



FT AIR SYSTEM

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OBJECTIVES

- Identify sub systems within the complete air system
- Identify components in all systems
- Understand operation of components







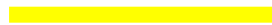
INTRODUCTION

The purpose of an air brake system on heavy duty vehicles is to convert air pressure to mechanical energy to activate the foundation brakes. Federal Motor Vehicle Safety Standard (FMVSS) 121 dictates how this is to be accomplished for over-the-road vehicles.

The purpose of this presentation is to help you identify air system components and understand how they operate within FMVSS 121 requirements.

- **Air systems are categorized into:**
- **Air Supply**
- **Parking/Emergency**
- **Primary Service**
- **Secondary Service**
- **Anti-Compounding**
- **Emergency**

Air Brake System Color Key

	SUPPLY
	PARK/EMERGENCY
	PRIMARY
	SECONDARY
	SIGNAL LINE TO GOV

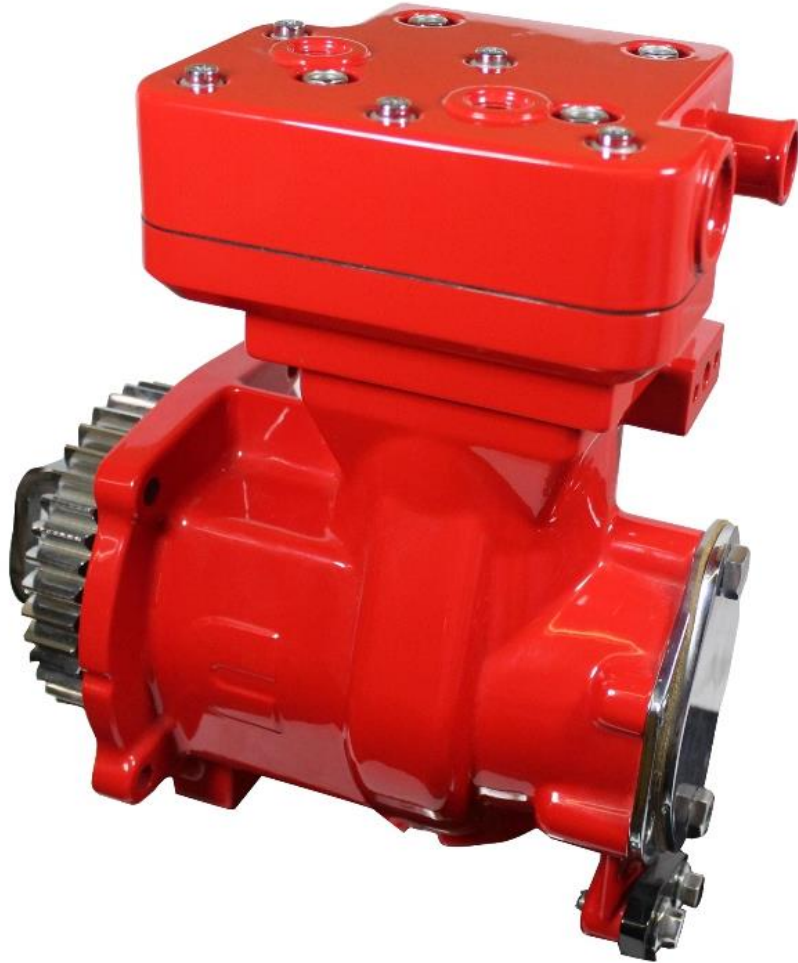


AIR SUPPLY SYSTEM



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AIR COMPRESSOR



- Compressors rely on the vehicle's engine to be driven, cooled and lubricated
- Compressors work on the same principal as a piston engine
- Sliding valve unloader for switching cycle
- FMVSS 121 requires that a compressor be of sufficient capacity to increase air pressure from 85 p.s.i. to 100 p.s.i. when operating at max RPM in approximately 25 seconds



AIR DRYER



- The dryer's main purpose is to remove moisture and contaminants created while compressing air
- Spartan utilizes the Meritor Wabco System Saver 1200 model with a system purge
- Requires Pressure Control Check Valve in air system for proper function
- External 150 p.s.i. safety blow off valve



SUPPLY TANK



- The supply tank (wet tank) is used to collect any moisture and contaminants not removed by the dryer
- FMVSS 121 states that the combined volume of all service and supply tanks must be at least 12 times the combined volume of all service chambers at maximum stroke



GOVERNOR



- The governor controls the compressor's operation similar to a on / off switch with an adjustable operating range
- The governor's cut-in (on) and cut-off (off) fixed pressure range is 25 p.s.i.
- When one end of the operating range is adjusted the other end changes the same amount
- FMVSS 121 requires that for trucks built after March 1997 the cut-in pressure must be 100 p.s.i. or greater



PRESSURE RELIEF VALVE



- The pressure relief valve, also referred to as a pop-off or safety valve, is used to protect the air system from excessive pressure
- 150 p.s.i. setting
- Located in air dryer and wet tank

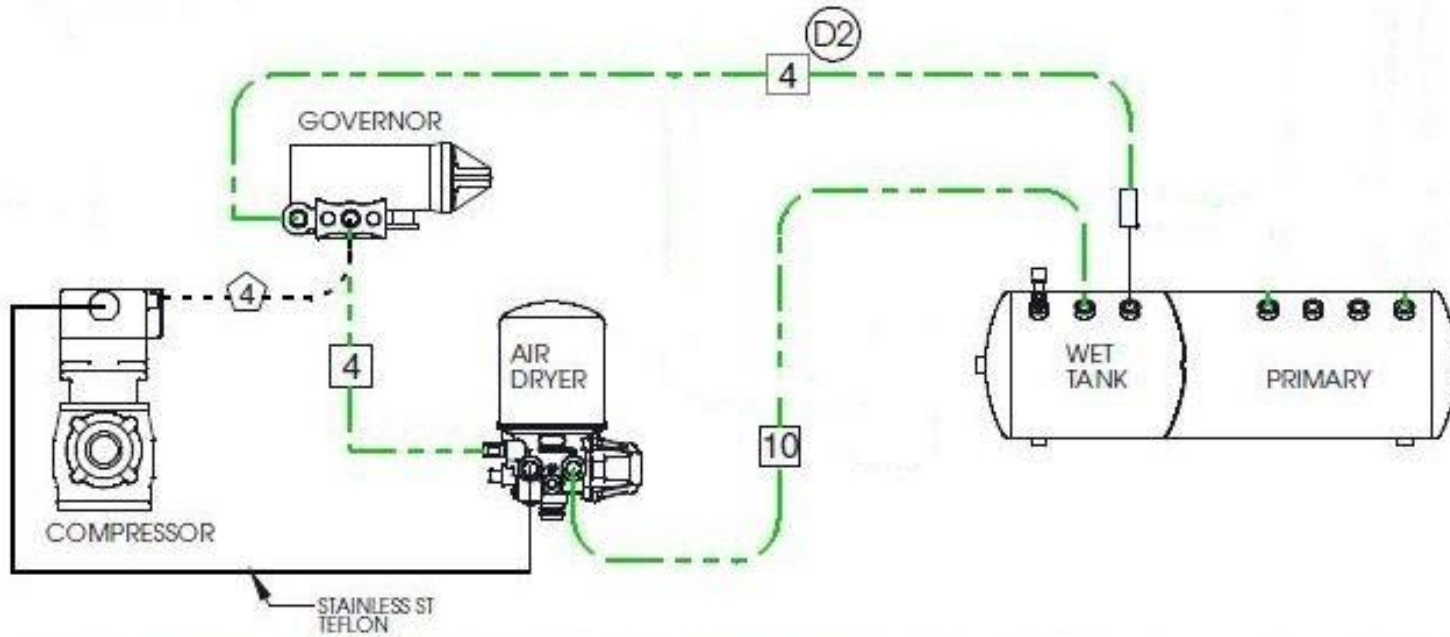


DRAIN VALVE



- Drain valves are required on primary and secondary reservoirs IF the vehicle is not equipped with a supply (wet) tank
- Manual and/or Automatic operation
- The Automatic valve works on internal pressure differential of 15-18 p.s.i.
- Automatic valves are available in heated versions for cold climates

SUPPLY AIR DIAGRAM



PRIMARY AIR SYSTEM

(Rear Brakes)

(air suspension, if equipped)



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PRESSURE CONTROL CHECK VALVE



- The Pressure Control Check Valve (PCCV) is used on the primary reservoir in conjunction with Wabco system purge style air dryer
- The PCCV maintains minimum air pressure (95 p.s.i.) in the primary tank. A One way check below 95 p.s.i.
- Once above 95 p.s.i., the PCCV allows air flow through the valve to purge the dryer
- FMVSS 121 requires that each reservoir system be protected against loss of air due to leak or failure



PRIMARY AIR TANK



- The primary air tank is used to provide an isolated storage area for air used to apply the rear brakes
- The combined volume of all service and supply tanks must be at least 12 times the combined volume of all service chambers at maximum stroke



DRAIN VALVE



- Drain valves are required on primary and secondary reservoirs IF the vehicle is not equipped with a supply (wet) tank
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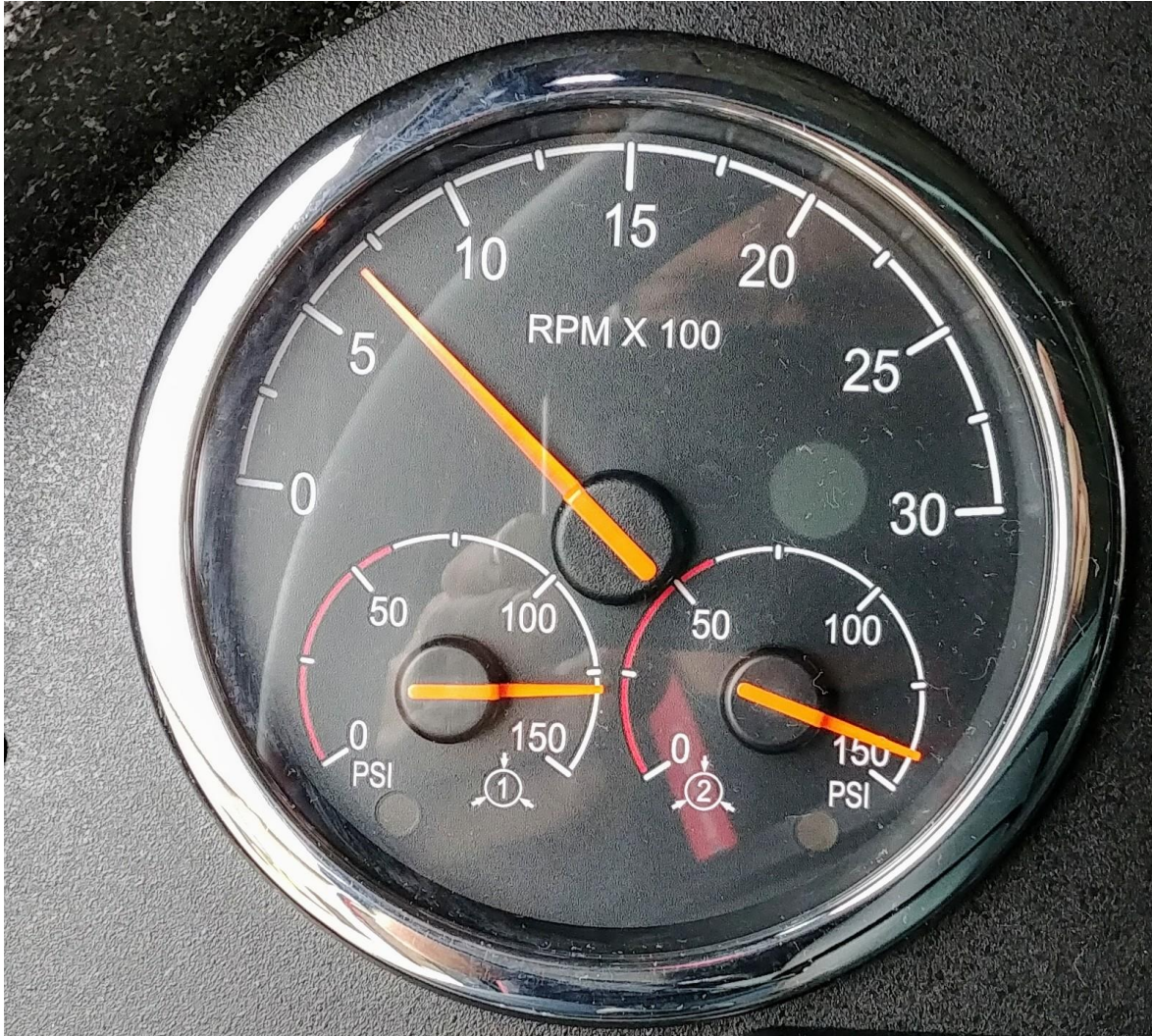
LOW PRESSURE SWITCH



- FMVSS 121 states that a warning indicator must be present when system air is below 60 p.s.i. in either the primary or secondary air tanks with the ignition on
- The warning indicator must be visual but can also be audio and visual



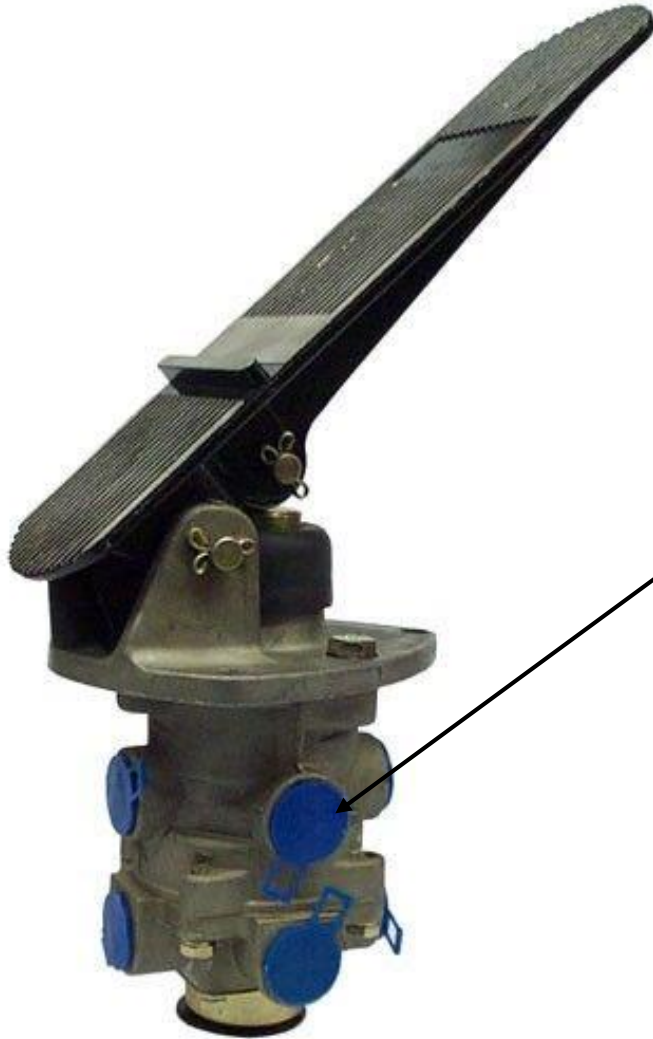
AIR GAUGE



- Air gauges are required by FMVSS 121 so the driver can monitor the pressure in each system while seated in a normal driving position
- System 1 gauge is the primary air system, green air lines (rear brakes). The System 1 gauge will be @10 p.s.i. lower than the System 2 gauge when system purges



FOOT CONTROL (TREADLE) VALVE



- The treadle valve provides the driver modulated control of the service brakes
- The primary (rear brakes) are closest to the pedal and applied first via mechanical force
- The primary section applies 3-5 p.s.i. before the secondary section begins to apply which aids in braking balance



STOPLIGHT SWITCH



- The stoplight switch is required by FMVSS 121 and states the brake lights must activate before brake chamber pressure reaches 6 p.s.i.
- Both primary and secondary are monitored



ATC VALVE



Automatic Traction Control helps move vehicles on slippery surfaces and reduces drive wheel over spin in two ways.

- If a drive wheel starts to spin, ATC brakes that wheel and transfers torque to the wheel with better traction
- If all drive wheels spin, ATC reduces engine torque to provide better traction
- Available option all ABS equipped trucks



COMBINATION VALVE



- The primary system (rear brakes) use a combination valve which incorporates the service relay valve and the ABS modulators into one unit

SERVICE RELAY VALVE



- A service relay valve is used to send a modulated signal from the treadle valve to the service chambers when sending air long distance
- Relay valves use crack pressure to promote brake balance. Crack pressure is the amount of pressure it takes to open the valve before any air passes through it. Crack pressure is built into the valve and is available from 0-12 p.s.i. depending on the brake timing/balance requirement



ABS MODULATOR VALVE



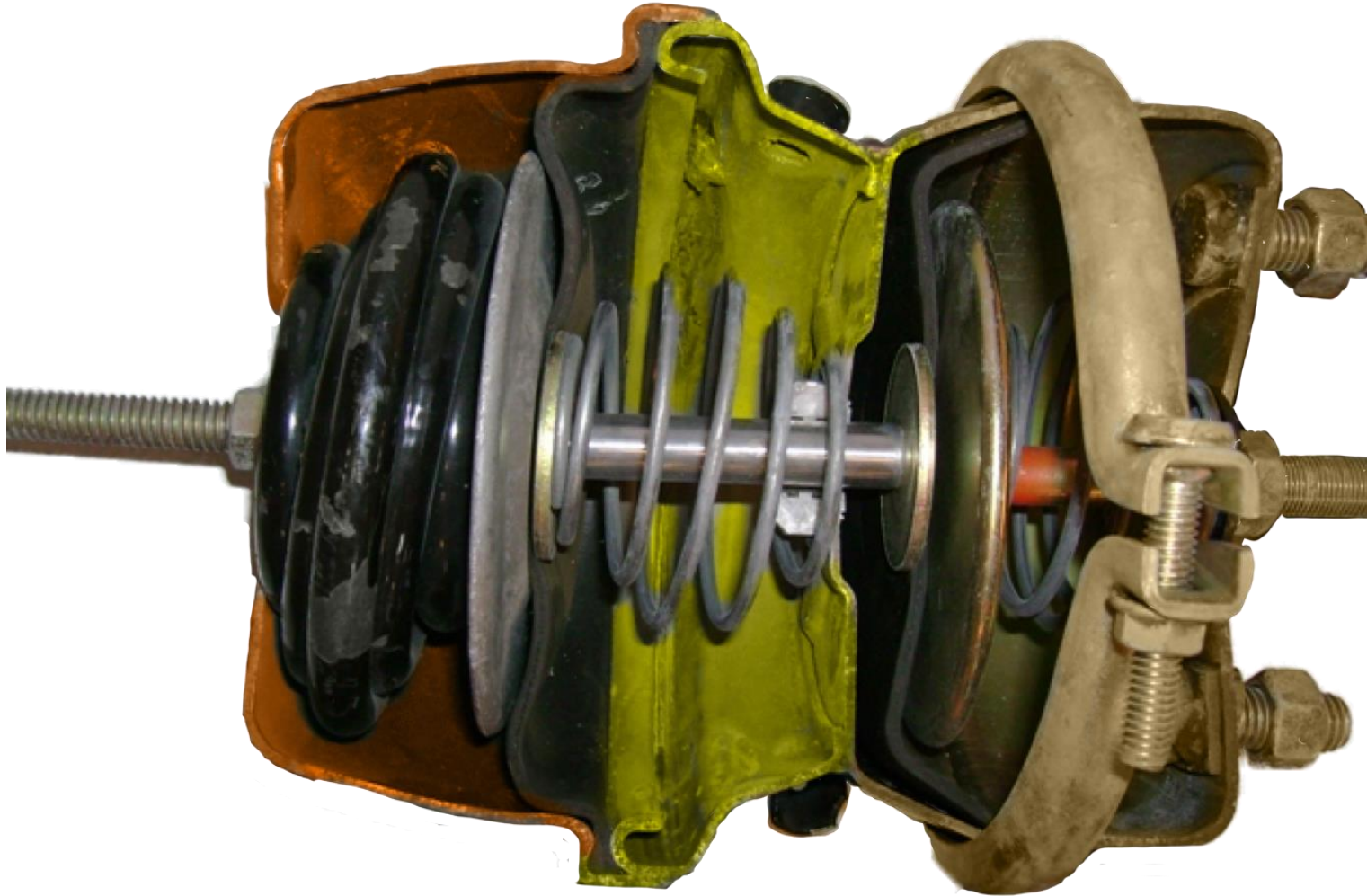
- The ABS modulator valve modulates the air pressure in the brake chamber if wheel lock-up is imminent. During normal braking air passes directly through the valve. If the ABS is actuated the valve will modulate chamber pressure

SERVICE SPRING BRAKE CHAMBERS



- Brake chambers are used to convert air pressure into linear motion to activate the brakes
- The push rod comes out of the service side of the chamber
- There is approximately 1800 lbs. of force inside the park brake side of the chamber making it one of the most dangerous components on a heavy duty truck

CHAMBER CUT AWAY

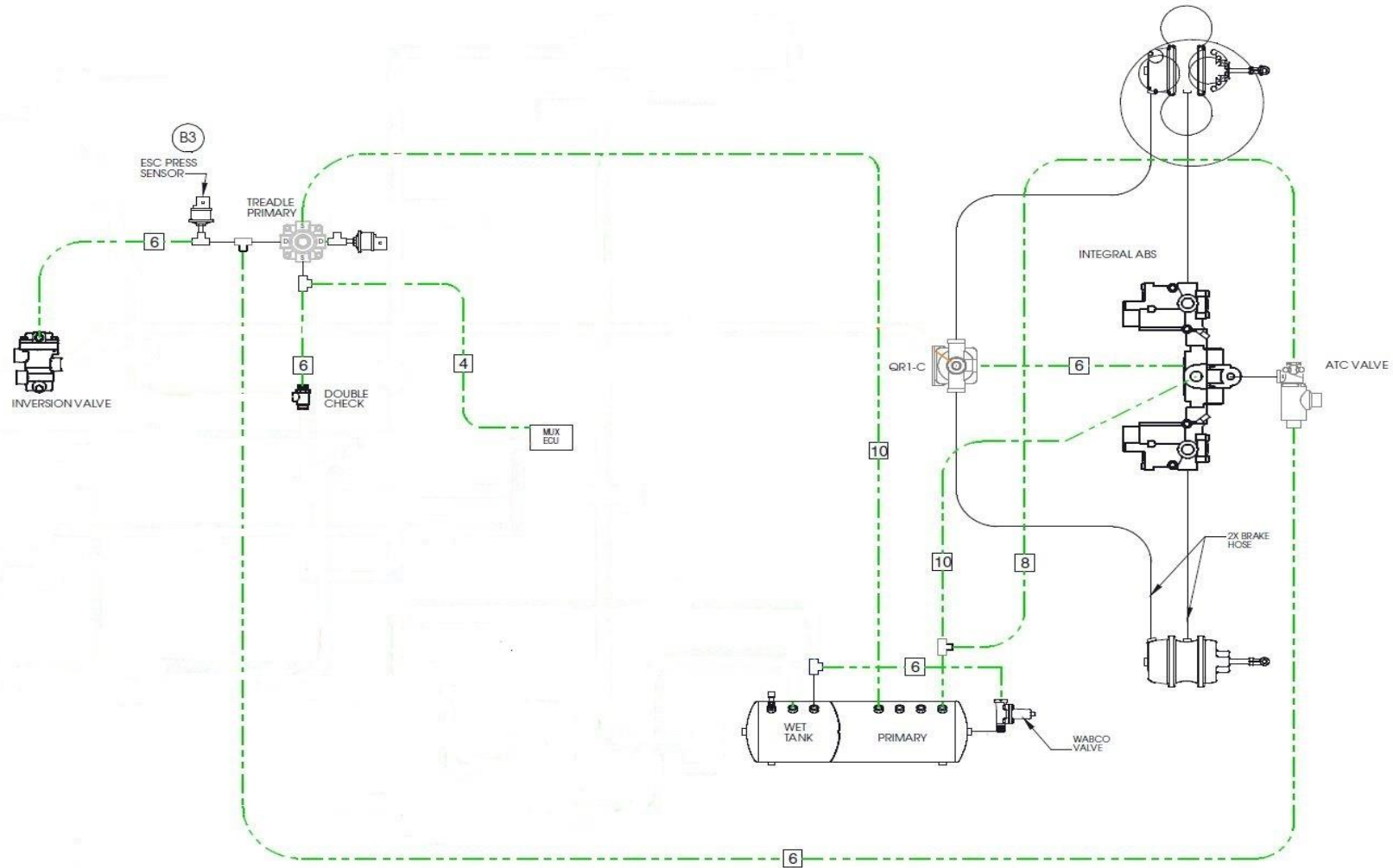


AUTOMATIC SLACK ADJUSTER



- Slack adjusters convert linear motion from the brake chamber to rotary motion to apply the foundation brakes
- A properly adjusted and working automatic slack adjuster will keep the brakes adjusted throughout the brakes friction materials life
- Automatic slack adjusters were mandated on all new vehicles manufactured on or after October 1994

PRIMARY AIR DIAGRAM



SECONDARY AIR SYSTEM

(Front Brakes)



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PRESSURE PROTECTION VALVE



- Normally closed until a specific pressure is reached on the supply port, once that pressure is reached it pushes on the piston and delivers air until pressure drops below the specific pressure again
- Used to protect tanks against excessive air leaks and to slow the rate of fill in auxiliary tanks to ensure sufficient air build up in main tanks



ONE-WAY CHECK VALVE



- A one-way check valve is used on the secondary reservoir to allow air to flow from the wet tank into the secondary reservoir but does not allow the air to flow in the opposite direction
- FMVSS 121 requires the service reservoirs to be protected against the loss of air pressure

SECONDARY AIR TANK



- The secondary air tank is used to provide an isolated storage area for air used in the front brakes
- The combined volume of all service and supply tanks must be at least 12 times the combined volume of all service chambers at maximum stroke



DRAIN VALVE



- Drain valves are required on primary and secondary reservoirs **IF** the vehicle is not equipped with a supply (wet) tank
- Manual and/or Automatic operation
- The Automatic valve works on internal pressure differential of 15-18 p.s.i.
- Automatic valves are available in heated versions for cold climates

LOW PRESSURE SWITCH



- FMVSS 121 states that a warning indicator must be present when system air is below 60 p.s.i. in either the primary or secondary air tanks with the ignition on
- The warning indicator must be visual but can also be audio and visual

AIR GAUGE



- Air gauges are required by FMVSS 121 so the driver can monitor the pressure in each system while seated in a normal driving position
- System 2 air gauge is the secondary air system, red air lines (front brakes and air suspension if equipped)



FOOT CONTROL (TREADLE) VALVE



- The treadle valve provides the driver modulated control of the service brakes
- The secondary (front brakes) section is applied via primary air, if primary air is not available due to a failed primary system, the secondary section is mechanically applied



ESC VALVE



Electronic Stability Control is the combination of Roll Stability Control, along with directional stability in order to keep the vehicle traveling safely by providing spinout and drift control.

- Provides application of one or both front brakes, as directed by the ESC module, in an ESC event
- Works in conjunction with the ATC valve during an ESC event to apply ANY brake the ESC module deems necessary
- Available option with ABS equipped vehicles



SERVICE RELAY VALVE



- A service relay valve is used to control a large amount of air with a small amount of air
- Required on trucks with ESC for proper operation of ESC valve
- Relay valves use crack pressure to promote brake balance. Crack pressure is the amount of pressure it takes to open the valve before any air passes through it. Crack pressure is built into the valve and is available from 0-12 p.s.i. depending on the brake timing/balance requirement



QUICK RELEASE VALVE (QRV)



- The quick release valve releases air pressure from the air chambers quickly (3 seconds or less) to meet FMVSS 121 release timing requirements
- The QRV may have a differential pressure to aid in brake balance. Differential pressure is the difference between inlet pressure and outlet pressure
- Example: A QRV-030 has a 3 p.s.i. differential meaning 10 p.s.i. in will give you 7 p.s.i. out



ABS MODULATOR VALVE



- The ABS modulator valve modulates the air pressure in the brake chamber if wheel lock-up is imminent. During normal braking air passes directly through the valve. If the ABS is actuated the valve will modulate chamber pressure

SERVICE BRAKE CHAMBER



- A service brake chamber is used during braking to convert air pressure into linear force
- Service chambers are available in standard and long stroke models
- A short stroke chamber will have round port extrusions and a long stroke will have square port extrusions
- The chambers are NOT interchangeable



AUTOMATIC SLACK ADJUSTER



- Slack adjusters convert linear motion from the brake chamber to rotary motion to apply the foundation brakes
- A properly adjusted and working automatic slack adjuster will keep the brakes adjusted throughout the brakes friction materials life
- Automatic slack adjusters were mandated on all new vehicles manufactured on or after October 1994

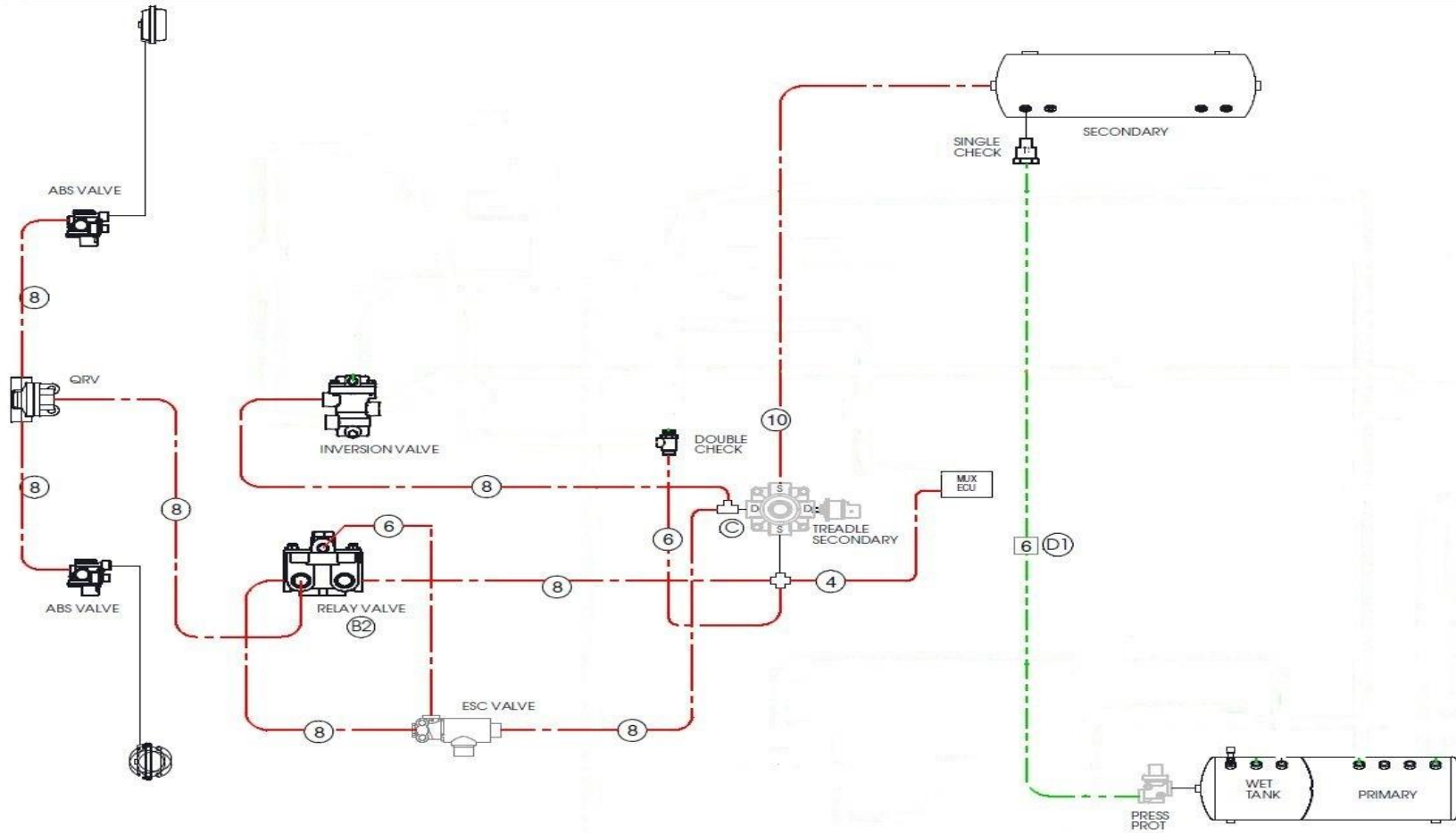
DISK BRAKE



- Disk brakes have very few moving parts compared to drum brakes
- Fewer moving parts equals less chance for parts to wear out



SECONDARY AIR DIAGRAM



PARK BRAKE SYSTEM



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TWO-WAY CHECK VALVE



- FMVSS 121 states that in the event either system (primary or secondary) fails you must still have the capability of releasing the vehicle parking brakes
- The two-way check valve meets this criteria by having both primary and secondary pressures at the two-way check and allowing dominant air to flow to the dash control valve



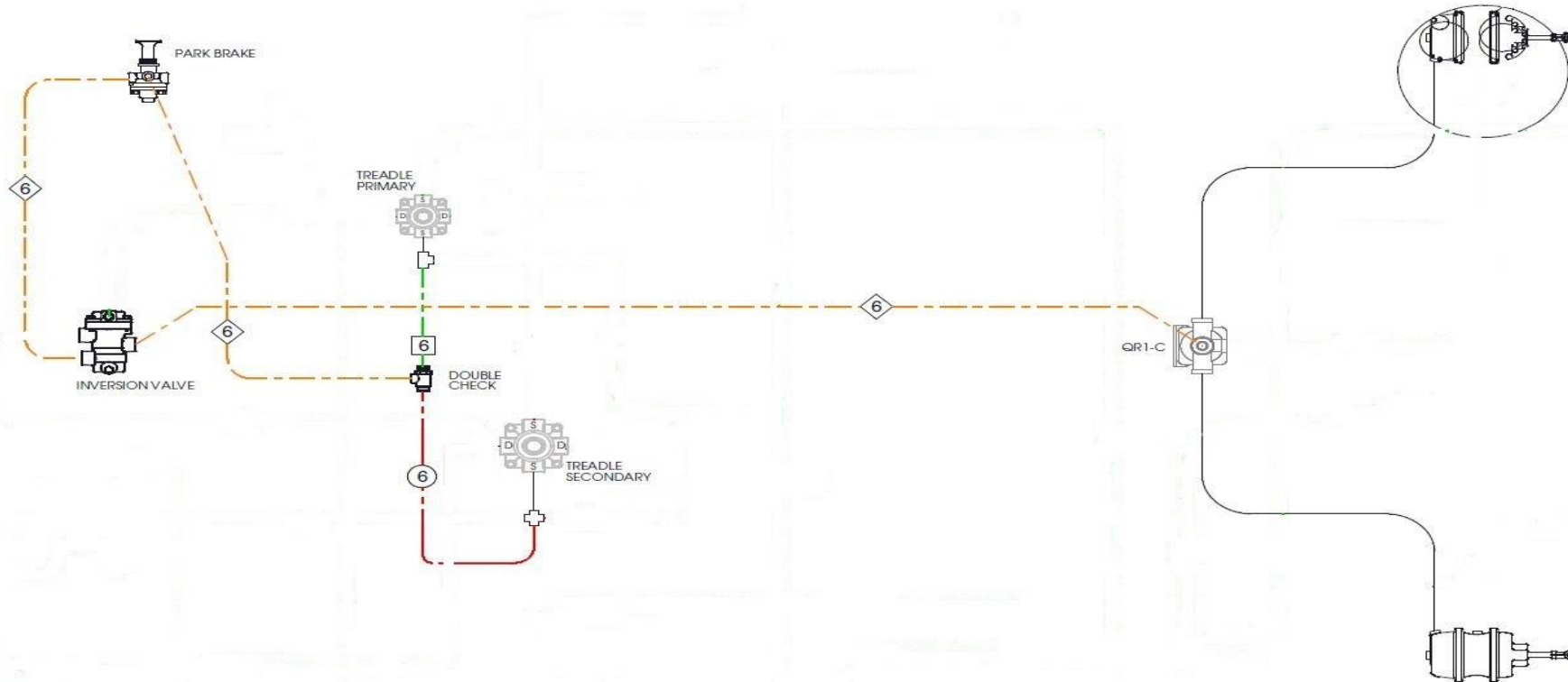
PARK BRAKE VALVE



- The park brake valve is needed to control the release and application of the vehicle parking brakes
- By regulation this valve must be identified as to what it controls and how it controls it



PARK BRAKE AIR DIAGRAM



ANTI-COMPOUNDING SYSTEM



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QUICK RELEASE DOUBLE CHECK VALVE



- The quick release double check valve is used for anti-compounding but is not mandated by law
- Anti-compounding prevents the service brake and park brake from applying simultaneously by sending the same amount of air to the spring side as the service side to equalize the force

QRV DOUBLE CHECK CONTINUED

Example of compounding:

- The spring in the brake chamber produces around 1800 lbs. of force. If the vehicle has 30/30 chambers and connected to a 6" slack adjuster:

$1800 \times 6 = 10,800\text{lbs}$ of force.

- At the same time, the driver steps on the brake pedal and delivers 50 p.s.i. to the service chamber:

$50 \text{ p.s.i.} \times 30" \text{ chamber} = 1500 \text{ lbs.}$

$1500 \text{ lbs.} \times 6" \text{ slack} = 9,000 \text{ lbs.}$

additional force

Things that can break due to compounding:

- Premature drum cracking
- Bent chamber push rods
- Broken mounting studs on chamber
- Premature slack wear
- Broken spring break mounting
- Broken S cams

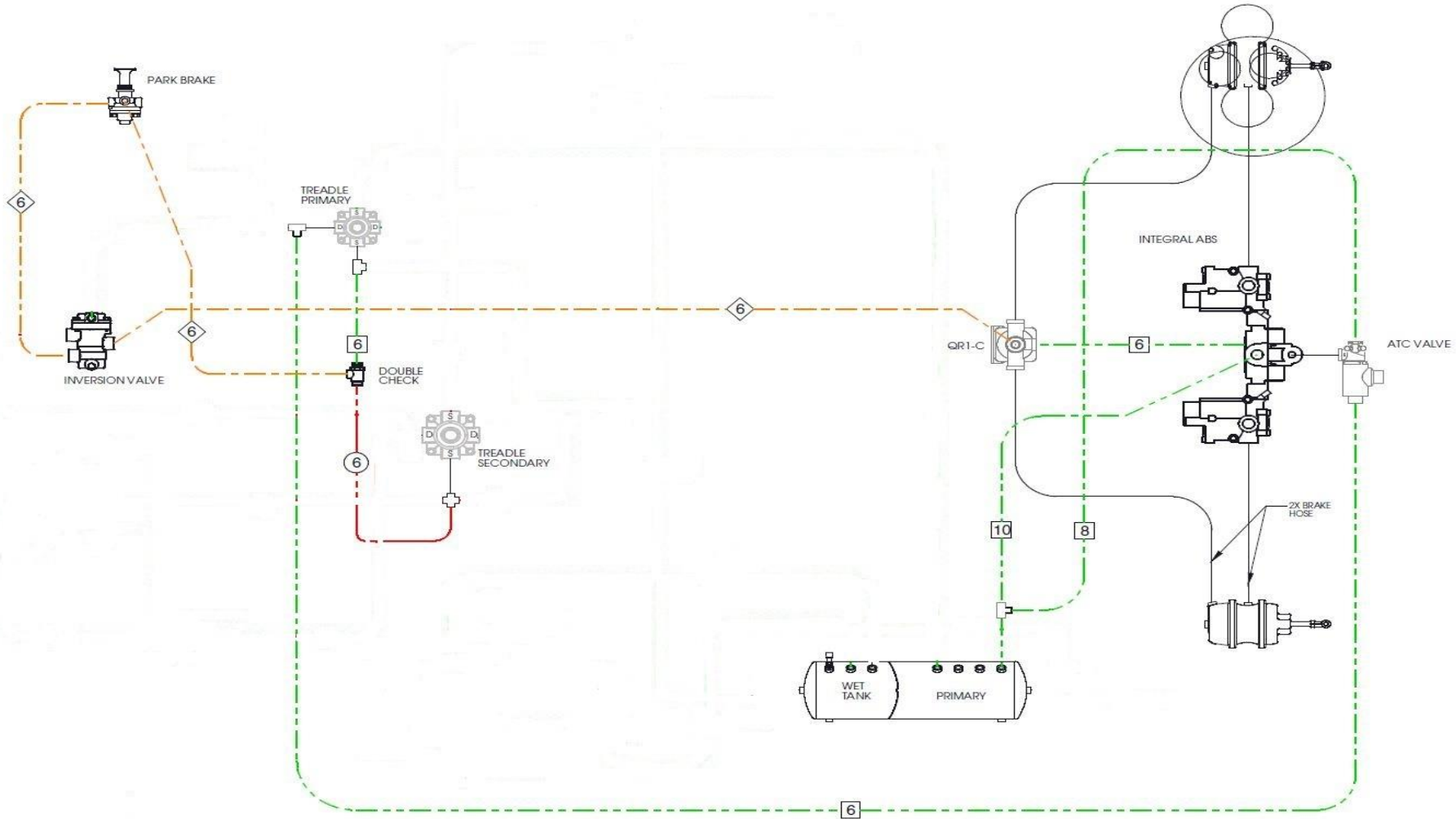


ANTI-COMPOUNDING TEST

- Start vehicle and build air until cut out
- Verify park brake is set
- Have someone apply service brake and watch the drive axle brake chambers
- They should NOT stroke past the park brake application



ANTI COMPOUNDING DIAGRAM



EMERGENCY SYSTEM



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INVERSION VALVE



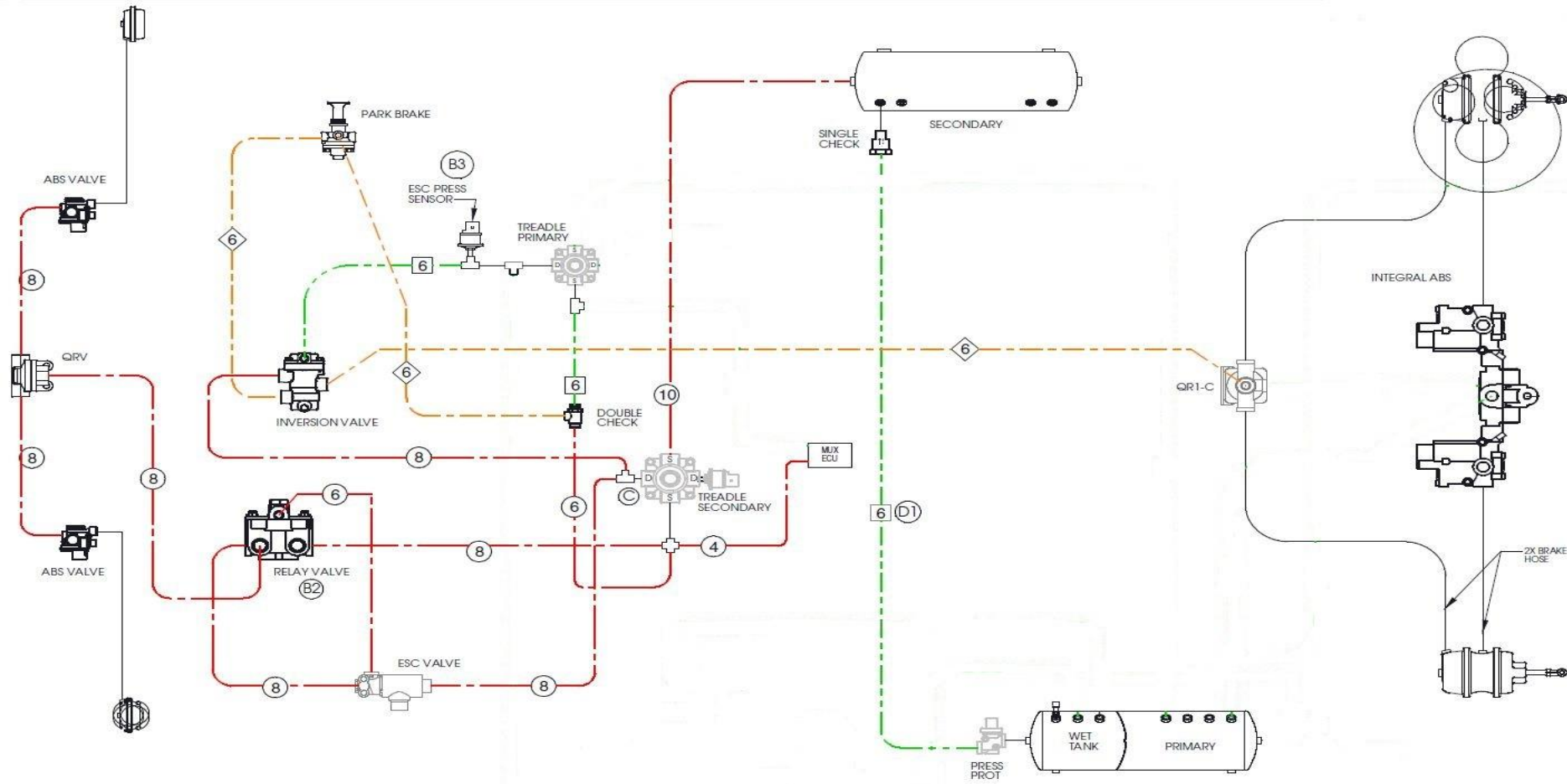
- The only time this valve must function is when there has been a primary system failure
- Parking brakes are held off via double check valve with secondary air
- The inversion valve receives the modulated secondary signal from the foot valve and equally releases air pressure from the spring chamber giving the drive axle a mechanical brake application

INVERSION VALVE TEST

- Start vehicle and build air until cut out
- Shut vehicle off
- Chock wheels and release parking brake
- Drain primary air tank to zero
- Have someone apply service brake a couple times and verify the drive axle chambers are stroking
- You should here air escaping as the service pedal is depressed and chambers are stroking



INVERSION VALVE DIAGRAM

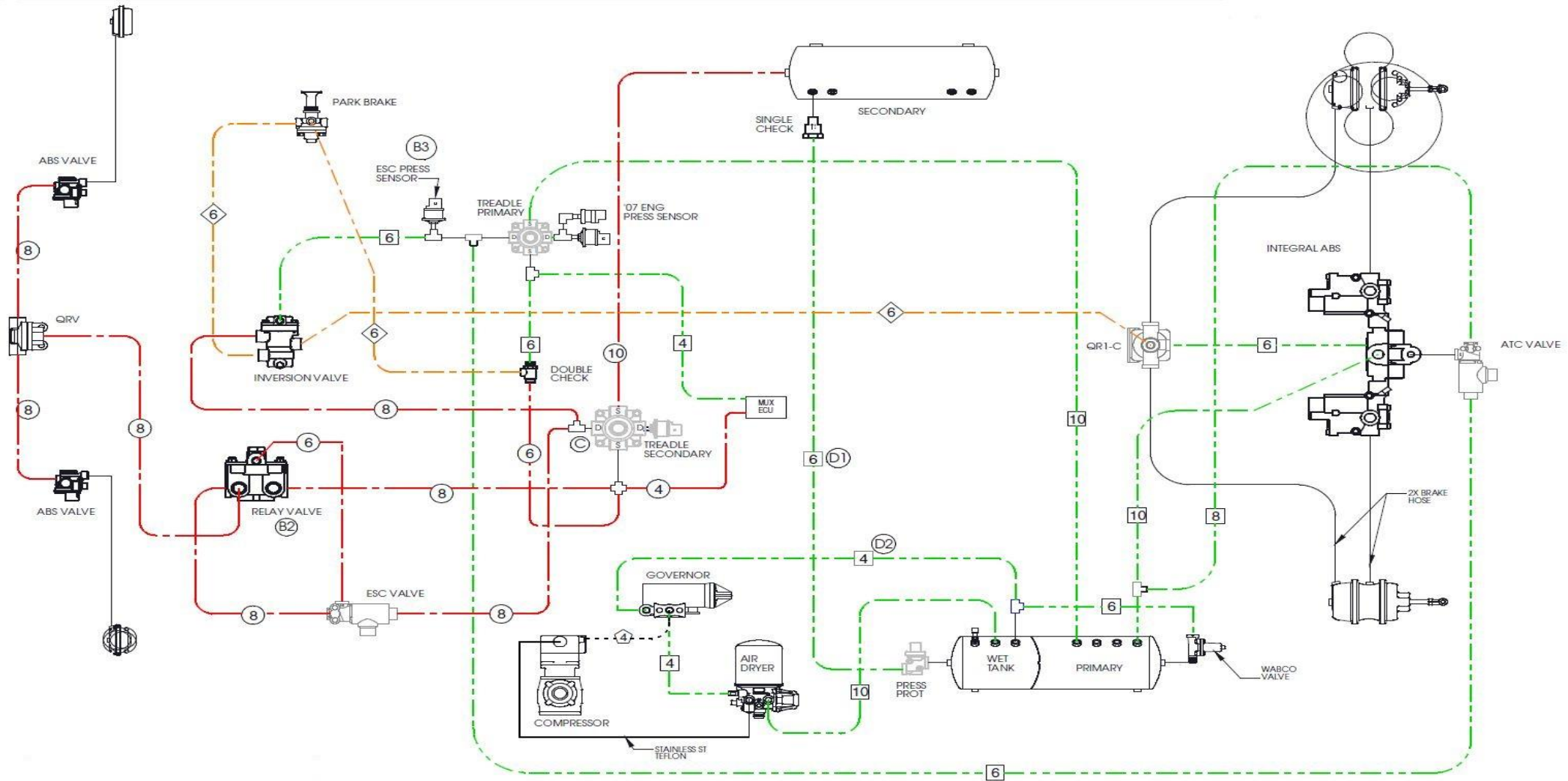


OBJECTIVES, WHAT DID YOU LEARN?

- Identify sub systems within the complete air system
- Identify components in all systems
- Understand operation of components



COMPLETE SYSTEM AIR DIAGRAM



TIMING AND BALANCE



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TEST DRIVE

Any unit that is safe to drive should be driven to access the brakes operation.

- Check for brake pull and noise
- On way back to shop make 4-5 slow downs from 40-10 mph
- Immediately upon arrival use temp gun to check drum/rotor temps and record them
- Temp readings will give information as to the operation of the foundation brakes



GOOD TEMPS SCENARIO

Test Drive

Checks when returning to shop

- Brake temperatures recorded
- Left front _185_ Right Front _190_
- Left Rear _210_ Right Rear _212_
- Left RR na Right RR na
- Example of brake temperatures



BAD BRAKE TEMP SCENARIO

Test Drive

Checks when returning to shop

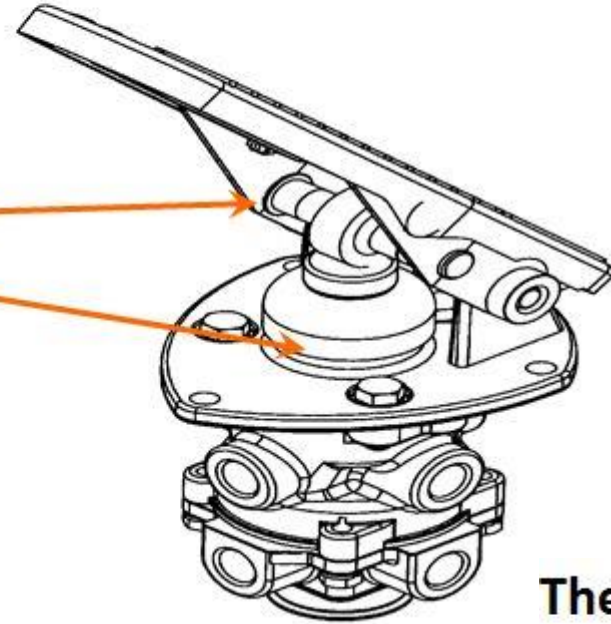
- Brake temperatures recorded
- Left front _345_ Right Front _348_
- Left Rear _375_ Right Rear _382_
- Example of brake temperatures



REPAIR

Air Brake System E6 foot valve

Lubricate
every
3 months
Or
25,000 miles
use
barium grease



The treadle valve (foot valve) is the only place that both primary and secondary brake can be activated or released on the unit so if all brakes are dragging or failing to release check foot valve for sticking.



BAD BRAKE TEMP SCENARIO #2

- Brake temperatures recorded
- Left front 345 Right Front 348
- Left Rear 165 Right Rear 167



REPAIR

Scenario #2 could be a few things

- Wrong quick release valve differential pressure
- Wrong crack pressure in relay valve
- Wrong friction material in front
- Front brakes hanging up



QUESTIONS, COMMENTS, CONCERNS?





THANK YOU