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Introduction

Objectives

After completing this section, the student will be able to:

• Explain the meaning of special information and abbreviations used in this booklet
• Identify the base brake system from the Regular Production Option (RPO) codes
• Identify and locate base brake components on the vehicle
• Describe brake system operation
• Describe brake system functions
• Describe the variations in the different types of braking systems
• Describe hydraulic theory and how it applies to base brakes
• Identify special tools and their function
• Identify recommended brake fluid types

Introduction

This handout gives you an overview of base brake components. It includes nine main sections:

1. Introduction
2. Apply System
3. Power Brake Boosters
4. Hydraulic System
5. Drum Brakes
6. Disc Brakes
7. Balance Control Systems
8. Warning Systems
9. General Brake Diagnosis
Service Manual References

Refer to the appropriate service information for vehicle specific troubleshooting sequences, checklists, system diagrams and service procedures.

- Hydraulic Brakes
- Disc Brakes
- Drum Brakes
- Parking Brake
- Antilock Brake System

Regardless of what service information or manual is used, the following topics can always be found in the table of contents:

- Description/Operation
- Diagnostic Procedures
- Repair Instructions
- Special Tools
- Specifications
Special Information and Abbreviations

Throughout this handout, you will see special information as follows:

• IMPORTANT-indicates information that deserves special attention. This information clarifies important points and exceptions
• NOTICE-indicates the potential for vehicle or service equipment damage unless specific steps are followed
• CAUTION-indicates the potential for personal injury. For your own safety, please read these reminders carefully

Abbreviations used to describe system components and operation include:

• ABS: Antilock Brake System
• ID: Inside Diameter
• in.: inch
• kPa: kilopascals
• mm: millimeters
• mph: miles per hour
• OD: Outside Diameter
• psi: pounds per square inch
• RBWL: Red BRAKE Warning Lamp
• RA: Roughness Analysis
• BTSI: Brake Transmission Shift Interlock
• ISO: International Standards Organization
Base Brake Introduction

Option Codes

The service parts identification label helps dealership personnel identify vehicle options and accessories. Vehicle options are identified on the service parts identification label by the Regular Production Option (RPO) codes (Figure 1-1). The option codes are three-digit combinations of letters and numbers. "J" options provide brake types installed during production. The "J" option information may be needed to distinguish the correct parts to use during service.

Base brake components are the parts of the brake system found on all vehicles (Figure 1-2). The term "base brakes" does not include antilock brakes or traction control systems.

Base brake components include:

- Brake pedal, pedal linkage, and parking brake
- Power brake boost system
- Master cylinder
- Cables, hoses and pipes
- Brake rotors and pads
- Brake drums and shoes
- Brake balance controls (proportioning valve and metering valve), if equipped.
- Red BRAKE Warning Lamp (RBWL) and other warning systems
**Brake System Operation**

Brakes slow and stop a vehicle by transforming kinetic (motion) energy into heat (brake) energy. The brake linings contacting the drum/rotor use friction to convert motion energy to heat energy. The intensity of the heat is proportional to the vehicle speed and the quickness of the stop. Faster speeds and quicker stops equal more heat.

Today’s high performance hydraulic brake systems are a result of years of design and component improvements.

**Brake System Functions**

The brake system includes components in several different sub-systems (Figure 1-3):

- Balance control system
- Warning system
- Apply system
- Boost system
- Hydraulic system
- Wheel brakes

![Figure 1-3, Base Brake Sub-Systems](image)

Stopping a vehicle requires that all brake sub-systems act together (see Figure 1-3).

1. The driver presses the brake pedal, operating the pedal linkage (apply system).
2. The brake booster (if equipped) increases the brake pedal force (boost system).
3. The pedal force moves the pistons in the master cylinder, forcing out pressurized brake fluid (hydraulic system). The brake fluid is directed through pipes and hoses to the wheel brakes.
4. At the wheel, the pressurized brake fluid moves pistons. The pistons press brake friction material against a spinning rotor or drum, slowing the vehicle (wheel brakes).
5. Hydraulic and mechanical valves ensure that brakes apply quickly, simultaneously and at balanced pressure for safest operation (balance control system).
6. An instrument panel lamp signals the driver of brake system failure (warning system).
Because of innovations in materials and technology, there is a wide variety of components specific to each of these base brake component systems. This handout discusses the theory and operation of the components most common on General Motors vehicles.

Types of Braking Systems

This handout includes theory, diagnosis, and service information about several variations of brake system components:

- Drum brake: leading-trailing, advance leading-trailing and duo-servo types
- Front disc brake: single-piston and dual-piston calipers
- Rear disc brake with integral and non-integral parking brakes
- Power booster: single-diaphragm and dual-diaphragm vacuum booster, hydraulic booster

Front-to-Rear Split Hydraulic System

A typical front-to-rear split hydraulic system is shown in figure 1-4. The master cylinder is connected through the combination valve to the wheel circuits. One master cylinder outlet is connected to the front brakes, the other to the rear brakes. This type of system is typically found on rear wheel drive vehicles.

If either system fails, the other remains unaffected.
**Diagonal Split Hydraulic System**

Due to vehicle weight distribution, most front wheel drive vehicles utilize a diagonally split design. In the diagonal split hydraulic system, diagonally opposite wheels share a hydraulic circuit (Figure 1-5).

- Left-front (LF) and right-rear (RR) brakes are connected to one channel of the master cylinder
- Right-front (RF) and left-rear brakes (LR) are connected to the other channel of the master cylinder

Proportioning valves are installed in the master cylinder circuits to the rear brakes to maintain the proper front to rear pressure balance.

![Figure 1-5, Diagonal Split Hydraulic System](image)

**Brake Operation-Non-Assisted**

In non-assisted brake systems, the force the driver applies to the brake pedal in combination with mechanical linkage is converted into hydraulic braking pressure.

**Brake Operation-Power Assisted**

Brake hydraulic operation is the same as manual brakes. Power brake systems add a vacuum or hydraulic brake power booster to supplement brake pedal pressure. Most vehicles today are equipped with some type of power assist.
Hydraulic Theory

In the brake system, a relationship exists between:

- Force and piston area
- Piston travel and piston area

Force and Piston Area

Hydraulic pressure, created by the master cylinder, is the same in all parts of the system.

For example, if the master cylinder generates 500 psi of its piston area, it also transfers 500 psi to the pistons in each wheel cylinder or caliper.

When pressure from the master cylinder exerts 500 psi on a piston having one square inch surface area, the piston transfers 500 pounds of force (figure 1-6). If hydraulic pressure exerts 500 psi on a piston that has two square inches, the piston transfers 1,000 pounds of force to the brake lining (500 psi x 2 in.² = 1,000 lb.) (figure 1-7).

Piston Travel and Piston Area

The operation of the wheel cylinder is affected by piston size. If the one square inch master cylinder piston moves one inch, a one square inch wheel cylinder piston will also move one inch.

When the one square inch master cylinder moves one inch, a two square inch wheel cylinder piston (twice the size) will move one-half inch (half the distance).

Figure 1-6, Piston Area and Travel (1 in.)

Figure 1-7, Piston Area and Travel (2 in.)
Special Tools and Lubricants

The following is a list of special tools needed to perform most base brake service procedures.

- J 8049 spring remover and installer
- J 8057 brake spring pliers
- J 21177-IA drum-to-brake shoe clearance gauge
- J 22348-01 drum brake spring remover and installer
- J 22364-01 drum-to-shoe clearance gauge
- J 23530 brake line flaring tool
- J 25310 universal tubing bender
- J 29117-A wheel bearing cup remover
- J 29532 pressure bleeder
- J 29567 reservoir adapter
- J 29803-A ISO flaring kit
- J 33067 cone grease machine
- J 38400 brake shoe spanner and spring remover
- J 39177 pressure bleed tool
- J 28662 pedal effort gauge
- J 29840 brake spring remover/installer
- J 42450-A hub cleaning kit
- J 37839 pushrod height gauge
- #12345579 silicon lube for caliper slides and bushings
- #1052196 14 oz. lubriplate
- #1052439 12 oz. aerosol can
- #1050109 1-3/4 oz. tube
Apply System

Objectives:
After completing this section, the student will be able to:

• Perform a brake pedal travel check
• Describe the parking brake systems on current GM vehicles
• Describe the operation of the different types of parking brake systems

Brake Pedal and Linkage
The brake pedal, which is connected to the master cylinder, actuates the brake system. The brake lamp switch lights the rear brake lamps when the driver presses the pedal (Figure 1-8). The brake pedal also provides a mechanical advantage to assist driver application.

Brake Pedal Travel Check
Example:
Brake pedal travel is the distance the pedal moves toward the floor from a full released position. This check should be made with brakes cold, engine OFF and about 445 N (100 lb.) of force on the pedal using a brake pedal effort gauge, such as J 28662 or equivalent.

Apply the brake pedal at least five times with the engine OFF to remove vacuum from the booster before performing the check.

Measure the distance from the bottom of the steering wheel to the top of the brake pedal.
1. Take the first measurement with the brake pedal released (Figure 1-9).

2. Take the second measurement after applying the brake pedal with about 445 N (100 lb.) of force using J 28662 (Figure 1-10).

3. Subtract measurement 1 from measurement 2.

4. Compare this measurement with the specification in the service manual.

5. If brake pedal travel is excessive, refer to the brake system diagnostic chart.

Example:

1st measurement = 20.5 in.
2nd measurement = 22.75 in.
Brake Pedal travel = 2.25 in.

**Parking Brake and Cables**

The parking brake system uses cables to operate the rear brakes (Figure 1-11). Parking brakes are mechanically applied and independent of the hydraulic system.

The driver applies the parking brake with either:

- Foot pedal mounted near the left kick panel
- Hand lever

When the driver operates the parking brake, the Red BRAKE Warning Lamp (RBWL) turns on to indicate that the parking brake is ON.
Drum Parking Brake (Duo-Servo)

To operate the drum parking brake (Figure 1-12):

1. The cable pulls the parking brake actuator lever inside the brake drum.
2. The lever moves one brake shoe outward.
3. The parking brake strut then engages the other shoe and moves it outward. Both brake shoes contact the brake drum.

Disc with Integral Parking Brake

When the driver applies the parking brake (Figure 1-13):

1. The cable actuated parking brake lever rotates the actuator screw.
2. The actuator screw unthreads on a nut inside the piston. The nut does not rotate, because it is splined to the cone. When the screw turns, it moves the nut outward by pressing against a cone inside the piston.
3. The piston presses against the inboard brake pad and applies the inboard brake pad against the rotor.
4. The motion of the piston slides the caliper assembly to apply the outboard pad.
5. The actuator screw also acts as a self-adjuster mechanism which moves the piston to compensate for pad wear.
Disc with Integral Parking Brake and Actuator Lever

The rear disc brake caliper has a single piston in an aluminum housing which is suspended in the anchor bracket on two guide pins. When the parking brake is applied, the lever on the caliper causes the pushrod, the actuating collar and the clamp rod to be moved outward and the caliper to slide inward, mechanically forcing the pads against the rotor. Parking brake application is completely independent of the hydraulic braking system.

Disc with Drum-in-Hat Parking Brake

The drum-in-hat system consists of a simple drum brake-shoe assembly which applies against a drum machined inside the rotor hat section. With the drum-in-hat park brake (Figure 1-14), the rear caliper doesn't have to perform both service and parking brake functions like the integral parking brake system. The system is simpler and provides for better service and parking brake performance.

A special clearance gauge, number J 21177-1A, is used to adjust the parking brake shoe and lining. The procedure is found in the brake section of the service manual.

Figure 1-14, Drum-in-Hat Parking Brake
Parking Brake Adjustment (Rear Drum)

The parking brake must be adjusted any time the parking brake cables are serviced, or the holding ability is not adequate. Before adjusting the parking brake, check the condition of the service brakes. The service brakes must be adjusted properly before adjusting the parking brake. Refer to the appropriate service information.

Example for C/K Truck:
1. Block the front wheels.
2. Raise the rear of the vehicle and support with safety stands.
3. Loosen the adjusting nut at the equalizer.
4. Push the parking brake pedal down 18 degrees to set it (Figure 1-15) by:
   5. Inserting a 3 mm (0.125 in.) pin into the locating hole in the pedal assembly (A)
   6. Pushing the pedal downward until the pin contacts the parking brake outer flange
5. Turn the adjusting nut until the rear wheels rotate forward with moderate drag (Figure 1-16).
8. Release the parking brake and rotate the rear wheels. There should be no drag.
9. Lower the vehicle and unblock the front wheels.

Important: Park brake adjustments vary depending on vehicle application.
Parking Brake Adjustment (Integral Rear Caliper)
Adjust the parking brake to specifications after caliper disassembly or overhaul. Incorrect parking brake adjustment can cause low brake pedal complaints.

Note: Use this procedure only on linings with less than 0.15 mm (0.006 in.) taper. Parking brake adjustment is not valid with heavily tapered pads and may cause caliper/parking brake binding.

Important:
• Inspect old pad and lining assemblies and replace if they are tapered
• Parking brake free travel should only be adjusted if the caliper has been taken apart
• This adjustment will not correct a condition where the caliper levers will not return to their stops

Service procedures vary among applications. For example:
1. Apply service brake pedal three times with a pedal force of approximately 778 N (175 lb.).
2. Apply and release parking brake three times.
3. Check parking brake hand lever for full release.
   • Turn ignition on.
   • Red BRAKE Warning Lamp should be off. If Red BRAKE Warning Lamp is still lit, and the hand lever is completely released, pull downward on the front parking brake cable to remove slack from lever assembly.
   • Turn ignition off.
4. Raise car and suitably support.
   • Mark relationship of wheel to axle flange.
5. Remove rear wheels and tires.
   • Reinstall two inverted lug nuts to retain rotor.
6. Pull parking brake hand lever exactly four (4) ratchet clicks.
7. Parking brake levers (2) on both calipers should be against the lever stops on the caliper housings. If levers are not against stops, check for binding in rear cables and/or loosen cables at adjuster until both left and right levers are against their stops.
8. Tighten parking brake cable at adjuster until either the left or right lever begins to move off the stop, then loosen adjustment until lever moves back barely touching stop.
9. Operate parking brake several times to check adjustments. After cable adjustment is performed, parking brake hand lever should travel 14 clicks. Rear wheels should not rotate forward when hand lever is applied 8 to 14 ratchet clicks.
10. Install wheels and tires, aligning previous marks and properly torquing lug nuts.
Parking Brake Adjustment
(Integral Rear Caliper with Actuator Level)

The adjustment process requires a second person to apply a light brake pedal load. Parking brake lever free-travel is set by the position of the adjuster screw. Turning the adjuster screw clockwise increases the free-travel; turning the adjuster screw counterclockwise decreases the free-travel.

Note: Pads must be new or parallel to within 0.006 in. (0.15mm). Parking brake adjustment is not valid with tapered pads and may cause caliper/brake binding.

Important:

• Inspect old pads and replace with new ones if they are tapered
• Parking brake free-travel should only be changed if the caliper has been taken apart, or when the pads are replaced
• This adjustment will not correct a condition where parking brake actuator levers will not return to their stops

Example:
1. Disconnect parking brake cable and remove actuator lever return spring.
2. Have an assistant apply light brake pedal load, enough to stop the rotor from turning by hand.
   • This takes up all clearances and ensures that components are correctly aligned
3. Apply light pressure to the parking brake actuator lever. Measure free-travel between parking brake actuator lever and caliper housing.
   • Free-travel must be 0.024 in. to 0.028 in. (0.61 mm to 0.71 mm)
4. If free-travel is incorrect, do the following:
   a. Remove adjuster screw
   b. Clean thread adhesive residue from threads
   c. Coat threads with adhesive
   d. Screw in adjuster screw far enough to obtain 0.024 in. to 0.028 in. (0.61 mm to 0.71 mm) free-travel between parking brake actuator lever and caliper housing.
5. Have assistant release brake pedal, then apply brake pedal firmly three times.
6. Recheck free-travel as described in steps 2 and 3 and adjust as necessary.
7. Install actuator lever return spring and parking brake cable.