A NAVISTAR COMPANY

# International®
# Air Brakes Series

## Study Guide
## TMT-040702

INTERNATIONAL®

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# International®
# Air Brakes Series

Welcome to the International® Air Brakes Series. The following DVD training series covers complete air brake fundamentals. It is designed to provide all the technical knowledge and skill necessary to diagnose and repair this brake system.

This series is divided into six programs. The first program covers the basic theories of this system, followed by an introduction to the individual components. Program II provides specific details on how these components function, both independently and within the total air brake system. Programs III–V cover specific tests for diagnosing the brake system and individual components. Program VI concludes the Air Brakes training series by providing some common service procedures.

To receive credit for completing each program, you are required to take a post-test on ISIS®/Education/Service/Online Testing.

## NOTES

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# Program I:
# System Theory & Components

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## Program I Objectives

**After completing this program, you will be able to:**

- **Describe the theory that makes air brake operation possible.**
- **Identify the different air brake systems and describe their differences.**
- **Identify the components that make up the various air brake systems.**

# System Theory

# Module 1

It takes a 450 hp truck with an 80,000 lb. load roughly 90 seconds to accelerate to 50 mph.

That truck must be able to stop in less than 5 seconds. If they could be measured in horsepower, a truck's brakes would need to be 10–20 times the horsepower rating of the engine.

A truck's brakes are actuated either hydraulically or with air. Air brakes are similar in some ways to hydraulic brakes except that compressed air is used to actuate the brakes instead of brake fluid.

The potential energy of an air brake system is from compressed air. The force delivered to the wheels has nothing to do with the pressure applied to the brake pedal.

In other words, braking effort is achieved in an air brake system the same way as in a hydraulic system. Braking effort is converted into mechanical force required to stop the vehicle.

Air brakes are used almost exclusively in heavy-duty trucks and trailers. They have the following advantages over hydraulic brakes:

First, the supply of air is unlimited. It only needs to be compressed, cleaned, stored and distributed. The air brake circuit can be easily expanded so trailers can be coupled and uncoupled from the tractor circuit.

***"Besides providing the energy required to stop the vehicle, compressed air is also used as the control medium."***

Besides providing the energy required to stop the vehicle, compressed air is also used as the control medium. It signals the foundation brakes when and with how much force the brakes should be applied in any situation.

Finally, air brakes are effective even when a leak reduces their capacity. The system can be designed with sufficient fail-safe devices to bring the vehicle safely to a stop, even in the event of an air leak.

Brake standards are controlled by the Department of Transportation (DOT) under Federal Motor Vehicle Safety Standard, or FMVSS, 121. The following are regulated by that standard:

- Split Brake System Concept
- Air System Timing
- Parking Capability
- Service Brake Dynamometer Certification

The law has special requirements for emergency performance. If air loss occurs on any of a vehicle's axles, the chassis must demonstrate stopping capability using the spring brake.

On straight trucks, the primary service brakes are on the rear axle. The secondary brakes are on the front axle. An inversion valve is used to apply the parking brakes on the rear axle through the secondary brakes if air loss occurs in the primary system.

Depending on the vehicle application, the parking spring brake chambers may be used on the forward/rear, rear/rear, or both of the tandem rear axles.

On tractors, the primary service system is at the rear and the secondary is at the front. In the event of partial brake system failure, the trailer service brakes assist either the primary or secondary systems.

The primary circuit is responsible for actuating the tractor rear wheel brakes and the trailer service brakes when applied from the foot valve.

The circuit consists of a primary tank, dual circuit foot valve, pressure gauge, relay valve and pressure modulator valves. This circuit is sometimes called the rear axle circuit.

***"If air loss occurs on any of a vehicle's axles, the chassis must demonstrate stopping capability using the spring brake."***

The secondary circuit consists of a secondary tank, dual-circuit foot valve, pressure gauge, quick release valve and pressure modulator valves. It is sometimes called the front axle circuit. Newer vehicles do not require a separate quick release valve because the quick release function is built into the pressure modulator valves.

The trailer brakes are controlled by the tractor. The trailer brake circuit consists of gladhands, air hoses, air tanks, pressure protection valves and relay valves. The compressed air required by the trailer circuit is supplied by the tractor. Two hoses connect the tractor air and brake circuits to the trailer. The source of the trailer air supply is the tractor dash control.

# Supply System Components

# Module 2

## Air Compressor

The air compressor provides and maintains air under pressure to operate devices in the air brake and auxiliary air systems.

***"The air compressor provides and maintains air under pressure."***

The Tu-Flo 550 compressor is a two-cylinder, single-stage, reciprocating compressor with a displacement of 13.2 cubic feet per minute at 1250 rpm. The 750 is similar, with a displacement of 16.5 cubic feet per minute at 1250 rpm.

The compressor assembly consists of two major subassemblies: the cylinder head and the crankcase. The head is an iron casting that houses the inlet, discharge, and unloader valves. It contains the air inlet port and is designed with both top and side air-discharge ports. Three water coolant ports provide coolant line connections.

Both the front and rear of the cylinder head have governor mounting surfaces. The head is mounted on the crankcase and is secured by six capscrews. The crankcase houses the cylinder bores, pistons, crankshaft and main bearings, and provides the flange mounting

surface. The compressor is driven by the engine and operates continuously.

## Air Compressor Governor

***"The governor can either be attached to the compressor or mounted remotely."***

The governor can either be attached to the compressor or mounted remotely. Connections in this system are to the reservoir, compressor unloader ports and to the control port of the air dryer. The governor also has an exhaust port.

## Air Dryer

The optional air dryer collects and removes solid, liquid and vapor contaminants before they enter the system. It provides clean, dry air to the air brake components.

The air dryer remains in the charge cycle until system pressure builds to the governor cut-out setting.

## System Saver 1000 Air Dryer

The System Saver 1000 Air Dryer features an aluminum casting base that all the air dryer components are attached to.

These include the bypass valve, desiccant cartridge, heater assembly, outlet check valve, purge valve, regeneration valve, turbo cut-off valve and an optional silencer that attaches

to the purge valve. When installed, it eliminates most of the noise associated with the air dryer purge.

## Air Dryer Operation

Because the operation of the AD-9 and System Saver 1000 differ slightly, refer to ISIS® for the exact operation of the air dryer that you are working on.

## Supply Tank

The supply tank is the first tank to receive air from the compressor, or the air dryer, if equipped. This tank provides the volume of compressed air required to operate the system.

There are at least three reservoirs on trucks with the FMVSS 121 brake system: the primary, supply and secondary. The primary reservoir is the air source for the rear brakes. The front brakes are fed by the secondary air tank. In some cases, the supply reservoir and secondary reservoir may be the same tank with an inside separation.

***"There are at least three reservoirs on trucks with the FMVSS 121 brake system: the primary, supply, and secondary."***

## Automatic Drain Valve

The automatic drain valve removes moisture and contaminants from the supply tank. It mounts in the bottom of

the reservoir or at the end of a reservoir drain.

***"For vehicles operating in subfreezing temperatures, an optional heater is available."***

For vehicles operating in subfreezing temperatures, an optional heater is available. A thermostat activates the heating element at 45°F (7°C). Once the valve reaches 85°F (29°C) the element deactivates.

# Actuation System Components

Module 3

## Gauges

The system has two gauges: one for the primary air reservoir system and one for the secondary system.

Each gauge registers and monitors the amount of reservoir air pressure in each circuit.

An optional third gauge indicates how much air pressure is delivered to the brake chambers through the foot brake valve.

## Check Valves

Check valves allow airflow in only one direction, indicated by an arrow on the side of the valve. Valves are installed at both the primary and secondary reservoirs to maintain the air supply if air loss occurs ahead of the valve. It is a federal requirement to have a check valve, one for the primary air reservoir system and one for the secondary system.

***"Check valves allow airflow in only one direction."***

## Pop-Off Valve & Pressure Protection Valve

The pop-off valve ensures pressure in the system does not exceed the maximum rating. If the governor fails, the pop-off valve trips at 150 psi to prevent damage to the air circuits.

***"The pressure protection valve is designed to close off air to any device whenever the air supply is below a specified rating."***

The pressure protection valve is designed to close off air to any device whenever the air supply is below a specified rating. The rating of the valve used in the FMVSS 121 air system is 65–75 psi.

It is important that this valve is installed any time auxiliary attachments are used. This will prevent a complete loss of air if there is a leak in any of the air-operated accessories.

## Dash Control Valves/Spring Brake Control Valve

The dash control valves include the parking brake, trailer air supply, power divider lock and fifth wheel lock valve. The parking brake and trailer air supply valves are a modular design and contain a two-button, push/pull control valve housed in a single body. This includes a dual circuit supply valve and a check valve.

The valve body, plungers and spools are made of a non-metallic, non-corrosive material. All connections are at the back of the valve except for the auxiliary port. The function, color and shape of each dash valve is determined by FMVSS 121, so they function the same no matter which vehicle they are in.

The spring brake control valve is a manually operated, push/pull type valve. It applies and releases the spring-actuated parking brakes. The valve is normally pushed in.

Air passes through the valve, delivering system pressure to retract and hold the parking brakes springs in the released, or compressed, position. Pulling the valve out closes off the air supply and vents air to the atmosphere. This allows the springs to expand, applying the parking brakes.

When the valve is pushed in, it remains in as long as the air supply is above 7–17 psi on previous models, or above 25–35 psi on newer vehicles. If it falls below this specification, the valve will move out and the brakes will apply. The spring in the valve automatically moves the piston out if inlet pressure drops.

Each year or every 100,000 miles, the valve should be removed, disassembled and a repair kit should be installed.

***"Each year or every 100,000 miles, the valve should be removed, disassembled and a repair kit should be installed."***

## Treadle & Suspended Pedal Foot Brake Valves

***"The foot brake valve is the control unit of the air brake system."***

The foot brake valve is the control unit of the air brake system. It allows the operator to apply or release the brakes.

Both the treadle and suspended brake valves are equipped with two separate supply and delivery circuits for service and emergency braking. Each provides the driver with graduated control for applying and releasing the brakes.

The primary circuit is the part of the valve between the spring seats. It contacts the plunger and the relay piston. The secondary circuit is between the relay piston and exhaust cavity.

The primary circuit is similar to a standard, single-circuit air brake valve. The secondary circuit is similar to a quick release valve. Both use a common exhaust check valve.

## Tractor Protection Valve

The tractor protection valve automatically isolates the tractor air supply from the trailer air supply when the tractor system pressure drops between 25 and 40 psi. This is also called the breakaway valve.

The valve incorporates a manifold that accommodates two brake valve ports, plus a hand control port through two built-in, two-way check valves for service brake application. It also has a quick release feature, automatic shut-off on loss-of-emergency-trailer air and an automatic bleed-back of any trapped service air.

The valve determines whether the service air brake line that connects the tractor and trailer systems is open or closed. The emergency passage through the valve is always open. The brake lines open and close by shuttling a spring-loaded, tapered piston that works against air pressure levels in the emergency passage.

***"The valve determines whether the service air brake line that connects the tractor and trailer systems is open or closed."***

When the red dash knob is pushed in and the supply control is opened, air pressure is supplied to the emergency port to open the valve. Pulling the knob out exhausts the emergency line at the air control valve, closing the valve.

A quick release feature incorporated in the service passage improves brake release response time. During service brake release, the line pressure in the trailer system is exhausted at the tractor protection valve instead of the foot valve or dash-mounted control valve.

***"The automatic shut-off bleed-back feature allows the valve to shut off automatically under a full service brake application."***

The automatic shut-off bleed-back feature allows the valve to shut off automatically under a full service brake application. When the trailer supply control is pulled out during a brake application, the trapped air in the trailer service line bleeds to 0 psi.

During tractor operation without a trailer, the dash knob is out and the service passage at the valve is closed. Air pressure is blocked from the emergency passage to the tractor protection valve. Air passages leading from the tractor system to the trailer couplings are also blocked.

When coupling the tractor to the trailer, the dash knob is pushed in. Air flows through the emergency line to charge the trailer reservoirs. Before coupling, the trailer brakes are released simultaneously if they are holding. When air pressure in the emergency line reaches approximately 40–50 psi, the valve service passage opens.

During normal tractor-trailer operation, the valve remains open, allowing air to flow in either direction between the tractor and trailer air brake systems. Trailer brakes are applied and released by either the foot brake or dash-mounted control valve. The reservoirs and system are replenished by airflow through the emergency passage.

## Quick Release Valve

The function of the quick release valve is to speed up air exhausting from the brake chambers. Doing so will ensure proper timing when applying and releasing the brakes. It's usually mounted on the vehicle axle, midway between the two brake chambers connected to it.

***"The function of the quick release valve is to ... ensure proper timing when applying and releasing the brakes."***

In the standard quick release valve, a flat, circular diaphragm is installed between the non-metallic upper body and stamped-steel lower body.

An O-ring seals the two body halves, which are held together with four 1/4-inch machine screws and flange nuts. The steel lower body also serves as the valve mounting bracket. The standard valve has a 1 psi maximum differential, or crack pressure.

A high-differential valve—rated at 3 psi—is available for special applications. The higher differential is gained by adding a spring and diaphragm follower to the standard quick release valve.

Identifying a standard or high-differential quick release valve can be determined by following one or more of these steps:

- Scrape any paint from the valve surface. If the plastic is gray, it's a high-differential valve.

- Remove the hose from the supply port fitting. Next, remove one of the hoses and its fitting from a delivery port. If there is a spring inside the port, it is a high differential valve.

- Remove the valve from the crossmember. The part number on the crossmember side lists the valve's crack pressure. When replacing the OEM valve, be sure the replacement has the same crack pressure rating. Doing so will ensure proper timing when applying and releasing the brakes.

With no air pressure applied to the valve, the diaphragm is slightly flexed by the upper and lower body. The center portion of the diaphragm rests on the exhaust port in the lower body while the outer edge and opposite side rests against the sealing lip of the upper body.

## Relay Valve

***"The valve operates as a remote controlled brake valve that delivers or releases air."***

The relay valve speeds up the application and release of the service and spring brakes. It's normally mounted close to the chambers that it serves. The valve operates as a remote

controlled brake valve that delivers or releases air.

The R-14 valve differs from the R-12 valve in that it incorporates a quick release and anti-compounding feature located above its horizontal service port. The anti-compounding feature allows the R-14 valve to be used as either a service or spring brake relay valve. An exhaust cover protects the 1/8-inch balance port when the anti-compounding feature is not in use.

## Inversion Valve

The inversion valve is used only on straight trucks with dual air brake systems. It allows for a modulated application of the spring brakes if there is air loss in the primary circuit. In conjunction, the check valve prevents the spring brakes from immediately and automatically applying during an air loss.

***"The inversion valve is used only on straight trucks with dual air brake systems."***

This valve is required because the secondary brakes alone cannot supply adequate braking force to stop the vehicle quickly enough to meet the FMVSS 121 requirements for emergency stopping.

The inversion valve detects the air loss and modifies the action of the rear axle spring brakes the same time the service brakes are applied or released. During

normal brake operation, the inversion valve also allows air pressure to enter the parking brake chamber, which releases the spring brakes.

The inversion valve is not required on tractors because trailer brakes–being supplied with air from both the primary and secondary tractor systems–provide the braking force required to meet FMVSS 121 emergency stopping requirements.

## Gladhands

***"Gladhands are couplers between the tractor and trailer."***

Gladhands are couplers between the tractor and trailer. They are called gladhands because when two are connected, they look like a pair of hands in a handshake.

## NOTES

## NOTES

# Application System Components

Module 4

## Brake Chambers

Brake chambers, or actuators, convert air pressure into mechanical energy by pushing against a plate at the end of a pushrod, which is connected to the brake slack adjuster. One brake chamber is used at each wheel end to activate the service brakes.

Air pressure enters the chamber behind the diaphragm and forces the pushrod outward, which rotates the slack adjuster, brake camshaft and cam, and applies the brakes. The higher the air pressure in the chamber, the greater the force pushing the brake shoes against the drum.

***"The higher the air pressure in the chamber, the greater the force pushing the brake shoes against the drum."***

The chamber consists of two dish-shaped metal sections: the pressure plate assembly and non-pressure plate. These are separated by a rubber diaphragm. The assembly is held together by a two-segment metal clamp. In front of the diaphragm are the pushrod, pushrod spring, and retainer.

When air pressure is released from the brake chamber, brake shoe return springs and chamber release springs move the shoes, slack adjusters, and

the brake chamber back to the released position.

## Double Diaphragm MGM® Spring Brake

In the event of an air pressure drop, the spring brake acts as both a parking brake and an emergency brake. It consists of a tandem-type cylinder assembly connected to the foundation brake through the air brake slack adjuster.

***"The spring brake contains a powerful spring that is completely compressed by air pressure during normal driving."***

The cylinder assembly consists of two basic sections. One section is a conventional service brake chamber. The second section is the spring brake chamber. The spring brake contains a powerful spring that is completely compressed by air pressure during normal driving. The spring applies the parking brake when air is released from the chamber.

If no air is present in the hold-off circuit, the force of the spring is applied fully to the chamber pushrod, placing the brake in park mode. To release the parking brakes, air pressure must be greater than 60 psi in the hold-off circuit.

A leak in the hold-off circuit will cause the spring brakes to apply the moment pressure drops below 60 psi. The effectiveness of the parking and service

brakes depends on the brake stroke adjustment, which is determined by the length of the chamber stroke, either a 3 inch “long stroke” or a 2 1/2 inch “standard stroke.”

## Slack Adjuster

The slack adjuster is a mechanical link between the brake chamber and the foundation brake assembly. It is basically a lever that amplifies the force from the brake chamber to the camshaft of the foundation brakes. The slack adjuster can be automatic or manual. Both types remove excess free play due to brake shoe wear.

***“The slack adjuster can be automatic or manual. Both types remove excess free play due to brake shoe wear.”***

## Quick-Connect Clevis

Some models of the automatic slack adjuster have a quick-connect clevis. This three-piece assembly cannot be separated after it’s assembled.

The collar of the clevis has a threaded hole for the pushrod. A quick-connect clevis can be straight or offset. An offset clevis is used, if needed, to give more clearance between the air chamber and the tire on a front axle.

## One-Piece Clevis

Some models of the automatic slack adjuster have a one-piece clevis with a

threaded hole. All service replacement slack adjusters have a one-piece clevis. They can also be straight or offset.

## Foundation Brakes

Foundation brakes convert the air pressure supplied by the primary and secondary circuits into the mechanical force required to stop the vehicle.

***"The parking and emergency brakes also use the foundation brakes."***

The parking and emergency brakes also use the foundation brakes to mechanically apply the brakes. Foundation brakes consist of brake chambers, slack adjusters, S-cams, shoes, linings and drums.

Vehicles with ABS also have wheel speed sensors mounted on the wheel assemblies. In an S-cam brake, the air system is connected to the foundation brake by a slack adjuster.

The actuator is a brake chamber with a pushrod. A clevis is threaded onto the pushrod, and a clevis pin connects the pushrod to the slack adjuster and also allows it to pivot. The slack adjuster is splined to the S-camshaft, which is mounted in fixed brackets with bushing-type bearings.

When force from the pushrod is applied to the slack adjuster, the S-camshaft rotates. The S-camshaft extends into

the foundation assembly in the wheel and its S-shaped cams are located between two arc-shaped brake shoes. The foundation assembly is mounted to the axle spider. This is bolted to a flange at the axle end.

The brake shoes are either mounted on the spider with a closed anchor pin that acts as a pivot, or they are open-anchor-mounted. This means that they are clamped to rollers with springs, which allow them to pivot.

Opposite the anchor end of the shoe is the actuating roller that rides on the S-cam. The shoes are lined on their outer surface. Attached to the wheel assembly and rotating around the brake shoes is a drum. When brake force is applied to the S-camshaft, the S-shaped cams are rotated against the S-cam rollers on the brake shoes, forcing them against the drum.

***"When brake force is applied to the S-camshaft, the S-shaped cams are rotated against the S-cam rollers on the brake shoes, forcing them against the drum."***

## NOTES

# ABS/ATC Components

# Module 5

## Wheel Sensor

The wheel sensors are mounted on the axle ends. They contain a permanent magnet and a coil of wire. When the magnetic field is interrupted by the teeth of the exciter ring, AC voltage is produced in the coil.

***"(The wheel sensors) contain a permanent magnet and a coil of wire. When the magnetic field is interrupted by the teeth of the exciter ring, AC voltage is produced in the coil."***

The frequency of the voltage increases or decreases with the wheel speed. The sensor has a pigtail with a two-pin connector wired to the ABS harness mating connector. A signal is sent from the sensor, through the ABS harness, to the controller. The front wheel sensors are connected to a 30-way connector; the rear wheel sensors to an 18-way connector.

## Exciter Ring

The exciter ring is installed on the wheel assembly. It is machined to close tolerances and has 100 equally spaced teeth.

As the wheel rotates, the teeth pass the sensor, breaking the magnetic field and creating an AC signal. One hundred cycles, or pulses, of the signal indicates one revolution of the wheel. The signal is transmitted from the sensor to the controller.

## ABS Controller

***"The controller performs a self-diagnostic test whenever the vehicle is started and continues to monitor ABS performance during vehicle operation."***

The controller houses the ECU that regulates ABS and traction control. The controller performs a self-diagnostic test whenever the vehicle is started and continues to monitor ABS performance during vehicle operation. The controller has LEDs that provide diagnostic information.

The controller is mounted to the ABS relay valve. It is also connected to the wheel sensors, brake modulators, and the cab antilock wire harness.

## Controller Power Supply

The controller receives power from the battery through the ABS ignition relay. With the relay energized, battery power from the relay terminal is applied through the cab and chassis harness to the controller connector.

## Antilock/Bobtail Proportioning Relay Valve

The antilock relay valve is a specialized service brake relay valve. The valve functions as a brake relay valve and also provides bobtail proportioning. If the vehicle is equipped with ATC, the valve will also contain an electrical solenoid for traction control.

Vehicles can be configured four ways:

- ABS with bobtail proportioning for tractors
- ABS with bobtail proportioning and traction control for tractors
- ABS for straight trucks
- and, ABS for tractors without bobtail proportioning

Also, on new vehicles the ECU is mounted remotely in the cab.

With each of these installations, a different combination of the controller/relay valve is used. However, the porting on the relay valve is the same.

The controller/relay valve speeds up the action of the rear service brakes. Inside the relay valve, next to the service port, is a quick release valve that rapidly releases control air pressure from above the relay piston. All air connections on the assembly are identified with cast, embossed letters.

***"The controller/relay valve speeds up the action of the rear service brakes."***

## Modulator Valve

The ABS modulator is essentially a high capacity, on/off air valve that incorporates a pair of electrical solenoids for control. The solenoids

provide the electro-pneumatic link between the ABS controller electronics and the air brake system.

***"The modulator valve can control braking on an individual wheel or two service actuators."***

The modulator valve can control braking on an individual wheel or two service actuators, as on a 6 x 4. It is the last control valve that air passes through on its way to the service brake actuators.

It has a die cast aluminum body that houses a solenoid assembly. The assembly contains one normally open and one normally closed solenoid, one inlet, and one exhaust diaphragm valve. It is integrated with an electrical connector that transmits control commands from the antilock controller to the valve.

The supply, delivery and exhaust ports on the modulator valve are identified with a cast, embossed numeral for positive identification.

Number 1 is the supply port, which receives air from the quick release valve on a front axle application. On a rear axle application, this number 1 port receives air from the relay valve.

Number 2 is the delivery port, which delivers air to the service brake chambers.

And number 3 is the exhaust port, which exhausts air during antilock control.

## Warning Light

The ABS warning light is located in the right gauge cluster. When the vehicle is started, the “Initial Start-Up Self Diagnostic Test” is performed with the yellow warning light turning on for a few seconds in the solid-on or non-flashing mode.

If a fault is detected within the ABS, this warning light will illuminate in the solid-on mode and remain on until the fault is no longer present. This light does not come on to indicate an ABS event.

## Warning Light Relay

During the Self Diagnostic Test, or if a failure occurs in the antilock system, the controller opens the ground path for the warning light relay coil. This causes it to de-energize, turning on the yellow instrument panel warning light.

## Traction Active Light

The Traction Active light is located in the left gauge cluster. This light turns on for a bulb test when the key is turned on, then goes out. During an ATC

***“During an ATC event, the light will flash throughout the duration of the event. If a traction control fault is detected, this remains in the solid-on mode until the fault is corrected.”***

event, the light will flash throughout the duration of the event. If a traction control fault is detected, this remains in the solid-on mode until the fault is corrected.

## Traction Control Switch

The traction control switch turns the system on or off.

## J1708/J1587 Datalink

The nine-pin datalink connector provides access for the EZ-Tech® to the ABS controller.

# Hoses, Tubing & Fittings

# Module 6

## Flexible Hose

Since hose is stocked in bulk according to size and type, any air system hose can be made in the shop as a replacement to the OEM installation if one is not available.

The hose is constructed of a seamless synthetic rubber lining, reinforced with a fabric braid of high tensile steel wire. It is covered with an oil-resistant rubber and fabric braid.

These hoses can be used for air systems and air brake systems, except for the air line from the air compressor to the air reservoir, where the temperature exceeds 300°F (149°C).

***"These hoses can be used for air systems and air brake systems, except for the air line from the air compressor to the air reservoir."***

The fittings used at the ends of the flexible hose are a swivel type. The swivel end permits one end of the hose to be disconnected without disturbing the complete hose.

## Nylon Tubing

Color-coded nylon tubing is an acceptable replacement for certain copper tubing in chassis air brake system applications.

## Quality Connect Air Systems

Quality Connect fittings are threadless and designed so that a collet in the fitting "bites" into the tube to hold it firmly in place. The fitting O-ring seals the tube to the valve, manifold or T-body to prevent leakage.

## Trailer Brake Hose Couplings & Dummy Couplings

***"When two gladhands are joined, their seals are forced together under pressure to form an airtight seal."***

Hose couplings, or gladhands, provide a convenient means for connecting and disconnecting air lines between tractors and trailers. When two gladhands are joined, their seals are forced together under pressure to form an airtight seal.

Dummy couplings are used to keep dirt or foreign matter out of air lines when the lines are not being used. Dummy couplings are either mounted to the truck or fastened by a chain.

## Trailer Brake Hose Assemblies & Connectors

Trailer brake hose assemblies are used to make flexible connections between components that change position, or for making flexible connections between the tractor and trailer. Hose lines or gladhands at the rear of the tractor are marked by tags identifying them as "Service" or "Emergency."

## NOTES

## NOTES

# Air Brake Subsystems

# Module 7

## Primary Circuit

The primary circuit is responsible for actuating the tractor rear wheel brakes and the trailer service brakes when applied from the foot valve.

The circuit consists of a primary tank, dual circuit foot valve, pressure gauge, relay valve and pressure modulator valves. This circuit is sometimes called the rear axle circuit.

## Secondary Circuit

The secondary circuit consists of a secondary tank, dual-circuit foot valve, pressure gauge, quick release valve and pressure modulator valves. It is sometimes called the front axle circuit. Newer vehicles do not require a separate quick release valve because the quick release function is built into the pressure modulator valves.

## Trailer Circuit

The trailer brakes are controlled by the tractor. The trailer brake circuit consists of gladhands, air hoses, air tanks, pressure protection valves, and relay valves. The compressed air required by the trailer circuit is supplied by the

***"The compressed air required by the trailer circuit is supplied by the tractor."***

tractor. Two hoses connect the tractor air and brake circuits to the trailer. The source of the trailer air supply is the tractor dash control.

To send air to the trailer from the tractor, the system park dash valve must first be actuated, followed by the trailer supply valve. This sends air to the tractor protection valve and moves it to the ON position. The trailer supply air then passes through the tractor protection valve and on to trailer hoses that are connected by the gladhands.

Two hoses are required to connect the air and brake system of the tractor with the trailer. Flexible hoses are required because the tractor and trailer articulate at the fifth wheel. The two hoses are usually connected directly to the tractor protection valve. At the other end of each hose are gladhands.

The brake system may not be the only pneumatic system on the trailer. Many trailers use an air suspension.

# Conclusion

This concludes Program I of the Air Brakes Series. Completion of this educational process is a key component towards International® technician certification. You are now required to take a post-test via ISIS®/ Education/Service/Online Testing.

## NOTES


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# Program II: System Operations & Inspection

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## Program II Objectives

**After completing this program, you will be able to:**

- **Describe the operation of air brakes system components.**
- **Describe how each component's operation affects the other components within the system.**
- **Properly inspect the components that make up the air brakes systems.**

# Air Compressor

# Module 1

## Intake and Compression of Air (Loaded)

During the down stroke of the air compressor piston, a slight vacuum is created between the top of the piston and the cylinder head, causing the inlet valve to move off of its seat and open. Air is drawn past the open inlet valve into the cylinder.

As the piston begins its upward stroke, the air drawn in on the down stroke is compressed. Air pressure on the inlet valve, plus the force of the inlet spring, returns the inlet valve to its seat and closes. The piston continues the upward stroke and compressed air pushes the discharge valve off its seat. Air flows by the open discharge valve into the discharge line and to the reservoirs.

As the piston reaches the top of its stroke and starts down, the discharge valve spring and the air pressure in the discharge line return the discharge valve to its seat. This prevents the air in the discharge line from returning to the cylinder bore as the intake and compression cycle is repeated.

## Lubrication

***"The engine provides a continuous supply of oil to the air compressor."***

The engine provides a continuous supply of oil to the air compressor. Oil is routed from the engine to the compressor oil inlet. A passage in the compressor crankshaft allows oil to lubricate the connecting rod crankshaft bearings. Connecting rod wrist pin bushings and crankshaft ball bearings are spray lubricated.

On a Model 550, the oil return line connected from the compressor drain outlet to the vehicle engine crankcase allows oil return. On flange-mounted models, the oil drains back directly to the engine through the mounting flange.

## Cooling

The compressor is air and liquid cooled. Air flowing through the engine compartment from the engine's fan and the movement of the vehicle helps cool the compressor.

Coolant flowing from the engine's cooling system enters the head and passes through internal passages and returns to the engine. Proper cooling is important in maintaining discharge air temperatures below the maximum recommended 400°F (205°C).

## Air Induction

There are two methods to provide clean air to the compressor:

- The compressor inlet is connected to the engine air cleaner or the vacuum side of the turbocharger.

- A pressurized induction inlet is connected to the pressure side of the turbocharger. Air entering the compressor inlet from the turbocharger during the loaded cycle must not exceed 250°F (121°C). A metal inlet line helps keep air below this temperature.

## NOTES

# Air Compressor Governor

# Module 2

Actual compression of air is controlled by the unloading mechanism and the governor. The governor maintains brake system air pressure within a preset maximum and minimum pressure level.

***"Actual compression of air is controlled by the unloading mechanism and the governor."***

The air compressor governor–along with the compressor unloader–automatically limits system pressure by opening unloading valves and stopping compression when pressure reaches the maximum limit. It also closes unloading valves and starts compression when pressure drops to the minimum pressure limit.

Air pressure acts on a piston in the governor to bypass the pressure-setting spring. This allows it to control the inlet/exhaust valve and any airflow to and from the compressor unloader.

Reservoir air pressure enters the governor at one of its reservoir ports and acts on the piston and the area above the inlet/exhaust valve. As pressure builds and reaches the cut-out setting, the piston moves against the resistance of the pressure-setting spring and the inlet/exhaust valve moves down.

The exhaust stem seats on the inlet/exhaust valve and then the inlet passage opens. With the exhaust valve closed,

reservoir air pressure flows by the open inlet valve, through the passage in the piston and out the unloader port to the unloader mechanism. The air also flows around and acts on the piston, ensuring positive action and fully opening the inlet valve.

As the reservoir air pressure drops to the cut-in setting of the governor, the force exerted on the piston is reduced, allowing the pressure-setting spring to move the piston down. The inlet valve closes and the exhaust opens. The air in the unloader line escapes back past the piston, through the exhaust stem and out the exhaust port.

# Automatic Drain Valve

# Module 3

With no pressure in the air system, the inlet and exhaust valves of the automatic drain are closed. When charging the air system, a slight pressure opens the inlet valve, which permits air and contaminants to collect in the sump.

The inlet valve remains open as pressure rises in the system until maximum governor cut-out pressure is reached. The spring action of the valve guide in the sump closes the inlet valve. Both the inlet and exhaust valves are closed.

When reservoir pressure drops slightly—approximately 2 psi—air pressure in the sump opens the exhaust valve, allowing moisture and contaminants to be ejected until pressure in the sump drops enough to close the exhaust valve.

The length of time the exhaust valve remains open and the amount of moisture and contaminants ejected depends on the sump pressure and reservoir pressure drop that occurs each time air is used from the system.

## NOTES

# Foot Brake Valve

# Module 4

## Brake Application Under Normal Conditions: Primary Circuit

When the brake pedal is depressed, the plunger exerts force on the spring seat, rubber graduating spring, and primary piston. The piston–which contains the exhaust valve seat–closes the primary exhaust valve. As this closes, the inlet valve is moved off its seat, allowing air pressure to flow out the delivery port.

## Brake Application Under Normal Conditions: Secondary Circuit

When the primary inlet valve is moved off its seat, air flows through the bleed passage and enters the relay cavity. The relay piston, which contains the exhaust seat, closes the secondary exhaust valve.

As the valve closes, the secondary inlet valve is moved off its seat, allowing air pressure to flow out the delivery port. Because of the small volume of air required to move the relay piston, the secondary circuit acts almost simultaneously with the primary circuit.

**NOTE**

**Within this module and some of the subsequent modules, the various brake valves will be shown as they transition between the Apply, Balanced and Release modes of brake operation.**

***"Because of the small volume of air required to move the relay piston, the secondary circuit acts almost simultaneously with the primary circuit."***

## Application: Loss of Air in Primary Circuit

The following is what happens if air is lost in the primary circuit:

Since there is no air pressure in the primary circuit supply and delivery ports, pressing the brake pedal will cause the primary piston to move the relay piston, using mechanical force. This allows the piston to close the secondary exhaust valve, open the secondary inlet valve, and allow air pressure to flow out the delivery port.

## Application: Loss of Air in Secondary Circuit

If air is lost in the secondary circuit, the primary circuit will continue to function.

## Balanced: Primary Circuit

When air pressure to the brake actuators and air pressure in the delivery side of the primary piston equals the force of the brake pedal application, the piston moves and the inlet valve closes, stopping air flow from the supply line through the valve. The exhaust valve remains closed, preventing any air from escaping through the exhaust port.

## Balanced: Secondary Circuit

When the air pressure on the secondary side of the relay piston starts to equal the primary side, the piston moves, closing the inlet valve and stopping the flow from the supply line through the valve. The exhaust remains closed as the supply pressure balances the delivery pressure.

When applications in the graduating range are made, a balanced position in the primary circuit is reached, since the air pressure on the delivery side of the piston equals the effort exerted by the driver on the brake pedal.

The secondary circuit reaches a balance when air pressure on the secondary side of the relay piston closely approaches the air pressure on the primary side of the relay piston.

When the brake pedal is fully depressed, both primary and secondary inlet valves remain open and full reservoir pressure is delivered to the actuators.

***"The secondary circuit reaches a balance when air pressure on the secondary side of the relay piston closely approaches the air pressure on the primary side of the relay piston."***

## Releasing: Primary Circuit

With the brake pedal released, mechanical force is removed from the spring seat, rubber graduating spring, and primary piston. Air pressure and

spring load move the piston, opening the exhaust valve and allowing air pressure in the delivery line to vent.

## Releasing: Secondary Circuit

With the brake pedal released, air is exhausted from the primary side of the relay piston. Air pressure and spring load move the relay piston, opening the secondary exhaust valve, and releasing air pressure in the delivery line.

# Quick Release Valve

# Module 5

## Applying Air

Air entering the supply port of the quick release valve causes the center portion of the diaphragm to seal the exhaust port. Simultaneously, the outer edge moves away from the sealing lip of the upper body, allowing air to flow from the supply port out the delivery ports to the brake chambers, applying the brakes.

## Balance

When air pressure on both sides of the diaphragm is approximately equal–at a 1 psi differential–natural flexibility causes its outer edge to move into contact with the upper body sealing lip.

The valve exhaust remains sealed because air pressure bears against the center portion of the diaphragm from one side only, allowing air to continue to flow out of the delivery ports to the brake chambers.

## Release

When air pressure is reduced or removed from the valve supply port, air pressure on the delivery side of the diaphragm is greater than the supply side.

The higher delivery side pressure holds the outer edge of the diaphragm against the upper body sealing lip while at the same time moving the center portion away from the exhaust port. Air from the delivery ports flows out the exhaust and releases the brakes.

# Relay Valve

# Module 6

## Apply Operation

Air pressure, known as the supply signal, is delivered to the service port of the relay valve and enters the small cavity above the piston, forcing it down. The exhaust seal moves down with the piston and seats on the inner portion of the inlet/exhaust valve, sealing off the exhaust passage.

At the same time, the inlet portion of the inlet/exhaust valve moves off its seat, allowing supply air to flow from the reservoir, past the open inlet valve and into the brake chambers.

## Balance

The air pressure delivered by the open inlet valve also has an effect on the bottom area of the relay piston. When air pressure beneath the piston equals the pressure above, the piston lifts slightly and the inlet spring returns the inlet valve to its seat.

***"The air pressure delivered by the open inlet valve also has an effect on the bottom area of the relay piston."***

The exhaust remains closed as the line pressure balances the delivery pressure. As delivered air pressure is changed, the valve reacts instantly, holding the brake application at that level.

## Release

When air pressure is released from the service port and pressure above the relay piston is exhausted, the piston rises. This moves the seal away from the valve, opening the exhaust passage. Then the air pressure in the brake chambers is vented through the exhaust port, releasing the brakes.

## Anti-Compounding

When the R-14 relay valve is used to control the spring brakes, a line is connected from the anti-compound port in the cover of the valve to the delivery port of the second relay valve.

***"This anti-compound port is also referred to as the balance/quick exhaust port."***

This anti-compound port is also referred to as the balance/quick exhaust port. When there is no air pressure at the anti-compound port of the relay valve, the parking brakes are released.

If the foot brake is applied while the parking brake is engaged, air from the second relay valve enters the anti-compound port of the R-14 relay valve. This moves the diaphragm, blocking the service port that is connected to the parking brake control valve circuit.

Air then moves through the anti-compound port and enters the cavity above the R-14 piston. This forces the

piston down, closing the exhaust and opening the inlet to deliver air to the spring brake cavity.

This air in the spring brake cavity counteracts the air in the service brake cavity, preventing any increase in force at the pushrod. This is the reason for the anti-compounding feature.

By preventing the service brakes and spring brakes from being applied simultaneously, any damaging forces are isolated from the wheel end components.

## NOTES

# ABS/ATC

# Module 7

## Antilock Control

During a brake stop, the maximum point of deceleration occurs just before wheel lockup. If this occurs, stopping distances increase and loss of directional control could result.

***"During a brake stop, the maximum point of deceleration occurs just before wheel lockup."***

To reduce wheel lockup, the antilock brake system monitors the speed of the wheels using sensors mounted on the axle ends and exciter rings mounted on the wheel assemblies.

When the wheels rotate, the exciter ring moves past the sensor to generate an AC voltage that is transmitted to the electronic control unit, which is part of the controller/valve assembly. The controller monitors the pulse rates.

If a wheel speed imbalance is sensed during a brake application, the electronic controller sends a signal to the appropriate modulator valve.

Within the modulator valve assembly are solenoid valves that are rapidly energized and de-energized within a fraction of a second. When a solenoid coil is energized, its shuttle moves, causing air pressure to exhaust or reapply to the brake chamber.

By opening and closing the valves in the appropriate modulator, the controller is actually simulating what the driver does when he "pumps the brakes."

***"The controller ... is able to pump each brake group on the vehicle independently and with far greater speed and accuracy."***

The controller receives input on which wheel is approaching lockup, and, unlike the driver, is able to pump each brake group on the vehicle independently and with far greater speed and accuracy.

## Rear Axle Brakes with 4 x 2 Chassis

The rear axle brakes are controlled independently from each other and brake application pressure at each wheel is adjusted based on how it reacts to the current road surface, as indicated by the speed sensors.

## Rear Axle Brakes with 6 x 4 Chassis

On vehicles equipped with tandem rear axles, the wheel speed sensors are installed at the wheel ends on the axle most likely to lose traction first.

With a four-spring suspension, the rear axle sensors are located on the forward/rear axle. On a truck with air suspension, sensors are located on the rear/rear axle.

A single modulator controls both left-side rear axle brakes and another controls both right-side rear axle brakes on a four-sensor system.

Both brakes on one side of a tandem rear axle will be modulated as one, since they will most likely be on the same type of road surface. On newer vehicles, a wheel speed sensor is located on each wheel end, making it a six-sensor system.

## Engine Brake

During an ABS event, the engine brake is disabled. With electronic engines, the ABS electronic controller is connected to the engine ECM through the J1939 datalink. The electronic controller sends a signal indicating a possible wheel lockup, and the engine ECM disables the engine brake.

**NOTE**

**With the Caterpillar 3406C engine, the ABS controller uses an Engine Brake Relay to turn off power to the engine brake system.**

## Traction Control

The traction control system is an extension of ABS. The wheel speed sensors not only detect rapid decreases in wheel speed for antilock, but also detect unreasonably high increases for traction control.

Traction control is only available with electronically controlled engines. Some differences between vehicles with

traction control and standard ABS include:

- A Traction Active light located below the ABS indicator light on the instrument panel.
- A Traction Control ON/OFF switch located on the instrument panel.
- A different combination of controller and relay valve. There are programming differences and a traction control solenoid that connects to the ABS controller using a two-pin connector.

***"Traction control instantly detects a spinning drive wheel."***

Traction control instantly detects a spinning drive wheel and compares its speed to all other wheels. Then it simultaneously reduces engine torque and pumps the brake on the spinning wheel.

Since the vehicle's rear axle differential tends to drive the wheel that has the least resistance, a slight brake application to a rapidly spinning wheel forces the differential to drive the stationary or slowly spinning wheel.

## Vehicle Speed: 0–25 mph

When wheel spin is detected and the vehicle is stopped or moving at less than 25 mph, the controller simultaneously executes the following:

- The controller flashes the Traction Active light on the instrument panel to let the driver know that there is wheel spin.
- The controller sends a message to the ECM on the J1939 datalink to reduce engine torque to a level suitable for the available traction.
- The controller opens and closes the solenoid in the appropriate modulator valve to gently pump the brake on the spinning wheel. This forces the differential to drive the stationary or slowly spinning wheel.

Once wheel spin is eliminated, the controller turns off the Traction Active light and disengages the system.

***"Once wheel spin is eliminated, the controller turns off the Traction Active light and disengages the system."***

## Vehicle Speed: 25+ mph

If wheel spin occurs at any speed above 25 mph, the controller does the following:

- The controller flashes the Traction Active light.
- The controller sends a message to the ECM on the J1939 datalink to reduce engine torque.
- However, the controller does NOT send a signal to the modulators to

apply service brakes at any speed above 25 mph.

Once wheel spin is eliminated, the controller turns off the Traction Active light and disengages the system.

## Component Failures

Any electrical failure of an ABS component results in these three events happening simultaneously:

- The appropriate warning light on the instrument panel will illuminate to alert the driver that the system has detected a malfunction.
- The controller disables all or part of the antilock/traction control system.
- The system reverts to standard braking on wheels no longer controlled by the ABS controller.

## Other Problems

For problems other than voltage, the system will not be restored until the error is corrected, and the controller is cleared using the magnetic reset switch.

The driver will be advised of degraded ABS operation by the instrument panel warning light. Standard braking is still available when the ABS system is disabled.

**NOTE**

**The controller LEDs will show one failure at a time. When the first failure is corrected and the system is reset, the next problem area will be displayed. This is done so the technician does not lose track of problem areas. The system is not restored to full ABS/ATC control until all errors are corrected and the controller is reset. Partial ABS/ATC function is possible even when errors are indicated.**

## NOTES

## NOTES

# Inspection

# Module 8

As we begin air brake system inspection, diagnostics, and repair, keep in mind that proper service techniques, environmental concerns and safety are the most important parts of this process.

When performing service work of any kind, always protect the interior of the vehicle by using a paper floor mat, a steering wheel cover, and a seat cover.

When working on the brake system, keep the work area and tools as clean as possible. Also, clean all connections or fittings before disconnecting or removing components.

Use a suitable pan to catch any fluid when disconnecting components.

All brake component and line openings should be immediately plugged during removal and remain so until reinstallation to prevent contamination by dirt, moisture or other foreign material. Even the slightest particle can cause unexpected problems within the brake system.

Be sure that you know the location of properly rated and charged fire extinguishers.

**⚠ WARNING**

**Before beginning diagnostic or service procedures, always shift the transmission to park or neutral, set the parking brake and block the wheels.**

**⚠ WARNING**

**Always provide proper ventilation when operating an engine in an enclosed area. Inhalation of exhaust gases can be fatal.**

**⚠ WARNING**

**When working with the brake system, always wear safety glasses with side shields and chemical-blocking nitrile gloves.**

Be sure you know the location of an emergency eyewash station.

Always wear a back support when lifting heavy objects and make sure to use proper lifting techniques.

Be sure to follow each warning, caution, and note as they are presented throughout this training program.

**⚠ WARNING**

**Failure to drain the system of air pressure before removing components can cause personal injury or death.**

Warnings indicate procedures and safety measures that must be followed precisely to avoid the risk of death or personal injury to yourself or other shop personnel, and to avoid damage to the vehicle, equipment or components.

Cautions indicate a procedure that you must follow exactly to avoid equipment or component damage.

Notes indicate operations, procedures or instructions that are important for proper service.

Start your preliminary inspection by verifying the driver's complaint, as written by the service writer. Next, conduct a general walk-around visual inspection of the brake system.

## Walk-Around Inspection

The starting point in troubleshooting a vehicle with air brakes is a good

vehicle walk-around inspection. A visual examination and listening for air leaks are obvious things to do, but let's discuss some specific areas in the order they would come in the basic DOT inspection.

If the air compressor is belt-driven, check the condition and tightness of the belt. The belt should be in good condition.

Shut off the engine. There should be enough air pressure so that the low-pressure warning signal is not on. Turn the electrical power on, then pump the brake pedal to reduce air tank pressure.

The low air pressure warning signal must come on before the pressure drops to less than 60 psi in the air tank. If the warning signal doesn't work, you could lose air pressure and not know it.

***"The low air pressure warning signal must come on before the pressure drops to less than 60 psi in the air tank."***

Block the wheels, release the parking brakes when you have enough air pressure to do so, and shut off the engine. Pump the brake pedal to reduce the air tank pressure. The parking brake knob should pop out when the air pressure falls between 20 and 40 psi. This causes the spring brakes to engage.

With a fully charged air system–typically 125 psi–turn off the engine,

release the spring brake, and time the air pressure drop. The loss rate should be less than 2 psi in one minute for single vehicles, or less than 3 psi in one minute for a combination vehicle.

***"... if the air pressure falls more than 3 psi in one minute for single vehicles or 4 psi for combination vehicles, the air loss rate is too high."***

Then apply 90 psi or more with the brake pedal. After the initial pressure drop, if the air pressure falls more than 3 psi in one minute for single vehicles or 4 psi for combination vehicles, the air loss rate is too high.

The air compressor should start pumping at about 100 psi and stop at about 125 psi. Run the engine at high idle. The air governor should cut-out the air compressor at about 125 psi. The air pressure shown by the dash gauge will stop rising.

With the engine idling, pump the brake pedal to reduce air tank pressure. The compressor should cut-in at about 100 psi and the pressure should begin to rise.

Open the drain valves on all of the tanks to drain any moisture from them. An excessive amount of moisture in the air tanks is an indication that the air dryer isn't functioning properly. Also, more moisture in the tanks will decrease air reserve capacity and affect valve operation.

Slack adjusters should rotate freely without binding when the brakes are applied. When the brakes are released, all slack adjusters must return to the released position freely and without binding.

The slack adjusters must be adjusted so that the angles formed by the brake chamber and the center of the slack adjuster are near 90 degrees during a full brake application.

Failure to adjust to this specification will cause an excessive amount of brake slack, preventing the maximum application of force to the slack adjuster and making the vehicle very hard to stop.

Out-of-adjustment brakes are the most common problem found during inspections. Refer to ISIS® for the specific maintenance procedures as determined by the type, manufacturer, and model of slack adjuster.

***"Out-of-adjustment brakes are the most common problem found during inspections."***

Brake drums must not have cracks longer than one half the width of the friction area. Linings must not be loose, or soaked with oil or grease. They must not be dangerously thin. Mechanical parts must be in place, not broken or missing. Check the air hoses connected to the brake chambers to

make sure they aren't cut or worn due to rubbing.

## Conclusion

This concludes Program II of the Air Brakes series. Completion of this educational process is a key component towards International® technician certification. You are now required to take a post-test via ISIS®/ Education/Service/Online Testing.

## NOTES

## NOTES


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# Program III: System Tests

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## Program III Objectives

**After completing this program, you will be able to:**

- **Test the parking and service brakes for proper operation.**
- **Properly inspect ABS/ATC components.**

# Parking Brake & Service Brake Tests

Module 1

## Parking Brake Test

With the vehicle stopped, put the parking brake on. Slowly pull forward in a low gear at low rpm to test that the parking brake will hold.

## Service Brake Test

Wait for normal air pressure. Release the parking brake, move the vehicle forward slowly—at about 5 mph—and apply the brakes firmly using the brake pedal. Note any "pulling" to one side, unusual feel, or delayed stopping action.

**⚠ WARNING**

**Before testing the parking brake, make sure the area around the vehicle is clear.**

After completing the basic inspection, a more detailed operational check of the system should be performed.

Start by blocking the wheels on the tractor and trailer. Inspect the primary and secondary reservoir inlet check valves for correct operation by doing the following:

- Build air pressure up to system pressure.
- Then, with the ignition key ON, open the drain cock at the supply air reservoir and completely drain

the reservoir. The low pressure buzzer and warning light should come on at 60–70 psi.

***"Pressure in both the primary and secondary reservoirs should remain at system air pressure."***

Pressure in both the primary and secondary reservoirs should remain at system air pressure. Verify this using the dash gauges. If there is a loss of air in either system, the one-way inlet check valve could be defective.

With the System Park brake dash valve and the Trailer Supply control valve in their released positions, open the drain cocks in both the primary and secondary tanks.

On a coupled tractor/trailer combination, the following should occur when the drain cocks are opened in the primary and secondary tanks:

- The trailer supply dash valve should pop out when the circuit tank with the highest pressure—either primary or secondary—reaches 40 psi. This dash valve could pop out immediately if air is depleted rapidly at the trailer supply line.

- When air pressure in the tank with the higher pressure reaches 30 psi, the park dash valve may pop out. When the air pressure drops to 25 psi, the dash valve must pop out.

Close all reservoir drain cocks. Build up air supply in the chassis system to approximately system cut-out pressure.

With the Trailer Supply dash valve pushed in, disconnect the trailer emergency gladhands from each other. The trailer supply valve should pop out at approximately 80 psi, cutting off the supply of air exiting the hose at the gladhand.

After the knob pops out, reconnect the trailer supply hose to the trailer gladhand. Push the trailer supply knob in to the released position and then pull the trailer supply knob out. This will apply the trailer parking brakes and leave the tractor parking brakes released.

Check the air pressure for leakage by observing the air gauges on the instrument panel. Leakage should not be greater than 2 psi in one minute.

***"Check the air pressure for leakage by observing the air gauges on the instrument panel."***

Fully open the drain cock in the secondary air tank. Air loss can be monitored by observing the dash air gauges. Only the secondary circuit should show a loss of air. With the ignition key on, the low-pressure indicator buzzer in the cab should sound between 60 and 70 psi.

Apply the service brakes and observe the slack adjusters and service brake chamber pushrods.

- The low air pressure buzzer and warning light should come on.
- The secondary circuit gauge should indicate zero.
- All the service brakes should apply and release.

Check for special application valves if this test does not confirm that the primary circuit is functioning properly.

Close the drain cock in the secondary air reservoir. Build up the air supply in both the primary and secondary circuits to system pressure.

Fully open the drain cock in the primary reservoir. Observe the secondary circuit air pressure gauge. There should be no air loss.

Apply the service brakes. What happens here will depend on how the brake system has been optioned.

- First, the low pressure buzzer and warning light should come on.
- Next, the primary circuit dash gauge should read zero.

- At a minimum, the front service chambers on the tractor and all of the service brakes on the trailer should apply and release.

- On some systems, all the service chambers will apply.

If the brake chamber pushrods move as described, the secondary circuit is functioning properly.

Close all drain cocks and build up the air supply to system pressure.

## NOTES

# ABS/ATC Tests Module 2

## Modulator Valve Inspection

If the modulator valve fails to function as described during the following tests, or if leakage is excessive, it should be replaced. Use only parts approved by International®.

Remove any accumulated debris and contaminants, then inspect the outside surfaces of the modulator for excessive corrosion and physical damage. Replace if necessary.

Inspect all air lines and wires connected to the modulator valve for signs of wear or physical damage. Replace as needed.

Test air line fittings for excessive leakage and tighten or replace as necessary.

## Modulator Valve Leakage Testing

Park the vehicle on a level surface and block the wheels. Release the parking brakes and build the system to full pressure.

**NOTE**

**The following test requires two (2) technicians.**

Turn the engine off, make four or five brake applications and make sure that

the service brakes apply and release promptly.

Start the engine and build system pressure to governor cut-out. Turn the engine off. Make and hold a full service brake application.

***"Leakage should not exceed a one inch bubble in less than three seconds."***

Apply a soap solution to the exhaust port of the modulator valve. Leakage should not exceed a one inch bubble in less than three seconds. If leakage exceeds the specified maximum, replace the modulator valve.

Apply a soap solution around the top and bottom of the solenoid assembly and around each diaphragm cover. If leakage exceeds the specified maximum, tighten the capscrews and retest. If leakage remains excessive after retesting, replace the modulator valve.

## Modulator Valve Operation Test (Chuff Test)

Each modulator valve contains an exhaust solenoid and a hold solenoid. During this test, the controller will "fire" or energize each solenoid briefly in a test cycle, making a "chuff" sound as the air exhausts.

The exhaust solenoid will fire for 10 milliseconds, then pause for only a few milliseconds and then the hold

solenoid will fire for 20 milliseconds. The two firing in rapid sequence will produce the “chuff” sound.

The controller will begin at the right front, then go to the left front, then right rear, and finish the cycle on the left rear. It will then repeat the cycle, making two complete cycles.

Park the vehicle on a level surface and block the wheels. Release the parking brakes and build the air system to governor cut-out.

**NOTE**

**The following test requires two (2) technicians.**

Turn the ignition key to the OFF position, then make and hold a full brake application.

With the brake application held and a service technician listening at one of the modulator valves, turn the vehicle ignition key ON.

- A short burst of air pressure should be heard first at the right front modulator valve exhaust;
- Then a short burst should be heard at the left front;
- Then at the right rear;
- Finally, a short burst should be heard at the left rear.

The test cycle will continue one more time, repeating the previous steps. If the air burst is not heard at one or more modulator valves, an electrical test must be performed.

## ABS Controller Inspection

Check all wiring and connectors to ensure they are secure and free from damage.

Although the controller performs self-check diagnostics, the LED display should be inspected to ensure that the LEDs are functional. With the vehicle ignition ON, a magnet held to the reset switch should cause all of the LEDs to illuminate.

If one or more of the LEDs do not light up and the antilock warning light indicates the system is functioning properly, the LEDs should be noted for future reference. Although the diagnostic capabilities will be limited, the system will continue to function as designed.

## ABS Controller Testing

**NOTE**

**For the next step, two (2) technicians are required: a vehicle driver and an observer.**

From a vehicle speed of 20 mph, road test the vehicle by making an antilock stop. When the stop is made, the modulator solenoids pulsate and a burst of air can be heard outside

the cab. The wheels should not enter a prolonged “lock” condition when vehicle speeds are above 7 mph.

Also, make a traction control test by accelerating on a road surface with reduced traction, such as gravel. As with ABS, bursts of air can be heard at the modulator valves when the traction control system is functioning.

## Exciter Ring & Wheel Speed Sensor

If a fault is indicated with any of the wheel speed sensors, inspect the exciter ring, wheel speed sensor, and wiring for corrosion or damage.

Any damaged components should be replaced. Refer to ISIS® for the proper removal and installation procedures. If no damage is found, verify that the wheel speed sensor is bottomed out against the exciter ring.

***“If no damage is found, verify that the wheel speed sensor is bottomed out against the exciter ring.”***

Observe the exciter ring to determine if it is properly seated on the wheel hub.

If it is properly seated, perform resistance tests on the wheel speed sensor. Refer to ISIS® for the proper procedures.

# Conclusion

This concludes Program III of the Air Brakes series. Completion of this educational process is a key component towards International® technician certification. You are now required to take a post-test via ISIS®/ Education/Service/Online Testing.

## NOTES

## NOTES

A NAVISTAR COMPANY

# Program IV: Supply System Component Tests

INTERNATIONAL®

## Program IV Objectives

**After completing this program, you will be able to:**

- **Test the Supply System components for proper operation.**
- **Perform leakage tests on the Supply System components.**
- **Assemble and test air hoses, tubing and fittings.**

# Air Compressor Tests

# Module 1

Vehicles manufactured after the effective date of FMVSS 121, with the minimum required reservoir volume, must have a compressor capable of building pressure to a minimum specification.

This is found by dividing the system's capacity by the system's required air pressure, multiplied by 25. Pressure build-up must occur within 25 seconds, with the engine operating at maximum recommended governed speed.

If the compressor fails to meet this specification, refer to ISIS® for the proper diagnostic procedure.

## Air Leakage Tests

Compressor leakage tests do not need to be performed on a regular basis. They should be performed when:

- It is suspected that discharge valve leakage is affecting compressor build-up performance.

- The compressor is cycling between the loaded and unloaded modes due to unloader piston leakage.

These tests must be performed with the vehicle parked on a level surface,

with the engine off, the entire air system drained to 0 psi, and the inlet check valve detail parts removed.

## Unloader Piston Leakage

To check the unloader pistons for leakage, first remove the cylinder head from the compressor. Next, cover the inlet flange securely. Install an air line fitting into the governor port.

Seal off the head mounting bolt hole that passes through the unloader piston area using a head bolt with two flat washers, two O-rings and a nut. Then apply 120 psi to the governor port. Listen for air escaping at the inlet valve. None should be heard.

## Discharge Valve Leakage

***"Before this test can be performed, any unloader piston leakage must be repaired first."***

Before this test can be performed, any unloader piston leakage must be repaired first. To find any leakage past the discharge valves, connect an air line fitting to the discharge port, install a plug in the second discharge port and apply shop air back through the discharge port.

Listen for air escaping at the compressor inlet cavity. A barely audible escape of air is generally acceptable.

If the compressor does not function as described or if the leakage is excessive, return it for a remanufactured compressor.

## Air Induction/Cooling Maintenance

Air induction is one of the most important aspects of preventive maintenance. Inspect all hoses and clamps to make sure they are secure and not damaged.

***"Air induction is one of the most important aspects of preventive maintenance."***

Inspect the compressor discharge port, inlet cavity and discharge line for restrictions and carbon buildup. If excessive buildup is found, thoroughly clean or replace the affected parts and closely inspect the compressor cooling system.

Check all compressor coolant lines for kinks or other restrictions. Minimum coolant line size is 3/8 inch inner diameter. Check lines for internal clogging from rust scale. If the lines look irregular, check the coolant flow and compare to the specifications found on ISIS®.

## Lubrication Maintenance

Check the external oil supply and return lines for kinks, bends, or flow restrictions. Supply lines must be a

minimum of 3/16 inch inner diameter and return lines must be a minimum of 1/2 inch inner diameter.

***"Oil return lines should slope back to the engine crankcase as sharply as possible."***

Oil return lines should slope back to the engine crankcase as sharply as possible. They should also have as few fittings and bends as possible. Refer to ISIS® for minimum oil pressure values.

## Drive Maintenance

Check for noisy compressor operation, which could indicate a worn drive gear coupling, a loose pulley, or excessive internal wear. Adjust or replace as necessary.

If the compressor is belt driven, check for proper belt and pulley alignment and belt tension. Check all compressor mounting bolts and retighten evenly, if necessary. Repair or replace parts as needed.

# Air Compressor Governor Tests

# Module 2

## Operating Test

Start the engine, build pressure in the system and check the pressure shown on the dash gauge or a test gauge when the governor cuts out. The cut-out pressure should match the specification for the governor, based on its part number. The standard cut-out pressure is 125 psi.

With the engine still running, make a series of brake applications to reduce the air pressure and observe at which pressure the governor cuts in the compressor.

As in the case of the cut-out pressure, the cut-in pressure should match the specifications of the governor part number. Common cut-in pressure is 100–105 psi. Governor pressure settings should be checked with the dash gauge or an accurate test gauge.

***"Governor pressure settings should be checked with the dash gauge or an accurate test gauge."***

If the pressure settings of the governor are inaccurate, or if they need to be changed, perform the following procedure. To adjust the governor, first unscrew the cover. Next, loosen the adjusting screw lock nut.

**NOTE**

**A 1/4 turn will change the setting approximately 4 psi. Any governor requiring more than a full turn adjustment should be cleaned and inspected.**

Turn the adjusting screw counter-clockwise to raise the pressure setting, and turn it clockwise to lower the pressure setting. After the adjustment is complete, the adjusting screw lock nut should be tightened to lock this adjustment. Screw the cover securely onto the governor.

## Leakage Test

Leakage checks on the governor are made at the exhaust port in both the cut-in and cut-out positions.

**NOTE**

**If the governor cover is marked "non-adjustable" and the adjusting stem has been sheared off, this indicates a non-serviceable governor that must be replaced with a new or remanufactured unit if the previous governor failed the operating and/or leakage tests.**

In the cut-in position, check the port for inlet valve leakage by applying a soap solution at the port. There could also be leakage at the bottom piston grommet.

In the cut-out position, check to determine if there is leakage at the exhaust valve seat or stem grommet. There could also be leakage at the upper piston grommet.

Leakage in excess of a one inch diameter soap bubble in three seconds is not permissible in either of these tests. If excess leakage is found, the governor must be repaired or replaced.

## Maintenance

Disassemble the governor, clean and inspect all parts and replace as necessary.

Also, clean or replace the governor filters. When cleaning, use a solvent that is safe on metal or rubber, such as mineral spirits.

***"When cleaning, use a solvent that is safe on metal or rubber."***

## NOTES

# Air Dryer Tests Module 3

## AD-9 Air Dryer Maintenance

First, check for moisture in the air brake system by opening reservoirs, drain cocks, or valves and check for water.

If moisture is present, the desiccant may need to be replaced. However, the following conditions can also cause water accumulation and should be considered before replacing the desiccant:

- An outside air source has been used to charge the system. This air did not pass through the drying bed.
- Air usage is exceptionally high. This can be due to accessory air demands, high air system leakage, or an unusual air requirement that does not allow the air compressor to load and unload in a normal fashion.
- A temperature range of more than 30°F (17°C) in one day. This will cause small amounts of condensation in the air brake system.

Check the air dryer mounting bolts for tightness. Tighten to the specification found on ISIS®.

**NOTE**

**A small amount of oil in the system may be normal and should not, in itself, be considered a reason to replace the desiccant. An oil-stained desiccant can function adequately.**

**NOTE**

**The desiccant change interval may vary from vehicle to vehicle. Although typical desiccant cartridge life is three years, many will perform adequately for a longer period of time. To take maximum advantage of desiccant life and to ensure that replacement occurs only when necessary, it is important that the following service checks be performed.**

## AD-9 Air Dryer Operation & Leakage Tests

**⚠ CAUTION**

**Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, governor pressure settings and other tests.**

Test the outlet port check valve assembly by building pressure in the air system until governor cut-out and observing a test air gauge installed in the primary, or number one, reservoir. Check all lines and fittings leading to and from the air dryer for leakage and integrity.

A rapid loss of pressure could indicate a failed outlet port check valve. This can be confirmed by bleeding the system, removing the check valve assembly from the end cover, applying air pressure to the unit and using a soap solution on the check valve side. Leakage should not exceed a one inch diameter bubble in one second.

Check for excessive leakage around the purge valve. With the compressor loaded, apply a soap solution to the purge valve housing assembly exhaust port and make sure the leakage does not exceed the specification. If it does, service the purge valve housing assembly.

Close all reservoir drain cocks. Build system pressure to governor cut-out and make sure the air dryer purges with an audible escape of air. The system

should once again build to full pressure, followed by a purge.

Check the operation of the end cover heater and thermostat assembly during cold weather operation as follows:

**Electric power to the dryer.** With the ignition switch in the ON position, check for voltage to the heater and thermostat assembly using a voltmeter. Unplug the electrical connector at the air dryer and place the test leads on each of the pins of the male connector. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check to see if a good ground exists.

**Thermostat and heater operation.** Turn the ignition switch OFF and cool the end cover assembly to less than 40°F (4°C). Using an ohmmeter, check the resistance between the electrical pins in the female connector. The resistance should be 1.5–3 ohms for the 12 volt heater assembly and 6.8–9 ohms for the 24 volt heater assembly.

Warm the end cover assembly to over 90°F (32°C) and again check the resistance. It should exceed 1000 ohms.

If the resistance values are outside these specifications, replace the purge valve housing assembly.

**NOTE**

**On models prior to January 3, 2001, the AD-9 dryer will have resistance readings of 1.0–2.5Ω for the 12V heater assembly and 4.8–7.2Ω for the 24V heater assembly. If the resistance is higher than the maximum, replace the purge valve housing assembly, which includes the heater and thermostat assembly.**

## System Saver 1000 Air Dryer Maintenance

The System Saver 1000 and AD-9 Air Dryer systems are similar in operation and design. Refer to ISIS® for proper maintenance procedures.

## Desiccant Cartridge Removal

Loosen and remove the cartridge. If necessary, use a strap wrench. Remove the O-ring.

Clean and inspect the surfaces where the O-ring and seal are seated. Repair any damage as required. If there is damage that prevents a tight seal, replace the air dryer.

## Desiccant Cartridge Installation

Apply a thin layer of grease to the O-ring and seal. Install the new O-ring. Thread the new cartridge onto the base until the seal touches the base. Then, tighten the cartridge one more complete turn.

# Automatic Drain Valve Tests

# Module 4

## Operation Test

With the system charged, make several brake applications and note each time if there is an exhaust of air at the exhaust port of the automatic drain valve. If air doesn't exhaust, push the wire stem. If there is still no exhaust of air, the filter is plugged and the valve should be removed and cleaned.

**NOTE**

**The following test requires two (2) technicians.**

**NOTE**

**Refer to ISIS® for the proper maintenance procedures, as this valve is optional.**

## Leakage Test

With the system charged and pressure stabilized, there should be no leaks at the drain valve exhaust. A constant, slight escape of air at the drain valve exhaust could be caused by excessive leakage in the air brake system.

If the automatic drain valve does not function as described, or if leakage is excessive, repair or replace the valve.

For details regarding the maintenance of the automatic drain valve, including removal and reinstallation, refer to the procedures found on ISIS®.

## NOTES

# Hoses, Tubing & Fittings: Assembly & Tests

# Module 5

## Hose Assembly

If it is necessary to make a replacement hose, refer to proper instructions on ISIS®.

**⚠ CAUTION**

**Do NOT mix different types of hoses or hose fittings.**

## Nylon Tubing Assembly

For the most part, nylon tubing is assembled much like copper tubing. The same fittings, sleeves and nuts used with copper can be used with nylon. Long or short tube nuts may be found on the chassis with nylon tubing. Either nut may be used on nylon lines.

**NOTE**

**Always use new components to make up a new hose assembly.**

To assemble tubing ends for use with compression-type fittings, refer to ISIS® for the proper instructions.

**NOTE**

**Tube supports are needed with all sizes of tubing, except 1/8 inch (3.175 mm), if compression-type fittings are used to repair accessory piping systems.**

## Special Instructions

In addition, the following precautions must be followed when using nylon tubing:

- Do not use for any application exposed to temperatures below –40° or above 200°F (93°C).
- Do not use in applications where pressure exceeds 150 psi.

**⚠ CAUTION**

**Nylon tubing should not be substituted in the field for any metallic tubing.**

- Do not use for frame-to-axle or tractor-to-trailer or where a high degree of flexibility is required.

- Use extreme care when welding near nylon tubing. Hot slag or sparks will damage the tubing.

- And, always protect nylon tubing from battery acid.

## Quality Connect Fittings & Service

Use a soap solution to find where air is leaking. Leakage should not exceed a bubble of 1/2 inch within three seconds with system pressure of 100–130 psi. If the leakage exceeds these specifications, the quality connect fittings should be serviced.

**⚠ WARNING**

**Failure to drain the system of air pressure before removing components can cause personal injury or death.**

If a leak is discovered, push the tube into the port to make sure it is fully seated.

If the leak still exceeds specifications, drain air from the system and disassemble the fitting to determine the cause of the leak. Select the appropriate tools and parts for the tube size being serviced.

**NOTE**

**Be sure to reinstall the tube support when reinstalling the tube.**

Place the release tool around the tube. Push to depress the fitting collet, allowing it to release. Then pull on the

tube. If the brass tube support pulls out of the fitting, inspect it for damage. Replace if necessary.

Inspect the port for any debris or contaminants. Clean as needed.

**NOTE**

**If the fitting is equipped with a black molded tube support, it cannot be removed.**

Inspect the tube end for scratches, burrs, or cracks. Do not reuse a damaged end.

Use the forked end of the repair tool to remove and discard the collet.

Remove the O-ring using the appropriate tool and discard. Avoid scratching the cavity during removal.

**CAUTION**

**If the O-ring cavity is scratched during removal of the O-ring, the fitting may leak.**

If the brass tube support remained in the fitting, inspect it for damage. If it is not damaged, leave it in place. If it is damaged, remove it with a needle-nosed pliers and discard.

Replace all parts as necessary. Refer to ISIS® for detailed information related to the service and repair of Quality Connect fittings and tube installation.

# Gladhands

## Service Check

With gladhands connected and brakes applied, coat the gladhands with a

soap solution to check for leaks. There should be no leakage. Leakage results from worn, damaged or improperly installed gladhand seals.

### Maintenance

If leakage is detected, the gladhand should be disassembled, cleaned and serviced.

Remove the old gladhand seal with a screwdriver. Make sure the seal groove is thoroughly cleaned.

***"Install the new gladhand seal by partially collapsing it with your fingers."***

Install the new gladhand seal by partially collapsing it with your fingers and inserting one side of it into the groove in the gladhand.

Work the remaining part of the packing ring into place. When properly installed, the exposed face of the gladhand seal will be flat and free of any bulges.

## Trailer Brake Hose

### Service Checks

If an air line is restricted, remove it and blow through it in both directions to ensure the passage is not obstructed. Damaged pipes should be replaced.

## Leakage Test

With the air system fully charged, the governor cut out, the trailer parking brakes released, and the service brakes applied, use a soap solution on all air lines, hoses and fittings to check for leakage. There should be none.

**NOTE**

**The following test requires two (2) technicians.**

Leakage at a fitting or connection is sometimes corrected by tightening the fitting or connector nut. If this fails to correct the leakage, replace the sleeve, fitting, connector or hose.

# Conclusion

This concludes Program IV of the Air Brakes series. Completion of this educational process is a key component towards International® technician certification. You are now required to take a post-test via ISIS®/ Education/Service/Online Testing.

## NOTES

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# Program V: Actuation System Component Tests

INTERNATIONAL®

## Program V Objectives

**After completing this program, you will be able to:**

- **Perform leakage and operation tests on the Actuation System components.**
- **Perform maintenance procedures on Actuation System components.**

# Spring Brake Control Valve Test

# Module 1

## Operation Test

With both control knobs out, charge the air brake system to 65 psi and check for leakage at the exterior cowl-mounted exhaust port. No leaks are permitted.

With pressure still at 65 psi, push the red knob in. The knob must stay in. Leakage at the exhaust port must not exceed a one inch bubble within five seconds.

**CAUTION**

**When checking brake valve delivery pressures, governor pressure settings, or any other tests, use only test gauges that are known to be accurate.**

Push the yellow knob in. With the engine off, actuate the foot valve several times to deplete the air supply. The red knob must pop out when the reservoir with the highest pressure reaches 35–40 psi. If air is depleted quickly, the red knob could pop out immediately. Leakage at the exterior cowl-mounted exhaust port must not exceed a one inch bubble within five seconds.

With the engine off, actuate the foot valve, depleting any additional air. Air must start to escape from the exhaust port when the air pressure in the reservoir with the higher pressure reaches 25–35 psi. The yellow knob must pop out at this time.

**NOTE**

**In order to access the valve, you may have to remove the access panel and instrument panel bezel.**

Build the supply pressure to at least 40 psi. Push in the yellow knob; the yellow knob must remain in. Leakage at the exhaust port should not exceed a one inch bubble within five seconds.

Charge the system to 120 psi and push both knobs in. Pull the red knob out. The yellow knob must remain in.

Push the red knob in and pull the yellow knob out. The red knob must pop out almost instantaneously.

Install a gauge between the quick release valve and the spring brake chamber to monitor the amount of air delivered to the spring brake.

***"Delivery pressure should equal the pressure in the primary reservoir."***

Apply 120 psi to both the primary and secondary reservoirs. Push the yellow knob in. Delivery pressure should equal the pressure in the primary reservoir.

Reduce pressure in the primary reservoir. Delivery pressure will hold steady as primary pressure drops. The dual circuit supply valve shuttle switches to the secondary reservoir as primary pressure drops toward 100 psi. If delivery pressure drops below 100 psi, the shuttle has failed.

After the primary reservoir pressure is reduced to zero, leakage should not exceed a 1/2 inch bubble

within five seconds at the primary reservoir opening. Close the leak created at the primary reservoir.

Leave the yellow knob in and recharge the primary reservoir to 120 psi. The delivery pressure should also read 120 psi. Slowly vent the secondary reservoir.

Delivery pressure will hold steady as secondary pressure drops. Again, the dual circuit supply valve shuttle switches to the primary reservoir. If delivery pressure drops, the shuttle has failed.

***"Delivery pressure will hold steady as secondary pressure drops."***

Close all vents or leakage points and recharge the secondary reservoir to 120 psi. Develop a leak in the spring brake delivery line and hold the yellow knob in. The primary and secondary reservoir pressures will drop in 5 psi increments alternately as the dual circuit supply valve shuttle cycles. This continues until pressure drops to 0 psi.

## NOTES

# Foot Brake Valve Tests Module 2

## Maintenance

Clean any dirt or gravel away from the heel of the treadle valve, plunger boot, and mounting plate.

Remove the hinge pin and pedal. Remove the roller pin and roller. Clean and lubricate the roller pin and roller with Fleetrite EP2 Moly grease or equivalent, then reinstall onto the pedal. Remove the plunger and boot. Inspect the boot for cracks, holes or deterioration and replace if necessary. Lubricate the plunger and reinstall the plunger and boot.

Lubricate the hinge pin and reinstall the pedal ensuring the cotter pin is properly reinstalled. Free pedal travel should be checked to ensure that the plunger is in contact with the spring seat. Also, adjust the stop button so that the roller and plunger just make contact. Clean the exhaust port.

## Operation Test

With a fully charged air system, use test gauges to check delivery pressure of both the primary and secondary systems. Depress the foot valve to

**NOTE**

**The following test requires two (2) technicians.**

several positions between the fully released and fully applied positions.

Check the delivered pressure on the test gauges to ensure that it varies proportionately with the movement of the brake pedal.

**⚠ CAUTION**

**A change in braking characteristics or a low-pressure warning may indicate a malfunction. The vehicle should not be operated until necessary repairs have been made. After performing brake work, always check the brakes before returning the vehicle to service.**

After a full application with the foot valve released, the reading on the test gauges should drop to 0 psi rapidly. The primary system delivery pressure should be about 2 psi more than the secondary system delivery pressure, with both supply reservoirs at the same pressure. This is normal for these valves.

## Leakage Test

Make and hold a high pressure application. Check the exhaust port for leakage. Leakage at the exhaust port must not exceed a one inch bubble within five seconds.

If the brake valve does not function as described, the valve should either be replaced or repaired.

# Quick Release Valve Tests Module 3

## Operation Test

Apply 100 psi of shop air to the supply port of the quick release valve that services the two spring brake chambers. Check that the brake chambers connected to the valve respond promptly.

## Leakage Test

With 100 psi of shop air applied to the quick release valve supply port, apply a soap solution to the exhaust port and around the junction of the upper and lower body halves.

Leakage must not exceed a one inch bubble within three seconds. No leakage is permitted between the body halves.

If the quick release valve does not function as described or if leakage is excessive, replace the unit.

Release the air pressure at the supply port and note whether the brake chambers connected to the quick release valve respond promptly and return to 0 psi. If the response is slow, continue to the next section and perform the balance test.

## Balance Test

If the brakes release slowly, the valve balance should be checked to determine if the quick release valve should be replaced. Block the wheels.

Remove the quick release valve supply line from the valve. Install a T in the supply line fitting.

Reconnect the supply line along with a shut-off valve and 125 psi gauge into the T.

Remove both delivery lines and install a plug in one delivery port.

In the other delivery port, install a hose long enough to extend into a container of water.

With system air pressure at a minimum of 80 psi, place the parking control valve in the release position.

***"A standard quick release valve should show bubbles at 1 psi. A differential valve should have bubbles at 3 psi, give or take 1 psi."***

Slowly open the shut off valve and watch for air bubbles in the container of water. A standard quick release valve should show bubbles at 1 psi. A differential valve should have bubbles at 3 psi, give or take 1 psi.

If bubbles appear at pressures other than those stated, the valve is defective and should be replaced.

# Inversion Valve Tests

# Module 4

## Operation Test

Block the vehicle wheels. Charge the system to governor cut-out pressure.

Place the parking control valve in the applied position. Make sure that the spring brake actuators apply promptly. Install a test gauge in the delivery port of the inversion valve. Place the parking control valve in the “release” position. Make sure that the spring brake actuators release fully.

With the parking control valve in the released position, the gauge pressure reading should be approximately the same as the gauge on the instrument panel. If the pressure reading is incorrect, the valve must be repaired or replaced.

***“With the parking control valve in the released position, the gauge pressure reading should be approximately the same as the gauge on the instrument panel.”***

Place the parking control valve in the applied position. The gauge reading should drop to zero rapidly. A slow release of pressure could indicate faulty operation of the single check valve within the modulating valve. At 7–35 psi, the spring parking brakes should be fully applied.

Place the parking control valve in the released position. Locate the No. 1 service reservoir and drain it completely.

Apply the foot brake valve several times and make sure that the pressure reading on the gauge decreases each time the foot brake valve is applied. After the foot brake valve has been applied several times, pressure on the gauge will drop to the point where the spring brake actuators will not release.

## Leakage Test

With the air system fully charged and the parking brake control valve in the released position, check the exhaust port for leakage. Slight leakage is permitted.

If the inversion valve does not function as described or if leakage is excessive, replace or repair the valve.

# Relay Valve Tests Module 5

## Operation & Leakage Tests

Block the wheels and charge the system.

**NOTE**

**The following test requires two (2) technicians.**

Make several brake applications and check for prompt application and release at each wheel, to verify the correct operation of the relay valve.

Check for inlet valve, O-ring, and exhaust valve leakage by coating the exhaust port and the area around the retaining ring with a soap solution. Leakage must not exceed a one inch bubble within three seconds.

**NOTE**

**Perform the following leakage tests with the service brakes "released" (R-12 relay valve) or with the spring brakes applied (R-14 relay valve).**

To check for leaks at the valve's perimeter, coat the outside of the valve where the cover joins the body to check for seal ring leakage. No leakage is permitted.

Finally, if an R-14 relay valve is used to control the spring brakes, place the park control valve in the released position and coat the balance/quick exhaust port with a soap solution to check the diaphragm and its seat. Leakage must not exceed a one inch bubble within three seconds.

**NOTE**

**The air line attached to the balance/quick exhaust port must be disconnected to perform this test.**

# Conclusion

This concludes Program V of the Air Brakes series. Completion of this educational process is a key component towards International® technician certification. You are now required to take a post-test via ISIS®/ Education/Service/Online Testing.

## NOTES

## NOTES


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# Program VI: Common Service Procedures

INTERNATIONAL®

## Program VI Objectives

**After completing this program, you will be able to:**

- **Properly cage a spring brake.**
- **Properly maintain, remove and install the spring brakes.**
- **Properly and safely disarm a spring brake.**
- **Properly maintain, remove and install foundation brakes.**

# Spring Brakes Module 1

## Caging the Spring Brake

In the event there is loss of air and the vehicle must be towed, or any time the service and spring brake assembly is serviced or removed from the vehicle, the spring brake must be caged.

## Using Mechanical Release

Block the wheels. Remove the plastic end cap from the spring brake chamber.

Loosen the release nut and remove the nut, flat washer, and release bolt the chamber's storage pocket.

Insert the release bolt into the center hole of the spring brake chamber. Make sure that the formed end of the bolt enters the hole in the piston and insert the bolt until it bottoms out.

Turn the release bolt 1/4 turn clockwise and pull it outward to lock the formed end into the piston.

Install the flat washer and the release nut on the end of the release bolt, and turn the nut down against the flat washer until finger tight.

**NOTE**

**If these parts are not stored on the chamber, they must be obtained from the vehicle tool box or the service department. The spring brake cannot be caged without them.**

**NOTE**

**If you are not absolutely sure of correct bolt-to-piston engagement, repeat this step until proper engagement is made.**

**NOTE**

**If the bolt does not lock into the piston with less than 1/2 inch outward movement, repeat the steps until it locks properly.**

**⚠ CAUTION**

**Do not exceed the lengths listed on ISIS® and do not exceed 50 ft.-lbs. torque on the release nut at any time or damage may occur that could prevent any further caging of the spring brake chamber. If 50 ft.-lbs. torque or more is required to obtain the measurement found on ISIS®, replace the spring brake assembly.**

**NOTE**

**To reactivate the spring brake from its manually released position, reverse the order of the previous steps.**

**NOTE**

**If the bolt does not lock into the piston with less than 1/2 inch (1.27 cm) outward movement, repeat the steps until you are sure it locks.**

Using a 3/4 inch wrench, turn the release nut clockwise until the bolt extends above the nut by the amount listed on ISIS®.

## Using Air Pressure

Block the wheels.

Remove the plastic end cap from the spring brake chamber.

Using a 3/4 inch wrench, loosen the release nut and remove the nut, flat washer and release bolt from their storage pocket on the side of the chamber.

Insert the release bolt into the center hole of the head and, making sure that the formed end of the bolt enters the piston inside the chamber, continue to insert the bolt until it bottoms out.

Turn the bolt 1/4 turn clockwise and pull the bolt outward to lock the formed end into the piston.

Install the flat washer and release nut on the end of the release bolt. Turn the nut down against the flat washer until it is finger tight.

Release the parking brake or apply a minimum of 90 psi air pressure to the inlet port marked “Spring Brake.”

Turn the nut down against the flat washer until it is finger tight. The bolt should extend above the nut by the amount listed on ISIS®.

Completely exhaust air from the spring brake and service brake.

## Spring Brake Maintenance

The MGM® Tamper Resistant spring brake chambers are an important part of the braking system. While they do not require scheduled servicing, it is good preventive maintenance to make the following routine inspections while they are in the shop for regular servicing of other components or at a minimum of every 50,000 miles.

**NOTE**

**When reinstalling the release bolt, flat washer and release nut into the storage pocket, torque the nut against the flat washer to the specification found on ISIS®.**

**⚠ CAUTION**

**If the length of the bolt extending above the nut is less than what is listed on ISIS®, the spring brake chamber is not functioning properly and must be replaced.**

**⚠ WARNING**

**The MGM® Tamper Resistant spring brake is factory sealed for your protection. There are no user-serviceable parts inside the spring brake chamber. If you experience any damage or failure, replace the complete assembly. Never attempt to disassemble the spring brake chamber, as serious injury or death could result from accidental release of the high-energy spring.**

## Recommended Inspection Points

**NOTE**

**Inspect the air ports to determine the model of brake chamber. Round ports indicate the 2 1/2 inch (6.35 cm) standard stroke brake chamber, while square ports indicate the 3 inch (7.62 cm) long stroke model. Brake chambers must be replaced with the exact same model.**

The plastic weather seal end cap requires no positioning or maintenance, but must be snapped tightly in place. Inspect the cap for damage and replace as necessary. Units equipped with a weather seal end cap must be equipped with a rubber O-ring to ensure proper sealing of the spring brake chamber.

Inspect the exterior surfaces of the unit for signs of damage, corrosion or rust. If any of these are seen or suspected, remove the complete combination chamber assembly after caging the spring brake.

Inspect the service brake clamp ring to ensure it is securely in place and damage-free. If any damage is seen or suspected, remove and replace the complete spring brake assembly.

**⚠ CAUTION**

**Failure to operate any MGM® Model Series "TR-T" and "TR LP3-T" chamber without the end cover cap installed and in good condition will cause premature failure of the spring brake assembly and void any warranty.**

Check to ensure the mounting stud hex nuts are tightened to the specification found on ISIS® and that washers are in place between the nut and the bracket.

Inspect air lines, hoses and fittings attached to the chamber. Replace any damaged or leaking parts. Tighten fittings into the chamber air inlet ports to the specification found on ISIS®.

Inspect the piston rod to make sure it is working free and not bent or binding and that it is square to the chamber bottom within ± 3 degrees in any direction, at any point in the stroke of the chamber.

If the pushrod is not square, reposition the chamber on the mounting bracket or shim the slack adjuster to the right or left on the camshaft as required.

Inspect the yoke assembly, making sure the yoke pin is installed and locked into place with a cotter pin.

Replace any damaged, worn or missing parts. Tighten the yoke locknut to the specification found on ISIS®.

## Spring Brake Removal

Cage the spring brake completely. Refer to the Caging the Spring Brake section of this program for the proper procedure.

Remove the cotter pin from the yoke pin and push the yoke pin out. Repeat this process for the second yoke pin and remove both air lines from the assembly.

Loosen the hex nuts on the mounting studs and carefully remove the chamber from the mounting bracket.

**NOTE**

**If only the parts within the service brake chamber require replacement, proceed now to the section on how to "Replace the Service Brake Diaphragm."**

**NOTE**

**Block the wheels before removing the air brake actuators.**

**NOTE**

**Make sure to mark the air line from the inlet port "Spring Brake" for reference during reinstallation.**

**⚠ CAUTION**

**The service pushrod of the new spring brake assembly must be cut to the proper length to ensure proper operation. Failure to do so could result in malfunction or failure of the braking system.**

**⚠ WARNING**

**The MGM® Tamper Resistant spring brake is factory-sealed for your protection. NEVER attempt to disassemble the spring brake chamber.**

**NOTE**

**If the spring chamber power spring cannot be caged and fully released, then the "X" and "Y" dimensions will need to be measured from another actuator of the exact type from the same vehicle, provided it is retracted to its zero stroke position and was operating correctly.**

## Cutting the Service Pushrod (Standard-Stroke Brake Chambers Only)

Make sure the spring chamber of the removed actuator is fully released and that the service brake pushrod is fully retracted to its zero stroke position.

Measure and record the "X" and "Y" dimensions.

The X dimension is from the bottom of the actuator to the end of the pushrod.

The Y dimension is from the bottom of the actuator to the centerline of the yoke pin.

On a new unit, be sure the spring chamber and pushrod are fully retracted before marking the pushrod to be cut. This can be done with the manual caging bolt. Refer to ISIS® for the specifications regarding the replacement chamber.

Transfer the X dimension from the removed unit onto the pushrod of the new unit.

Thread the yoke jam nut past the mark on the pushrod.

Cut the pushrod on the mark.

## NOTES

## NOTES

Next, thread the jam nut off to clean up the thread. Thread the jam nut back onto the pushrod.

Thread the yoke onto the pushrod. The yoke from the old unit may be reused, provided the pinhole is not worn. Adjust the yoke to the same Y dimension as measured from the removed unit.

Hold the yoke to prevent it from turning, and tighten the locknut against the yoke to the specification found on ISIS®.

## Spring Brake Installation

Remove the hex nuts and the flat washers on the mounting studs of the new chamber.

Clean the face of the mounting bracket and install the chamber on the bracket. Pay close attention to the position of the chamber air inlet ports for correct alignment to the vehicle air lines.

Install one flat washer and hex nut on each mounting stud and tighten to the specification found on ISIS®.

Reconnect the yoke to the slack adjuster, making sure that the correct diameter and length of yoke pin is installed into the correct hole in the slack adjuster. Secure the yoke pin with a new cotter pin.

**NOTE**

**If the pushrod is not square, reposition the chamber on the mounting bracket or shim the slack adjuster to the right or left on the camshaft as required.**

**NOTE**

**After replacing the service brake diaphragm or the spring and service brake chamber, the service piston rod stroke and actuating alignment must be checked to ensure correct installation and foundation brake adjustment. No foundation brake adjustments can be made at the spring brake chamber or at the service brake chamber–all stroke adjustments must be made at the slack adjuster. Refer to the adjustment procedures outlined later in this module.**

Inspect the piston rod to ensure it is not binding and is square to the chamber bottom within ± 3 degrees in any direction, at any point in the stroke of the chamber.

Apply Teflon® tape or sealing compound to the hose fittings and reinstall both of the air lines to the chamber, making sure each is mated to the correct air inlet port according to the markings made earlier. Tighten the fittings into the chamber air inlet ports to the specification found on ISIS®.

Using vehicle system air, charge the spring brake with full line pressure. Using soapy water, inspect for air leaks at the air lines and fittings. If bubbles appear, re-tighten the fittings to the specification found on ISIS®.

With air pressure now exhausted from the service brake chamber, but still applied on the spring brake, remove the release nut, flat washer, and release bolt.

Stow these parts in the chamber's storage pocket and tighten the nut against the flat washer to the specification found on ISIS®.

Properly replace the end cap.

**NOTE**

**If the service brake clamp ring was loosened to reposition the air inlet ports, apply air to the spring brake and then apply and hold down the foot brake valve to charge the service brake chamber. Test for air leaks around the circumference of the service clamp ring. If bubbles appear, firmly tap the circumference of the clamp ring with a hammer and retighten the clamp nuts until leakage stops. Tighten the clamp nuts to the specification found on ISIS®. Completely exhaust air from the service brake chamber when finished.**

**CAUTION**

**Operating units without the end cap securely in place will cause premature failure of the spring brake assembly and will void any warranty.**

**WARNING**

**The MGM® Tamper Resistant spring brake is factory sealed for your protection. There are no serviceable parts inside the spring brake chamber. If you experience any damage or failure, replace the complete assembly. Never attempt to disassemble the spring brake chamber.**

## Single (Piggyback) Spring Brake Removal

The removal and installation of a single spring brake chamber can be made easier by “locking off” the service chamber piston.

Apply the foot brake. Clamp a pair of vise-grips onto the pushrod so that they abut the mounting bracket. This will prevent the rod from retracting when air pressure is released.

Release the spring brake completely by performing the “Caging the Spring Brake” procedure found earlier in this program.

Remove both air lines from the chamber.

Remove the clamp nuts on the service clamp ring. Then, while holding the spring brake in place, remove the clamp ring. This will allow the spring brake to be removed from the service chamber.

**NOTE**

**On models fitted with external breather tubes, refer to Service Manual number S04020X, titled “Double Diaphragm MGM® Spring Brake,” found on ISIS®.**

**⚠ CAUTION**

**Refer to the Recommended Spring Brake Disarming Procedure regarding the proper techniques and equipment required to properly dispose of the spring brake assembly.**

**NOTE**

**Be sure to mark the air line from the inlet port marked “Spring Brake” for use later during reinstallation.**

**NOTE**

**Before installing the piggyback assembly, be sure to inspect all parts in the service chamber, especially the diaphragm, and replace this and any other parts that may be damaged or worn. Refer to the section "Replace the Service Brake Diaphragm" for the proper procedures.**

**NOTE**

**These units must be mounted with the breather tube in the upper half of the non-pressure chamber facing away from the road surface. The tube must be glued or clamped securely into the rubber elbows. Failure to comply with these installation instructions will void any warranty. Refer to ISIS® for additional information regarding breather tube orientation.**

## Single (Piggyback) Spring Brake Installation

Make sure the new spring brake is fully released. Place the diaphragm in the bottom recess of the chamber and then position the spring brake chamber.

Replace the service clamp ring, making sure that all mating parts are aligned and the air lines are positioned to mate with the vehicle air supply lines.

Reinstall the clamp ring bolts and nuts. Firmly tap around the circumference of the clamp ring with a hammer to ensure the clamp is fully seated.

Alternately tighten each nut in 5–10 ft.-lb. increments while rechecking the alignment of the mating parts. Tighten to the specification found on ISIS®.

Apply a sealing compound to the hose fittings and reinstall both the air lines to the chamber, making sure each is mated to the correct air inlet port according to the markings made earlier. Tighten to the specification found on ISIS®.

Using vehicle system air, charge the spring brake with full line pressure. With the spring brake still fully charged, apply and hold the foot brake to charge the service brake chamber.

**NOTE**

**After replacing the service brake diaphragm or the spring and service brake chamber, the service piston rod stroke and actuating alignment must be checked to ensure correct installation and foundation brake adjustment. No foundation brake adjustments can be made at the spring brake chamber or at the service brake chamber–all stroke adjustments must be made at the slack adjuster. Refer to the adjustment procedures outlined later in this module.**

**NOTE**

**Remove the vise-grip pliers from the service pushrod so that the piston can return to a normal position in the chamber. Test for air leaks around the circumference of the service clamp ring with a soap solution. If bubbles appear, tap the circumference of the clamp ring with a hammer and retighten the clamp nuts until the leakage stops. Tighten to the specification found on ISIS®.**

Use a soap solution to check for air leaks. If bubbles appear, tighten the fittings.

With air pressure exhausted from the service chamber, but with line pressure still on the spring brake, remove the release nut, washer and bolt.

Stow these parts in their storage pocket on the chamber and tighten the nut against the flat washer to the specification found on ISIS®.

Replace the end cap properly. Operating these units without the end cap securely in place will void any warranty.

## Recommended Spring Brake Disarming Procedure

Once a spring brake assembly has been removed from the vehicle, disarm the spring brake chamber spring using the following procedure:

- Place the assembly inside a safety chamber for disarming. Close and lock the lid on the safety chamber. The service pushrod may need to be cut off for the assembly to fit.

- Using an acetylene cutting torch, cut a 1/2 inch by 1 1/2 inch segment out of the spring brake chamber wall through one of the openings in the safety chamber.

Once the spring brake chamber spring is exposed, use the torch to cut the exposed spring in one or more places until it can be moved around inside the safety chamber with a long screwdriver.

**WARNING**

**MGM® Double Diaphragm Spring Brake Assemblies must be disarmed before disposal, or forceful release of the spring brake chamber may occur in the future without warning.**

**NOTE**

**Refer to ISIS® for details on how to construct a safety chamber.**

**WARNING**

**When using a cutting torch, always wear properly rated protective eyewear and protective gloves.**

**NOTE**

**Make sure to mark the air line from the inlet port of the Spring Brake for use later during reinstallation.**

**WARNING**

**The MGM® Tamper Resistant spring brake is factory sealed for your protection. There are no serviceable parts inside the spring brake chamber. If you experience any damage or failure, replace the complete assembly. Never attempt to disassemble the spring brake chamber.**

**NOTE**

**On models fitted with external breather tubes, refer to Service Manual number S04020X, titled "Double Diaphragm MGM® Spring Brake," found on ISIS®.**

## Replacing the Service Brake Diaphragm

The removal and installation of the service brake diaphragm can be made easier by "locking off" the service chamber piston.

Apply the service brake by pressing the foot brake and, while applied, clamp a pair of vise grip pliers on the piston rod to prevent the rod from retracting when air pressure is released.

Release the spring brake completely. Refer to the Caging the Spring Brake procedure found earlier in this program.

Remove both air lines from the chamber. Use a $^{9}/_{16}$-inch wrench or socket to remove the clamp ring nuts on the service brake clamp ring.

While holding the spring brake chamber securely in place, remove the clamp ring to allow the removal of the spring brake chamber from the assembly.

When servicing a 3 inch “long stroke” model brake, be sure to replace with the correct diaphragm. Installation of a standard, or 2 1/2 inch, stroke diaphragm in a 3 inch “long stroke” chamber could result in failure of the unit.

Position the diaphragm in the bottom recess of the chamber. Replace the service brake clamp ring, making sure that all mating parts and the air inlet ports are aligned to reconnect properly.

Reinstall the clamp ring bolts and nuts. Firmly tap around the circumference of the clamp ring with a hammer to ensure the clamp is fully seated.

**NOTE**

**Inspect all parts in the service chamber (especially the diaphragm) and replace the return spring, and any other parts that may be damaged or worn.**

**NOTE**

**Remove the vise-grip pliers from the service piston rod so that the piston can return to a normal position in the chamber. Test for air leaks around the circumference of the service brake clamp ring. If bubbles appear, firmly tap the circumference of the clamp ring with a hammer and retighten the clamp ring nuts to 25–30 ft.-lbs.**

**CAUTION**

**Operating units without the end cap securely in place will cause premature failure of the spring brake assembly and will void any warranty.**

Alternately tighten each nut in 5–10 ft.-lb. increments while rechecking the alignment of the mating parts. Tighten to the specification found on ISIS®.

Apply Teflon® tape or sealing compound to the hose fittings and reinstall both of the air lines to the chamber, making sure each is mated to the correct air inlet port according to markings made earlier. Tighten the fittings into the chamber air inlet ports.

Use vehicle system air to charge the spring brake chamber with full line air pressure. With the spring brake still fully charged with full line pressure, apply and hold the foot brake pedal to charge the service brake chamber.

Use soapy water to inspect for air leaks at the air lines and fittings. If bubbles appear, tighten fittings slightly, but not more than 30 ft.-lbs.

With air pressure exhausted from the service chamber, but with line pressure still on the spring brake, remove the release nut, flat washer and release bolt.

Stow these parts in the storage pocket on the chamber and tighten the nut against the flat washer to the specification found on ISIS®.

Replace the end cap properly. Operating these units without the end cap securely in place will void any warranty.

## NOTE

**After replacing the service brake diaphragm or the spring and service brake chamber, the service piston rod stroke and actuating alignment must be checked to ensure correct installation and foundation brake adjustment. No foundation brake adjustments can be made at either the spring brake chamber, or at the service brake chamber–all stroke adjustments must be made at the slack adjuster. Refer to the adjustment procedures outlined later in this module.**

## NOTES

# Foundation Brakes Module 2

## Wheel, Hub & Drum

Raise the vehicle and support it with suitable jack stands.

**WARNING**

**A jack must NEVER be used alone to support a vehicle while under-chassis service is being performed. Always support the vehicle with suitable jack stands.**

If servicing a brake assembly with a spring brake, the spring brake must be caged. Refer to the Caging the Spring Brake section of this program.

It may be necessary to back off the brake adjustment to gain enough clearance for drum removal.

Remove the brake drum assembly. The type of drum mounting determines how it is removed.

Inboard-mounted drums are secured to the hub assembly on the brake side of the hub. With this type of drum, the wheel, hub and drum are removed as one assembly.

Outboard-mounted drums are secured between the wheel and the hub. When these drums are serviced, the wheels are removed first, so that the drum can be removed without disturbing the hub assembly. This will eliminate having to service the wheel bearings.

## Removing Brake Groups with Spiders

There are three basic variations of brake groups that use spiders:

- Eaton® brake groups use a fixed anchor pin with open end shoes at the anchor end.
- Rockwell “P” Series have removable anchor pins that use brake shoes with closed anchor pin openings.
- Rockwell “Q” Series have removable anchor pins with bushings and brake shoes with open anchor pins.

## Rockwell “Q” Series Brake

Remove the brake shoes.

# Cleaning & Inspection

## Anchor Pins

Anchor pins should be inspected for signs of wear. Clean all dirt and rust from the anchors and apply a light coat of lubricant. Ensure that the anchor pins, anchor pin ears, and S-cam roller ears are properly lubricated before installing new brake shoes.

If anchor pins are worn, they must be replaced.

**NOTE**

**Anchor pins can be replaced on all brake groups except Eaton®. Eaton® anchor pins are staked in place and are replaced with the spider.**

## Brake Shoe Return Springs

Inspect the brake shoe return springs for nicks, twisted shanks, or spread coils. Damaged springs must be replaced. The return spring should be replaced whenever the shoes or linings are replaced.

## Spider

Inspect the spider for damage. If any cracks are found, the spider must be replaced.

## Camshaft Bushings & Rollers

Clean all dirt and rust from rollers and the camshaft.

Inspect the camshaft, and bushing for wear. If noticeable signs of wear exist, replace worn parts.

Only remove camshaft bushings from the spider or mounting bracket when replacement is necessary.

**⚠ CAUTION**

**Brake Automatic Slack Adjusters (ASAs) should not need to be manually adjusted in service. ASAs should not routinely have to be adjusted to correct excessive pushrod stroke. Excessive stroke indicates that a problem exists with the foundation brake, ASA, brake actuator, other brake system component, or their initial adjustment.**

## Installing Brake Groups with Spiders

On “Q” Series brake groups, anchor pins are held in place by the shoes,

eliminating snap rings, felts and set screws. Ensure that the anchor pins, anchor pin ears, and S-cam roller ears are properly lubricated before installing new brake shoes.

Install the brake shoes.

**⚠ CAUTION**

**In the event that a manual adjustment must be performed, a complete inspection of the foundation brakes, ASA, and other brake system components must be made BEFORE the manual adjustment. This will ensure the integrity of the overall brake system, prior to returning the vehicle to service.**

## Automatic Slack Adjusters

Refer to ISIS® for the correct angle between the slack adjuster arm and the pushrod length. This is necessary since different dimensions are required for automatic and manual slack adjusters and also due to the various slack adjuster lengths and manufacturers.

# Conclusion

This concludes Program VI of the Air Brakes series. Completion of this educational process is a key component towards International® technician certification. You are now required to take a post-test via ISIS®/ Education/Service/Online Testing.

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