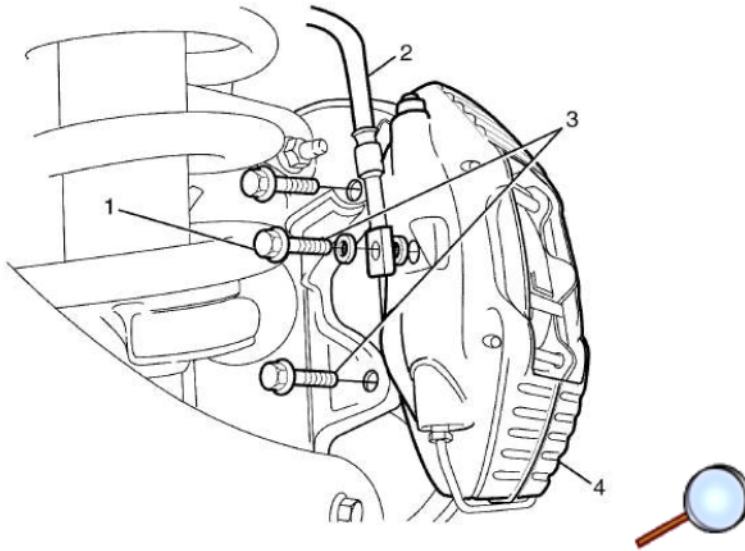


10. Remove the rear brake hose to rear brake caliper retaining banjo bolt (1).
11. Remove the rear brake hose (2) from the rear brake caliper (4).
12. Cap the brake hose fitting to prevent brake fluid loss and contamination.
Note: Do not reuse the brake hose fitting gaskets.
13. Discard the brake hose fitting gaskets.
14. Gently warm the rear brake caliper to suspension knuckle retaining bolts (3) with a heat gun to soften the micro encapsulated adhesive on the bolts.
Note: Do not reuse the rear brake caliper to suspension knuckle retaining bolts.
15. Remove and discard the rear brake caliper to suspension knuckle retaining bolts (3).
16. Remove the rear brake caliper (4).

Installation Procedure

1. Clean the brake caliper threaded mounting holes with a M12x1.75 thread chaser to remove any remaining threadlocker.

2. Clean the rear brake caliper mounting surfaces and rear brake caliper mounting threads using brake cleaner or equivalent.



Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

3. Position the rear brake caliper over the rear brake rotor and align the rear brake caliper with the suspension knuckle.

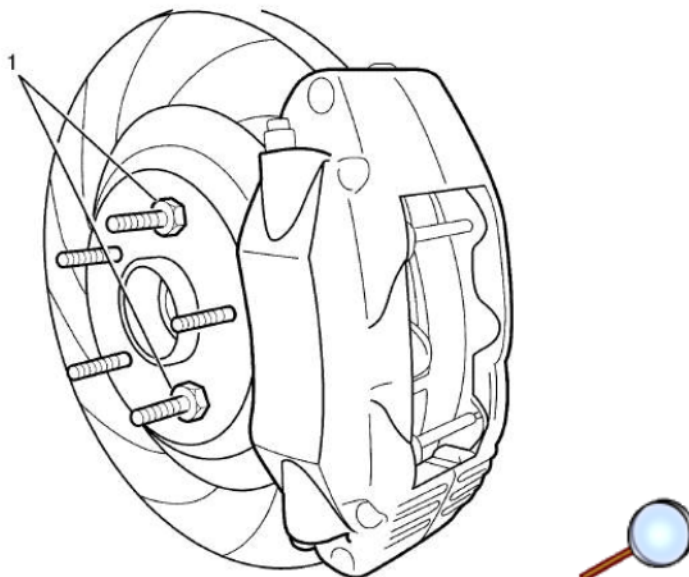
Caution: Refer to [Fastener Caution](#).

Note: Under no circumstances is an impact wrench to be used on caliper mounting bolts.

4. Install the NEW rear brake caliper to suspension knuckle retaining bolts (3) and tighten to **110 N·m (81 lb ft)**.

Note: Install new brake hose fitting gaskets.

5. Assemble the rear brake hose fitting gaskets and the rear brake hose to rear brake caliper retaining banjo bolt (1) to the rear brake hose (2).
6. Install the rear brake hose to rear brake caliper retaining banjo bolt (1) to the rear brake caliper (4) and tighten to **33 N·m (24 lb ft)**.
7. Install the rear disc brake pads. Refer to [Rear Disc Brake Pads Replacement](#).
8. Bleed the hydraulic brake system. Refer to [Hydraulic Brake System Bleeding](#).



9. Remove the 2 wheel nuts (1) from the wheel studs.
10. Install the rear tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
11. With the ignition OFF, gradually apply and release the brake pedal to approximately 2/3 of its travel distance.

12. Repeat step 11 until a firm brake pedal application is obtained.
13. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
14. Burnish the brake pads and brake rotors if required. Refer to [Brake Pad and Rotor Burnishing](#).

Front Brake Caliper Overhaul (Except HSV)

Disassembly Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

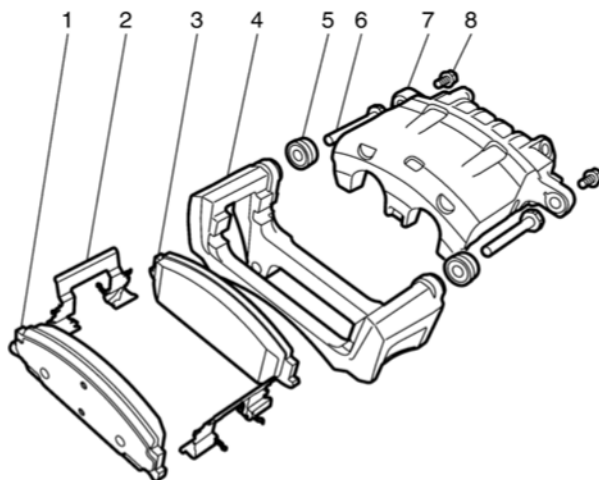
Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the front wheel. Refer to [Tire and Wheel Removal and Installation](#).
3. Remove the front brake caliper from the vehicle. Refer to [Front Brake Caliper Replacement](#).

Note:

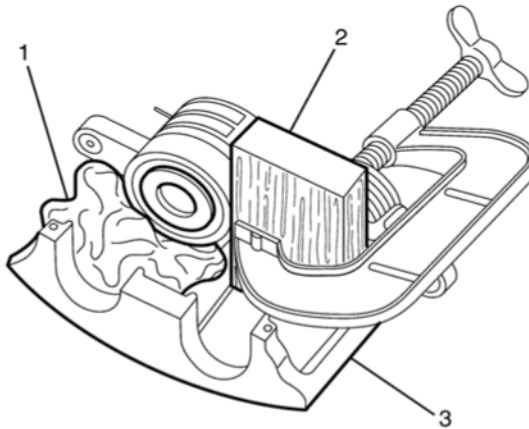
- Replace all the components included in the repair kit used to service the front brake caliper.
 - Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to [Brake System Specifications](#) for correct brake fluid specification.
 - If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
 - The torque values specified are for dry, non-lubricated fasteners.
 - Perform the service operations on a clean bench, free from all mineral oil materials.
4. Drain the brake fluid from the front brake caliper.



Note: To remove the guide pin bolts (8) use a suitable tool to hold the flat section on the guide pins (6) while loosening the guide pin retaining bolts (8).

5. Remove the guide pin retaining bolts (8).
6. Separate the front brake caliper housing (7) from the front brake caliper anchor plate (4).

7. Remove the brake pads (1 and 3).
 8. Remove the retainer clips (2).
 9. Withdraw the guide pins (6) and dust boots (5) from the front brake caliper anchor plate (4).
- Separate the dust boots (5) from the guide pins (6).



Warning: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

Caution: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

Note: Observe the pistons coming out of the bores. If one of the pistons appears to be seized, STOP applying air pressure.

10. Remove the front brake caliper pistons by directing low pressure compressed air into the front brake caliper inlet hole.

If one of the pistons appears to be seized, perform the following steps:

- 10.1. Place a 25 mm (1 in) block of wood between the front brake caliper and the front brake caliper piston that was moving freely.

Note: Position the ends of the G-clamp against the rear of the front brake caliper and against the 25 mm (1 in) block of wood.

- 10.2. Install a large G-clamp over the body of the front brake caliper.

- 10.3. Remove the seized piston from the front brake caliper by directing low pressure compressed air into the front brake caliper inlet hole.

- 10.4. Remove the G-clamp from the front brake caliper.

- 10.5. Remove the block of wood from the front brake caliper.

11. Install clean workshop cloths (1) to pad the interior of the front brake caliper (3) between the remaining front brake caliper piston and the body of the front brake caliper (3).

12. To cover the open front brake caliper bore place a 25 mm (1 in) block of wood (2) between the body of the front brake caliper (3) and the front brake caliper dust boot seal.

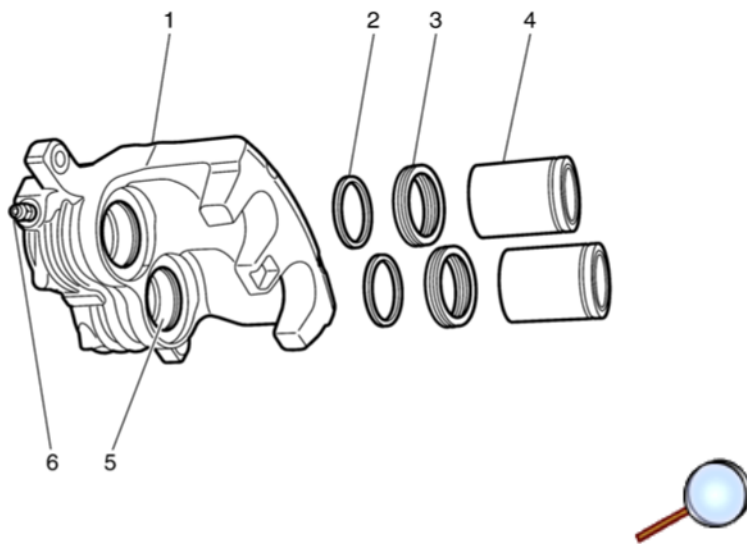
Note: Position the ends of the G-clamp against the rear of the front brake caliper (3) and against the 25 mm (1 in) block of wood (2).

13. Install a large G-clamp over the body of the front brake caliper (1).

14. Remove the front brake caliper piston by directing low pressure compressed air into the front brake caliper inlet hole.

15. Remove the G-clamp from the front brake caliper (3).

16. Remove the block of wood (2) from the front brake caliper (3).



Note: Use a small wooden or plastic tool to avoid damage to the front brake caliper (1).

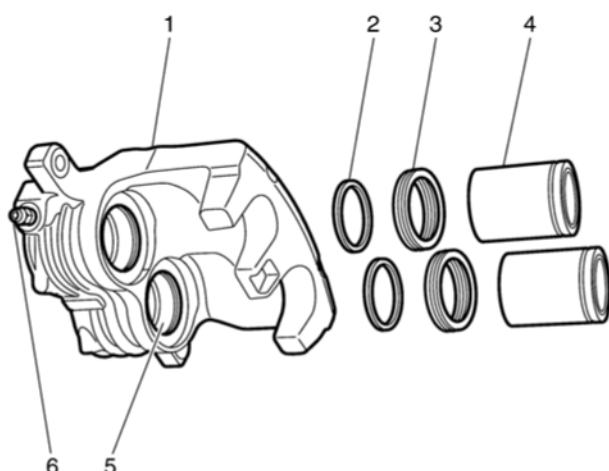
Note: The front brake caliper seals are single use components only and must be discarded after removal.

17. With the front brake caliper pistons (4) removed, remove the front brake caliper piston dust boot seal (3) from the front brake caliper (1).
Discard the front brake caliper piston dust boot seal (3).
18. Remove the front brake caliper piston seal (2) from the front brake caliper (1).
Discard the front brake caliper piston seal (2).
19. Remove the front brake caliper bleeder valve (6).
20. Inspect the front brake caliper anchor plate guide surfaces for corrosion and wear.
Replace the front brake caliper assembly if damaged or worn.
21. Clean the front brake caliper piston bores (5) with denatured alcohol, or equivalent.
- Note:** DO NOT use abrasives to clean the front brake caliper assembly.
22. Clean the front brake caliper pistons (4) with denatured alcohol, or equivalent.
23. Clean the front brake caliper bleeder valve (6).
24. Dry the front brake caliper piston bores (5) with non-lubricated, filtered air.
25. Dry the front brake caliper pistons (4) with non-lubricated, filtered air.
26. Dry the front brake caliper bleeder valve (6) with non-lubricated, filtered air.
27. Inspect the front brake caliper bores (5) for cracks, scoring, pitting, too much corrosion.
If cracks, scoring, pitting, and too much corrosion are present in the front brake caliper bores (5), replace the front brake caliper assembly.
28. Inspect the front brake caliper pistons (4) for cracks, scoring, and/or damage.
If cracks, scoring, and/or damage are present in the front brake caliper pistons (4), replace the front brake caliper pistons (4) if any of these conditions exist.

Assembly Procedure

Note:

- Replace all the components included in the repair kit used to service the front brake caliper.
- Lubricate the rubber parts with NEW HN-1796 brake fluid to make assembly easier.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.



Caution: Refer to [Fastener Caution](#).

1. Install the front brake caliper bleeder valve (6) and tighten to **12 N·m (106 lb in)**.

2. Lubricate the NEW front brake caliper piston seals (2) with Super DOT 4 or DOT 4 Plus brake fluid from a clean, sealed brake fluid container.

Note: When installing, make sure the front brake caliper piston seals (2) are not twisted.

3. Install the front brake caliper piston seals (2) into the seal grooves in the front brake caliper bores (5).

4. Lubricate the front brake caliper bores (5) and pistons (4) with brake fluid.

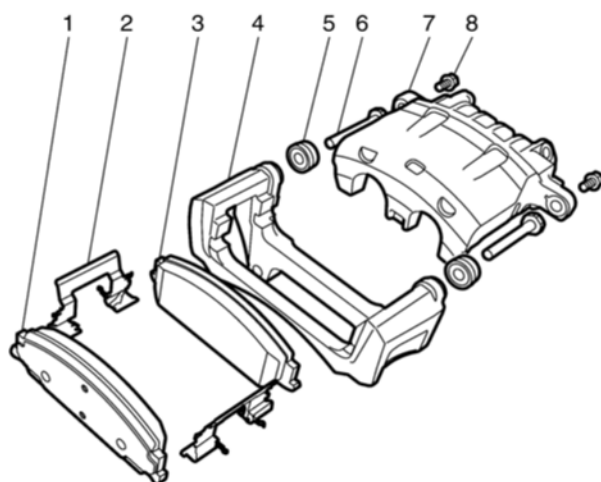
5. Install the front brake caliper pistons (4) into the caliper bores (5).

6. Install the NEW front brake caliper piston dust boot seals (3) over the front brake caliper pistons (4).

7. Complete the following for both front brake caliper piston dust boot seals (3).

7.1. Fully seat the front brake caliper piston dust boot seal (4) into the front brake caliper (1).

7.2. Make sure the front brake caliper piston dust boot seal (4) is correctly seated into the groove in the front brake caliper bore (5).



8. Lubricate the guide pins (6) with silicone grease, such as Dow Corning No. 44 or equivalent.

9. Install guide pins (6) into the front brake caliper anchor plate (4).

Do not fit the two guide pin boots (5) at this stage.

Note: To install the guide pin bolts (8) use an open-end spanner to hold the flat section on the guide pins (6) whilst installing the guide pin bolts (8).

10. Install the front brake caliper (7) to the front brake caliper anchor plate (4) and install NEW guide pin bolts (8). Tighten the guide pin bolts to **42 N•m (31 lb ft)**.
Note: Make sure that the front brake caliper (7) and guide pins (6) slide in and out easily from the front brake caliper anchor plate (4). If any binding is evident, then steps 8 and 9 must be repeated.
11. Detach the front brake caliper (7) from the front brake caliper anchor plate (4) and install the NEW guide pin boots (5) to the guide pins (6).
12. Install the brake pad retainers (2) to the front brake caliper anchor plate (4).
Note: The brake pads (1 and 3) are marked as inner and outer only. Failure to install the front brake pads (1 and 3) in their correct position will cause the brake pads (1 and 3) not to seat correctly in the front brake caliper (7).
13. Install the brake pads (1 and 3) to the front brake caliper anchor plate (4).
Note: Remove all excess air from the guide pin boot (5) and make sure that each guide pin boot (5) is correctly located in the grooves in the guide pin (6) and the front brake caliper anchor plate (4).
14. Assemble the front brake caliper (7) and front brake caliper anchor plate (4) together.
15. Install the front brake caliper assembly to the vehicle. Refer to [Front Brake Caliper Replacement](#).
16. Bleed the braking system. Refer to [Hydraulic Brake System Bleeding](#).
17. Lower the vehicle to the ground.
18. With the Ignition Off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
19. Repeat the previous step until a firm brake pedal application is obtained.
20. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).
21. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

Front Brake Caliper Overhaul (HSV)

Disassembly Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

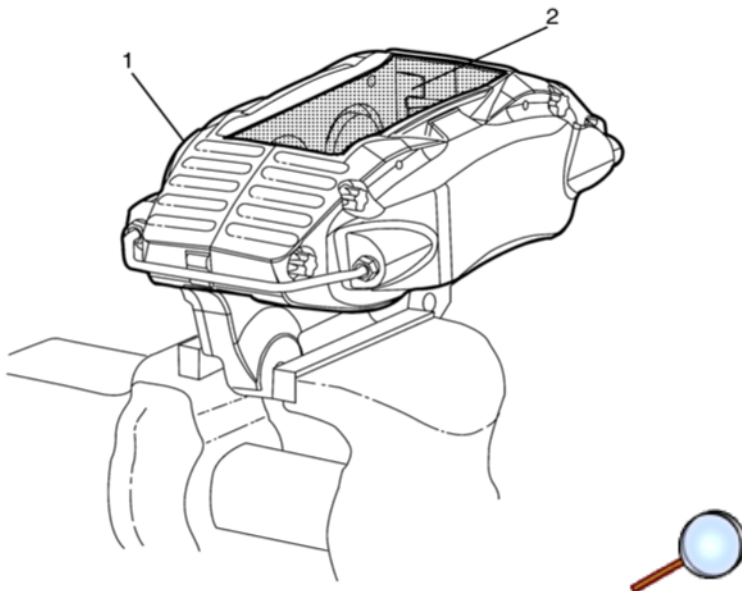
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the front wheel. Refer to [Tire and Wheel Removal and Installation](#).
3. Remove the front brake pads. Refer to [Front Disc Brake Pads Replacement](#).
4. Remove the front brake caliper. Refer to [Front Brake Caliper Replacement](#).

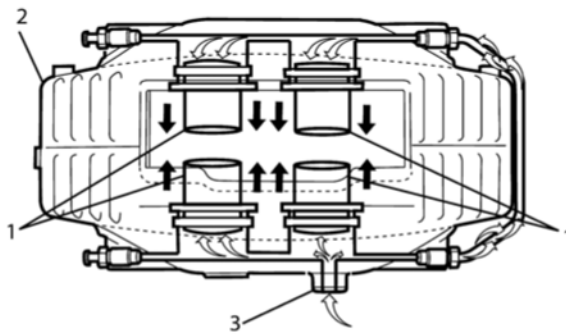
Note:

- Replace all the components included in the repair kit used to service the front brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to [Brake System Specifications](#) for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

5. Drain the brake fluid from the front brake caliper.



6. Using a suitable vice, securely position the front brake caliper (1) in a way that permits full access to the working area of the front brake caliper pistons (2).



Warning: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

Caution: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

Note: Observe the pistons coming out of the bores. If one of the pistons appears to be seized, STOP applying air pressure.

7. Expel the front brake caliper pistons (1) from the front brake caliper (2) by directing low pressure compressed air into the brake fluid inlet hole (3).

If one of the pistons appears to be seized, perform the following steps:

- 7.1. Evenly push the seized piston back into the bore using a suitable block of nylon or wood.
- 7.2. Repeat Step 5 until all front brake caliper pistons have been expelled from the front brake caliper.

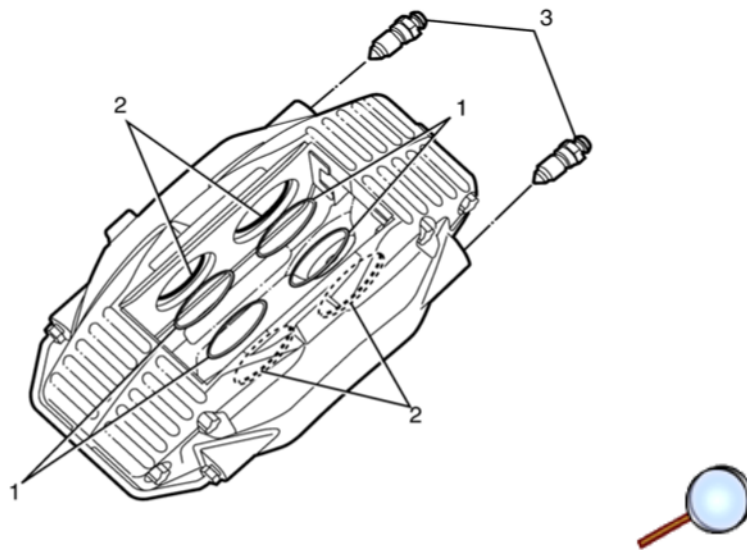


Note: Use a small wooden or plastic tool to avoid damage to the front brake caliper (2) when removing the front brake caliper piston dust boot seals (1).

Note: The front brake caliper piston dust boot seals (1) are single use components only and must be discarded after removal.

8. With the front brake caliper pistons removed, remove all the front brake caliper piston dust boot seals (1) from the front brake caliper (2).

Discard the front brake caliper piston dust boot seals (1).



Note: Use a small wooden or plastic tool to avoid damage to the front brake caliper piston bores (2) when removing the front brake caliper piston seals (1).

Note: The front brake caliper piston seals (1) are single use components only and must be discarded after removal.

9. Remove all 4 front brake caliper piston seals (1) from the grooves in the front brake caliper piston bores (2) and discard.

Discard the front brake caliper piston seals (1).

10. Remove the front brake caliper bleeder valves (3).

11. Clean the front brake caliper piston bores (2) with denatured alcohol, or equivalent.

Note: DO NOT use abrasives to clean the front brake caliper piston.

12. Clean the front brake caliper pistons with denatured alcohol or equivalent.
13. Clean the front brake caliper bleeder valves (3) with denatured alcohol or equivalent.
14. Dry the front brake caliper piston bores with non-lubricated, filtered air.
15. Dry the front brake caliper pistons with non-lubricated, filtered air.
16. Dry the front brake caliper bleeder valves (3) with non-lubricated, filtered air.

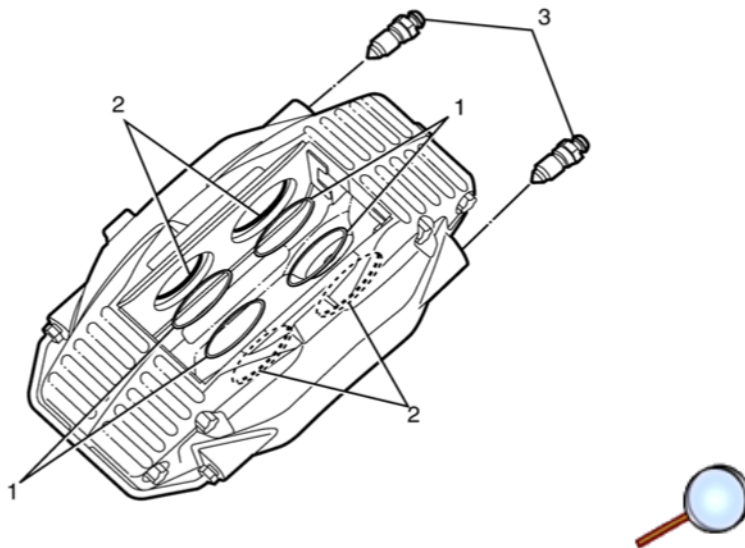
17. Inspect the front brake caliper piston bores (2) for cracks, scoring, pitting or excessive corrosion.

- If light corrosion is present in the front brake caliper bores, attempt to remove the imperfection with a fine emery paper. If the imperfection cannot be removed, replace the front brake caliper assembly.
- If cracks, scoring, pitting or corrosion are present in the piston bores, replace the front brake caliper assembly.

18. Inspect the front brake caliper pistons for cracks, scoring and/or damage.

If cracks, scoring or damage are present on the front brake caliper pistons, they must be replaced.

Assembly Procedure

**Note:**

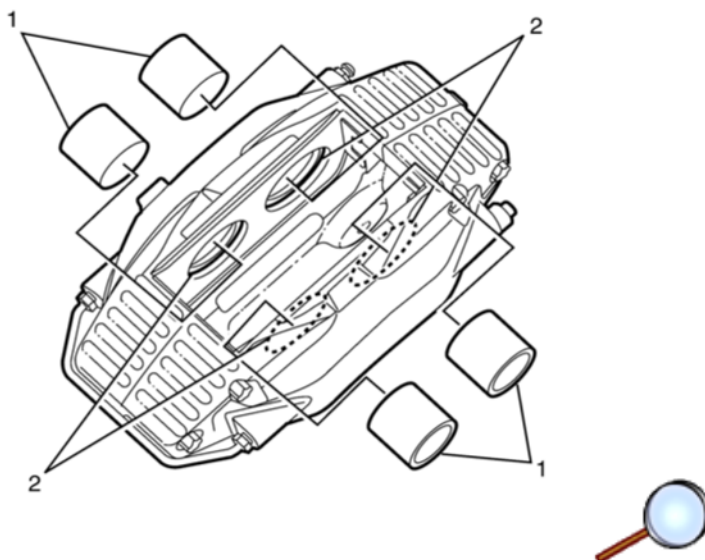
- Replace all the components included in the repair kit used to service the front brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to [Brake System Specifications](#) for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

Caution: Refer to [Fastener Caution](#).

1. Install the front brake caliper bleeder valves (3) and tighten to **17 N•m (13 lb ft)**.
2. Lubricate the NEW front brake caliper piston seals with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.

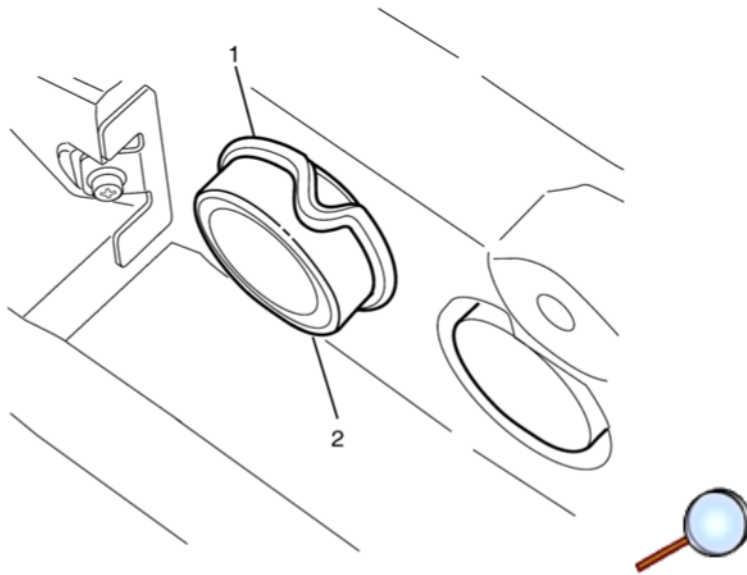
Note: When installing, make sure the front brake caliper piston seals (1) are not twisted.

3. Install the front brake caliper piston seals (1) into the grooves in the front brake caliper piston bores (2).



4. Lubricate all the front brake caliper piston bores (2) with brake fluid conforming to specification. Refer to [Brake System Specifications](#) for correct brake fluid specification.

5. Lubricate and install all the front brake caliper pistons (1) into the front brake caliper piston bores (2).



6. Install the NEW front brake caliper piston dust boot seals (1) over the front brake caliper pistons (2).
7. Complete the following for all front brake caliper piston dust boot seals (1).
 - 7.1. Fully seat the front brake caliper piston dust boot seals (1) into the front brake caliper (2).
 - 7.2. Make sure the front brake caliper piston dust boot seals (1) are correctly seated into the groove in the front brake caliper piston bores (3).
8. Install the front brake caliper. Refer to [Front Brake Caliper Replacement](#).
9. Install the front brake pads. Refer to [Front Disc Brake Pads Replacement](#).
10. Bleed the braking system. Refer to [Hydraulic Brake System Bleeding](#).
11. Lower the vehicle to the ground.
12. With the Ignition Off, gradually apply and release the brake pedal approximately 2/3 of its travel distance.
13. Repeat the previous step until a firm brake pedal application is obtained.
14. If a firm brake pedal application can not be obtained. Refer to [Hydraulic Brake System Bleeding](#).
15. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

Front Brake Caliper Overhaul (Redline)

Special Tools

J-23738-A Vacuum Pump

Disassembly Procedure

Note: Fabricate blocks of soft wood with the following dimensions which are to be used to perform the procedure below:

- BLOCK ONE: 19 mm ($\frac{3}{4}$ in) X 51 mm (2 in) X 51 mm (2 in)
- BLOCK TWO: 19 mm ($\frac{3}{4}$ in) X 51 mm (2 in) X 127 mm (5 in)

1. Inspect the brake fluid level in the brake master cylinder reservoir.

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: This brake caliper is coated with a specialized paint. Use care when handling and servicing to ensure the paint does not get chipped or scratched. Clean any brake fluid from painted surfaces with denatured alcohol, or equivalent, as soon as possible.

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Note:

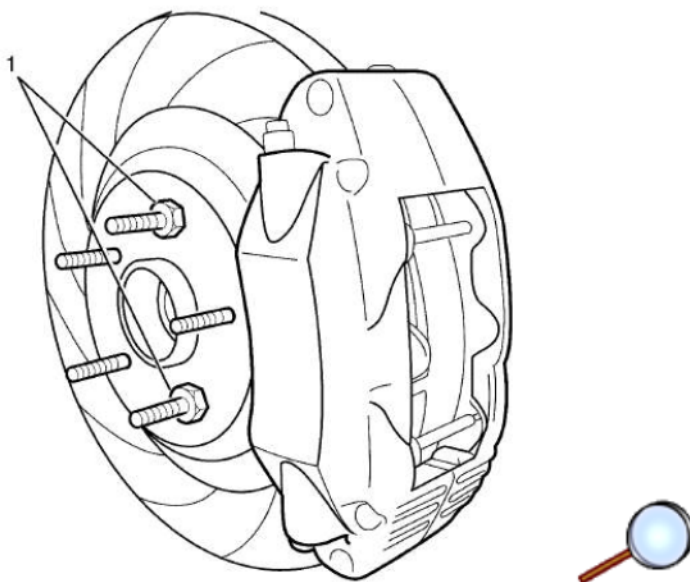
- Do not completely empty the brake master cylinder reservoir.
- The brake fluid level must be midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

2. If required, use J-23738-A vacuum pump to remove some brake fluid until the brake fluid level is midway between the maximum brake fluid level marking and the minimum brake fluid level marking.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the front wheel. Refer to [Tire and Wheel Removal and Installation](#).



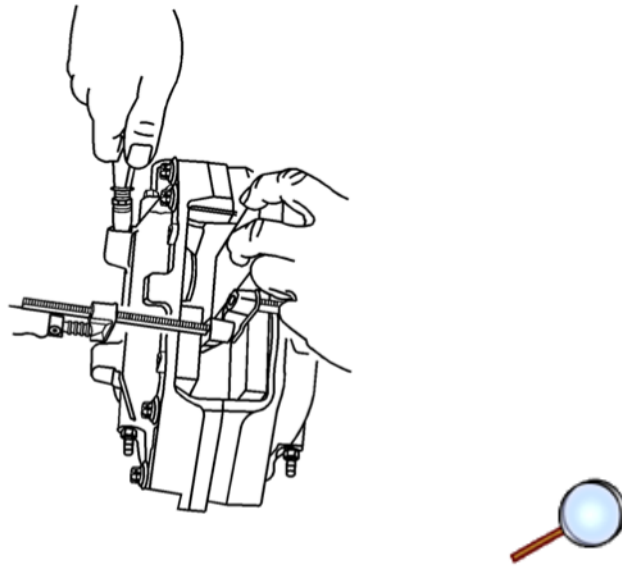
5. Install two opposite wheel nuts (1), with the flat side of the wheel nut against the brake rotor to retain the brake rotor to the wheel hub.

Caution: This brake caliper is coated with a specialized paint. Use care when handling and servicing to ensure the paint does not get chipped or scratched. Clean any brake fluid from painted surfaces with denatured alcohol, or equivalent, as soon as possible.

6. Remove the front brake pads from the brake caliper. Refer to [Front Disc Brake Pads Replacement](#).
7. Remove the brake caliper from the vehicle. Refer to [Front Brake Caliper Replacement](#).
8. Drain the brake fluid from the brake caliper into an approved container.

Note: Use plastic vise caps or similar to protect the brake caliper mounting bosses from marring.

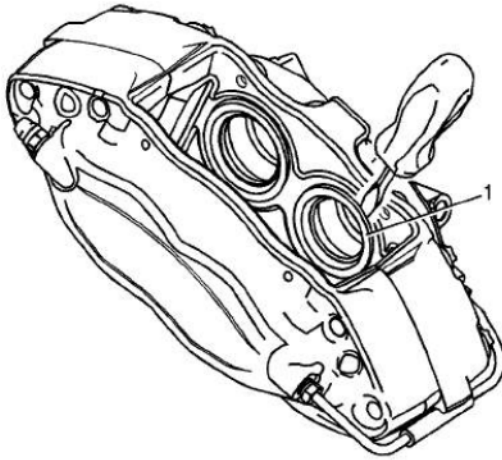
9. Suitably support the brake caliper in a vise.



Caution: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

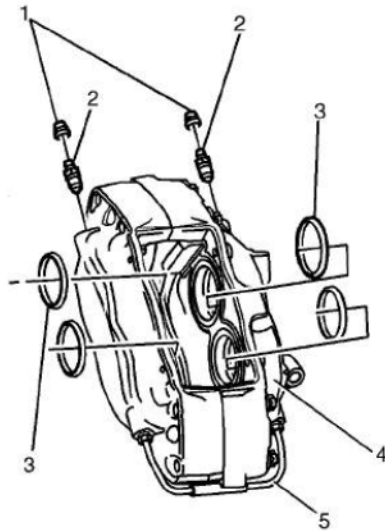
Note: Make a note matching the brake caliper bores with their respective brake caliper pistons.

10. Place BLOCK TWO over 2 adjacent pistons and secure in place with a non-marring C-clamp.
11. Place BLOCK ONE over one of the opposing piston bores and secure BLOCK ONE in place with a non-marring C-clamp.
12. Use clean workshop towels to pad the interior of the brake caliper housing before removing the brake caliper piston.
13. Remove the brake caliper piston by directing low pressure compressed air into the brake caliper brake fluid inlet hole. If the dust boot seal came off the brake caliper piston, reinstall the dust boot seal to the brake caliper.
14. Move BLOCK ONE over the empty piston bore and secure it in place with a non-marring C-clamp.
15. Use clean workshop towels to pad the interior of the brake caliper housing before removing the second piston.
16. Remove the brake caliper piston by directing low pressure compressed air into the brake caliper brake fluid inlet hole. If the dust boot seal came off the piston, reinstall the dust boot seal to the brake caliper.
17. Repeat steps 10 through 17 for the adjacent brake caliper pistons.



Note: Do not scratch or mar the painted surfaces or brake caliper piston bore.

18. Remove all the dust boot seals (1) using a suitable flat-bladed tool.
19. Discard the dust boot seals (1).



Caution: Do not remove the caliper external crossover tube or separate the 2 caliper halves. If the crossover tube and/or the caliper halves are separated, corrosion and damage to the caliper may result.

20. Using a suitable wooden or plastic tool, remove the brake caliper piston seals (3) from the piston bores.
21. Discard the piston seals (3).
22. Remove the brake caliper bleeder caps (1).
23. Remove the brake caliper bleeder valves (2).
24. Remove the brake caliper (4) from the vise and clean the brake caliper (4) with denatured alcohol, or equivalent.
25. Dry the brake caliper piston bores with non-lubricated filtered air.
26. Make sure that the external crossover pipe (5) and the internal fluid ports are clean and free of obstructions.

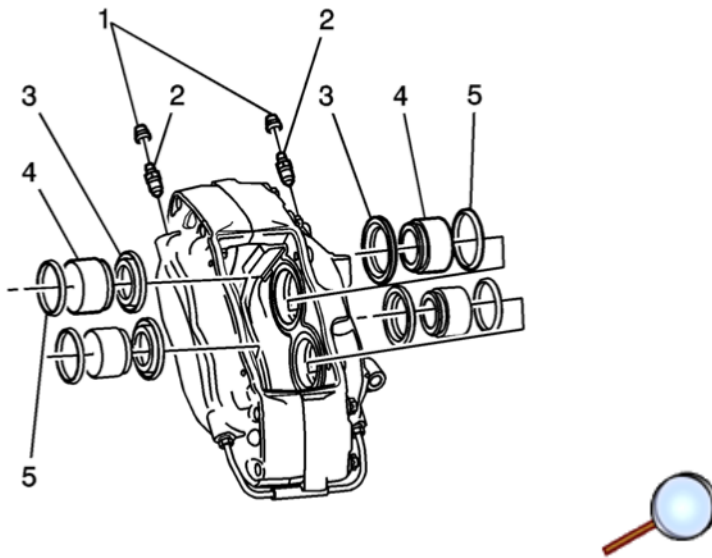
Note: DO NOT clean the brake caliper piston bores by honing or using abrasive materials.

27. Inspect the brake caliper cylinder bores and piston seal counter-bores for scratches, cracks, pitting, and/or corrosion.
28. If the brake caliper piston bores are marred, cracked, or pitted, or if corrosion cannot be cleaned with denatured alcohol, replace the brake caliper assembly (4).

Assembly Procedure

Note:

- Replace all the components included in the repair parts kit supplied to service the brake caliper.
- Lubricate the rubber parts with NEW DOT 4 or NEW Super DOT 4 brake fluid to assist in the assembly of the rubber parts.
- If any hydraulic components has been removed or disconnected, bleed the hydraulic brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.



Note: Make sure the dust boot seal (3) is correctly seated in the dust boot seal groove of the brake caliper pistons (4).

1. Install the NEW piston dust boot seals (3) over the brake caliper pistons (4).
2. Lubricate the NEW piston seals (5) with NEW DOT 4 or Super DOT 4 brake fluid from a clean, sealed brake fluid container.

Note: Make sure that the piston seals (5) are not twisted.

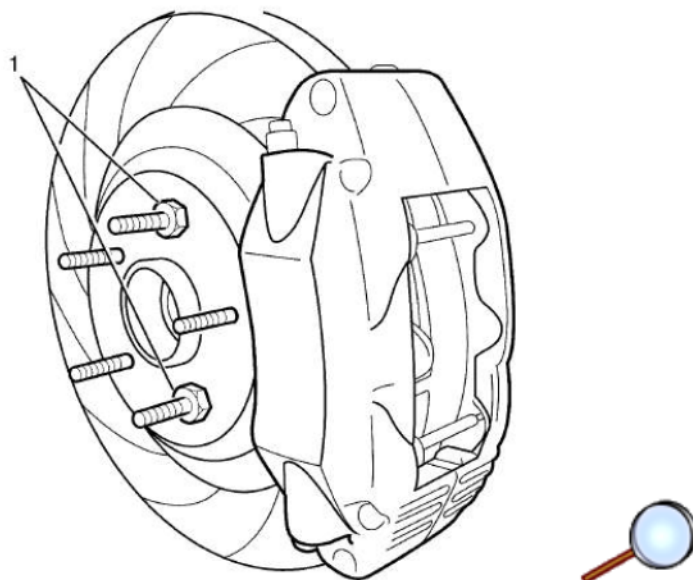
3. Install the lubricated, NEW piston seals (5) into the brake caliper bore seal grooves.
4. Apply a thin coat of NEW DOT 4 or NEW Super DOT 4 brake fluid from a clean, sealed brake fluid container, onto the brake caliper piston bores and the outer surface of the brake caliper pistons (4).
5. Match the pistons of one side of the brake caliper with their respective bores and install the brake caliper pistons.

Note: Do not force the brake caliper pistons into the brake caliper bores. The pistons should slide easily into the brake caliper bores.

6. Carefully press the pistons (4) and dust boot seals (3) of the inserted pistons all the way into the brake caliper bores by hand.
7. Make sure that the dust boots (3) and pistons (4) of the inserted pistons are fully seated in the brake caliper by placing BLOCK TWO over two adjacent piston bores and apply light pressure with a non-marring C-clamp.
8. Repeat steps 5 through 7 for the opposite brake caliper pistons.

Caution: Refer to [Fastener Caution](#).

9. Install the brake caliper bleeder valves (2) and tighten to **14 N•m (124 lb in)**.
10. Install the brake caliper bleeder valve caps (1).
11. Install the front brake pads to the brake caliper. Refer to [Front Disc Brake Pads Replacement](#).
12. Install the brake caliper to the vehicle. Refer to [Front Brake Caliper Replacement](#).



13. Remove the two opposite wheel nuts (1) from the wheel studs.
14. Install the front wheel. Refer to [Tire and Wheel Removal and Installation](#).
15. Lower the vehicle to the ground.

Rear Brake Caliper Overhaul (Except HSV)

Warning: Refer to [Brake Fluid Irritant Warning](#).

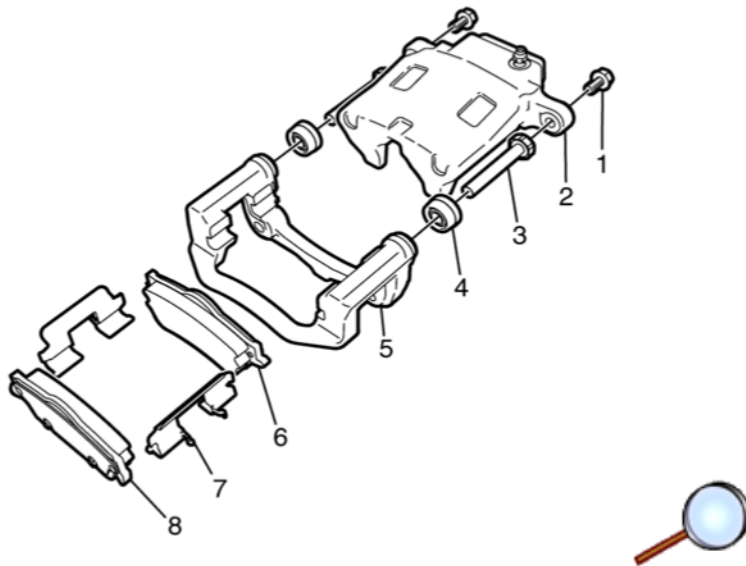
Warning: Refer to [Brake Dust Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Disassembly Procedure

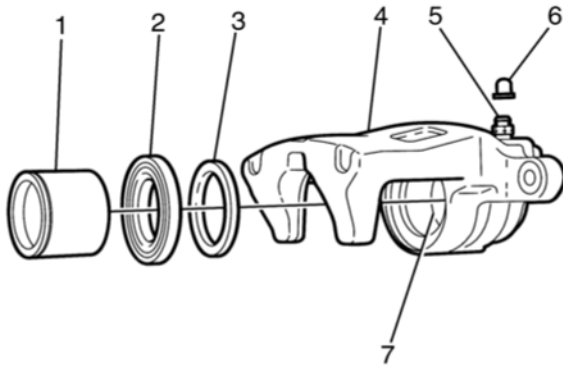
Note:

- Replace all the components included in the repair kit used to service the brake caliper.
 - Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to [Brake System Specifications](#) for correct brake fluid specification.
 - If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
 - The torque values specified are for dry, non-lubricated fasteners.
 - Perform the service operations on a clean bench, free from all mineral oil materials.
1. Remove the brake caliper from the vehicle. Refer to [Rear Brake Caliper Replacement](#).
 2. Drain the brake fluid from the brake caliper.



Note: To remove the guide pin bolts (1) use a suitable tool to hold the flat section on the guide pins (3) whilst loosening the guide pin bolts (1).

3. Remove the guide pin retaining bolts (1).
4. Separate the brake caliper housing (2) from the brake caliper anchor plate (5).
5. Remove the brake pads (6 and 8).
6. Remove the retainer clips (7)
7. Withdraw the guide pins (3) and dust boots (4) from the brake caliper anchor plate (5).
8. Separate the dust boots (4) from the guide pins (3).



Warning: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

Caution: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

9. Install clean cloths to pad the interior of the caliper (4) between the caliper piston (1) and the caliper (4).
10. Carefully remove the brake caliper piston (1) by directing low pressure compressed air into the brake caliper (1) inlet hole.

Note: Use a small wooden or plastic tool to avoid damage to the brake caliper (4).

Note: Brake caliper seals are single use components only and must be discarded after removal.

11. With the brake caliper piston (1) removed, remove the brake caliper piston dust boot seal (2) from the brake caliper (4).

Discard the brake caliper piston dust boot seal (2).

12. Remove the brake caliper piston seal (3) from the brake caliper (4) and discard the brake caliper piston seal (3).

Discard the brake caliper piston seal (3).

13. Remove the brake caliper bleeder valve cap (6).

14. Remove the brake caliper bleeder valve (5).

15. Inspect the brake caliper anchor plate guide surfaces for corrosion and wear. Replace the brake caliper assembly if damaged or worn.

16. Clean the brake caliper piston bore (7) with denatured alcohol, or equivalent.

Note: DO NOT use abrasives to clean the brake caliper piston (1).

17. Clean the brake caliper piston (1) with denatured alcohol, or equivalent.

18. Clean the brake caliper bleeder valve (5)

19. Dry the brake caliper piston bore (7) with non-lubricated, filtered air.

20. Dry the brake caliper piston (1) with non-lubricated, filtered air.

21. Dry the brake caliper bleeder valve (5) with non-lubricated, filtered air.

22. Inspect the brake caliper bore (7) for cracks, scoring, pitting, too much corrosion.

23. If light corrosion is present in the brake caliper bore (7), attempt to remove the imperfection with a fine emery paper. If the imperfection cannot be removed, replace the brake caliper assembly.

24. If cracks, scoring, pitting, and too much corrosion are present in the brake caliper bore (7), replace the brake caliper assembly.

25. Inspect the brake caliper piston (1) for cracks, scoring, and/or damage, replace the brake caliper piston (1) if any of these conditions exist.

Warning: Refer to [Brake Fluid Irritant Warning](#).

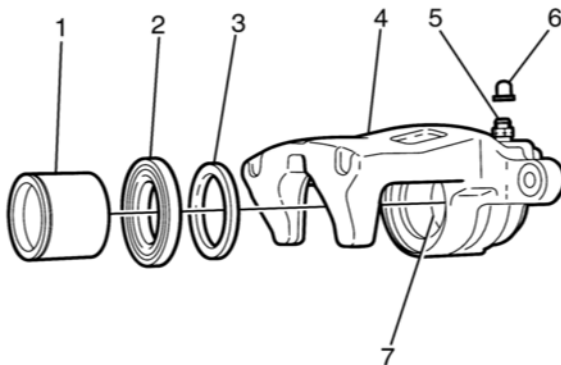
Warning: Refer to [Brake Dust Warning](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Assembly Procedure

Note:

- Replace all the components included in the repair kit used to service the brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to [Brake System Specifications](#) for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.



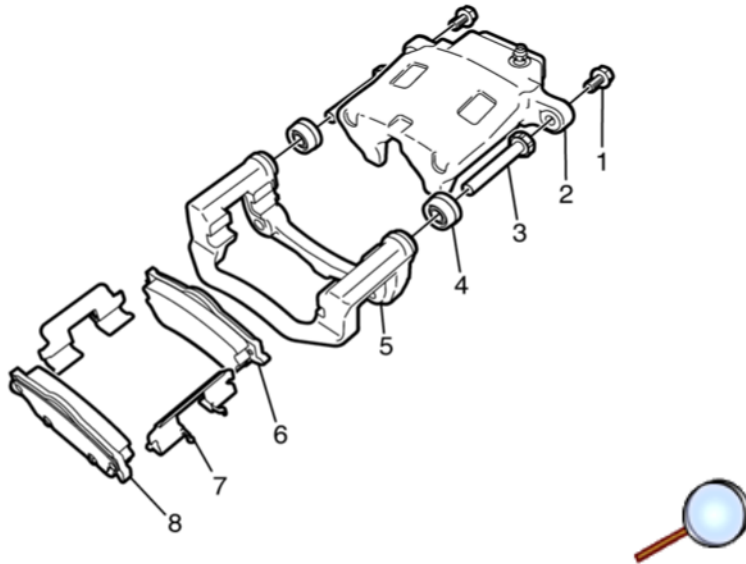
Caution: Refer to [Fastener Caution](#).

1. Install the brake caliper bleeder valve (6) to the brake caliper (4).

Tighten

Tighten the brake caliper bleeder valve when dry 12N•m (106 lb in).

2. Install the brake caliper bleeder valve cap (7) to the brake caliper bleeder valve (6).
3. Lubricate the NEW brake caliper piston seal (3) with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.
4. Install the lubricated brake caliper piston seal (3) into the seal groove in the brake caliper bore (7). Make sure the brake caliper piston seal (3) is not twisted.
5. Lubricate the brake caliper bore (7) and the brake caliper piston (1) with brake fluid.
6. Install the brake caliper piston (1) into the brake caliper bore (7).
7. Install the NEW brake caliper piston dust boot seal (2) over the brake caliper piston (1).
8. Complete the following for the brake caliper piston dust boot seal (2).
 - 8.1. Fully seat the brake caliper piston dust boot seal (2) into the brake caliper (4).
 - 8.2. Make sure the brake caliper piston dust boot seal (2) is correctly seated into the groove in the brake caliper bore (7).



9. Lubricate the guide pins (1) with silicone grease, such as Dow Corning No. 44 or equivalent.
10. Install guide pins (1) into the brake caliper anchor plate (5).
Do not fit the two guide pin boots (2) at this stage.
11. Install the brake caliper (4) to the brake caliper anchor plate (5) and install NEW guide pin bolts (3).
12. Use an open-end spanner to hold the guide pin flat section, tighten the NEW guide pin bolts (3) to the correct torque.

Tighten

Tighten the guide pin bolt to 42 N•m (31 lb ft).

Note: Make sure that the brake caliper and guide pins slide in and out easily from the brake caliper anchor plate. If any binding is evident, then steps 9–12 must be repeated.

13. Detach the brake caliper (4) from the brake caliper anchor plate (5) and install the NEW guide pin boots (4) to the guide pins (3).

Note: Remove all excess air from the guide pin boot and make sure that each guide pin boot is correctly located in the guide pin and brake caliper anchor plate grooves.

14. Assemble the brake caliper (4) and brake caliper anchor plate (5) together.
15. Install the brake pads. Refer to [Rear Disc Brake Pads Replacement](#).
16. Install the brake caliper to the vehicle. Refer to [Rear Brake Caliper Replacement](#).

Rear Brake Caliper Overhaul (HSV)

Disassembly Procedure

Warning: Refer to [Brake Fluid Warning](#).

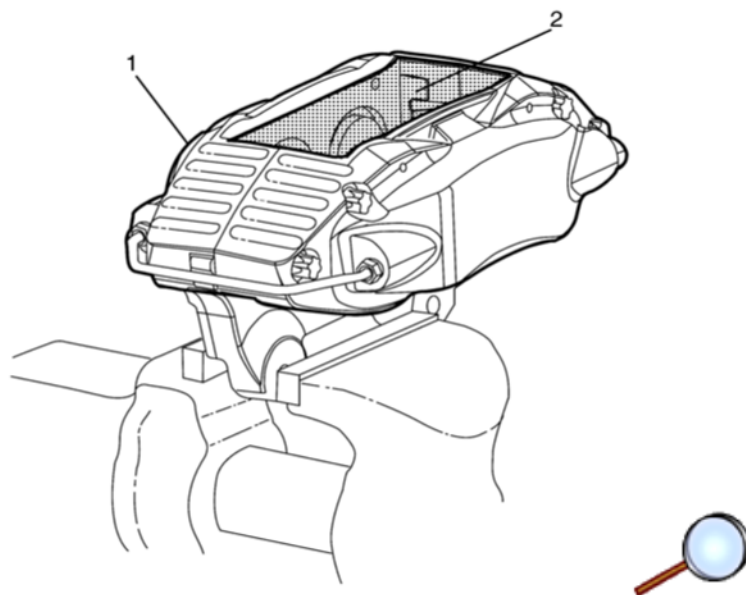
Warning: Refer to [Brake Fluid Irritant Warning](#).

Warning: Refer to [Brake Dust Warning](#).

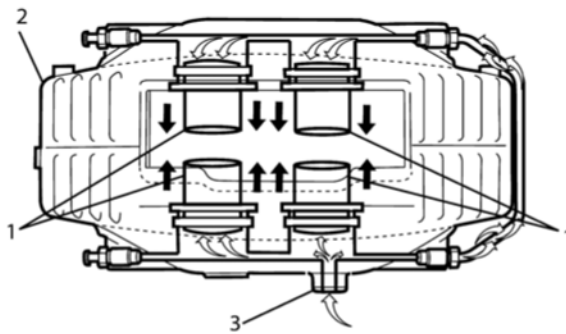
Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

Note:

- Replace all the components included in the repair kit used to service the brake caliper.
 - Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to [Brake System Specifications](#) for correct brake fluid specification.
 - If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
 - The torque values specified are for dry, non-lubricated fasteners.
 - Perform the service operations on a clean bench, free from all mineral oil materials.
1. Remove the brake pads, brake pad retaining pins and anti-rattle clip. Refer to [Rear Disc Brake Pads Replacement](#).
 2. Remove the brake caliper from the vehicle. Refer to [Rear Brake Caliper Replacement](#).
 3. Drain the brake fluid from the brake caliper.



4. Using a suitable vice, securely position the brake caliper (1) in a way that permits full access to the working area of the brake caliper pistons (2).



Warning: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

Caution: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

Note: Observe the pistons coming out of the bores. If one of the pistons appears to be seized, STOP applying air pressure.

5. Expel the brake caliper pistons (1) from the brake caliper (2) by directing low pressure compressed air into the brake fluid inlet hole (3).

If one of the pistons appears to be seized, perform the following steps:

- 5.1. Evenly push the seized piston back into the bore using a suitable block of nylon or wood.
- 5.2. Repeat Step 5 until all brake caliper pistons have been expelled from the brake caliper.

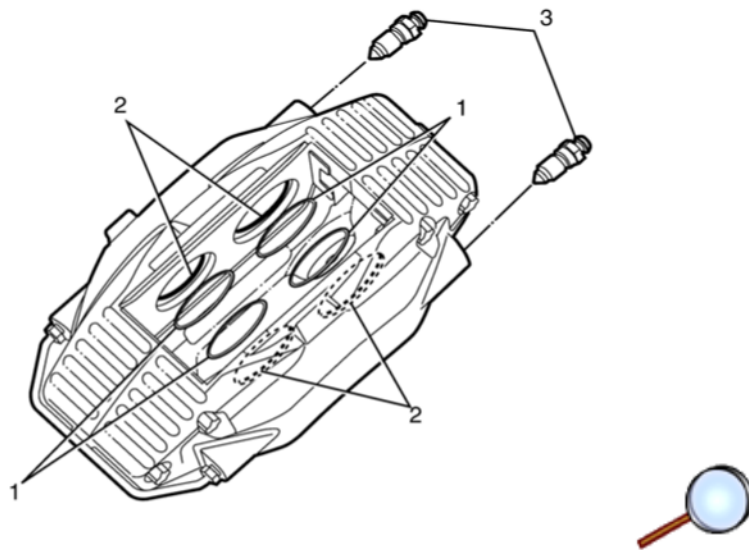


Note: Use a small wooden or plastic tool to avoid damage to the brake caliper (2) when removing the brake caliper piston dust boot seals (1).

Note: Brake caliper piston dust boot seals (1) are single use components only and must be discarded after removal.

6. With the brake caliper pistons removed, remove all the brake caliper piston dust boot seals (1) from the brake caliper (2).

Discard the brake caliper piston dust boot seals (1).



Note: Use a small wooden or plastic tool to avoid damage to the brake caliper piston bores (2) when removing the brake caliper piston seals (1).

Note: Brake caliper piston seals (1) are single use components only and must be discarded after removal.

7. Remove all 4 brake caliper piston seals (1) from the grooves in the brake caliper piston bores (2) and discard.

Discard the brake caliper piston seals (1).

8. Remove the brake caliper bleeder valves (3).

9. Clean the brake caliper piston bores (2) with denatured alcohol, or equivalent.

Note: DO NOT use abrasives to clean the brake caliper piston.

10. Clean the brake caliper pistons with denatured alcohol or equivalent.

11. Clean the brake caliper bleeder valves (3) with denatured alcohol or equivalent.

12. Dry the brake caliper piston bores with non-lubricated, filtered air.

13. Dry the brake caliper pistons with non-lubricated, filtered air.

14. Dry the brake caliper bleeder valves (3) with non-lubricated, filtered air.

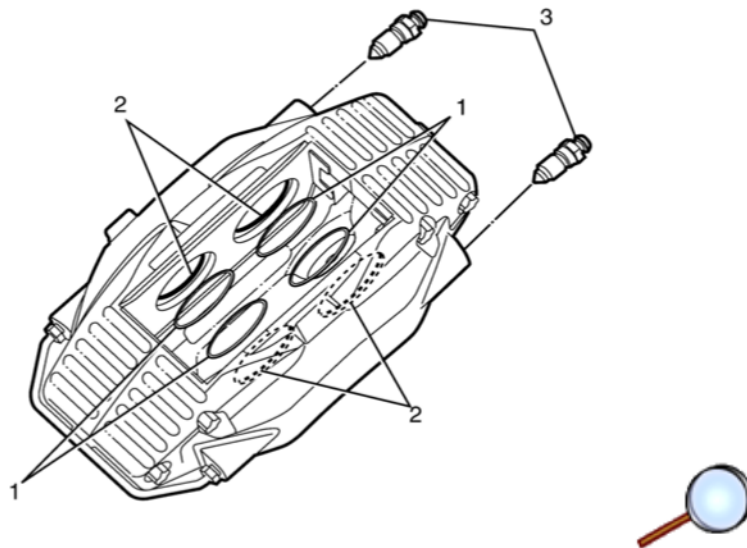
15. Inspect the brake caliper piston bores (2) for cracks, scoring, pitting or excessive corrosion.

- If light corrosion is present in the brake caliper bores, attempt to remove the imperfection with a fine emery paper. If the imperfection cannot be removed, replace the brake caliper assembly.
- If cracks, scoring, pitting or corrosion are present in the piston bores, replace the brake caliper assembly.

16. Inspect the brake caliper pistons for cracks, scoring and/or damage.

If cracks, scoring or damage are present on the brake caliper pistons, they must be replaced.

Assembly Procedure

**Note:**

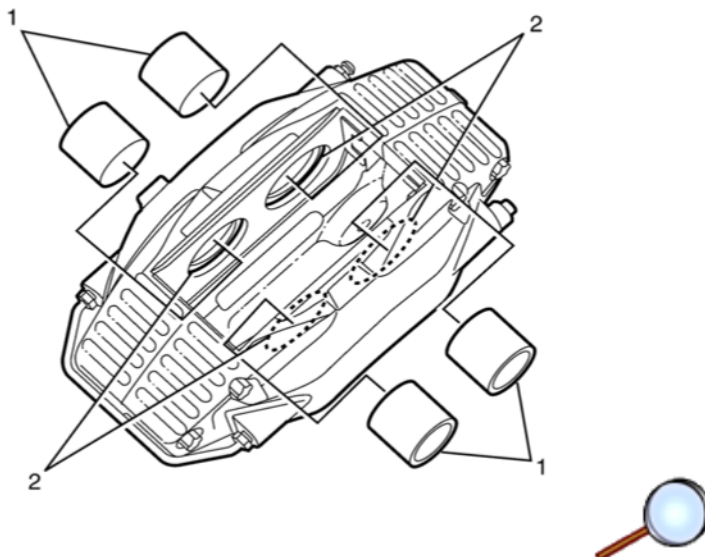
- Replace all the components included in the repair kit used to service the brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to [Brake System Specifications](#) for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

Caution: Refer to [Fastener Caution](#).

1. Install the brake caliper bleeder valves (3) and tighten to **17 Nm (97 lb in)**.
2. Lubricate the NEW brake caliper piston seals with brake fluid conforming to specification from a clean, sealed brake fluid container. Refer to [Brake System Specifications](#) for correct brake fluid specification.

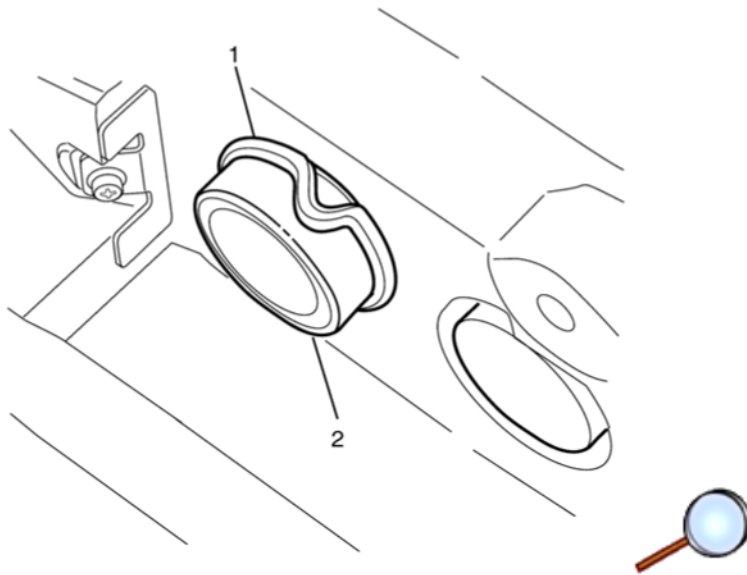
Note: When installing, make sure the brake caliper piston seals (1) are not twisted.

3. Install the brake caliper piston seals (1) into the grooves in the brake caliper piston bores (2).



4. Lubricate all the brake caliper piston bores (2) with brake fluid conforming to specification. Refer to [Brake System Specifications](#) for correct brake fluid specification.

5. Lubricate and install all the brake caliper pistons (1) into the brake caliper piston bores (2).



6. Install the NEW brake caliper piston dust boot seals (1) over the brake caliper pistons (2).

7. Complete the following for all brake caliper piston dust boot seals (1).

7.1. Fully seat the brake caliper piston dust boot seals (1) into the brake caliper (2).

7.2. Make sure the brake caliper piston dust boot seals (1) are correctly seated into the groove in the brake caliper piston bores (3).

Note: The brake pads are marked as inner and outer only. Failure to install the brake pads in their correct position will cause the brakes not to seat correctly in the brake caliper.

Note: The anti-rattle clip can only be installed with the arrow facing the direction of majority rotation. Failure to do so will cause vibration under heavy load.

8. Install the brake pads, anti-rattle clip, and brake pad retainer pins into the brake caliper. Refer to [Rear Disc Brake Pads Replacement](#).

9. Install the brake caliper assembly to the vehicle. Refer to [Rear Brake Caliper Replacement](#).

Front Brake Rotor Replacement (Except HSV)

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

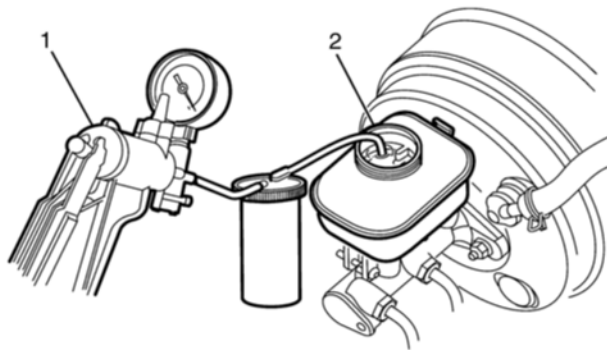
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

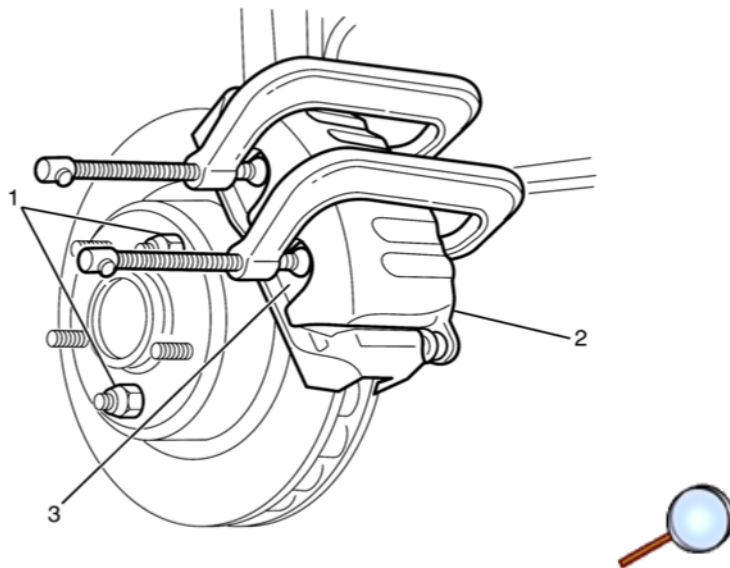
Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).
 - If the brake fluid level is midway between the maximum-fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

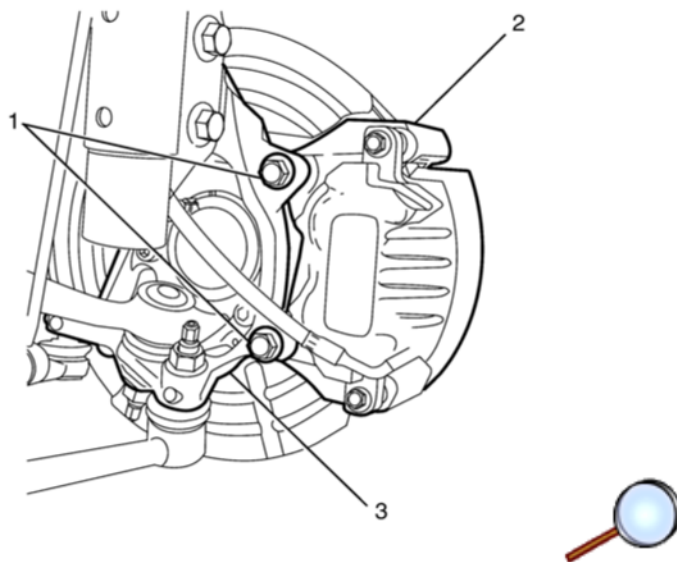
Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.
 - If the brake fluid level is higher than midway between the maximum-fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).



4. Install two wheel nuts (1) in reverse to opposite wheel studs to retain the brake disc to the hub.

Note: Position the ends of the G-clamps against the rear of the brake caliper (2) and against the outboard brake pad (3).

5. Install large G-clamps over the body of the brake caliper (2).
6. Tighten the G-clamps evenly until the brake caliper pistons bottom out in each brake caliper bore.
7. Remove the G-clamps from the brake caliper (2).



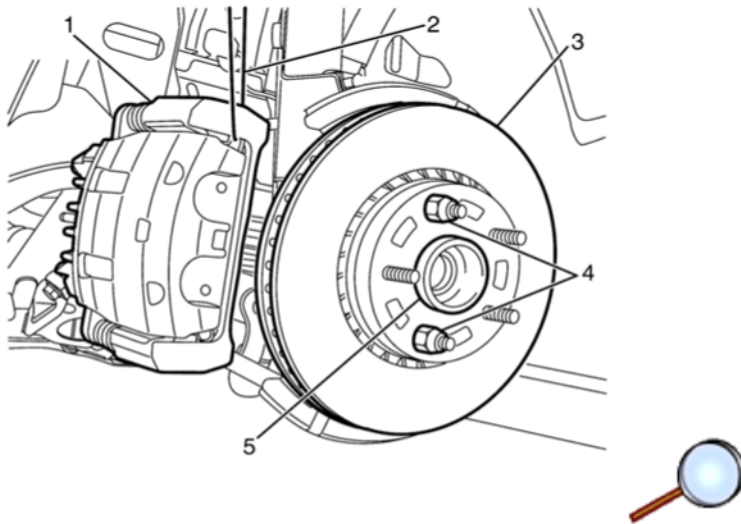
Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Note: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

8. Remove the brake caliper anchor plate to knuckle retaining bolts (1).
Discard the bolts.
Clean the bolt holes.

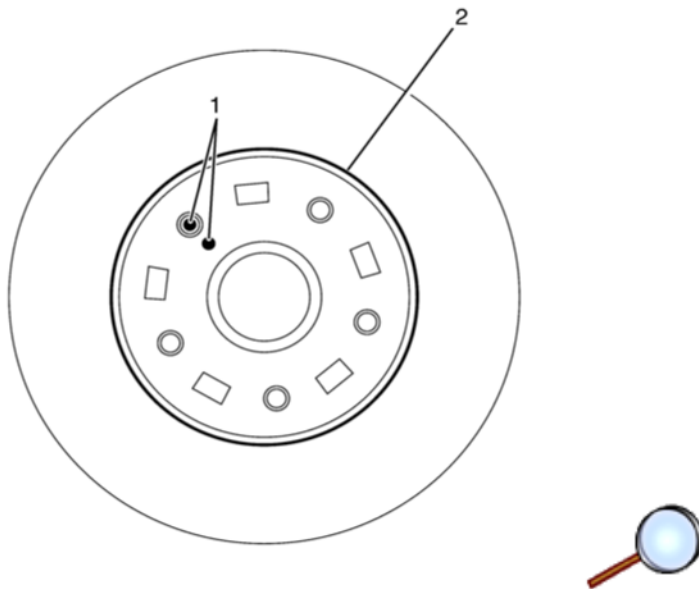
Note: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

9. Remove the brake caliper (2) from the steering knuckle (3).



Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

10. Support the brake caliper (1) with heavy mechanic's wire, or equivalent (2).
11. Remove the two wheel nuts (4) retaining the brake disc (3) to the hub (5).



Note: The brake disc to hub relationship is indexed during production. Mark the relationship of the brake disc to a wheel stud end for installation to minimise the potential of brake shudder.

Note: If the brake disc is being removed to be machined or replaced to rectify brake shudder, or if brake disc to hub matching is not evident, the brake disc to the hub must be indexed. Refer to [Brake Rotor Assembled Lateral Runout Correction - Indexing](#).

12. Matchmark the position of the brake disc (2) to the wheel studs (1).
13. Remove the brake disc (2).

Installation Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

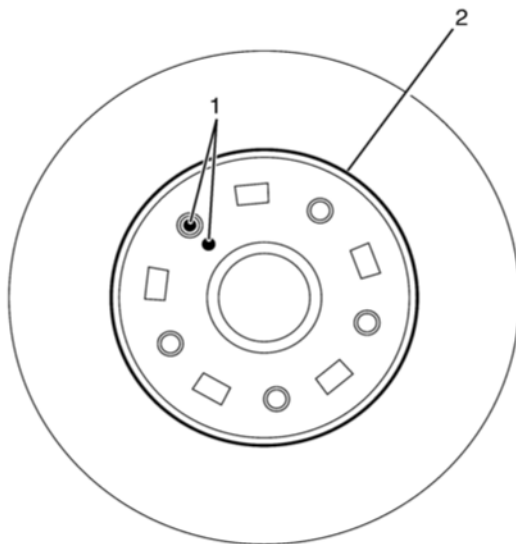
Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

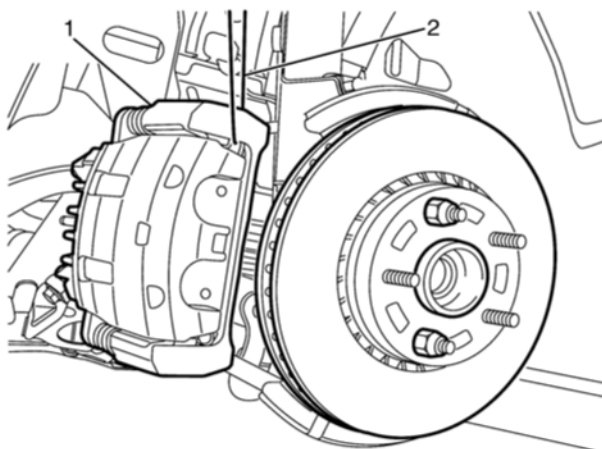
Note: Whenever the brake disc has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in too much assembled lateral runout (LRO) of the brake disc, which may lead to brake pulsation.

1. Clean any rust or corrosion from the mating surface of the hub/axle flange and mounting surface of the brake disc.
2. Inspect the mating surfaces of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.

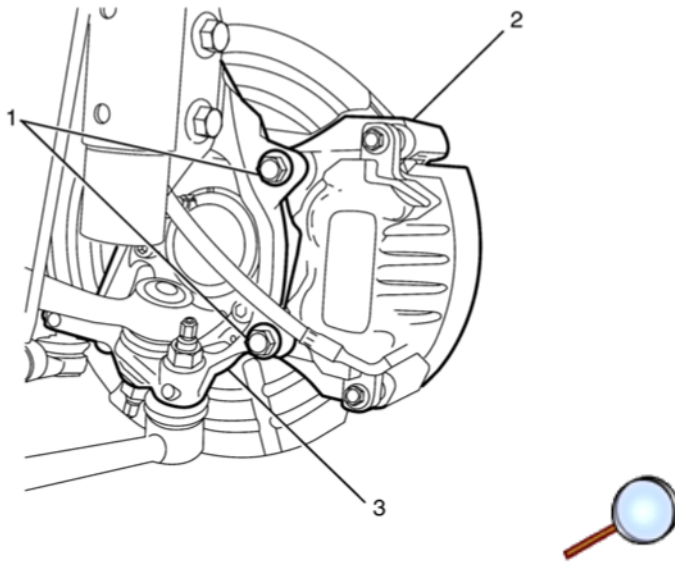


Note: Use the matchmark (1) made prior to removal for correct orientation to the flange.

3. Install the brake disc (2) to the hub/axle flange.
4. If the brake disc (2) was removed and installed as part of a brake system repair, measure the assembled lateral runout (LRO) of the brake disc (2) to make sure optimum performance of the disc brakes. Refer to [Brake Rotor Assembled Lateral Runout Measurement](#).
5. If the brake disc (2) assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to [Brake Rotor Assembled Lateral Runout Correction](#).



6. Remove the heavy mechanic's wire, or equivalent support (2) from the brake caliper (1).



Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

7. Install the brake caliper assembly (2) to the steering knuckle (3).

Caution: Refer to [Fastener Caution](#).

8. Install the NEW brake caliper anchor plate to knuckle retaining bolts (1) and tighten to **60 N•m + 120° (44 lb ft + 120°)**.
9. Install the front wheels. Refer to [Tire and Wheel Removal and Installation](#).
10. Lower the vehicle to the ground.
11. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
12. Slowly release the brake pedal.
13. Repeat steps 11 and 12 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.
14. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
15. If the brake disc was refinished or replaced, or if new brake pads were installed, burnish the brake pads and brake discs. Refer to [Brake Pad and Rotor Burnishing](#).

Front Brake Rotor Replacement (HSV)

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

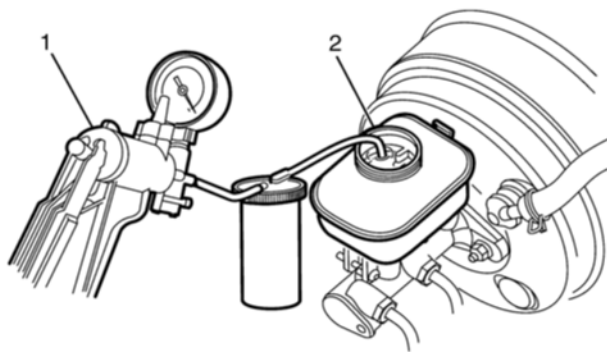
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).
 - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir before proceeding.
 - Note:** DO NOT reuse the removed fluid.
 - If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).
 - Note:** DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.
 - Note:** Nuts with micro-encapsulated thread sealant must be discarded after removal.
4. Remove the front brake caliper. Refer to [Front Brake Caliper Replacement](#).
 - Caution:** Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.
5. Support the brake caliper with heavy mechanic's wire, or equivalent.

Note: The brake rotor to hub relationship is indexed during production. Mark the relationship of the brake rotor to a wheel stud end for installation to minimise the potential of brake shudder.

Note: If the brake rotor is being removed to be machined or replaced to rectify brake shudder, or if brake rotor to hub matching is not evident, the brake rotor to the hub must be indexed. Refer to [Brake Rotor Assembled Lateral Runout Correction - Indexing](#).

6. Matchmark the position of the brake rotor to the wheel studs.
7. Remove the brake rotor.

Installation Procedure

Note: Whenever the brake rotor has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in excessive assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.

1. Clean any rust or corrosion from the mating surface of the hub/axle flange and mounting surface of the brake rotor.
2. Inspect the mating surfaces of the hub/axle flange and the brake rotor to make sure that there are no foreign particles or debris remaining.

Note: Use the matchmark made prior to removal for correct orientation to the flange.

3. Install the brake rotor to the hub/axle flange.
4. If the brake rotor was removed and installed as part of a brake system repair, measure the assembled lateral runout (LRO) of the brake rotor to make sure optimum performance of the disc brakes. Refer to [Brake Rotor Assembled Lateral Runout Measurement](#).
5. If the brake rotor assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to [Brake Rotor Assembled Lateral Runout Correction](#).
6. Remove the heavy mechanic's wire, or equivalent support from the brake caliper.

Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

7. Install the front brake caliper. Refer to [Front Brake Caliper Replacement](#).
8. Install the front wheels. Refer to [Tire and Wheel Removal and Installation](#).
9. Lower the vehicle to the ground.
10. With the Ignition Off, gradually apply the brake pedal to approximately 2/3 of its travel distance.
11. Slowly release the brake pedal.
12. Repeat steps 11 and 12 until a firm brake pedal application is obtained. This will correctly seat the brake caliper pistons and brake pads.
13. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
14. If the brake rotor was refinished or replaced, or if new brake pads were installed, burnish the brake pads and brake rotors. Refer to [Brake Pad and Rotor Burnishing](#).

Rear Brake Rotor Replacement (HSV)

Removal Procedure

Warning: Refer to [Safety Glasses Warning](#).

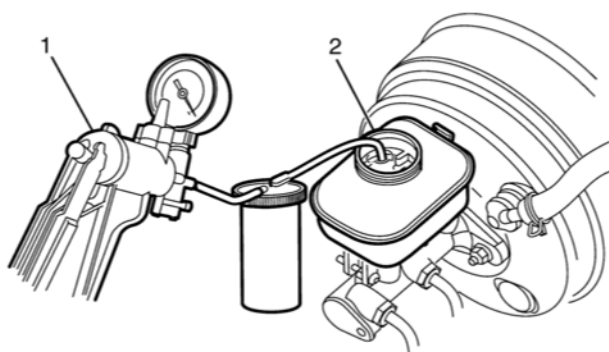
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).



1. Inspect the fluid level in the brake master cylinder reservoir (2).
 - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir before proceeding.

Note: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Note: DO NOT re use the removed fluid.

 - If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).

Note: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

Note: Ensure all bolts and threaded holes are thoroughly cleaned of all micro-encapsulated thread sealer residue.

Note: Inspect the brake caliper anchor to suspension knuckle bolts for damage. Replace any damaged bolts.
4. Remove the rear brake caliper. Refer to [Rear Brake Caliper Replacement](#).

Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

5. Support the brake caliper with heavy mechanic's wire, or equivalent.

Note: The brake rotor to hub relationship is indexed during production. Mark the relationship of the brake rotor to a wheel stud end for installation to minimise the potential of brake shudder.

Note: If the brake rotor is being removed to be machined or replaced to rectify brake shudder, or if brake rotor to hub matching is not evident, the brake rotor to the hub must be indexed. Refer to [Brake Rotor Assembled Lateral Runout Correction - Indexing](#).

6. Matchmark the position of the brake rotor to the wheel studs.
7. Remove the brake rotor.

Installation Procedure

Note: Whenever the brake rotor has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in excessive assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.

1. Clean any rust or corrosion from the mating surface of the hub/axle flange and mounting surface of the brake rotor.
2. Inspect the mating surfaces of the hub/axle flange and the brake rotor to make sure that there are no foreign particles or debris remaining.

Note: Use the matchmark made prior to removal for correct orientation to the flange.

3. Install the brake rotor to the hub/axle flange.
4. If the brake rotor was removed and installed as part of a brake system repair, measure the assembled lateral runout (LRO) of the brake rotor to make sure optimum performance of the disc brakes. Refer to [Brake Rotor Assembled Lateral Runout Measurement](#).
5. If the brake rotor assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to [Brake Rotor Assembled Lateral Runout Correction](#).
6. Remove the heavy mechanic's wire, or equivalent support from the brake caliper.

Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

7. Install the brake caliper. Refer to [Rear Brake Caliper Replacement](#).
8. Install the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).
9. Lower the vehicle to the ground.
10. With the Ignition Off, gradually apply the brake pedal to approximately 2/3 of its travel distance.
11. Slowly release the brake pedal.
12. Repeat steps 11 and 12 until a firm brake pedal application is obtained. This will correctly seat the brake caliper pistons and brake pads.
13. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).
14. If the brake rotor was refinished or replaced, or if new brake pads were installed, burnish the brake pads and brake rotor. Refer to [Brake Pad and Rotor Burnishing](#).

Rear Brake Rotor Replacement (Except HSV)

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

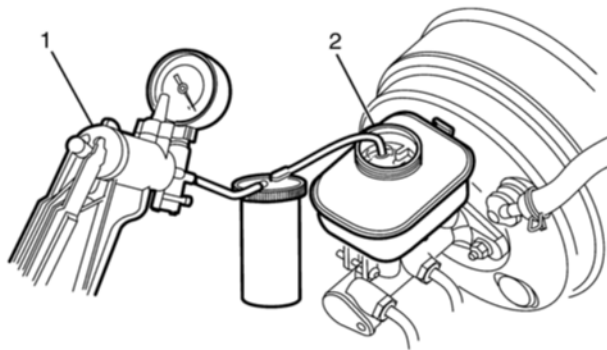
Warning: Refer to [Brake Dust Warning](#).

Warning: Refer to [Brake Fluid Warning](#).

Warning: Refer to [Brake Fluid Irritant Warning](#).

Caution: Refer to [Adding Fluid to the Brake System Caution](#).

Caution: Refer to [Brake Fluid Effects on Paint and Electrical Components Caution](#).

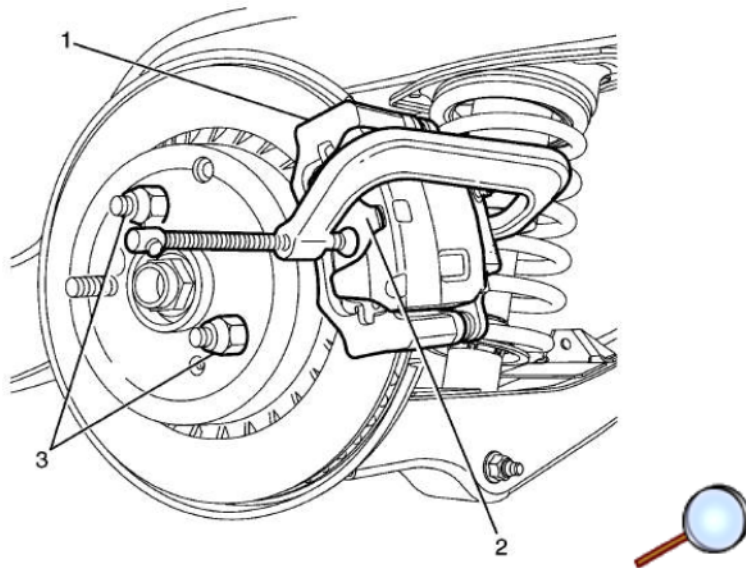


1. Inspect the fluid level in the brake master cylinder reservoir (2).
 - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Note: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Note: DO NOT re use the removed fluid.
 - If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.

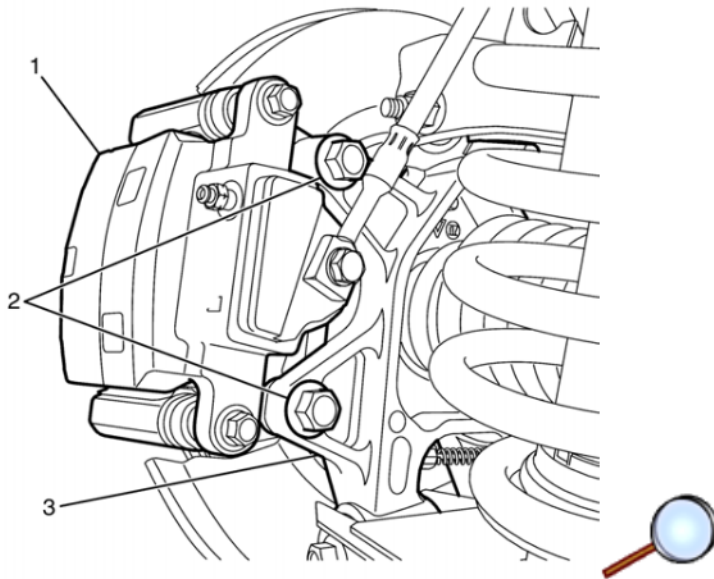
Note: Make sure the park brake is fully released.
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).



4. Install two wheel nuts in reverse (3) to opposite wheel studs to retain the brake disc to the hub.

Note: Position the ends of the G-clamp against the rear of the brake caliper (1) and against the outboard brake pad (2).

5. Install large G-clamp over the body of the brake caliper (1).
6. Tighten the G-clamp until the brake caliper piston bottoms out in the brake caliper bore.
7. Remove the G-clamp from the brake caliper (1).



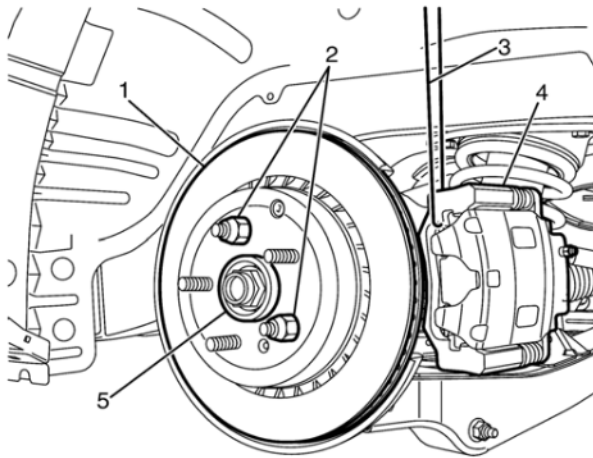
Note: Inspect the brake caliper anchor plate to knuckle retaining bolts (2) for damage. Discard any damaged bolts.

Note: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

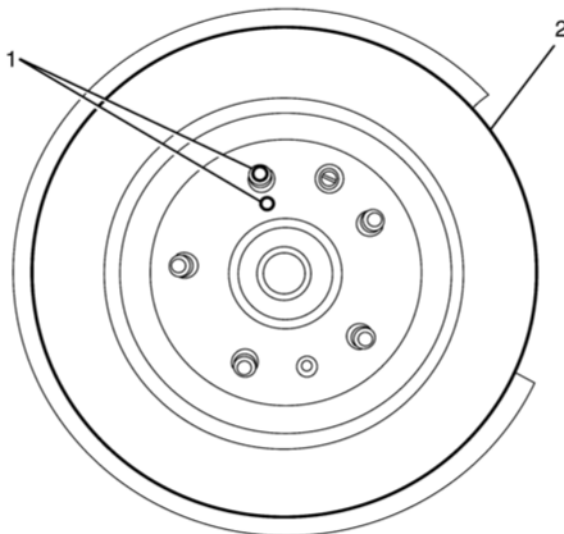
8. Remove the brake caliper anchor plate to knuckle retaining bolts (2).
 - Clean and inspect the bolts.
 - Clean the bolt holes.

Note: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

9. Remove the brake caliper (2) from the knuckle (3).



10. Support the brake caliper (1) with heavy mechanic's wire, or equivalent (2).
11. Remove the two wheel nuts (4) retaining the brake disc (3) to the hub (5).



Note: The brake disc to hub relationship is indexed during production. Mark the relationship of the brake disc to a wheel stud end for installation to minimize the potential of brake shudder.

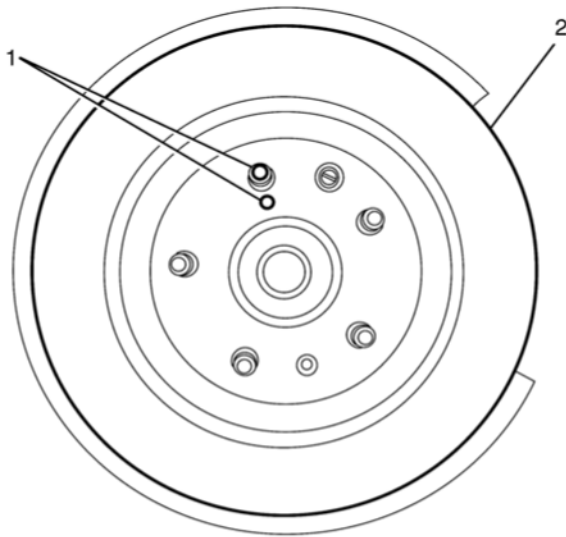
Note: If the brake disc is being removed to be machined or replaced to rectify brake shudder, or if brake disc to hub matching is not evident, the brake disc to the hub must be indexed. Refer to [Brake Rotor Assembled Lateral Runout Correction - Indexing](#).

12. Matchmark the position of the brake disc (2) to the wheel studs (1).
13. Remove the brake disc (2).

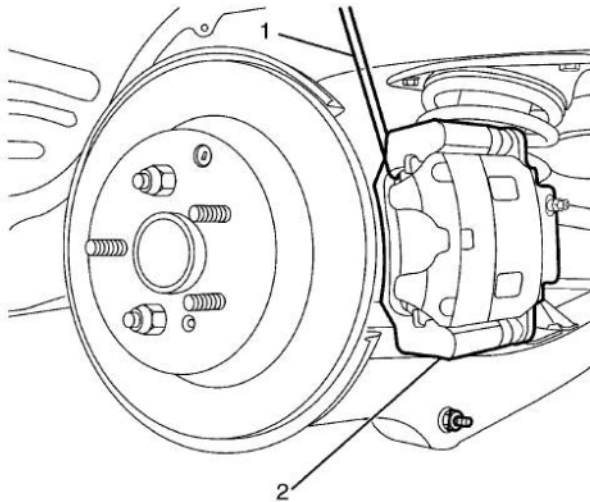
Installation Procedure

Note: Whenever the brake disc has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in too much assembled lateral runout (LRO) of the brake disc, which may lead to brake pulsation.

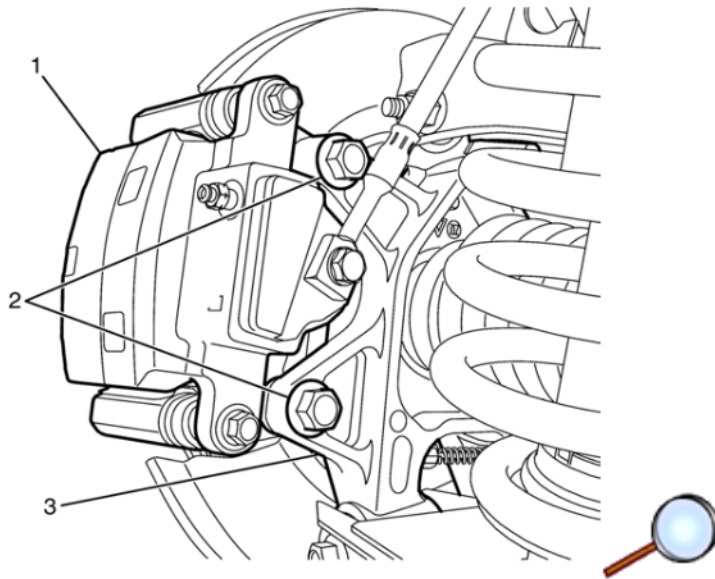
1. Clean any rust or corrosion from the mating surface of the hub/axle flange and mounting surface of the brake disc.
2. Inspect the mating surfaces of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.



3. Install the brake disc (2) to the hub/axle flange. Use the matchmark (1) made prior to removal for correct orientation to the flange.
4. If the brake disc was removed and installed as part of a brake system repair, measure the assembled lateral runout (LRO) of the brake disc to make sure optimum performance of the disc brakes. Refer to [Brake Rotor Assembled Lateral Runout Measurement](#).
5. If the brake disc assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to [Brake Rotor Assembled Lateral Runout Correction](#).



6. Remove the heavy mechanic's wire or equivalent support (2) from the brake caliper (1).



Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

7. Position the brake caliper assembly (1) to the knuckle (3).

8. Apply Loctite® 243 to the brake caliper anchor plate to knuckle bolts (2).

Caution: Refer to [Fastener Caution](#).

9. Install the brake caliper anchor plate to knuckle retaining bolts (2) and tighten to **110 N•m (82 lb ft)**.

10. Install the rear wheels. Refer to [Tire and Wheel Removal and Installation](#).

11. Lower the vehicle to the ground.

12. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.

13. Slowly release the brake pedal.

14. Repeat steps 12 and 13 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.

15. Fill the master cylinder reservoir to the correct level. Refer to [Master Cylinder Reservoir Filling](#).

16. If the brake disc was refinished or replaced, or if new brake pads were installed, burnish the brake pads and brake discs. Refer to [Brake Pad and Rotor Burnishing](#).

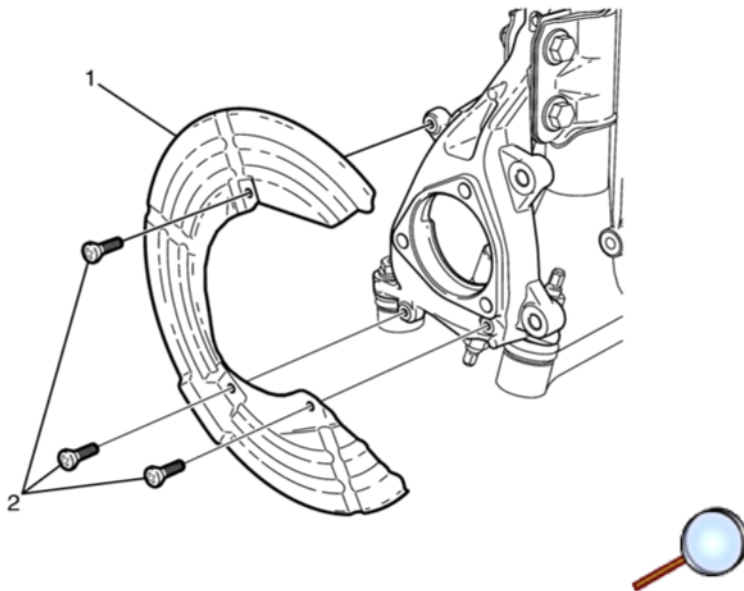
Front Brake Shield Replacement

Removal Procedure

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

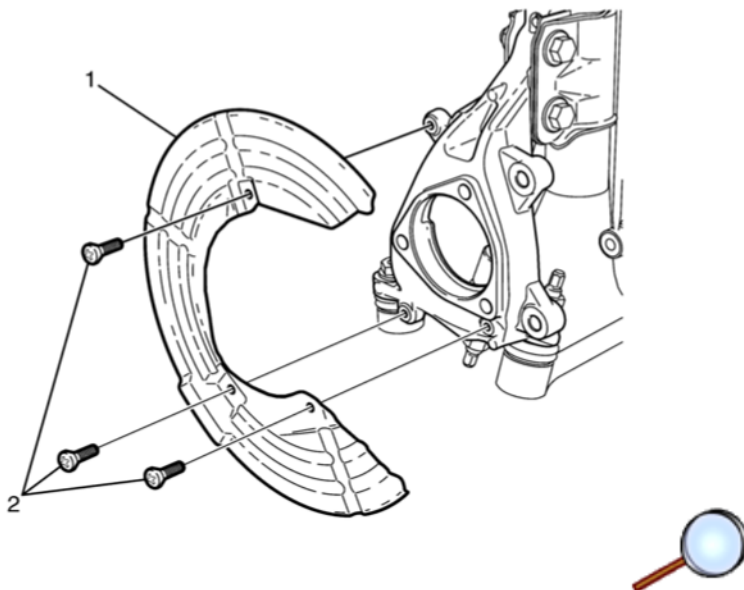
Warning: Refer to [Safety Glasses Warning](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the front wheel. Refer to [Tire and Wheel Removal and Installation](#).
3. Remove the front wheel hub assembly. Refer to [Front Wheel Bearing and Hub Replacement](#).



4. Remove the brake disc splash shield to steering knuckle retaining bolts (2).
5. Remove the brake disc splash shield (1).

Installation Procedure



1. Install the brake disc splash shield (1).

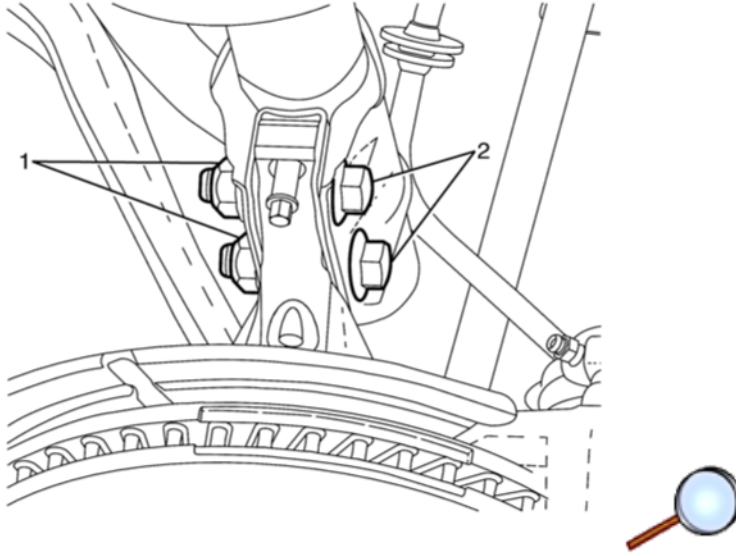
Caution: Refer to [Fastener Caution](#).

2. Install the brake disc splash shield to steering knuckle retaining bolts (2).

Tighten

Tighten the nut to 9 N•m (89 lb in).

3. Install the front wheel hub assembly. Refer to [Front Wheel Bearing and Hub Replacement](#).



Important: If the steering knuckle has been replaced, the end-float measurement must be inspected.

4. Install the front wheel. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the safety stands.
6. Lower the vehicle to the ground.
7. Bounce the vehicle several times to settle the suspension.
8. Inspect and adjust the wheel alignment. Refer to [Wheel Alignment Measurement](#).
9. Tighten the strut assembly to steering knuckle retaining bolts (2) and nuts (1).

Tighten

Tighten the bolts a first pass to 85 N•m (63 lb in). **Tighten**

Tighten the bolts a second pass to 100 N•m (74 lb in). **Tighten**

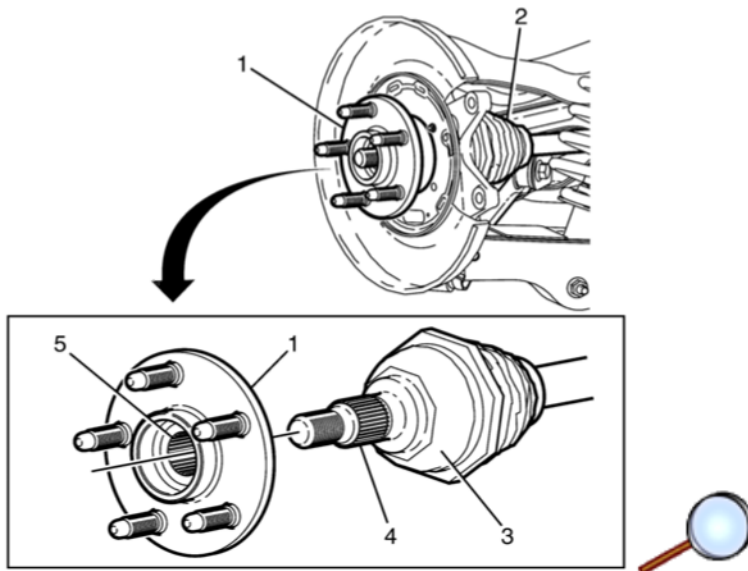
Tighten the bolts an additional 90 degrees.

Rear Brake Backing Plate Replacement

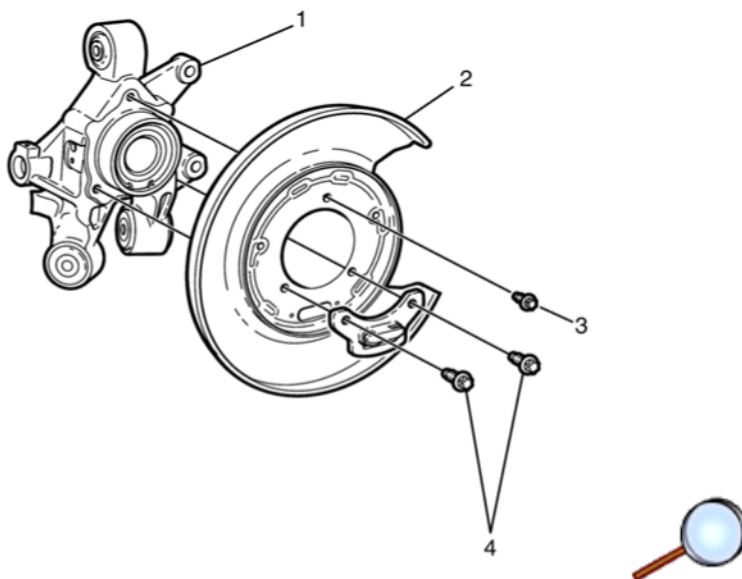
Removal Procedure

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

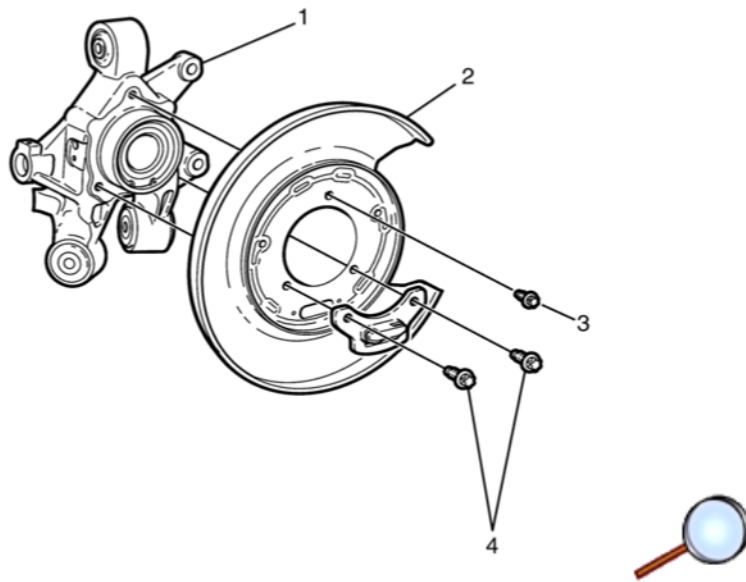


1. Remove the wheel hub (1). Refer to [Rear Wheel Bearing Stud Replacement](#).



2. Remove the upper disc brake backing plate to knuckle retaining bolt (3).
3. Remove the lower disc brake backing plate to knuckle retaining bolts (4).
4. Remove the disc brake backing plate (2) from the knuckle (1).

Installation Procedure

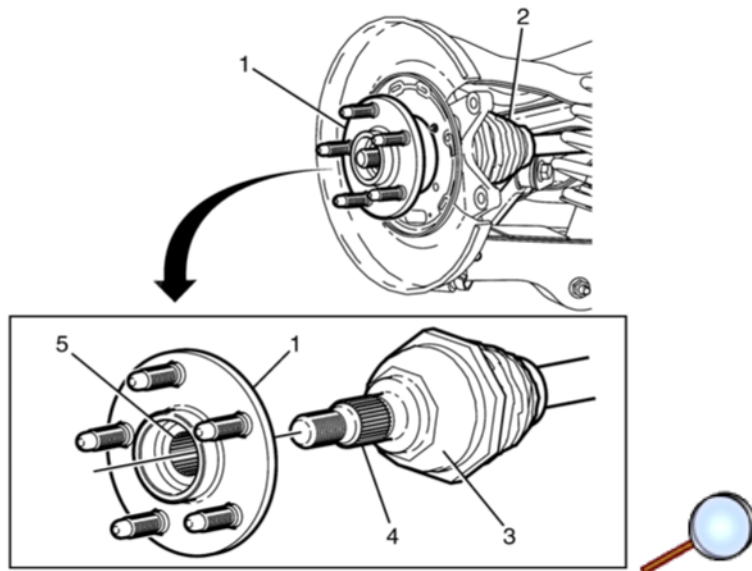


1. Install the disc brake backing plate (2) to the knuckle (1).

Caution: Refer to [Fastener Caution](#).

2. Install the upper disc brake backing plate to knuckle retaining bolt (3) and tighten to **58 N•m (43 lb ft)**.

3. Install the lower disc brake backing plate to knuckle retaining bolts (4) and tighten to **50 N•m (37 lb ft) + 60 degrees**.



4. Install the wheel hub (1). Refer to [Rear Wheel Bearing Stud Replacement](#).

Brake Rotor Assembled Lateral Runout Correction

Important:

- Brake disc thickness variation **MUST** be inspected **BEFORE** inspecting for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to [Brake Rotor Thickness Variation Measurement](#).
- Brake disc assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake disc over time, usually between 4 800–11 300 km (3,000–7,000 mi). Refer to Part 2 in [Brake Rotor Assembled Lateral Runout Correction - Indexing](#).

Review the following acceptable methods for bringing the brake disc assembled LRO to within specifications. Determine which method to use for the vehicle being repaired.

- The indexing method of correcting assembled LRO is most effective when the LRO specification is only exceeded by a relatively small amount: 0.025–0.127 mm (0.001–0.005 in). Indexing is used to achieve the best possible match of high spots to low spots between related components. Refer to [Brake Rotor Assembled Lateral Runout Correction - Indexing](#).
- The on-vehicle brake lathe method is used to bring the LRO to within specifications through compensating for LRO while refinishing the brake disc. Refer to [Brake Rotor Assembled Lateral Runout Correction - On Vehicle Lathe](#).

If the assembled LRO cannot be corrected using these methods, then other components must be suspected as causing and/or contributing to the LRO concern.

Brake Rotor Assembled Lateral Runout Correction - Indexing

Note: Brake disc thickness variation **MUST** be inspected **BEFORE** inspecting for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to [Brake Rotor Thickness Variation Measurement](#).

Note: Brake disc and hub indexing is required so the minimum installed brake disc runout is achieved. Brake disc and hub indexing involves aligning the point of maximum runout on the hub with the point of least runout on the brake disc.

Note: The procedure is to be used when installing NEW brake discs or brake discs that have been removed for any reason and where the brake disc to hub matching is not evident.

The procedure consists of three parts:

- Clean Mating Surfaces.
- Indexing Brake Disc to Hub. If these measurements are not within specification, go to Hub Runout Inspection.
- Hub Runout Inspection.

Clean Mating Surfaces

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

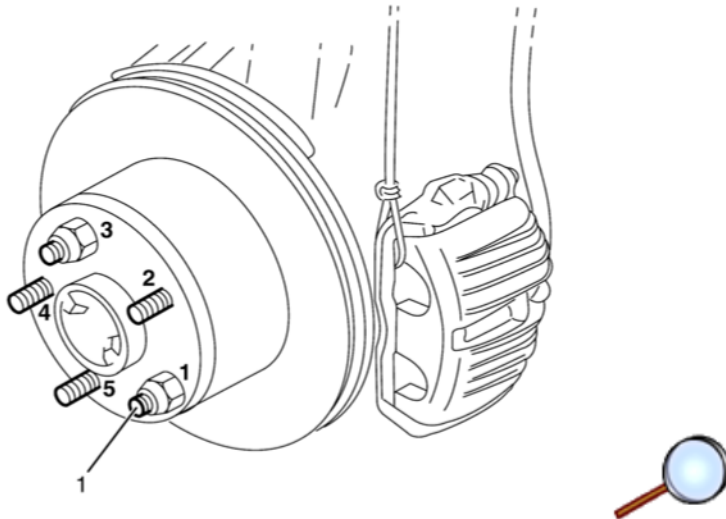
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove wheels. Refer to [Tire and Wheel Removal and Installation](#).
3. Remove the brake caliper. Refer to [Front Brake Rotor Replacement](#) or [Rear Brake Rotor Replacement](#).
4. Make sure that brake disc and hub mating surfaces are free from dirt, corrosion, etc. If required, use fine emery paper to clean surfaces.

Indexing Brake Disc to Hub – Front

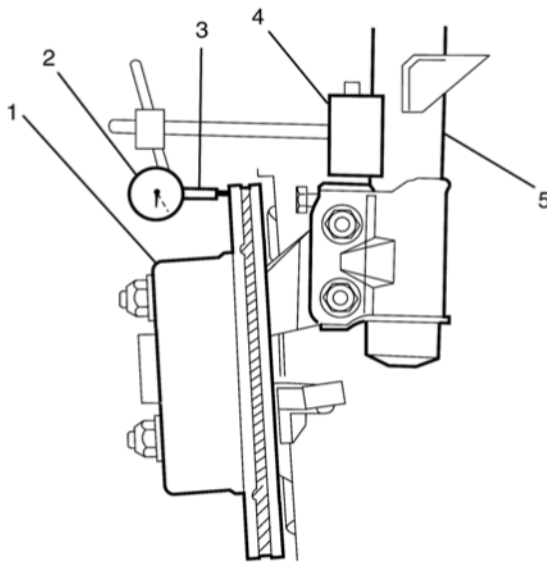
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).



1. Install 2 wheel nuts in reverse to opposite wheel studs to retain the brake disc to the hub.
2. Number each of the wheel stud holes on the front surface of the brake disc from 1 to 5.
3. Place a chalk mark on the end of the wheel stud adjacent to the number "1" hole (1).



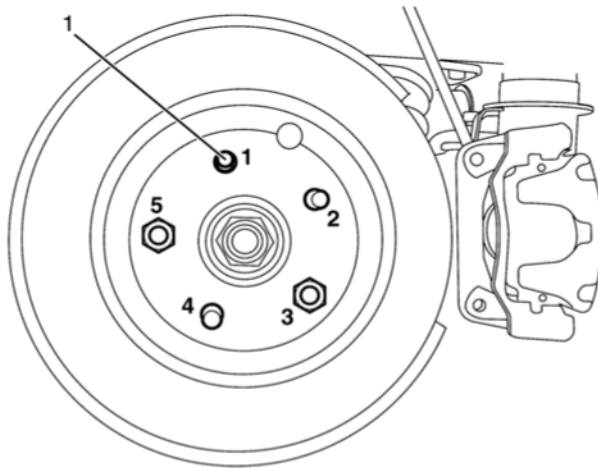
4. Set up a dial indicator (2) on a magnetic base (4) and attach to the front strut unit (5) above the brake disc (1).
5. Position the pointer (3) about 10 mm ($\frac{3}{8}$ in), from the outer edge of the disc.
- Note:** The number of divisions between the points of minimum and maximum runout on the dial indicator is the total indicated runout.
6. Rotate the brake disc (1) and note the points of minimum and maximum runout on the dial indicator (2).
- Note:** If the lowest assembled disc runout achieved is more than 0.05 mm (50 micron), then the hub runout should be inspected as detailed in the Hub Runout procedure.
7. Record the figure together with the number on the brake disc aligned with the chalk-marked stud.
8. Remove and reinstall the brake disc with hole number '2' over the marked stud. Repeat Steps 4 to 7. This procedure is to be repeated for all 5 hole positions. Refer to specifications [Disc Brake Component Specifications](#).
9. Mount the brake disc to the hub in the stud position which recorded the least amount of runout.

[Index Brake Disc to Hub – Rear](#)

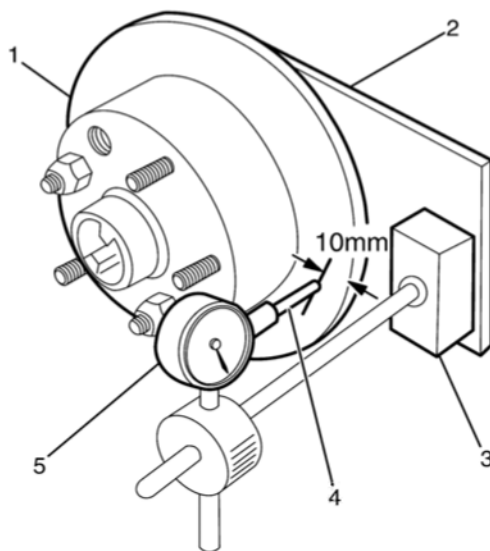
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).



1. Install 2 wheel nuts in reverse to opposite wheel studs to retain the brake disc to the hub.
2. Number each of the wheel stud holes on the front surface of the brake disc from 1 to 5.
3. Place a chalk mark on the end of the wheel stud adjacent to the number "1" hole (1).
4. Bolt the dial indicator plate (3) to the brake caliper attaching points on the rear knuckle. Refer to Dial Indicator Plate in Special Tools for dial indicator plate details.



5. Set up a dial indicator (1) on a magnetic mounting base (2) and attach to the dial indicator plate (3).
6. Position the pointer (4) about 10 mm ($\frac{3}{8}$ in), from the outer edge of the brake disc (5).

Note: The number of divisions between the points of minimum and maximum runout on the dial indicator is the total indicated runout.

7. Carefully rotate the brake disc and note the points of minimum and maximum runout on the dial indicator.

Note: If the lowest assembled brake disc runout achieved is more than 0.05 mm (50 micron), then the trunnion hub runout should be inspected as detailed in the Hub Runout procedure.

- Record this figure together with the number on the brake disc aligned with the chalk-marked stud.
- Remove and reinstall brake disc with hole number 2 over the marked stud and repeat Step 4. This procedure is to be repeated for all 5 hole positions. Refer to specifications [Disc Brake Component Specifications](#).
- Mount the brake disc to the hub in the stud position which recorded the least amount of runout.

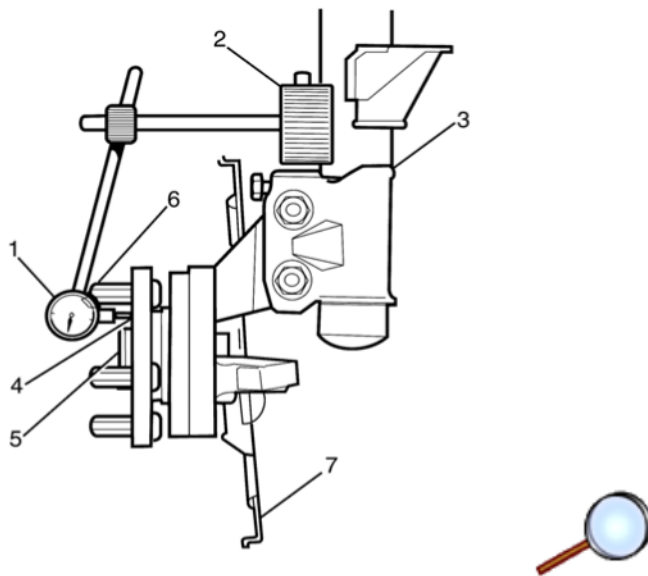
Hub Runout Inspection – Front

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

- Clean the front hub face with fine emery paper.



- Locate the dial indicator magnetic base (2) on the front strut unit (3) and position the pointer (4) on the hub face midway between the spigot (5) and the studs (6).

Note: For this inspection to be performed with 100 percent accuracy, a flat parallel surface plate attached to the hub should be used. However, measuring runout between spigot (5) and the studs (6) should yield adequate results.

Note: The number of divisions between the points of minimum and maximum runout on the dial indicator (1) is the total indicated runout.

- Rotate the hub by the hub spigot (5) (to avoid loading the bearing) and note the points of minimum and maximum runout on the dial indicator (1).

Note: The maximum runout at hub face–front hub is 0.025 mm.

- If the runout measured in Step 3 exceeds 0.025 mm (25 micron), replace the hub unit. Refer to [Front Wheel Bearing and Hub Replacement](#).

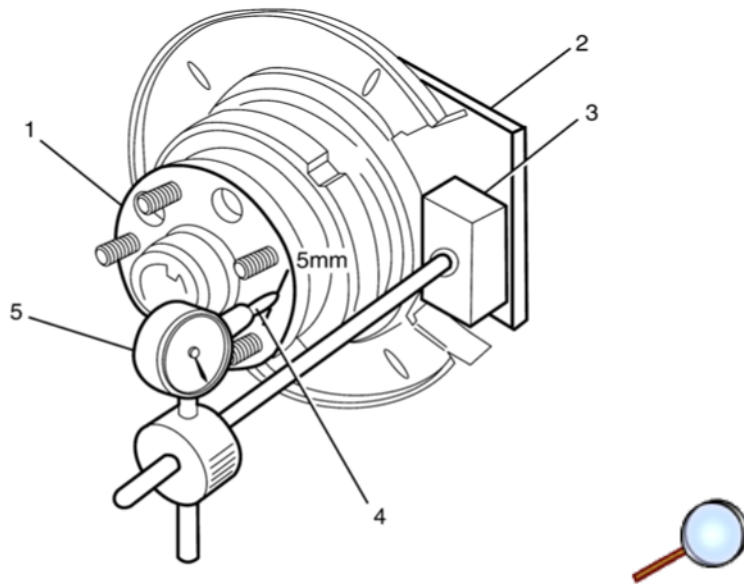
Hub Runout Inspection – Rear

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

- Clean the hub face by rubbing lightly with fine emery paper.



2. Set up a dial indicator (5) on a magnetic base (3) and attach to the pre-fabricated mounting plate (2).
3. Position the pointer (4) on the hub face 5 mm (0.2 in) from the edge of the hub (1).

Note: For this inspection to be performed with 100 percent accuracy, a flat parallel surface plate attached to the hub should be used. However, measuring runout on the hub face 5 mm (0.2 in) from the edge of the hub (1) should yield adequate results.

Note: The number of divisions between the points of minimum and maximum runout on the dial indicator (5) is the total indicated runout.

4. Rotate the hub by the wheel studs and note the points of minimum and maximum runout on the dial indicator (5).
5. If the runout measured in Step 3 exceeds 0.025 mm (25 micron), replace the hub assembly.

Brake Rotor Assembled Lateral Runout Correction - On Vehicle Lathe

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Important:

- Brake disc thickness variation must be inspected before inspecting for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to [Brake Rotor Thickness Variation Measurement](#).
- Brake disc assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake disc over time, usually between 10 000–20 000 km (6,213–12,427 mi). Refer to [Brake Rotor Assembled Lateral Runout Measurement](#).
- Before refinishing a brake disc, the brake disc must first be inspected for adequate thickness to allow the brake disc to be refinished and remain above the minimum allowable thickness after refinish specification. Refer to [Brake Rotor Thickness Measurement](#).

1. Make sure that the brake caliper and brake caliper anchor plate that are already being supported, are clear from contacting any rotating components, such as the brake disc.
2. Remove the dial indicator and the wheel nuts that were installed during the assembled LRO measurement procedure and/or the indexing correction procedure.
3. Inspect the mounting surface of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.
4. Set up the lathe, following the manufacturer's instructions.
5. Refinish the brake disc, following the brake lathe manufacturer's instructions.
6. After each successive cut, inspect the brake disc thickness. Refer to [Brake Rotor Thickness Measurement](#).
7. If at any time the brake disc exceeds the minimum allowable thickness after refinish specification, the brake disc must be replaced. After replacing the brake disc, proceed to step 10.
8. After refinishing the brake disc, use the following procedure in order to obtain the desired non-directional finish:
 - 8.1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish.
 - 8.2. Using moderate pressure, apply the non-directional finish:
 - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120 grit aluminum oxide sandpaper.
 - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150 grit aluminum oxide sandpaper.
 - 8.3. After applying a non-directional finish, clean each friction surface of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.
9. Remove the lathe from the vehicle.
10. Measure the assembled LRO of the brake disc. Refer to [Brake Rotor Assembled Lateral Runout Measurement](#).

11. If the brake disc assembled LRO measurement still exceeds the maximum allowable specification, refer to [Brake Rotor Assembled Lateral Runout Correction](#).
12. If the brake disc assembled LRO is within specification, install the brake caliper and depress the brake pedal several times to secure the brake disc in place before removing the dial indicator and the wheel nuts.

Brake Rotor Refinishing

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Brake Dust Warning](#).

Note:

- The brake discs do not require refinishing as part of routine brake system service. NEW brake discs do not require refinishing.
- DO NOT refinish brake discs in an attempt to correct the following conditions:
 - Brake system noise – squeal, growl, groan
 - Uneven and/or premature brake pad wear
 - Superficial or cosmetic corrosion/rust of the brake disc friction surface
 - Scoring of the brake disc friction surface less than the maximum allowable specification
- Before refinishing a brake disc, the brake disc must first be inspected for adequate thickness to allow the brake disc to be refinished and remain above the minimum allowable thickness after refinish specification. Refer to [Brake Rotor Thickness Measurement](#).
- Brake discs should only be refinished if they have adequate thickness to be refinished and if one or more of the following conditions exist:
 - Thickness variation in excess of the maximum allowable specification.
 - Too much corrosion/rust and/or pitting.
 - Cracks and/or heat spots.
 - Too much blueing, discoloration.
 - Scoring of the brake disc surface in excess of the maximum allowable specification.
- Brake discs may need to be refinished as part of the process for correcting brake disc assembled lateral runout (LRO) that exceeds the maximum allowable specification.

Note: Whenever the brake disc has been separated from the hub/axle flange, clean any rust or contaminants from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in increased assembled LRO of the brake disc, which may lead to brake pulsation.

1. Clean any rust or corrosion from the mating surface of the hub/axle flange.
2. Clean any rust or corrosion from the mating surface and mounting surface of the brake disc.
3. Inspect the mating surfaces of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.
4. Mount the brake disc to the brake lathe according to the lathe manufacturer's instructions, ensuring that all mounting attachments and adapters are clean and free of debris.
5. Make sure that any vibration dampening attachments are securely in place.
6. With the brake lathe running, slowly bring in the cutting tools until they just contact the brake disc friction surfaces.
7. Observe the witness mark on the brake disc. If the witness mark extends approximately three-quarters or more of the way around the brake disc friction surface on each side, the brake disc is correctly mounted to the lathe.
8. If the witness mark does not extend three-quarters or more of the way around the brake disc, re-mount the brake disc to the lathe.

9. Following the brake lathe manufacturer's instructions, refinish the brake disc.
10. After each successive cut, inspect the brake disc thickness. Refer to [Brake Rotor Thickness Measurement](#).
11. If at any time the brake disc exceeds the minimum allowable thickness after refinish specification, the brake disc must be replaced.
12. After refinishing the brake disc, use the following procedure in order to obtain the desired non-directional finish:
 - 12.1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish
 - 12.2. Using moderate pressure, apply the non-directional finish:
 - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120 grit aluminum oxide sandpaper.
 - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150 grit aluminum oxide sandpaper.
 - 12.3. After applying a non-directional finish, clean each friction surface of the brake rotor with a solution of mild dish washing detergent and water, or a GM approved brake cleaner and a clean shop towel to remove metal particles remaining from machining. Repeat the cleaning process if necessary to remove all metal particles.
13. Remove the brake disc from the brake lathe.
14. Measure the assembled LRO of the brake disc to make sure optimum performance of the disc brakes. Refer to [Brake Rotor Assembled Lateral Runout Measurement](#).
15. If the brake disc assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to [Brake Rotor Assembled Lateral Runout Correction](#).

Note: Thoroughly cleaning the brake rotor will prevent the possible transfer of finite metal dust left as a by-product of machining to the brake pad material during the burnishing process, thereby reducing the possibility for brake squeal or other brake noises to occur.

Fastener Tightening Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve to Brake Caliper, Dry Torque (Except HSV)	12 N•m	106 lb in
Brake Caliper Bleeder Valve to Brake Caliper, Dry Torque (HSV)	17 N•m	13 lb ft
Brake Hose to Caliper Retaining Banjo Bolt, Dry Torque (Except HSV)	35 N•m	26 lb ft
Brake Hose to Caliper Retaining Banjo Bolt, Dry Torque - Front (HSV)	35 N•m	26 lb ft
Brake Hose to Caliper Retaining Banjo Bolt, Dry Torque - Rear (HSV)	33 N•m	24 lb ft
Front Brake Caliper Anchor Plate to Steering Knuckle Retaining Bolt		
• First Pass	40 N•m	30 lb ft
• Final Pass	+ 90 Degrees	
Front Brake Caliper Guide Pin to Front Brake Caliper Retaining Bolt	42 N•m	31 lb ft
Front Brake Caliper to Steering Knuckle Retaining Bolt (HSV)	160 N•m	118 lb ft
Front Disc Brake Splash Shield to Steering Knuckle Retaining Bolt	9 N•m	80 lb in
Rear Brake Caliper Anchor Plate to Knuckle Retaining Bolt	110 N•m	81 lb ft
Rear Brake Caliper Guide Pin to Rear Brake Caliper Retaining Bolt	42 N•m	31 lb ft
Rear Brake Caliper to Suspension Knuckle Retaining Bolt (HSV)	110 N•m	81 lb ft
Rear Disc Brake Backing Plate to Knuckle Retaining Bolt (Lower)		
• First Pass	50 N•m	37 lb ft

Application	Specification	
	Metric	English
• Final Pass	+ 60 Degrees	
Rear Disc Brake Backing Plate to Knuckle Retaining Bolt (Upper)	58 N•m	43 lb ft
Steering Knuckle to Front Strut Assembly Retaining Bolt and Nut		
• First Pass	100 N•m	74 lb ft
• Final Pass	+ 90 Degrees	

Disc Brake Component Specifications

Disc Brake Component Specifications

Application	Specification	
	Metric	English
Front Brake Rotors - LFW, LFX, LWR, L77		
• Rotor Diameter - LFW, LFX, LWR	298.00 mm	11.73 in
• Rotor Diameter - L77	321.00 mm	12.64 in
• Rotor Discard Thickness	28.00 mm	1.10 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Rotor Maximum Allowable Scoring	0.50 mm	0.01 in
• Rotor Maximum Allowable Thickness Variation	0.02 mm	0.001 in
• Rotor Minimum Thickness after Refinishing	28.75 mm	1.13 in
• Rotor Thickness New	30.00 mm	1.18 in
Front Brake Rotors - LS3		
• Rotor Diameter	367.00 mm	14.45 in
• Rotor Discard Thickness	29.80 mm	1.17 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Rotor Maximum Allowable Scoring	0.50 mm	0.01 in
	0.02 mm	0.001 in

Application	Specification	
	Metric	English
• Rotor Maximum Allowable Thickness Variation		
• Rotor Minimum Thickness after Refinishing	30.00 mm	1.18 in
• Rotor Thickness New	32.00 mm	1.26 in
Front Brake Rotors - LSA		
• Rotor Diameter	390.00 mm	15.35 in
• Rotor Discard Thickness	33.50 mm	1.32 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Rotor Maximum Allowable Scoring	0.50 mm	0.01 in
• Rotor Maximum Allowable Thickness Variation	0.02 mm	0.001 in
• Rotor Minimum Thickness after Refinishing	33.50 mm	1.32 in
• Rotor Thickness New	35.50 mm	1.40 in
Rear Brake Rotors - LFW, LFX, LWR, L77		
• Rotor Diameter - LFW, LFX, LWR	302.00 mm	11.89 in
• Rotor Diameter - L77	324.00 mm	12.76 in
• Rotor Discard Thickness	20.00 mm	0.79 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Rotor Maximum Allowable Scoring	1.50 mm	0.06 in

Application	Specification	
	Metric	English
• Rotor Maximum Allowable Thickness Variation	0.02 mm	0.001 in
• Rotor Minimum Thickness after Refinishing	20.75 mm	0.82 in
• Rotor Thickness New	22.00 mm	0.87 in
Rear Brake Rotors - LS3		
• Rotor Diameter	367.00 mm	14.45 in
• Rotor Discard Thickness	25.80 mm	1.02 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Rotor Maximum Allowable Scoring	0.50 mm	0.01 in
• Rotor Maximum Allowable Thickness Variation	0.02 mm	0.001 in
• Rotor Minimum Thickness after Refinishing	26.00 mm	1.02 in
• Rotor Thickness New	28.00 mm	1.10 in
Rear Brake Rotors - LSA		
• Rotor Diameter	372.00 mm	14.65 in
• Rotor Discard Thickness	26.00 mm	1.02 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Rotor Maximum Allowable Scoring	0.50 mm	0.01 in

Application	Specification	
	Metric	English
• Rotor Maximum Allowable Thickness Variation	0.02 mm	0.001 in
• Rotor Minimum Thickness after Refinishing	26.00 mm	1.02 in
• Rotor Thickness New	28.00 mm	1.10 in

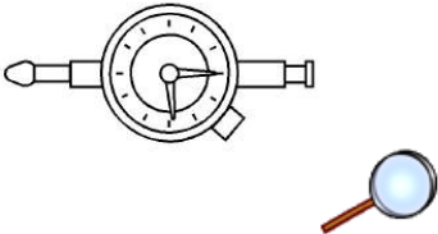
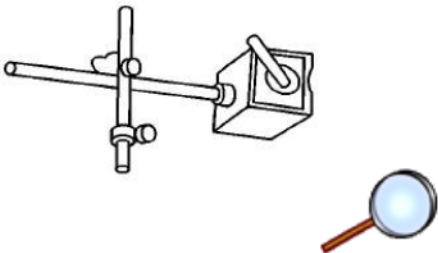
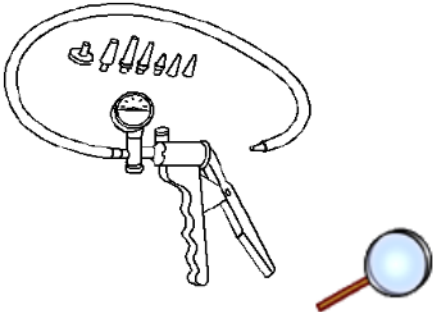
[2014 Holden VF Sedan](#) | [VF/WN - Sedan, Ute, Sportwagon, Caprice, Lumina, HSV Service Manual 5617662](#) | [Brakes](#) |
[Disc Brakes](#) | [Specifications](#) | **Document ID: 3284191**

Adhesives, Fluids, Lubricants, and Sealers

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material
Hydraulic Brake System	DOT 4 Hydraulic Brake Fluid Conforming to Specification Number GMW3356 or HN2456

Special Tools

Illustration	Tool Number/ Description
	DT 26900-12 GE 571-B GE 7872 GE 8001 J 26900-12 Dial Indicator
	DT 26900-13 GE 26900-13 J 26900-13 Magnetic Indicator Base
	GE 23738-A J 23738-A Hand Vacuum Pump