Motorcoach Brake Systems and Safety Technologies

An introduction to retarders, anti-lock brake systems (ABS), and other electronically controlled safety devices.

U.S. Department of Transportation
Federal Motor Carrier Safety Administration

www.fmcsa.dot.gov

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Introduction

This booklet provides information and guidance to motorcoach drivers who have the challenge of understanding and properly handling complex mechanical devices, technologies, and safety related systems. **Each section of this booklet concludes with important summary points. Always refer to the manufacturer's operating instructions for specific vehicle model information.**

This booklet will answer the following questions:

- What is the "acceptable" air system leakage limit above which you should not operate the motorcoach? (answer on page 2)
- What does your air pressure gauge tell you? (answer on pages 2 & 3)
- What does it mean when the ABS light is lit while you are driving? (answer on pages 6 & 7)
- When should cruise control not be used? (answer on page 12)
- Should you use a retarder on a slippery road? (answer on pages 15 & 16)
- How much longer will it take you to stop when traveling at 60 mph with drum brakes instead of disc brakes after repeated brake applications? How much longer at 75 mph? (answer on page 20)

Air Brake Systems

All air-braked motorcoaches built since March 1, 1975 for operation in the United States must meet minimum requirements known as “Federal Motor Vehicle Safety Standard 121, Air Brake Systems” or FMVSS 121. This booklet will cover the most common air brake system designs from 1975 to 2006.

Air Compressor and Air System Pressure - You should be aware of common air pressure thresholds of your motorcoach’s brake system. The air pressure gauge tells you the adequacy of the air system. Air compressors typically have a “cut-out” pressure between 110 psi and 130 psi and a “cut-in” pressure about 20 psi lower. Air pressure build-up from 85 psi to 100 psi should take 45 seconds or less. While driving, observe the air pressure gauge during build-up to ensure proper air system operation.

Every motorcoach is different, some by design and some by condition. **Know what is “typical” for your motorcoach.** To test air system integrity, make and hold a full brake application for at least 2 minutes while watching the air pressure gauge with the engine off, the key in the “on” position, and the park brake off. Leakage, if present, should be less than 5 psi for the 2 minutes. Continue the test by applying the park brake and then “pumping” the brake pedal to release air. A visual warning should activate when the air pressure gauge drops below 60 psi.

Air Brake Systems

Air pressure gauges - The most common air brake system designs since March 1, 1975 isolate the front axle system from the rear axle system and have two air pressure gauges. The gauges for both air systems show how much air is consumed during braking and when the compressor activates to build up pressure. **If you notice frequent activation (compressor cut-in and cut-out) or excessive air loss in either system during braking, pull over at a safe place and perform the 2 minute / 5 psi leakage test.** If a failure occurs in either the front or rear axle system, there is usually enough air in the other axle system to bring the vehicle to a safe stop. You should seek brake system service immediately if one system fails.

Caution about park brakes - Remember the park brakes are for parking only and are not designed as emergency brakes. Always leave the transmission in neutral (both manual and automatic) when applying the park brakes.

Important Points About Air Brake Systems:

- **Air Leakage** - Frequent compressor cycling usually indicates an air loss somewhere in the air brake system. It is unsafe to operate a motorcoach with a noticeable air leak. Even though frequent compressor cycling may maintain adequate air system pressure, you should seek a brake system inspection without delay.
- **Air Pressure Gauges** - It is advisable to continuously monitor the gauges for early detection of system malfunction such as unusual or imbalanced air consumption. Any leak in the air system can affect the braking performance of your motorcoach.
- **Low Pressure Warning** - In most cases, you should notice an air leak or malfunction before getting a low pressure warning. When a low pressure warning occurs, immediately bring the motorcoach to a safe stop, off of the roadway. Continuing to operate the motorcoach could result in an automatic application of the park brakes, possibly leading to a loss of control or a stop in an unsafe position.
- **Continual Awareness** - Know your motorcoach, its features, and its condition at start-up and throughout the trip.
- **Proper Use of Park Brakes** - The park brakes should only be used to park. Do not use the park brakes to stop the motorcoach during an emergency.

Be prepared to handle a malfunction at any time.

Anti-Lock Braking Systems

Since March 1, 1998, new motorcoaches are required to have an anti-lock braking system (ABS). An ABS monitors all wheels for skidding during brake application and momentarily releases some or all of the brake action until the skid stops. The basic function of an ABS is to prevent wheel lock and provide directional control during braking. ABS keeps the wheels rolling for optimum braking and steering.

On some slippery surfaces, ABS can provide wheel lock control that may not be readily detected by the driver. Because most highway travel is on dry pavement and the typical brake application is less than 20 psi, the ABS seldom activates. It is important for you to know whether the motorcoach that you are operating has an ABS. If your motorcoach is ABS equipped, you should know how to use this technology and be familiar with the signals of ABS malfunction.

Anti-Lock Braking Systems

ABS Lamp on the Instrument Panel - Turn the ignition key to “on” and look for the yellow lamp, light, or lighted icon on the instrument panel marked ABS. After engine start-up, the system does a self-diagnosis and, if no malfunction is found, the lamp will turn off after a few seconds. When the motorcoach speed approaches 6 to 10 mph, the system checks for proper wheel speed signals.[1] The sequence at motorcoach start-up is:

Lamp On → System Check → Followed by Lamp Off → System OK

Critical malfunctions or signals that shut down all or part of the system will activate the ABS lamp. The two most important messages to remember are:

Vehicle Start-up → No Yellow ABS Light → Means No ABS

While Driving → Yellow ABS Light Illuminates → Means ABS Malfunction

[1] On some earlier production systems, the lamp remains lit until the motorcoach speed reaches 6 to 10 mph.

Anti-Lock Braking Systems

What to do when the ABS light illuminates - If the yellow light illuminates while driving, the ABS is malfunctioning and should be inspected as soon as possible. The malfunction could be as simple as a loose wire or sticking modulator valve. It is a safety violation to operate a motorcoach with a malfunctioning ABS. ABS malfunctions leave the motorcoach with a traditional braking system which means the driver has more responsibility for motorcoach braking and handling.

What to do when ABS activates - When ABS activates, you may or may not feel the ABS operating. When you must slow or stop the motorcoach quickly and whenever ABS activates, keep a steady brake application and let the ABS modulate the brake pressure as needed. You will not see the yellow ABS light when ABS activates. The purpose of the ABS light is to tell you the ABS may be malfunctioning and needs inspection.

ABS Based Safety Technologies

ABS based technologies include traction control systems, electronic stability control systems, and anti-roll systems. These systems, through the use of additional sensors, will apply the motorcoach's brakes under certain circumstances.

Traction Control Systems use a sensor to monitor and control traction loss when increased engine output or roadway conditions cause wheel slippage. The system reduces power to the slipping wheel(s) until traction is regained. For optimum control and safety, traction control systems keep the wheels rolling at the same speed.

A motorcoach equipped with a traction control system may have an ON-OFF switch and a green light marked TC, ATC, or Traction Control. The preferred operating mode is to leave the traction control system switch in the "ON" position. When driving in mud, snow, or ice, and one drive wheel starts to spin, the computer tells the traction control valve to apply the brake at the spinning wheel and transfer the engine power to the opposite wheel. This function, known as differential braking, may also tell the engine electronic control unit to reduce engine power.

A Typical Scenario Without Traction Control

While climbing a hill on wet pavement, you cross a bridge and discover the surface is icy and the drive wheels start to spin. You must immediately back off the throttle to maintain steering and control.

A Typical Scenario With Traction Control

While climbing a hill on wet pavement, you cross a bridge and discover the surface is icy and the drive wheels start to spin. The traction control system senses the wheel slippage and automatically reduces power to the slipping wheels until traction is regained.

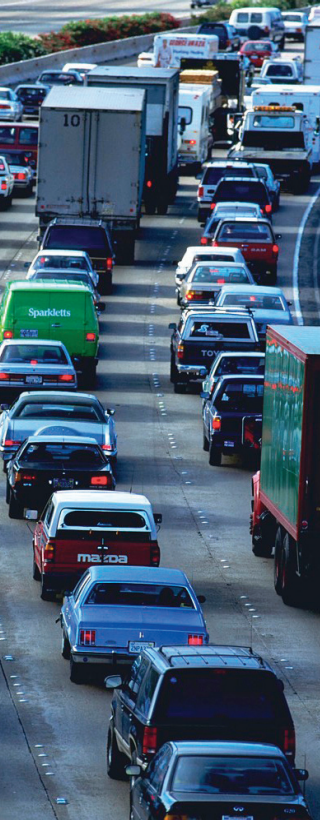
ABS Based Safety Technologies

Electronic stability control systems are totally automatic and use roll, pitch and yaw sensors to determine whether the motorcoach is leaning, changing direction, or slowing down. Such systems typically look for lane changes and similar maneuvers where motorcoach speed is too fast for conditions and countermeasures are advisable. A typical maneuver could call for the traction control valve and the brake modulator valve to apply a small amount of braking to one or more wheels to assist the turn and maintain vehicle control. Some systems also use a steering wheel position sensor.

Anti-roll systems are also totally automatic. They use a sophisticated set of algorithms to interpret steering wheel position, yaw and roll, and other signals to predict potential rollover and apply the brakes to help prevent a rollover.

Important Points to Remember About ABS and Related Technologies

- Know whether your motorcoach is equipped with an ABS or traction control system, and whether the ABS is functioning and the traction control system is turned on.
- Slippery road – motorcoach has ABS – start to brake – ABS starts cycling – what should you do?
  1. Keep your foot on the brake – do not try to pump or modulate the brake.
  2. Bring the motorcoach to a stop or a safe speed before releasing the foot brake.
  3. Remember that ABS always beats "driver best effort braking."
- Stopping distance is almost always longer with locked (skidding) wheels. Loss of directional control is another potentially serious consequence of wheel lock-up.
- ABS light on while driving means the ABS is malfunctioning. Be extra careful to avoid locking the wheels when braking.
- Learn all you can about ABS, traction control systems, and other safety technologies even if the motorcoach you currently drive is not equipped with such technologies.



Safe Use of Cruise Control

For safety concerns, some motorcoach companies prohibit their drivers from using cruise control. Cruise control should be used with caution and sparingly. It should not be used under the following circumstances:

- During adverse driving conditions such as wet, icy, or slippery roads,
- During congested highway conditions with heavy traffic, and
- During times when you are feeling fatigued. Because of circadian rhythms in human alertness, increased sleepiness occurs during nighttime and the early afternoon. Cruise control should not be used during the dark of night. In addition, it should only be used with extreme caution, if at all, between 2 p.m. and 6 p.m.

To enhance safety, some motorcoaches are installed with an **intelligent cruise control system**. This system differs from a standard cruise control system by using forward looking sensors to monitor motorcoach closing speed and warn the driver of a potential rear-end collision with the vehicle ahead.

Retarders

Retarders give you another way to slow down, lessen the need to use the brakes, and reduce brake wear. All retarders can be turned on or off by the driver. As with cruise control, retarders should never be used on wet, icy, or slippery roads. We will discuss three types of retarders (exhaust brake, engine compression brake, and driveline retarder):

(1) The **exhaust brake** uses a valve installed on the engine exhaust system to restrict or hold back the engine exhaust. The closed valve causes a buildup of exhaust gases that flows back into the combustion chamber of the cylinders. Pressure buildup in the cylinders creates a power loss by restricting the fuel mixture delivery to the cylinders.

(2) The **engine compression brake** (often referred to as a "Jake Brake") is installed in the engine cylinder head and directly controls the engine exhaust valves or throttle valves. As a new driver, you learned that the compression of the engine alone will slow (retard) the motorcoach when you take your foot off the throttle. If an engine compression brake is installed on a 300 horsepower engine, you can expect up to 150 horsepower from the engine to slow the motorcoach. When the retarder is turned on, the engine compression brake activates when you remove your foot from the throttle. Most engine compression brakes have multiple settings.

For example, the “Jake Brake” has three settings. The use of an engine compression brake is restricted or prohibited in some areas due to Federal, State, or local noise standards.

(3) The **driveline retarder** works by generating force which causes the driveshaft to resist turning, thereby slowing the motorcoach. Hydraulic is the most common type of driveline retarder. The efficiency of driveline retarders (horsepower available to slow the motorcoach) is generally greater than exhaust brake and engine compression brake retarders. Driveline retarders can continuously provide smooth retardation over a wide range of speeds. Remember that activation only occurs when the retarder master switch is turned on. It is important to remember that a hydraulic driveline retarder is cooled by the transmission oil and excessive use can cause overheating.

The popularity of driveline retarders increased as more automatic transmission motorcoaches became equipped with electronic engine controls. For example, it is possible on newer motorcoaches to interconnect the retarder and cruise control to keep the motorcoach at a constant speed as it travels up and down hills. On other newer motorcoaches, the electronic control monitors throttle position, cruise control setting, motorcoach speed, and even transmission temperature, to recommend or select upshifts and downshifts.

WARNINGS

- **DO NOT USE A RETARDER WHILE DRIVING ON WET, ICY, OR SLIPPERY ROADS. DOING SO CAN CAUSE A LOSS OF CONTROL.**
- **IN COLD WEATHER, TURN THE RETARDER OFF WHEN APPROACHING BRIDGE DECKS, ON-RAMPS, OR EXIT RAMPS.**
- **DURING SLIPPERY CONDITIONS, TURN THE RETARDER OFF USING THE MASTER CONTROL (ON/OFF) SWITCH LEVER.**
- **IF YOU EXPERIENCE A LOSS OF DIRECTIONAL CONTROL, IMMEDIATELY TURN OFF THE RETARDER.**

IMPORTANT POINTS ABOUT RETARDERS

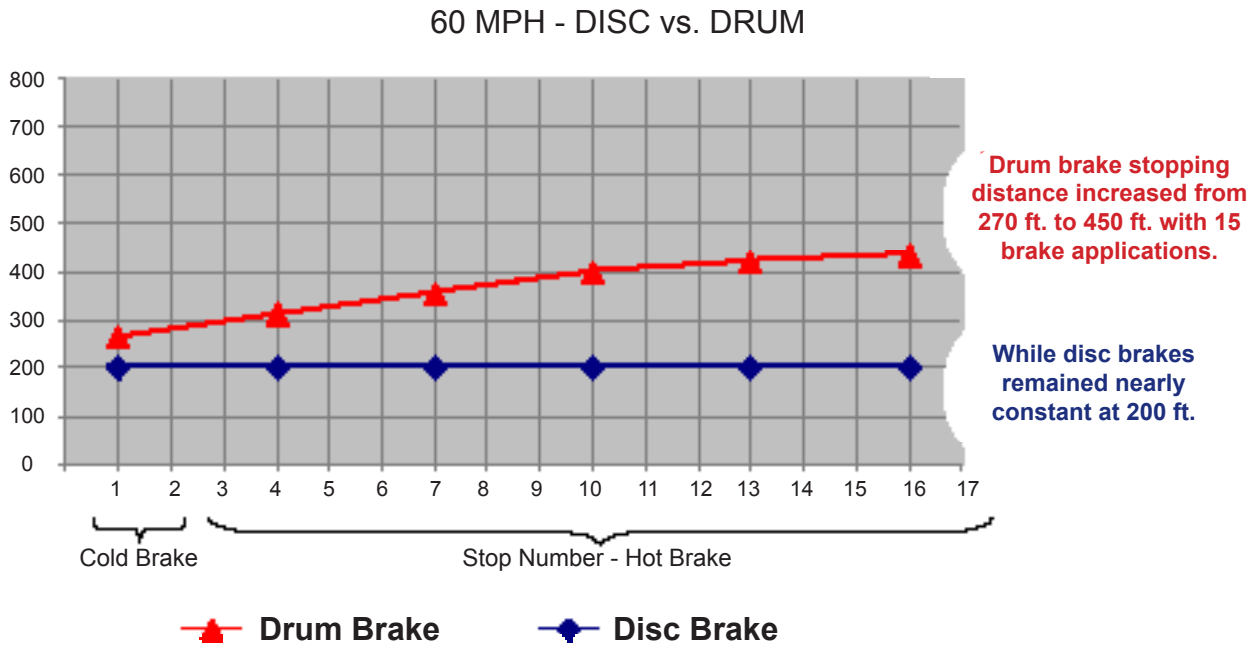
- The master control (ON/OFF) switch is usually accompanied by a light which indicates the system is activated. Periodically check to verify the retarder is functioning by activating the master control switch at closed throttle only. Throttle activation automatically deactivates the retarder.
- The retarder is not a replacement for your brakes. However, it can be used to slow down or maintain motorcoach speed during most highway operations. Retarders help to extend brake life and prevent brake fade.
- Remember that the retarder only brakes the drive axle and cannot detect slippery roads or other environmental hazards. It is possible for the rear of the motorcoach to lose traction on wet, icy, or slippery roads when the retarder is applied. Do not use the retarder during such conditions.
- To minimize the risk of brake fade, use the retarder with the proper transmission gear for the slope and length of the grade and the speed of the motorcoach.
- With some motorcoaches, the ABS is designed to deactivate the retarder when wheel-lock starts. Panic stops, wet surfaces, and driver over-reaction may activate the ABS and deactivate (turn off) the retarder.

Brake Fade

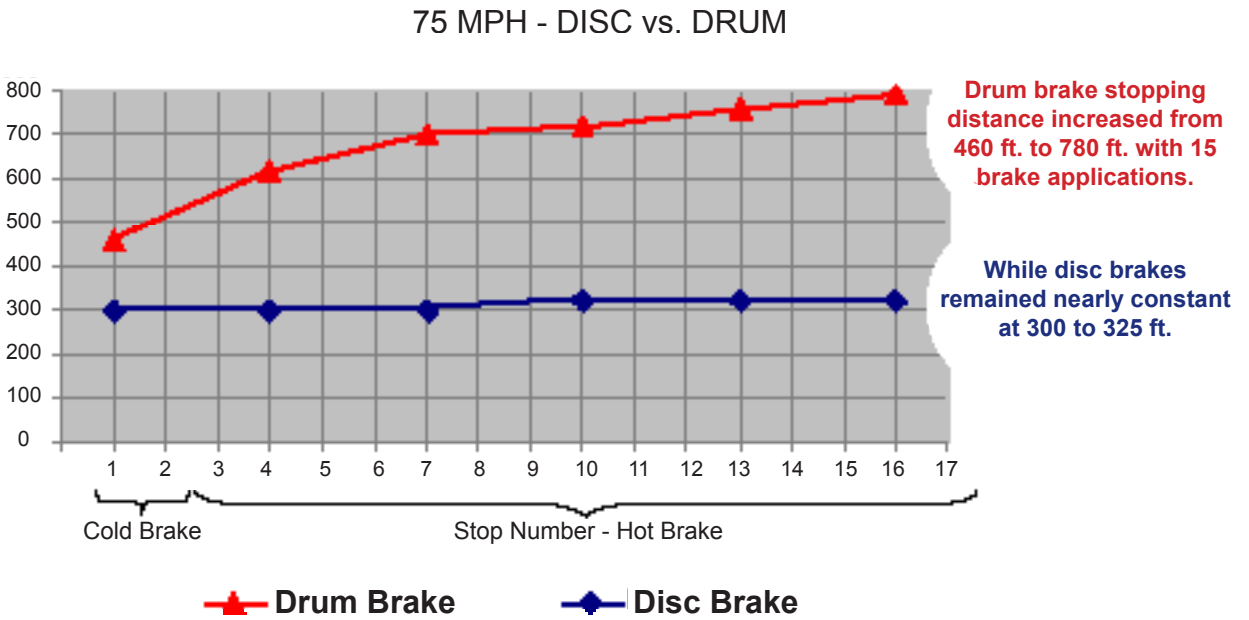
In the late 1990s, the majority of motorcoaches manufactured for operation in North America switched from being equipped with **drum brakes** to **disc brakes** because of better braking performance. Disc brakes are less susceptible to "brake fade" or diminished braking capacity. Brake fade becomes an important factor when the brakes are applied while descending long grades. All drivers should know whether their motorcoach is equipped with drum or disc brakes. It is easy to look at the wheel area and determine the type of brakes on the motorcoach.

A study comparing the braking effectiveness of air disc brakes versus air drum brakes for tractor-trailers was conducted by Bendix Commercial Vehicle Systems. Tested at 60 mph, the disc brake stopped the vehicle at about 200 feet and the drum brake did so at about 270 feet. This braking distance difference is the result of the different braking systems. After 15 stops from 60 mph, the stopping distance for the drum brake deteriorated from 270 feet to 450 feet, while stopping distance for the disc brake remained at close to the initial 200 feet. The increased braking distance for drum brakes at successive stops is the result of brake fade. The 75 mph results are even more dramatic. Both the early and later stops were both significantly affected by brake fade. If disc versus drum brake testing was performed with motorcoaches at 60 mph and 75 mph, similar results would occur.

Testing Results Beyond FMVSS 121 Fade Resistance



Testing Results Beyond FMVSS 121 Fade Resistance



IMPORTANT POINTS ABOUT BRAKE FADE

- Brake fade is a function of the type of brake system (drum vs. disc) and motorcoach speed. Repeated stops at 60 mph with drum brakes can double the stopping distance due to brake fade.
- Increasing speed by 25% from 60 mph to 75 mph can double the stopping distance for both drum and disc brakes. Repeated braking at 75 mph with drum brakes can take three times longer than initial drum braking at 60 mph. In short, braking at higher speeds will likely result in more brake fade.
- The heat caused by extensive brake use (e.g. while descending a long downgrade) causes less brake fade with disc brakes than drum brakes. Brake drums expand away from the friction material (brake shoes). Disc brake rotors expand into the friction material (brake pads). Thus, disc brakes can be more safely used than drum brakes when descending a downgrade.
- Brake components are designed to work together. If you are selecting replacement brake parts, follow the manufacturer's recommendations.

The following list of driving tips and cautions are reminders:

- Drivers should always drive within the posted speed limit and adjust speed in accordance with prevailing road conditions.
- Before you start driving, check the motorcoach's air system integrity. During the trip, monitor air consumption by checking the air pressure gauges for warnings of potential leaks.
- The park brake is for parking only. It is not an "emergency brake."
- While driving, never put the transmission in neutral and attempt to bring the motorcoach to a stop.
- Before you start driving, check the ABS status. During the trip, monitor the ABS malfunction light and report any activation to maintenance personnel.
- During a panic stop on slippery pavement, let the ABS control wheel-lock. Do not pump the brakes if you have a functioning ABS.
- Use the retarder and cruise control to save your brakes, but never use the retarder or cruise control on wet, icy, or slippery roads.
- Drive downhill properly - reduce speed, place your motorcoach in an appropriate gear, use the retarder, and apply the brakes sparingly.

Where to Go for Additional Information

For Brakes, ABS, and Air Systems:

www.bendix.com

www.arvinmeritor.com/products

www.meritorwabco.com

www.hbsna.com

For Retarders:

www.allisontransmission.com
Search for “retarder”

www.jakebrake.com
Click “Product Info”

Related Web Sites:

Federal Motor Carrier Safety Administration
www.fmcsa.dot.gov

American Bus Association
www.buses.org

United Motorcoach Association
www.uma.org

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Pub #FMCSA-ESO-07-01

March 2007