EMERGENCY VEHICLE OPERATOR
CLASS “B”

Module 2

Major Vehicle Systems

Pre-trip Inspections

Objectives

- Identify the major vehicle systems and their component parts
- Determine methods and requirements for pre-trip inspection of vehicle systems
- Define maintenance requirements for vehicle systems
- Review MCFRS out-of-service criteria for fire department apparatus
- Review defect reporting and resources for apparatus operators

Motivation
Why Know the Components?

- Correctly identify defects and write accurate defect reports
- Determine and differentiate between normal, monitoring, and out of service conditions
- Identify critical safety issues before they cause injury or damage
- Ability to communicate with mechanics when describing conditions – “speaking their language”
- Make educated decisions about the vehicle you are driving!

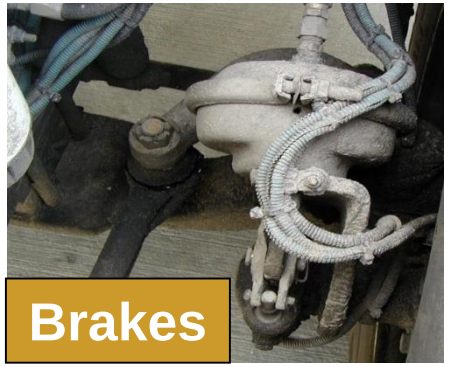
Definitions

- Leakage
  - Class 1: seepage of fluid; not enough to form drops
  - Class 2: leakage great enough to form drops; drops do not drip
  - Class 3: leakage great enough for drops to drip
- Operational Test: A test to determine the operational readiness of a component on a fire apparatus by observing the actual operation of the component.

Five Major Systems

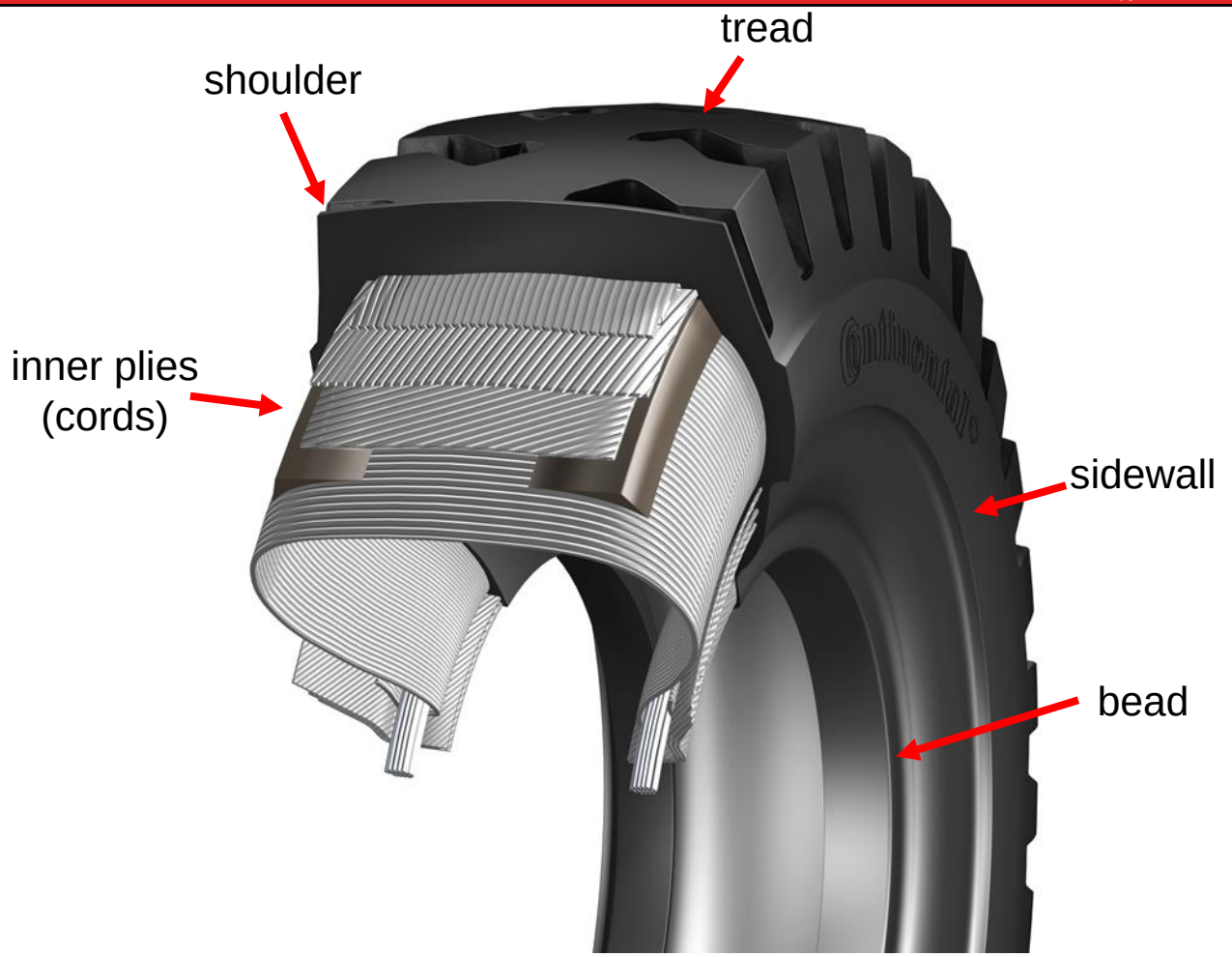
There are five primary vehicle systems that impact your ability to safely control the apparatus:

1. Tires
2. Wheels
3. Steering
4. Suspension
5. Brakes



Tires

- Key to all vehicle movement
  - Steering
  - Braking
  - Accelerating
- CID
  - Condition
  - Inflation
  - Depth



Tires
C: Condition

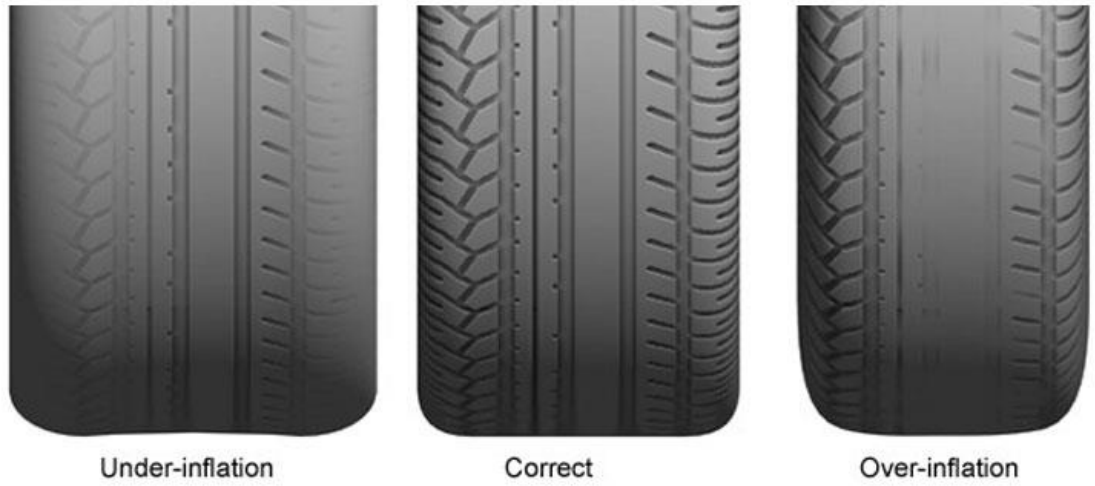
- No cuts that expose cord
- No bulges on sidewall which indicates cord separation
- Front tires are not re-grooved or recapped
- Front tires are not mismatched

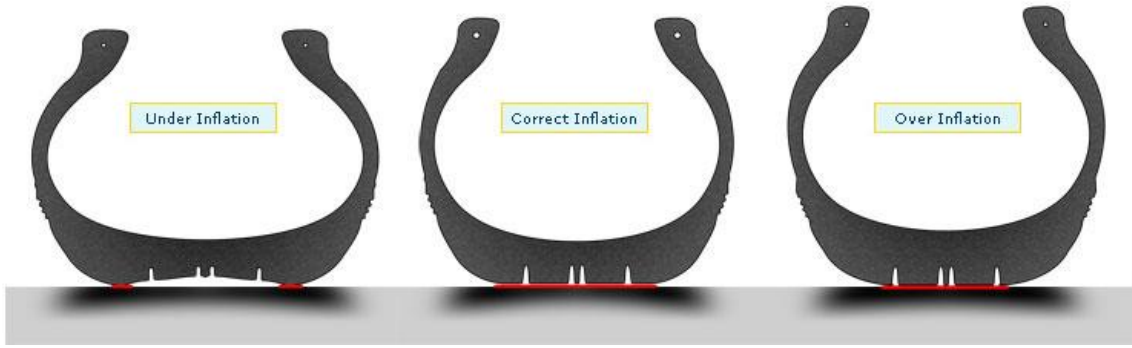
CID

Tires
I: Inflation

Improper inflation….

- ✓ Increases stress on the tire
- ✓ Reduces performance in emergency handling
- ✓ Increases wear
- ✓ Increases resistance to rolling and creates heat





Tires
I: Inflation

- Any tires obviously flat?
- Listen and look for leaks
- Look for abnormal bulging
  - Dual wheels should not be touching each other
  - 4 lugs touching the ground
- Measure the tire pressure
  - Verify against pressures provided by the manufacturer
  - On the data plate in the cab or on a door frame
- Ensure valve stems are capped and not touching the wheel
- Automated pressure monitoring systems are not in use in MCFR

CID

Tires
D: Depth

Insufficient tread depth….

- Increases stopping distance
- Reduces steering performance
- Fails to channel rain and snow from beneath the tread
  - hydroplaning

Tires
D: Depth

- DOT minimum tread depths
  - Steering axles: 4/32 inch
  - Other axles: 2/32 inch
- No pieces of tread missing exposing cords
- Tread should be worn evenly
- Tread depth will be obtained from any major groove
  - Check multiple areas around the tire
  - Check in different grooves
  - Check the deepest portion of the groove and not on top of a tie bar or hump

CID

Tires
D: Depth

Steering Axles—4/32”

When a Quarter is inserted into the grooves of the tread the top of George Washington’s head should be below the tread surface. The tread depicted in the photo has just enough tread depth.

Non-Steering Axles—2/32”

When a Penny is inserted into the grooves of the tread the top of Abraham Lincoln’s head should be below the tread surface. The tread depicted in the photo has just enough tread depth.

Tires
Other considerations

- Steering tires
  - Do the tread patterns match from side to side?
  - Are they the same size and type?
- Non-steering tires - duals
  - Each pair of tires is designed to carry a load together
  - Damage, incorrect inflation, or uneven wear transfers more load to one tire
  - Best practice is to mount only the same brand of tire with the same tread pattern and depth (within 4/32) in a dual assembly

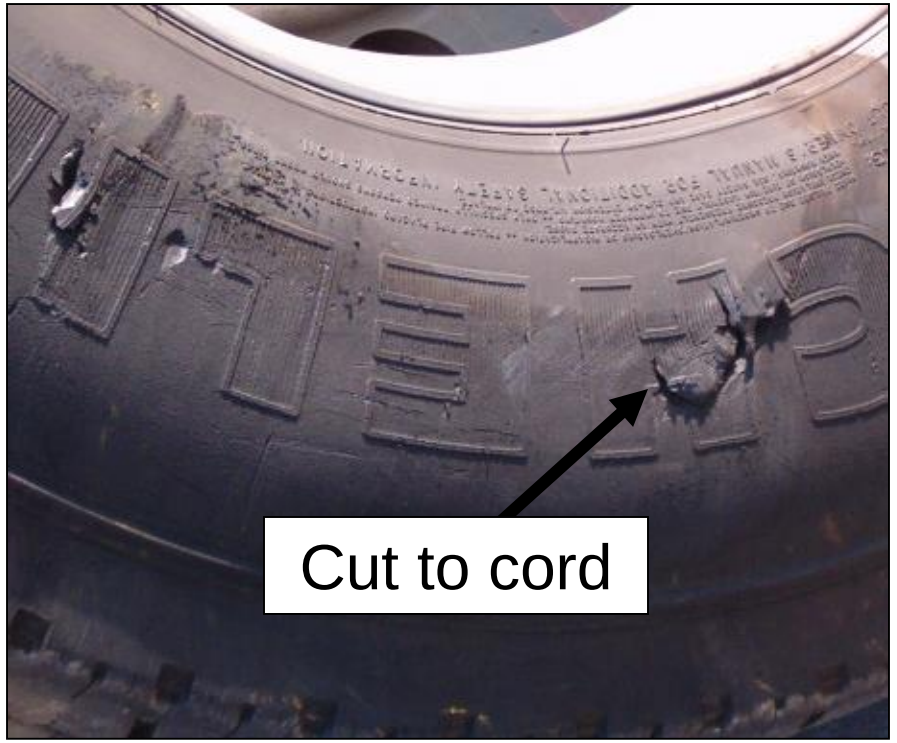
DOT does not mandate tire specifications

Tires
Other Considerations

- Does the tire capacity match the axle weight ?
- Does the tire's maximum air pressure match the wheels maximum air pressure ?
- Does the wheels maximum weight match the axle weight ?
- Are they certificate tire's
- Are they certificate wheels

Tires
OOS Criteria

- Steering tires with <4/32” of tread
- Rear tires with <2/32” of tread
- Tire pressure that exceeds maximum air pressure of the wheel
- Dual tires that are contacting each other even when at maximum pressure (overload)
- Tire that is cut to the cord
- Tire that is flat or has a detectable or audible leak
- Any tire with a noticeable bulge on the sidewall



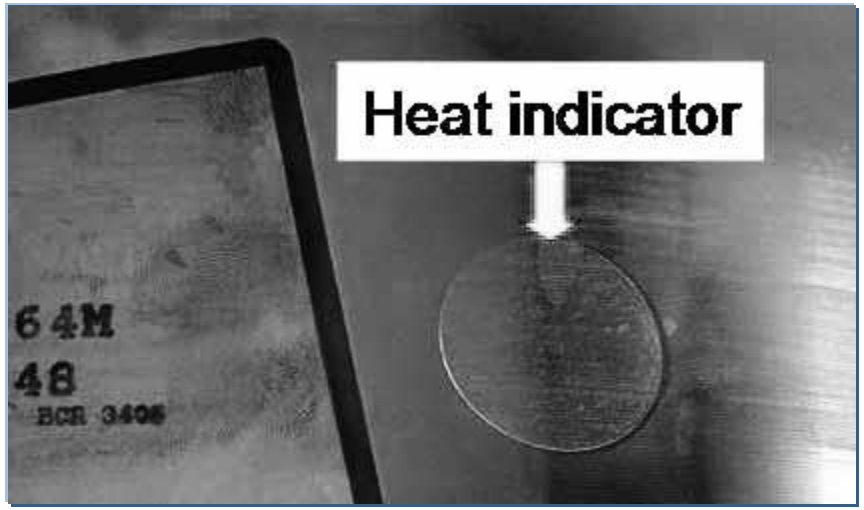
Wheels
Aluminum

- Single piece aluminum
- Inspect for:
  - Cracks
  - Corrosion
  - Wear
  - Rust streaks
  - Other damage
- Lugs must be hand tight
- Heat damage

Wheels
Aluminum – Pre-2009

A blistered, blackened or cracked looking logo decal on an Alcoa wheel may indicate that the wheel has been exposed to excessive heat

Wheels
Aluminum – Post-2009

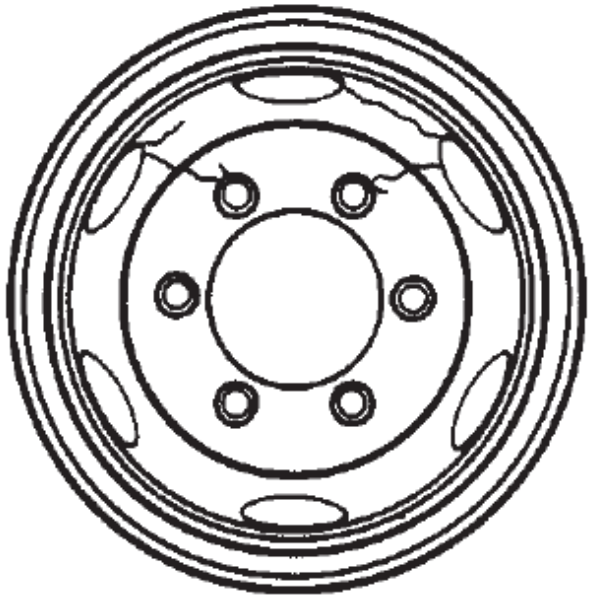


- Starting in January 2009, 1-inch round clear heat indicator near the stamp on the wheel
- Blistering, charred, blackened, or cracked appears indicates excessive heat

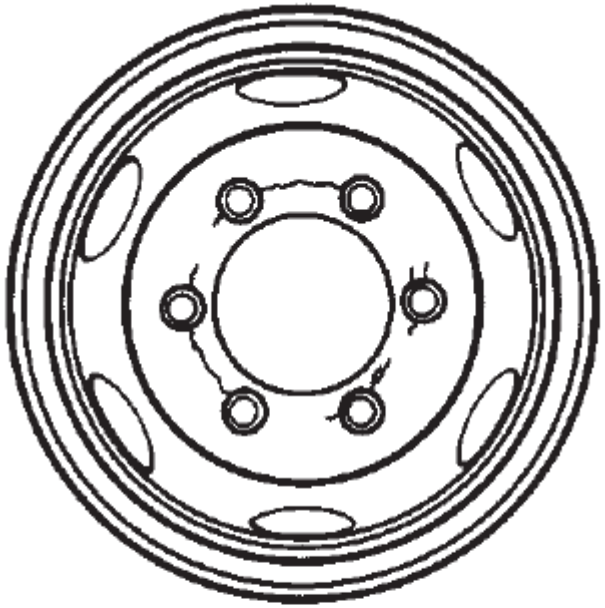
Wheels
Steel

- Single piece steel
- Inspect for:
  - Cracks
  - Corrosion
  - Wear
  - Other damage
- Lugs must be hand tight

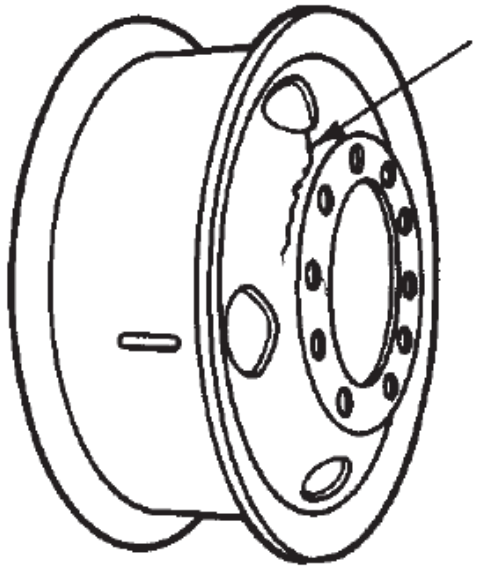
Wheels
Steel



Handhole to handhole.
Handhole to bolt hole.
Handhole to rim.
Cause: Overloading.



Bolt hole to bolt hole.
Causes: Loose cap nuts, small hub backup (also see bolt hole cracks/distortions).



Cracks at disc nave and/or handhole.
Causes: Bad fit-up, damaged hub, overload or sharp edge at handhole.

Wheels
Aesthetic Covers

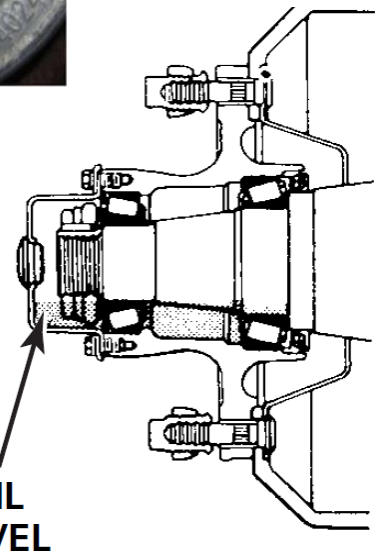
- Economical alternative to aluminum wheels
- Covers installed over steel wheels or old aluminum wheels
  - Hook onto hand holds
- Covers bear NONE of the load
- Hide corrosion, damage, leaking hubs, or defects in the load-bearing component of the wheel
- Obscures hub oil window

Wheels
Aesthetic Covers

Covers can hide a great deal of damage!

Wheels
Front Axle Hub Oil

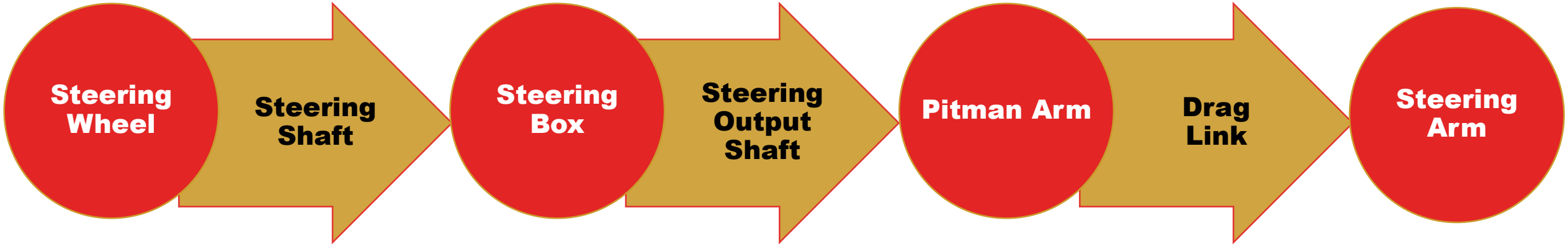
- Check hub seals for leaks
  - Look for oil spray on the hub and rims
- Before pulling the center plug, view the oil level through the sight glass
- With the plug removed, oil level should be well below the lip of the center plug
- Do not remove center plugs with screwdrivers or tools
  - Damage to the rubber seal or housing will result



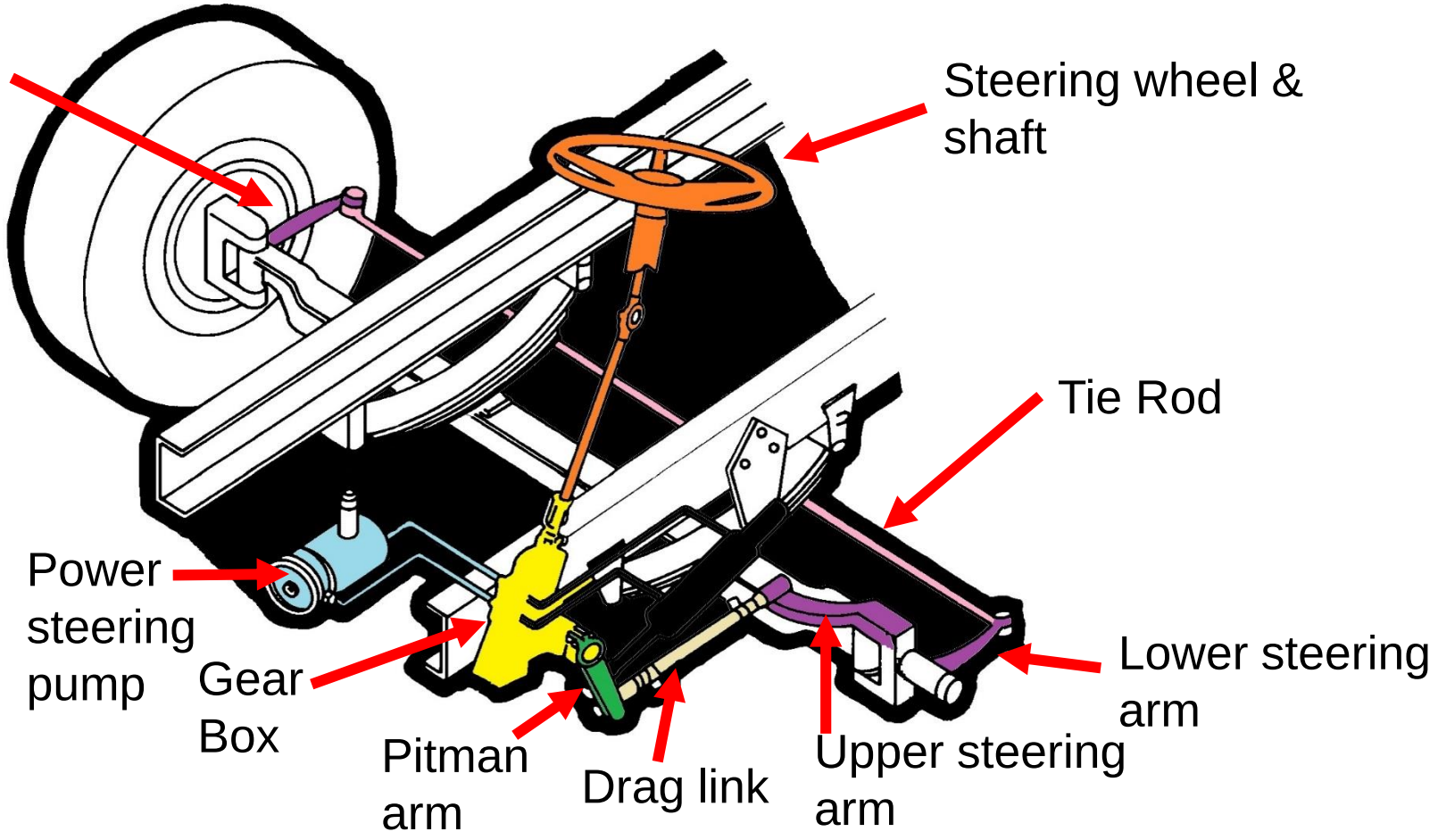
Wheels
OOS Criteria

- Wheel studs missing
- Loose wheel lugs
- Cracked, bent, or broken
- Hub seal with a Class 3 leakage or an empty reservoir

Steering System



Steering System

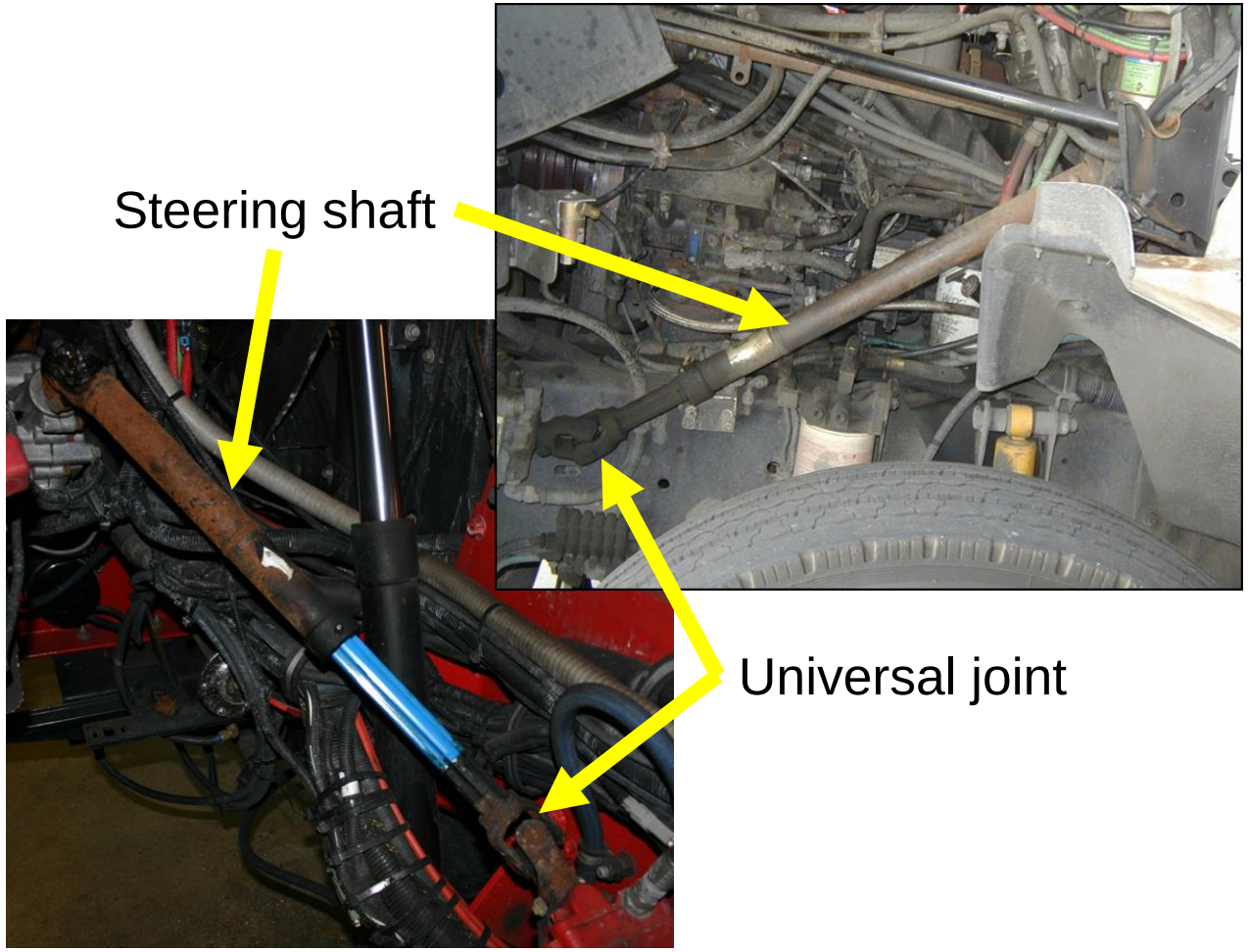


Steering System
Power Steering

- Fluid Reservoir
  - No leaks
  - No damage
  - Securely capped
  - Adequate fluid level
- Power Steering Pump
  - No leaks
  - No damage
  - Securely mounted

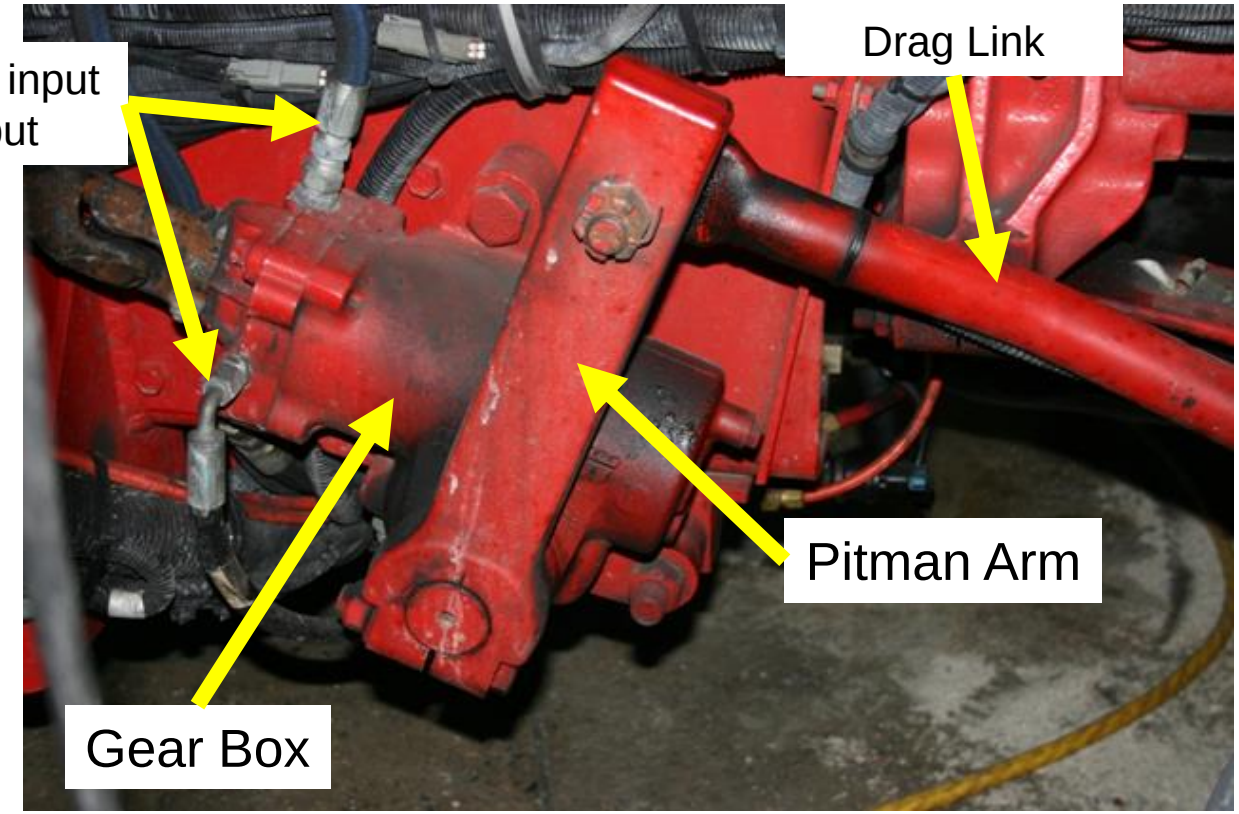
Steering System
Steering Shaft

- No bends
- No welds or repairs
- Universal joint(s) intact with no excessive play



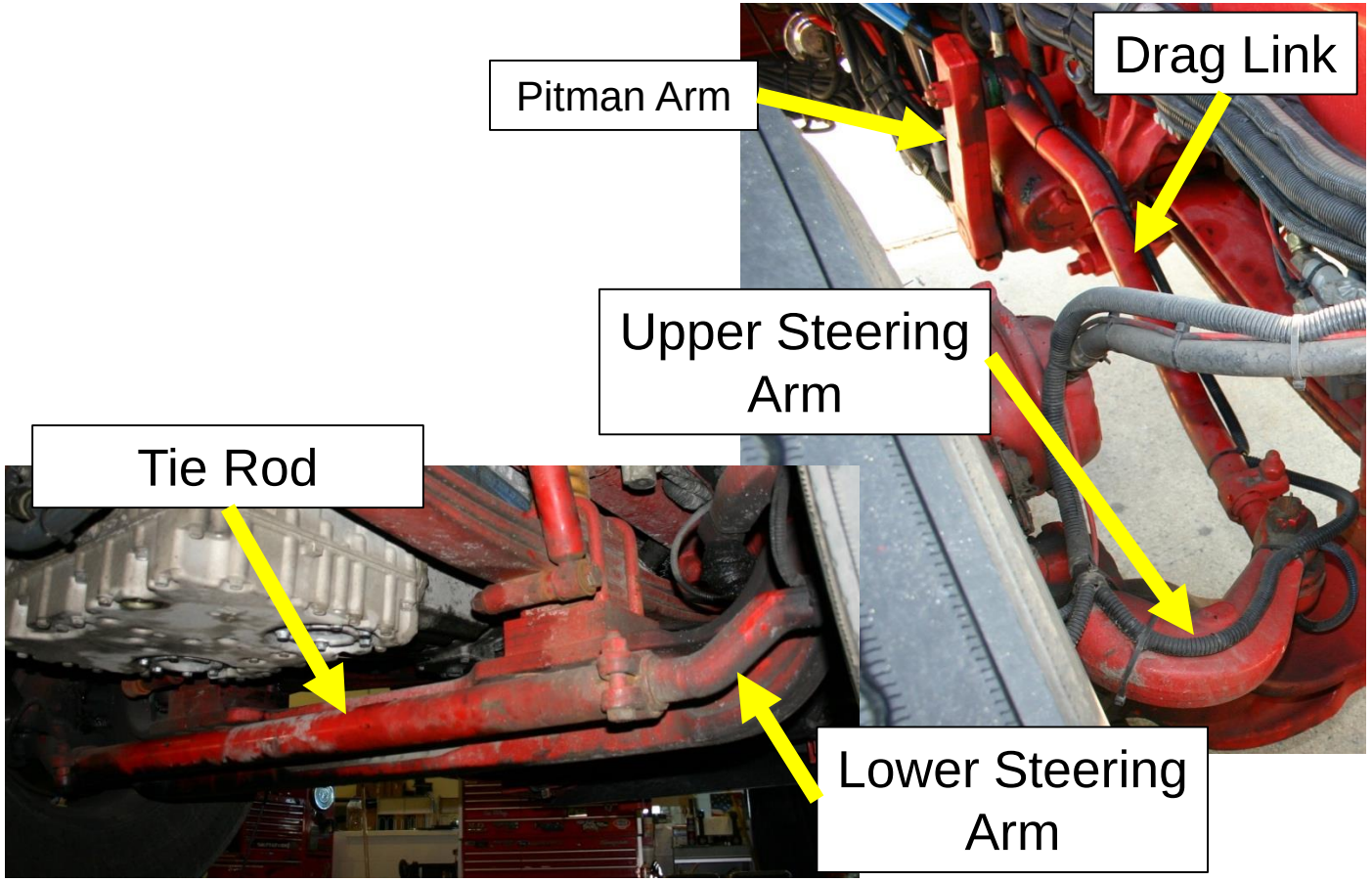
Steering System
Gear Box & Pitman Arm

- Gear Box
  - Securely mounted
  - Hoses in good condition
  - Hydraulic leaks
- Pitman Arm
  - Secure to the output shaft of the gear box
    - Markings on the pitman arm align with marking on the output shaft
  - Castle nut for drag link intact with cotter pin
  - No side to side play



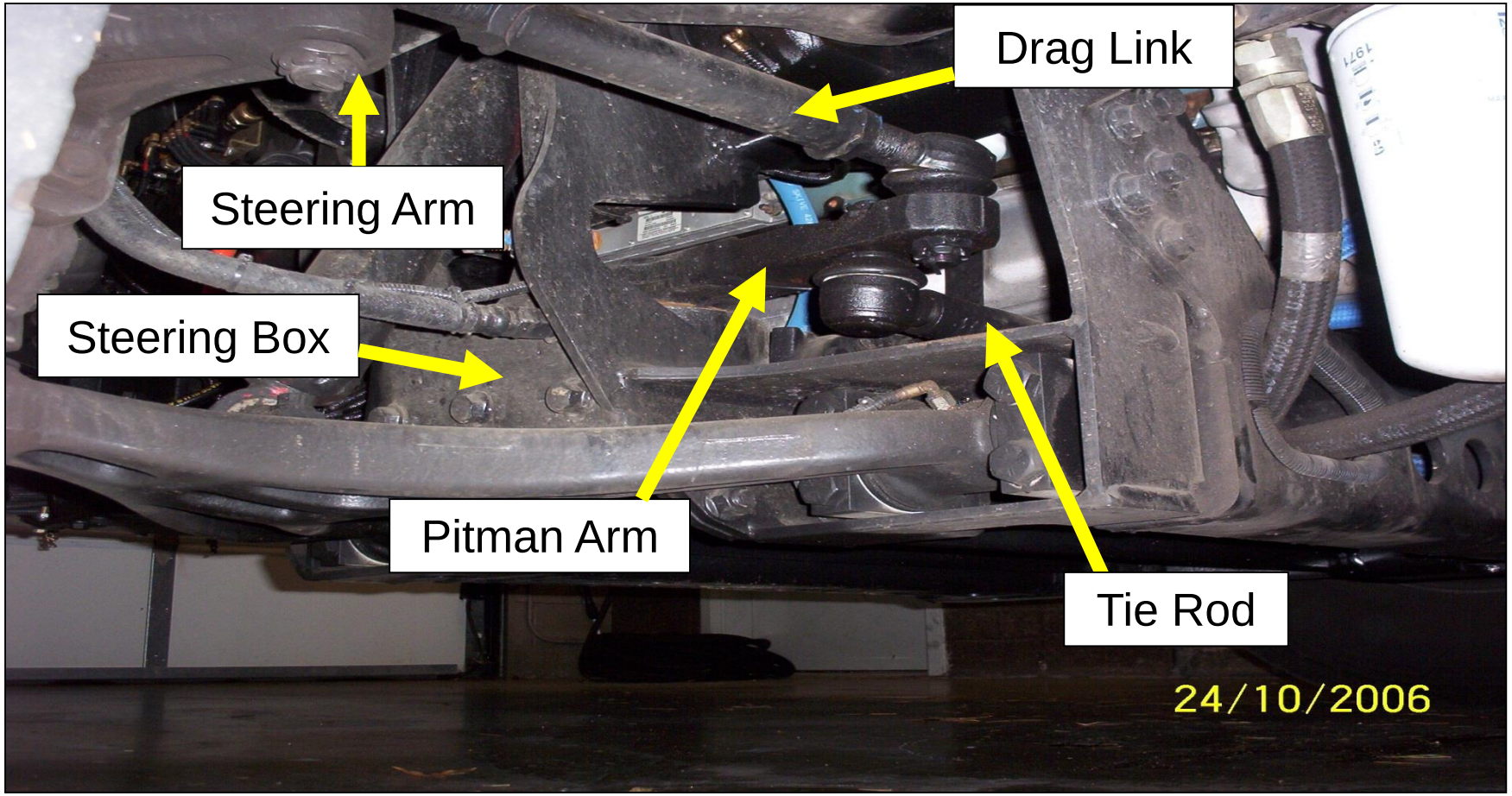
Steering System
Drag Link, Steering Arms, Tie Rod

- Drag Link
  - <1/8” play horizontally
  - <1/8” play vertically
  - No bends or damage
  - Secure to Pitman Arm and Steering Arm with castle nut & cotter pin
- Steering Arm
  - No damage
  - No play
- Tie Rod
  - No damage
  - No play
  - Secured to Steering Arm with castle nut & cotter pin



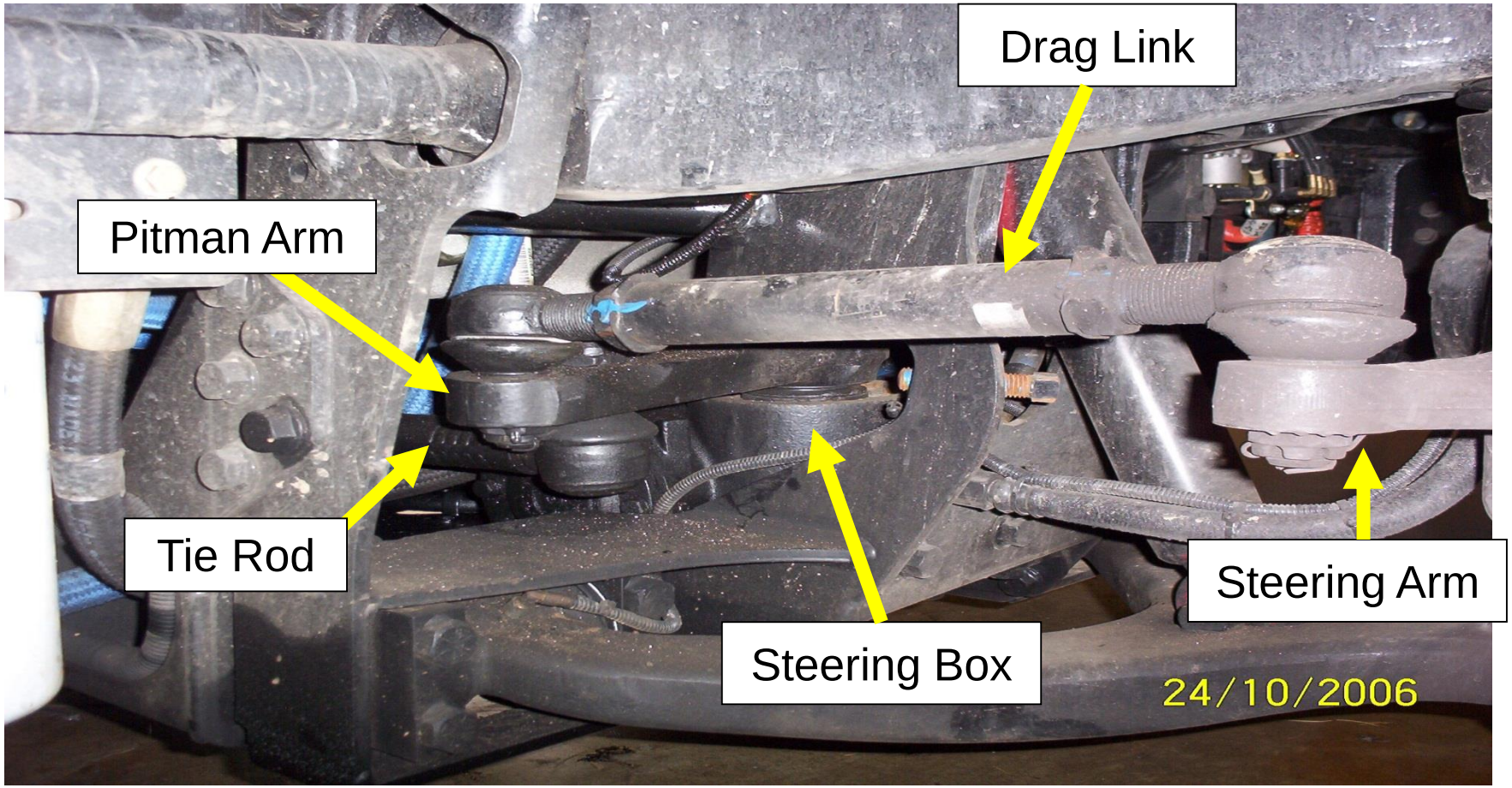
Steering system
Pierce TAK4

Driver side



Steering system
Pierce TAK4

Curb side



Suspension

- Everything that connects the body and accessories to the wheels
  - Frame
  - Body mounts
  - Springs
  - Shock absorbers
  - Axles
- Enables the vehicle to adjust to imperfect travel surfaces
  - Improves handling
  - Improves passenger comfort
  - Reduces wear on the body and accessories

Suspension
Weight Ratings

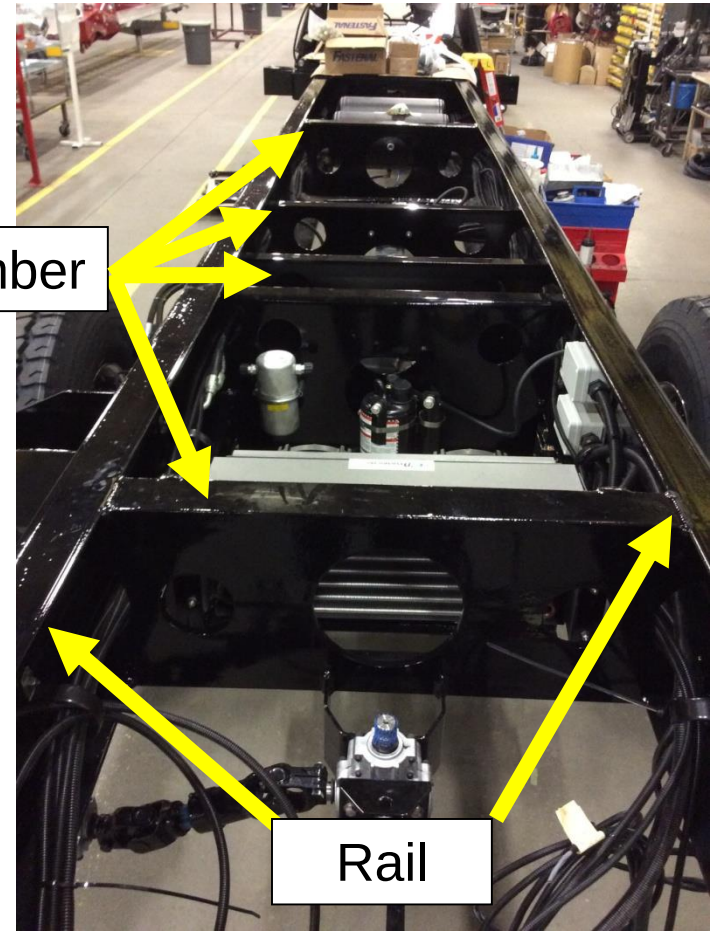
- Gross Vehicle Weight Rating (GVWR)
  - includes curb weight, additional equipment that's been added, the weight of cargo and the weight of passengers
  - Maximum total weight vehicle may ever be
- Curb Weight
  - Includes all vehicle components without passengers or cargo

20,000lb Axle weight rating

27,000lb Axle weight rating

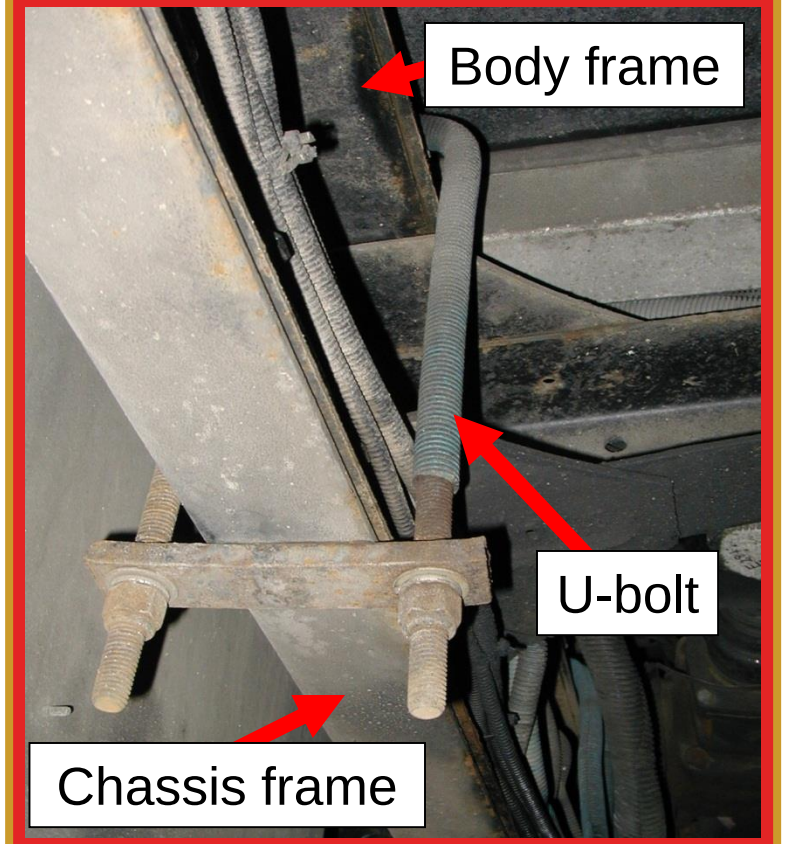
Suspension
Frame

- Functions as the spine of the vehicle
- Check for:
  - Alterations or holes
  - Cracks
  - Excess rust
  - Dents or bends
  - Broken, loose, or missing bolts



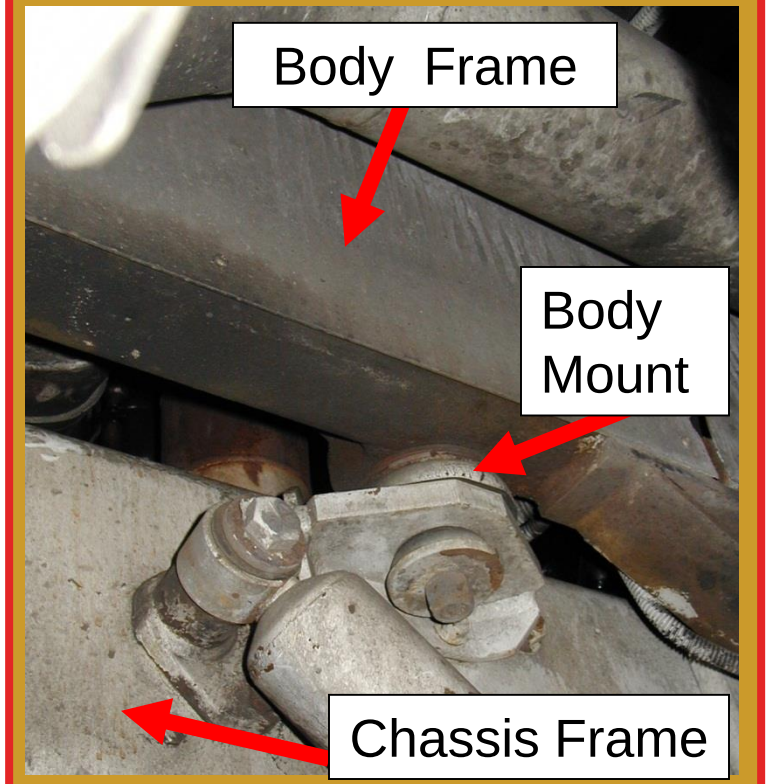
Suspension
Body Mounts

U-bolt



- Secures the body to the vehicle frame
- Two primary types
  - Cushioned
  - U-bolt
- Subject to great stress
  - Body twists
  - Frame twists
  - Vibration
  - Corrosion
  - Collisions

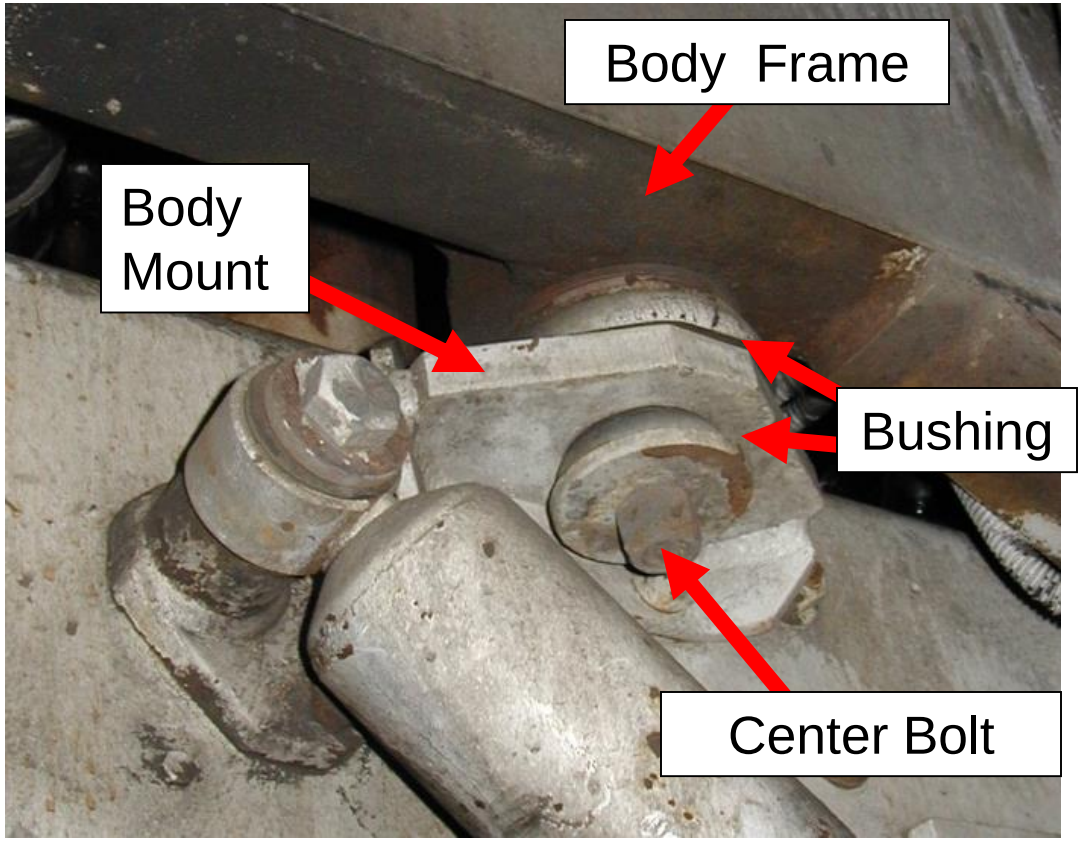
Cushioned



Suspension
Cushioned Body Mounts

OOS Defects

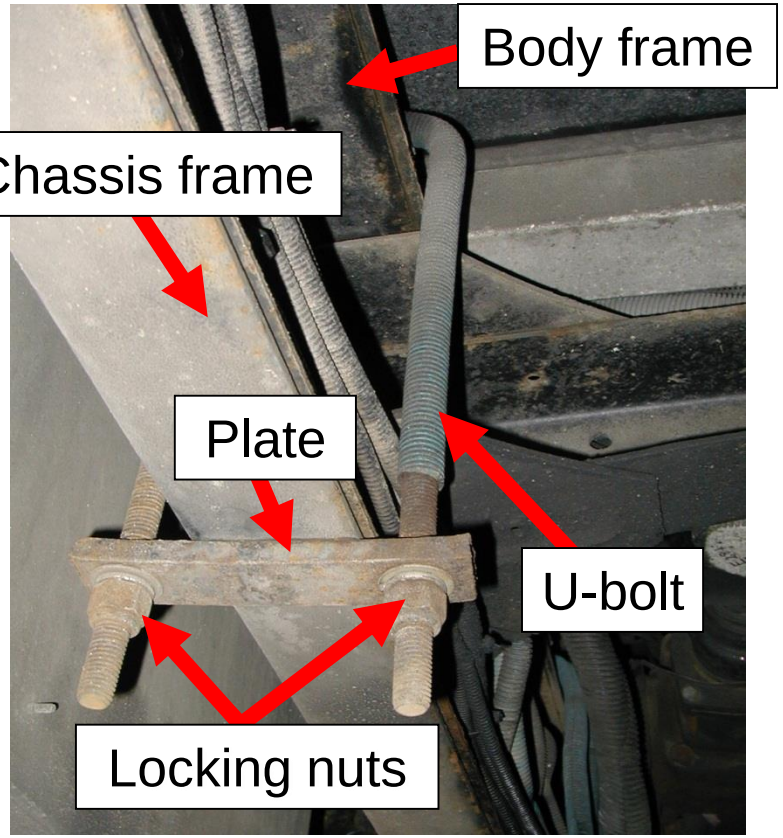
- Any rubber bushings that are missing
- Any center bolt that is missing or will not tighten
- Mounts that have broken welds or not attached to the frame



Suspension
U-Bolt Body Mounts

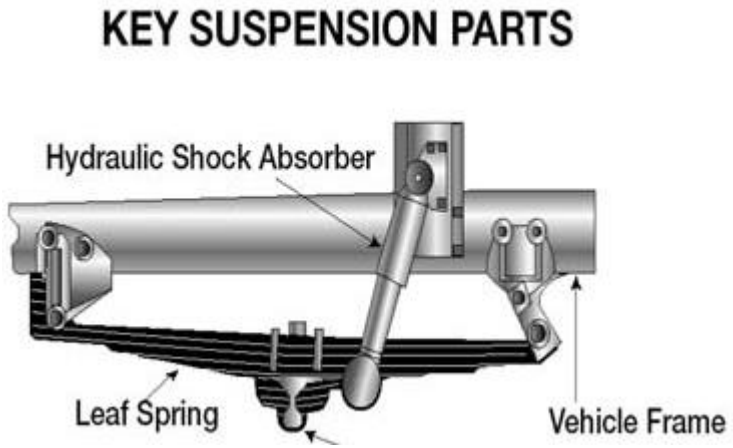
OOS Defects

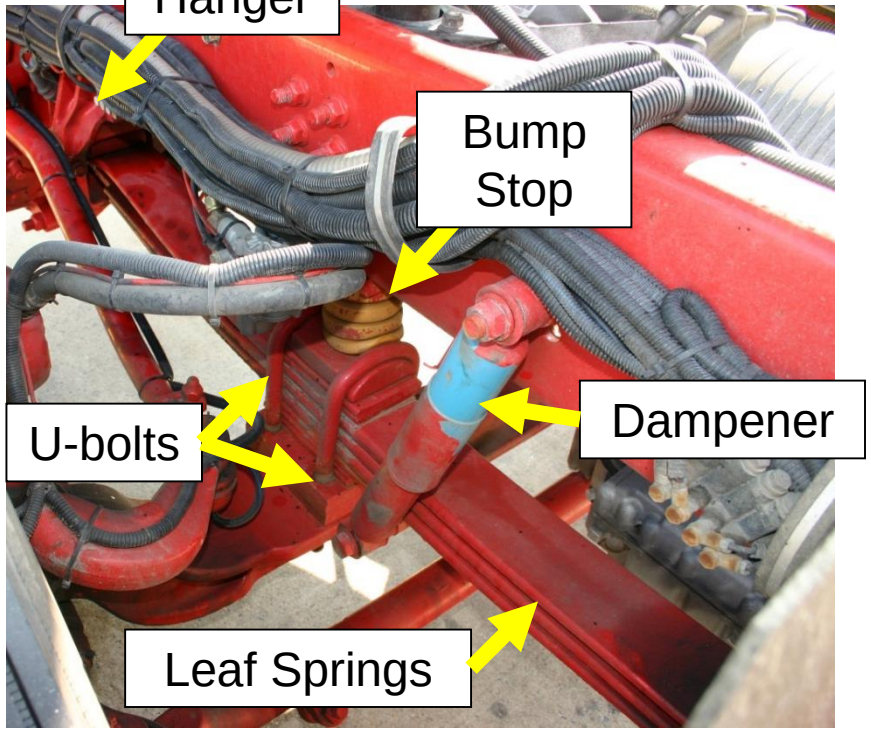
- Broken components
- Missing locking nuts
- Loose U-bolt that allows sliding on the frame
- Cracked or broken plate securing the U-bolt.



Suspension
Springs

- Provides the necessary flex and shock absorption to adjust to road surfaces
- Constantly under stress and load



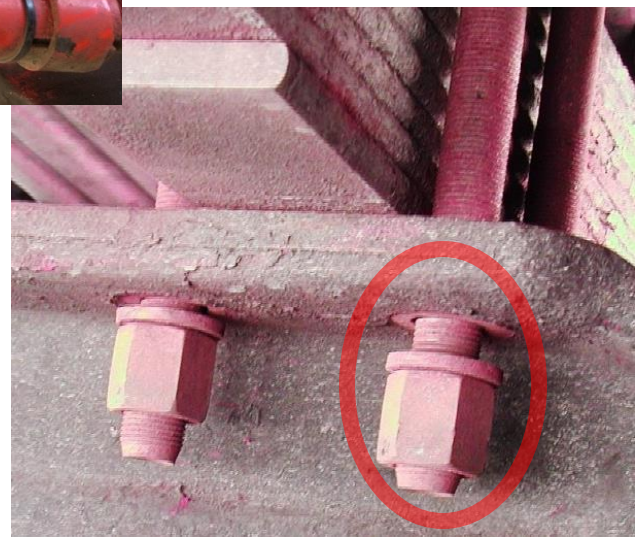


Suspension

springs

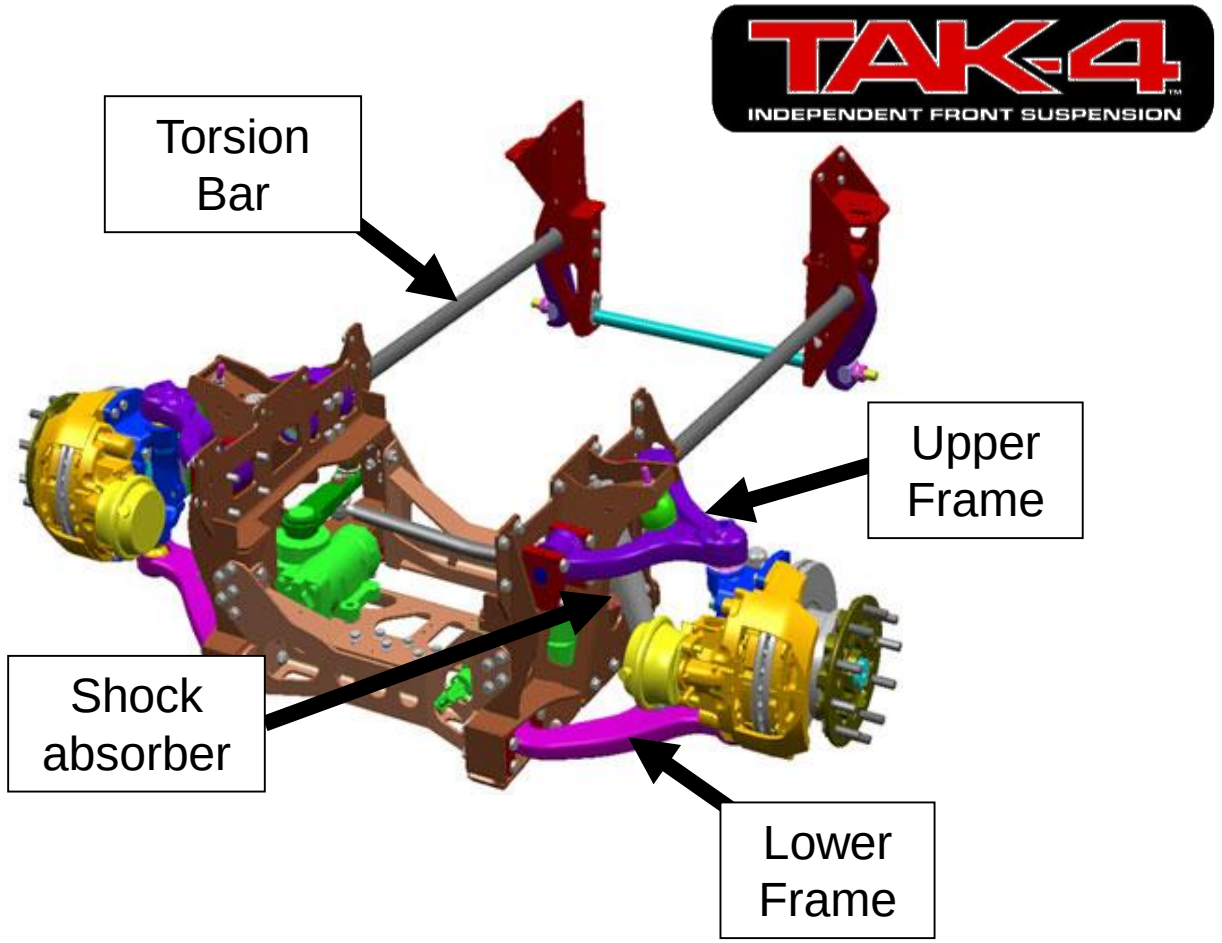
OOS Criteria

- Missing or misaligned leaf springs
- Cracked or broken leaf spring
  - Top or bottom of the stack requires a tow
- Missing or loose bolts at spring shackle or spring mount
- Broken spring hanger
- Broken or dislodged dampener

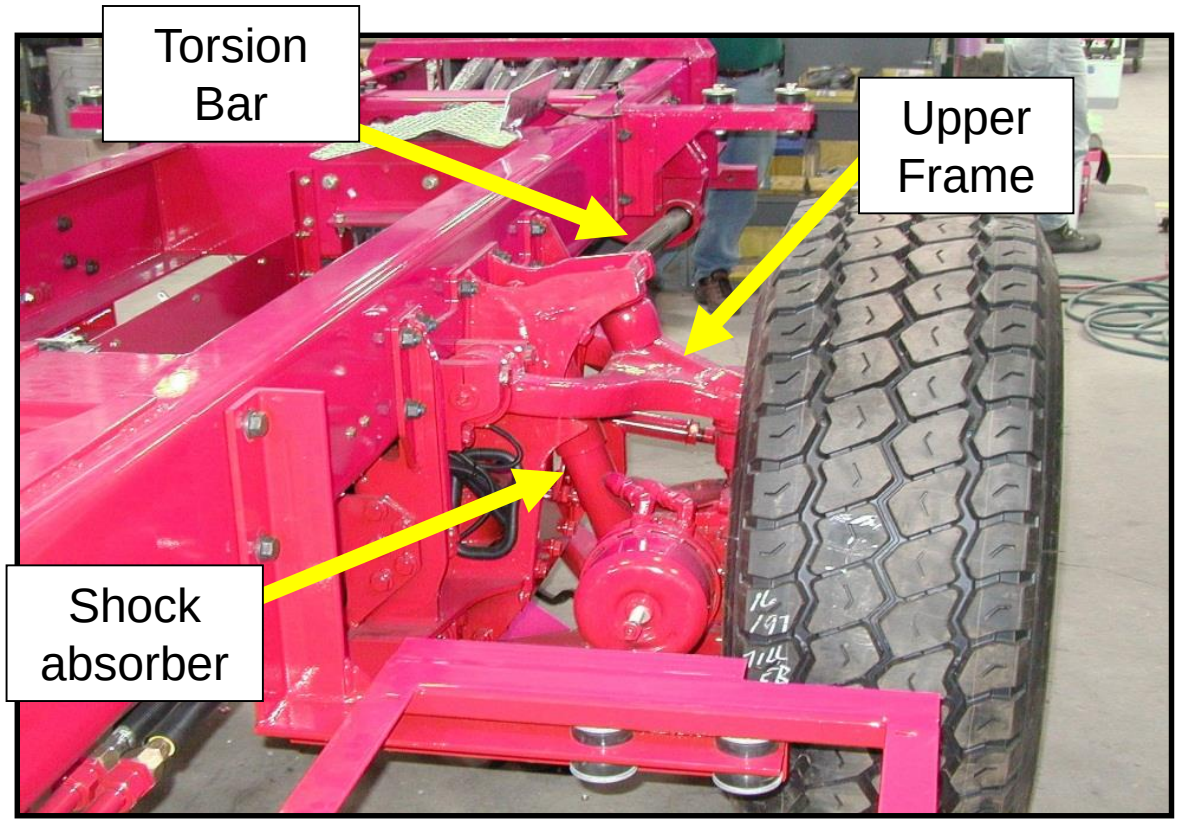


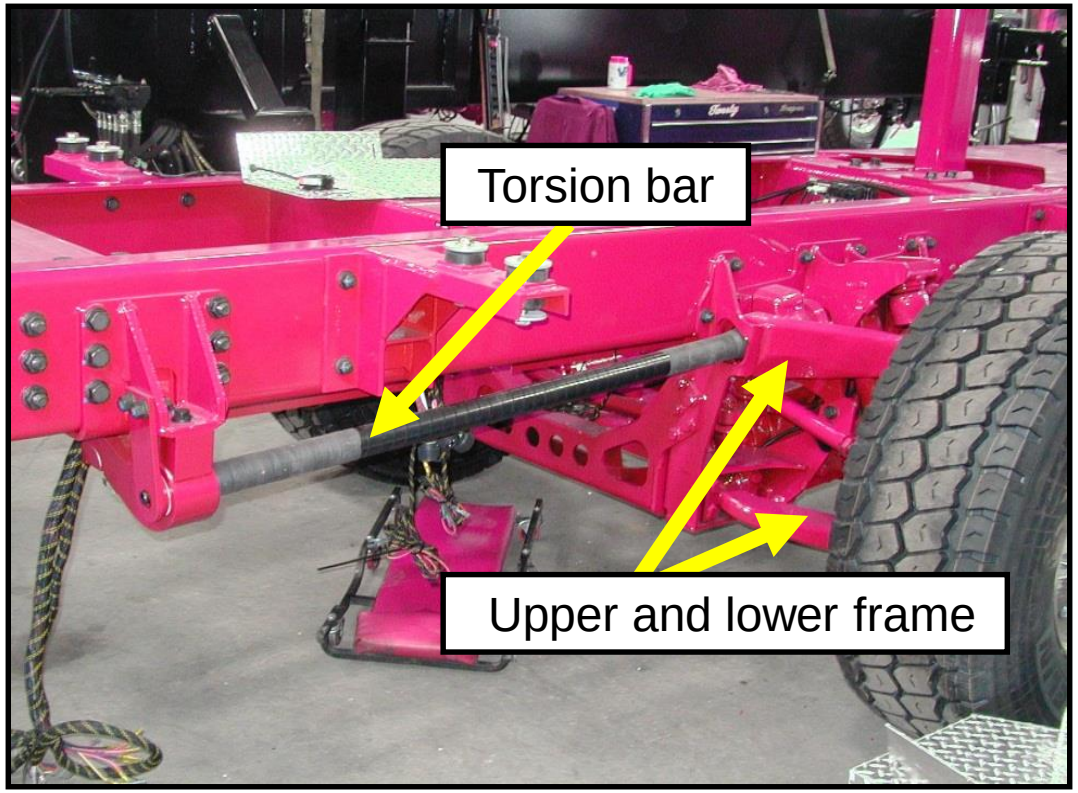
Suspension
Pierce TAK4 – Steering Axle

- Steering axle on Pierce units
  - Front axle
  - Tiller axle
  - NOT on All-Steers
- Uses a torsion bar system – no springs
  - upper and lower A-frame assembly
  - shock absorber for wheel control.



Suspension
Pierce TAK4



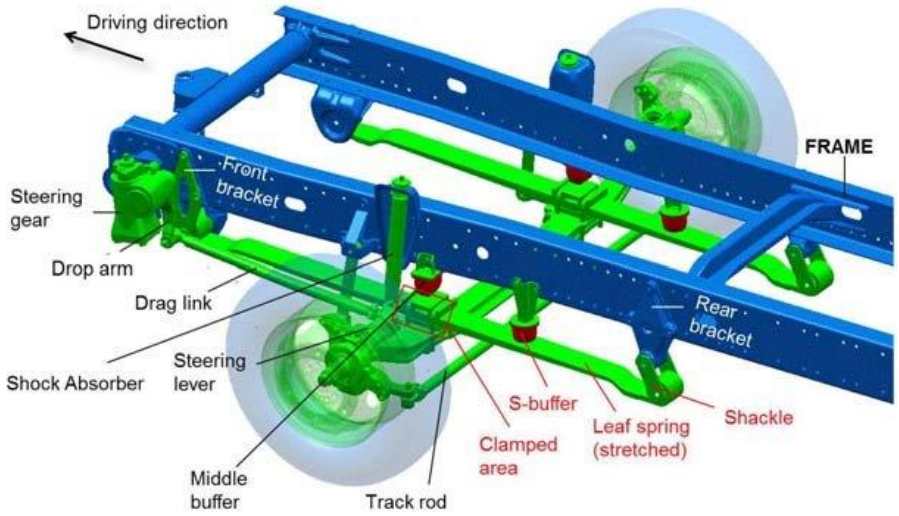


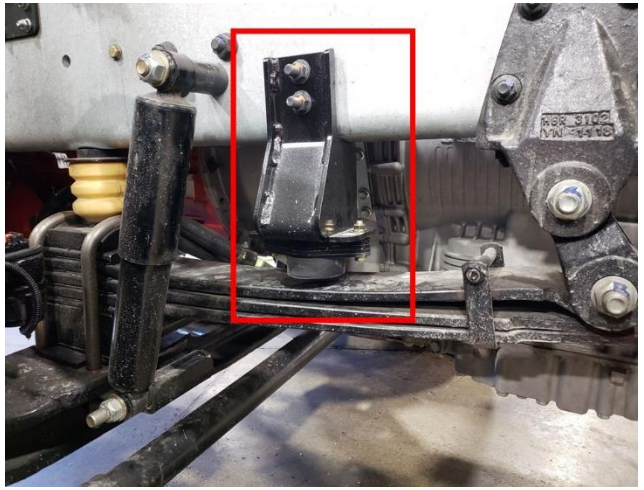
Suspension
Pierce TAK4 – Steering Axle

- Model years 2004-2013
  - Ball joint failure
- Model years 2009-2013
  - Lower control arm failure
- Check these components thoroughly during pre-trip

Front Suspension
Pierce Enforcer Engines

- When placed under the stress of emergency braking, front springs flatten and then assume a shape resembling an “S” as the front axle tries to rotate
- To reduce undesirable steering reaction during emergency braking, the front suspension includes “S-buffers” that stiffen the springs when the springs are compressed.

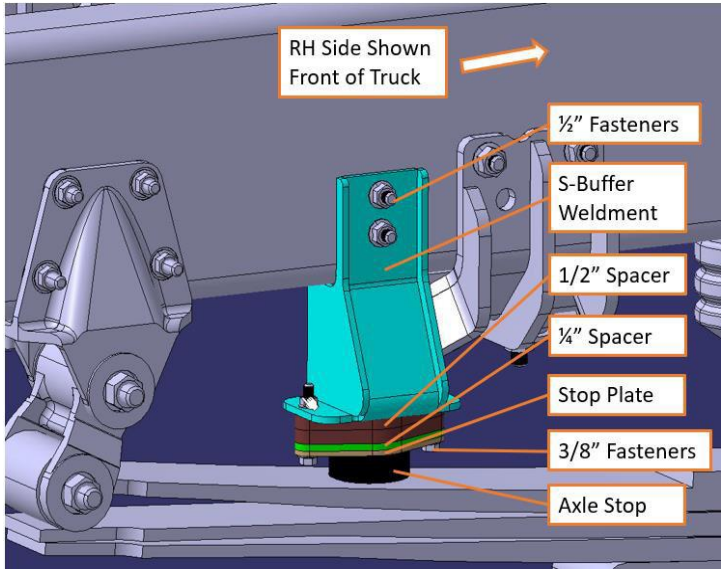




Front Suspension
Pierce Enforcer Engines

Daily

1. Inspect for loose hardware of the S-Buffer Assembly.
2. Inspect welds and surrounding metal of the S-Buffer Assembly for cracks.
3. Look for signs of failure or tearing of the Rubber Axle Stop.

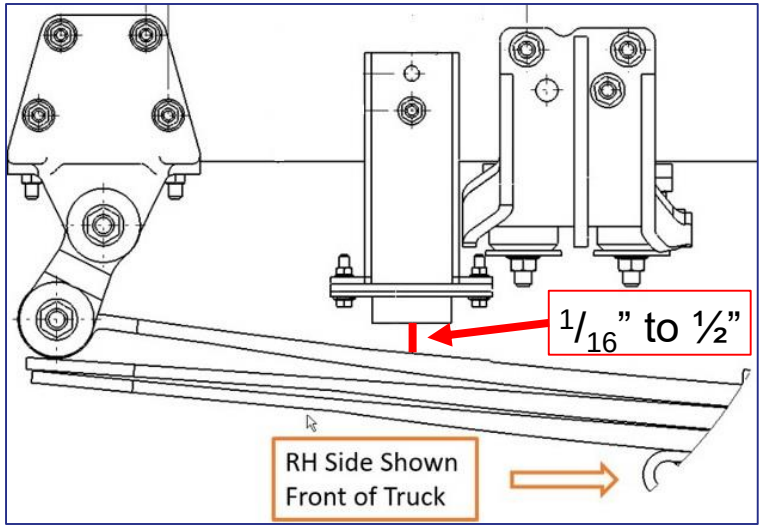


☒ If cracks are found in the metal of the S-Buffer, or if loose hardware is found, submit a defect report.
☒ If the Rubber Axle Stop has surface cracks, submit a defect report.
☒ If the Rubber Axle Stop is missing, failed, or torn, the truck should be placed out of service and the Rubber Axle Stop replaced. Physical inspection of spring for mechanical damage should take place.

Front Suspension
Pierce Enforcer Engines

Monthly

1. Complete the daily inspection and;
2. Park loaded vehicle (with water, foam, equipment) on flat level ground with wheels pointed straight. Ensure parking brake is applied and wheels are chocked.
3. Inspect gap between Rubber Axle Stop and spring. Acceptable range is 1/16” to 1/2”.

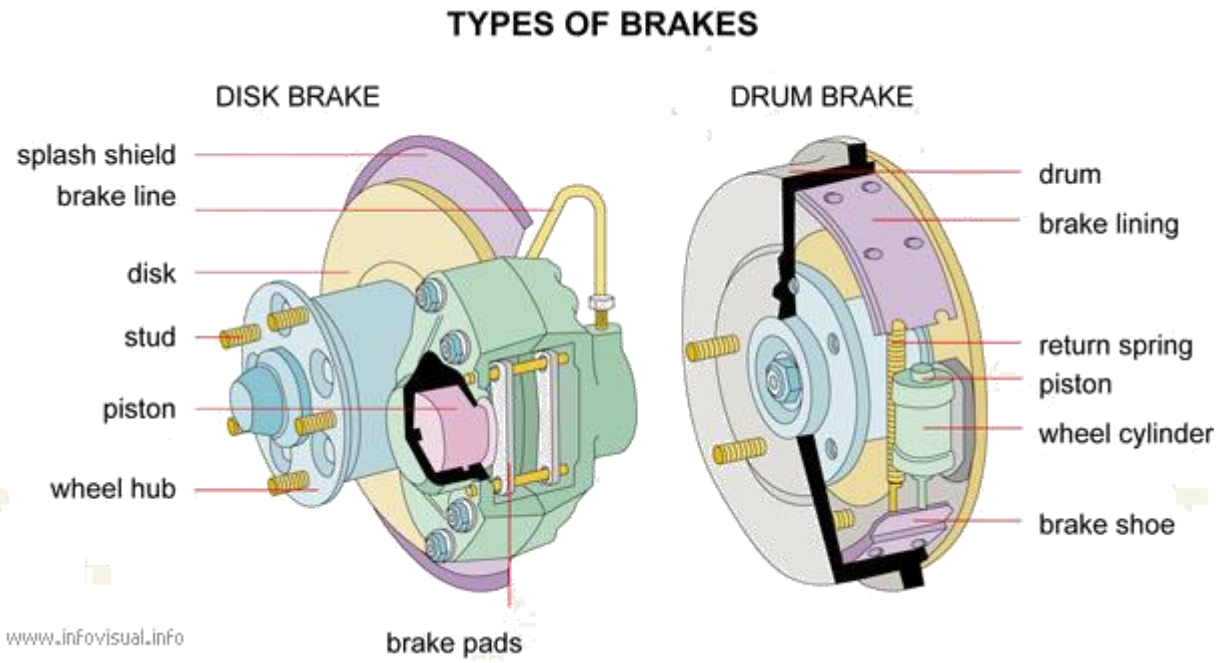


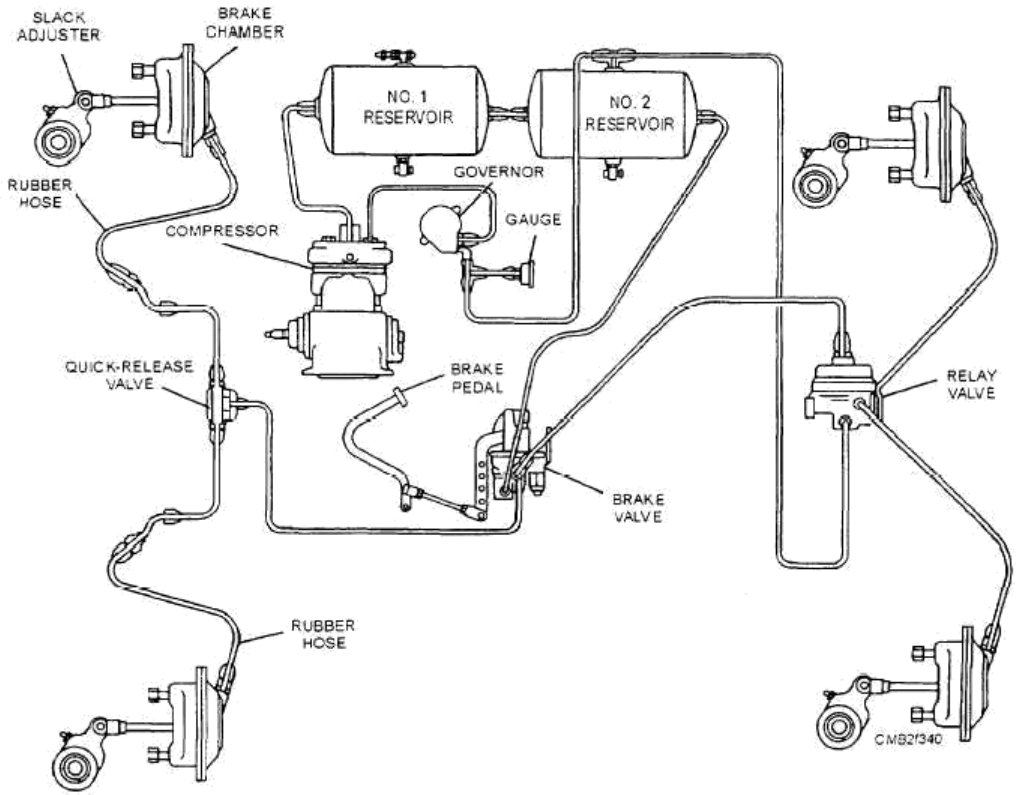
If the gap is outside of accepted range drive cautiously around parking lot, re-position on flat level ground with wheels straight and re-measure the gap.

> 1/2”: place the vehicle out of service and contact CMF.

< 1/16” or the Rubber Axle Stop is touching: submit a defect report. NOTE: This is not an immediate out of service condition.

Air Brakes
Components

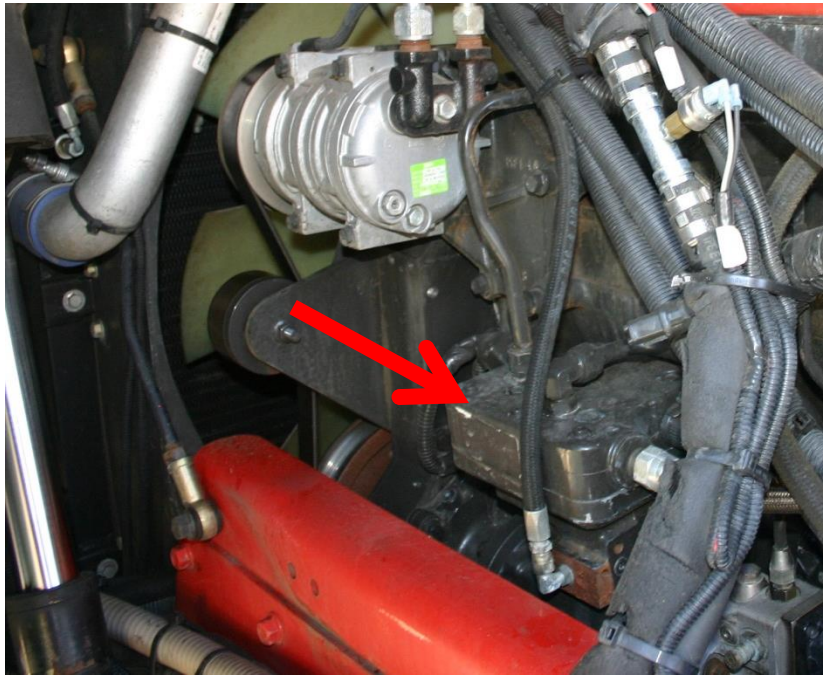




*Note: these diagrams are for hydraulic brakes, but the systems are similar to air brakes

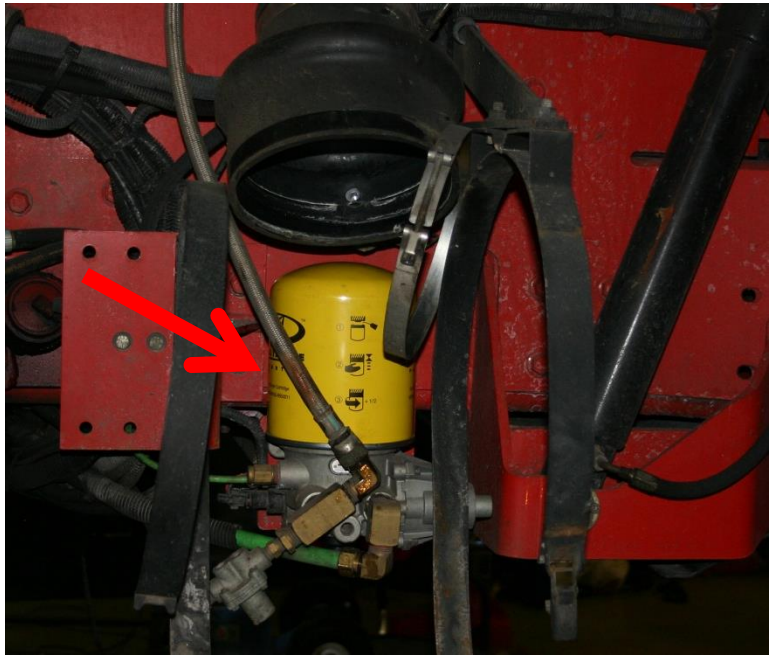
Air Brake System Video

Air Brakes
Components



Gear-driven air compressor

- Braided hoses are indicative of higher pressures and heat resistance



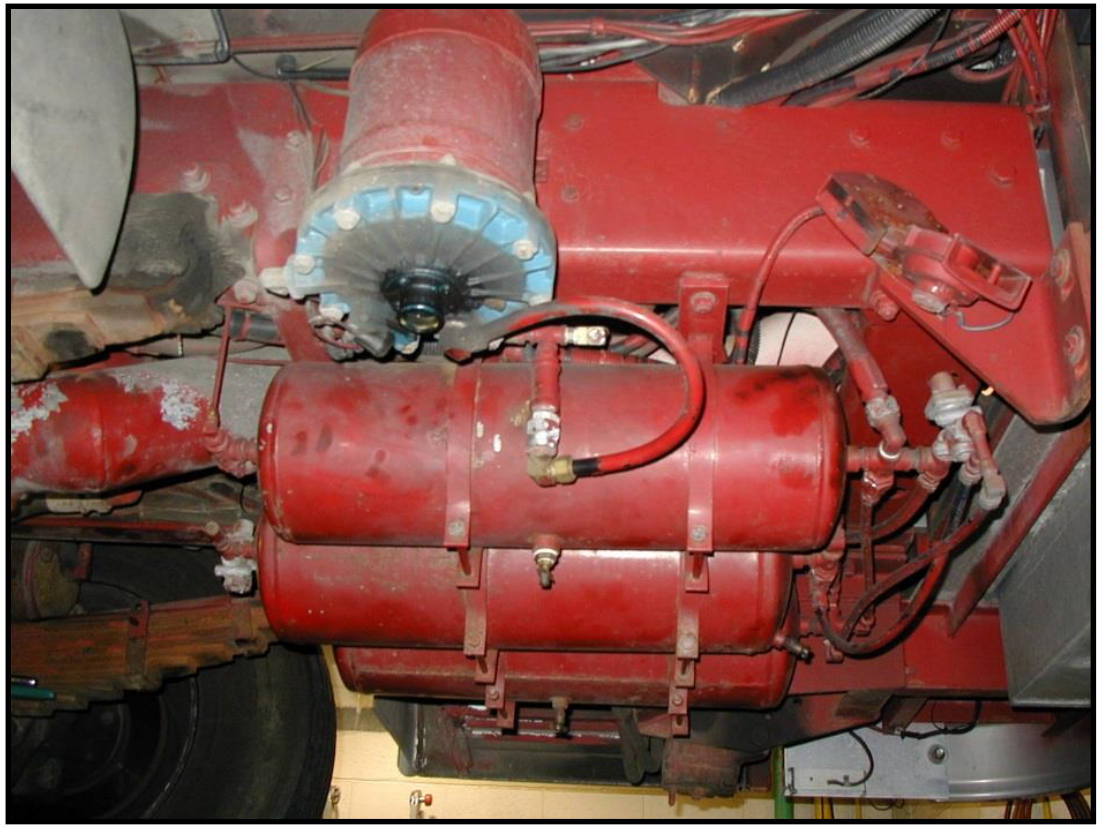
Air Dryer

- Reduces contaminants in the storage tanks and system valves

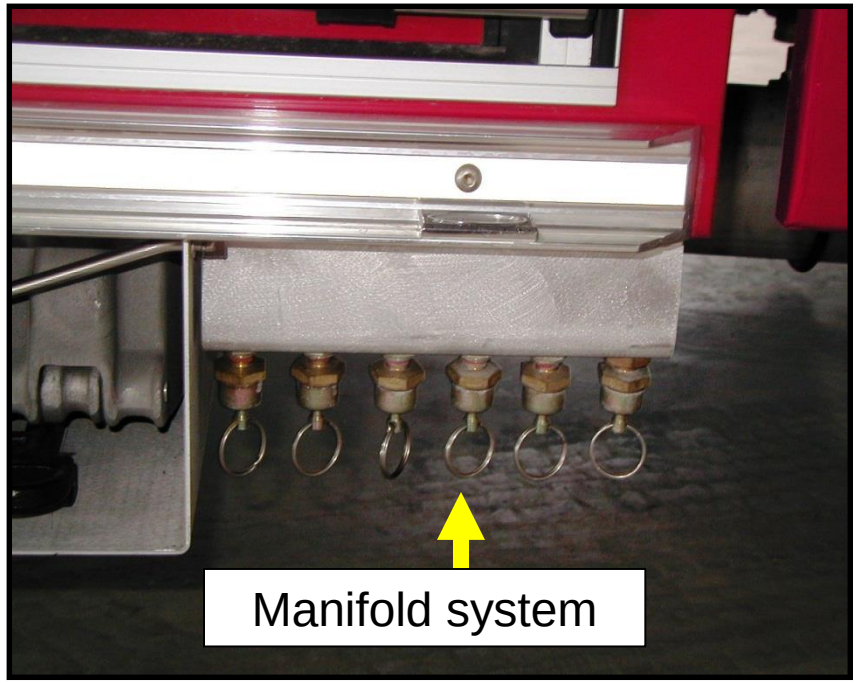
Air Brakes
Components

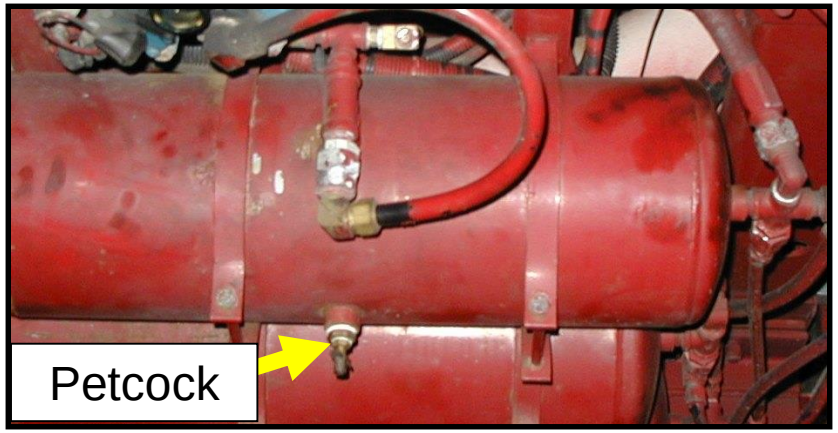
Air Storage Tanks

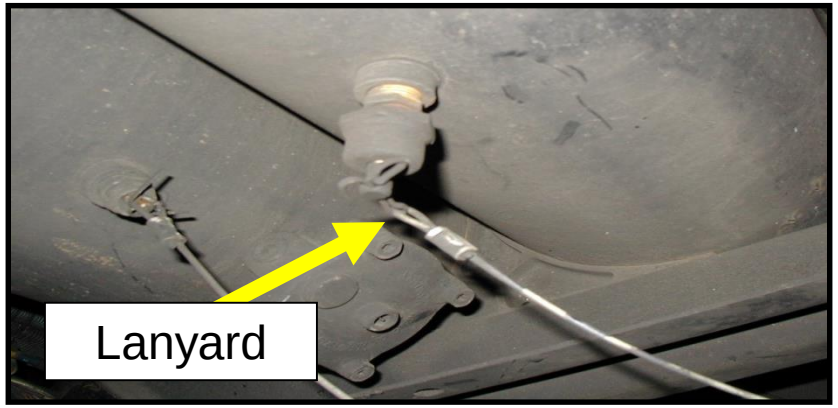
- Wet or Supply Tank
  - First tank after the compressor
  - Generally where heated compressor air cools and water condenses
- Primary, Secondary Tanks
  - Usually two or three
  - Volume depends on the size of the brake system



Air Brakes
Air Storage - Bleeders



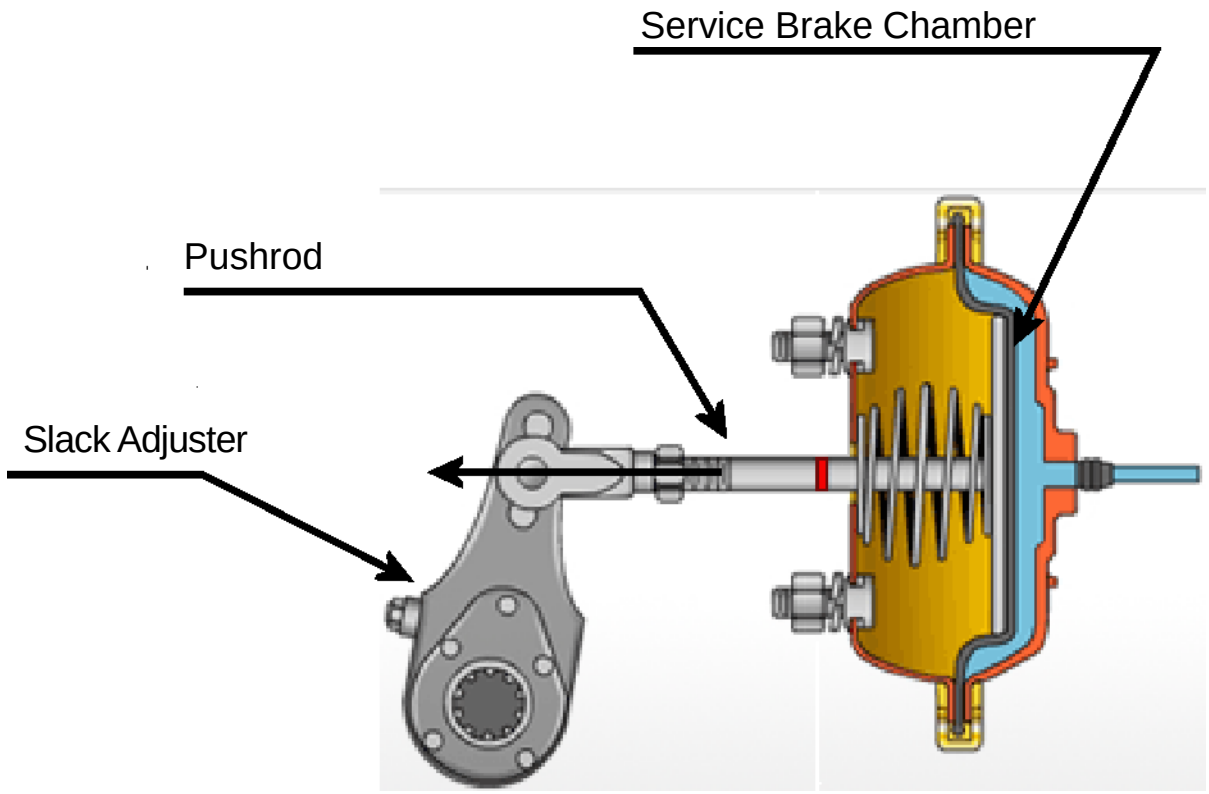




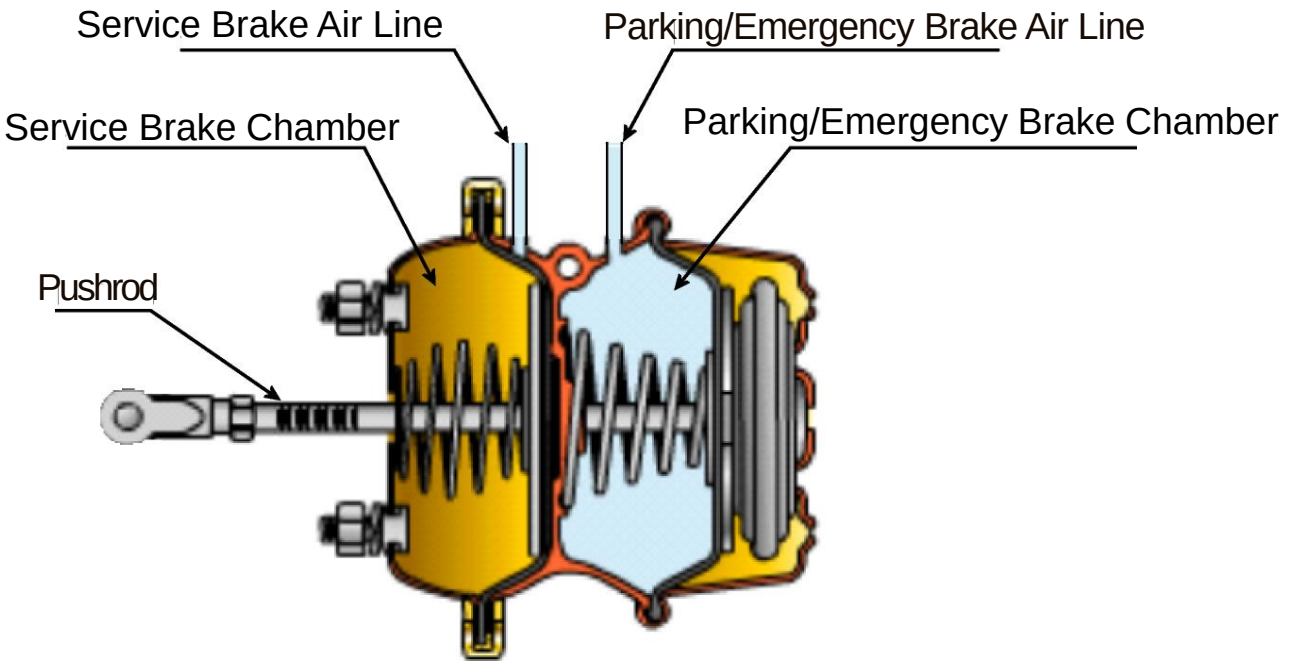
Draining the tanks is a weekly task

Air Brake System
Components

Single Chamber



Dual Chamber



Air Brake System
Crimson Components

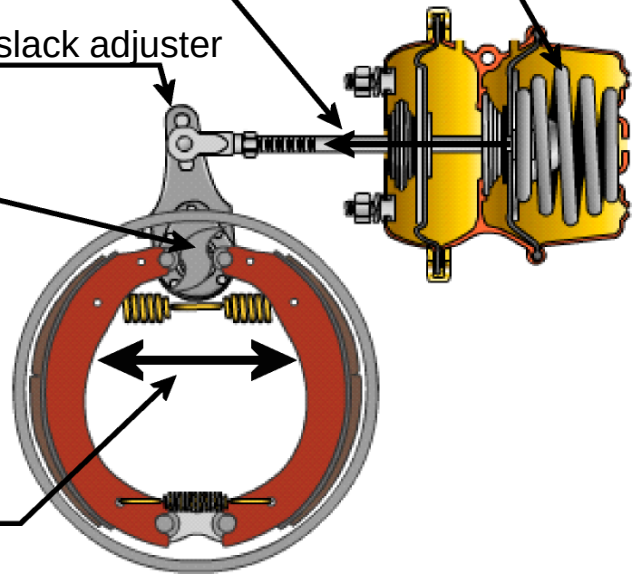
- Front Axle
  - No parking brake
  - Single chamber air can
  - Disc brakes

- Rear Axle
  - Dual chamber air can
  - Parking brake
  - Drum brakes

Air Brakes
Parking – Spring Brake

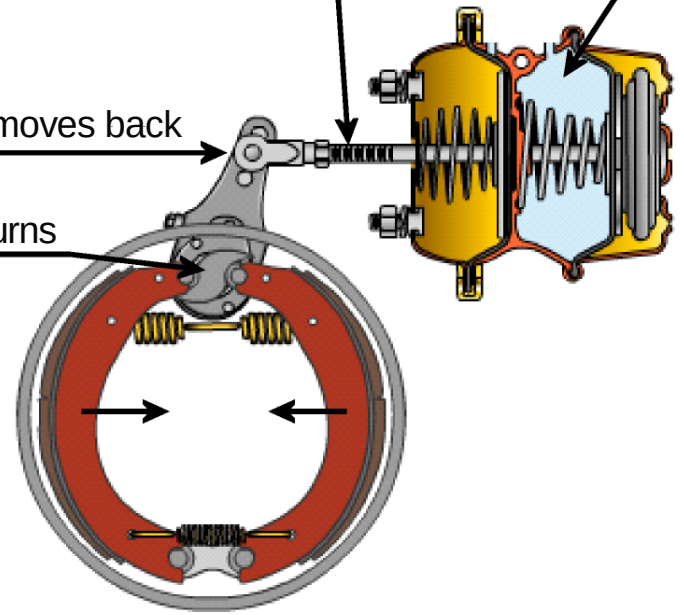
Parking Brake Applied

1. A large spring pushes against a plate
2. It moves the pushrod out
3. Pushes on the slack adjuster
4. Turns the S Cam
5. Pushes the brake shoes against the brake drum



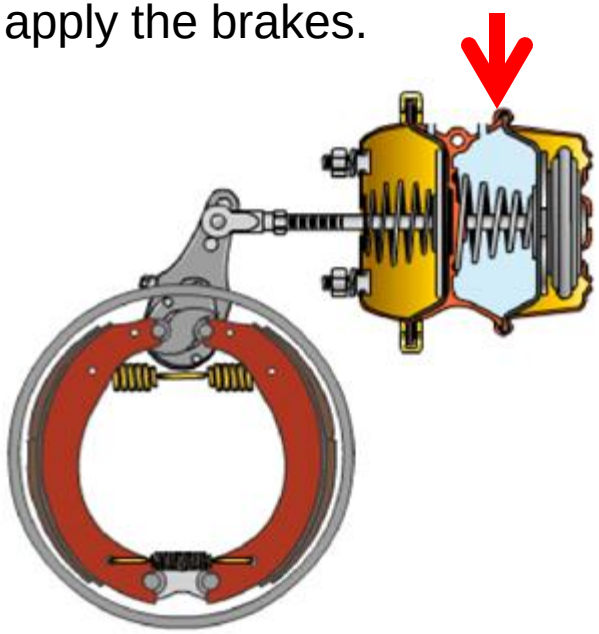
Parking Brake Released

1. Air pressure pushes the spring back
2. The pushrod moves back
3. The slack adjuster moves back
4. The S Cam turns
5. Brake shoes move away from the brake drum, releasing the brakes

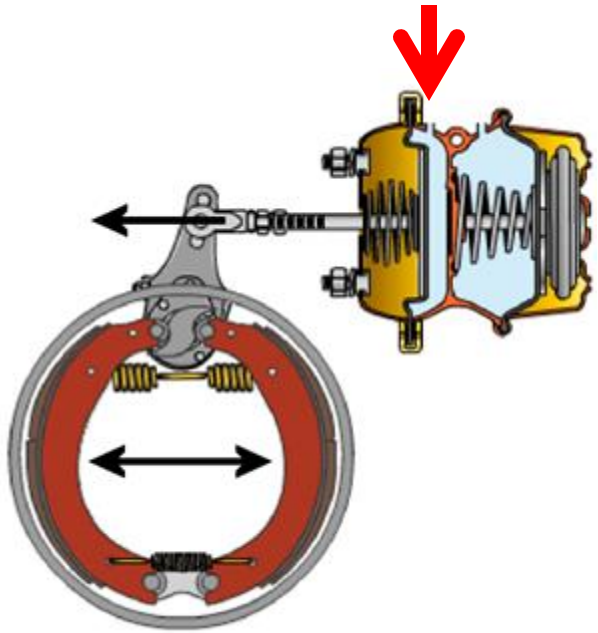


Air brakes
Travel – Service Brake

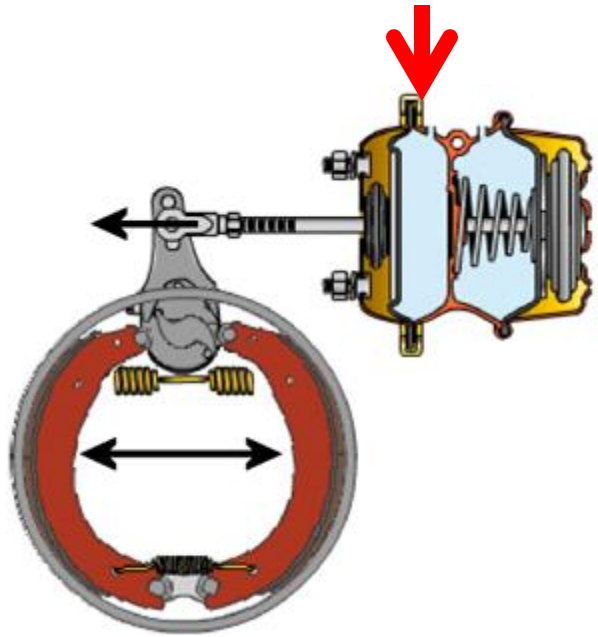
Accelerating or Coasting
Air pressure disengages the parking/ emergency brake, so the wheels can turn. If air pressure is lost in this chamber, the spring will apply the brakes.



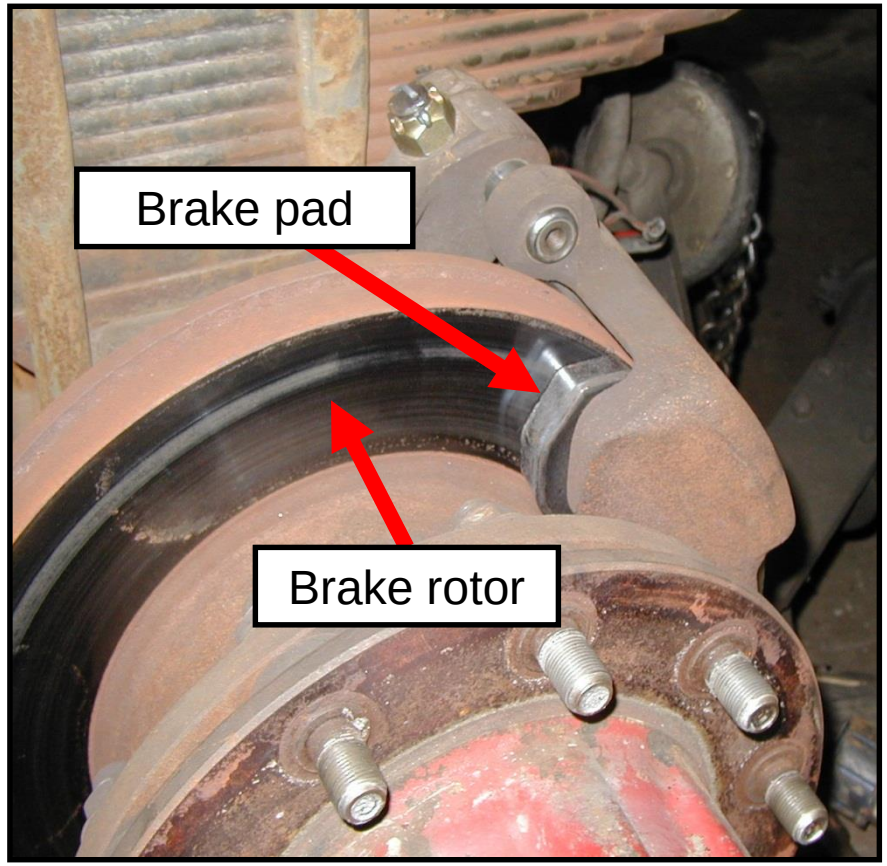
Braking – Lag/Reaction Time
The brake pedal is push and air is forced into the service side brake chamber. The pushrod moves out, turning the slack adjuster and S cam.

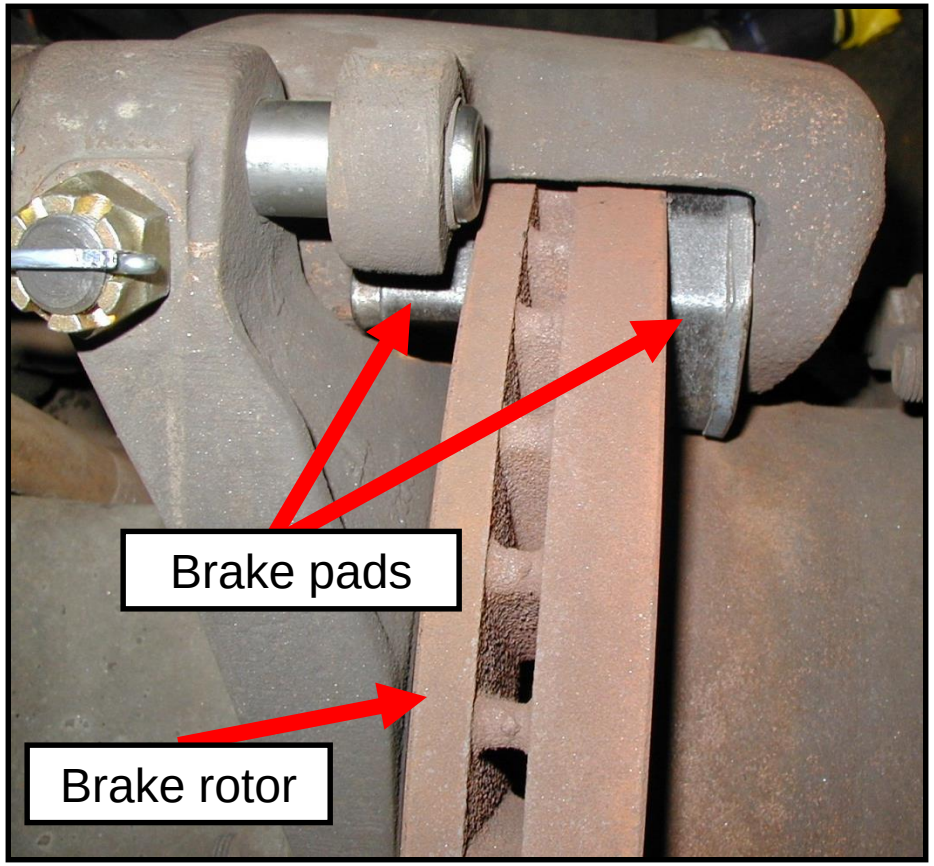


Braking – Slowing/Stopping
The brake shoes are pushed against the brake drums causing the truck to slow.

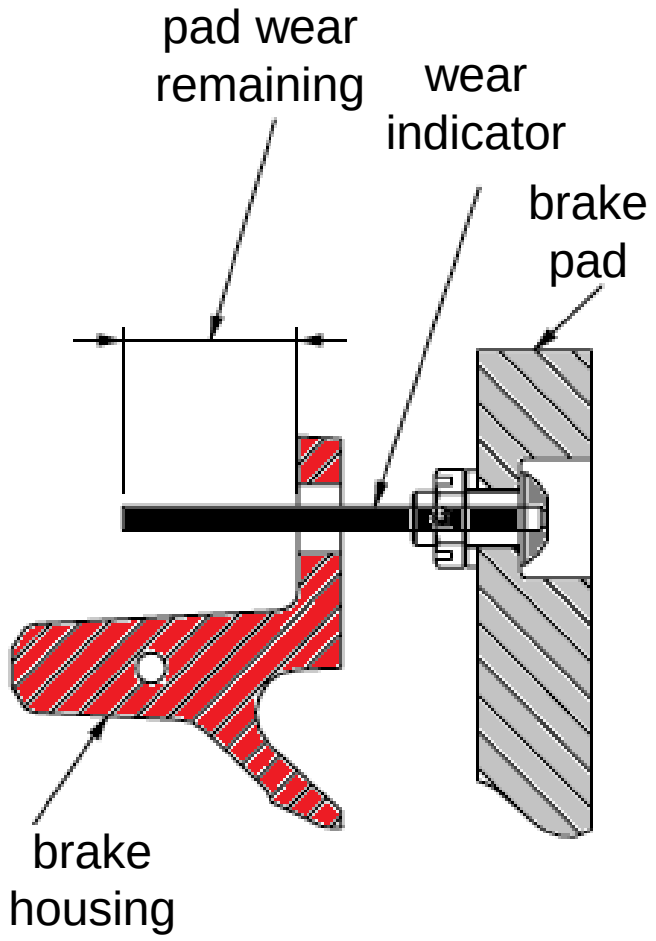


Disc Brakes
Components



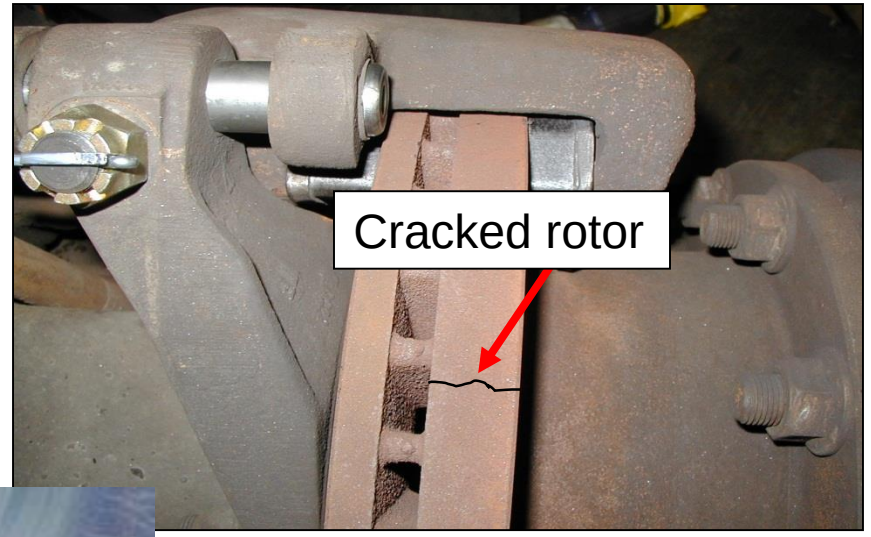


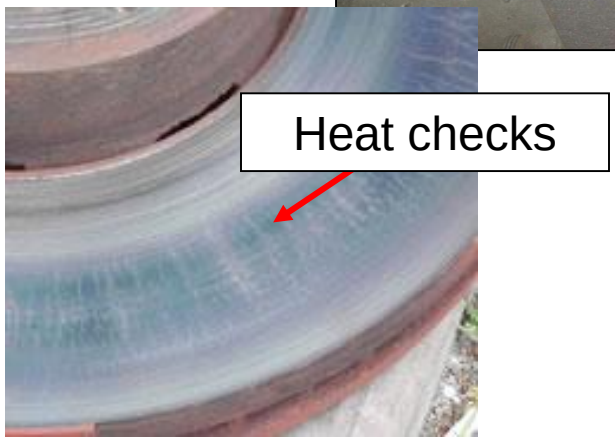
Disc Brakes
Crimson Front Axle



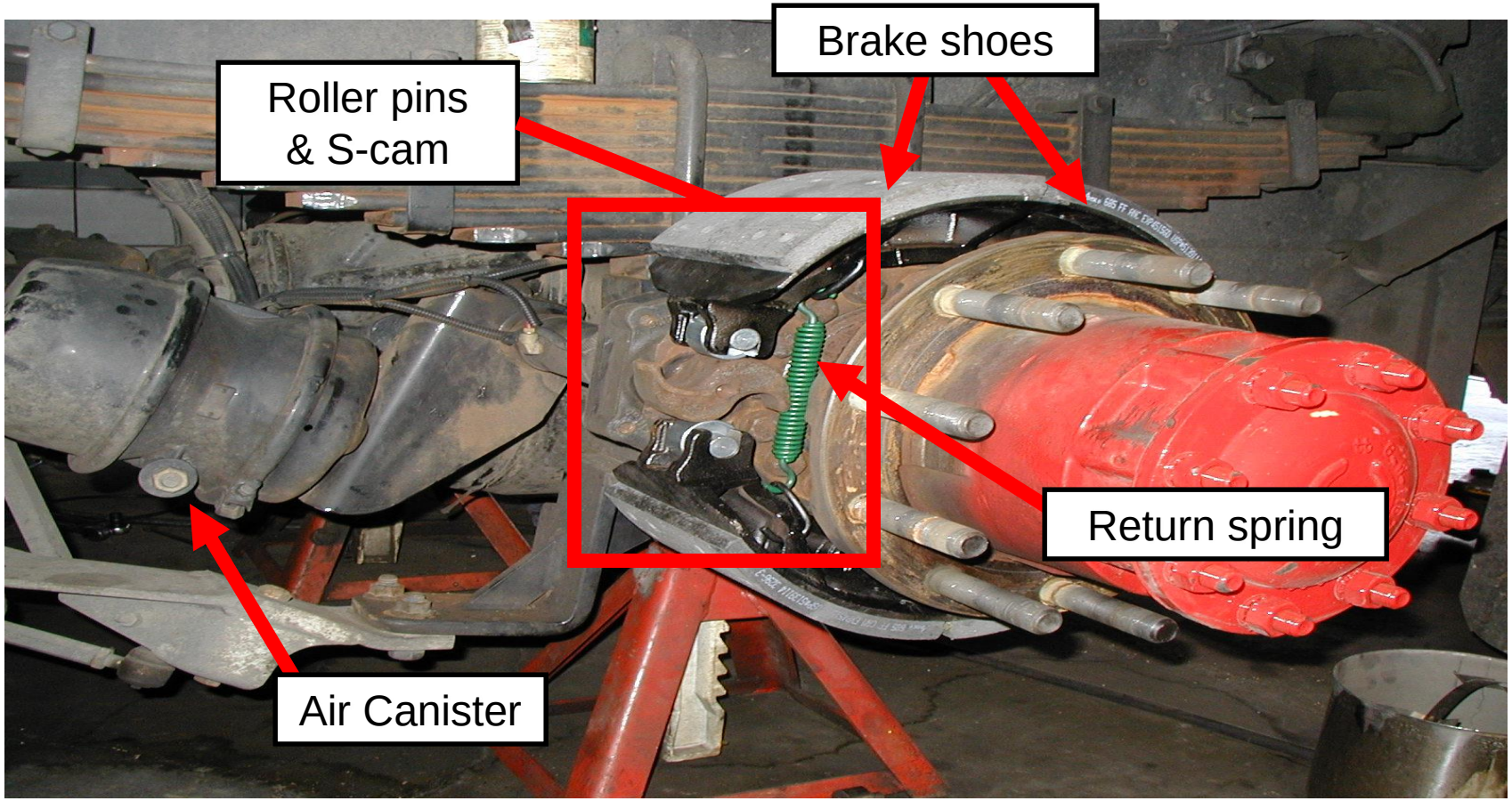
Disc Brakes
OOS Criteria - Rotors

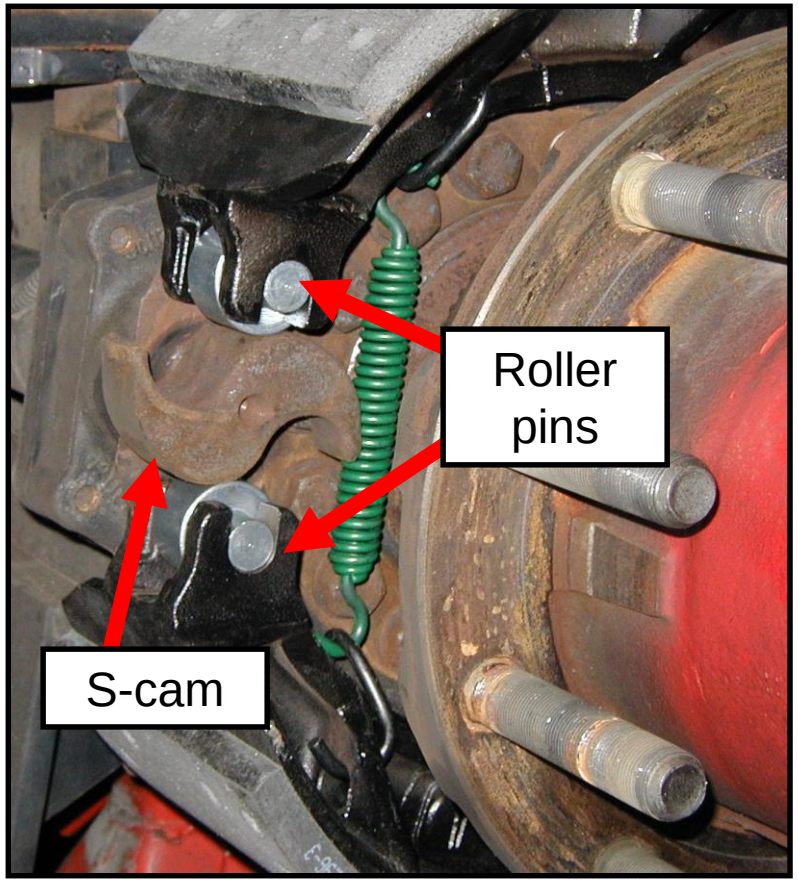
- Cracked rotor
  - Broken from the face of the rotor to the cooling fins
  - Can occur on either side.
  - OOS condition
- Heat checks
  - >1/8” deep, or
  - Extend >¾ across the face of the rotor





Drum Brakes
components

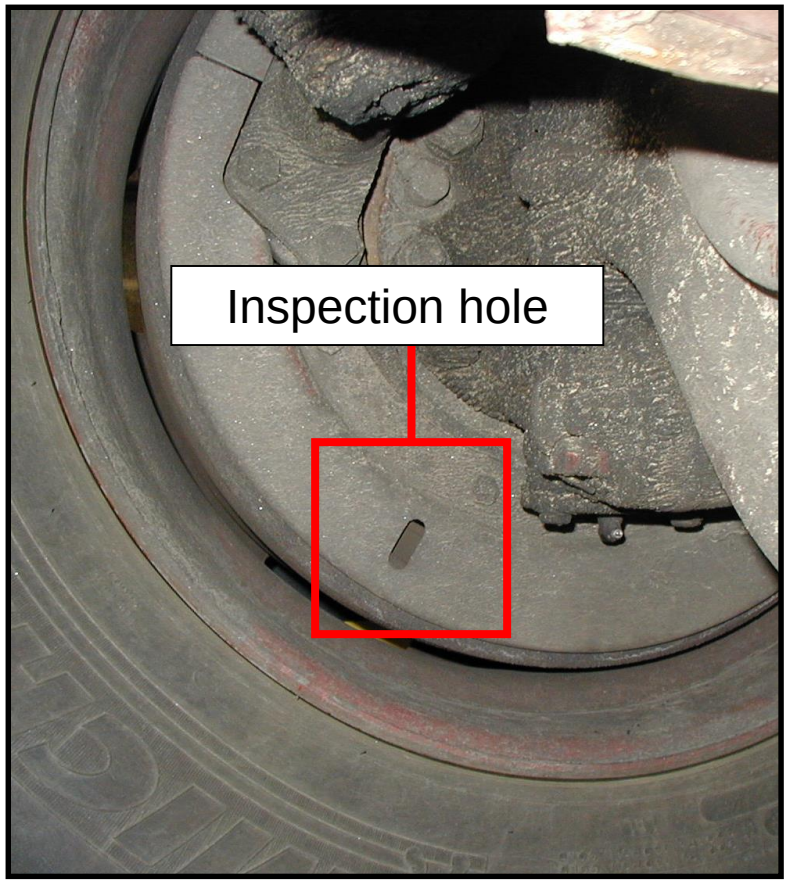




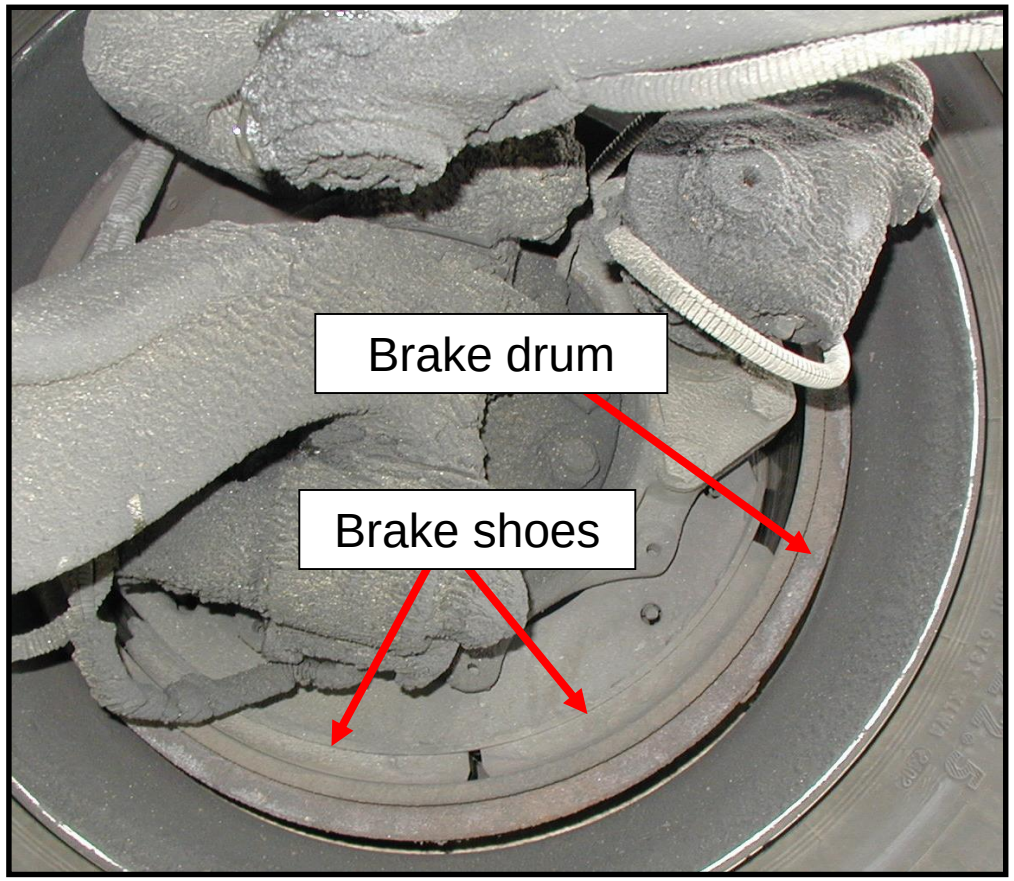
Drum Brakes
Crimson Rear Axle

Drum Brakes
Brake Shoe Inspection

Wheel with Dust Cover

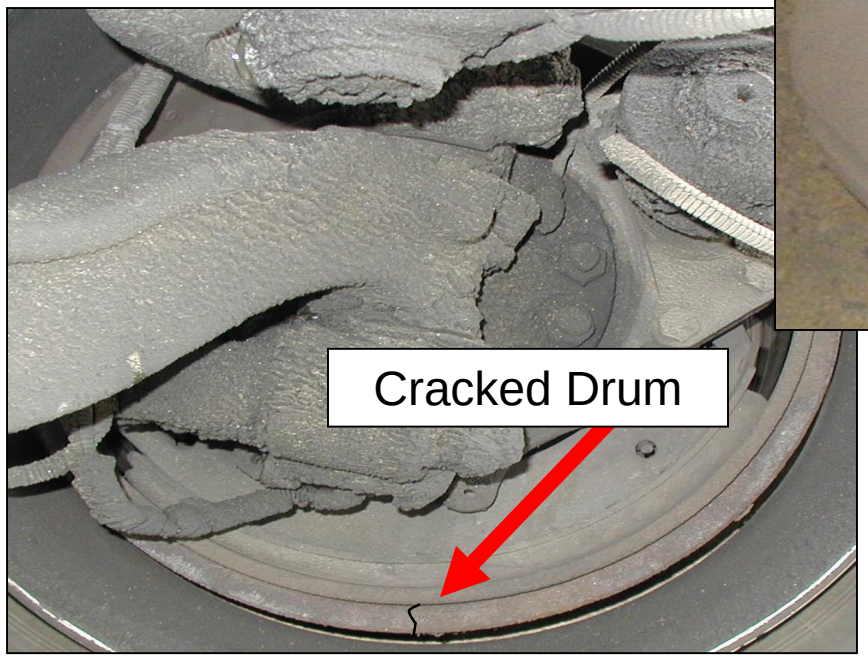


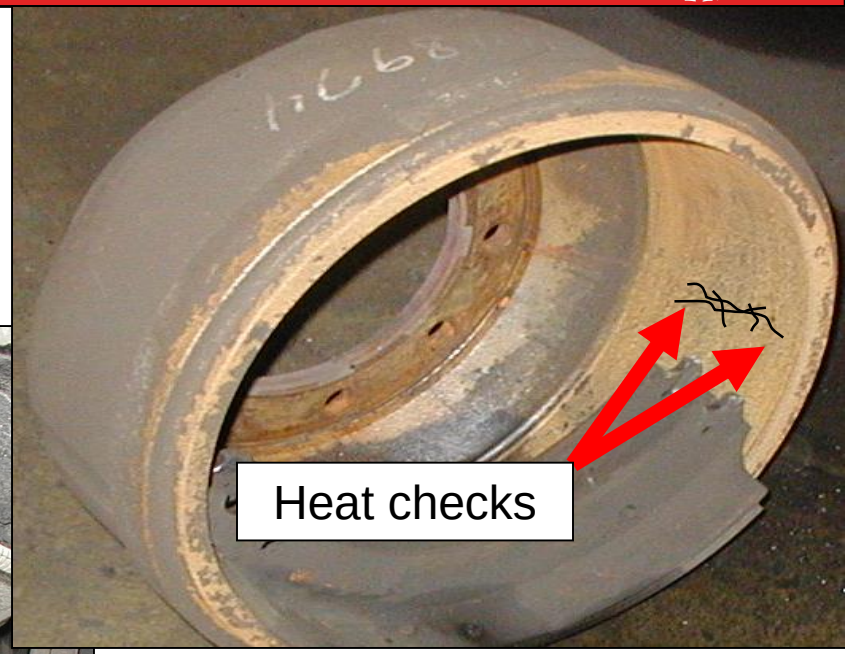
Wheel without Dust Cover



Drum Brakes
OOS Criteria - Drums

- Cracked drums
  - breaks that go thru the drum
  - crack expands when brake is applied
- Heat checks
  - >½ the width of the drum, and
  - >1/8” deep

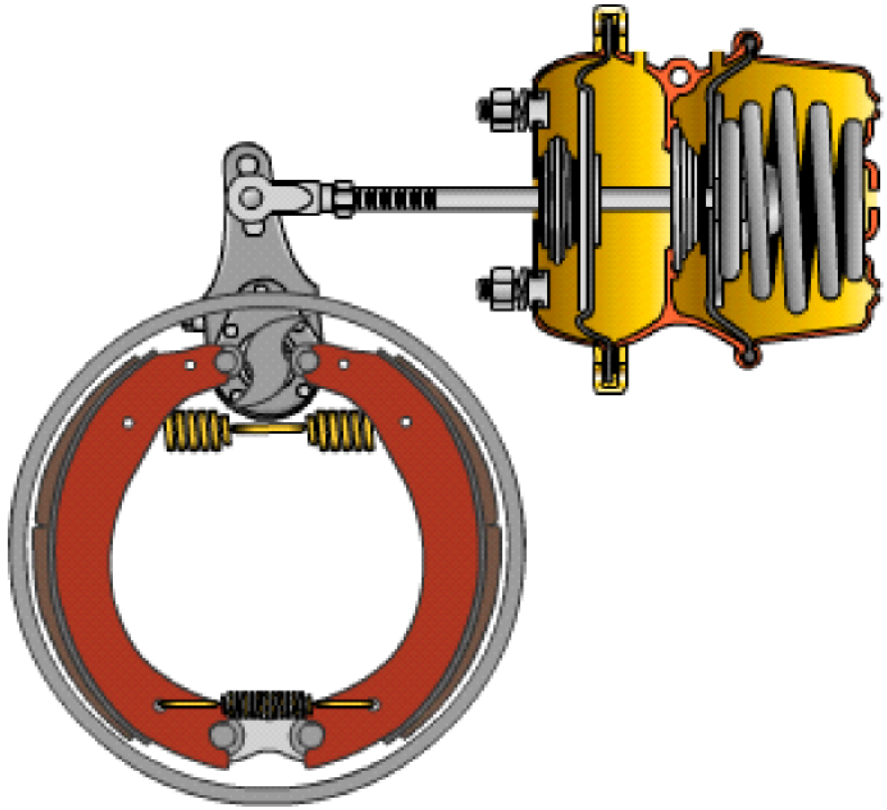




Air Brakes
Emergency – Loss of Air

If pressure is lost in the parking/emergency supply, then the spring brake will lock up the wheels.

If pressure is lost in the service supply, then the truck will have no service brakes. If this happens, use a combination of the auxiliary braking systems, transmission, and emergency brake to bring the truck to a stop.



Air Brakes
DOT Inspection

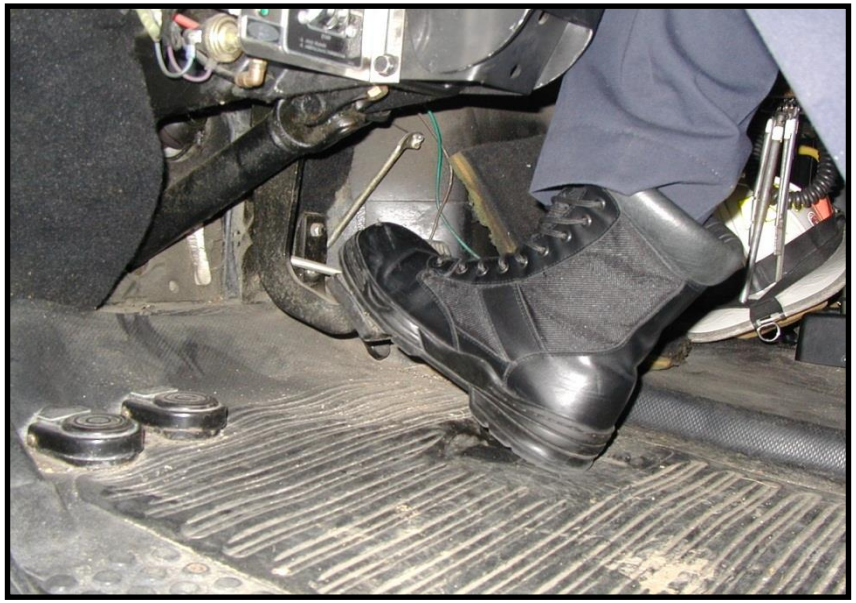
- Conducted in a specific sequence
  - Ensures all critical features are checked properly
- Incorrect sequence
  - Does not check operation of the system sufficiently
  - Will result in a failure during candidate exams - PAGS
- Requires a watch, phone, or other means to keep time
- Park on reasonably flat ground
- Place wheel chocks on both sides of a wheel
- Battery and ignition switches must be on for gauges and warning devices to operate

Air Brakes
DOT Inspection

1. Release the parking brake
   a. Push valve in
   b. Charges the system with air
2. Let pressure in storage tanks settle
3. Observe the air storage gauges for 1 minute
   a. <3psi loss (<4psi for TDA)
4. Apply steady pressure to the brake pedal
5. Let pressure in the storage tanks settle

Air Brakes
DOT Inspection

6. Observe the air storage gauges for 1 minute
   a. <3psi loss (<4psi for TDA)
7. Press and release the brake pedal repeatedly to bleed down the air storage tanks
   a. Low air alarm must sound between 60 and 90psi
   b. Parking brake must automatically engage at 20psi – valve pops out
8. Stop pressing the brake pedal once the parking brake engages
9. Start the motor and increase throttle to 1,200rpm
   a. Pressure must increase from 50psi to 90psi in <3 minutes
   b. Pressure must not exceed 135psi



Air Brakes
DOT Inspection

10. Ensure all systems and gauges are back to normal operating conditions
11. Remove the wheel chocks
12. Place the vehicle in forward or reverse gear at idle
    a. Parking brake should restrain the vehicle from moving
13. End the test by engaging the parking brake and returning the transmission to neutral

- Report any defects to CMF as needed
  - Consult with CMF if the safety of the vehicle is in doubt

Air Brakes
C-O-L-A

C=Cut in Pressure

- Indicates compressor is engaging properly
  - Motor running and fanning the service brake
  - Storage pressure drops until compressor engages **>95psi**
  - Cut-in pressure of **<80psi** is OOS criteria

O=Cut out Pressure

- Indicates governor is working properly and compressor is disengaging properly
  - Motor running and storage tank pressure rising
  - Compressor shuts off between **120** and **135**psi
  - Listen for the air dryer to exhaust air
  - Cut-out pressure of >135psi is OOS criteria

Air Brakes
C-O-L-A

L=Low Pressure warning

- Verifying that the low air alarms are functioning
  - Motor shut down but ignition on
  - Fan the service brakes to bleed storage tanks
  - Low air visual and audible alarms should engage **60** to **90**psi
  - Alarms that do not engage <60psi are an OOS criteria
- **A=Air Leakage rate**
- Assessing the ability of the entire system to hold air
  - Motor shut down
  - Monitor storage air levels for 1 minute
  - Levels should drop <**3**psi; or <**4**psi for tractor drawn vehicles

Air Brakes
Anti-Lock Braking Systems

- Computer control over the air brake system
- Senses the status of each wheel independently
- Allow the tires to turn while the apparatus is slowing down – maintaining rolling friction with the road
- Stops the apparatus in the same – or shorter – distance than regular brakes
- Replaces skid reduction techniques of “pumping” or “threshold” braking
  - Brakes need to be firmly applied and held
  - ABS will NOT work if brakes are “pumped”

Air Brakes
Anti-Lock Braking Systems

- Automatically returns full air pressure to the brakes when wheel speed is acceptable
- Any failure in the ABS is designed to return the affected wheel(s) to a non-ABS braking function
  - Should not result in complete loss of brakes
- Illuminated ABS warning light may be an OOS criteria

Air Brakes
Anti-lock Braking Systems

- **Electronic Control Unit**: the brain of the ABS
  - Controls the air pressure to the brake chamber via the modulation valve
- **Exciter or Pulse Ring**: attached to the axle or wheel hub turning at the same speed as the wheel
- **Wheel Speed Sensor**: a small induction coil mounted in close proximity to the pulse ring
  - Generates an impulse to the electronic control unit, which determines the speed at which each wheel is turning.
- **Modulation Valves**: control air pressure to the brake chambers on command from the electronic control unit
  - As quickly as 5 times per second - apply, release, or hold air pressure

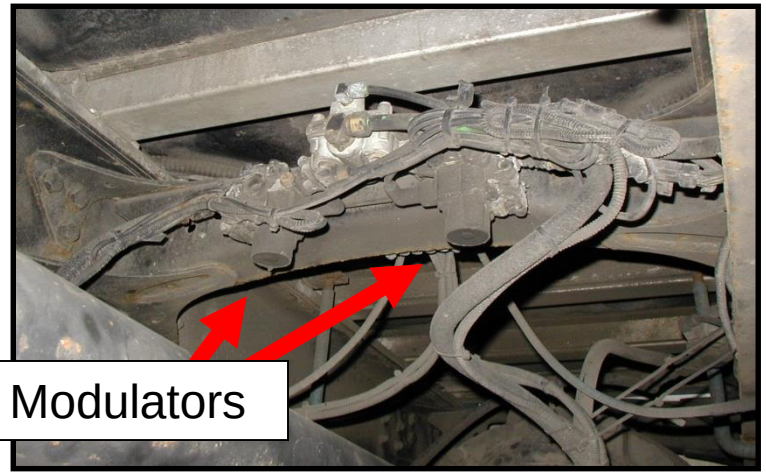
Air Brakes
Anti-Lock Brakes

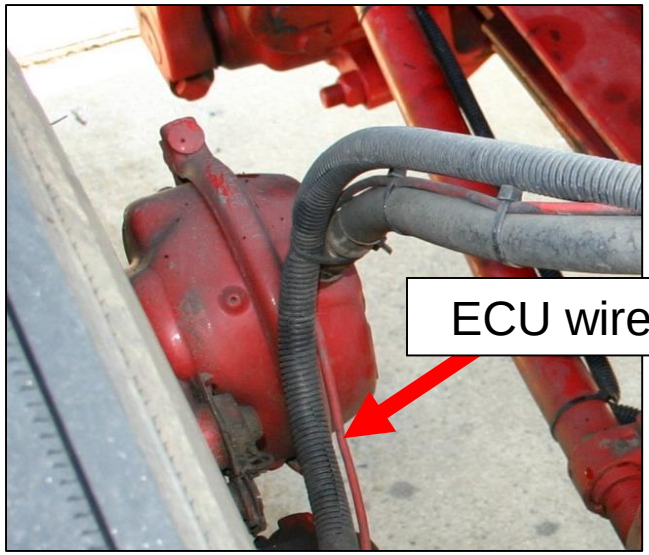
Physical check

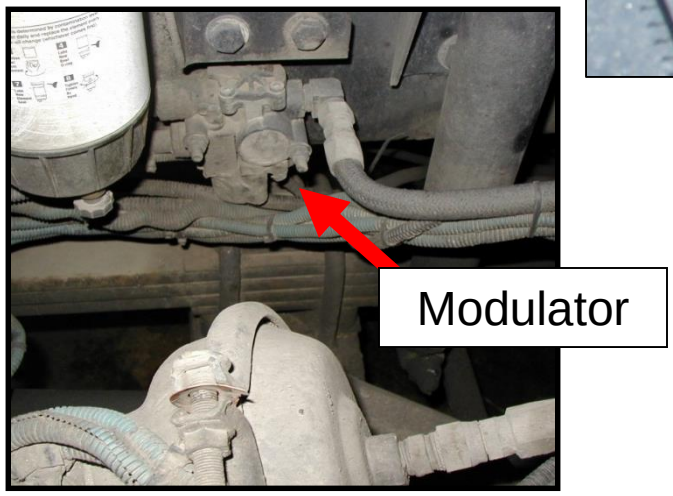
- Loose or damaged wires
- Missing or damaged components

Visual check

- ABS warning light status







Air Brakes
Threshold Braking

- Used to avoid skidding in vehicles *without* ABS
- Dependent upon the driver “feeling” the brakes
  - Pressure applied just prior to the wheels locking
- Pressure must be reduced if wheels lock
- Technique used for slippery conditions to maintain steering control while slowing
- Avoid “pumping” the brake pedal
  - Pumping can reduce available air pressure

Air Brakes
Brake Fade

- A full stop at 60mph might raise the drum temperature 600°F
- Drums that reach 800-1000°F become subject to fade
  - Drum expand with the heat and require increased pushrod stroke
- Brake shoes and pads are essentially composed of glue and a binder material
  - With excessive heat the glue softens, starts to melt, and the face of the shoes or pads becomes slick
- Excessive heating may create conditions that exceed the pushrod stroke
  - combined drum expansion and shoe/pad failure

Brake Failure

- Stay calm!
- Apply firm steady pressure to the pedal
- Shift to a lower gear
  - Downshift transmission by pressing the down arrow on the selector
- Ensure auxiliary braking systems are fully engaged
- Make small steering movements to create more friction with tires
- Rub tires against curb
- Look for an escape path that leads uphill or has a soft driving surface that will naturally slow the truck

Auxiliary Braking Devices

- Reduce need to apply service brakes
- Assist the service brakes in stopping the vehicle
- Systems in use in MCFRS
  - Jacobs Engine Brake
  - Telma Driveline Retarder
  - Allison Transmission Retarder
- Become familiar with the features of the specific apparatus you are driving

Auxiliary Braking Devices
Jacobs Engine Brake

- "Jake" brake
- Fully integrated into the motor cylinders
- Engages automatically when the accelerator is released
- Disengages when:
  - Accelerator is depressed, or
  - Motor speed falls below 1,000rpm
- Uses the motor to absorb energy instead of producing energy
  - Is most effective in higher rpm ranges; 2,100+ rpm
  - <1,700rpm effectiveness greatly reduced
- Newer models are much quieter than old due to emissions standards

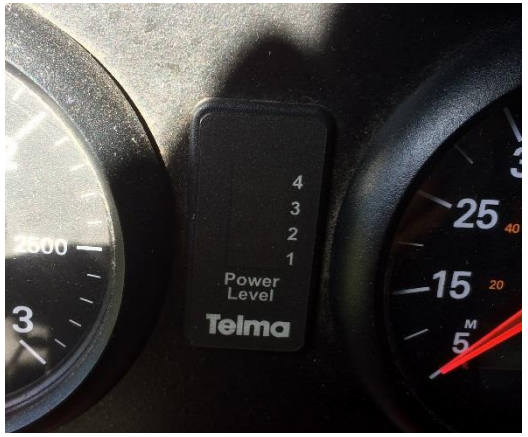
Auxiliary Braking Devices
Jacobs Engine Brake

- For dry weather and normal conditions, switch should be set to “high”
- For wet or slippery surfaces, gradually engage the engine brake starting at low and progressing to higher levels as wheel slip allows
  - Any fishtail or locking of the wheels mandates moving back to the last lower setting or turning the system off

Jacobs Vehicle Systems®

Auxiliary Braking Devices
Telma Retarder

- Mounted on the drive shaft near the rear axle
- Slows the rotation of the drive shaft through electromagnetic force
- Generates heat that is dissipated by the cooling vanes on the device
  - Have a history of overheating on some units
- Operates in four stages
  - Release the accelerator – stages 1 & 2
  - Depress the brake lightly – stage 3
  - Depress the brake hard – stage 4
- Slippery road conditions may require disengaging the device completely



Telma Introduction Video

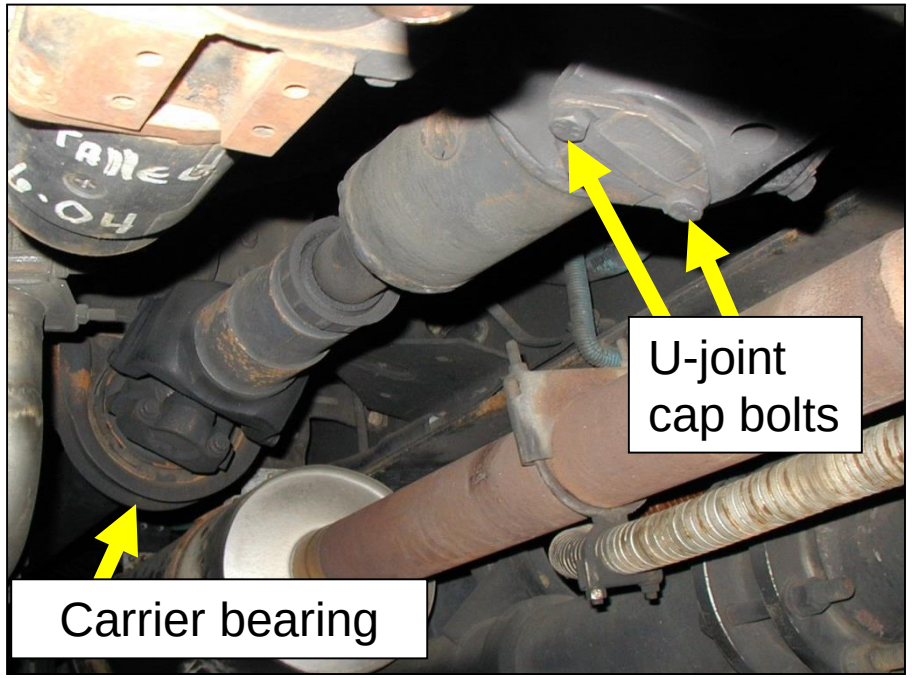
Auxiliary Braking Systems
Transmission Retarder

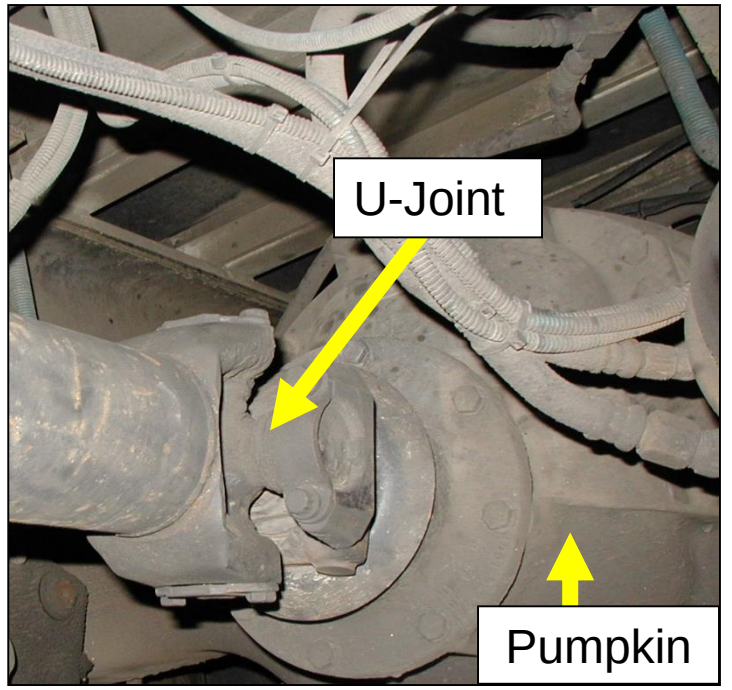
- FL80 chassis
- Vaned flywheel within transmission
- Oil directed into the flywheel to slow the transmission
- Heats up the transmission
  - Shift points become abrupt
  - Overheat condition can shut down the vehicle

Other Components
Driveline

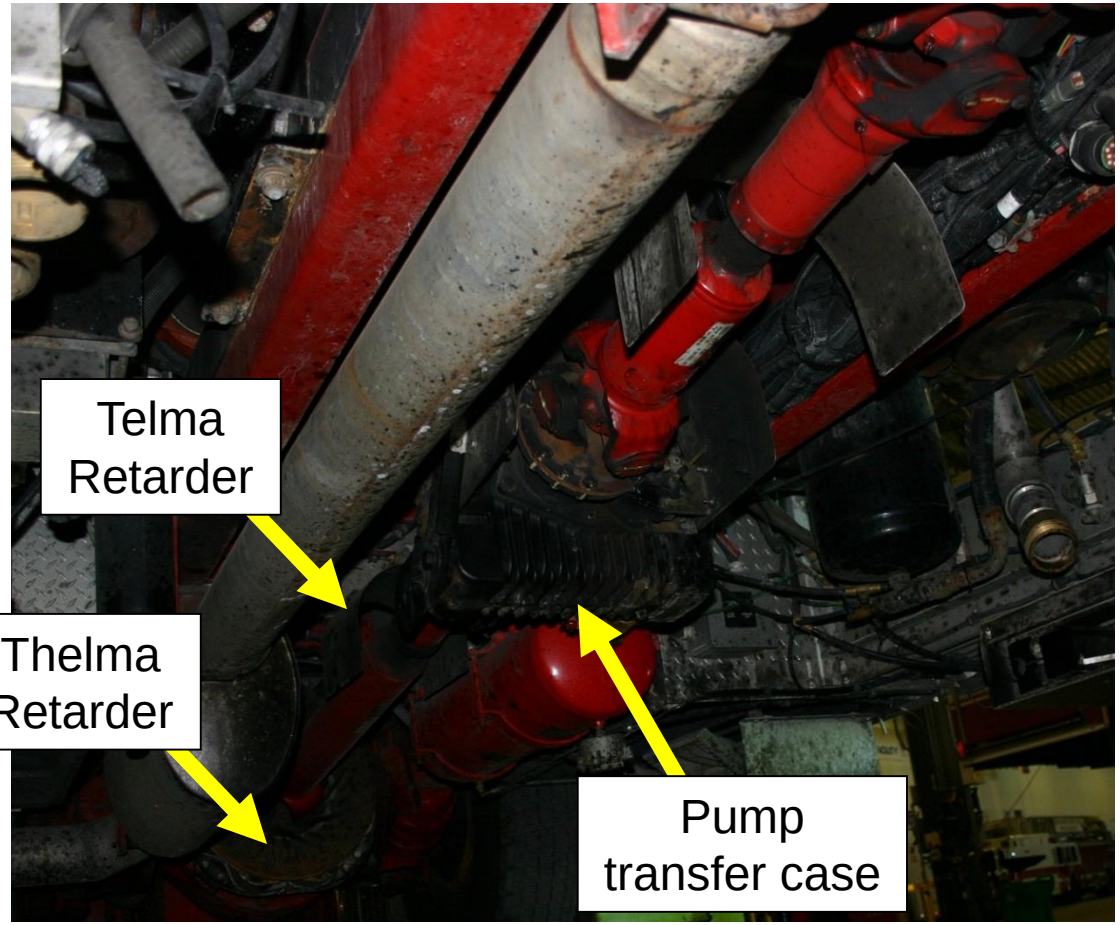
OOS Criteria

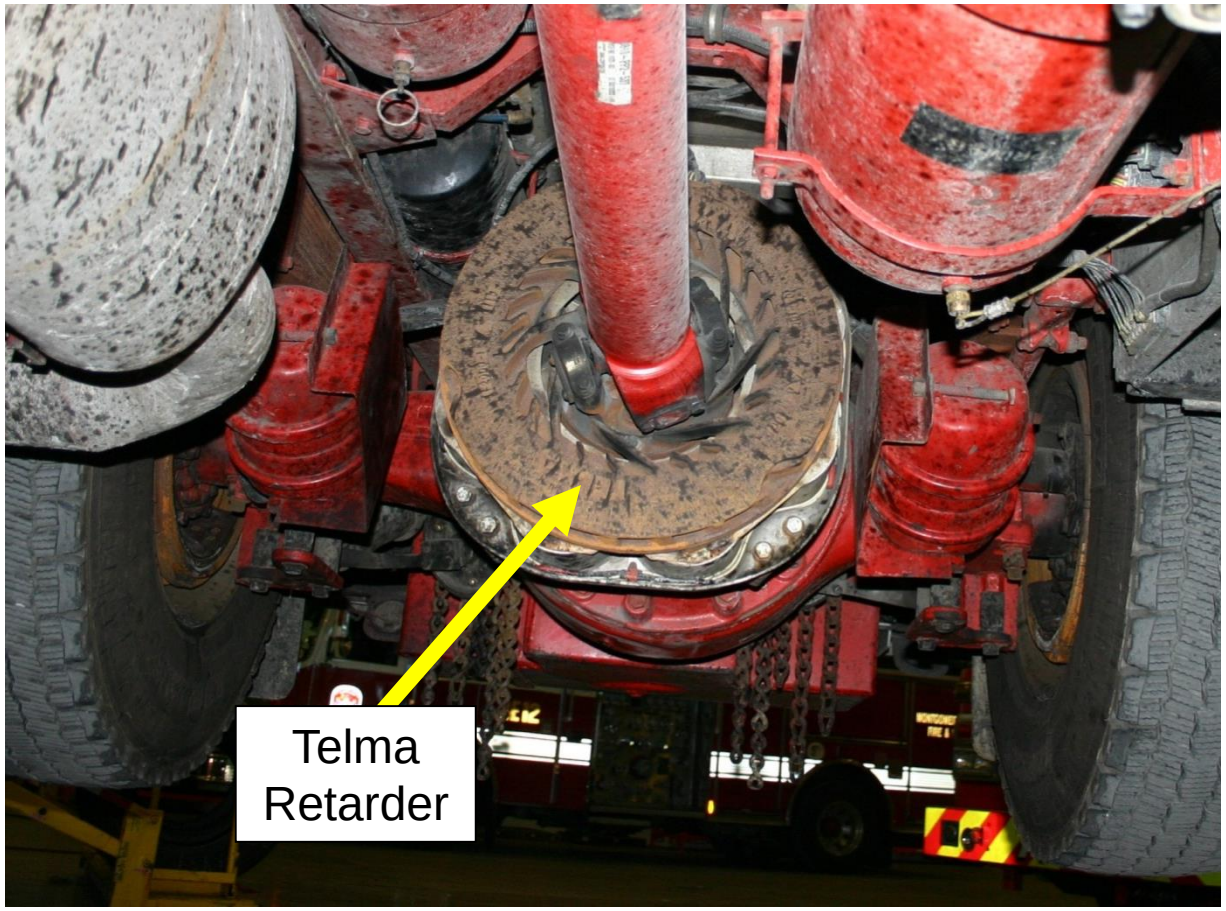
- Missing or broken bolts on the carrier bearing
- Missing or broken bolts in the U-joints
- Class 2 fluid leak at rear pumpkin





Other Components
Crimson Driveline

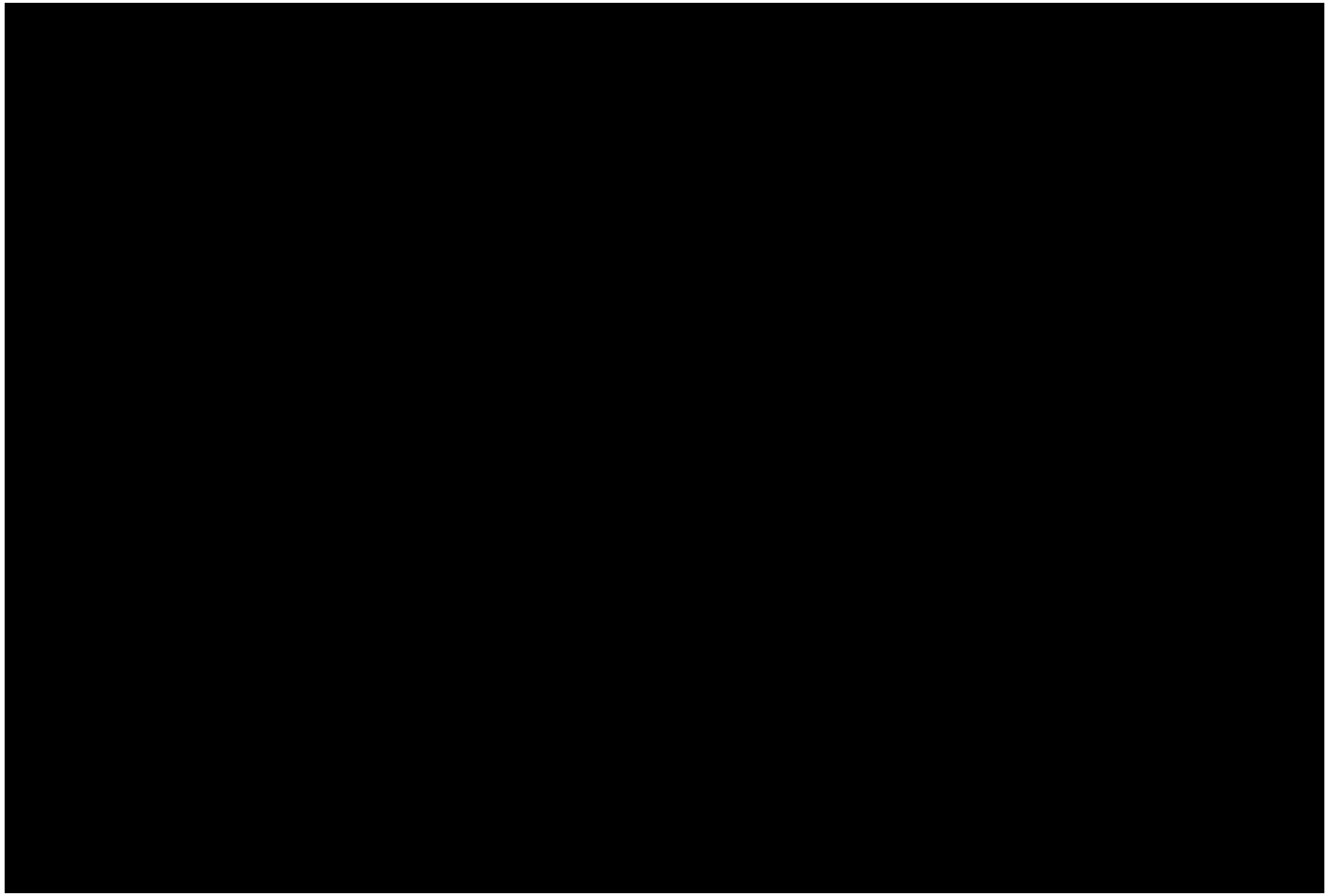




Engine Aftertreatment

- Enables compliance with EPA emissions standards – emergency vehicles are NOT exempt
- After 2006, all diesel exhaust systems have a particulate filter and associated regeneration system
  - Diesel Particulate Filter (DPF) captures soot and ash
  - Regeneration burns off the soot and ash that accumulates
- After 2009, aftertreatment systems include Diesel Exhaust Fluid (DEF) for additional treatment of exhaust gases
- There are two operator interventions necessary with these systems:
  - Active Regeneration – aka “parked” regeneration
  - Refilling the DEF tank

Diesel Particulate Filter
How does it work?



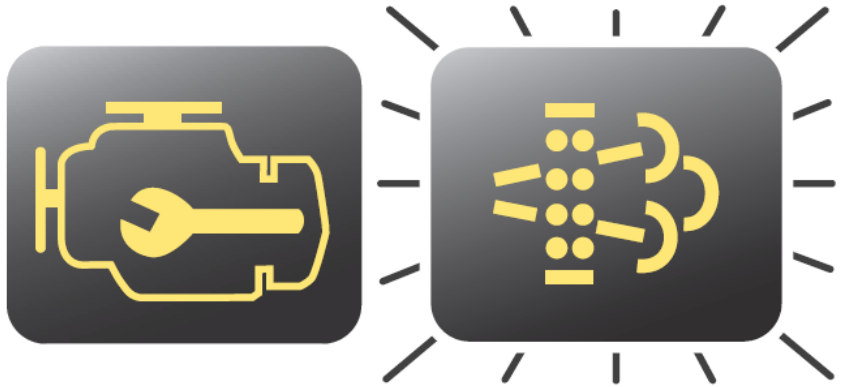
Diesel Particulate Filter
Indicator Lamps

Aftertreatment Diesel Particulate Filter

- Indicates a regeneration is needed – passive or active
- When flashing, regeneration is more urgently needed

High Exhaust System Temperature

- Does not signify any need for service – regeneration occurs at high temperatures
- Keep the exhaust pipe outlet away from combustibles



Flashing DPF Light + Check Engine

- Regeneration is needed immediately
- Active regeneration is required

Diesel Particulate Filter
Passive Regeneration

- Occurs automatically as needed when driving over 40mph
  - Does not require any action on the part of the driver

- It is unlikely that MCFRS apparatus will drive enough highway miles for Passive Regeneration to complete it's cycle

Diesel Particulate Filter
Active Regeneration – "Parked Regen"

1. DPF lamp illuminates or flashes
2. Determine a suitable location to park the apparatus
   - Away from combustibles or items that could be damaged by exhaust heat – need at least 5 feet of clearance
   - Outdoors and NOT connected to the PlymoVent
3. After parking the unit, engage the manual regeneration
   - May be a toggle switch, rocker switch, or other control
   - Motor rpm should increase to approximately 1100rpm.
4. The driver must remain with the vehicle during regeneration
   - Duration varies by amount of soot in the DPF – 5 to 20 minutes

Diesel Particulate Filter
Active Regeneration – "Parked Regen"

- Regeneration will stop:
  - Automatically when the motor controls sense the particulate filter is cleaned
  - Manually if the brake pedal is depressed
- Unit may remain in service during regen
- Regen may not engage when other vehicle functions are in use, i.e. pump, PTO, hydraulics – older generation vehicles
- Vehicle exhaust components will remain very hot following the regen process
  - High temperature light will illuminate

Diesel Particulate Filter
Active Regeneration – "Parked Regen"

PRESSING BRAKE, THROTTLE, REGEN INHIBIT SWITCH WILL STOP REGENERATION PROCESS

1. Stop vehicle completely, transmission in N (neutral), and set the parking brake.
   - Park on a clean surface that will not melt or burn (clean concrete or gravel, not grass or asphalt).
   - Engine control should be from accelerator pedal (not PTO, remote PTO, cruise, etc) PTO and running at normal idle (high idle should be OFF).
   - Clear exhaust outlet area 5 ft of any items, gasses, vapors that can melt, burn or explode.
   - If indoors, exhaust discharge pipe must be rated at least 1500°F (816°C).
2. Keep foot off the throttle pedal and the brake pedal.

⚠CAUTION

STAY with the vehicle. Monitor the area during the operation. if any unsafe conditions occur, shut off engine immediately!

NOTE: Diesel Particulate Filter (DPF) lamp must be ON in order to start a stationary regeneration.

3. With the engine running, press and hold the vehicle's regeneration switch for several seconds.
   - Engine speed increases. The turbocharger may make a different sound during the event.
   - DEF lamp turns OFF. As hydrocarbons are added, temperature goes up. HEST lamp illuminates when exhaust temperature reaches 977°F (525°C).
   - Regeneration may take 20-40 minutes or more, depending on soot level.
   - Exhaust temps stay high at least 3-5 minutes after completion.
4. To stop a regeneration before completion, depress throttle pedal, release parking brake, press the regeneration inhibit switch, or turn off the engine.
5. When the regeneration is complete, the engine returns to normal idle speed and operation.
   — If excessive soot remains in the filter, the DPF light(s) will return to the appropriate stage until another regeneration occurs. Repeat parked regeneration. If the DPF light still remains on, call for service.

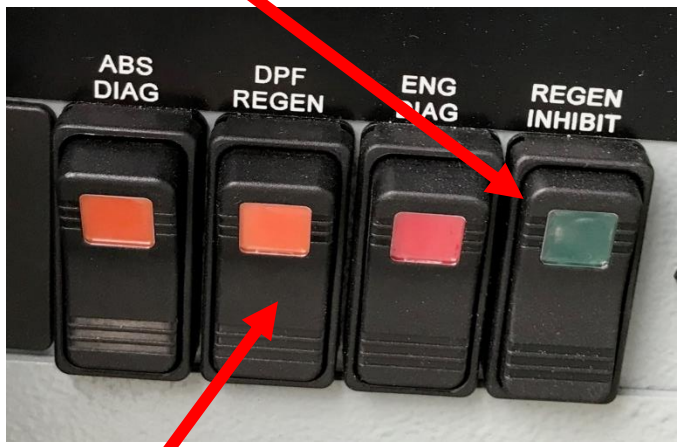
Do not perform regen inside a building or while attached to an exhaust removal system!

A minimum of 5 feet of clearance is required to the exhaust outlet.

When pumping it may be necessary to inhibit regen if clearances to the exhaust are not available!

Active Regeneration
Pierce Enforcer Engines

Prevents system from entering or continuing in active regeneration mode; used when regen may engage in an undesirable location



Used to manually initiate a parked regeneration; DPF lamp must be illuminated to engage

Regeneration occurs:

a. When an intervention by the operator during *travel or pumping* operations creates correct conditions for regen
   - Requires sufficient exhaust flow and temperatures
   - Speedometer >5mph
   - NO engine speed variations will occur when pumping or driving

b. Manually by activating the DPF Regen switch while parked

Regeneration will not effect motor RPM during pumping operations if it engages automatically.

Diesel Particulate Filter
Active Regeneration – "Parked Regen"

Example of active regen controls

Diesel Exhaust Fluid (DEF)
What is it & What does it do?

- Non-hazardous solution of 32.5% urea and 67.5% de-ionized water used in post-2009 diesel vehicles
- DEF is sprayed into the exhaust stream of diesel vehicles to break down NOx emissions into nitrogen and water
- DEF is **not a fuel additive** and never comes into contact with diesel
- DEF is stored in a separate tank, typically with a blue filler cap.

Diesel Exhaust Fluid
Levels & Location

DEF fill located inside driver's side rear cab door

DEF fill co-located with driver's side diesel fill

DEF level display located above fuel gauge on dash, as a separate gauge, or within a vehicle system screen.

Diesel Exhaust Fluid
Contamination – Fuel vs. DEF

- Nozzle sizes
  - DEF nozzles are 0.75”; diesel nozzles are 0.87”
  - The diesel nozzle should not fit into the DEF tank
  - The cap for the DEF tank is blue and will be clearly marked
- Diesel in the DEF tank
  - Diesel will float on top of DEF
  - Small amounts of diesel can damage the exhaust system
  - If any fluid except DEF is poured into the DEF tank, contact CMF immediately and do not drive the vehicle.
- DEF in the fuel tank
  - The motor will stop running almost immediately, and the vehicle will require repair

Diesel Exhaust Fluid
Supply, Handling, and Refill

- Stocked in 2.5 gallon containers with filler tubes
  - requested as needed through normal supply procedures
- DEF crystallizes when stored for prolonged periods as the water evaporates
  - Do not use DEF that shows signs of crystallization
  - Always completely use a container to avoid storing opened containers
- Refill when the level indicator reaches 1/2 or less
  - The tank should accept one full 2.5 gallon container of DEF
  - No need to continuously top off the DEF tank
- Filler tube is supplied with the case
- Spills can be safely washed down with water. DEF is not corrosive to human skin, however is corrosive to aluminum. Do not allow it to remain on the diamond tread.
- The freezing point of DEF is 12°F, however vehicles are equipped to thaw the DEF and this should not restrict use of the vehicle.
- Personal protective equipment is not necessary when handling DEF, however it will stain clothes.

Rear Axle Differentials

- The differential allows the wheels on the rear axle spin at different rates while the vehicle is turning
  - Permits tighter turning
  - Less wear and tear on the tires
- Differential Lock
  - Locks both sets of drive wheels together as if they were rotating on a solid shaft
  - Used during poor traction situations; without it one wheel may continue to spin with little torque transferred to the wheel with traction
  - Never engage >25mph or with wheels spinning
  - Disengage once traction is regained; do not use on dry pavement

Inter-Axle Differential
Tandem Axle Apparatus

- Allows the wheels of either axle to revolve faster or slower than the wheels of the other axle
- Compensates for cornering, uneven road surfaces, and slightly different tire sizes
- Inter-axle Differential Lock
  - Sends equal power to all rear tires
  - Used during poor traction situations
  - Never engage while moving or with wheels spinning
  - Disengage once traction is regained; do not use on dry pavement

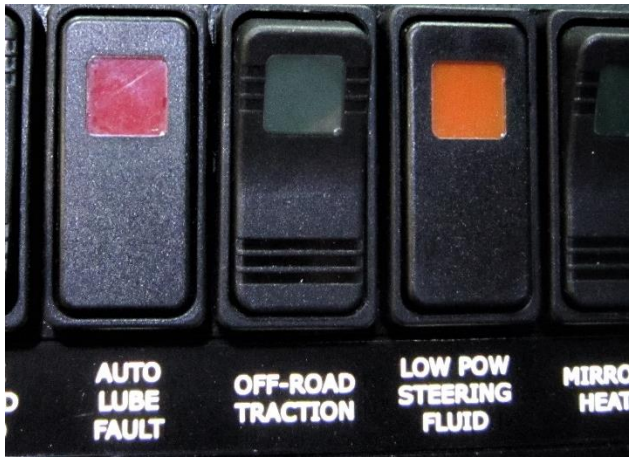
Automated Control Features

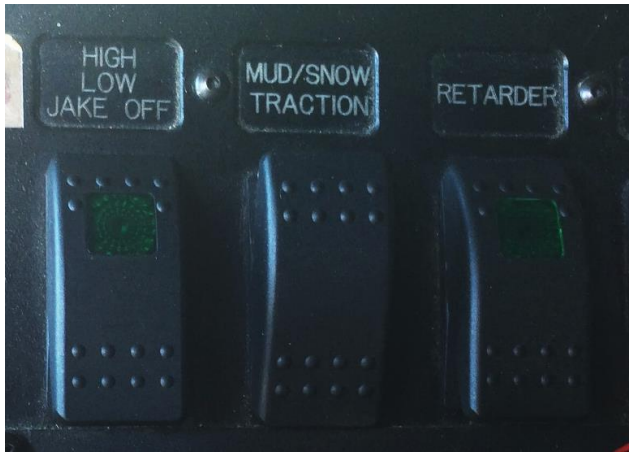
Automatic Traction Control (ATC)

- Automatically applies the service brake to the spinning wheel
- Transfers torque through the differential to the opposite wheel
  - If both wheels lose traction, the system reduces engine torque until traction is sensed
- If the vehicle is stuck and the ATC keeps reducing engine speed, disengage by pressing the “Mud/Snow Traction” or “Offroad Traction” switch on the dashboard

Roll Stability Control (RSC)

- Senses lateral acceleration integral to the ABS
- Automatically adjusts vehicle components
  - Reduces engine torque
  - Engages engine brake or retarder
  - Applying the service brakes



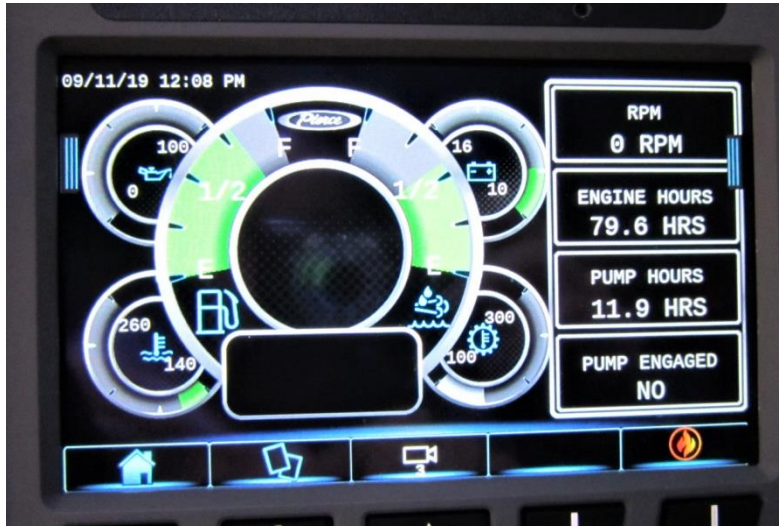


Automated Control Features

- Electronic Stability Control (ESC)
  - Pierce Enforcer feature
  - stabilizes the vehicle during cornering maneuvers
  - Compares where you are steering and where the vehicle is actually going
  - Intervenes by applying the brakes to individual wheels asymmetrically in order to create torque about the vehicle's vertical axis
  - system may reduce engine power or operate the transmission to slow the vehicle down

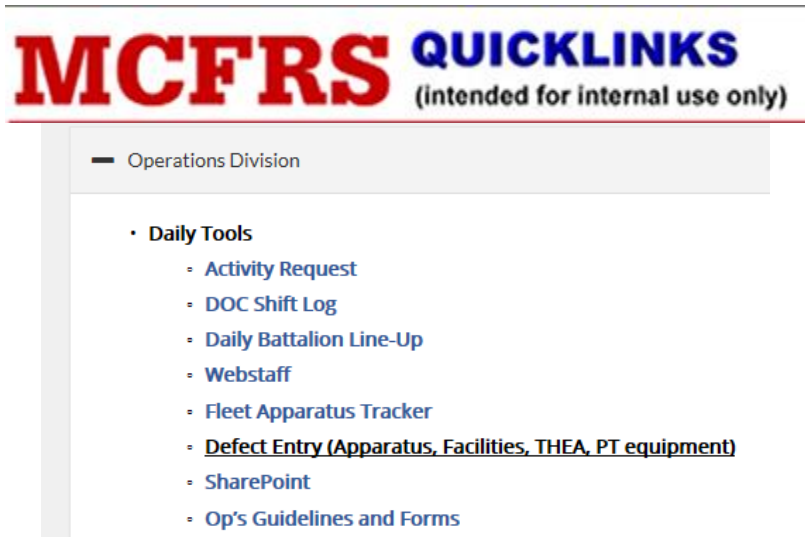
Vehicle Diagnostics
Pierce Enforcer Engines

- Command Zone offers layers of vehicle system status
- Command Zone displays engine hours and pump hours needed for defect reporting



Defect Reporting
Fleet Management Reporting System

- Requires employee ID # and password
  - Not the same as single sign-in or network info
- Statistics are required to complete the online report
  - Vehicle mileage
  - Engine Hours
  - Pump Hours
  - Generator Hours
- Enter only one defect per report
  - Provide a detailed description of the issue
  - Include photos when applicable
- Permits the operator to see what defects exist and who reported them when



Additional Resources

- MCFRS Operator's Guide to Fire Apparatus Out of Service Criteria
  - http://www.montgomerycountymd.gov/frs-gl/resources/files/apparatus/MCFRSOOSCriteria12.pdf
- PSTA Driver Training Website
- MCFRS Apparatus Checkout Form
  - http://www.montgomerycountymd.gov/frs-gl/resources/files/apparatus/checkout/ApparatusCheckout.pdf

QUESTIONS?

End of Session 2