Welcome to the Air Brakes Course

About the facilities

- Washrooms
- Coffee and lunch facilities
- Breaks
- Emergency exits/ muster area
- Cell phones
- Public health requirements, if applicable

Course overview

- Understand the importance of air brake inspections
- Basics of how air brakes systems work
- Components of a single unit air system
- Air brake pre-trip and enroute inspections
- How to identify major and minor defects in the air system
- How to check and adjust air brake pushrod travel

Licensing

- Who needs an air endorsement?

How to apply for an air brake endorsement

- Book your knowledge test online at icbc.com
- Study the air brake sections in the Driving Commercial Vehicles (DCV) guide to prepare
- Present your course card when you attend for your test
- Provide primary and secondary ID and pay the test fee ($15)
  - Acceptable ID is listed on inside back cover of the DCV guide or on icbc.com

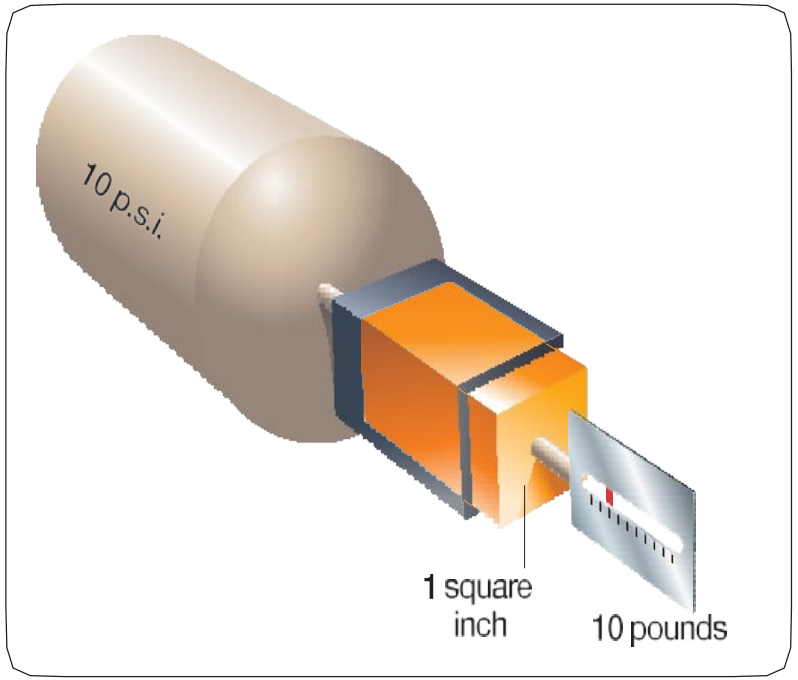
Air brake knowledge test

- Multiple choice test
- Available in English only – no translators
- 20 out of 25 correct answers required to pass
- If unsuccessful, must wait seven days to try again
- Three attempts are allowed – after that you must take the course again

Introduction to air brakes

- Air brakes are used as an alternative to hydraulic brakes which are used on lighter vehicles such as automobiles.
- Hydraulic brakes use a liquid (hydraulic fluid) to transfer pressure from the brake pedal to the brakes to stop the vehicle.
- Air brakes are used in heavy commercial vehicles due to their reliability.

Why do we have air brakes?



Air brake systems:

- Use a much greater force to apply the brakes than hydraulic braking systems do, which is needed to cope with the heavy loads.
- Are more tolerant to small leaks, which in a hydraulic system could result in brake failure.
- An air brake system includes a compressor to generate more compressed air as needed.
- Are capable of stopping heavy vehicles safely.

What is compressed air?

Air can be compressed (squeezed) into a much smaller space than it would normally occupy.

For example, tires are filled with compressed air to support the weight of a vehicle. Squeezing air into a smaller space increases the air’s resistance.

This resistance creates pressure, which can be converted into mechanical force to apply the brakes.

Air brakes are able to generate more braking force than hydraulic brakes.

Heavy vehicle braking

Heat

Motion

Traction

Friction

Heavy vehicle braking cont.

The energy goes full circle.

The basics behind braking systems is that friction converts the energy of motion to heat energy.

Heat Energy - Energy of Motion - Heat Energy.

Stopping distance and stopping time

Total stopping distance is the distance your vehicle will travel from the moment you:

- **see** — a hazard
- **think** — decide to stop
- **do** — place your foot on the brake pedal until you stop.

It takes about 3/4 of a second of **perception time** to see the problem (see-think) and another 3/4 of a second to **react** (do).

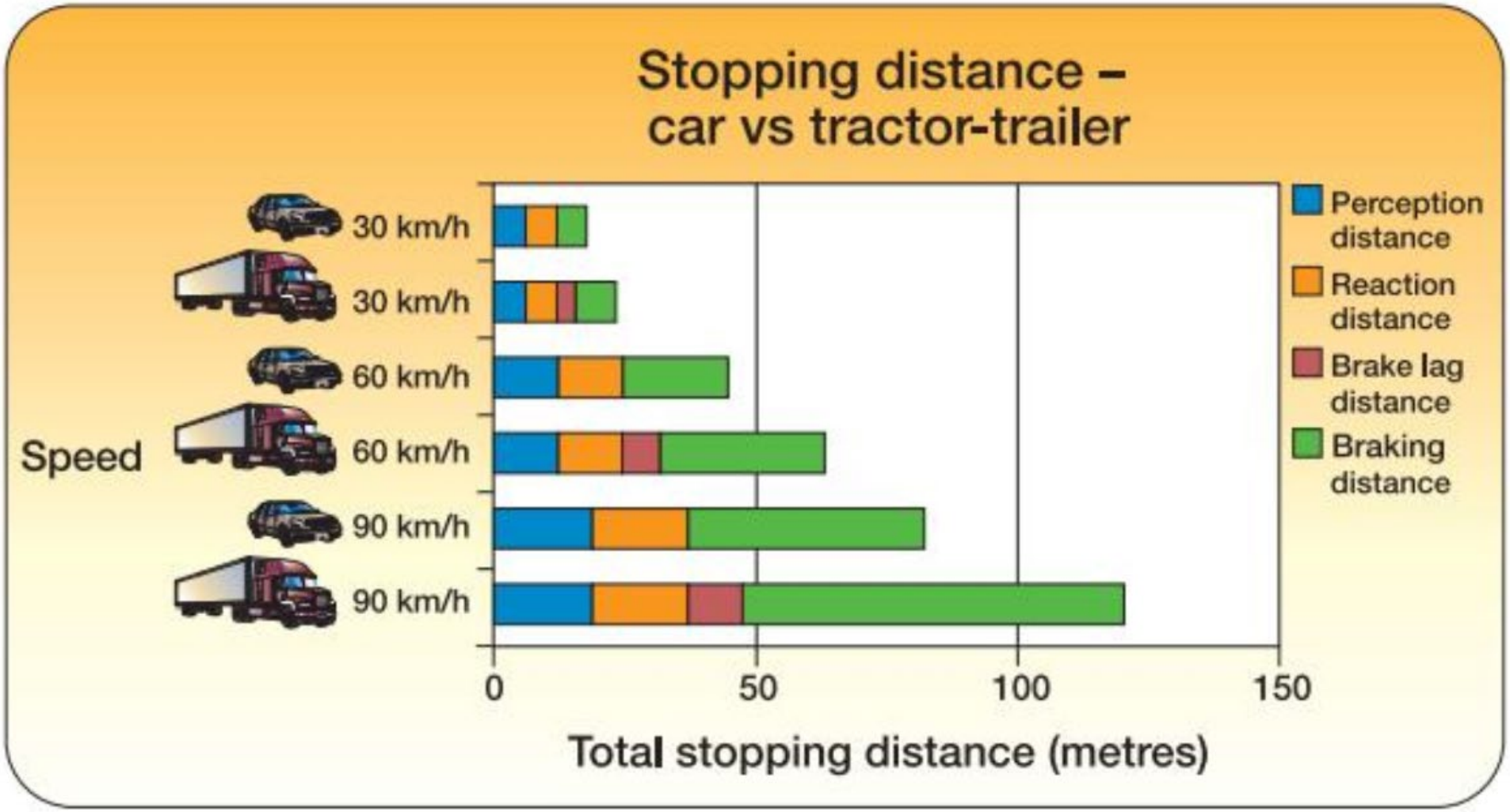
Only then will your vehicle begin to slow down.

Brake lag and braking distance

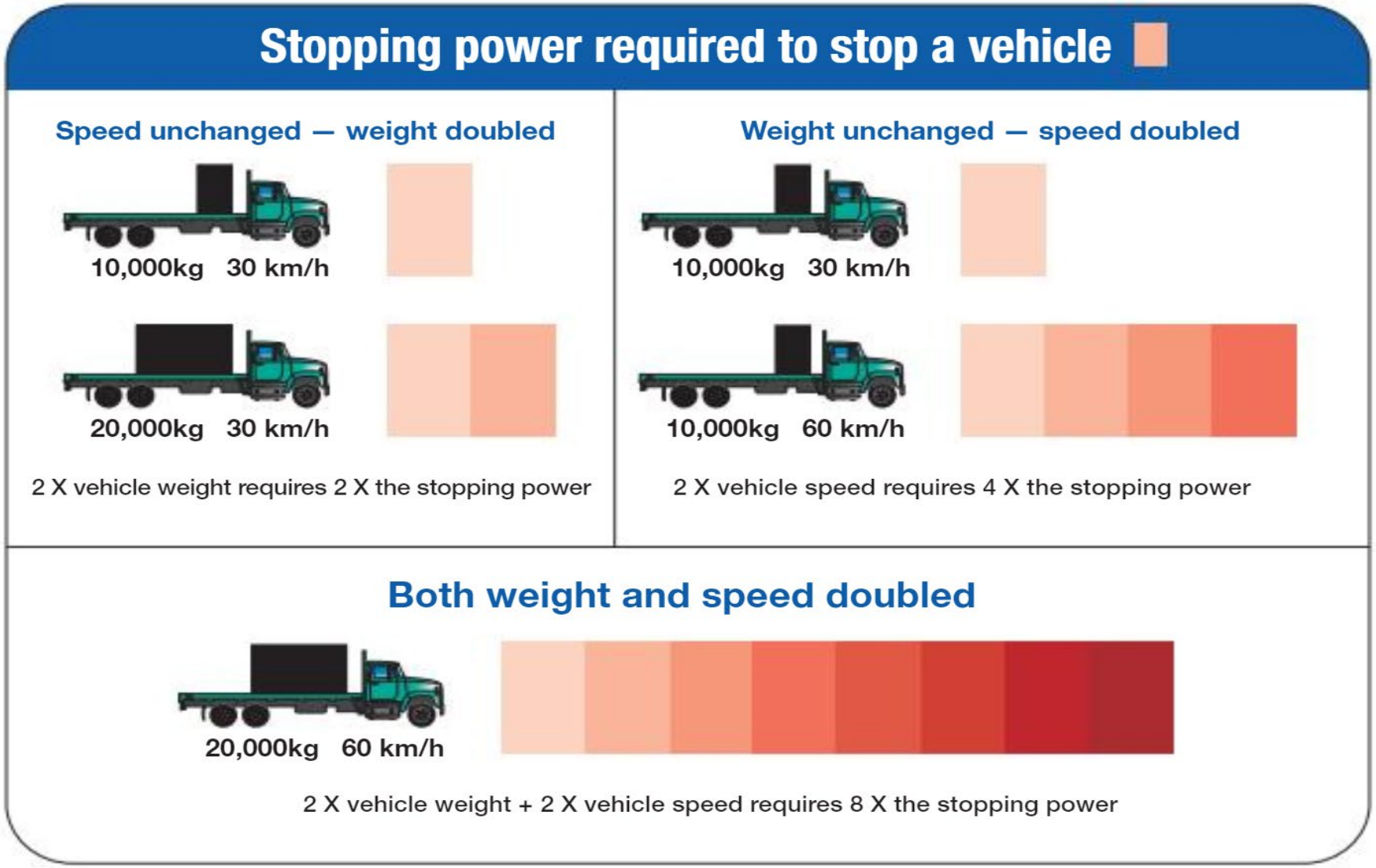
A car’s brakes begin to work almost instantly when you press on the brake pedal, but this is not the case when operating a vehicle with air brakes.

Brake lag time	Braking distance
There’s a brake lag time of approximately 4/10 of a second from when you apply the brake pedal (foot valve) to when the air reaches the wheel and applies the brake	Add to this the braking distance, which is the distance the vehicle travels after the brakes are applied until it stops

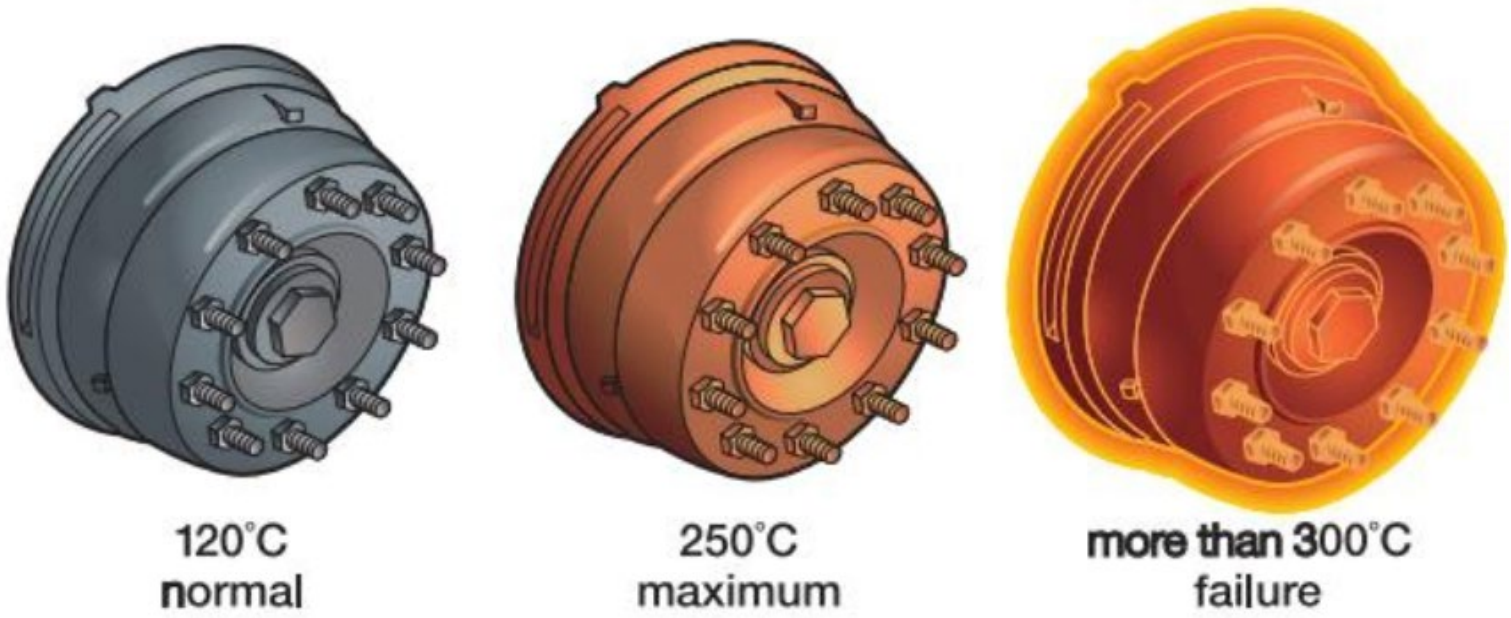
Importance of following distance



Stopping power



How much heat can brakes handle?



Brake fade

- Brake fade occurs when your brakes stop working properly because they're overheated.
- Your vehicle takes longer to stop or may not stop at all if you haven't properly controlled the speed.
- You'll need to apply more pressure to maintain the same braking force as brake fade increases
- Brake drums can expand and move away from the shoes. The brakes won't work – you're having a runaway!
- Brakes may catch fire.

Engine retarders

Engine retarders provide an additional (or auxiliary) way of slowing of the vehicle

They, along with the appropriate gear, are the best way to control your speed on long downgrades

Engine retarders (also known as engine brakes) help save the main braking system for emergency stopping

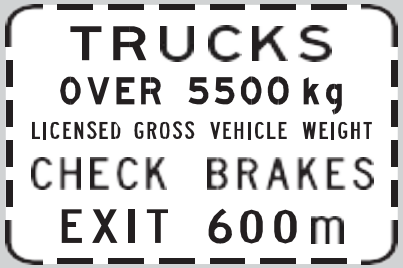
Four main types of retarders:

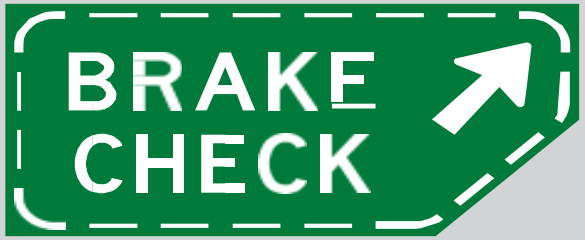
- engine retarders
- exhaust retarders
- hydraulic driveline retarders
- electric driveline retarders

Using retarders

- More efficient at a higher engine rpm and a lower vehicle speed - it’s important to select the right gear
- Select gear before start down the hill - more likely to miss a shift if you wait until you’re on the downgrade
- Be cautious if you’re using retarders/engine brakes on slippery roads – this can cause lock up, engine stall, loss of control or a jackknife if towing a trailer
- A modern truck with an engine retarder and properly maintained muffler system shouldn’t be noisy
- Many municipalities post signs restricting drivers from using engine retarders/engine brakes.

En route pre-hill brake checks





BRAKE CHECK ADVISORY

AIR BRAKE SYSTEM

1. Compressor Maintains Full Reservoir Pressure
2. Push Rod Travel Within Limitations On All Chambers
3. No Audible Air Leaks
4. Glad Hands And Lines Are Secure
5. Drums, Bearings And Tires Are Not Overheating
6. Trailer Supply Valve Operates Properly

HYDRAULIC BRAKE SYSTEM

1. Pedal Pressure
2. Vacuum Booster Is Operating
3. Drums For Overheating
4. Hydraulic Fluid Leaks

TRAILER BRAKE SYSTEMS
(ELECTRIC, SURGE, VACUUM, AIR ACTIVATED HYDRAULIC)

1. Disconnect Brake System From Tow Vehicle For Electric And Vacuum Brake System
2. Activate Break-Away Devices And Lock Trailer Brakes "ON"
   -Electric Brakes: set break-away switch
   -Surge Brakes: pull and lock mechanical lever
   -Vacuum and air activated Hydraulic Brakes: disconnect both (2) hoses to trailer
3. Perform "Tug" Test By Attempting To Pull Trailer
   Trailer Wheels Should Now Be Locked And Not Move Or Skid
4. Reconnect Break-Away Devices

Runaway lanes

These two road signs alert you to runaway lanes.

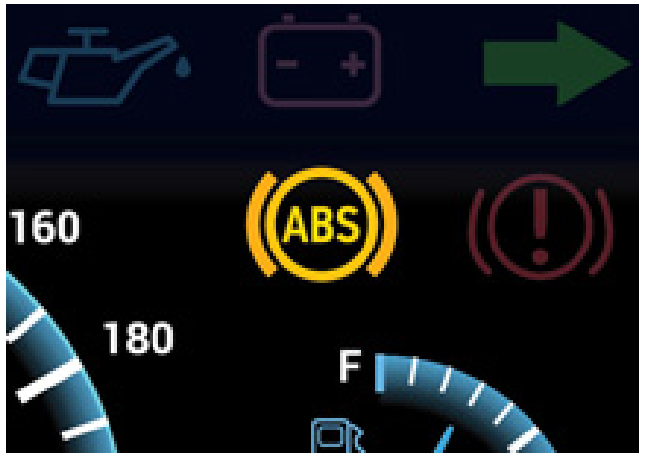
This sign is posted in advance of a runaway lane.

This sign is found at the entrance to a runaway lane.

- The most common cause of downhill runaways is travelling a speed that requires you to use your service brakes
- Runaway lanes are located beside the road on some downhill grades
- These lanes are there to help slow and stop vehicles if their brakes fail
- These lanes are there for safety. Don’t use them for any other purpose.

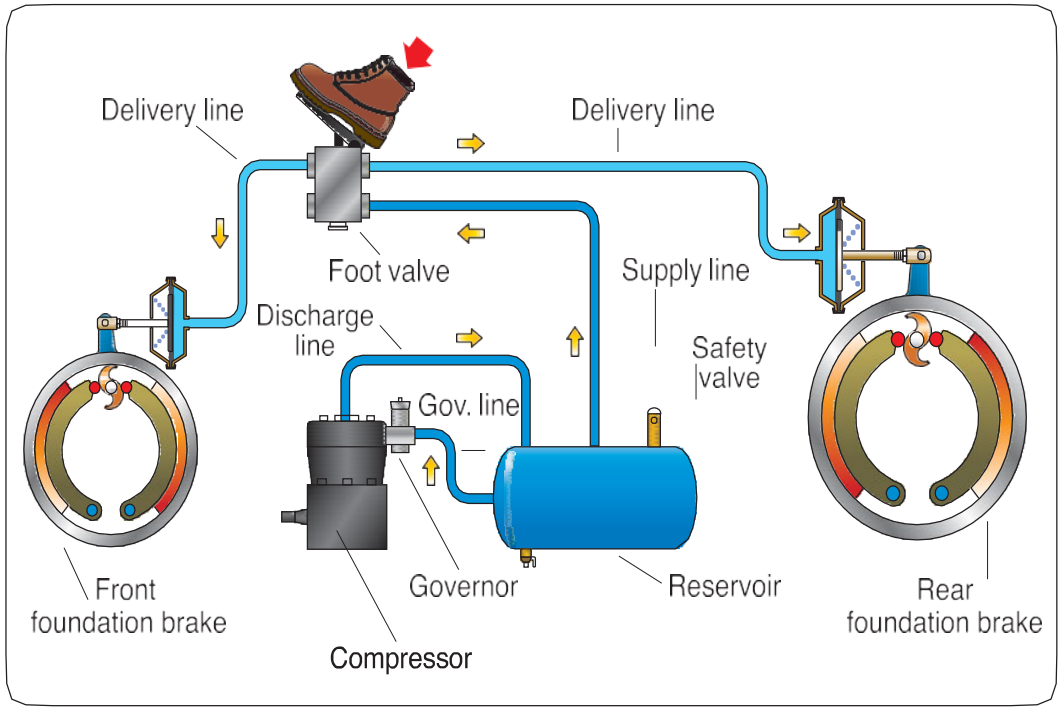
Anti-lock braking systems (ABS)

- Additional to a normal air brake system
- Doesn’t allow you to drive faster or stop sooner
- Stopping distance may be longer on some surfaces such as gravel
- Can prevent wheel lock-up on slippery surfaces
- You can brake hard and maintain steering control. Do not pump the brakes
- Only as good as the driver - learn the correct technique and practice so you’re ready in an emergency. Read your vehicle manual.



Basic air brake components

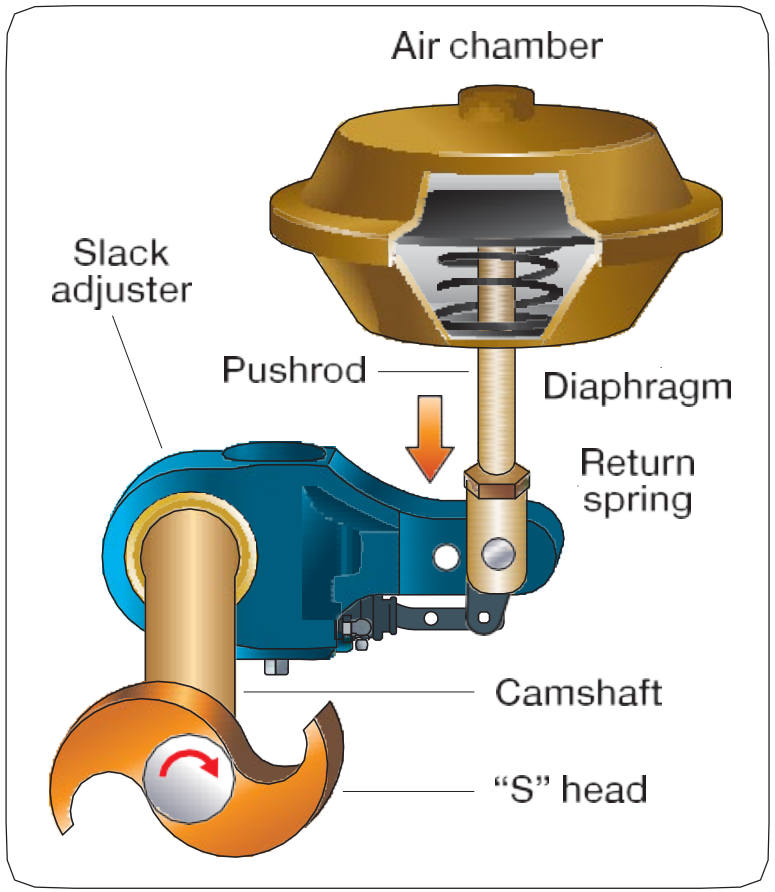
- Air compressor
- Governor
- Air lines
- Air reservoirs
- Foot valve (brake pedal)
- Foundation brakes



Brake chamber components

Includes:

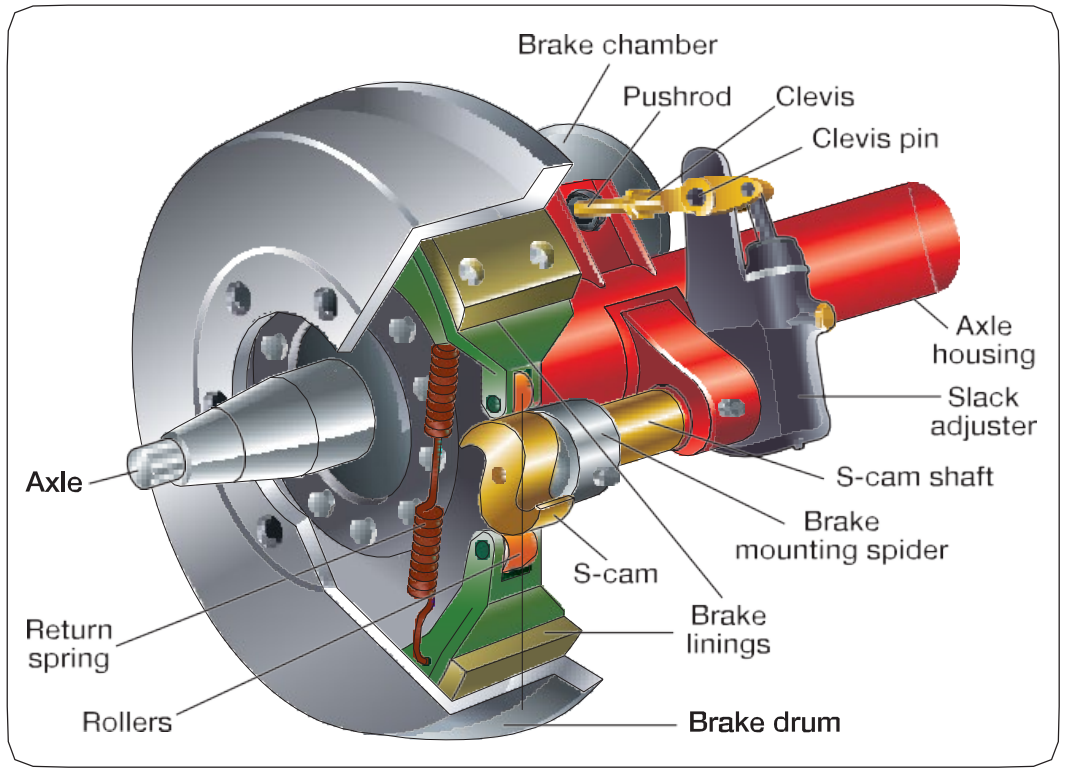
- The diaphragm - converts compressed air into a mechanical force - size of the diaphragm directly effects the amount of force.
- The slack adjuster - acts as a lever to increase pressure which converts the pushing motion to a twisting motion.



Long stroke and regular stroke brake chambers

Foundation brakes

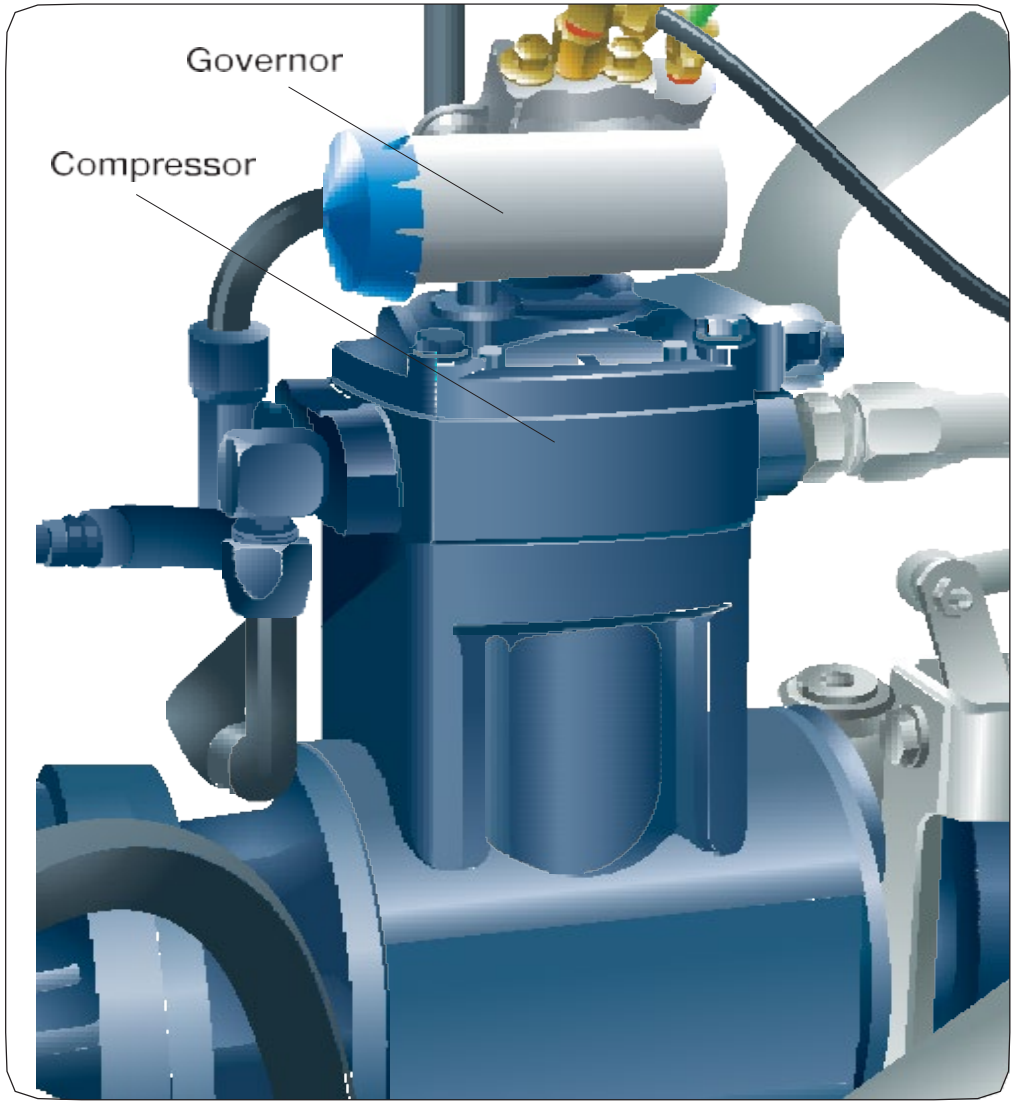
The brake assembly at each wheel is commonly called the foundation brake.



S-cam type

Air disc brakes

Compressor



An air brake system requires a way to compress air and store it in reservoirs (tanks) so that it’s available for instant use.

The compressor takes air from the atmosphere and compresses (pressurizes) it and pumps it through an air line to a supply reservoir.

As long as the engine is running, the compressor is producing air

The air that leaves the compressor is hot (over 204° C or 400° F) and will form condensation when it reaches the cold reservoirs.

Compressor needs a clean air supply

- The compressor needs a supply of clean air to work properly.
- The air from the atmosphere supplies both the truck engine and the compressor.
- A piston-type compressor operates on a similar principle to that of the intake and compression strokes of a typical car engine.

How are compressors cooled?

To prevent the compressor from overheating, two types of cooling systems are used:

- The most common method on heavy trucks is to circulate engine coolant through the compressor.
- Oil lubricates the moving parts of the compressor, similar to oil lubricating the moving parts of a car’s engine.
- Oil helps to cool the compressor and is usually supplied by the same oil as the engine.
- It’s important to ensure there is sufficient oil supply.

Governor

Once the desired air pressure has been reached, there needs to be a way to stop compressing air. This is the job of the **governor**.

When enough pressure has been built up, the governor causes the compressor to go into the “unloading” stage.

If the air pressure in the tanks drops below a certain level (such as after a series of brake applications), there needs to be a way to start compressing air again.

Governor cont.

- Governors are usually set to unload the compressor (stop the compressor from pumping air to the reservoirs) when the air pressure reaches between 105 and 135 psi (724 and 931 kPa).
- The range between minimum and maximum pressure should be approximately 20 psi (138 kPa).
- The governor must restart the compressor anytime the air pressure drops below 80 to 85 psi (552 to 586 kPa).

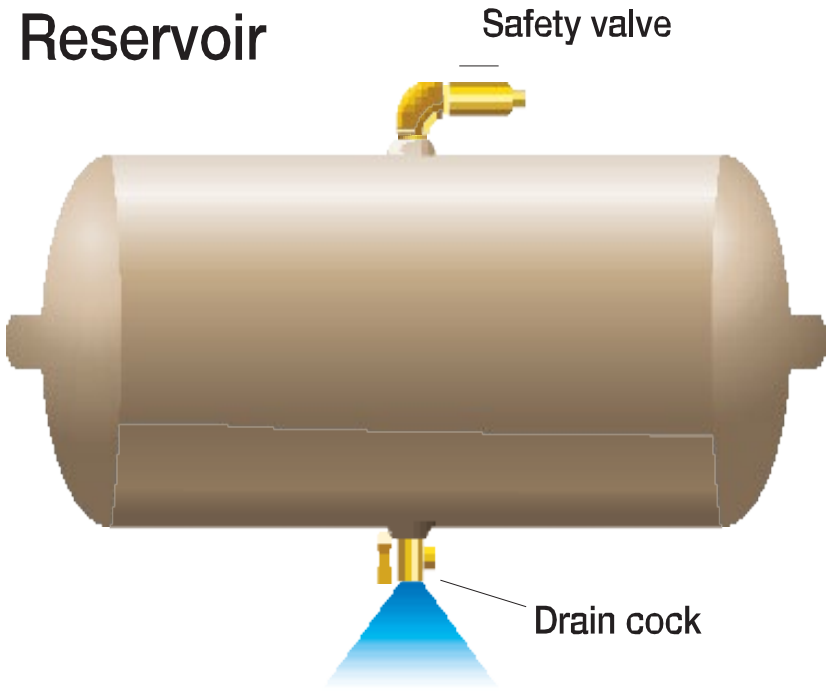
For example, if the maximum air pressure was 125 psi, the governor would restart the compressor if air pressure in the reservoirs dropped to 105 psi. Applying the brakes several times would likely cause the air pressure to drop to this level.

Air reservoirs

Reservoirs are steel or aluminum tanks used to store the compressed air produced by the compressor.

A **safety valve** on the first reservoir protects the reservoirs from being over-pressurized and bursting if the governor fails to unload the compressor.

Safety valves are normally set to vent the excess pressure at approximately 150 psi (1,034 kPa).



Air reservoirs cont.

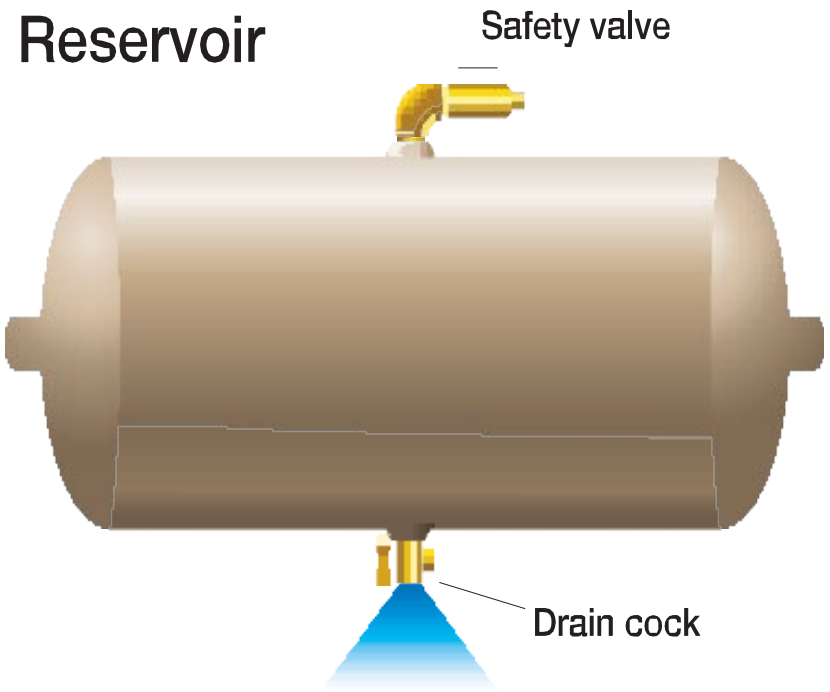
Sludge will make its way to the reservoirs. It is a combination of water and oil from the compressor caused when hot air meets the cold tanks.

To prevent sludge from contaminating the air valves in the system, **drain valves** (**drain cocks**) are installed in all reservoirs.

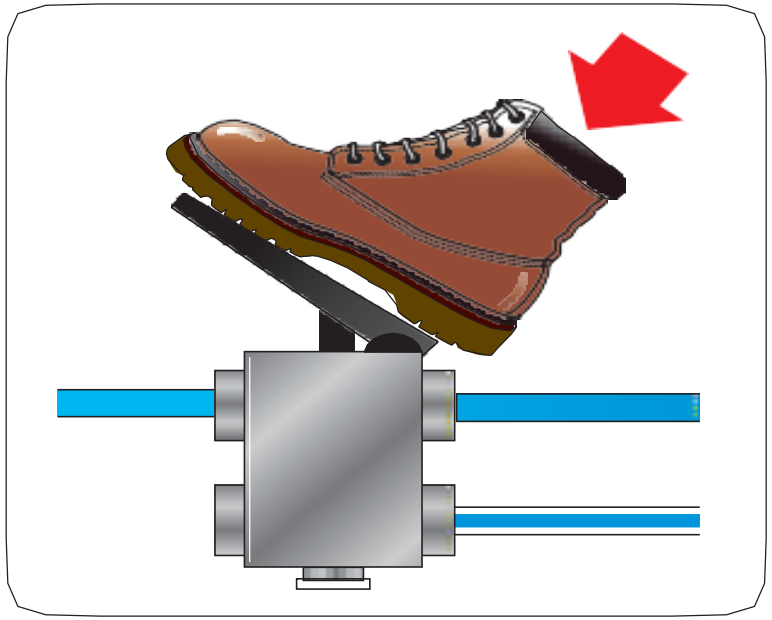
The wet (or supply) tank should be drained first.

Most manufacturers recommend that you drain reservoirs daily.

When draining reservoirs, allow time for the air to completely drain.



Foot valve



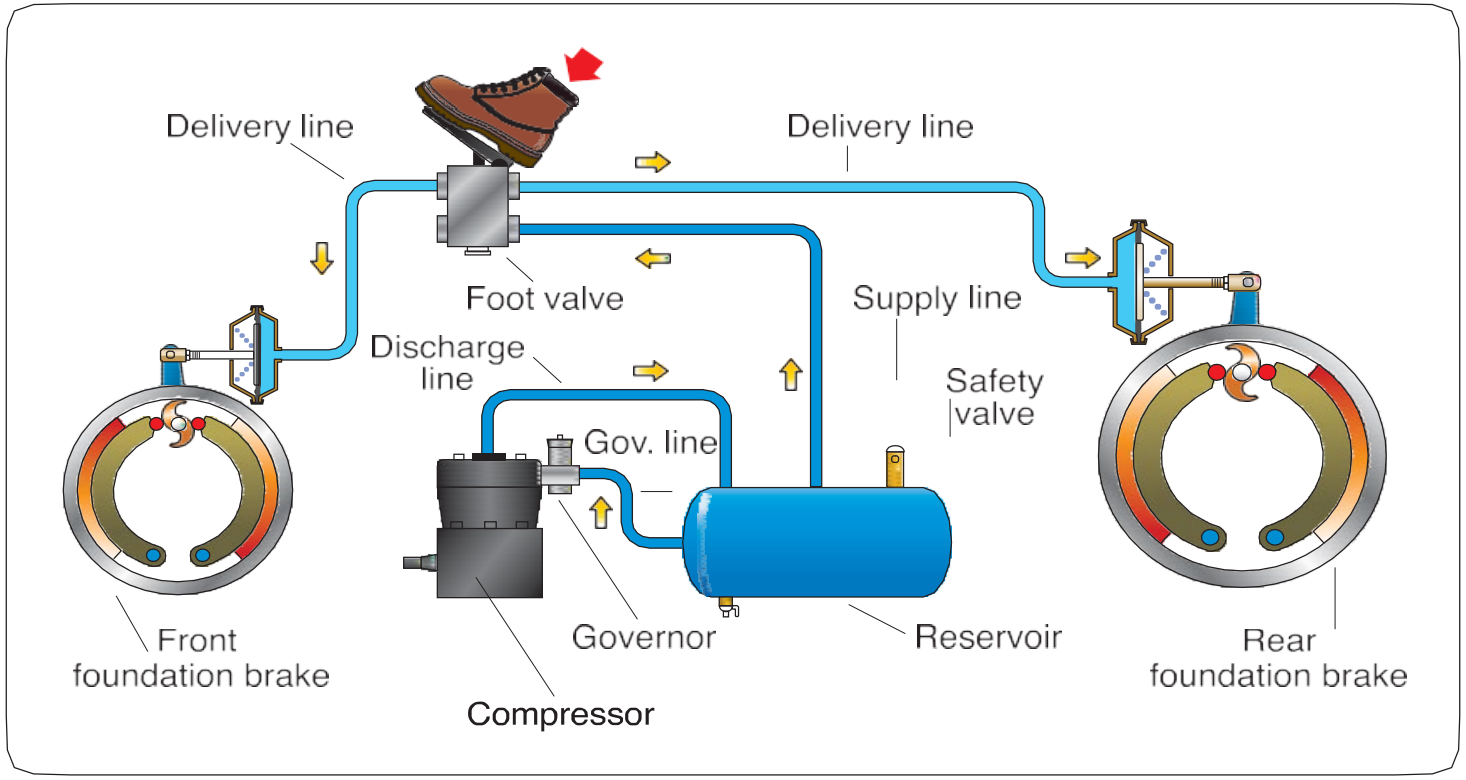
Pressing on the brake pedal (called the foot valve or treadle) applies the air brakes, just like stepping on the brake pedal applies the brakes in a car.

Releasing the foot valve allows the application air to be exhausted through the assembly's exhaust ports to the atmosphere.

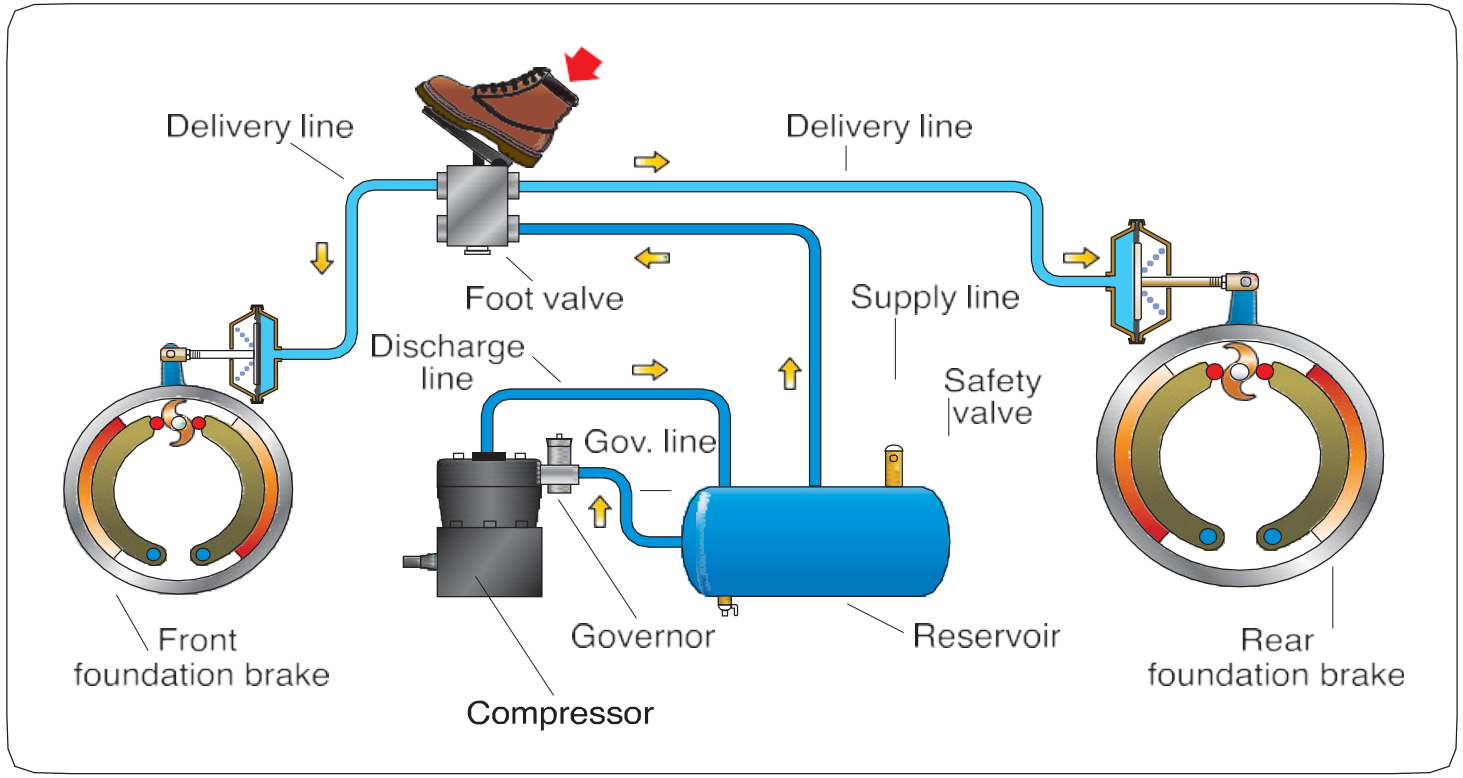
Simply put, it is a foot-controlled pressure regulator. It's the device that allows you to select any pressure needed to make a gentle, or a very rapid stop.

Foot valve cont.

A unique feature of a foot control valve is the ability to maintain the application pressure that you've chosen, even if there is a small leak downstream from the foot valve.

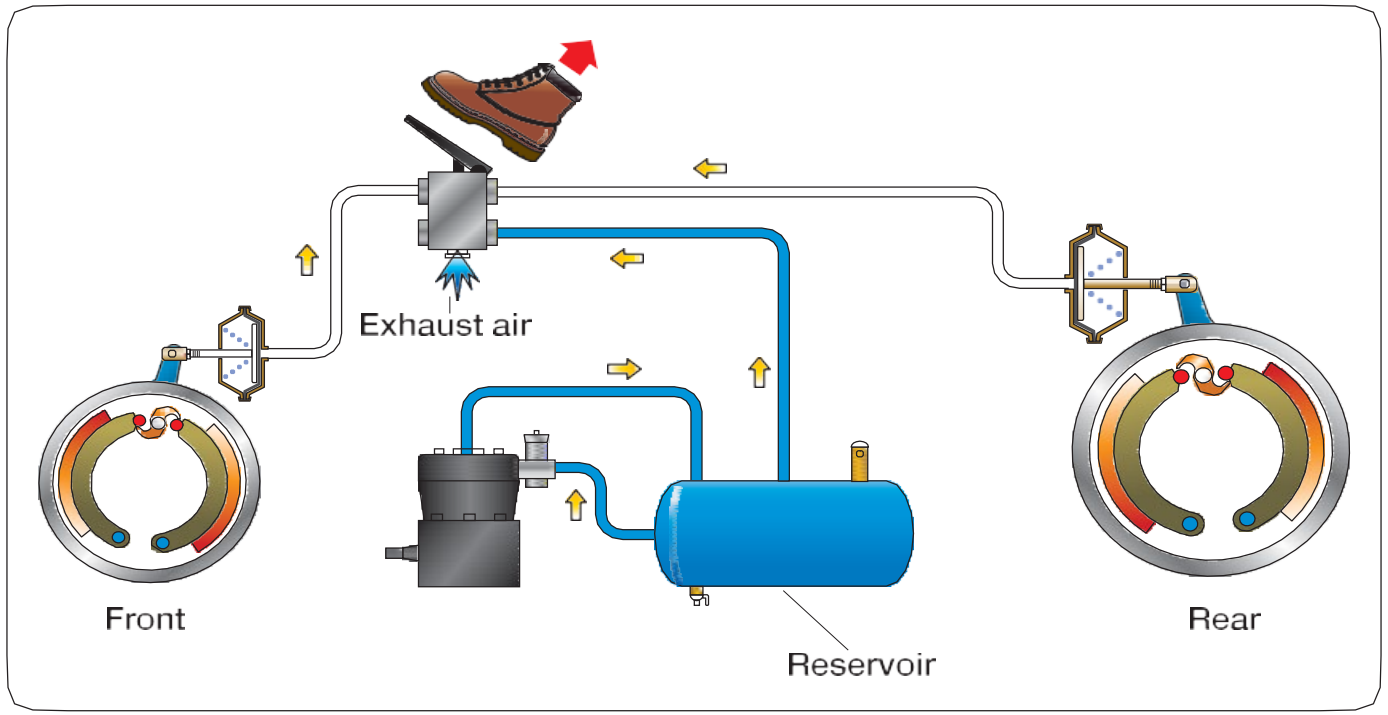


Foot valve cont.



The driver is applying the brakes, this can be seen by the light shading in the air lines connecting the foot valve to the air chambers. The arrows show the direction of air flow. The air chambers are pressurized and the brake linings have contacted the brake drums, slowing the vehicle.

Foot valve cont.



In this simplified diagram, the driver’s foot is off the brake pedal, allowing the brakes to release.

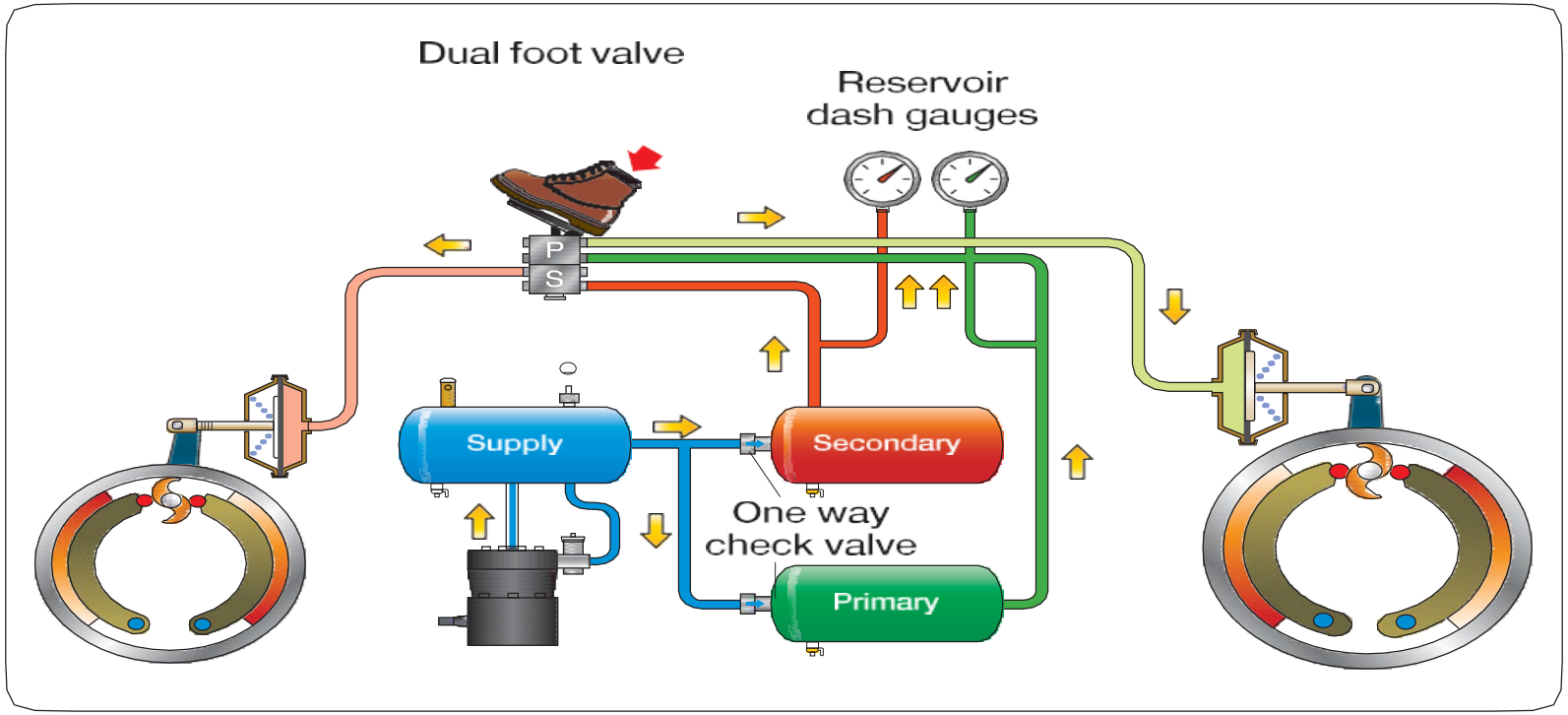
When the driver releases the foot valve, air pressure in the brake chambers exhausts into the atmosphere.

Dual air brake systems

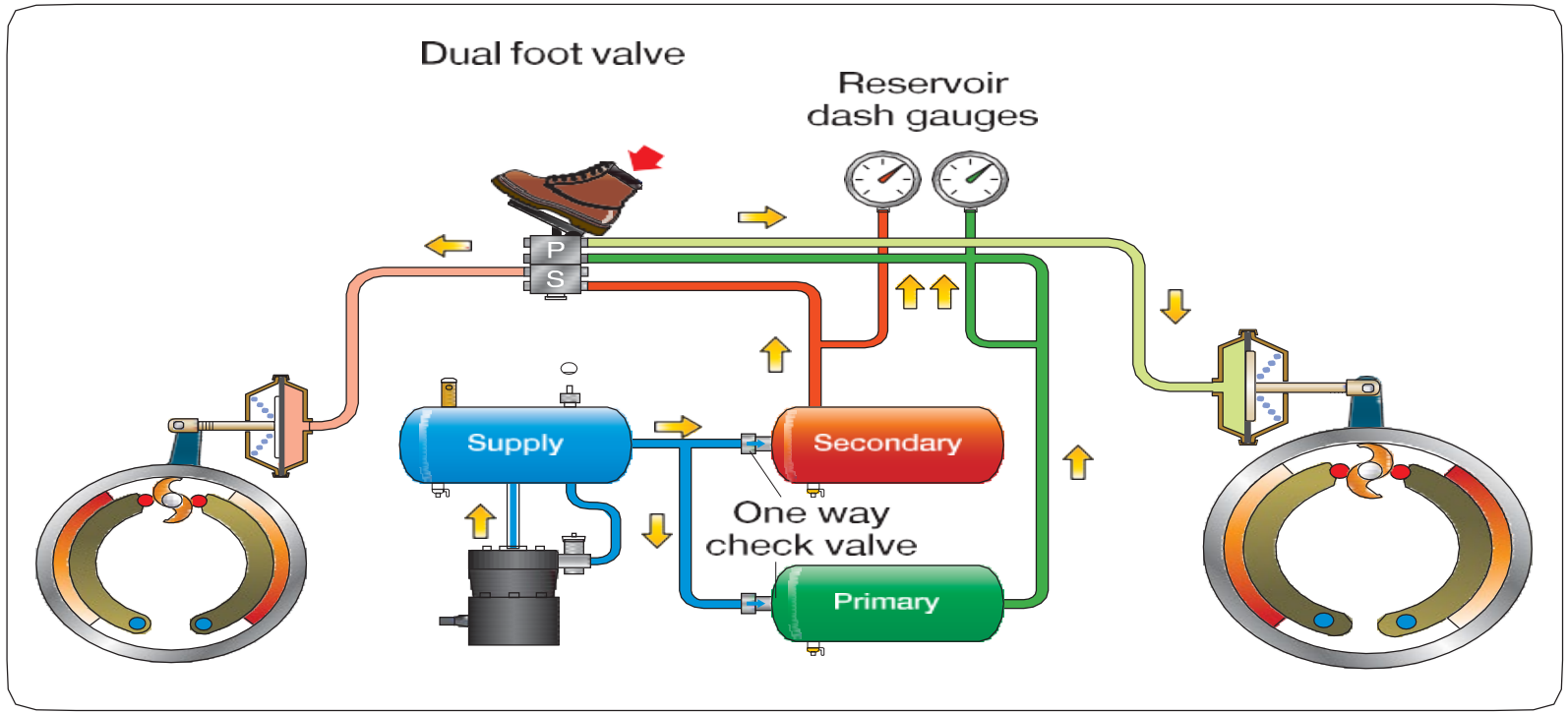
Dual foot valve - two control valves operated by a single pedal.

Allows the brake system to be divided into two independent sections.

Each section has its own supply, delivery, and exhaust ports.



Dual air brake systems cont.



The two sections of the dual foot valve are the primary and secondary.

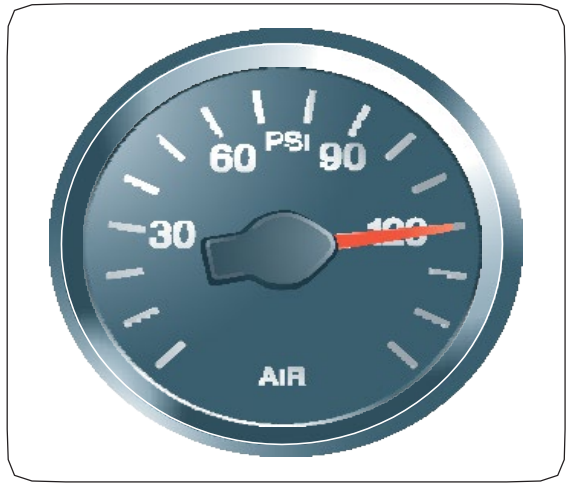
When brakes are applied, both sections are activated.

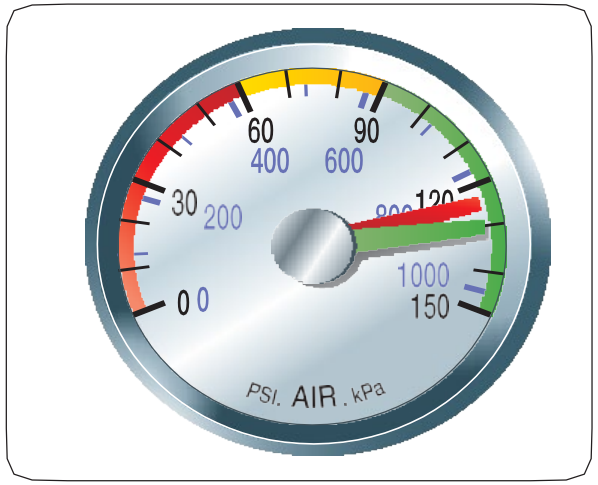
Air from primary tank is applied to the rear drive axle brakes, air from secondary tank is applied to the front steering axle brakes.

Reservoir pressure gauges

All air brake-equipped vehicles have at least one **air pressure gauge** on the instrument panel to indicate the air pressure in the service reservoir system.

Rather than having two separate reservoir gauges, one for primary and one for the secondary, some vehicles have a single gauge with two needles, indicating the pressure in the primary and secondary reservoirs as shown below on the right.





Low-air warning device

The low-air warning device (with a light and buzzer) must come on when air pressure drops below 60 psi (414 kPa).

All vehicles equipped with air brakes must have a warning device to indicate if the air pressure in the system drops to a dangerous level.

This could occur if there’s an air leak, or if you apply the brakes repeatedly and have used up the air supply more rapidly than the compressor can replenish it.

Low-air warning device cont.

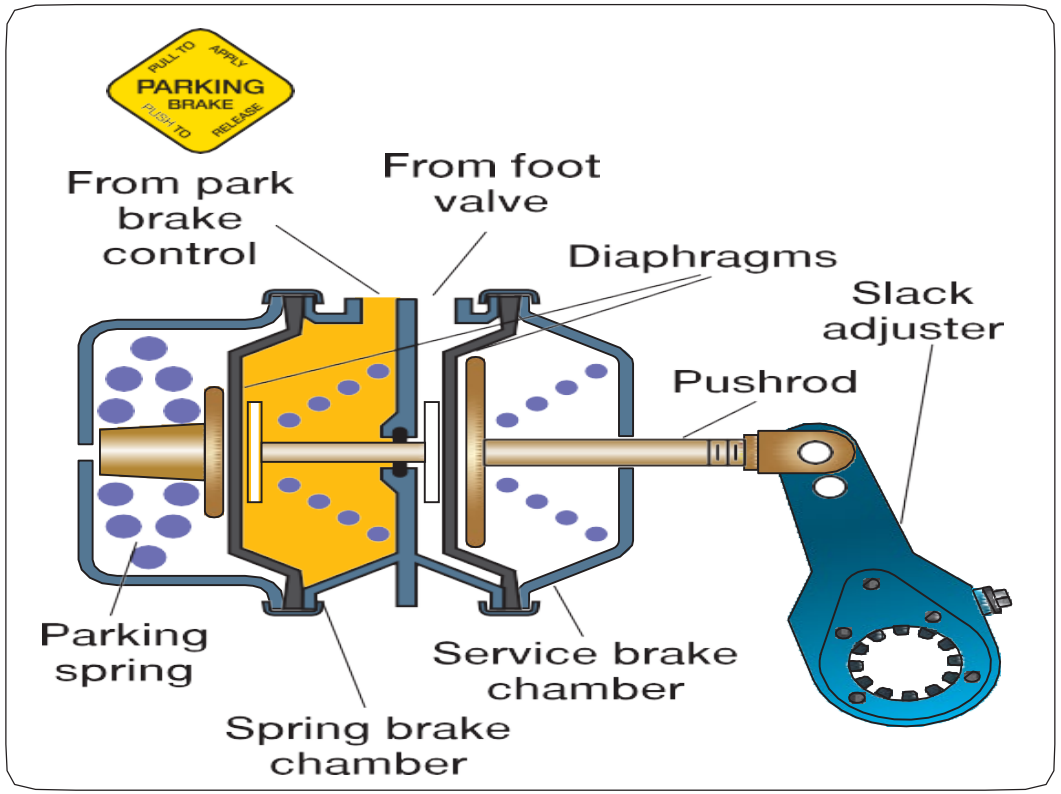
Some older vehicles have a low-air warning device near the top of the windshield that drops into the driver's view when air pressure drops below approximately 60 psi.

Known as a **wig-wag**.

If it activates – stop and find the cause of the air loss.

Air pressure remaining in the system (about 60 psi) will be enough to stop the vehicle if you act promptly.

Parking brakes – spring parking brake

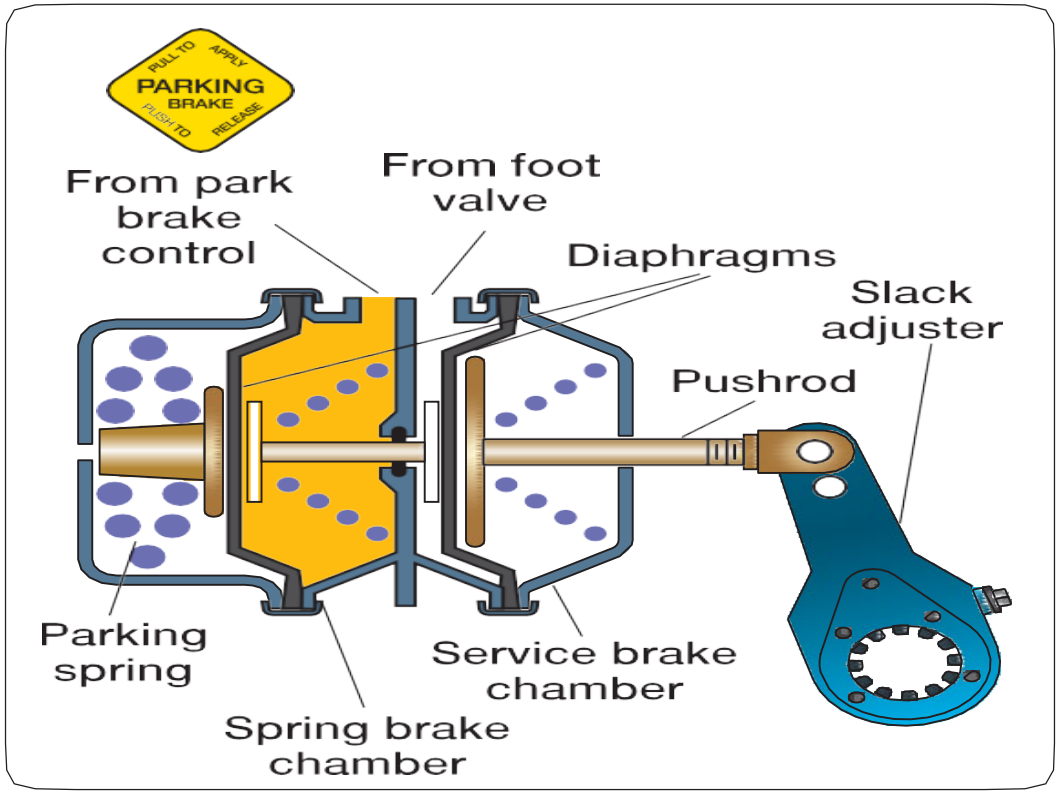


While air pressure does an excellent job to help stop a vehicle by applying the foundation brakes, it's unreliable (and illegal) for use for parking.

If you park a vehicle using only the air, any leaks in the system, or any failure in a hose, diaphragm, or air valve would result in loss of air pressure and a possible rollaway collision.

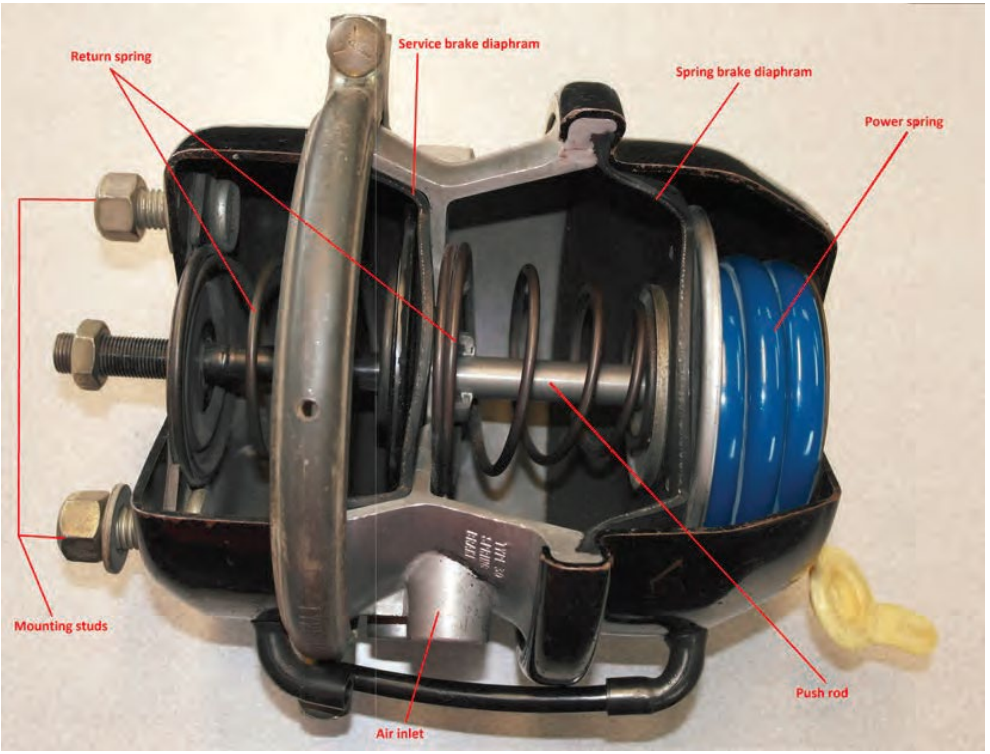
Regulations for parking brakes require that the parking force must be maintained by mechanical means and be unaffected by loss of air pressure.

Parking brakes – spring parking brake cont.



Most spring parking brakes consist of an additional chamber attached to the rear of a service brake chamber. The added chamber contains a powerful coil spring arranged so that the spring force can be applied to the brakes through the normal service chamber pushrod.

Parking brakes – spring parking brake cont.



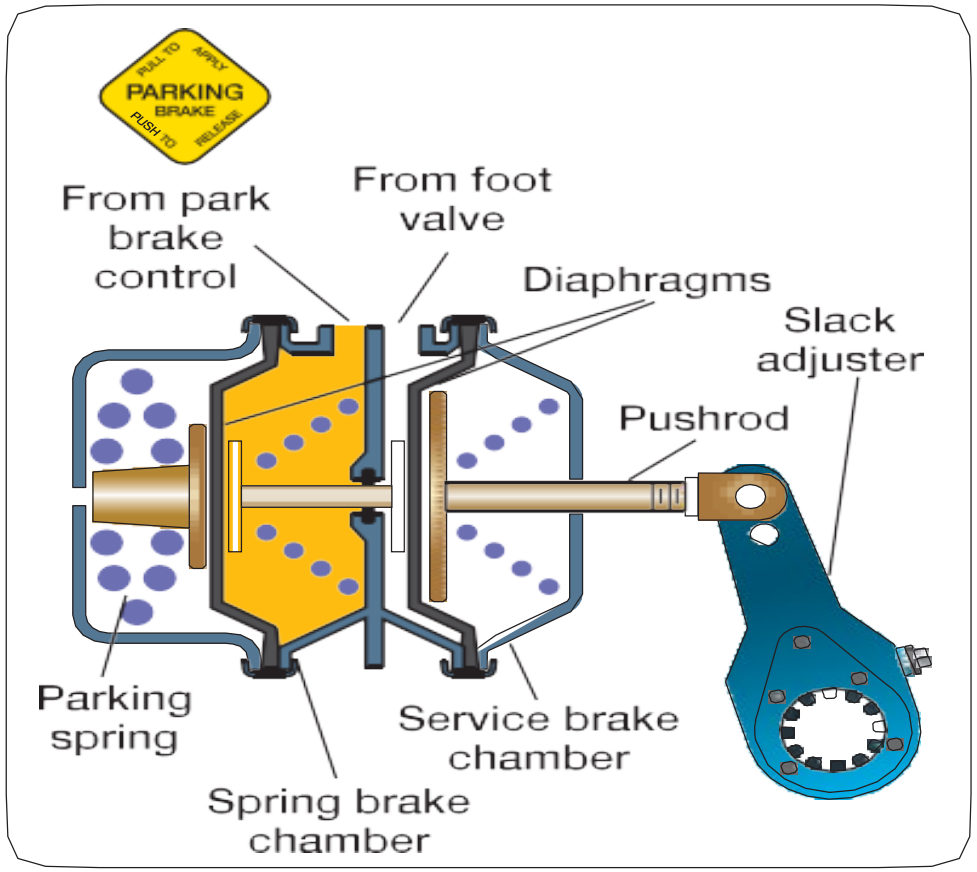
These brakes are applied and remain applied by mechanical spring pressure, not by air pressure. If air pressure falls beneath the amount needed to keep the spring compressed, the spring pushes against the pushrod in the service brake chamber.

This pushes the pushrod out against the slack adjuster to apply the foundation brakes.

Parking brake chambers are piggy-backed onto the service brake chambers and operate the foundation brakes through the same linkage

Applying and releasing spring parking brakes

- Spring brakes are normally applied and released by using the parking brake control valve on the dashboard.
- If the air pressure in the system falls below approximately 60 psi, the spring brakes may begin to apply or drag.
- This diagram shows a spring parking brake chamber in the released position. The service brake is also in the released position. The parking brake diaphragm has inflated, compressing the main spring. The spring parking brakes are now released.



Parking brake control valve

A parking brake control valve (usually a yellow button) is mounted on the dashboard. In most cases, pushing this valve in allows air pressure to flow to the spring parking brake chambers, causing these spring parking brakes to release.

Pulling this valve out exhausts the air pressure against the spring parking brake chamber, causing these brakes to apply. Instructions are usually on the button.

While the push-pull parking brake control is the most common, some systems may use a switch instead. Usually flipping it in one direction applies the spring parking brakes and flipping it in the other direction releases them.

Driver alert – compounding of brakes

When spring parking brakes are applied, there’s up to 2,000 lbs. of force applied to all of the brake components.

If a heavy service brake application is made, the force of the air application is added to the spring force. This could add a further 3,000 lbs. for a total of 5,000 lbs. This is known as compounding and can damage slack adjusters, S-cams, brake chamber mounting bolts, brake shoe rollers, shoes and brake drums.

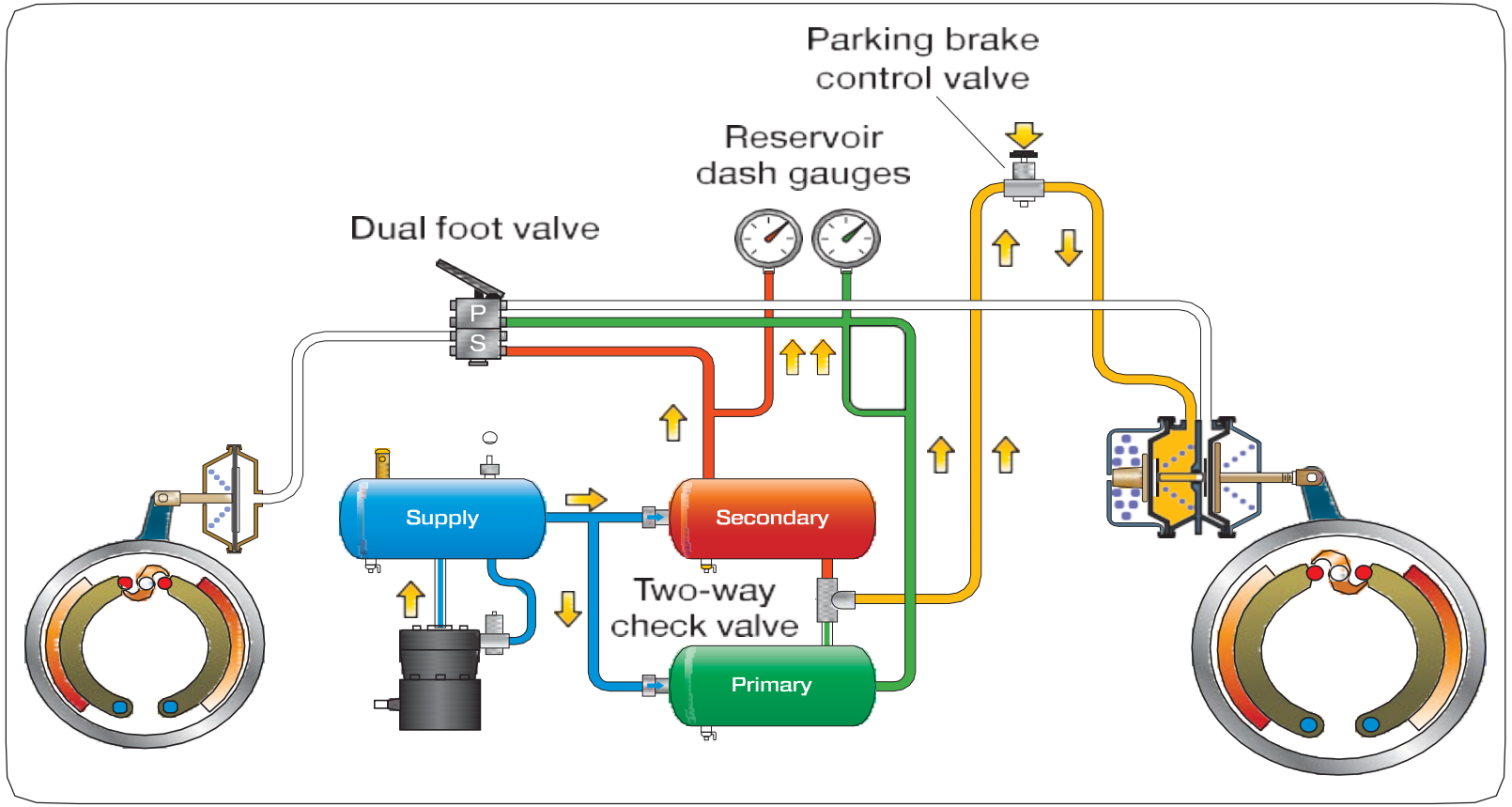
Note: lighter brake applications of less than 30 to 40 psi (207 to 276 kPa), to prevent a vehicle from rolling while the spring parking brakes are being released or applied, aren’t harmful.

Always be sure that you have released the spring parking brakes before making heavy service brake applications, such as during a pre-trip inspection.

Spring parking brakes in dual air systems

The **two-way check valve** uses both primary and secondary reservoirs to supply the parking brake dash control with air.

The air that is delivered from the two-way check valve is frequently called **blended air**.

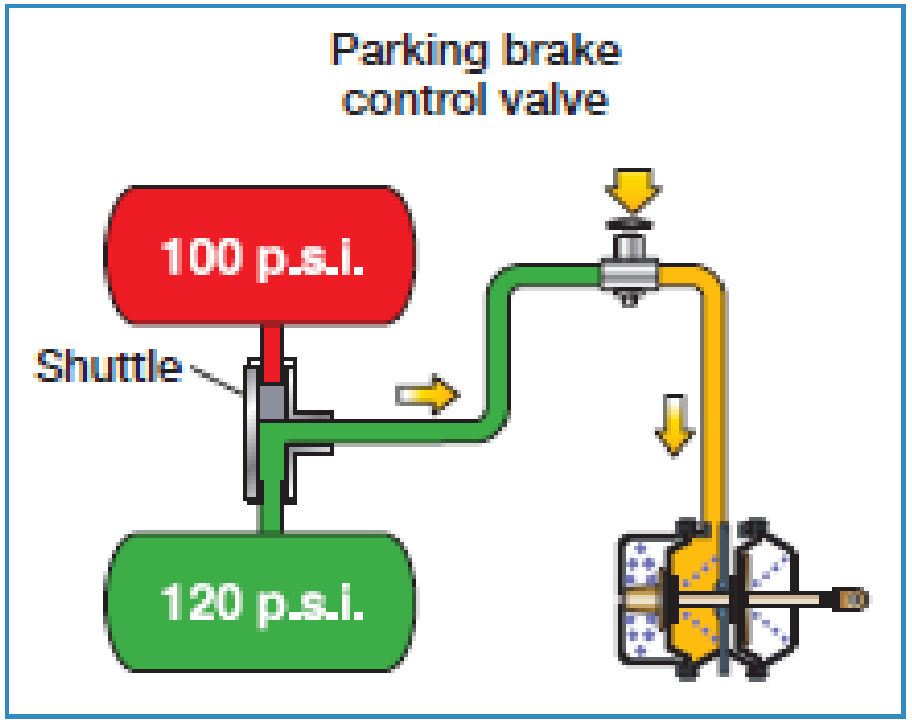


Two-way check valve

Two-way check valves have two inlet ports and one delivery port.

A free-floating shuttle within the valve moves away from the inlet with the higher pressure, and the higher pressure will be supplied to the parking brake control.

This ensures that spring parking brakes will not automatically apply if there's total loss of air in one of the reservoirs.



Spring brakes – when air is lost from the primary circuit

Spring parking brakes don’t apply automatically in a dual air system when air is lost from one circuit.

The low-air warning system alerts you to the air loss, allowing you to make a controlled stop using the front axle brakes.

Some vehicles with dual air systems have an optional device called a **spring brake modulator**.

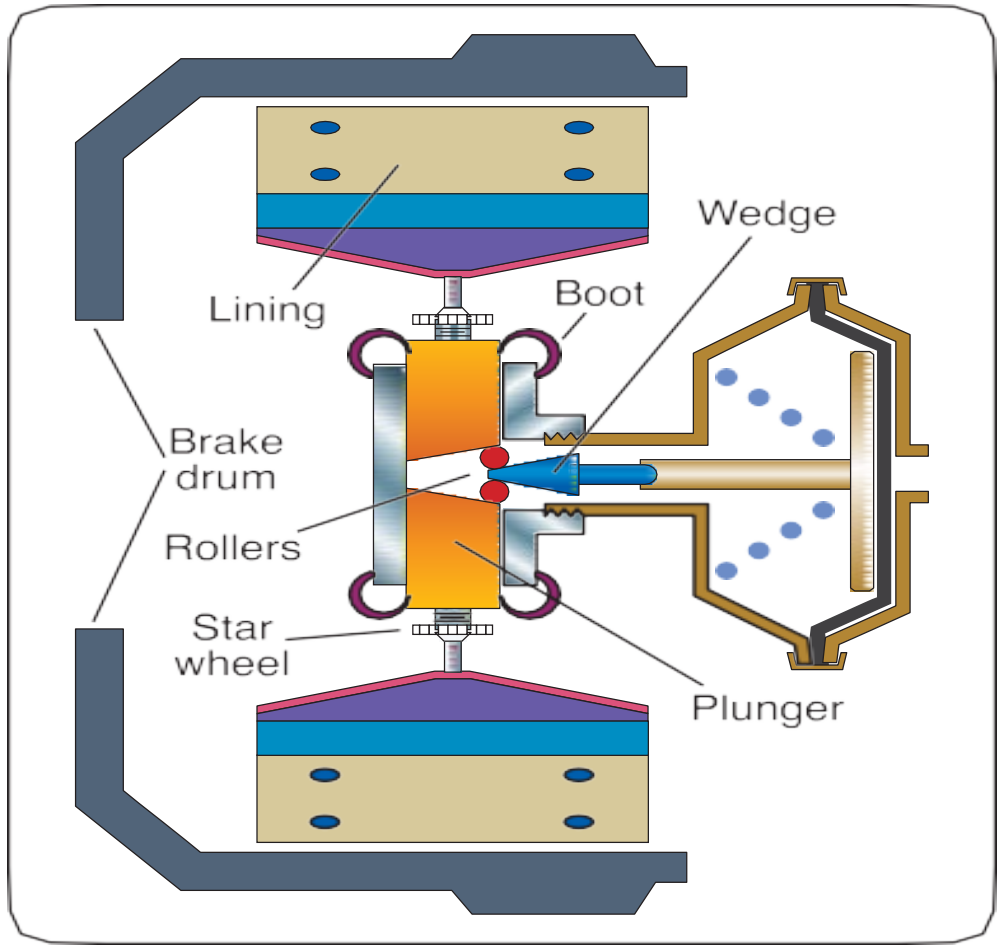
The spring brake modulator senses a loss of pressure in the primary system, and when the service brakes are applied, causes air to be exhausted from the spring parking brakes in direct proportion to the brake application.

When applying the foot valve normally, you can control the amount of spring force used to assist the front brakes to bring the vehicle to a controlled stop.

Other types of foundation brakes

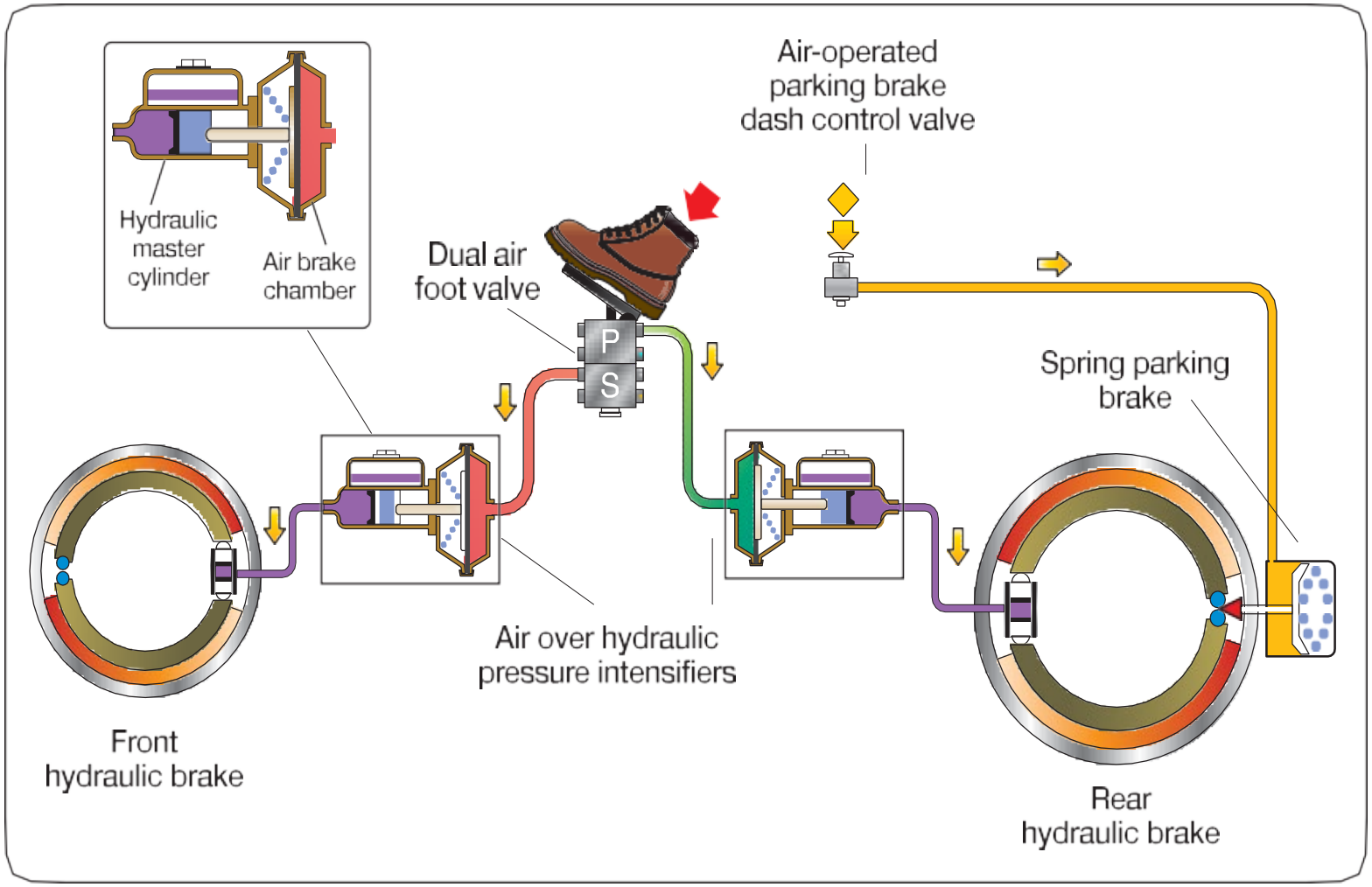
- Wedge brakes
- Air Disc Brakes
- Air-over-hydraulic brakes

Wedge brakes

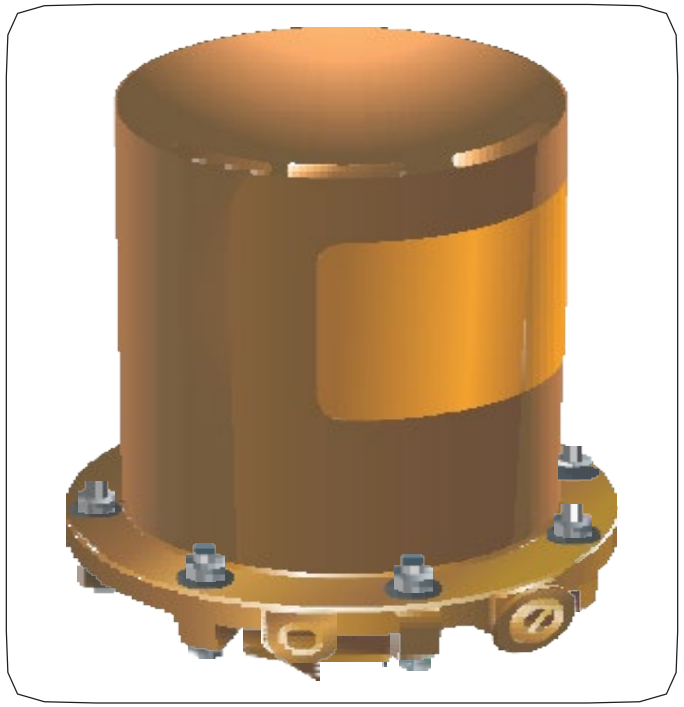


Air disc brakes

Air over hydraulic brakes

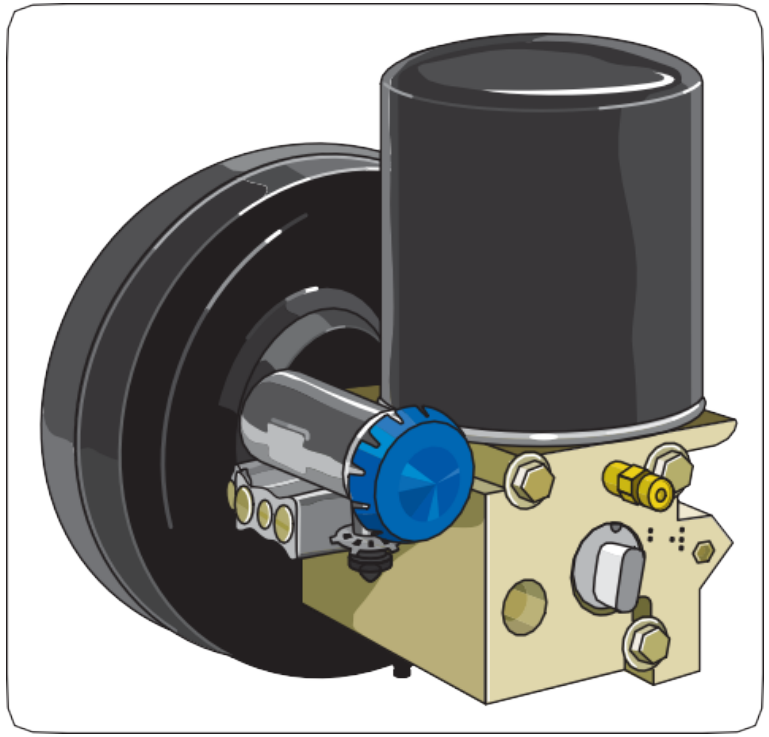


Air dryers



- Air dryers are optional devices installed in the compressor discharge line between the compressor and the first reservoir.
- Designed to remove any water vapour, oil mist and carbon particles from the air before it’s delivered to the first reservoir.
- Even if the air brake system includes an air dryer, air reservoirs should still be drained daily to check for contaminants.

Air dryer integrated system (ADIS)



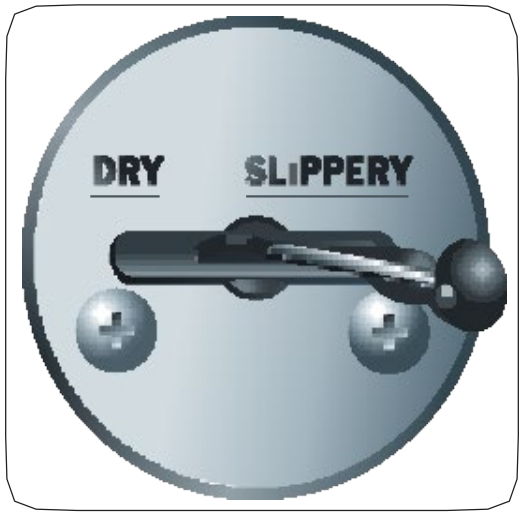
- Integrated air dryer systems are common with most modern vehicle manufacturers.
- One way to determine if you have an integrated air dryer system is the air dryer will be mounted to a small air tank.

Alcohol evaporators and injectors

- **Alcohol evaporators** and **alcohol injectors** are optional devices that introduce a small amount of alcohol vapour into the air system.
- The alcohol vapour combines with any moisture that may be present. In effect, the alcohol acts as an anti-freeze, lowering the freezing point of any moisture that’s collected in the air system

Front wheel limiting systems

- Found on older trucks – pre year 2000.
- Automatic front wheel limiting systems and manual front wheel limiting systems.



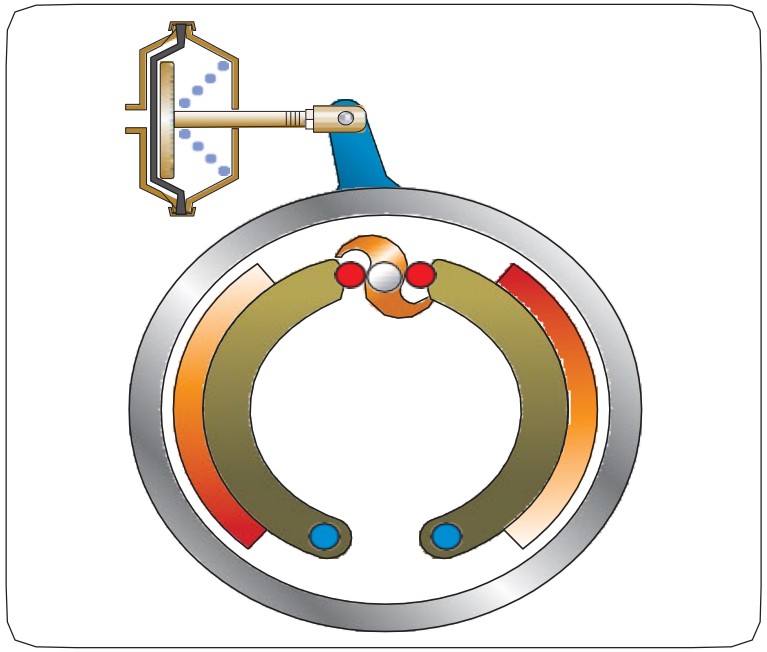
Air brake adjustment

Federal and Provincial law require you check manual and automatic slack adjuster daily during the pre-trip inspection.

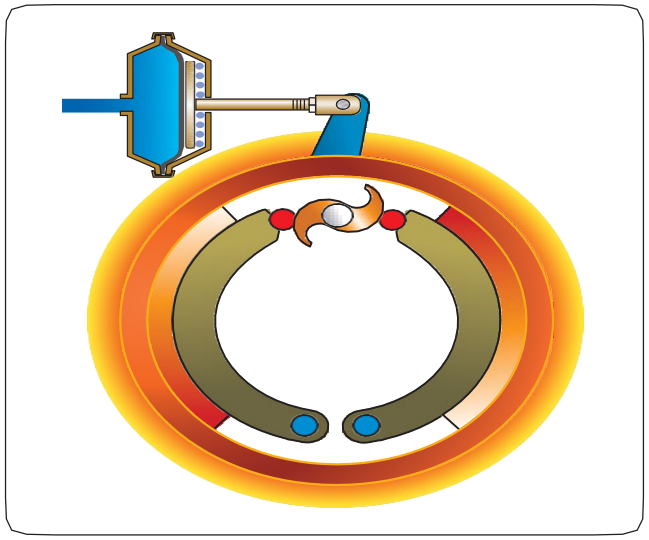
Slack adjustment = adjusting the brakes to keep the air chamber pushrod travel within tolerance.

Pushrod travel = the distance the pushrod extends from the brake chamber when the brakes are applied.

- Slack Adjustment
- Pushrod travel
- Brake chambers



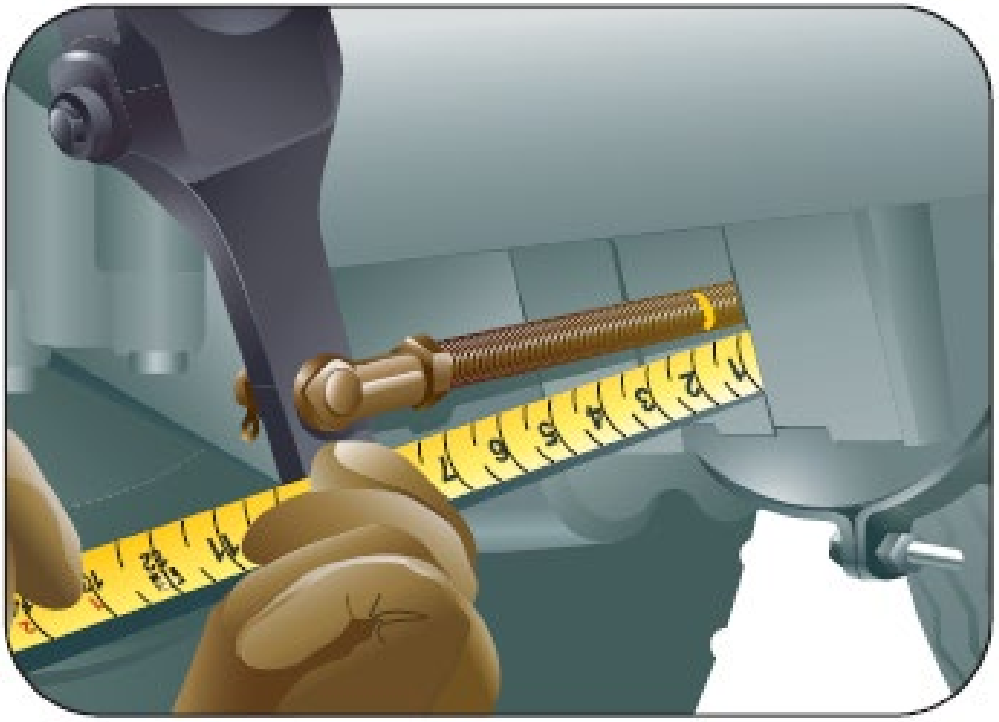
Importance of brake adjustment

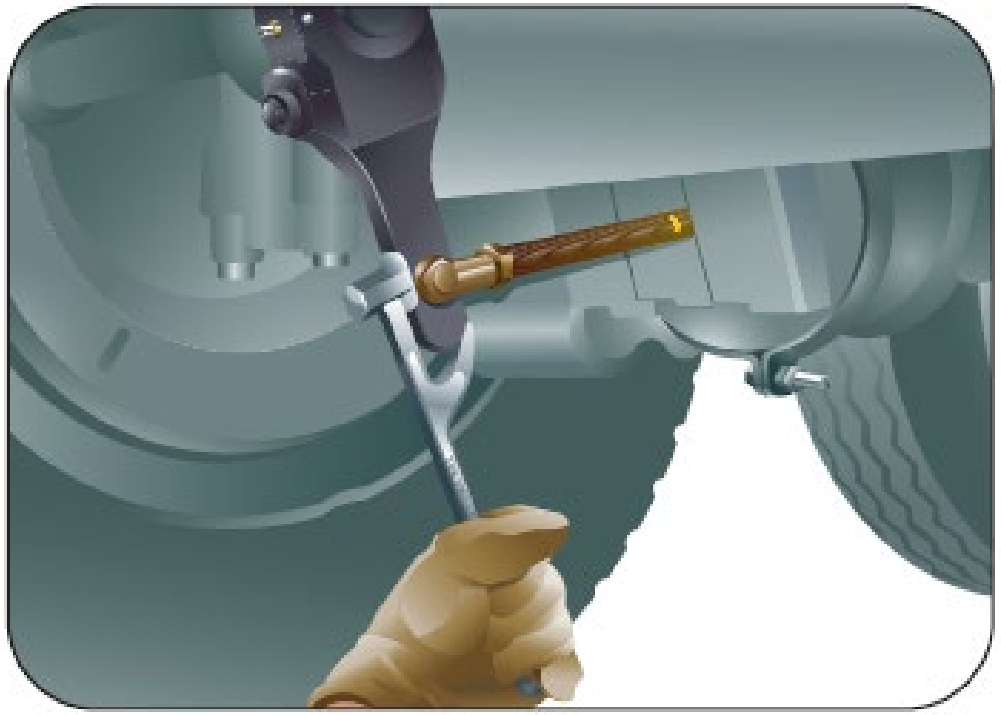


Importance of properly adjusted brakes:

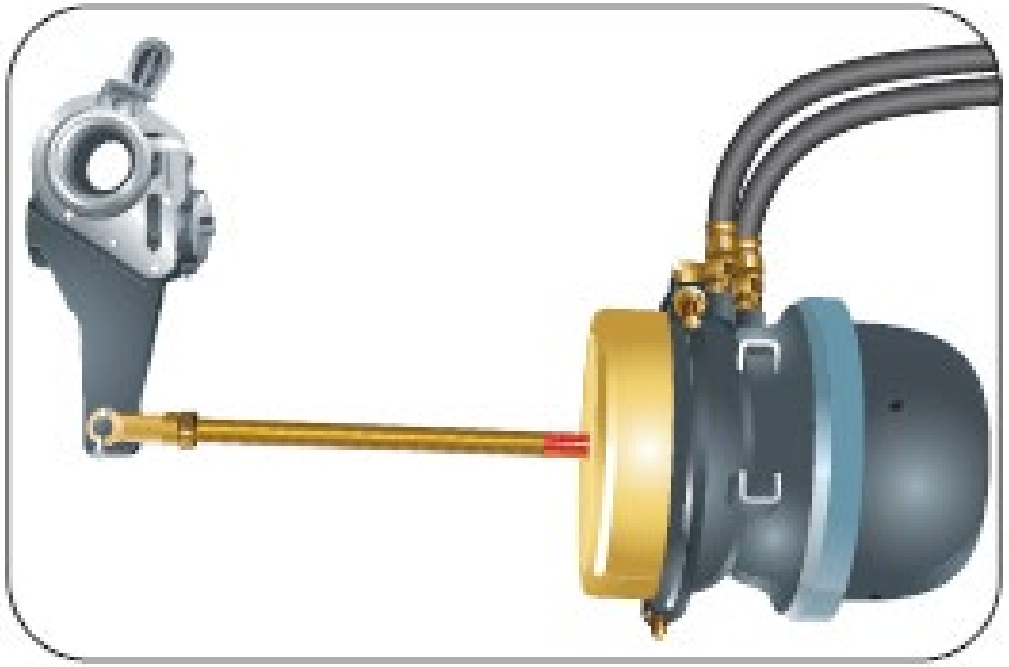
- **Overheating** – improperly adjusted brakes or worn parts in brakes.
- **Brake fade** - brake drum expands away from the brake shoes, you have to push harder on the brake pedal to maintain the same braking force.
- If the drum continues to expand away from the shoes, the pushrod plate inside the brake chamber hits the bottom of the brake chamber and you have no more stroke available to apply the brakes. This will now be a runaway situation.

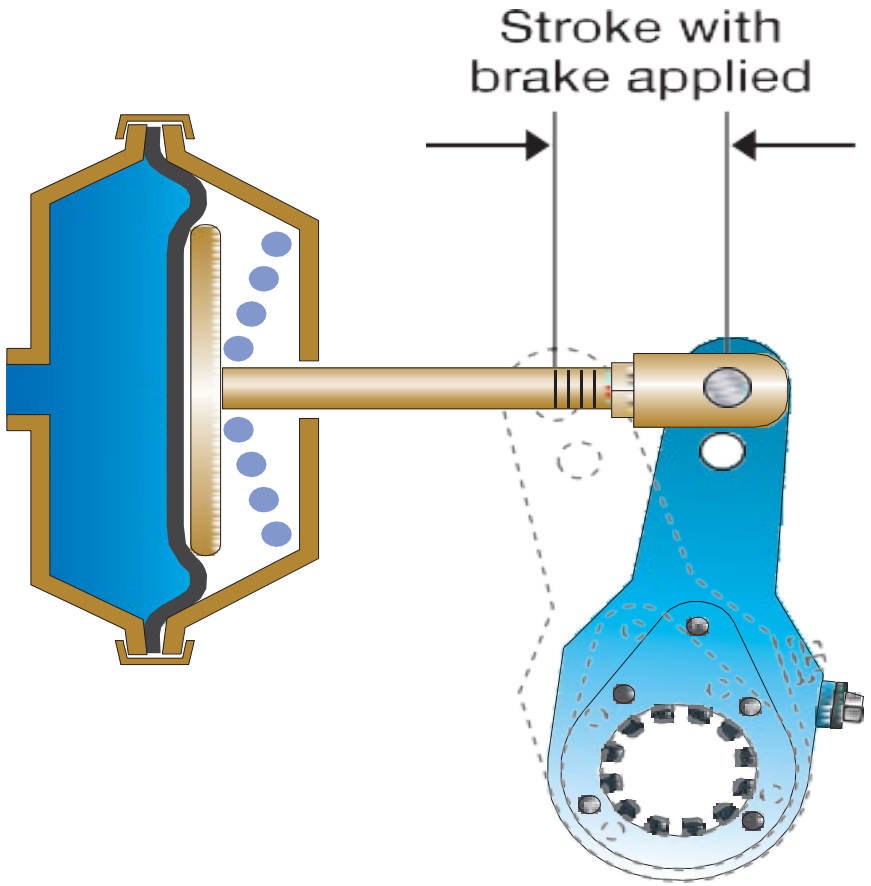
Checking brake adjustment





Adjusting a manual slack adjuster





Automatic slack adjusters

Crewson Brunner

Gunite

Rockwell

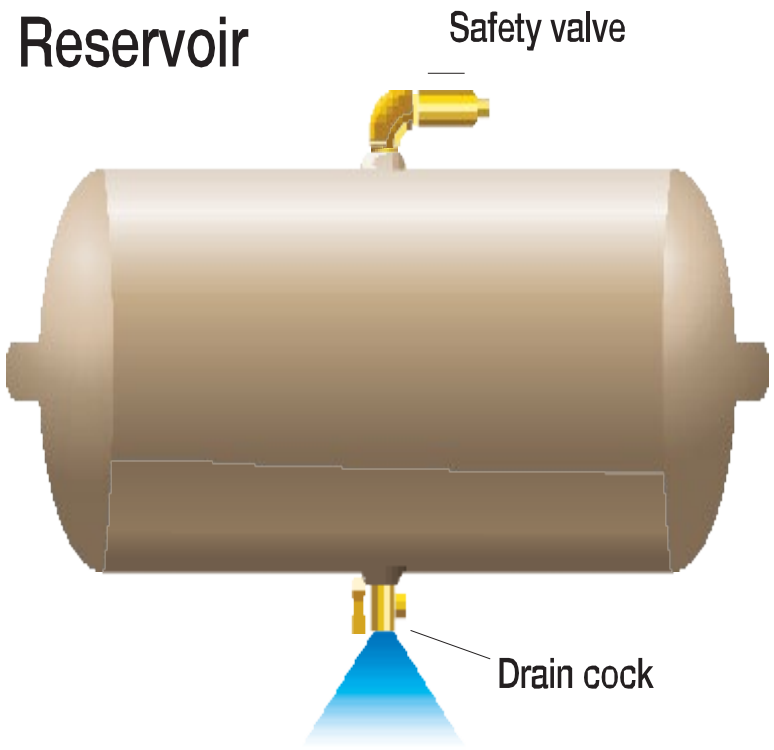
Haldex

Air brake pre-trip – getting started

Before getting started:

- make sure you are safe and seen
- block the wheels
- place transmission in low gear.

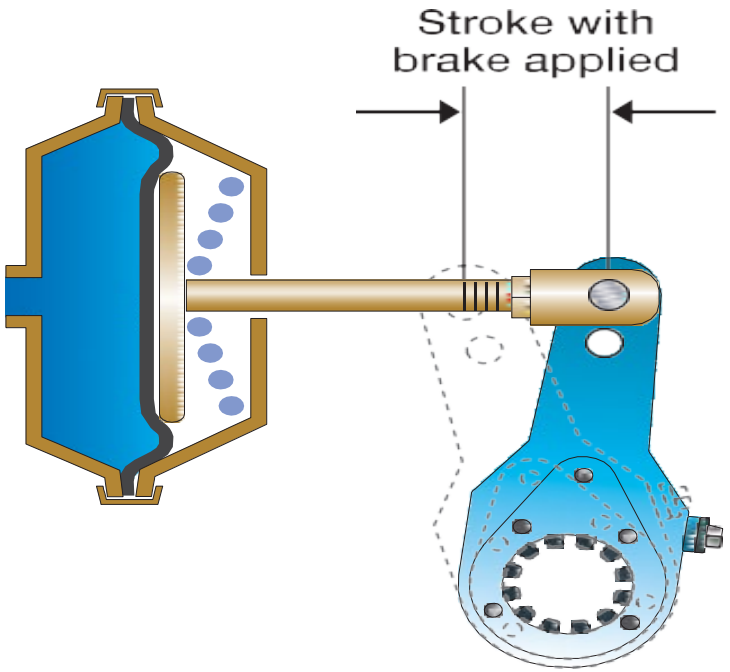
Air brake pre-trip - reservoirs



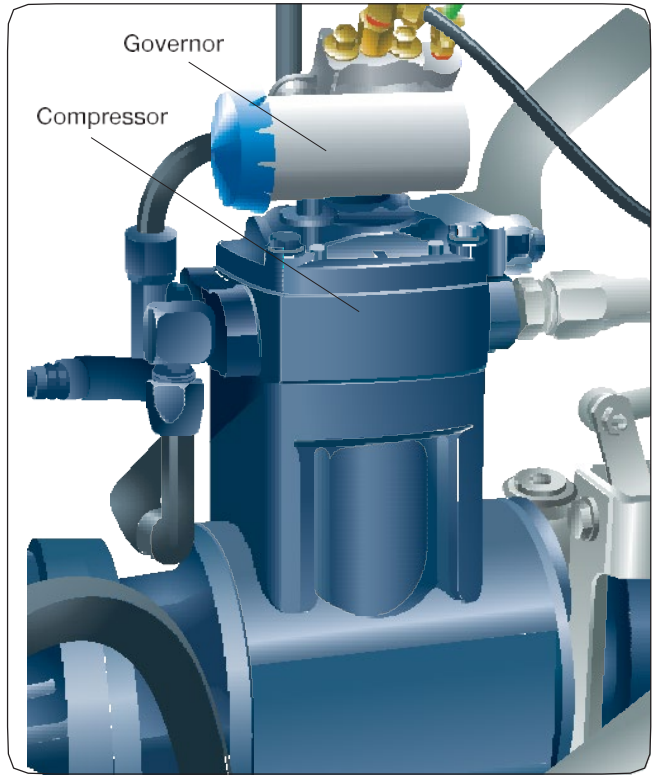
- Check to see if you have some air on the air gauges.
- Drain the supply tank(wet tank) if equipped.
- Recheck the gauges to see if the air in the reservoirs remained the same this confirms the one way check valve is working.

Air brake pre-trip – foundation brakes

- Open the hood and check the travel of the slack adjustor.
- Check the air line coming out to the brake chamber for cracks or damage.
- Check the brake chamber to ensure it is in good condition and secure (firmly mounted).
- Repeat this on both sides.



Air brake pre-trip - compressor



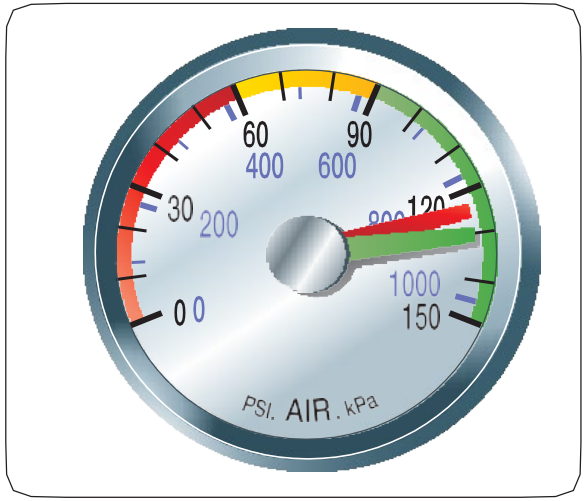
- Check the compressor to ensure it is secure and the discharge line (the main line of the compressor) is in good condition.
- Check that all other air lines under the hood are secure and in good condition.
- Check that there are no coolant or oil leaks.

Air brake pre-trip – in cab

- Get into the vehicle, confirm the vehicle is in neutral, and start the vehicle.
- Release the brakes by pushing in the yellow parking brake control valve.

Air brake pre-trip – governor

- Press and release the brake pedal – called fanning down - to lower the air no lower then 80 PSI. Allow the compressor to build to maximum air pressure between 105-135.
- Next, lower the air 20 PSI to confirm the governor puts the compressor into the reload stage, this will be determined when the needles begin to climb. Continue to fan down to check that the low air warning comes on by 60 PSI.
- Continue to lower the air pressure until both needles are below 50.



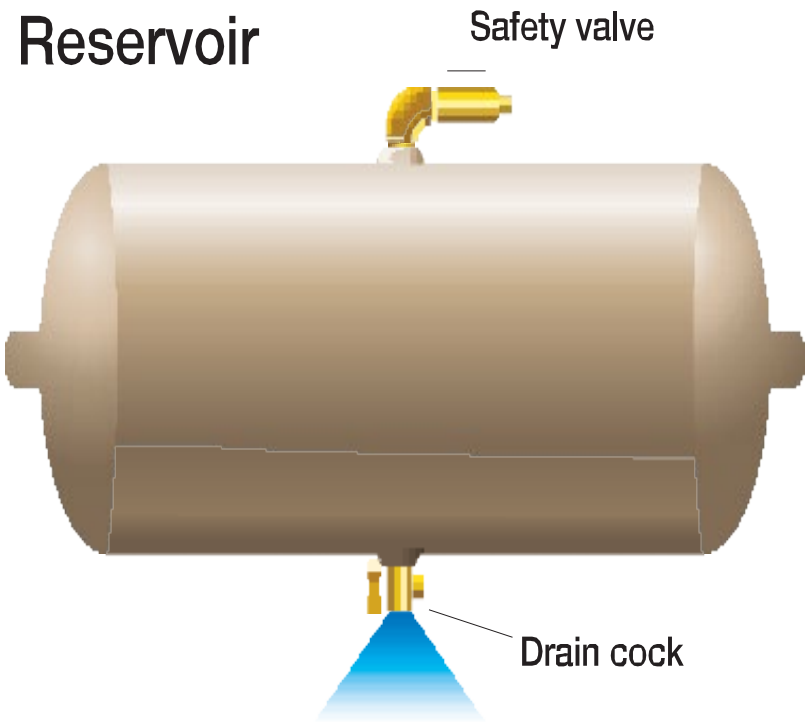
- Then, check the compressor. When the first needle hits 50 PSI start timing. The compressor must build from 50 to 90 PSI in under 3 minutes at 1000-1200 RPM. Stop the timing when the last needle goes through 90 PSI.
- Confirm the parking brakes remained released, and continue to build to maximum air to confirm that the governor puts the compressor into the unload stage between 105 and 135.

Air brake pre-trip – leak test

- With the brakes released, the engine off and the window open to hear any audible air leaks, make a firm brake application.
- To perform a leak test, hold a firm brake application for 1 minute, you cannot lose any more then 3 PSI during that time.
- Listen for any audible air leaks.
- Once completed, confirm there is a minimum of 100 psi in the reservoirs, confirm the brakes remained released, put the vehicle in low gear, take the keys, and exit the vehicle.

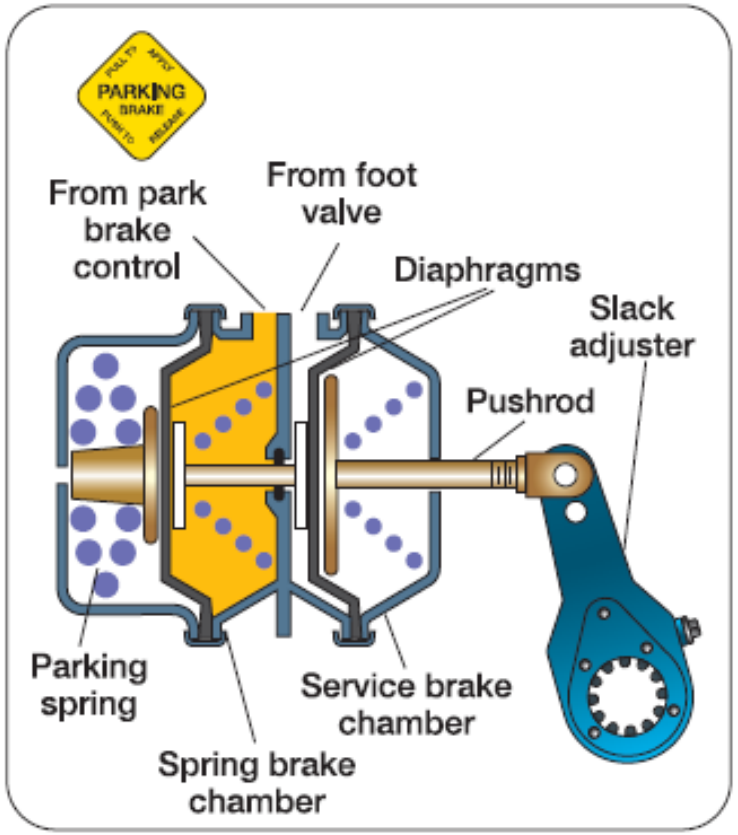
Air brake pre-trip – under vehicle

- Go under the rear of the vehicle to check the air tanks to confirm they are secure, the air lines are tied up and secure
- Then, move back to the rear wheels to perform the same checks as at the front wheels



Air brake pre-trip – rear wheels

- Check at each wheel that the air lines going into the brake chambers are in good condition, the brake chambers are in good condition, and that you have the correct travel.
- Use either the pry bar method or the applied stoke method.



Air brake pre-trip – apply the brakes

- Exit from under the vehicle and apply the brakes by pulling the yellow button.

Air brake pre-trip – remove blocks

- Once the brakes are applied remove the wheel blocks.

Air brake pre-trip – brake response

Two-way brake response test

1. Enter the vehicle and confirm the transmission is in neutral.
   - Start the vehicle, place in low gear with the parking brakes applied.
   - Try to move the vehicle to confirm the parking brakes are holding.

2. If the brakes hold, release the parking brakes and allow the vehicle to roll ahead.
   - Using the foot valve make a brake application to confirm the vehicle will stop.

Recap critical checks

You must not drive if:

- Pushrod stroke of any brake exceeds the adjustment limit
- Air loss rate exceeds prescribed limit
- Low air warning system fails or system is activated
- Inoperative service or parking brake

You may be able to drive but get these checked by a mechanic:

- Audible air leak
- Slow air pressure build-up rate