AIR BRAKES

EXPLAINED SIMPLY

An updated step-by-step guide for Truck, Bus, and RV Drivers to pass CDL Air-Brake Endorsement.

Rick August, PhD
SMART DRIVE TEST©

ABOUT THE AUTHOR

Dr. Rick August became an air-brake and commercial driving instructor in 1997. For a decade prior to that time, he was an over-the-road truck driver delivering freight in both Canada and the United States.

In 2000, he returned to university and, in 2006, earned his PhD in legal history and policing from the University of Melbourne, Australia. During his university years, Dr. August worked part time as a bus driver for Greyhound Australia.

Air Brakes Explained Simply explains complicated concepts with simple and easy to understand language.

In *Air Brakes Explained Simply*, Dr. August:

- simplifies technical information and provides understandable comparisons;
- provides you with the exact Commercial Driver's License (CDL) questions you will be asked;
- highlights the precise knowledge you need to pass your CDL.

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INTRODUCTION

BRAKES ARE SIMPLE.

This manual is for anyone getting a CDL in the United States, a Class 1 or Class "A" in Canada. And for anyone getting an air brake endorsement to drive an air brake equipped vehicle. Or anyone interested in air brakes as a subject.

The air brake component of the CDL (Commercial Driver's License) is the most technical and the most difficult for students to understand.

There's a lot of information you need to know and most places are still teaching a forty-year-old air brake course. And just in case you encounter an old (like dinosaur-old) vehicle, authorities stick everything and the kitchen sink into these air brake courses.

Unfortunately, this old information only confuses students and leaves them with the false impression that air brakes are prone to failure.

Air Brakes Explained Simply provides the information you must absolutely understand to pass the air brake component of your CDL.

Its goal is to get you a CDL, get you a job, get you making more money, and get you home safe to your family at the end of the week.

Brakes are simple, regardless of whether they're hydraulic or air brakes, and the information is grouped under the following three brake types:

1. **Service brakes** – brakes that apply when you push the brake pedal;

2. **Parking brakes** – hold the brakes in the applied position—forever, or at least until the driver intentionally releases the parking brakes;

3. **Emergency brakes** – in the event of an emergency caused by service brake failure, the parking brakes can bring the vehicle to a stop, and are now called emergency brakes.

Parking brakes and emergency brakes are one and the same. It is their use that designates the name. In a hydraulic brake system, the driver applies the emergency brakes manually; in an air brake system the emergency brakes apply automatically when system air pressure drops to unacceptable levels.

VIDEO:
Basic CDL Air Brake Components | Air Brake Smart

Maddie the Mechanic

The baby-boomer generation of truck drivers learned to drive air brake vehicles with manual slack adjusters. As part of their job, they maintained the vehicle and did repairs. Because these drivers worked on the truck, the expectation of repairing and maintaining the vehicle persists for drivers of large vehicles. However, technology has changed, and for issues of personal safety when dealing with air brake issues, drivers should contact a professional technician.

In *Air Brakes Explained Simply*, when safety is an issue our professional technician—Maddie the Mechanic—is brought in.

TOPIC ORGANIZATION

This e-book will help you pass your air brakes and drive an air brake equipped vehicle. The book organizes the information under four headings:

MUST KNOW – WORKING
Information to drive safely and come home to your family at the end of the week.

NEED TO KNOW – CDL PRACTICAL & THEORY TEST
Accurate and precise information you must know to pass your CDL knowledge and practical tests. Some information is about older systems and is no longer applicable to modern air brakes.

SHOULD KNOW
Provides a deeper understanding and knowledge of how an air brake system works, and why air brakes are used in the manner suggested.

COULD KNOW
Provides mechanical problems and their solutions; explains terminology and the evolution of the air brake system.

PROLOGUE

PUT STUFF IN YOUR HEAD

One of the ways you can learn the information required to pass your CDL faster is to use flash cards.

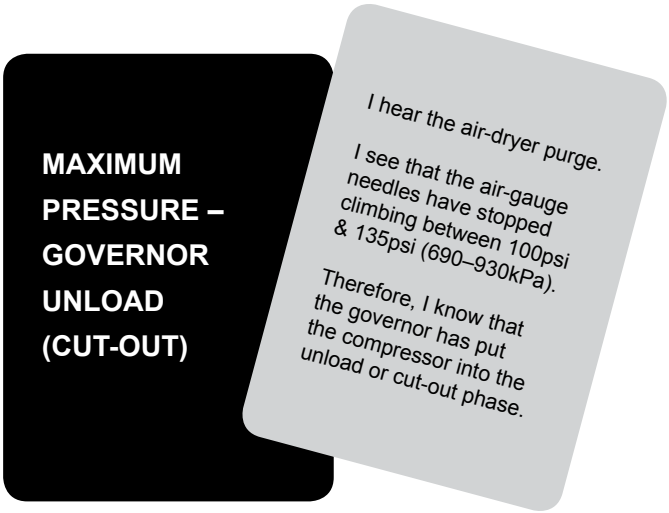
Get yourself index cards—sometimes called flash cards. These are available at all stationery stores.

On the front of the flash card, write the information or test you need to know or do.

For example, on the front, write: **The Governor test – Maximum Setting.**

On the back write: **How do you know that the system is at maximum pressure?**

“The air dryer purges and the needles stop climbing. I hear...I see... I hear the air dryer purge, I see that the needles have stopped climbing between 100 and 135psi (690–930kPa) and they are no longer climbing; therefore, the system is at maximum pressure, and the governor has put the compressor into the unload (cut-out) phase.”



Or the low-air warning test, or the tractor protection system test or whatever the test is, write it on the front of the index card and the answer on the back. Carry them around with you. Turn them over and the answer to the question will be on the back.

It's a great technique for those of you learning and earning air brakes and your CDL.

Be sure to carry your flash cards with you. Anytime you're sitting and waiting, or have a minute while waiting in line at the local coffee shop, look at your flash cards.

Both the flash cards and the process of writing out the information will help to get the stuff into your brain.

BRAKING BASICS

Rubbing two bits together….STOP

WHAT IS A BRAKE?

In horse-and-cart days, the brake was simply a block of wood attached to a fixed lever that the driver pulled. The fixed block of wood rubbed against the wheel, creating friction. The friction slowed the wheel and eventually brought the vehicle to a stop. The force of these brakes was limited by the strength of the driver's arms.

Modern braking systems use the same principle; however, advances in technology, component parts, and engineering have made brakes effective.

The block of wood is now a brake pad that is attached to the axle. Around the brake pad is a steel hub or drum. The tire is affixed to the hub, and both the hub and tire rotate together. To bring the vehicle to a stop, the pad is forced out against the drum, creating friction and heat, and subsequently slowing the wheel and vehicle.

If the tire has traction with the road, the vehicle will come to a stop. If traction is compromised due to ice, snow or rain, the vehicle will have difficulty stopping and/or starting.

VIDEO:
Air Brakes Explained: How Service, Parking and Emergency Brakes are the Same | Air Brakes Smart

BRAKES...ONLY THE POWER SOURCE IS DIFFERENT

First and foremost, air brakes are no different from the brakes on your regular car or light truck.

The only difference between air brakes and hydraulic brakes on your car or light truck is the power source and size.

Brakes on your car are applied by either hydraulic pressure or energy from your body; and air brakes are applied by either air pressure or the energy from large, powerful springs.

Hydraulic brakes are released by small, return springs in the system; and service air brakes also are released by small, return springs. This action occurs in both systems after the driver releases the brake pedal.

On an air brake system, the parking/emergency brakes are held in the released position by air pressure. If air pressure is lost or evacuated from the spring-brake chamber, the large, powerful springs will apply the emergency brakes.

NEED TO KNOW
Know that most driving manuals use the term “spring brake” interchangeably to denote parking/emergency brakes.

WHAT IS A SPRING?

When a spring is stretched or compressed, depending on its design, it creates motion and energy on its way to its resting position.

A children's pogo stick is a perfect example of a spring. The child bounces on the footholds and compresses the spring inside the telescopic tube. The pogo stick creates motion as the spring returns to its natural resting position. The jumping motion is repeated so long as the child continues to bounce and compress the spring.

WHAT IS A VALVE?

A valve is a device that controls the flow of a liquid or gas through a pipe or tube. A water tap is the most common type of valve. It both controls and regulates water into your kitchen sink. Many modern water tap valves will pull and mix the water from both the hot- and cold-water sources. Valves are everywhere: the valve stems on your car's tires control the flow of air into and out of your tires; your heart has valves that direct fluids to only travel one direction in your body; and a trumpet (musical instrument) has valves that regulate air flow and changes its musical notes. The air brake valves regulate, control, and direct the flow of air by opening, closing or partially obstructing air flow. The air brake valves:

1. Control the flow of air by turning the supply OFF/ON, forcing it to move in one direction, or discharging it from the system (trailer air supply valve: ON/OFF; one-way check valve: one direction; quick release valve: discharge from system;

2. Regulate the flow of air like a water tap. If you turn the tap on a little, you get a small flow of water; if you open the tap full, you get a flood of water (Foot valve (brake pedal) regulates how much pressure is directed to the service brakes.)

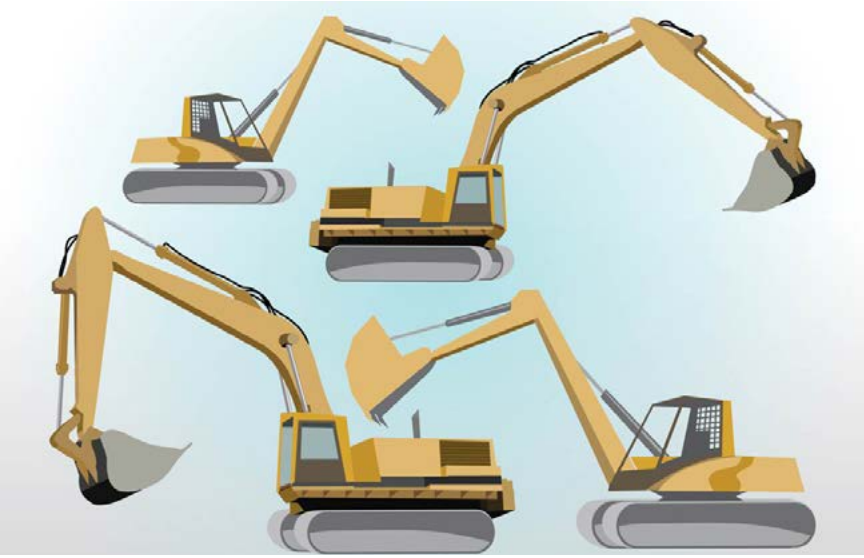
3. Direct the flow of air from one location to another. (Relay valve directs air shortest distance from air tanks to brake chambers).

CONVERTING AIR AND HYDRAULIC PRESSURE TO MECHANICAL FORCE

On an air brake system, instead of using hydraulic power, the service brakes are applied using air pressure. The pressure created by compressed air applies the service brakes—the brakes going up and down the road.

The brake chamber converts air pressure to strong mechanical force, in the same way that a piston converts hydraulic pressure to strong mechanical force. In their simplified forms, a piston and brake chamber are little more than a glorified soup can. Take a soup can, open it, empty the contents, and clean it. For an air brake chamber, put a balloon in the bottom of the soup can and set the can's lid on the balloon. If you inflate the balloon, the lid will move up and down creating linear mechanical motion.

A hydraulic piston works the same way. If you could seal the space around the soup can's lid and fill the soup can with liquid, the lid too would go up and down, thus creating linear mechanical motion with the rise and fall of the liquid. Thus, a hydraulic piston and air brake chamber are the same; only the power source is different.



SERVICE BRAKES

A car or light truck is fitted with hydraulic brakes, which means there's fluid in the system. A pump forces the fluid through the lines and into the pistons located between the brake pads. Unlike air, fluid cannot be compressed.

The pump is composed of the brake pedal and the master cylinder. The action of pressing the brake pedal activates the pump and moves the fluid stored in the master cylinder's reservoir. The fluid moves through the lines to the brake located at the wheel.

An old-fashioned well pump works in a similar manner. Someone pumps the pump's handle, and water moves from the well up to the pump.

The hydraulic pressure created by the pump is converted to mechanical force by a piston inside the brake assembly. The piston pushes the brake pads outward against the drum. Friction and heat are created between the brake pad and the drum, thus slowing and bringing the vehicle to a stop. The heat created is dissipated into the atmosphere similar to an air-cooled engine like the one on your lawn mower.

PARKING/EMERGENCY BRAKES

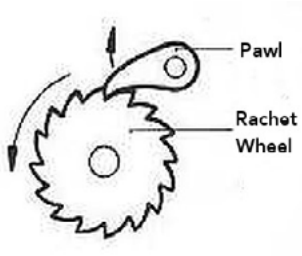
MUST KNOW

On both hydraulic and air brake systems, the service brakes will not work if the parking/emergency brakes are engaged.

In other words, for the vehicle to move up and down the road and the service brakes to work, the parking/emergency brakes must be released.

To engage the parking brakes on your vehicle, pull up on the handle or push down on the pedal; a ratchet mechanism via a cable locks the brakes into the engaged position. Energy to apply the parking brake comes from your body.

The ratchet mechanism and cable are similar to the winch on a boat trailer that hauls the boat onto the trailer - *click, click, click*. When you're finished winching the boat onto the trailer, the pawl (the little clicker thingy), prevents backward movement and subsequently keeps the boat from sliding off the trailer. The parking brake lever on your vehicle works the same way.



You pull or push the lever and apply the parking brake. The pawl prevents backward movement of either the pedal or lever and, subsequently, the parking brakes are engaged indefinitely.

If, however unlikely, this does occur, the parking brakes can be used to bring the vehicle to a stop. In the unlikely event this occurs, the parking brakes are now emergency brakes. The parking/emergency brakes are one and the same.

The force, generated by large, powerful springs, applies the parking brakes on a large vehicle. The energy from these springs is harnessed to apply the parking brakes indefinitely. Compressed air is used to hold these large, powerful springs in the OFF position while the vehicle is going up and down the road.

Similar to your car's parking/emergency brakes, the springs in the air brake system will engage the parking brakes to act as an emergency brake. Unlike your car, however, this event happens automatically if air pressure in the system drops to unacceptable levels: below 60psi (pounds per square inch) (414kPa).

Before parking brakes were fitted to air brake equipped vehicles in the late-1960s and early-1970s, a few trailers had rolled away, careened down a hill, and killed a port-a-potty. Authorities then considered it necessary that brakes on big trucks and buses had to be applied indefinitely when the vehicle was left parked.
You know…for purposes of safety and whatnot.

COULD KNOW

Juice brakes are slang for hydraulic brakes—often used when a commercial vehicle is fitted with hydraulic brakes.

WHY AIR BRAKES?

MUST KNOW

Air brakes:

- have proven reliable for almost a century;
- can transmit tremendous force over distance;
- are tolerant to leaks.

First and foremost, air brakes have proven reliable for more than a century. Air brakes were first fitted to trains in the 1800s and to trucks in the early-1900s. During that time, air brakes have proven reliable in stopping large vehicles and transmitting incredible force over distance.

Think of a large tractor-trailer unit that's almost 75 feet long (23m). The driver can control the brakes from the brake pedal in the cab all the way back to the rear of the trailer almost 70 feet (22m) away. The trailer brakes activate almost immediately when the driver pushes the brake pedal.

The gargantuan amount of fluid needed if hydraulic brakes were fitted to large vehicles makes this power source a silly notion.

As well, air brakes are tolerant to leaks. And when I say tolerant to leaks, modern air brake systems are tolerant to significant leaks. On the other hand, hydraulic brakes are intolerant to leaks and will not work unless the system is purged of residual air. Think of air in a hydraulic-brake system like air in a hypodermic needle—it's death to the system!

Because airlines and valves are plumbed into the vehicle's dash, you will hear an air leak long before the low-air warning comes on!

Think of it as water running through the pipes in your house. You know when there's a water leak because you can hear the water running.

So pay attention—you're going to know there's an air leak in the system, even a minor one.

The braking system on an air brake equipped vehicle is divided into three parts. All systems use the same foundation brakes. The foundation brakes are the components at the wheel that are responsible for creating friction, heat, and slowing the vehicle.

1. The **service brakes** activate when you apply the brake pedal and bring the vehicle to a gentle stop when coming to a traffic light or stop sign.

   The service brakes will work only when the parking/emergency brakes are released.

2. **Parking brakes**, which are applied by the large, powerful springs inside the spring-brake chambers. Air pressure is used to compress those large, powerful springs, thus disengaging the parking brakes. If you lose sufficient air pressure, however, the springs will engage and act as…

3. **Emergency brakes** in the event there is loss of air pressure.

There are three kinds of brakes on an air brake system:

1. **Service brakes**:
   a. powered by compressed air;
   b. held in the released position by small, return springs.
2. **Parking brakes**:
   a. powered by large, powerful spring;
   b. held in the released position by compressed air.
3. **Emergency brakes**:
   a. one and the same as parking brakes;
   b. powered by large, powerful springs;
   c. held in the released position by compressed air.

Parking brakes and emergency brakes are one and the same thing—the same as in your car.

In an air brake system, both the parking and emergency brakes are powered by large, powerful springs held off by air pressure—greater than 60psi (414kPa). If air pressure is lost, the springs start to expand and the parking brakes will act as emergency brakes. Both the parking and emergency brakes override the service brakes.

WHAT IS COMPRESSED AIR?

The first thing we need to apply the brakes going up and down the road (the service brakes) is a power source.

Fluid cannot be compressed; therefore, in a sealed system such as a hydraulic-brake system, you can pump the fluid and create force. On the other hand, air in an air brake system has to be compressed significantly to generate force.

Compressed air is the power source for air brakes and other accessories on the large vehicle. When harnessed, compressed air can apply the brakes to stop a vehicle weighing 63,500kg (140,000lbs) in a distance not much more than it would take to stop a passenger vehicle weighing forty times less.

Normal atmospheric pressure—the air that we breath and walk around in everyday—is a little less than 15psi (pounds per square inch). More specifically, 15psi (103kPa) means that on one square inch of area, there is 15 pounds of weight, or a large pumpkin pushing down on an area about the size of your thumbprint.

By forcing a greater volume of air into a confined space using an air compressor, we can increase the amount of pressure. Most air brake systems operate at a pressure of 125psi (860kPa). And by applying 125psi against a 30^2 inch diaphragm, we can create a total force of 3,750 pounds (1,700kg). And with the use of levers, 3,750 pounds can be increased to a force of almost 5,000lbs (2267kg) at the brake.

AIR BRAKE COMPONENTS

The knee bone is connected to the thigh bone, the thigh bone is ….

VIDEO:
Air Compressor | Air Brake Smart

AIR COMPRESSOR

Essentially, an air compressor is a pump. But because air can be compressed, unlike fluid, the air compressor must pump a significant amount of air before there is enough to generate a useable force.

The air compressor on a vehicle fitted with air brakes is little different to the one that you would find in a garage.

Both have a piston, an intake, and exhaust port. When the piston is turned to the bottom of its stroke, it creates a vacuum like a syringe in a needle. And because nature abhors a vacuum, the empty void is filled with air. At the same time, the piston moves to the bottom of its stroke, the intake port opens.

At the bottom of the stroke, the intake port closes, the exhaust port opens, and the air is ram-forced into the system—usually into an air tank to be stored for later use.

All compressors in this day and age are both gear driven and bolted to the side of the engine.