Diesel Bus and Truck

Shane Gill

Diesel Fuel

- Hydrocarbon mixture that is a byproduct of crude oil
- Very low evaporation point
- Regular gas can evaporate at room temperature, by comparison
- Combustible, meaning it requires heat and compression
- Gasoline is flammable, meaning it requires a spark
- Contains more sulfur than gas (smells)

Why Diesel?

The power produced by diesel fuel and regular gas

There are many reasons why diesel is more powerful than gasoline. This is a benefit for many industries that rely on diesel-powered vehicles. Here are some quick facts to know about the power output of both fuels.

- Opponents of diesel don't mention that the power generated from its combustion is several times greater than that of regular gas. The increase in power output makes this fuel more efficient.
- Diesel has a higher energy density than gasoline, with one gallon producing 155x 10 to the sixth power joules. Gasoline only produces 132×10 to the sixth power joules. In other words, one gallon of diesel produces 147,000 BTUs compared to 125,000 BTUs of a gallon of regular gas.
- Diesel fuel does not need Ethanol, an additive that increases efficiency.
- While diesel fuel is highly efficient for use within trucks and heavy machinery, it is less effective in automobiles.
- The EPA has conducted studies that show diesel performs less-efficiently in cold weather conditions than regular gas. But, it is known to perform better at higher altitudes.

More Energy

Diesel and gasoline are both refined from crude oil. However, gasoline is more refined than Diesel. This makes gasoline thinner in density and more volatile. So, in practical use, gasoline burns faster, which allows it to produce more power or horsepower.

Whereas Diesel fuel is thicker in density, it evaporates more slowly. It has a higher energy density, which means that 20% more energy is produced from Diesel than the same amount of gasoline.

This is why Diesel engines are favored in big machines as they can produce more energy at lower RPMs and provide more torque. In contrast, gasoline engines are used in lightweight vehicles that need less torque and more horsepower to go faster.

Compression Ignition –vs- Spark

While both engines use the same concept, it is the process of combustion that makes the difference.

In gasoline engines, the fuel is first mixed with air and then compressed by the piston. Then a spark plug creates a spark to cause an explosion (combustion). The explosion then again moves the piston, which moves the crankshaft and ultimately moves the wheel.

A Diesel engine, however, doesn't need spark plugs for combustion.

Diesel engines work on a system called compression-ignited injection. Unlike gas engines, where a simple spark is needed for ignition, Diesel fuel first needs to be vaporized. Then it is sent to the combustion chamber, where it ignites at a high temperature.

Compressed air is used to increase the temperature of the combustion chamber. As the piston compresses the air, it gets hotter due to pressure. The hot air, when mixed with vaporized Diesel, ignites, and combustion happens. A glow plug is used with some engines to increase temperature.

Diesel engines have a high compression ratio which allows them to be more efficient than gasoline. Meaning they can produce more energy compared to gas.

Engine Differences

- Much heavier construction of engine components
- Much larger capacity oil system and almost always includes an engine oil cooler
- Heavy duty engine oil required
- Cooling system capacity is much larger
- May have more than one cooling system
- Drivetrain components are much larger

Diesel vs Gas

Advantages

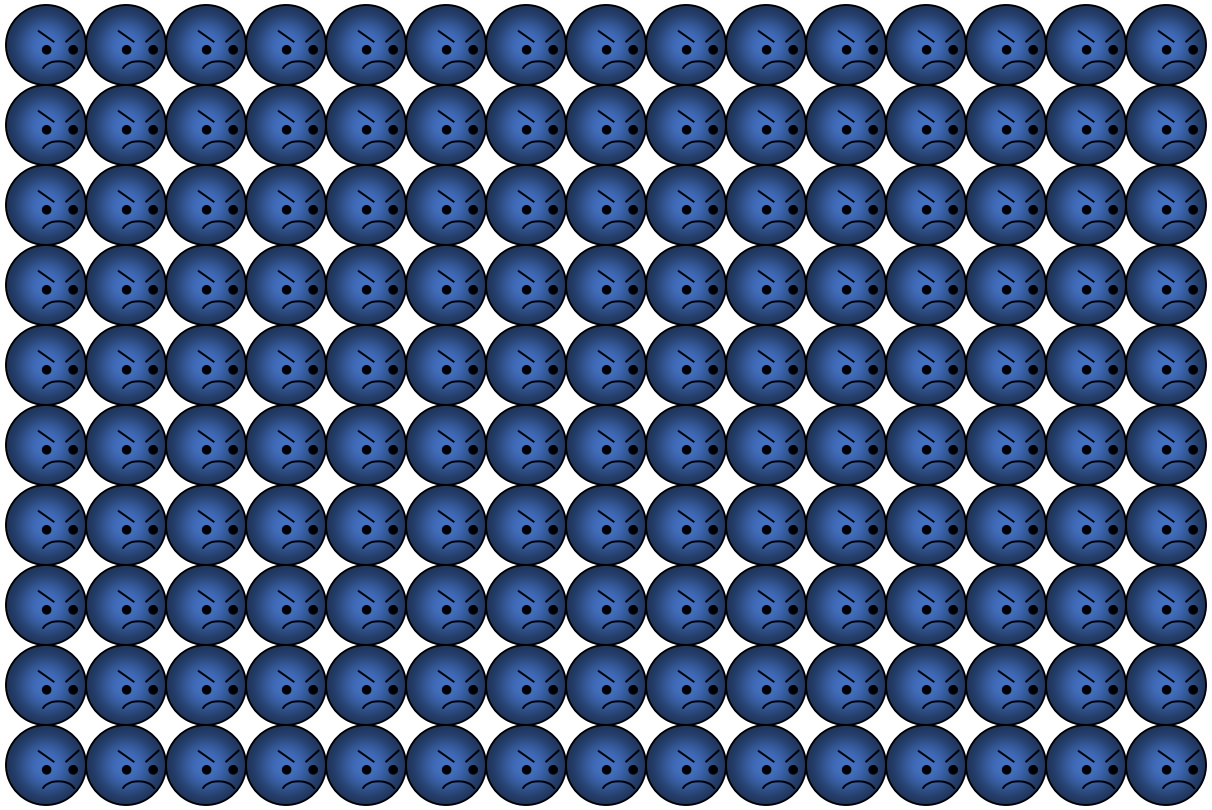
- More power - torque
- Durable (500,000–1,000,000 mi)
- More fuel-efficient
- Work at a lower and more consistent RPM

Disadvantages

- More expensive to build
- More expensive to maintain
- Diesel fuel attracts water which forms bacteria.
- More issues with the fuel than with gasoline
- Emission control regulations and devices have escalated

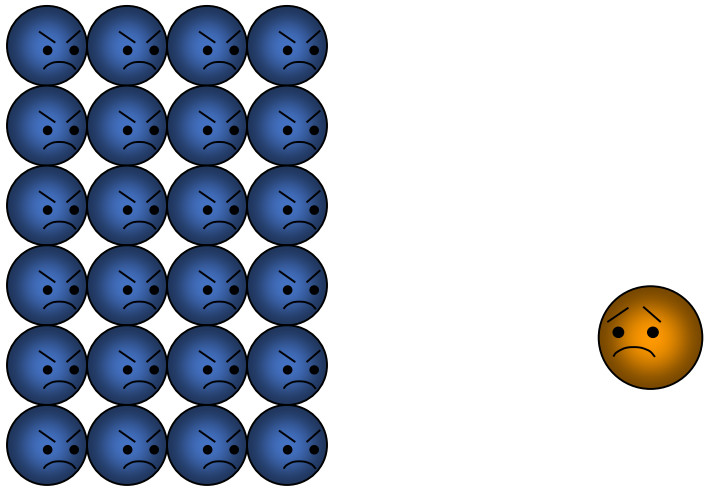
Diesel Engine Air to Fuel Ratio

- At Idle or no load the A/F ratio can be as high as 145:1 vs 14.7:1 for gas



Air to Fuel Ratio

- At full load, the air/fuel ratio on a turbocharged diesel engine:
- 17:1 to 29:1 vs 14.7:1 on a gasoline engine



ULTRA-LOW SULFUR HIGHWAY DIESEL FUEL

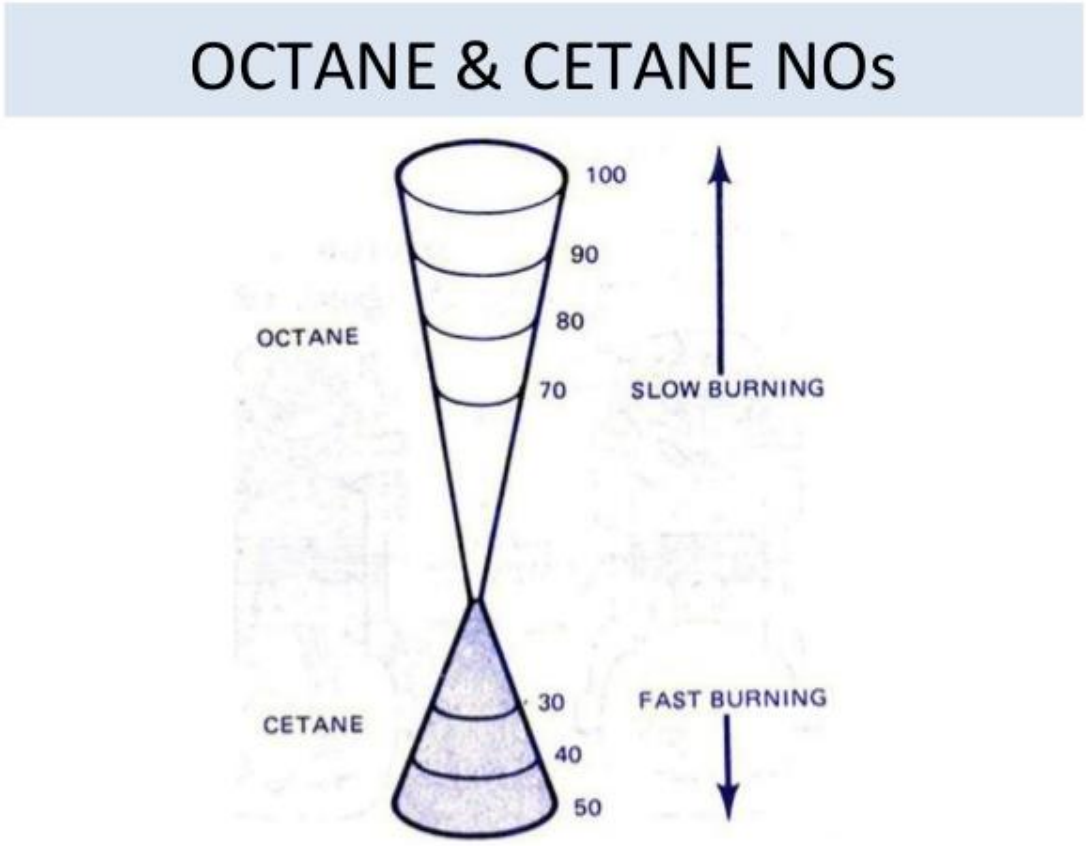
(15 ppm Sulfur Maximum)

Required for use in all model year 2007 and later highway diesel vehicles and engines.

Recommended for use in all diesel vehicles and engines.

Diesel Fuel Properties

- Viscosity
  - Injector spray pattern
  - Flow through filters
  - Affected by temperature (gelling near 0)
- Cetane
  - Opposite of octane
  - Measure of ignition “delay”
  - Higher #=less delay=faster ignition
  - Too low cetane=too much delay=lots of noise
  - Typical cetane rating 44



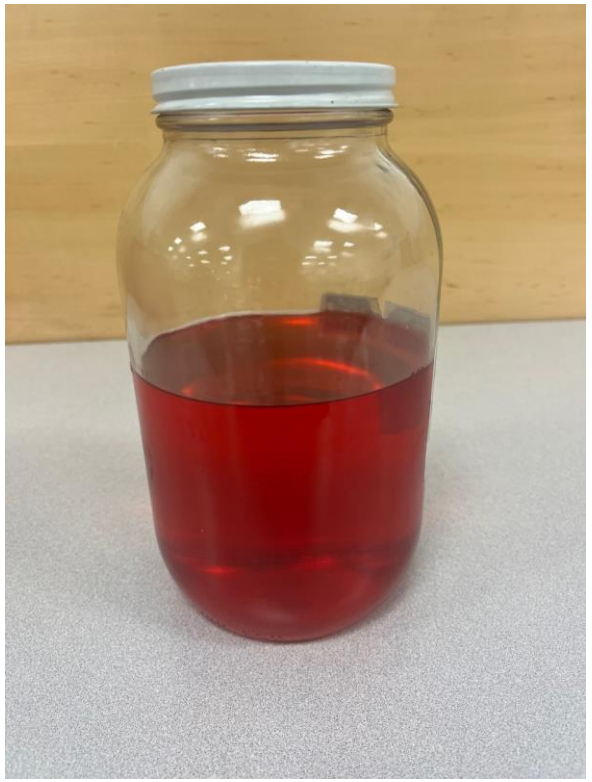
Diesel Fuel

- Number 2
  - Used most often
  - “thicker” viscosity
  - More BTU’s (energy)
  - Has more paraffin wax
  - More lubricity
  - Begins to gel at 14 deg F
  - Will need to be blended or have additives in cold climates
- Number 1
  - Less lubricating
  - “thinner” viscosity
  - Less BTU’s (energy)
  - Has less paraffin wax
  - Less lubricity
  - Will not gel till -30 deg F
  - Cannot be used “straight”

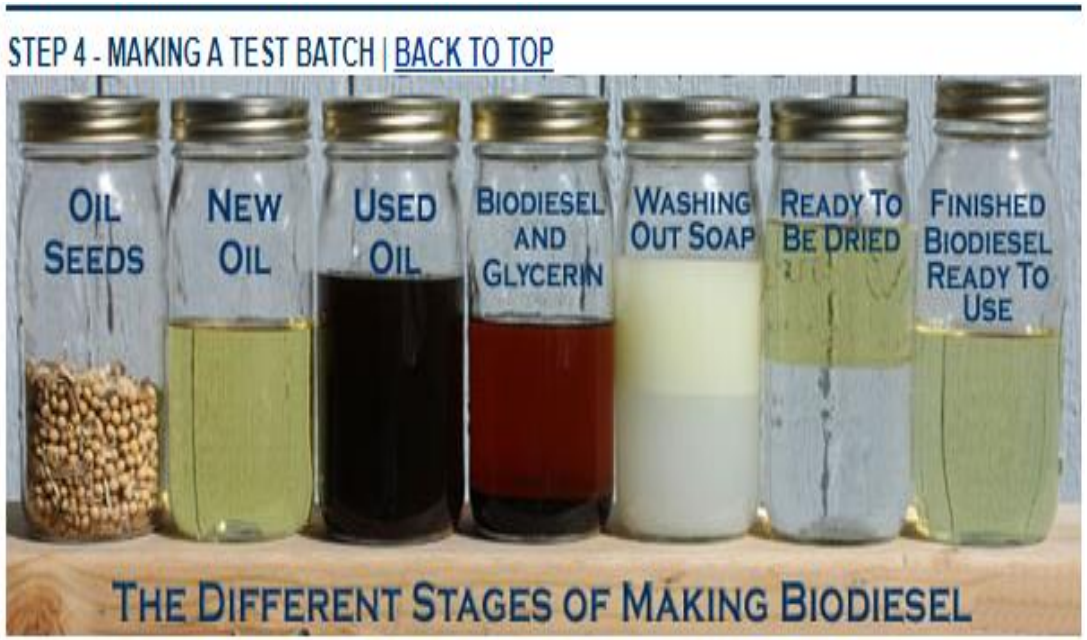
Off Road Diesel Fuel

Taxed

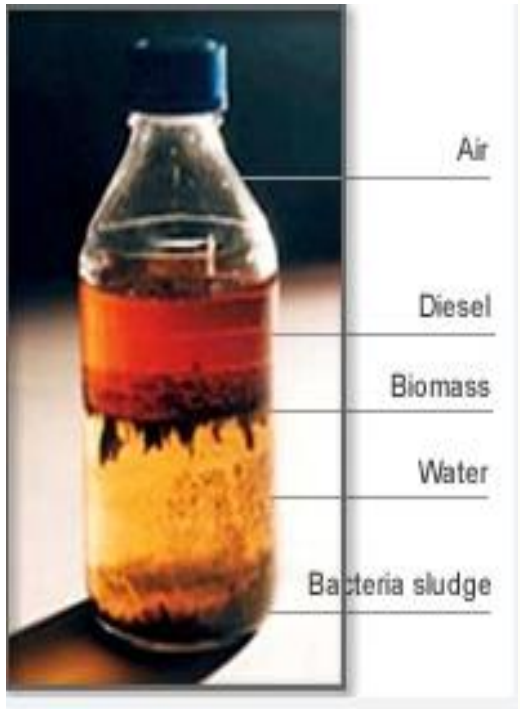
Not Taxed



Making Diesel fuel……

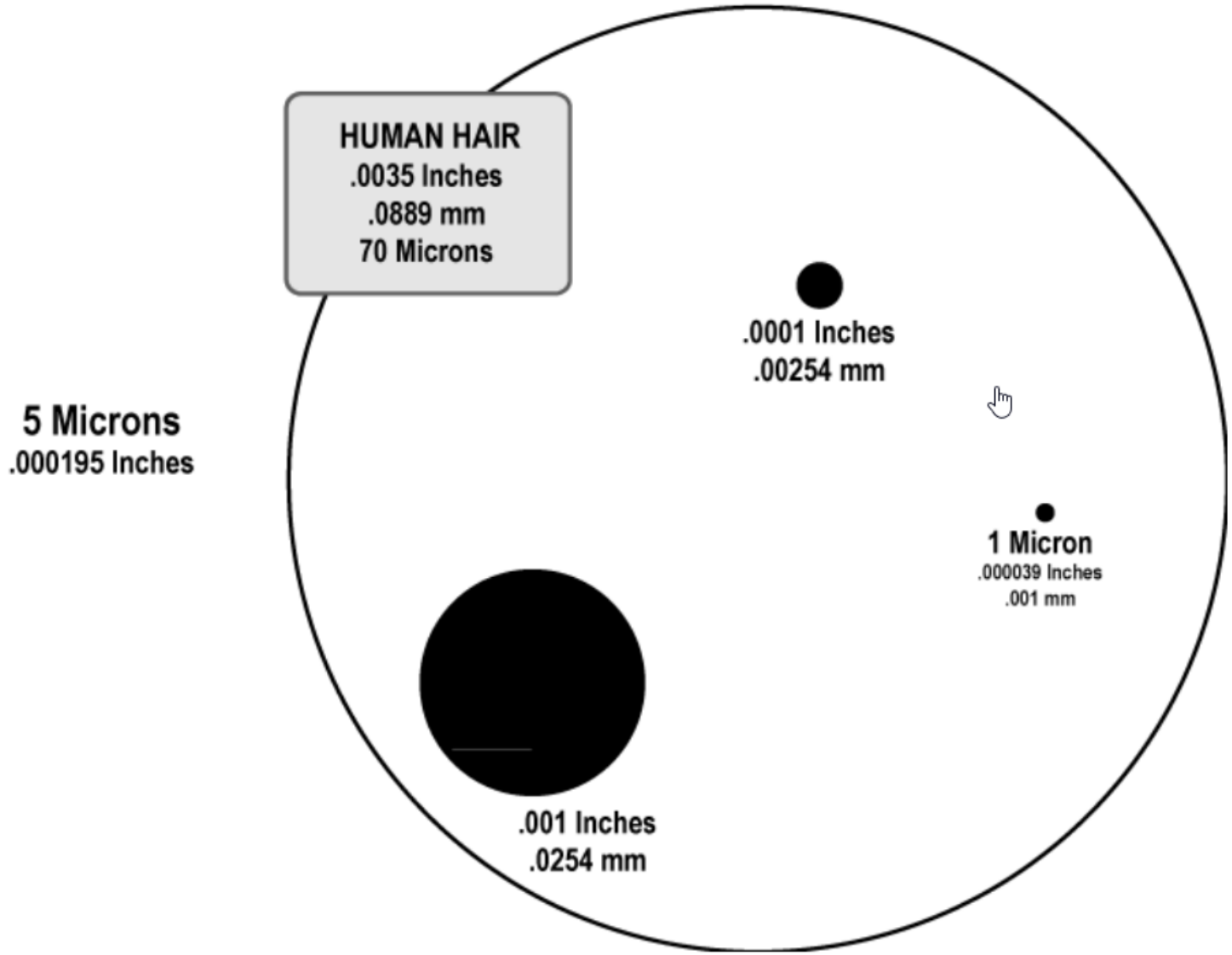


MUST BE CLEAN!



Injector tip hole size (.133mm = 0.005”)

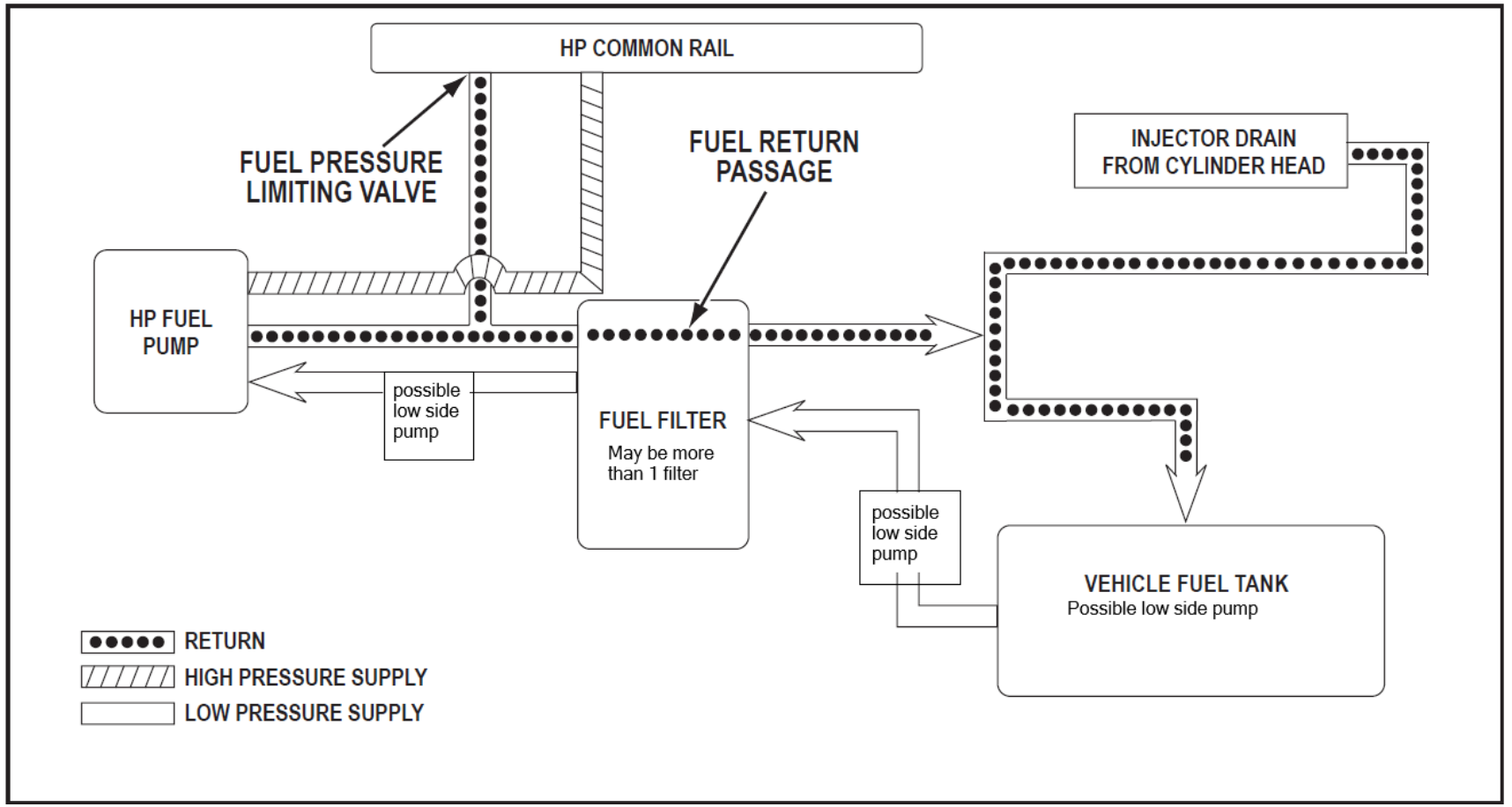
Injector type	Electro-hydraulically controlled injector	
Nozzle type	Dual guided VCO	
Flow Number	400cm^3/30s @100bar	
Number of nozzle holes	6	8
Hole diameter	0.154mm	0.133mm
Spray included angle	50°, 85°	120°, 130° 140°, 154°


HUMAN HAIR
.0035 Inches
.0889 mm
70 Microns
.0001 Inches
.00254 mm
5 Microns
.000195 Inches
1 Micron
.000039 Inches
.001 mm
.001 Inches
.0254 mm

What happens when you fill a diesel with the “green” nozzle????

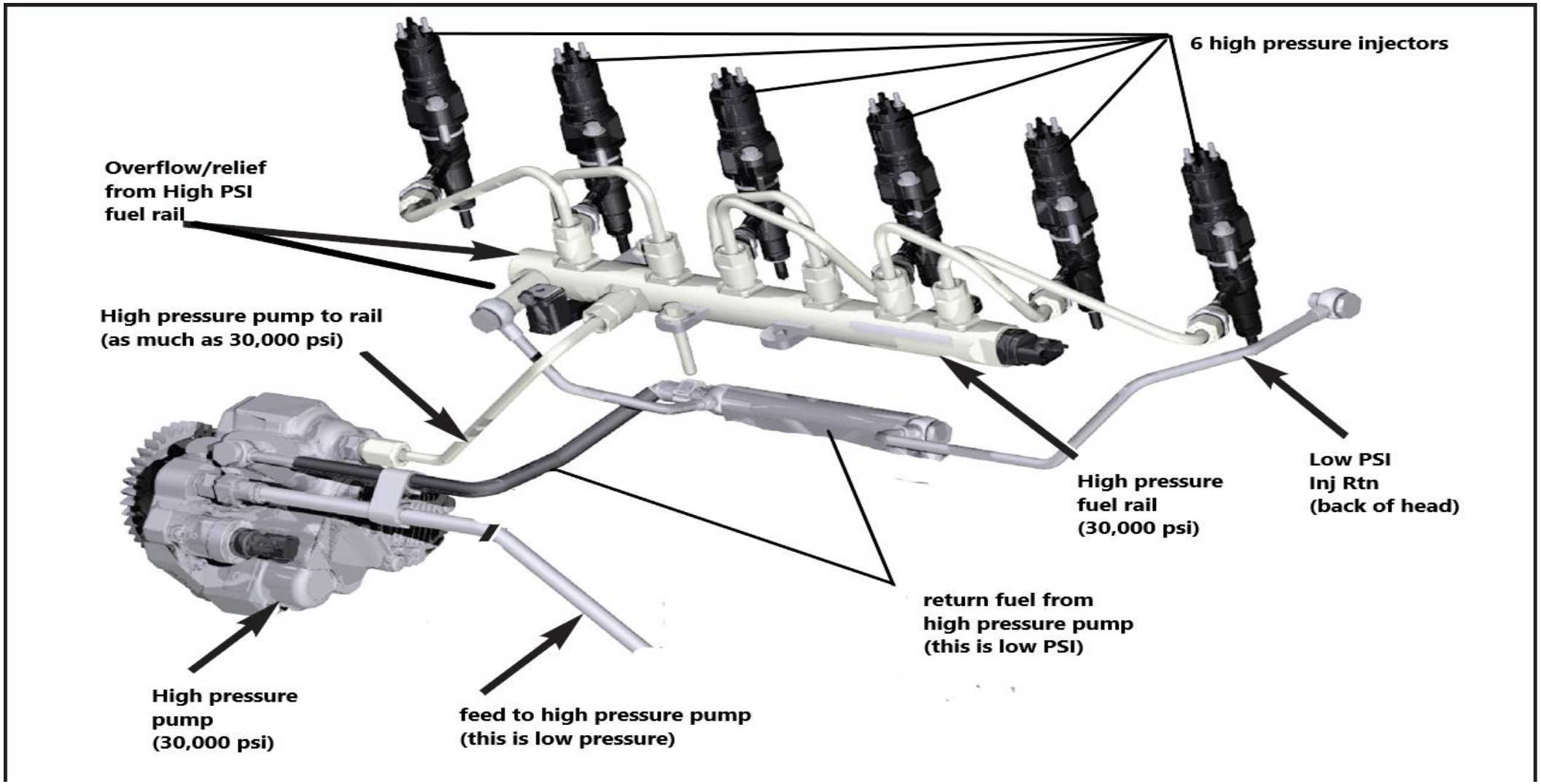
Diesel is a lubricant (oily) has “lubricity”
Gasoline “washes” off oil

Diesel Common Rail Injection – Low Side



Components that are damaged:
Not uncommon to be over $10,000 to repair

Diesel Common Rail – High Side



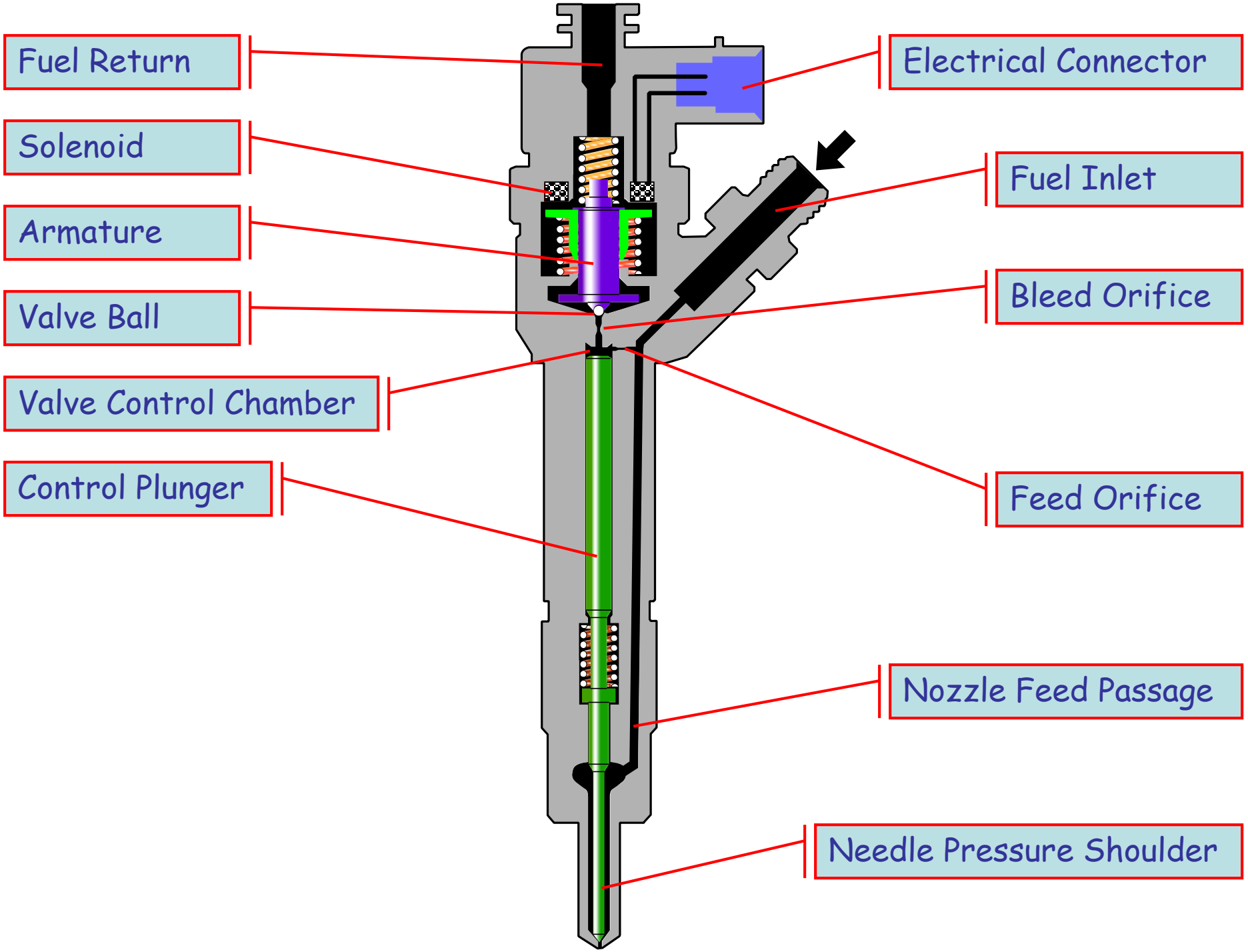
WARNING

Do not open high pressure fuel system with engine running. Engine operation causes high fuel pressure. High pressure fuel spray can cause serious injury or death.

Shop Activity

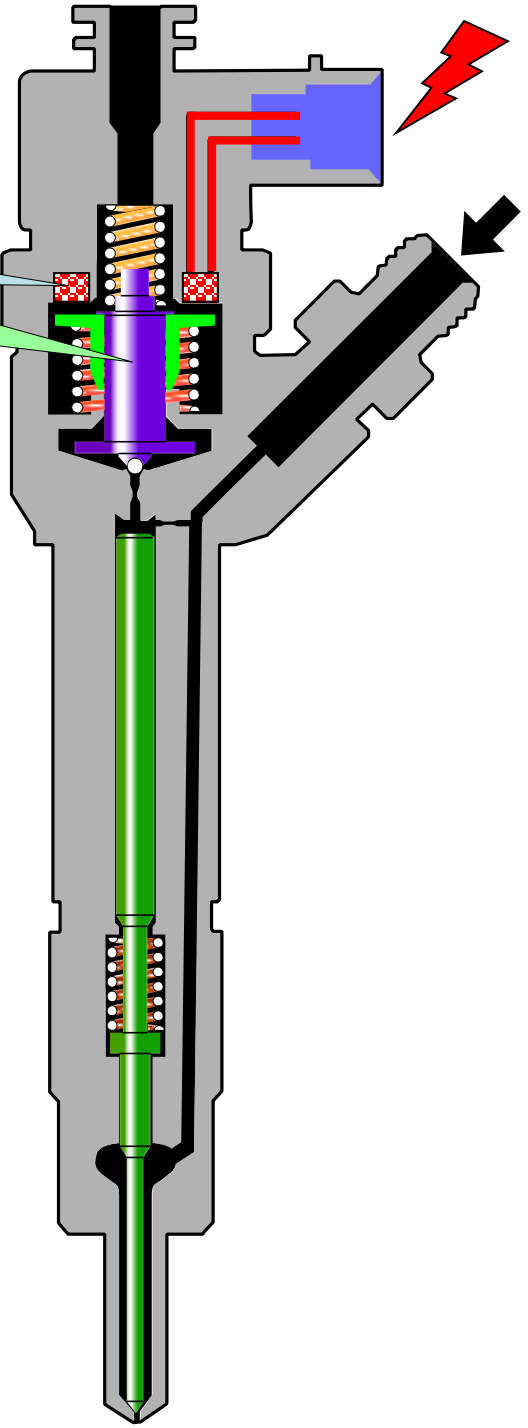
- Locate components on engines and trucks!

Injector Components

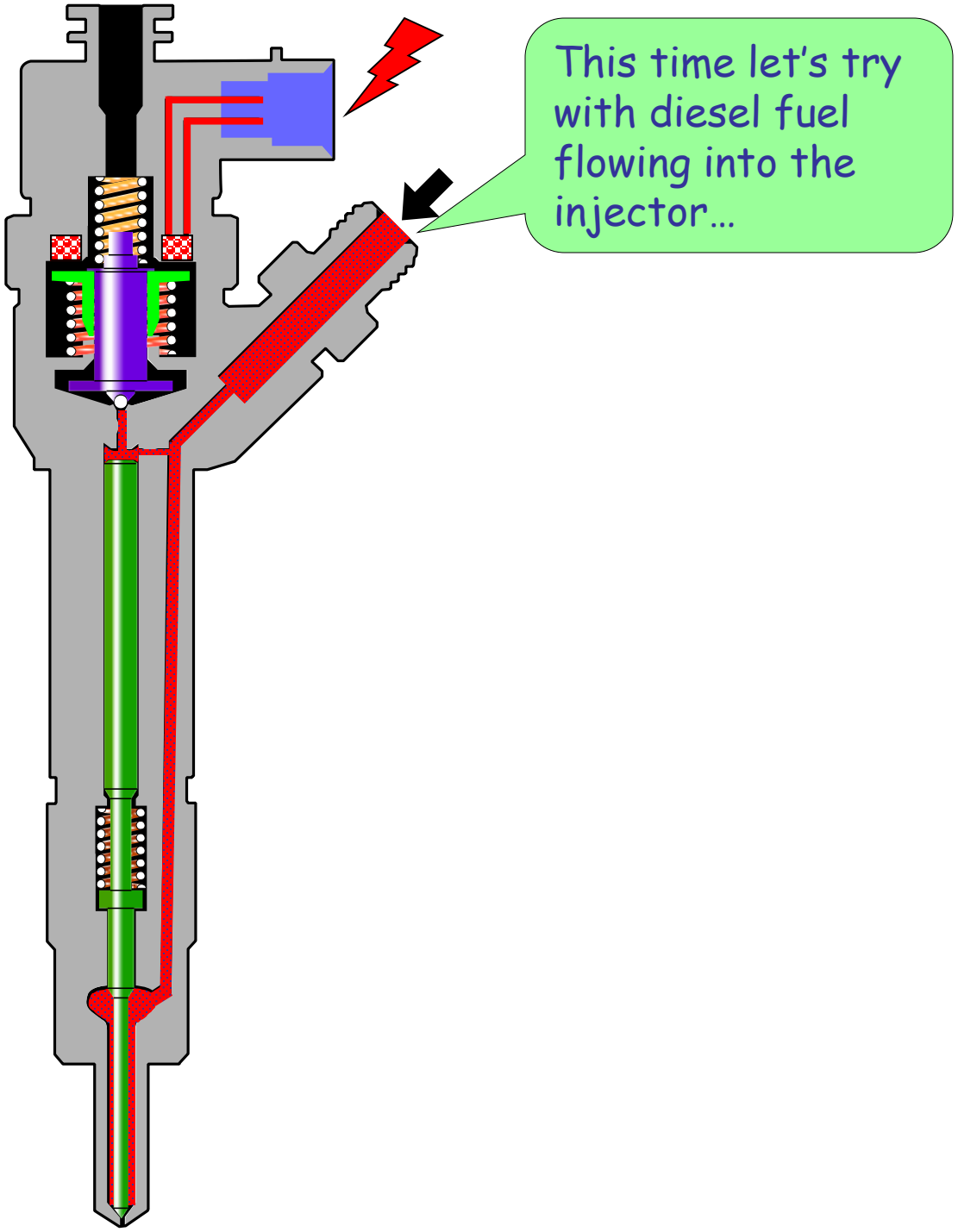

Fuel Return
Solenoid
Armature
Valve Ball
Valve Control Chamber
Control Plunger
Electrical Connector
Fuel Inlet
Bleed Orifice
Feed Orifice
Nozzle Feed Passage
Needle Pressure Shoulder

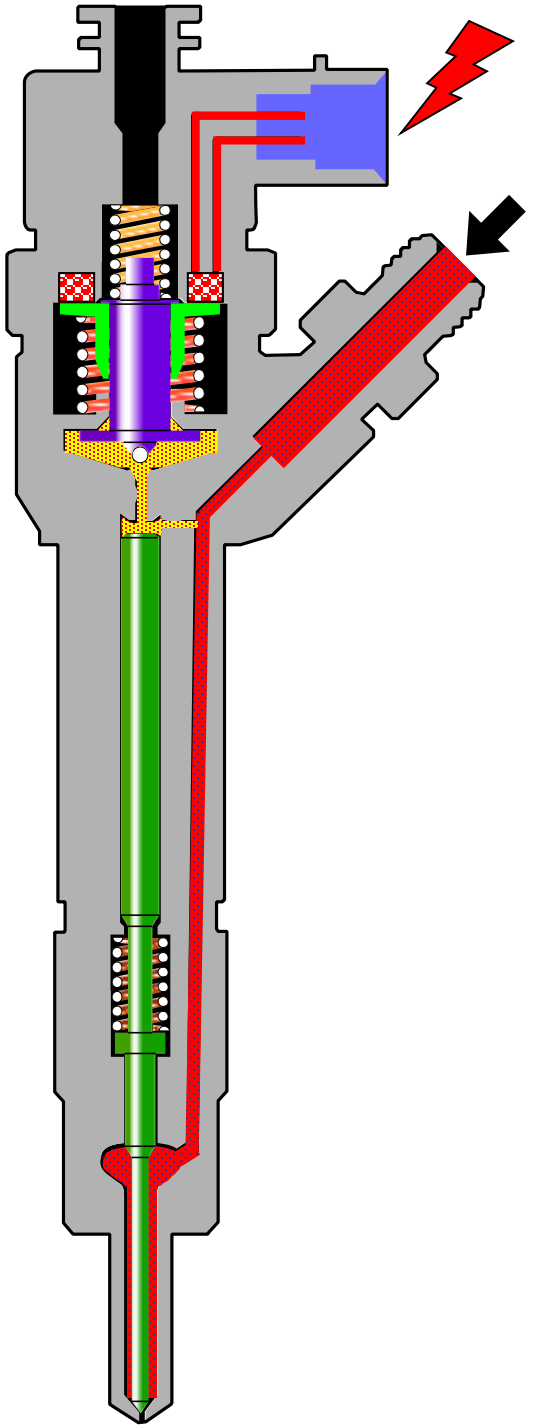
Operation

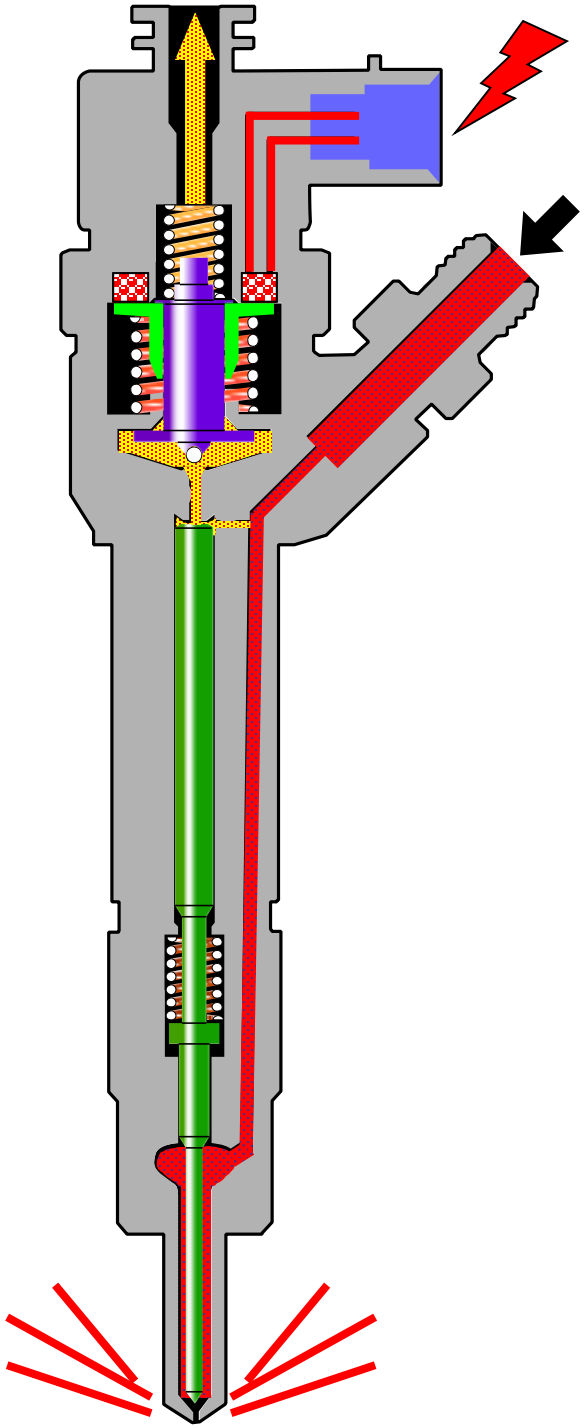
The armature is pulled up by the magnetic force

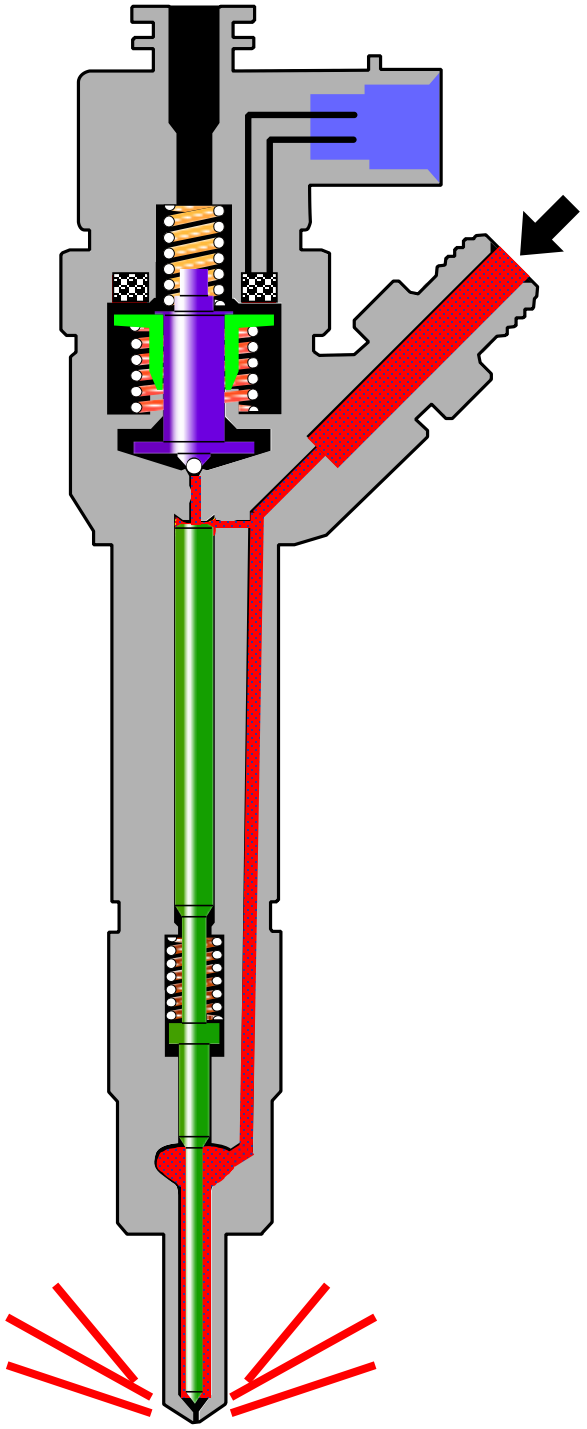


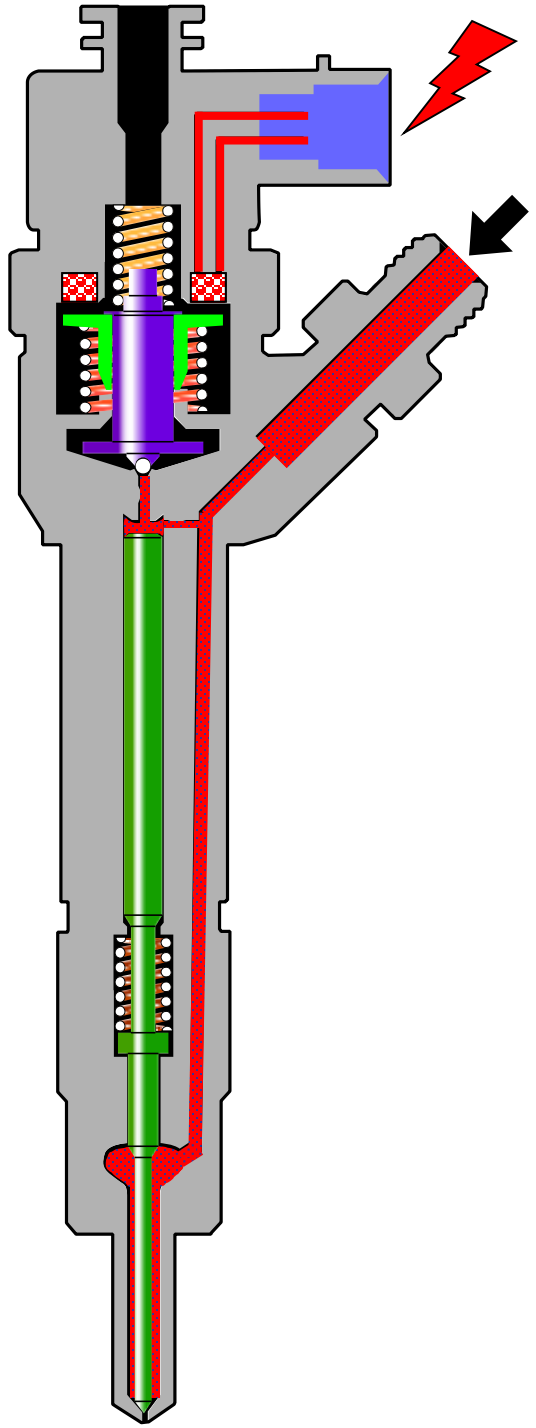
Let's check it out again…

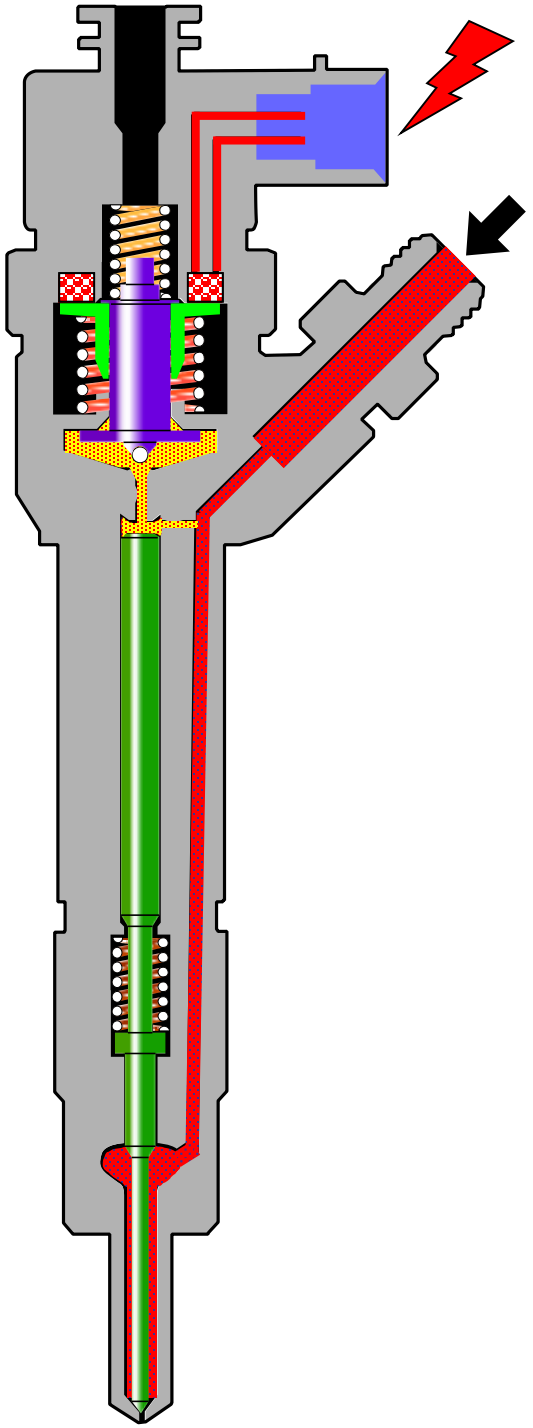

This time let's try with diesel fuel flowing into the injector…

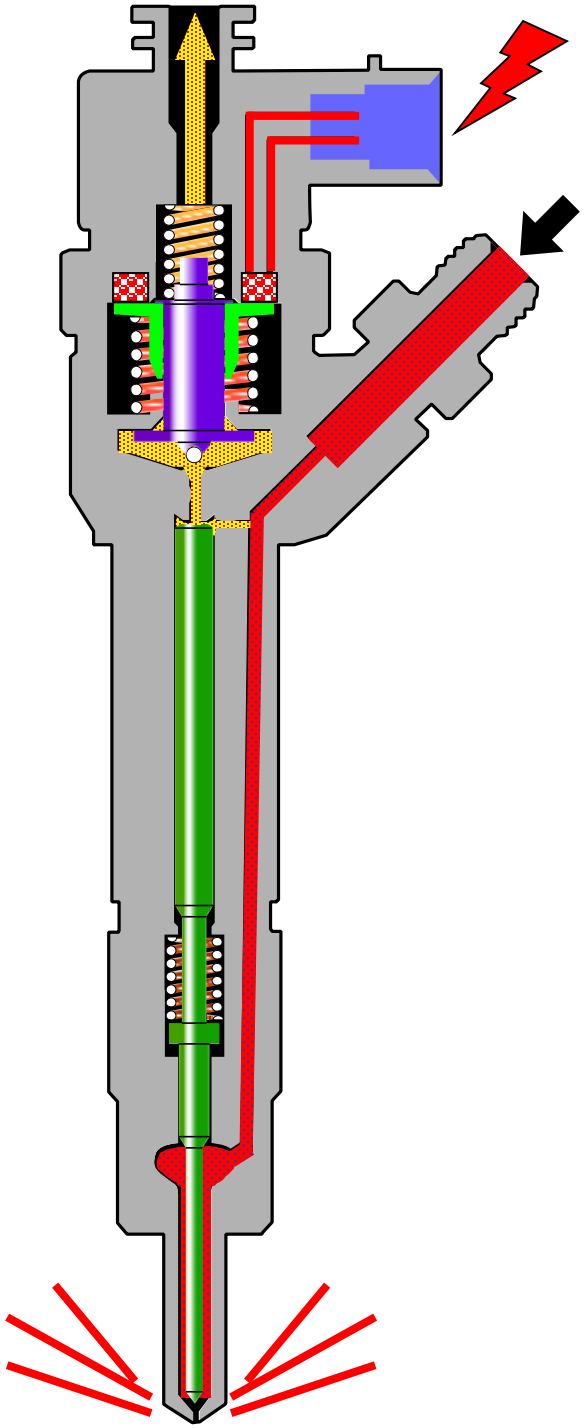


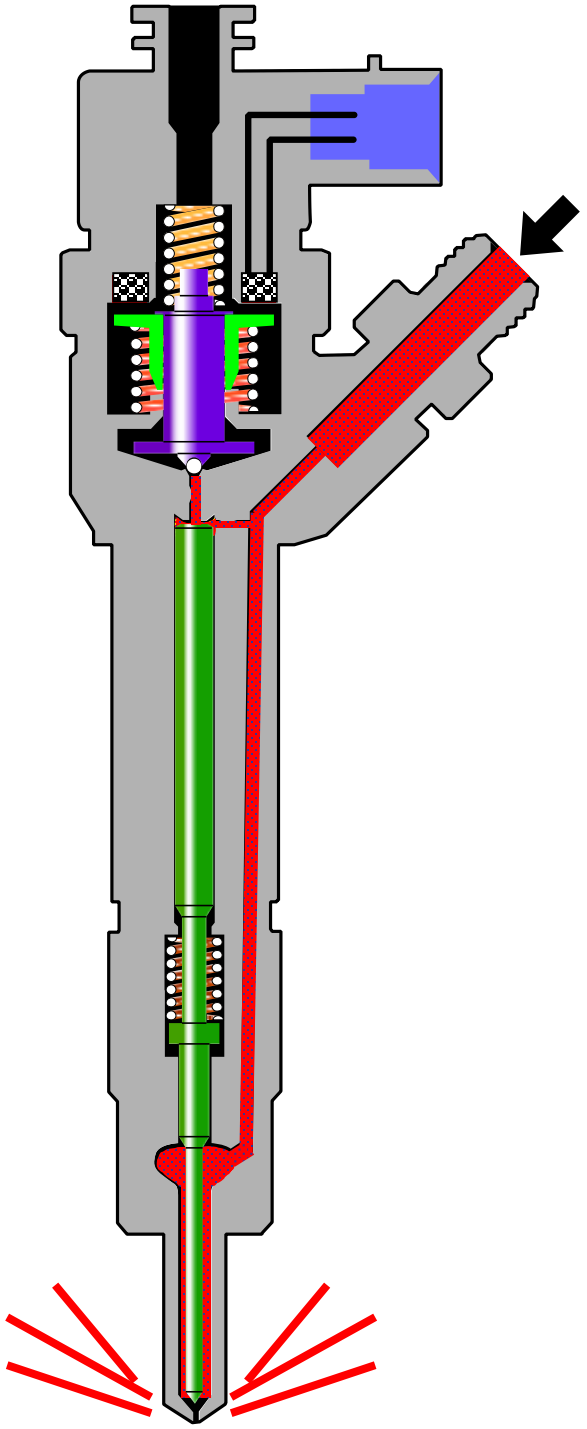


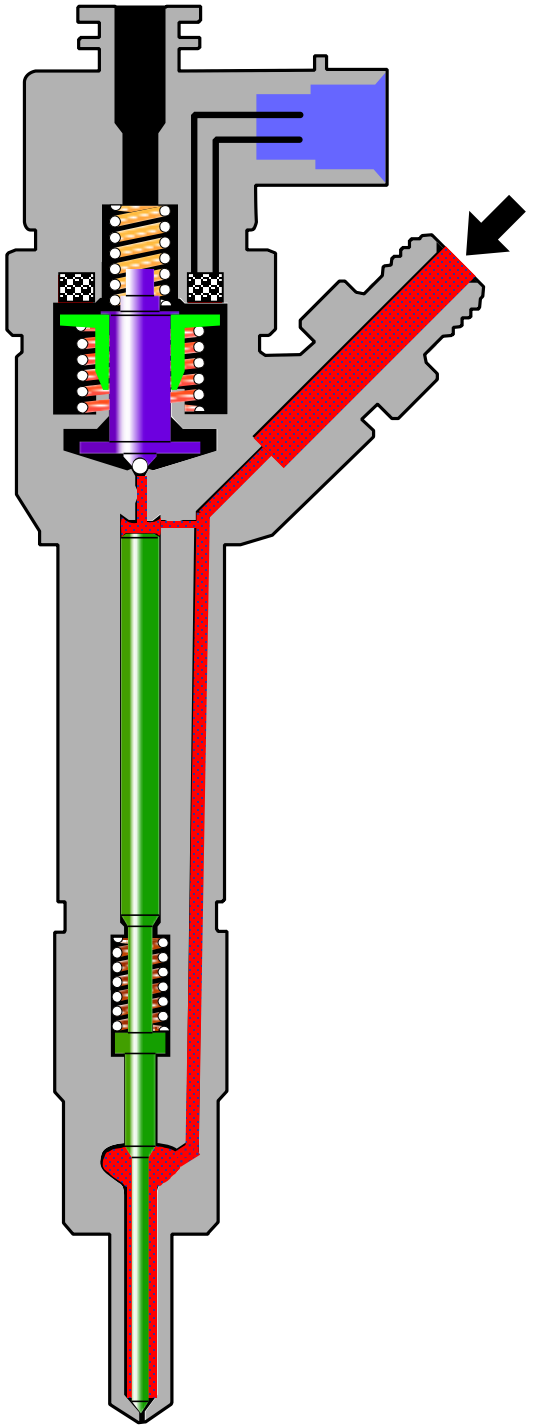




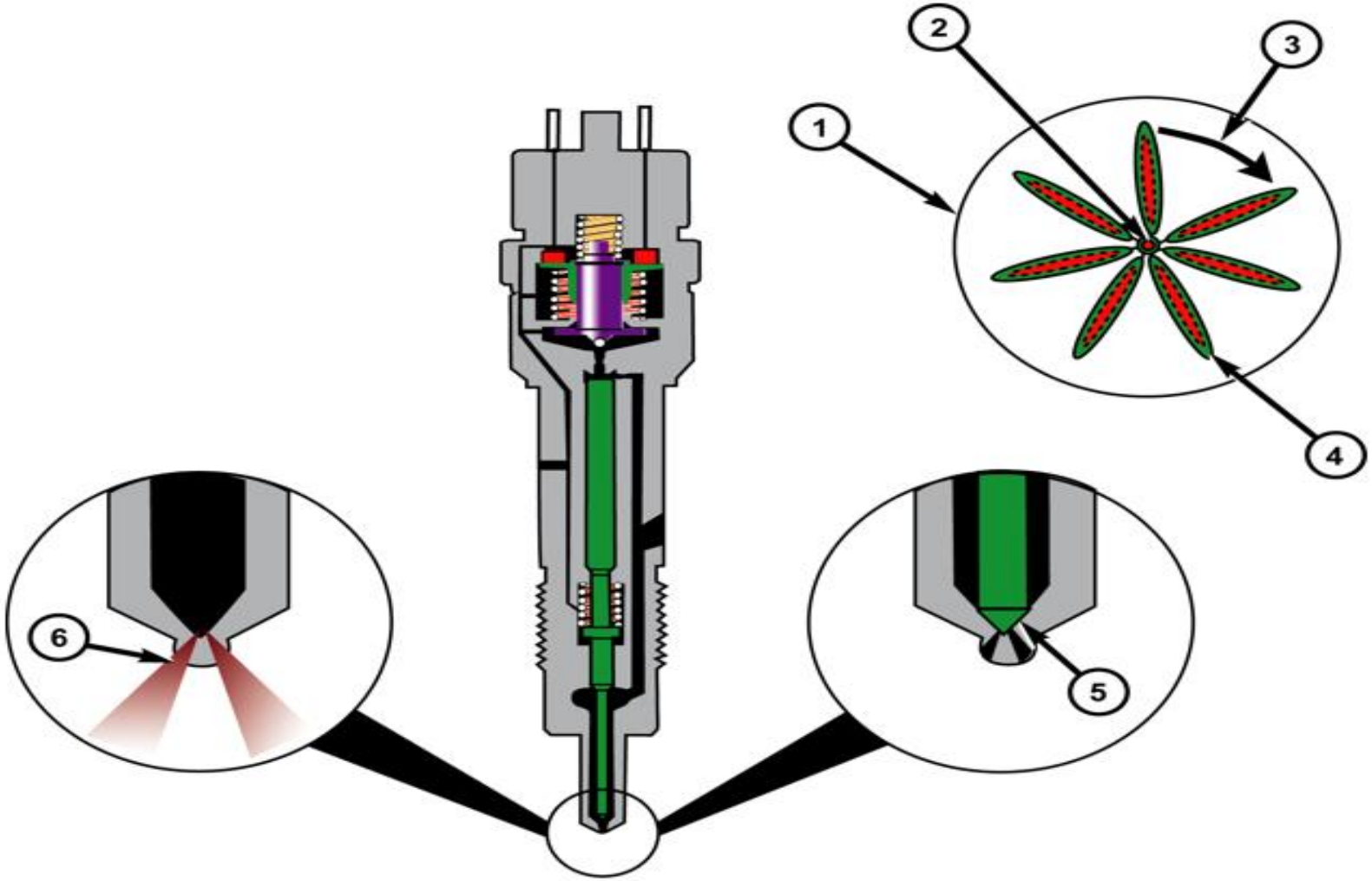




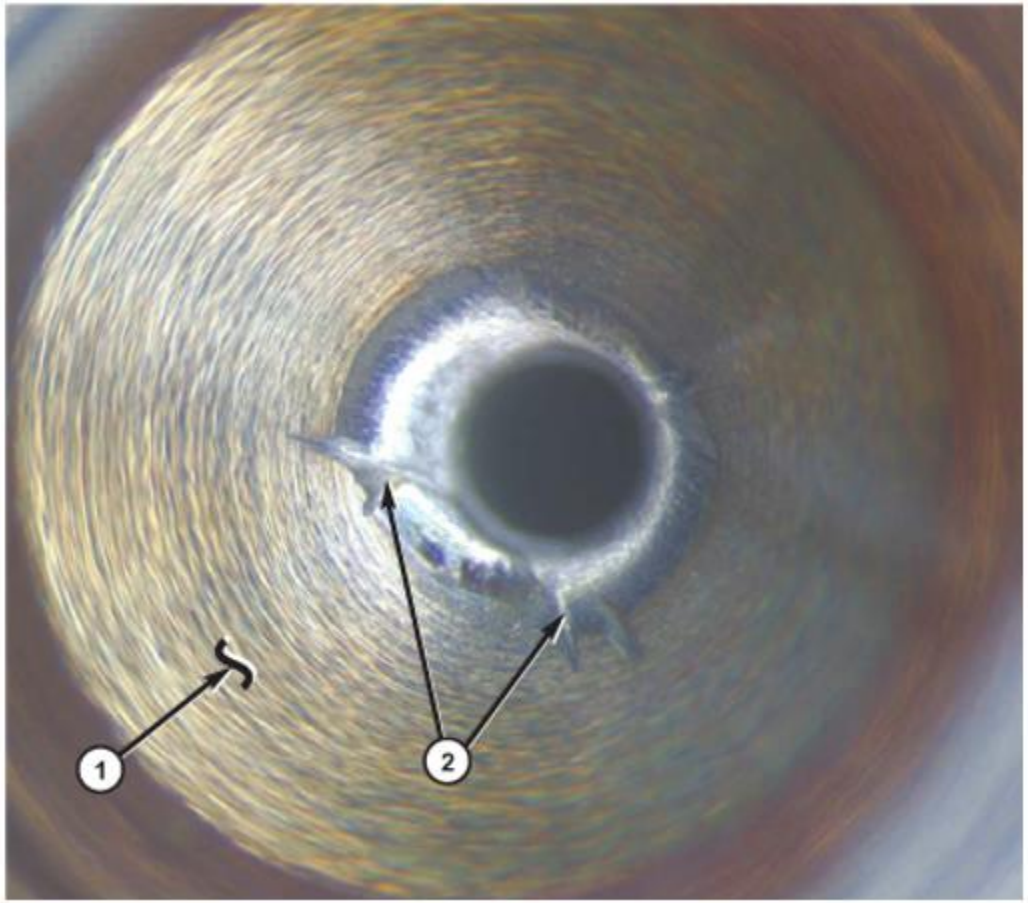


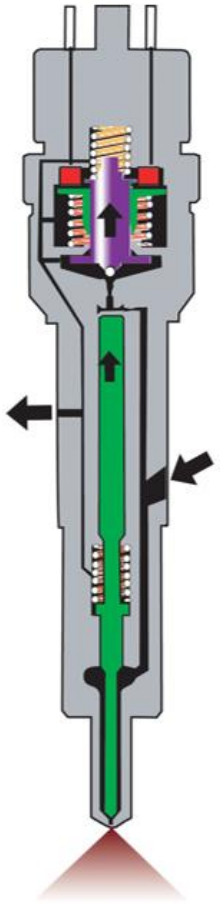


Common Rail Diesel Injector

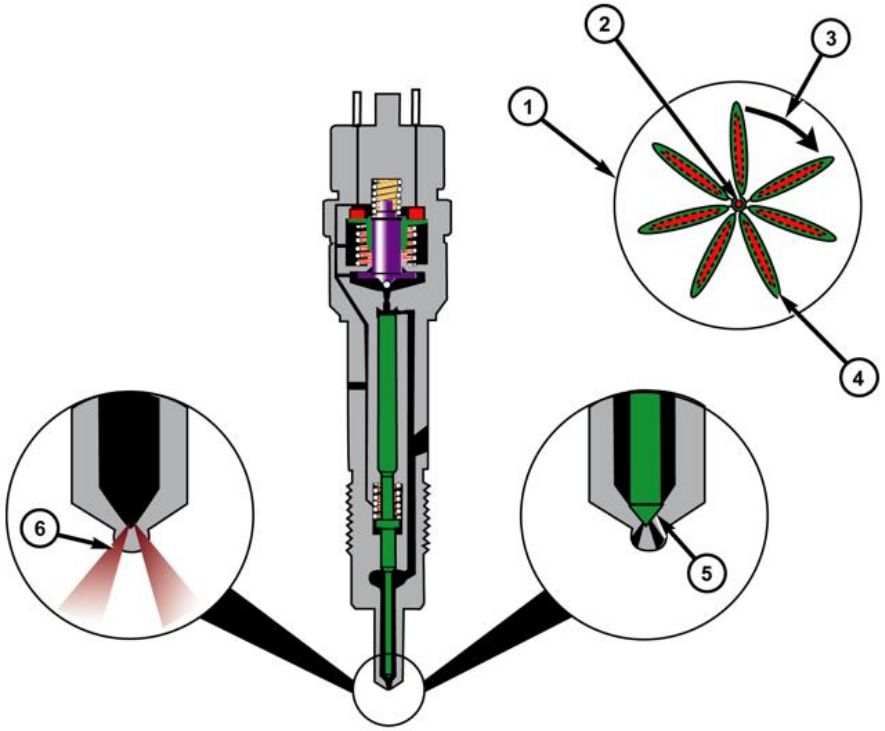


Eroded Ball Seat

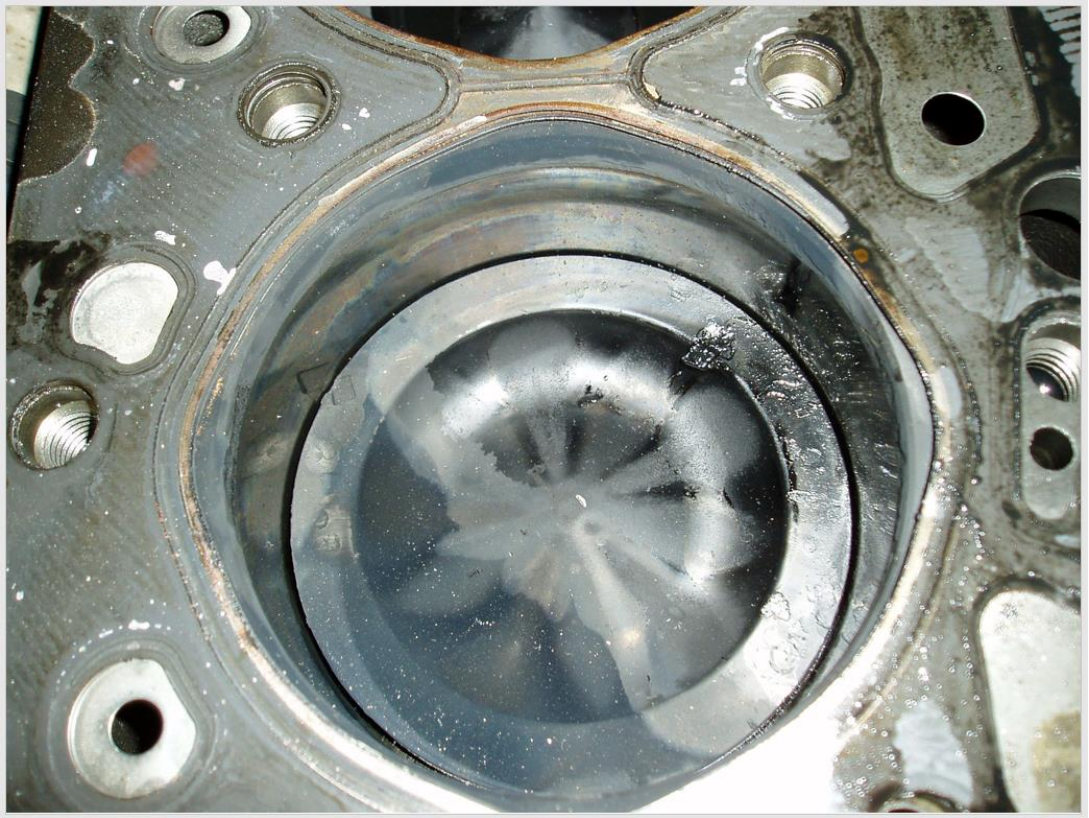


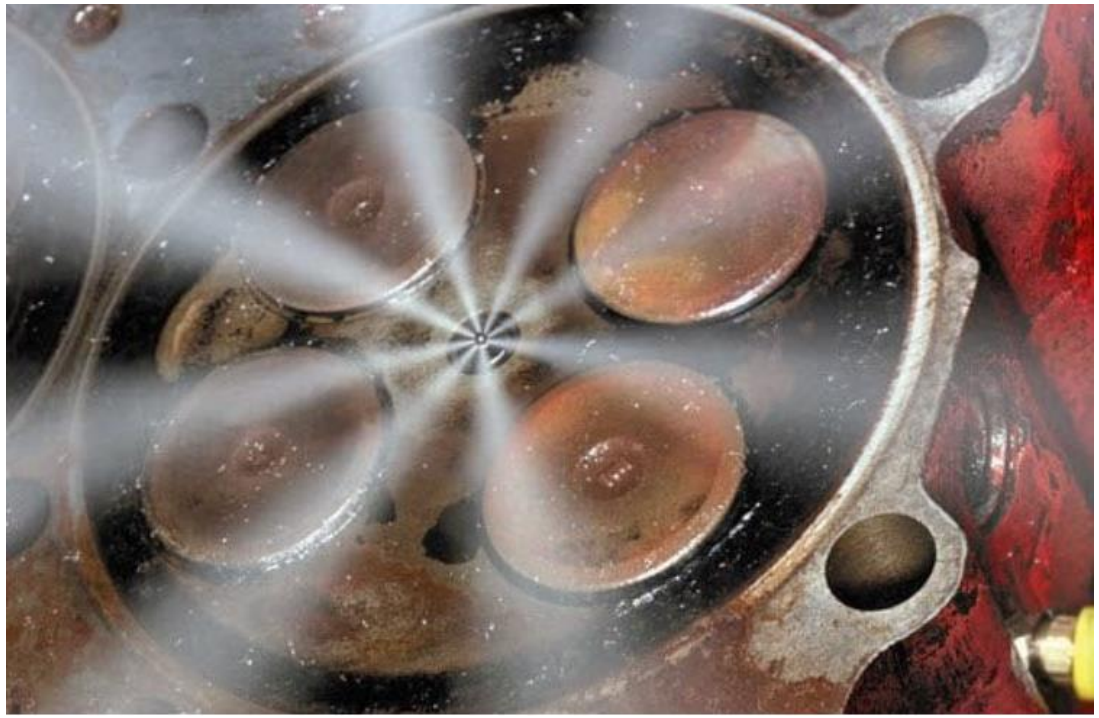


Over fueled Piston

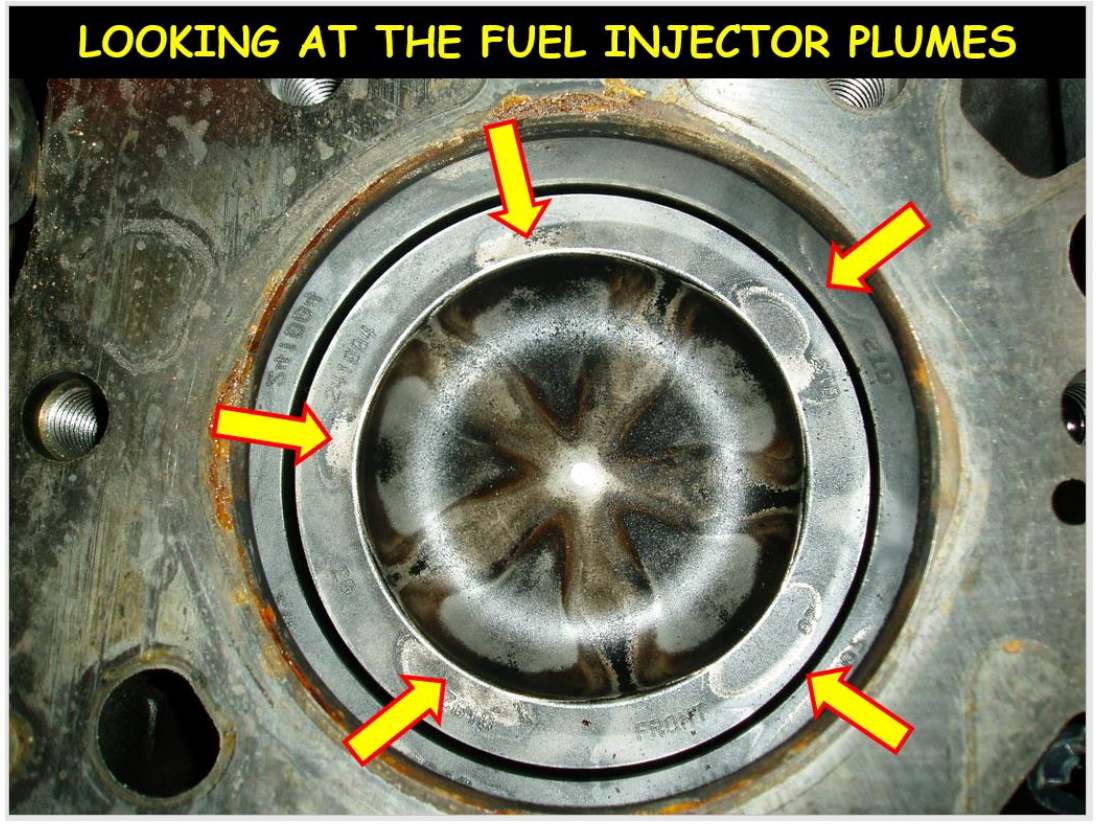


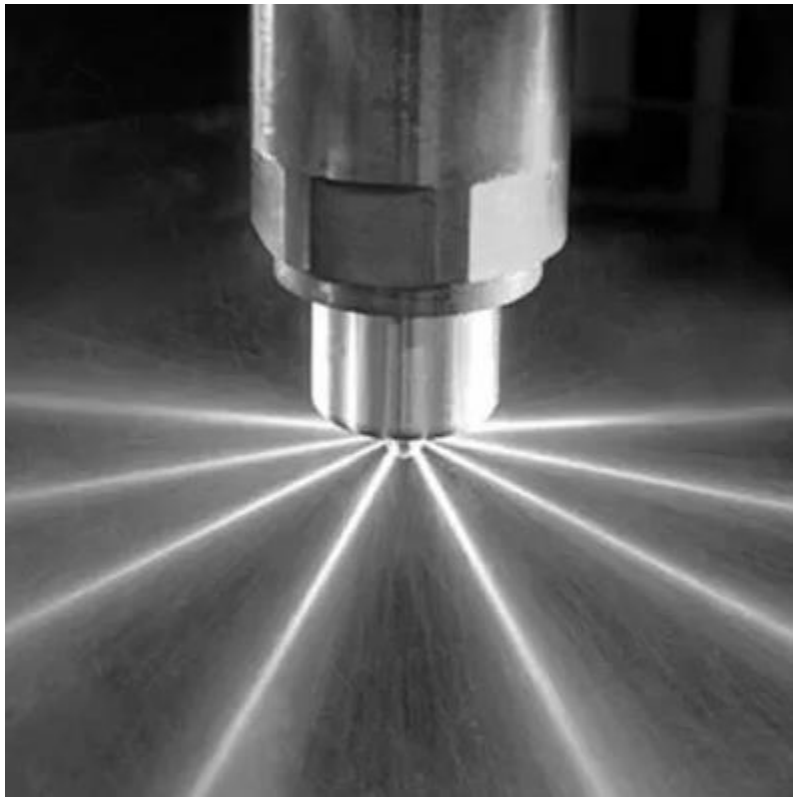
Poor spray pattern



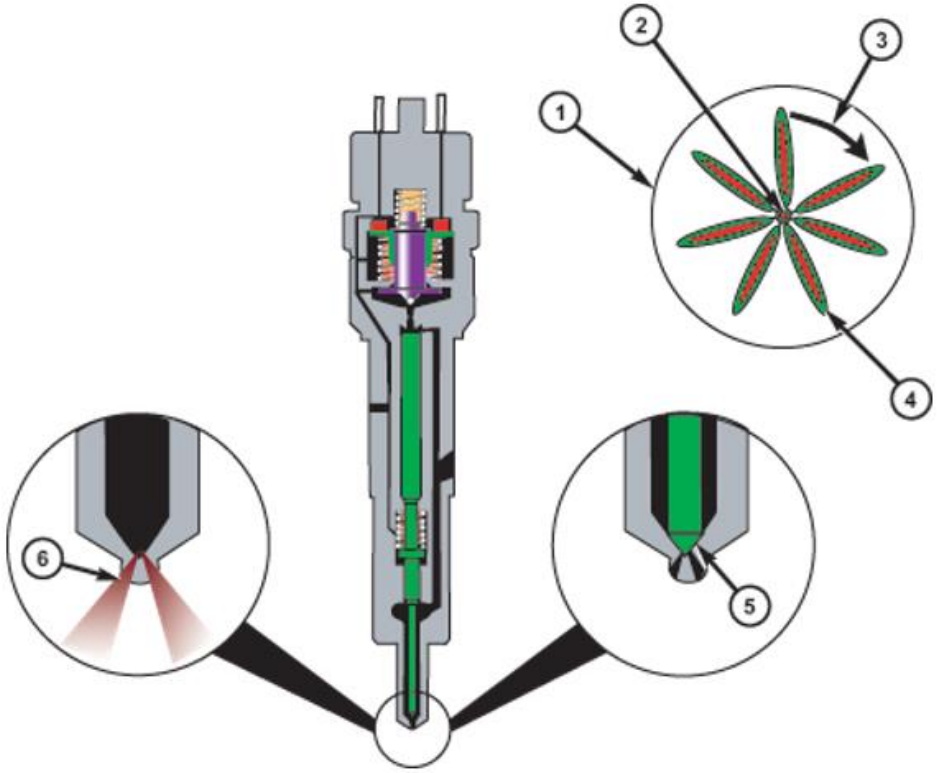


Incorrect fuel pattern/timing

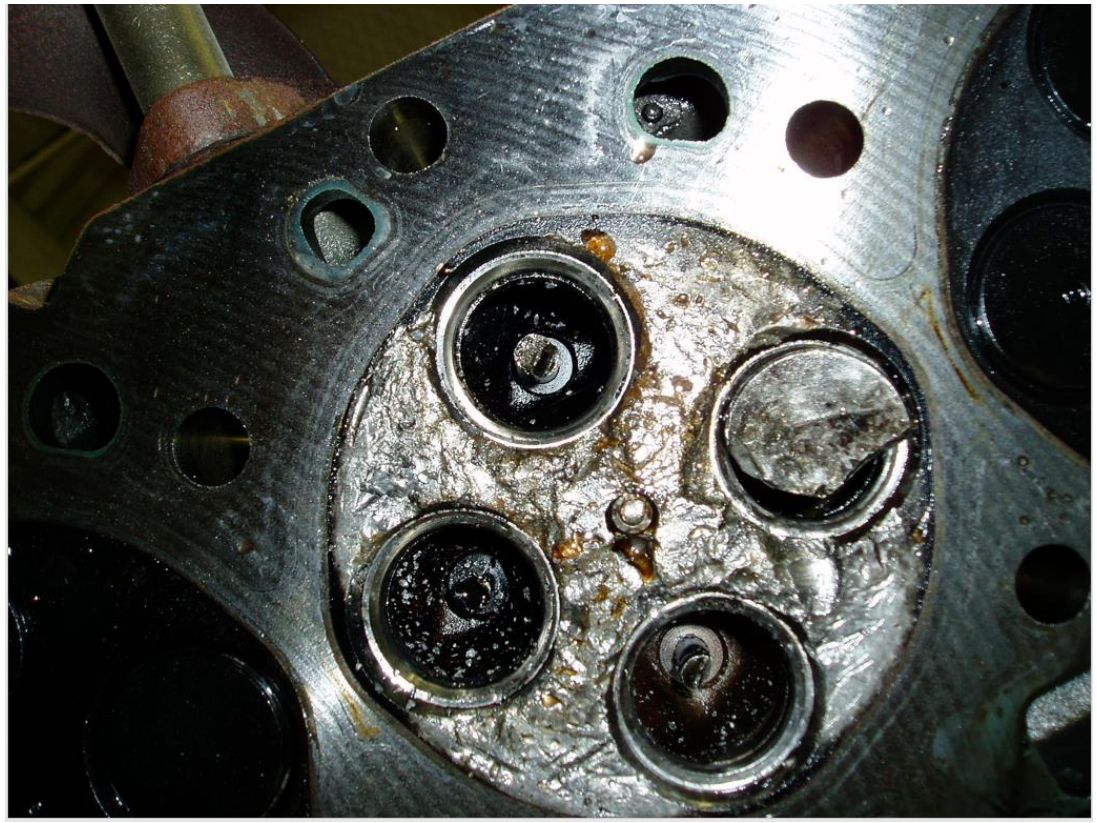




Injector “torches” piston



Injector “torches” off head of valve



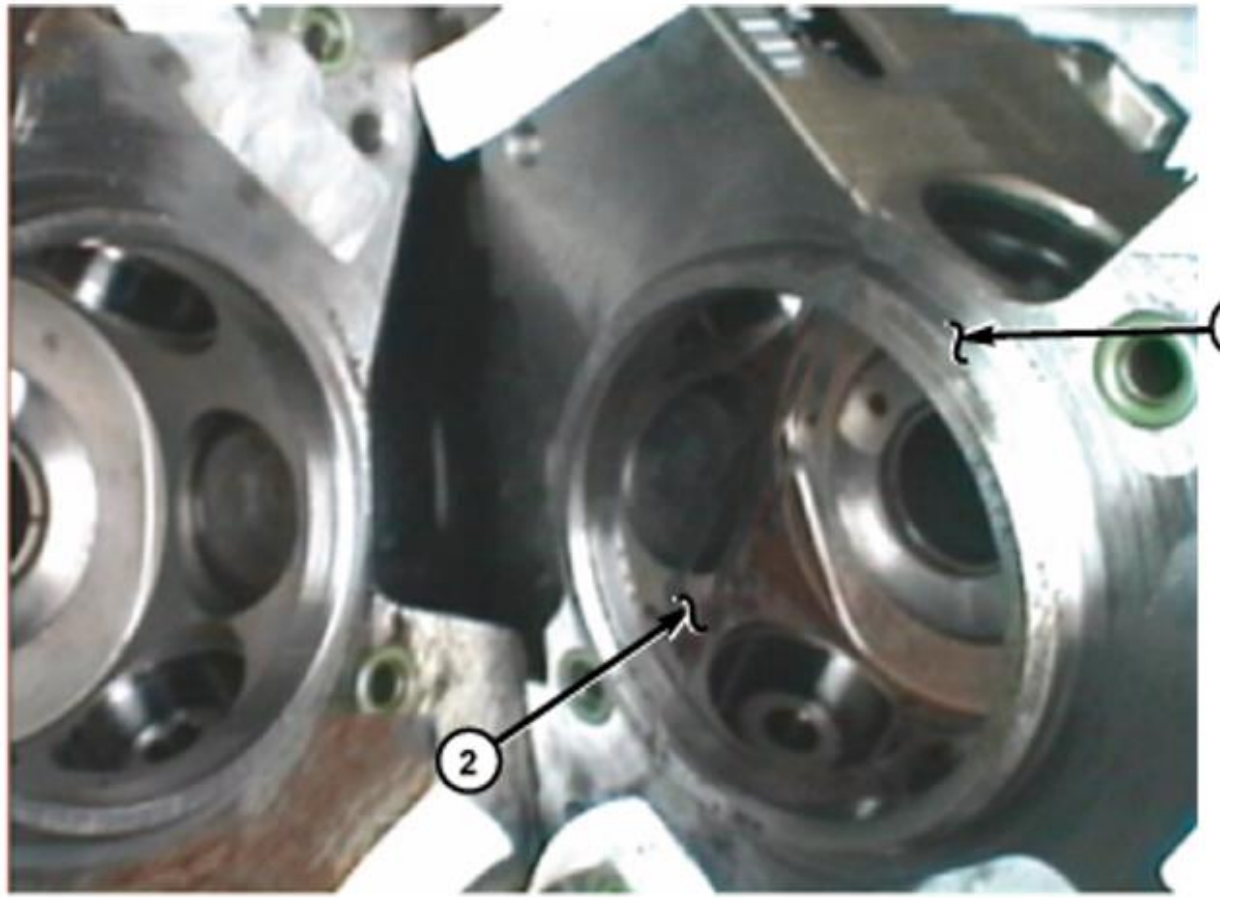
Dirty Fuel Filter


A TRUCK WITH THIS MUCH DIRT IN IT'S
FILTER HEAD, HAS A FULL FILTER !!

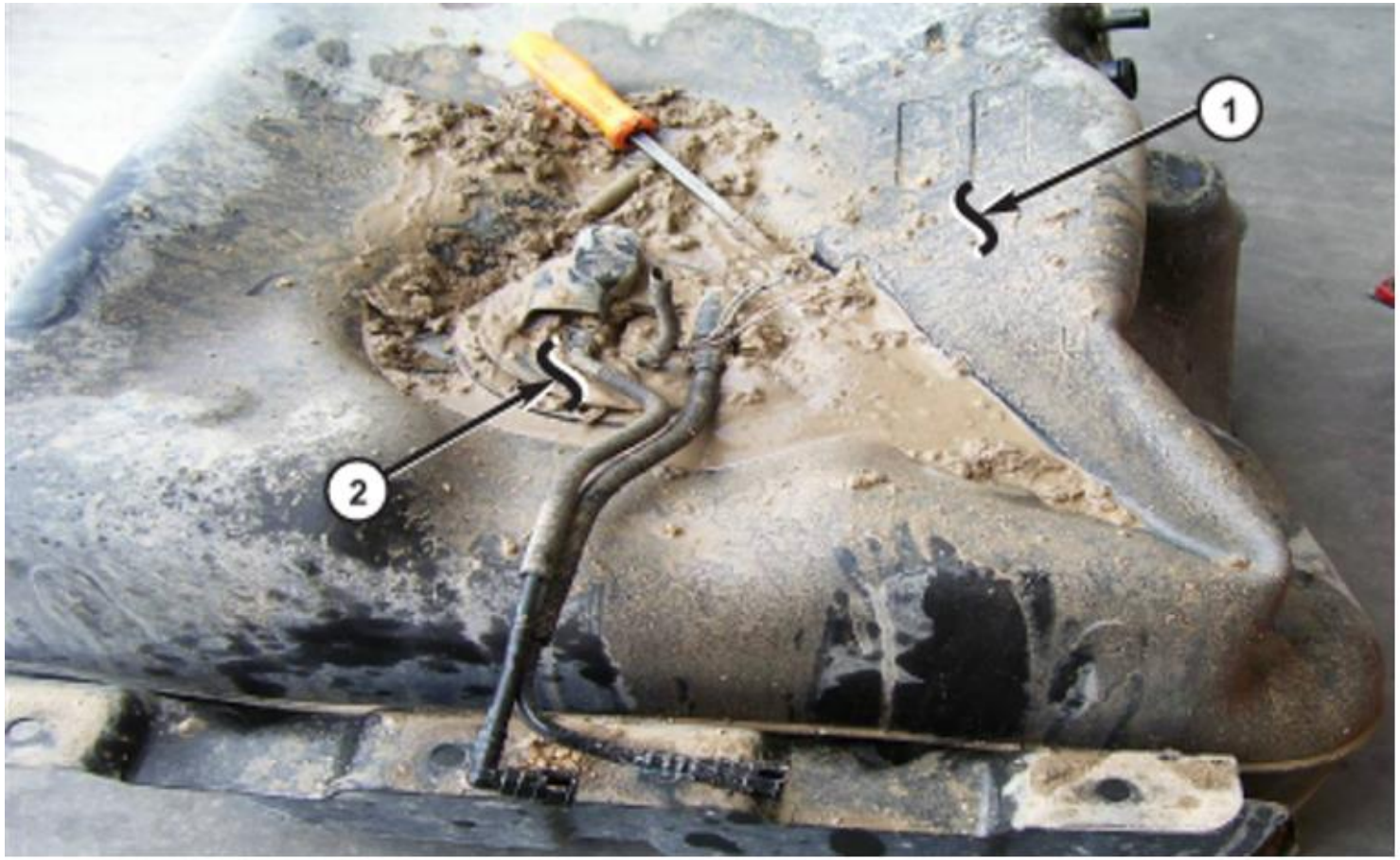
Contamination

Contaminated Connector Tubes

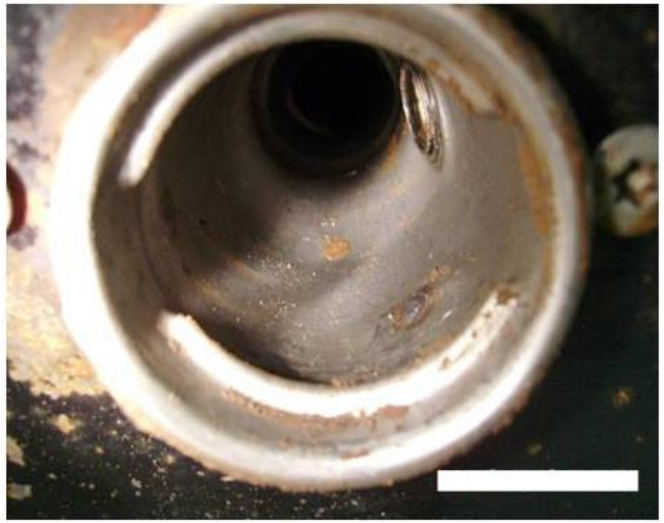
Damaged High Pressure Pump

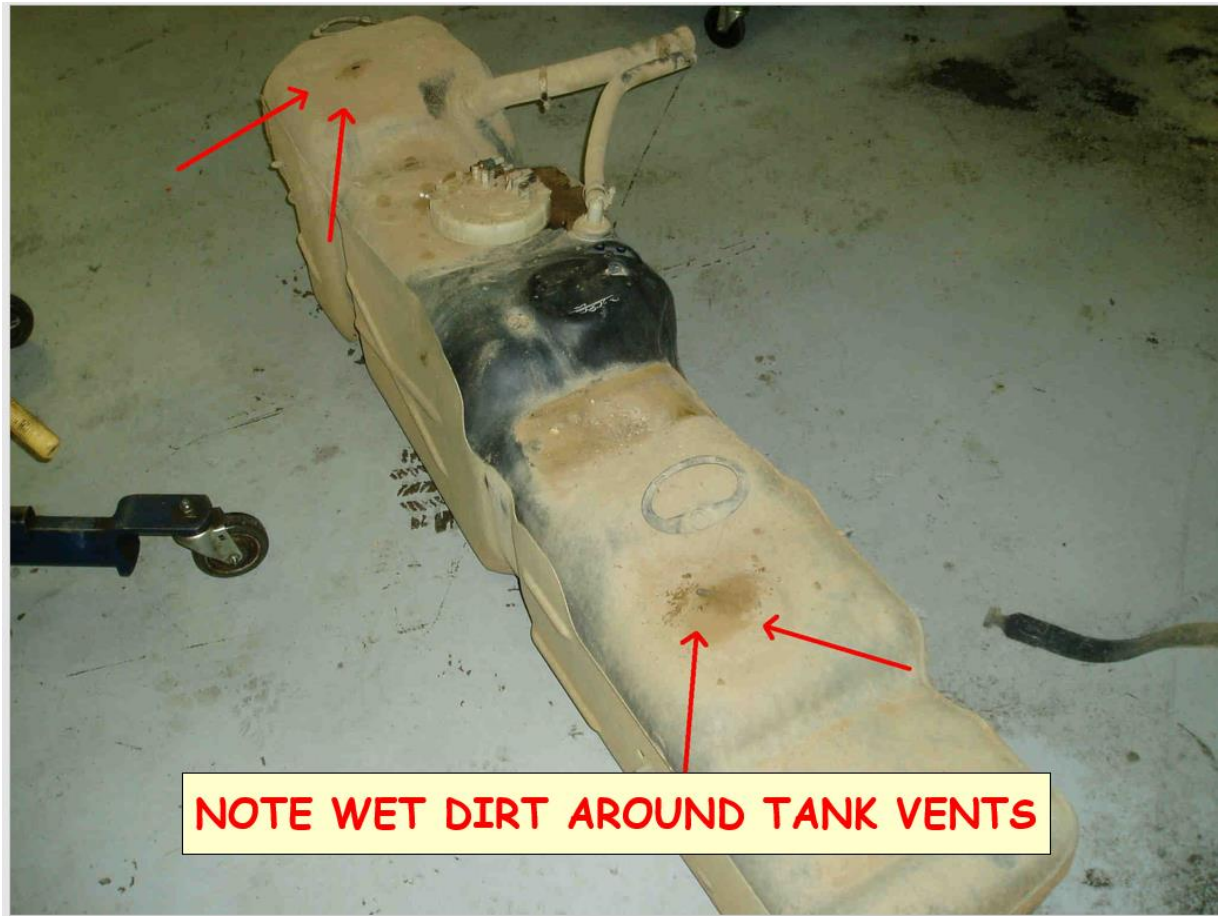


Dirty Fuel Tank



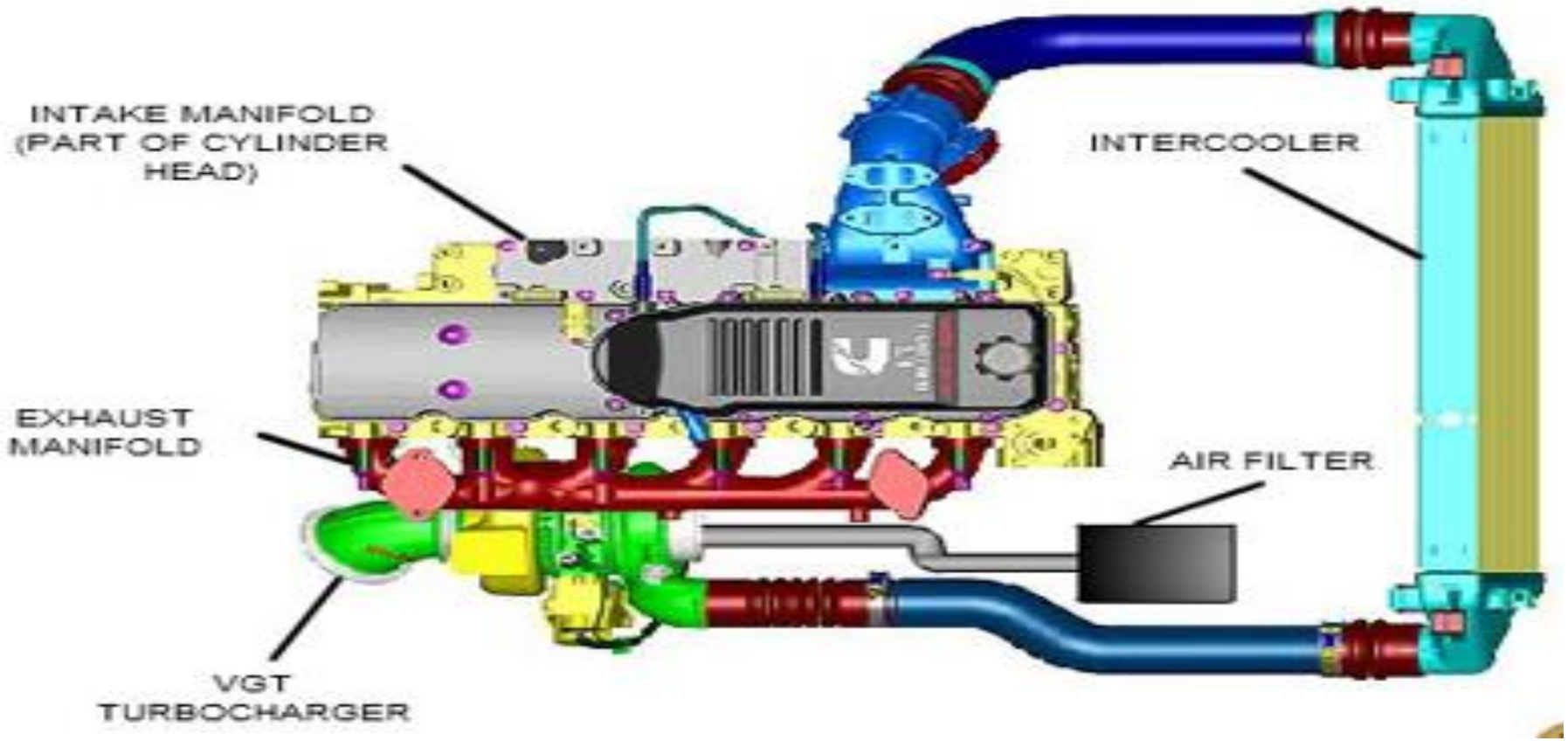
Contaminated Fuel Cap




NOTE WET DIRT AROUND TANK VENTS

Dirty Fuel Tank Vent

Air intake system



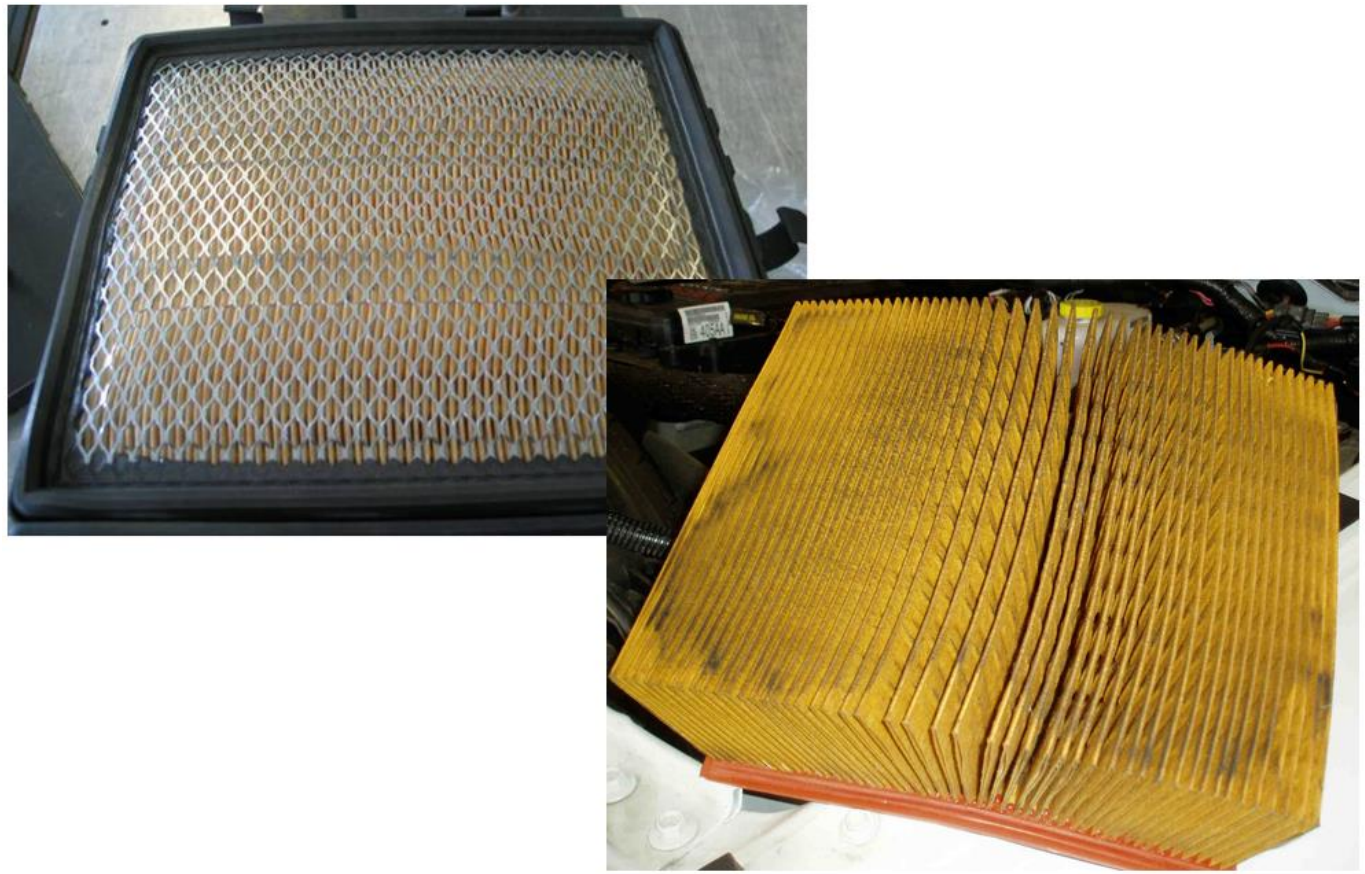
Locate Air Intake Components on Engine

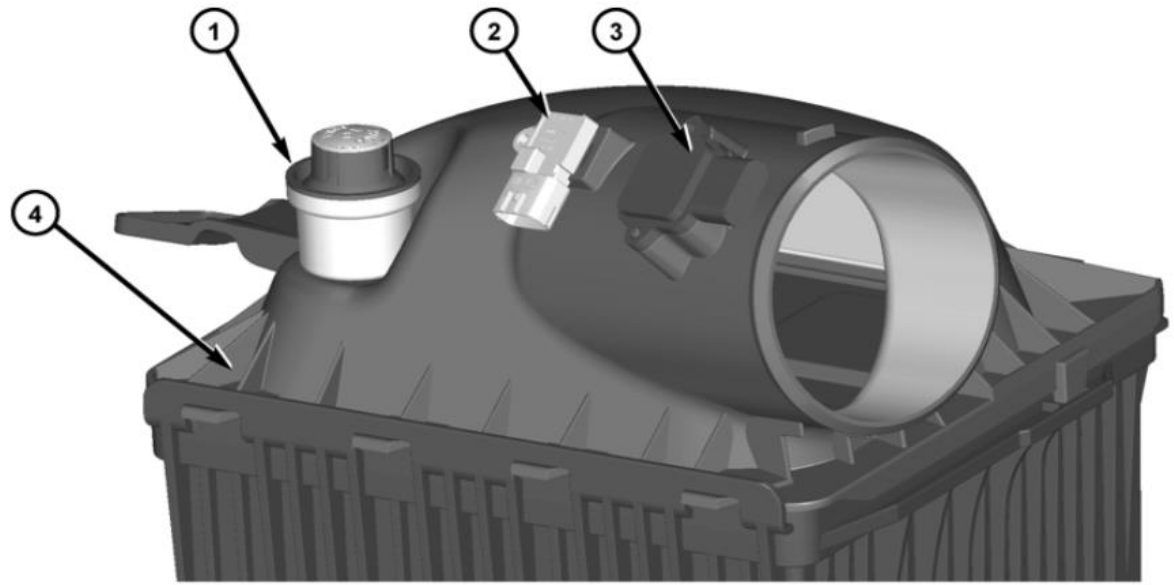
Turbocharger

Wastegate

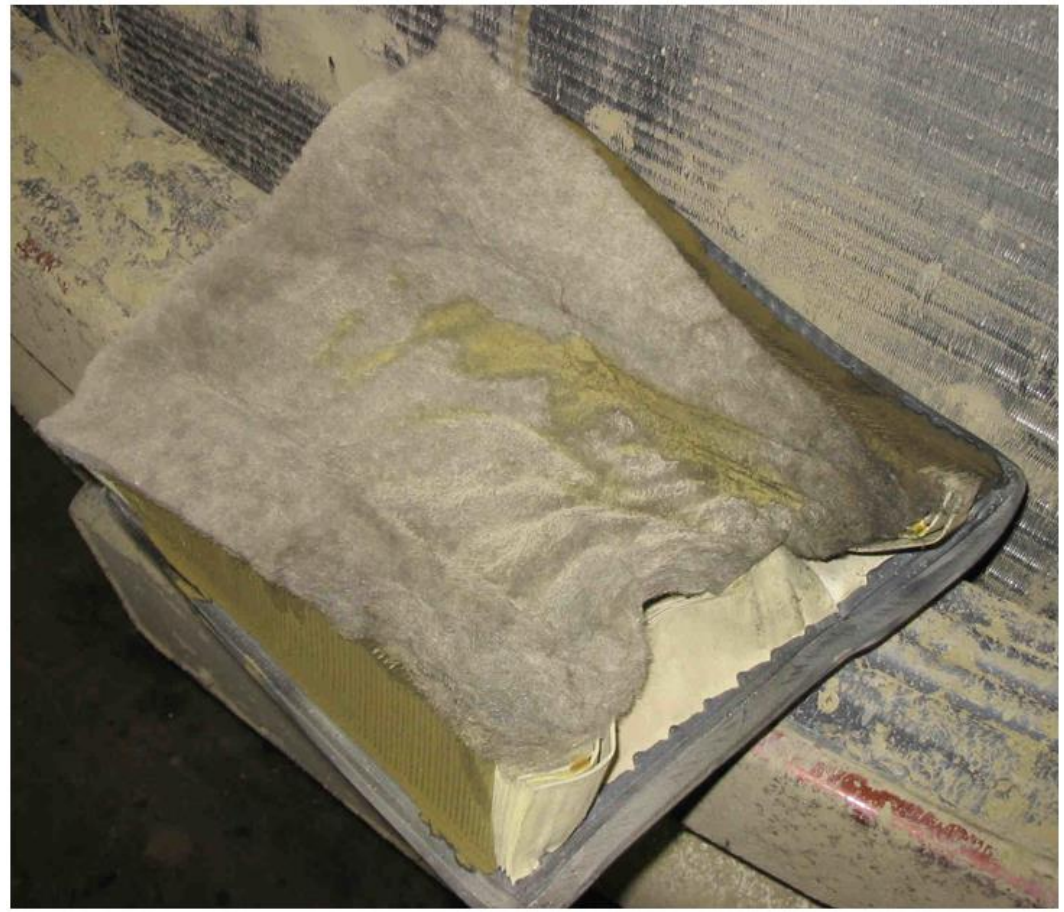
VGT

VNT



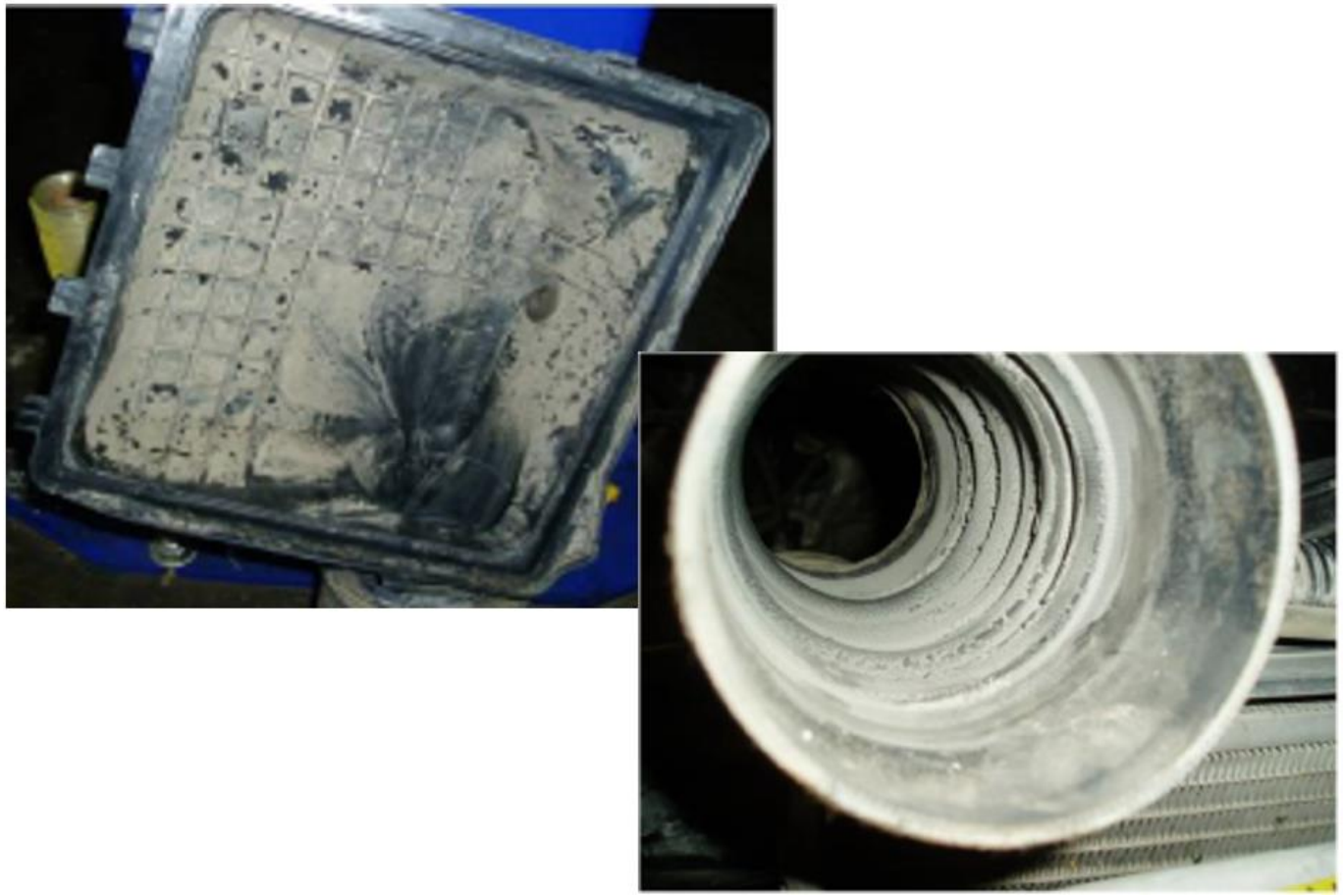


Mass Air Flow Sensor Location

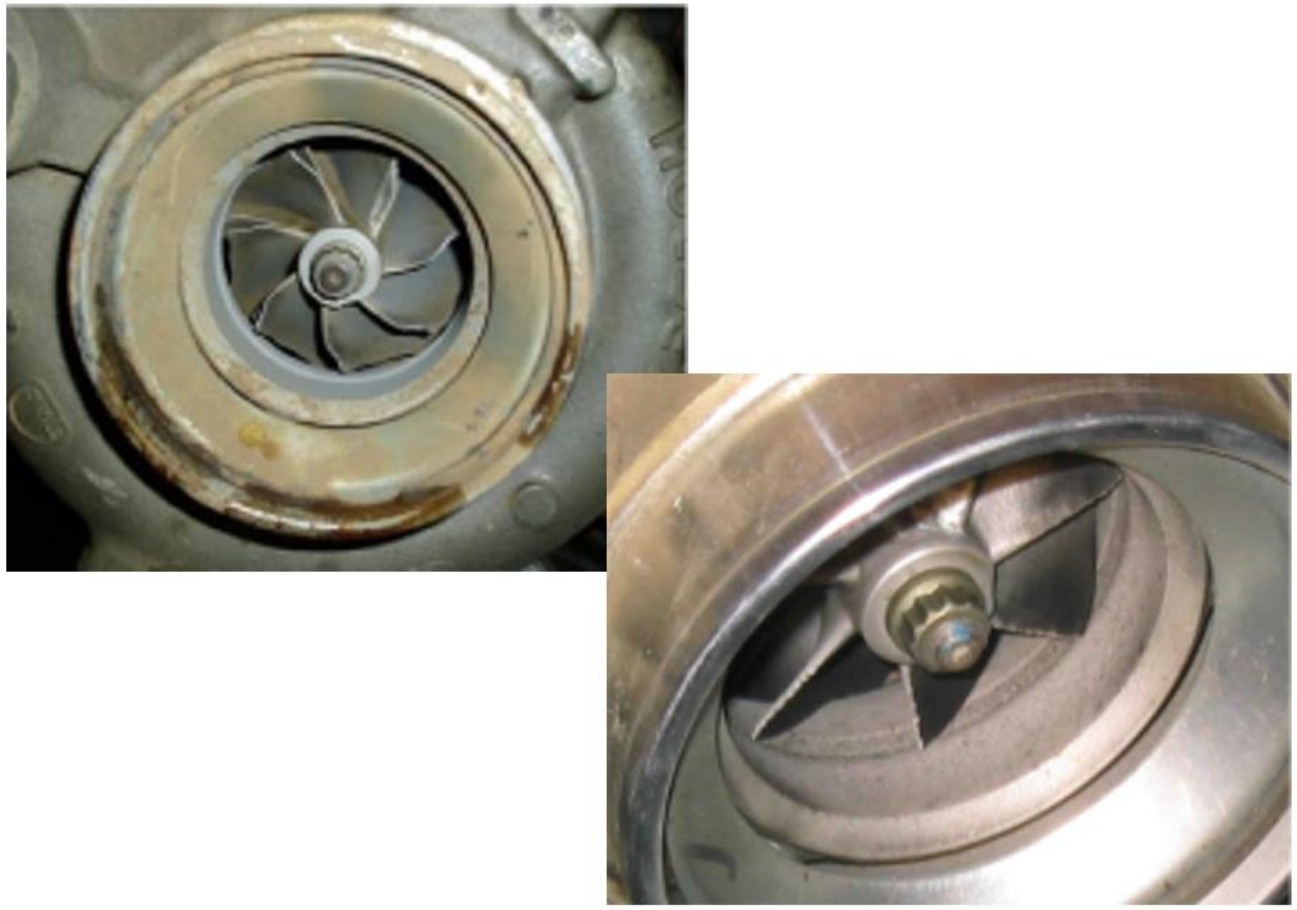


Dirty Air Intake

Dusted Intake



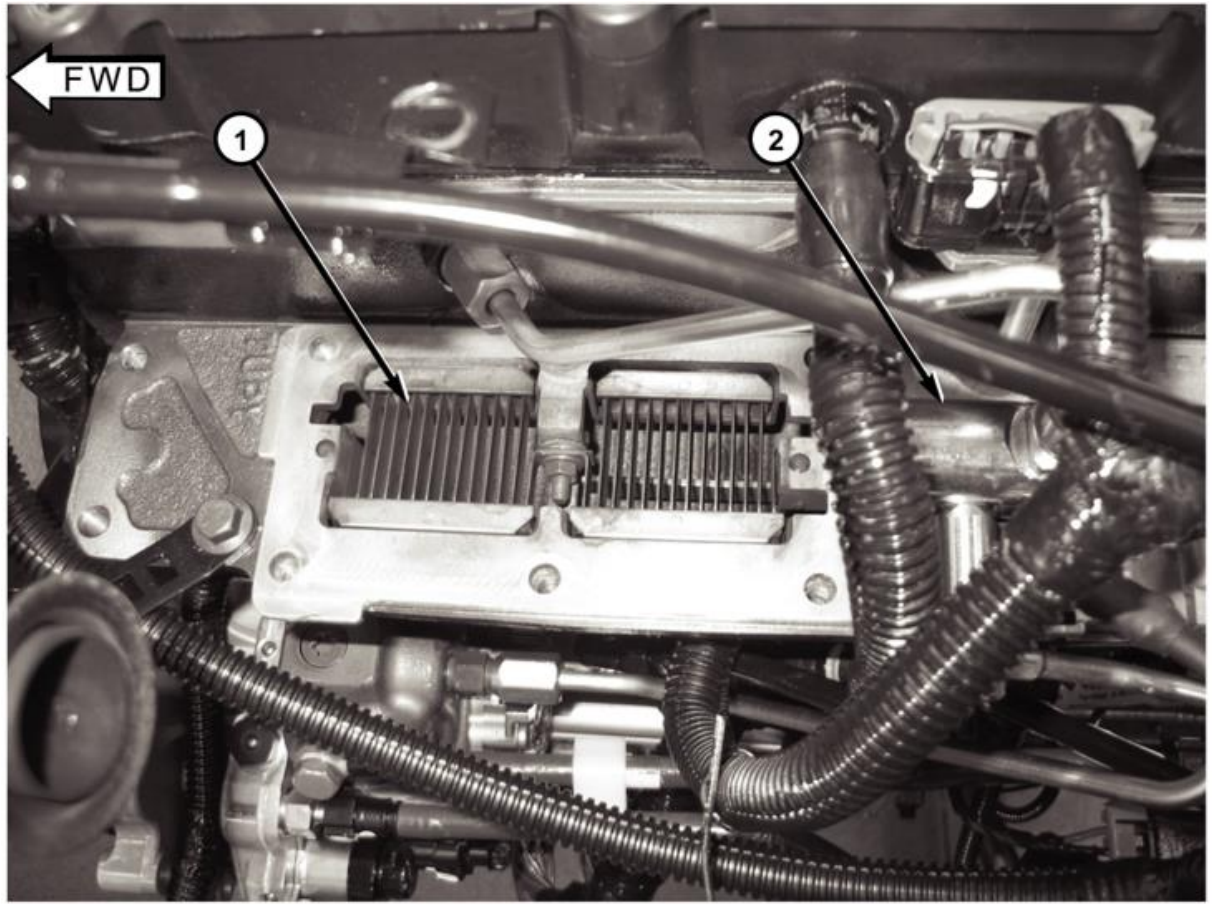
Dusted Turbo



Dusted Cylinder Wall

Dusted Piston Ring

Intake heater grid



GLOW PLUGS

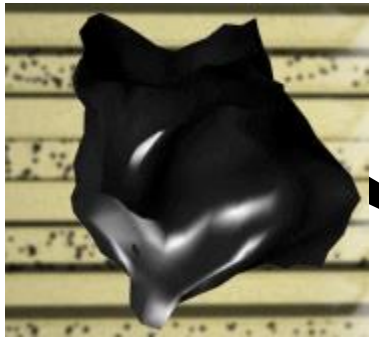
Figure 187 Glow Plug

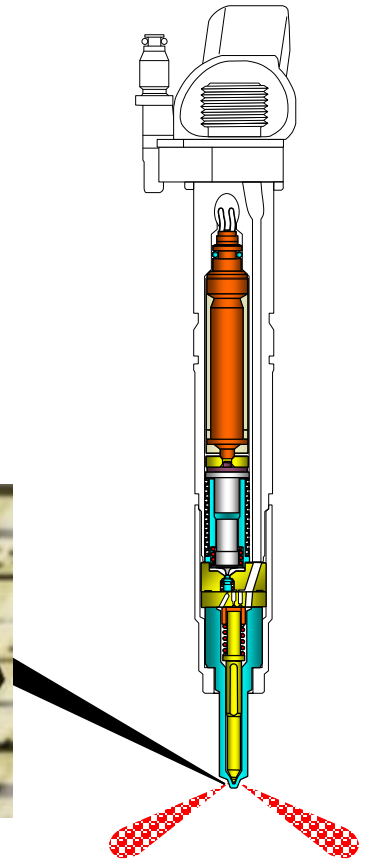
Diesel Emissions Controls

- PM – Particulate Matter – unburned (hydrocarbon) particle of fuel
- NOx – Created by heat/compression (nitrogen combined w/oxygen)
- 90% reduction from 2004 levels!
- Had to be compliant for 2010 model year

Particulate Matter (PM)

- Particulates (soot) are produced in those localized areas where rich mixtures are present





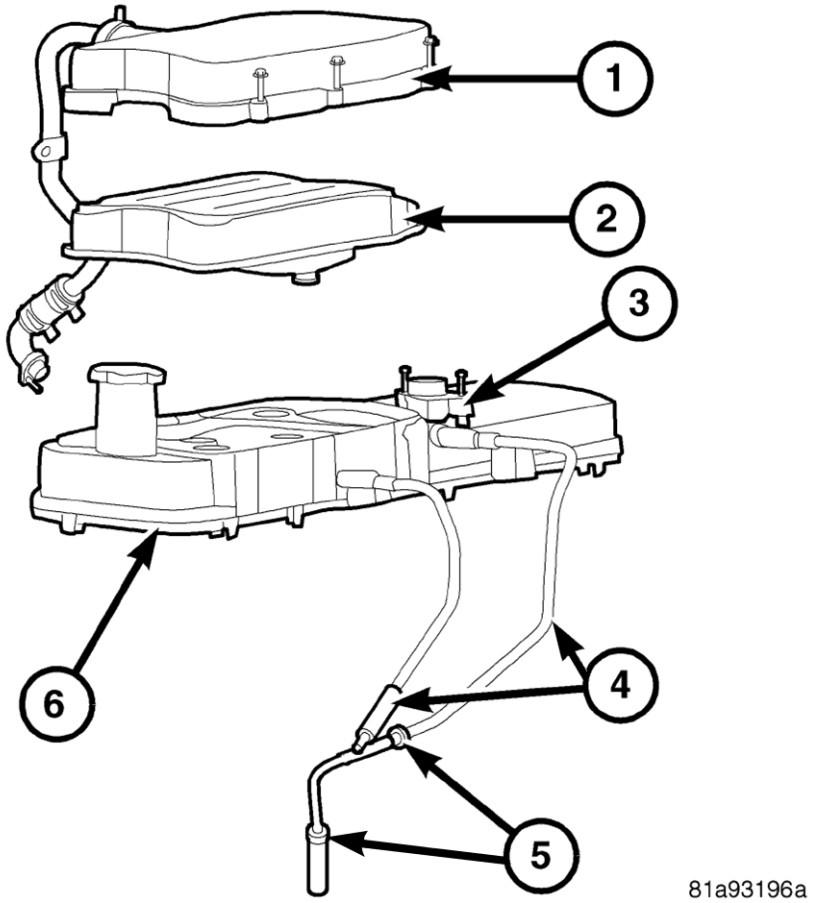
Lowering PM emissions

- More efficient fuel control systems
  - OBDII engine management systems
    - Detects emission related malfunctions
  - Common rail fuel systems
    - More precise fuel metering
    - Improved atomization of fuel
    - Multiple stage injection
    - More fuel efficiency/power
  - Advanced turbocharger technology
    - More closely match boost and engine rpm

Lowering PM emissions

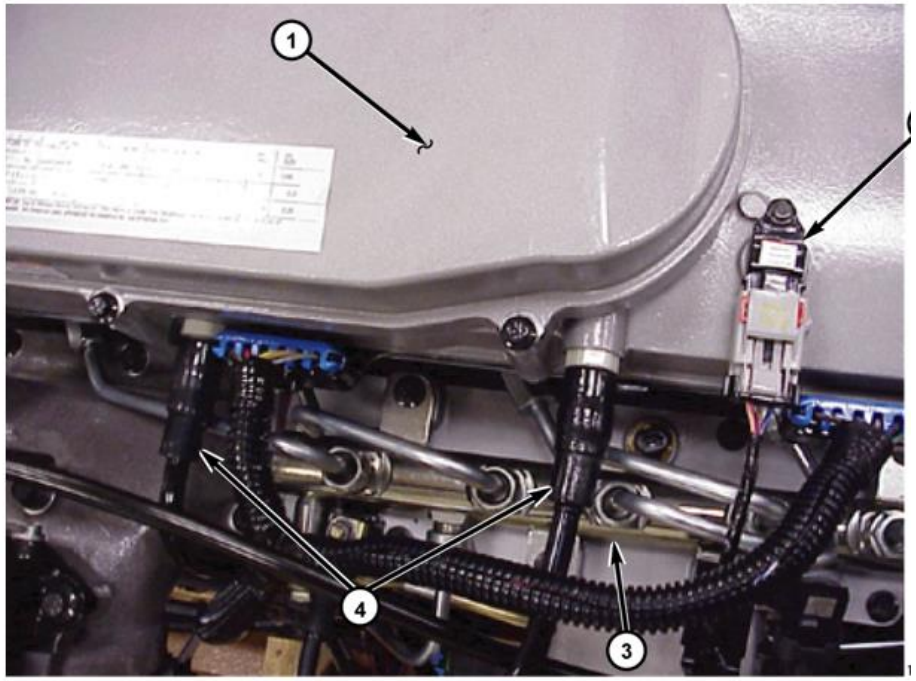
- Closed Crankcase Ventilation
  - Blow-by gasses=10%-50% of PM
  - Reroute blow-by gasses into intake
  - Returns filtered oil to crankcase
  - Required for 2007 EPA compliance
  - Virtually eliminate crankcase emissions
  - Significant reduction in PM emissions
  - Separates oil from blow-by gasses

Closed Crankcase Ventilation



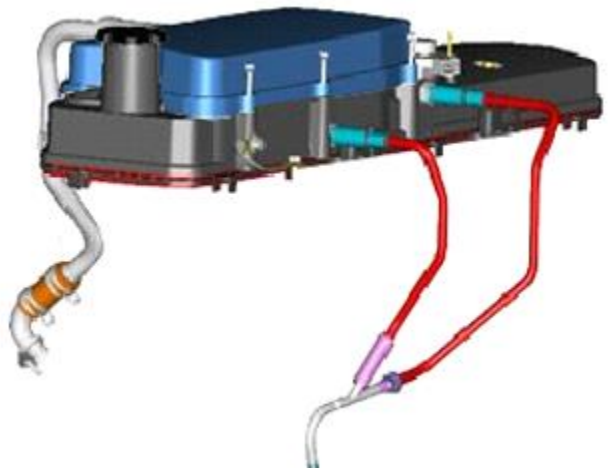
1. Breather Filter Cover
2. Breather Filter
3. Crankcase Pressure Sensor
4. Oil Drain Tubes
5. Check Valves
6. Cylinder Head Cover

Crankcase Pressure Sensor



Crankcase Pressure Sensor

Crankcase Filter



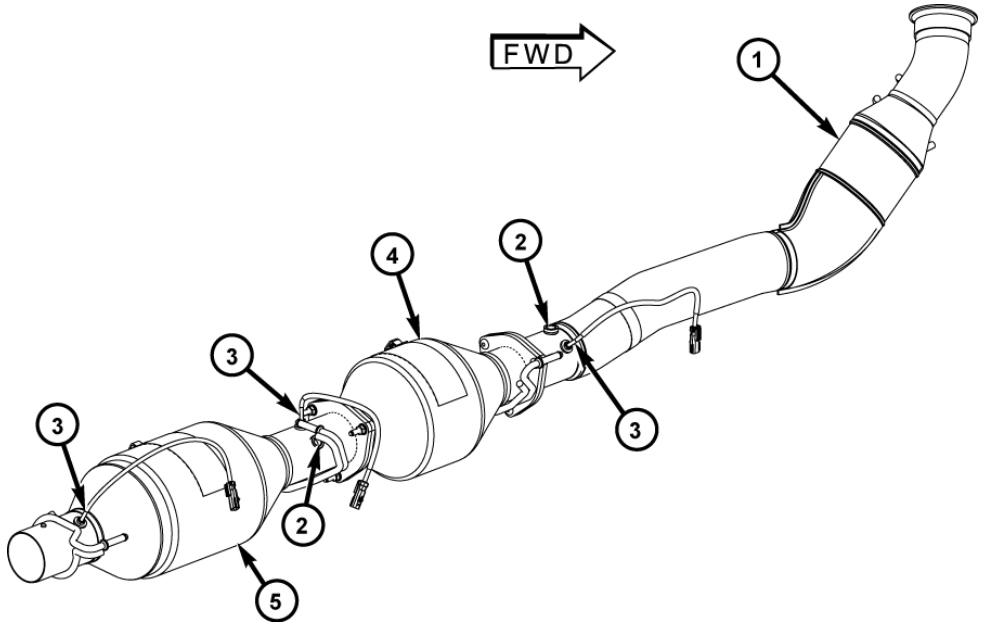
Low Ash Oil

- DPF system requires use of low ash oil
- Assists in reduction of PM emissions
- API CJ-4 oils meet low ash specs
- Required to meet manufacturers warranty requirements

Lowering PM emissions

- Diesel Particulate Filters
  - Component of exhaust aftertreatment system
  - Traps PM in a reusable filter media
  - Heat from engine oxidizes (burns) PM
    - Regeneration
  - All EPA complaint diesel engines use diesel particulate filter technology
  - “active systems”
    - PCM strategy
  - Require low ash oil and ULSD fuel
    - Ash and sulfur can damage DPF

Exhaust Aftertreatment Components

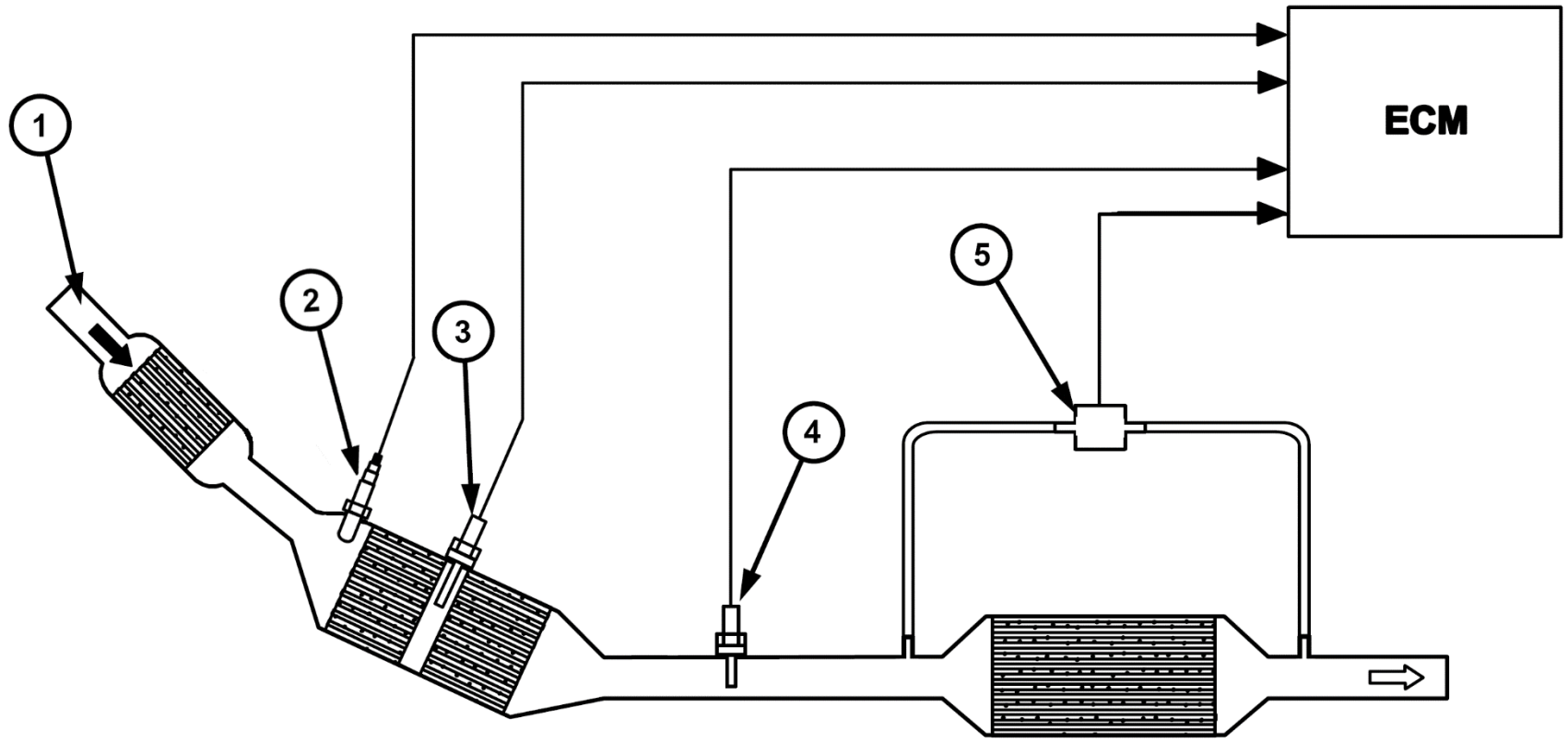


1. Diesel Oxidation Catalyst #1
2. Oxygen Sensor Bung
3. Exhaust Temperature Sensors
4. NOx Adsorber Catalyst
5. Diesel Particulate Filter

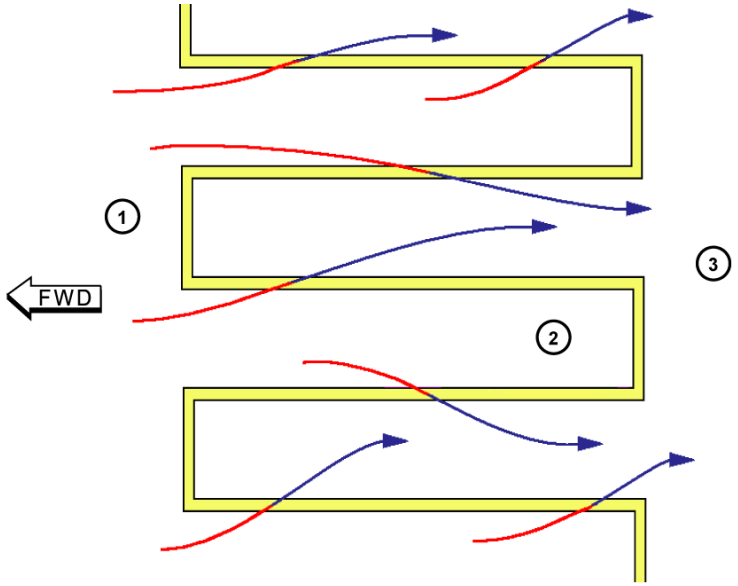
Lowering PM emissions

- Diesel Oxidation Catalyst (DOC)
  - Flow-thru design
  - Promotes chemical oxidation of hydrocarbons and carbon monoxide
  - Produces heat for DPF regeneration cycles
- Sensors
  - Pressure sensors determine need to Regeneration
  - Temp sensors determine Regeneration status

Aftertreatment Sensor Overview



Diesel Particulate Filter (DPF)



- Wall-flow design
- Filters, stores, burns particulate matter
- PM oxidized into CO2 at 600 degrees C
- Ash residue will remain in DPF
- Will require service eventually

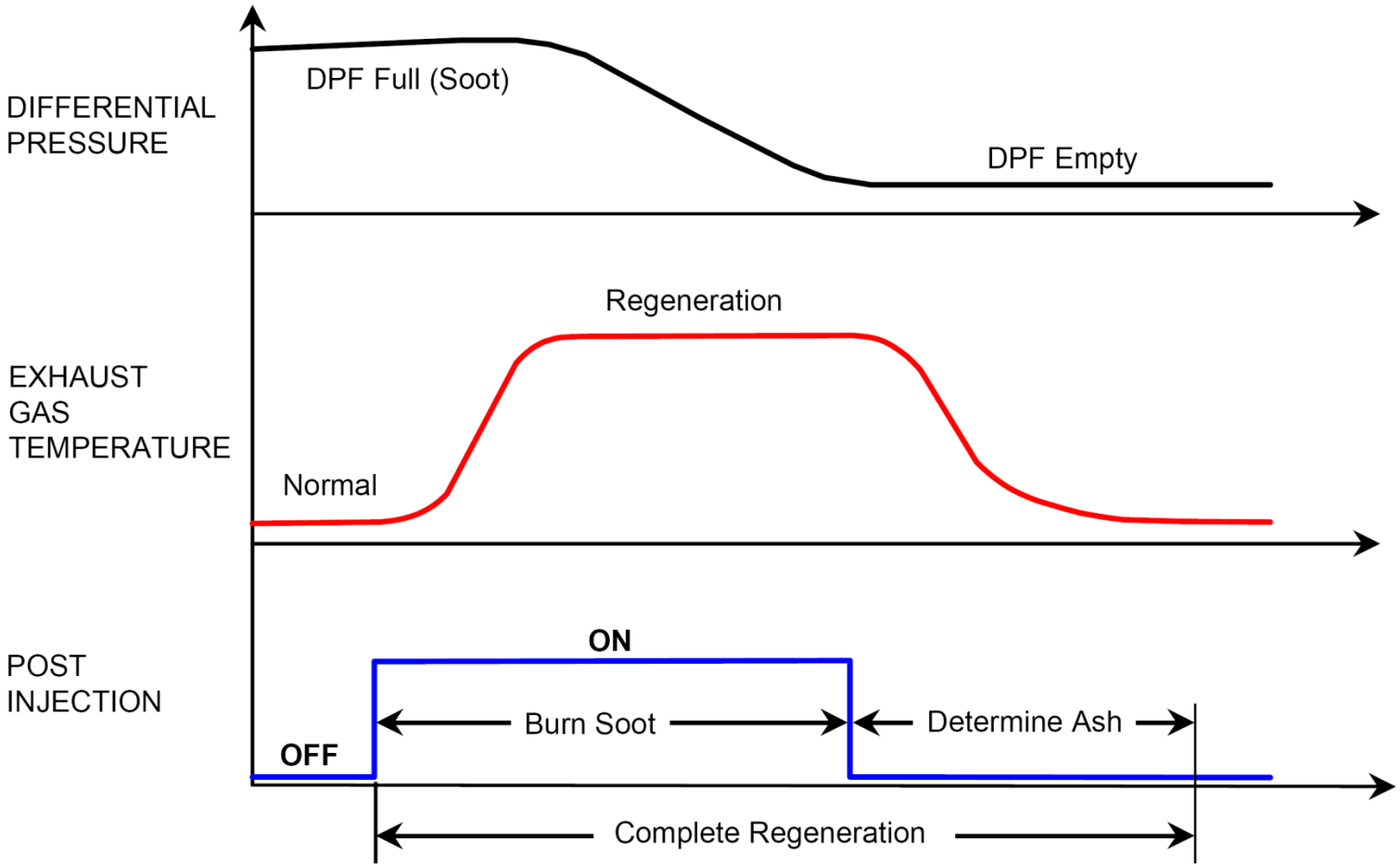
Regeneration

- Process of burning PM trapped in DPF
- Three types of Regeneration
  - Passive
    - High loads/High exhaust temperatures
    - Transparent to driver
  - Active
    - Low loads/Low exhaust temps
    - ECM adds extra fuel to increase temperatures
  - Manual
    - Performed by service technicians

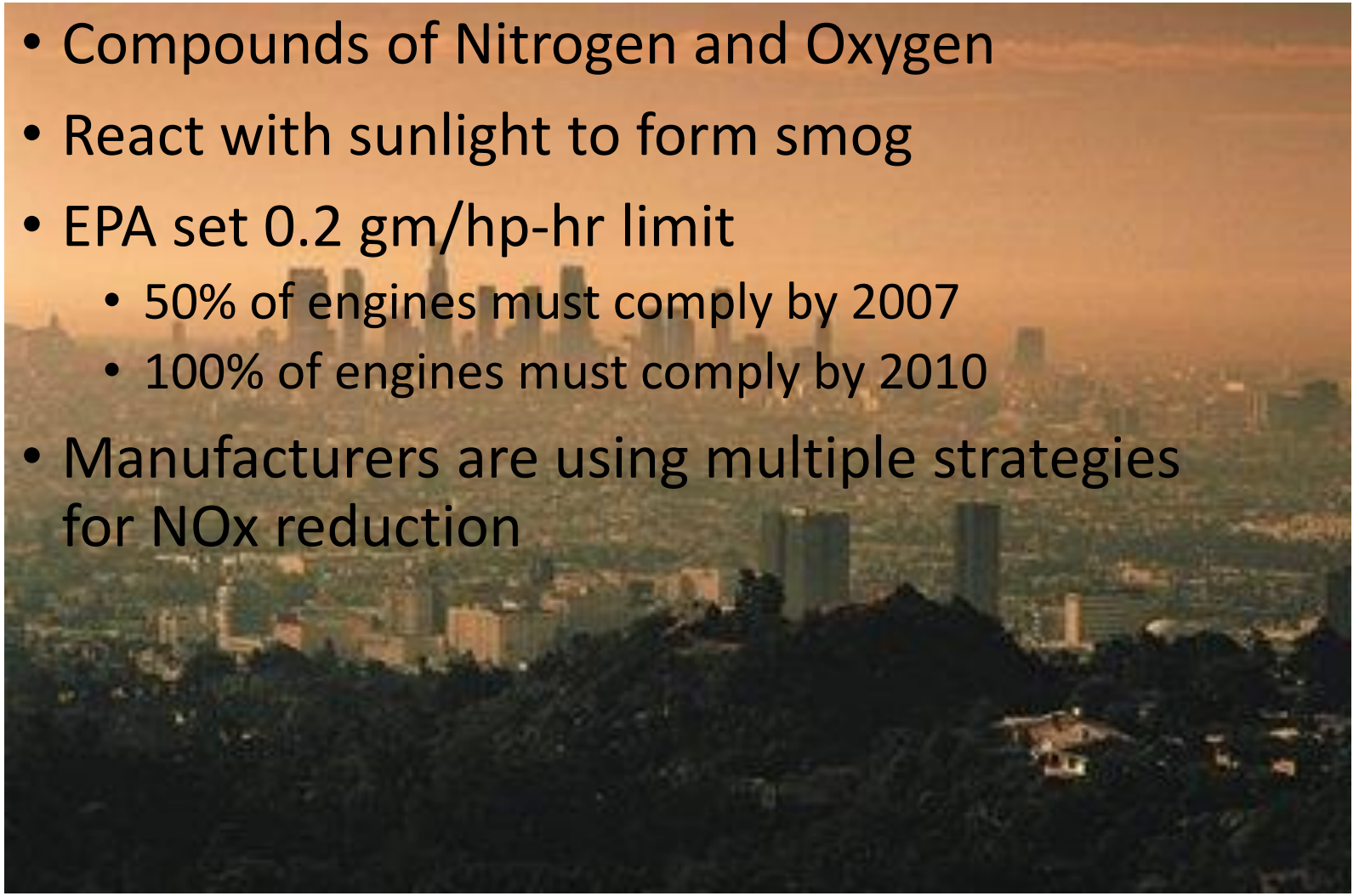
Active Regeneration

- Exhaust pressure differential sensor voltage exceeds limit value
- ECM bypasses EGR cooler
- Injectors are post-injected
- Exhaust temperature exceeds 600 deg. C
- Soot burned into ash and carried away
- Exhaust pressure differential lowers
- ECM disables Regeneration

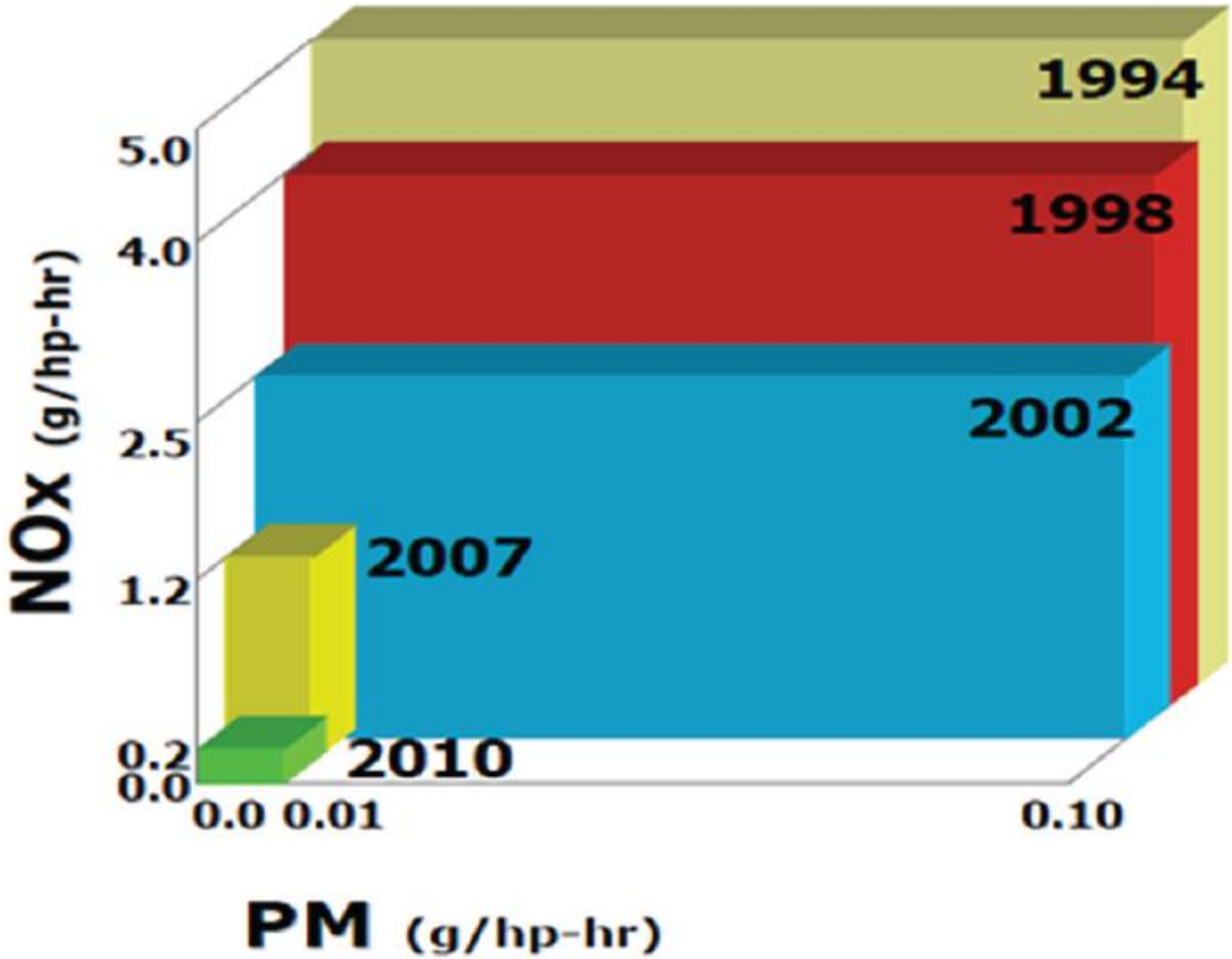
Regeneration Timeline



Oxides of Nitrogen (NOx)



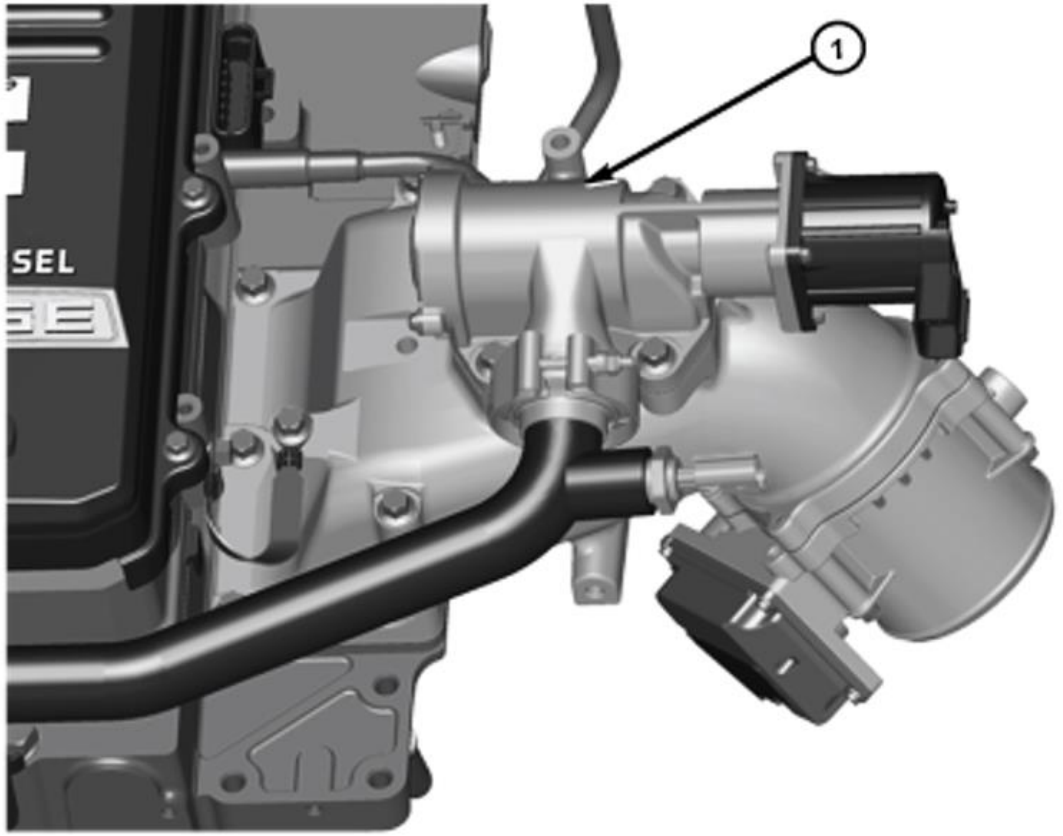
- Compounds of Nitrogen and Oxygen
- React with sunlight to form smog
- EPA set 0.2 gm/hp-hr limit
  - 50% of engines must comply by 2007
  - 100% of engines must comply by 2010
- Manufacturers are using multiple strategies for NOx reduction


1994
1998
2002
2007
2010
5.0
4.0
2.5
1.2
0.2
0.0
NOx (g/hp-hr)
0.0
0.01
0.10
PM (g/hp-hr)

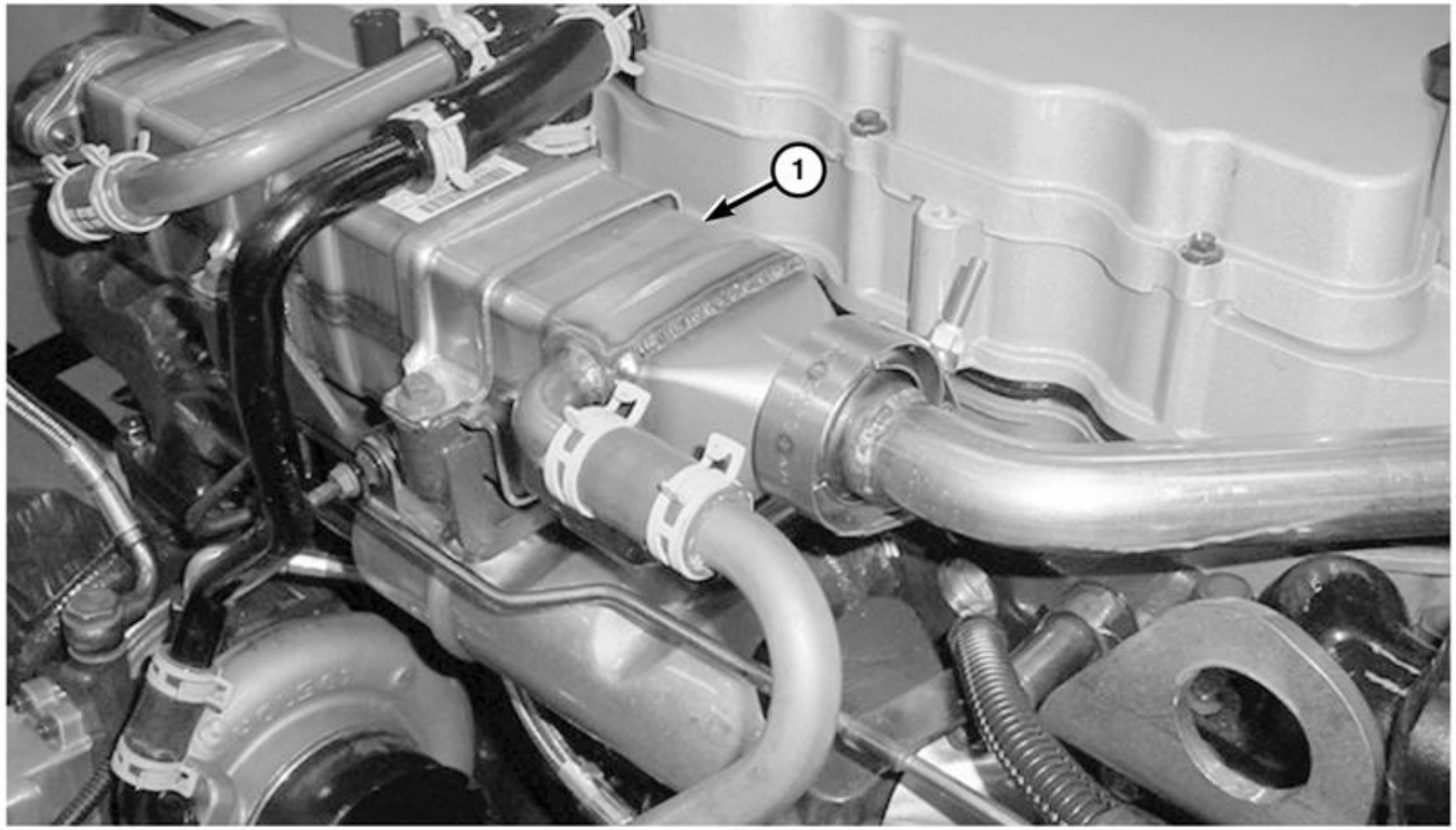
Lowering NOx emissions

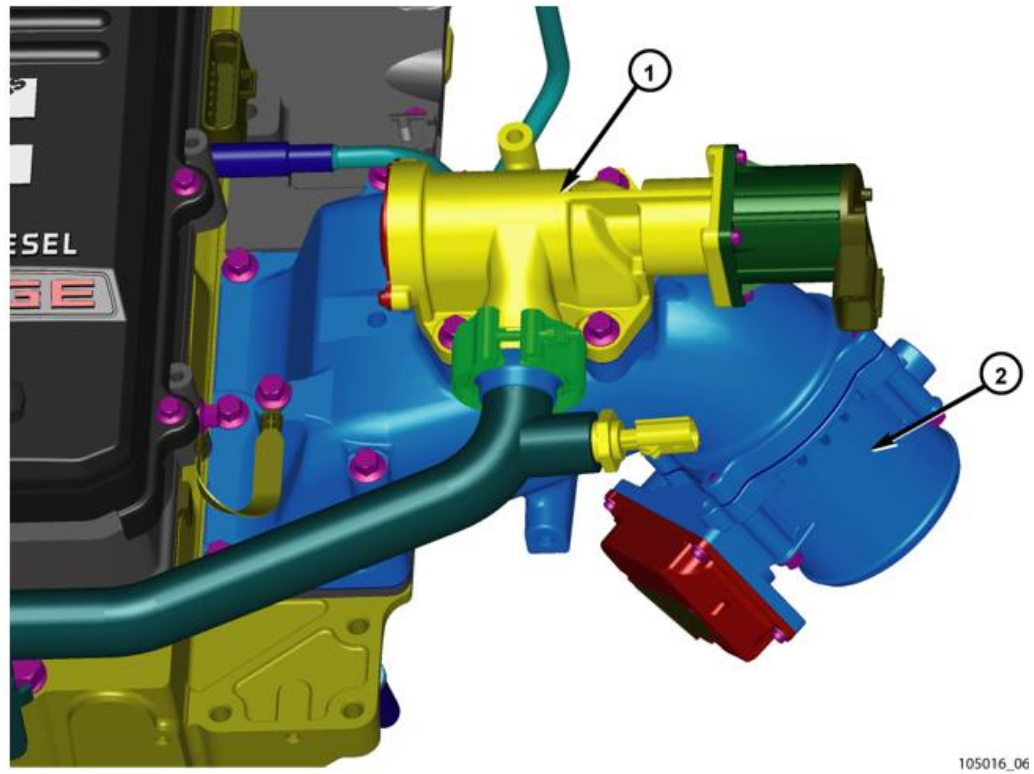
- Cooled EGR Systems
  - Designed to reduce NOx by lowering combustion chamber temperatures
  - Introduces inert gas (exhaust) to dilute intake air charge
  - EGR cooler used to lower exhaust gas temperature, further reducing NOx
  - EGR cooler uses engine coolant to lower exhaust gas temperature

EGR



EGR Cooler



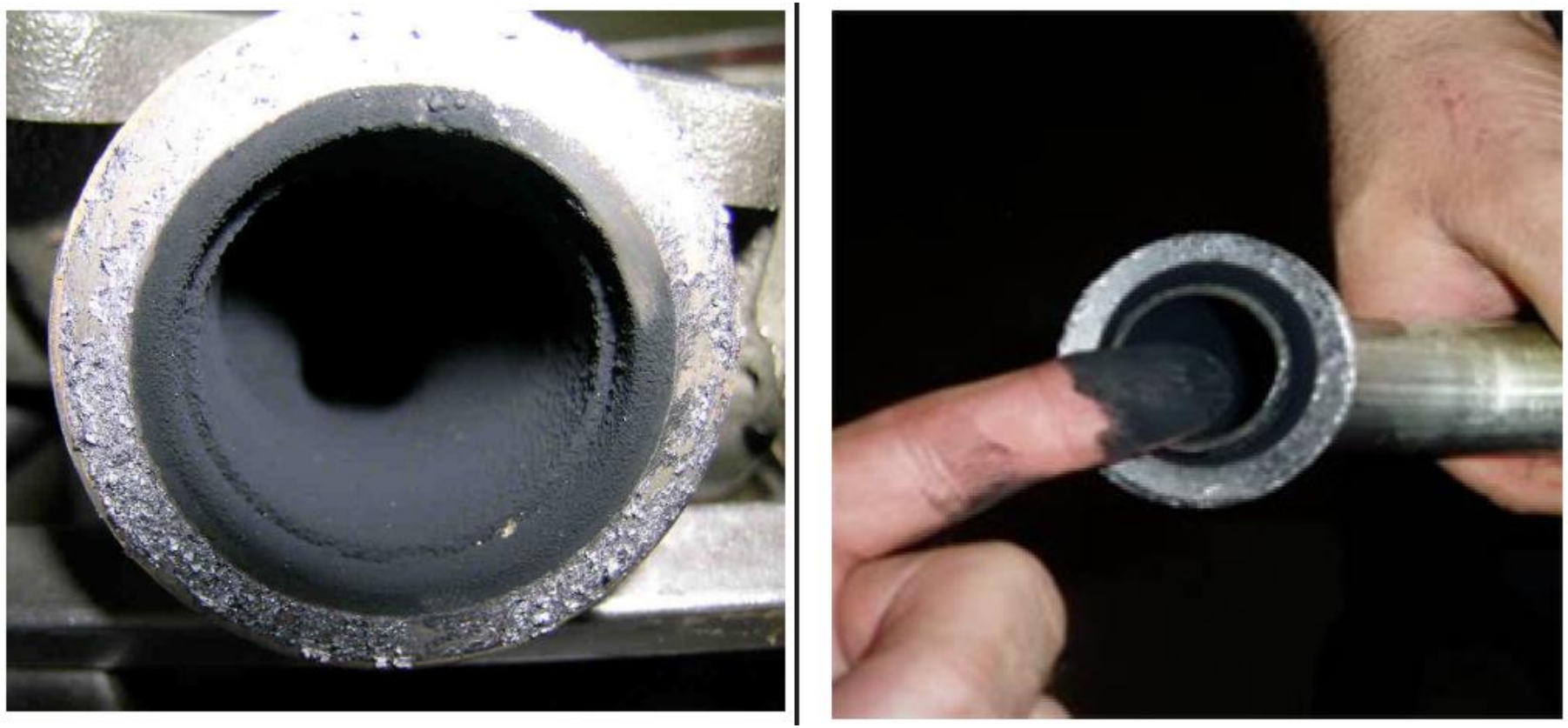


EGR Airflow Throttle Control Valve Location

EGR System

- Active at low loads and low speeds
- On at cold start, shuts off after approx 5 minutes idle time, back on after throttle input
- Determines need for EGR based upon sensor inputs
- ECM can output control EGR valve and EGR Airflow Throttle Control Valve
- Uses MAF to verify EGR flow

Figure 97 Sooted EGR Components

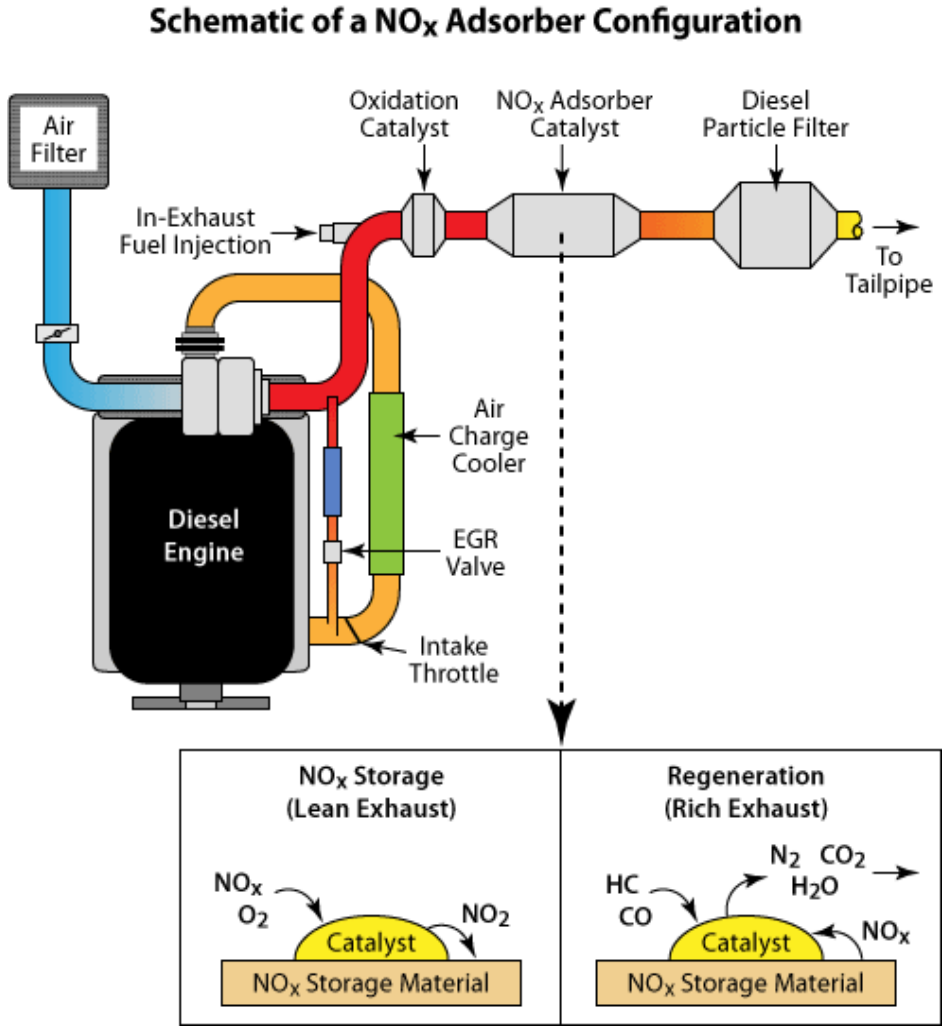


EGR Cooler

- Located on top of exhaust manifold
- Coolant flows thru cooler “radiating” heat from exhaust into coolant
- Require soaking/cleaning as maintenance
- EGR Cooler Bypass protects EGR cooler
  - During active regeneration mode
  - Reroutes exhaust gasses around cooler
  - Disables when EGR temp sensor drops

Lowering NOx emissions

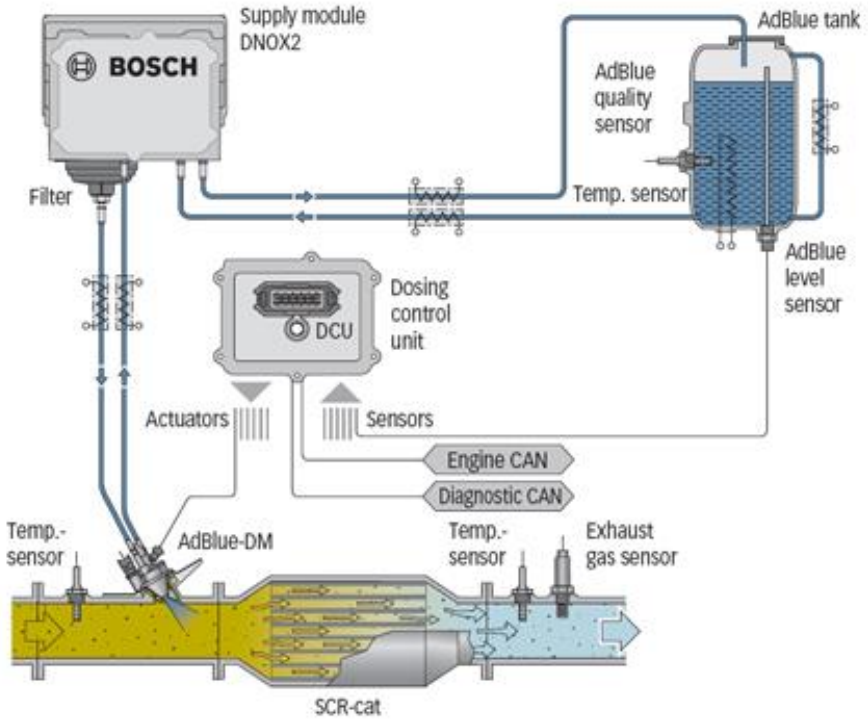
- NOx Adsorbers
  - Trap NOx on catalyst membrane during lean burn conditions
  - Convert NOx and HC into Nitrogen & Water during rich conditions
  - PCM adds extra fuel to purge Adsorber
    - Regeneration



NOx Adsorbers

- Recent technology
- Aftertreatment
- Expensive
- Do not require a reactant (DEF)
- Require regeneration to purge
- Require ULSD fuel
  - Sulfur hinders NOx storage

Selective Catalyst Reduction (SCR)

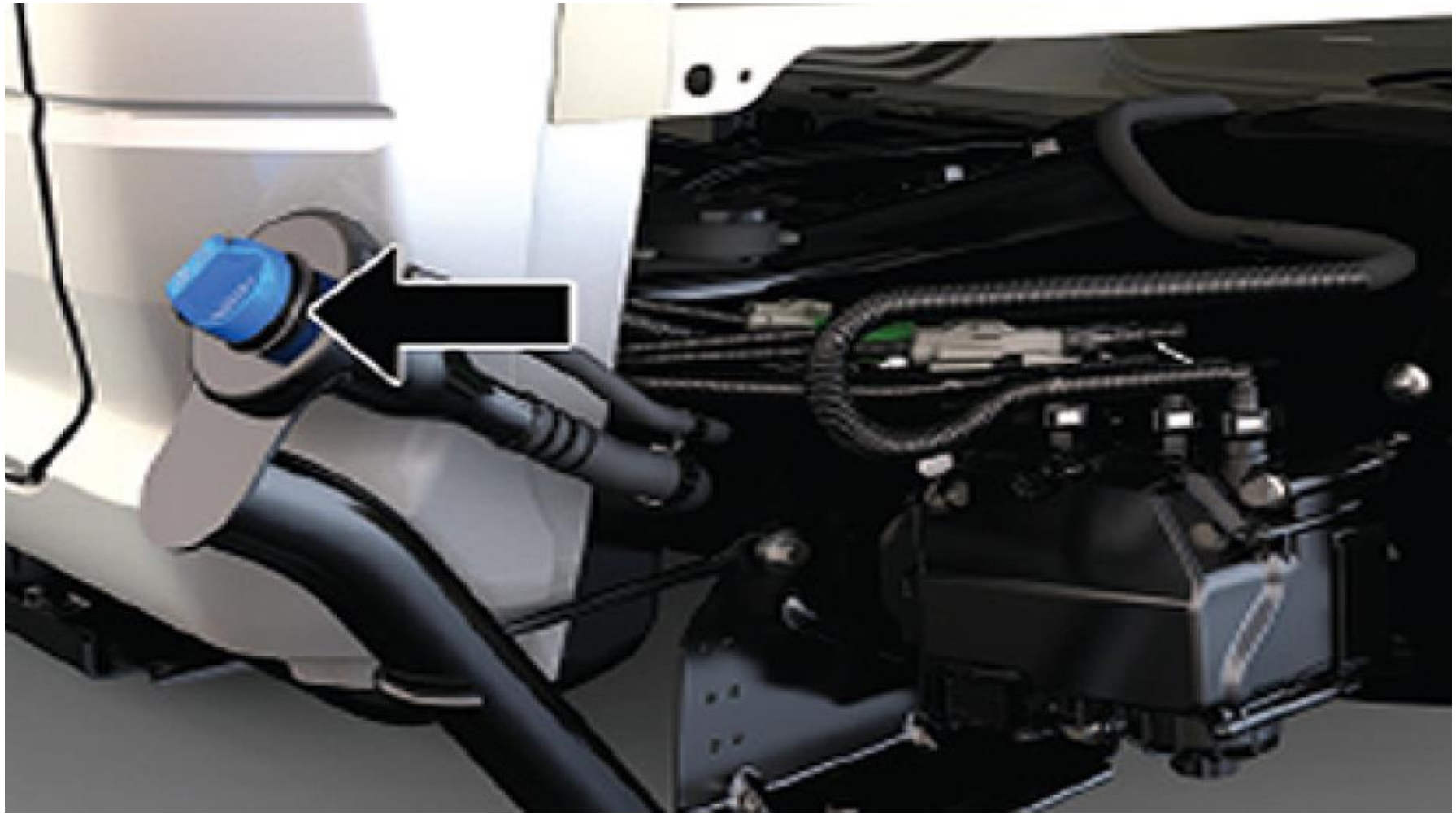


- Dosing system
  - Module
  - Tank
  - Injector
  - Sensors

Selective Catalyst Reduction (SCR)

- Require a reactant to convert NOx
- Typical reactant 32.5% urea solution
- Heat in exhaust converts urea into ammonia
- Ammonia reacts NOx to convert into nitrogen and water
- Similar to Adsorber technology
- Aftertreatment

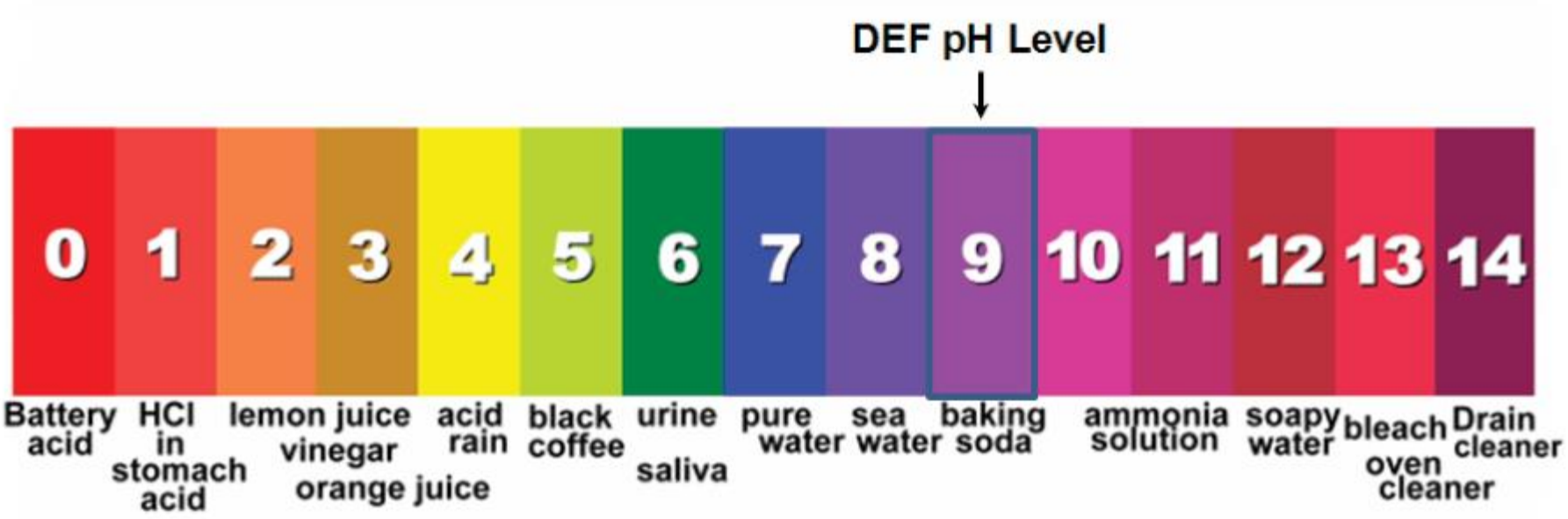
DEF Fuel Tube Assembly



DEF Properties

API
AMERICAN PETROLEUM INSTITUTE
CERTIFIED
DIESEL EXHAUST FLUID

pH Scale


DEF pH Level
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Battery acid
HCl in stomach acid
lemon juice
vinegar
orange juice
acid rain
black coffee
urine
saliva
pure water
sea water
baking soda
ammonia solution
soapy water
bleach
oven cleaner
Drain cleaner

SCR Catalyst Assembly

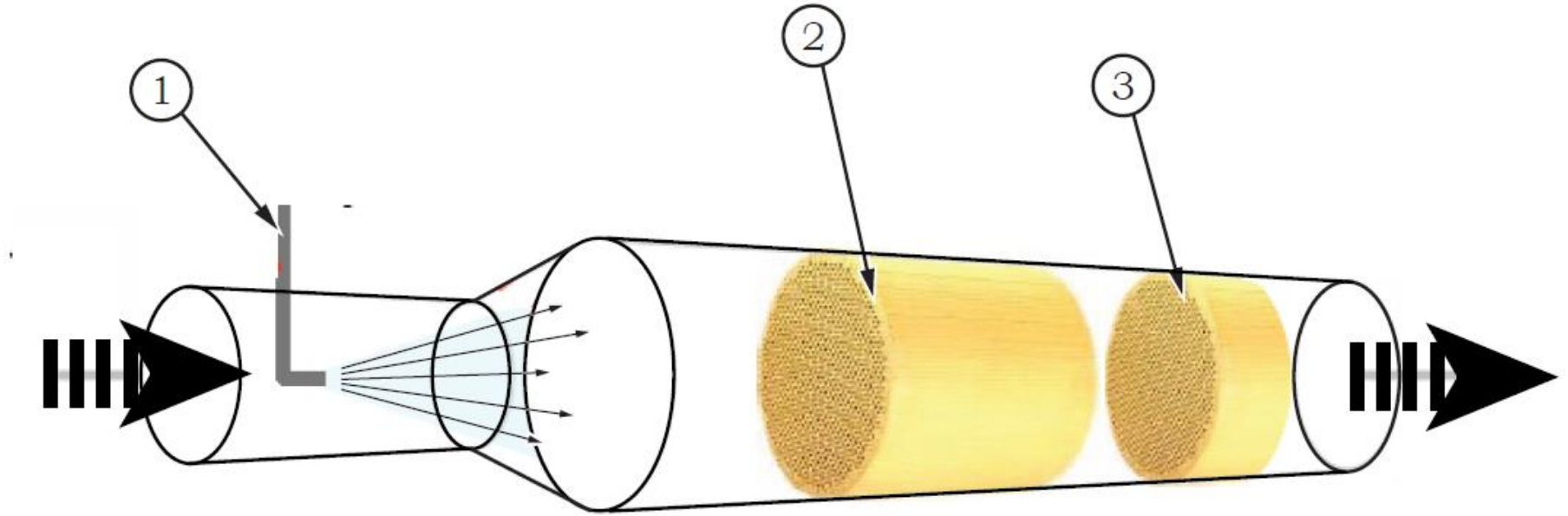


Figure 93 Selective Catalylytic Reduction

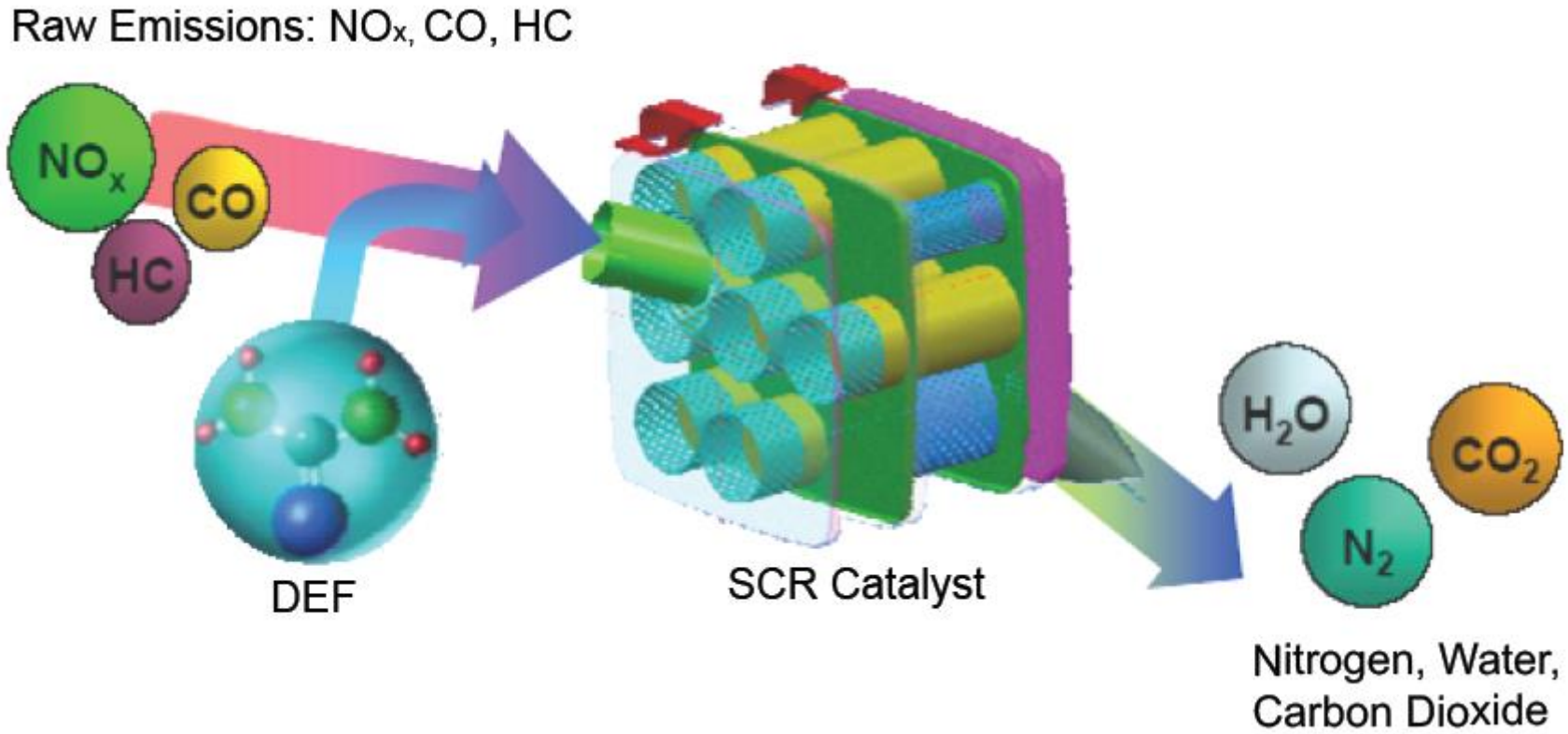
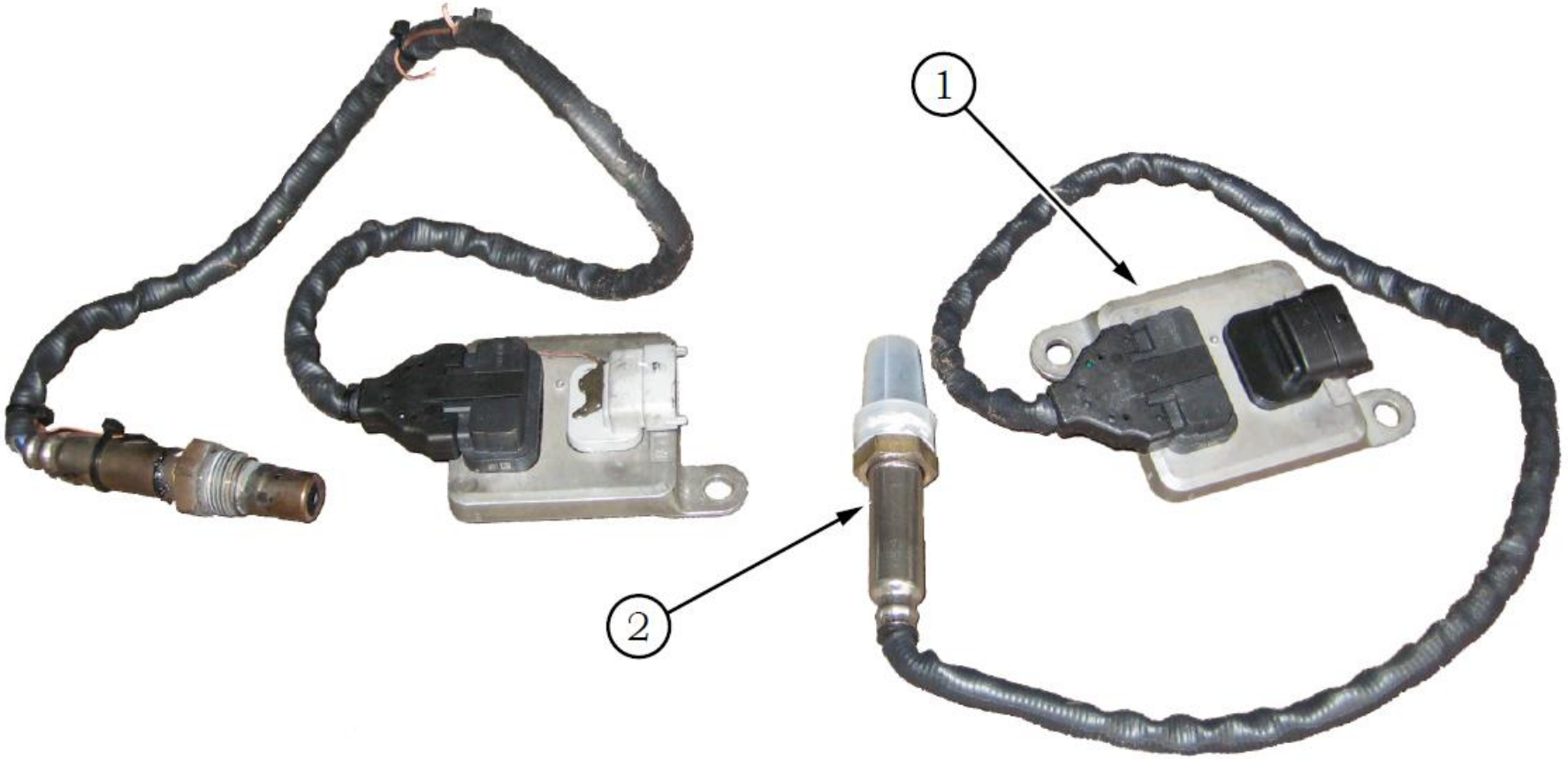
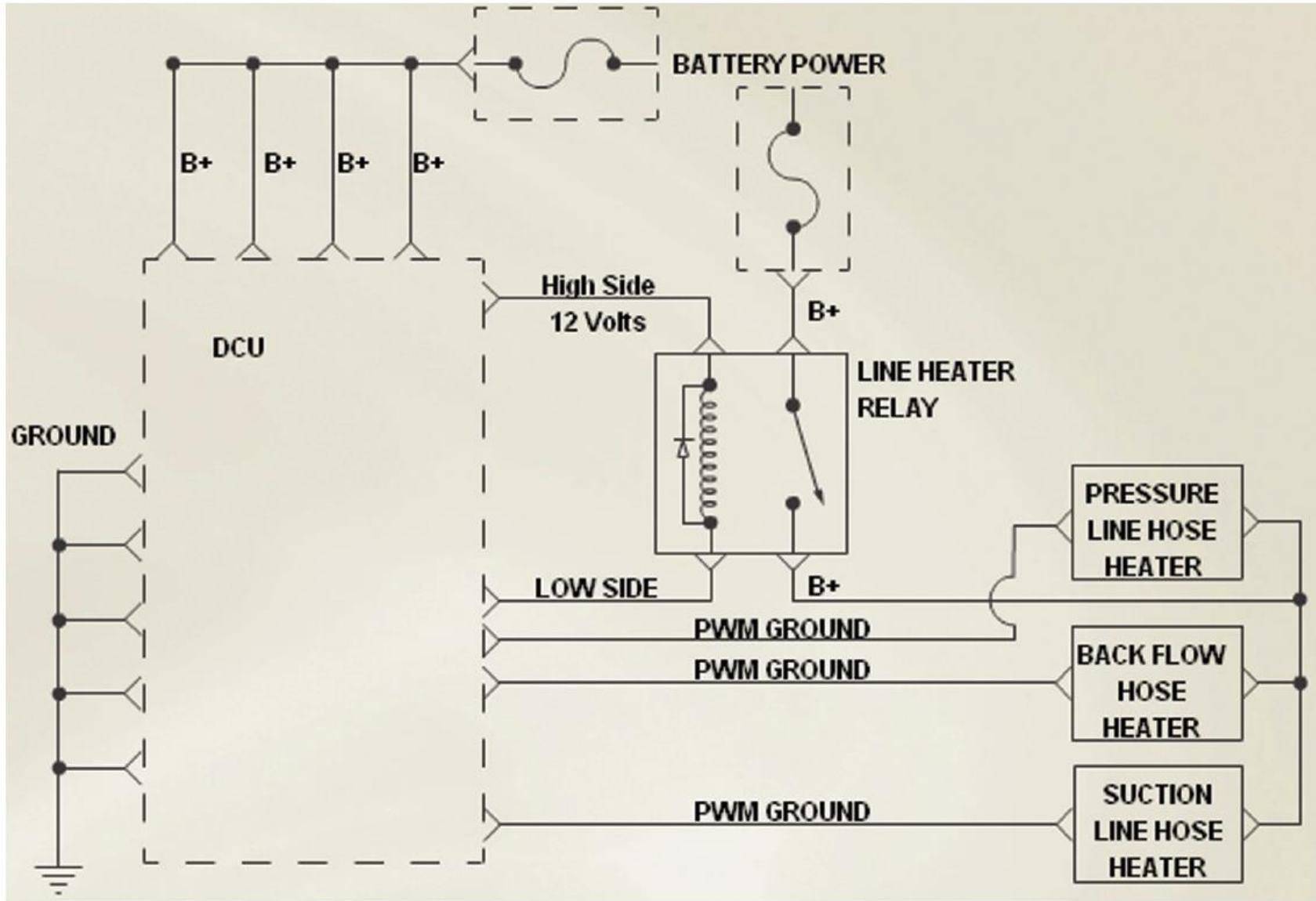
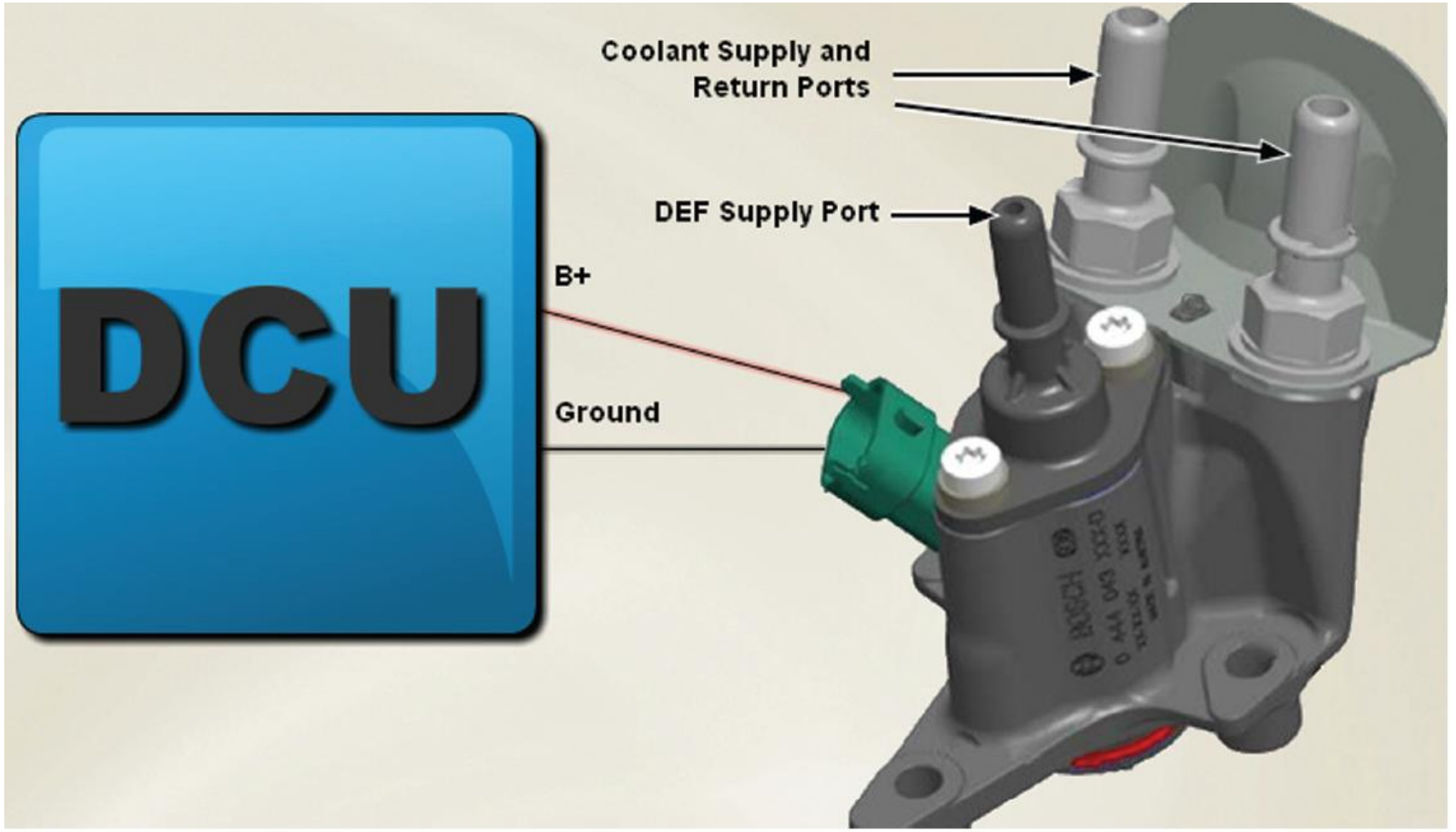


Figure 73 DEF NOx Modules and Sensors

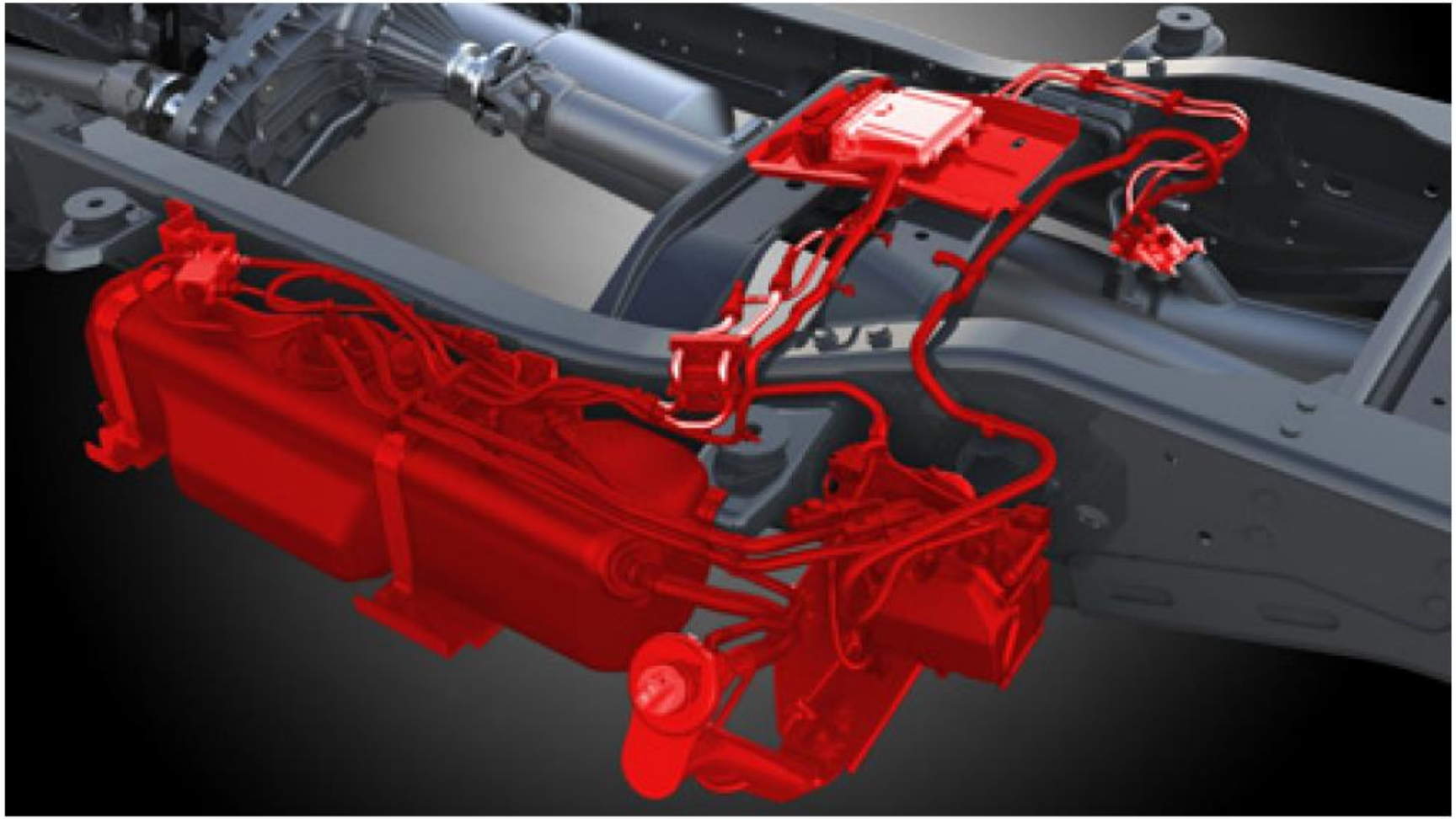



BATTERY POWER
B+
B+
B+
B+
High Side
12 Volts
B+
DCU
LINE HEATER
RELAY
GROUND
PRESSURE
LINE HOSE
HEATER
LOW SIDE
B+
PWM GROUND
PWM GROUND
BACK FLOW
HOSE
HEATER
PWM GROUND
SUCTION
LINE HOSE
HEATER

DEF Dosing Injector Control



Diesel Exhaust Fluid System



DEF System Operating States:

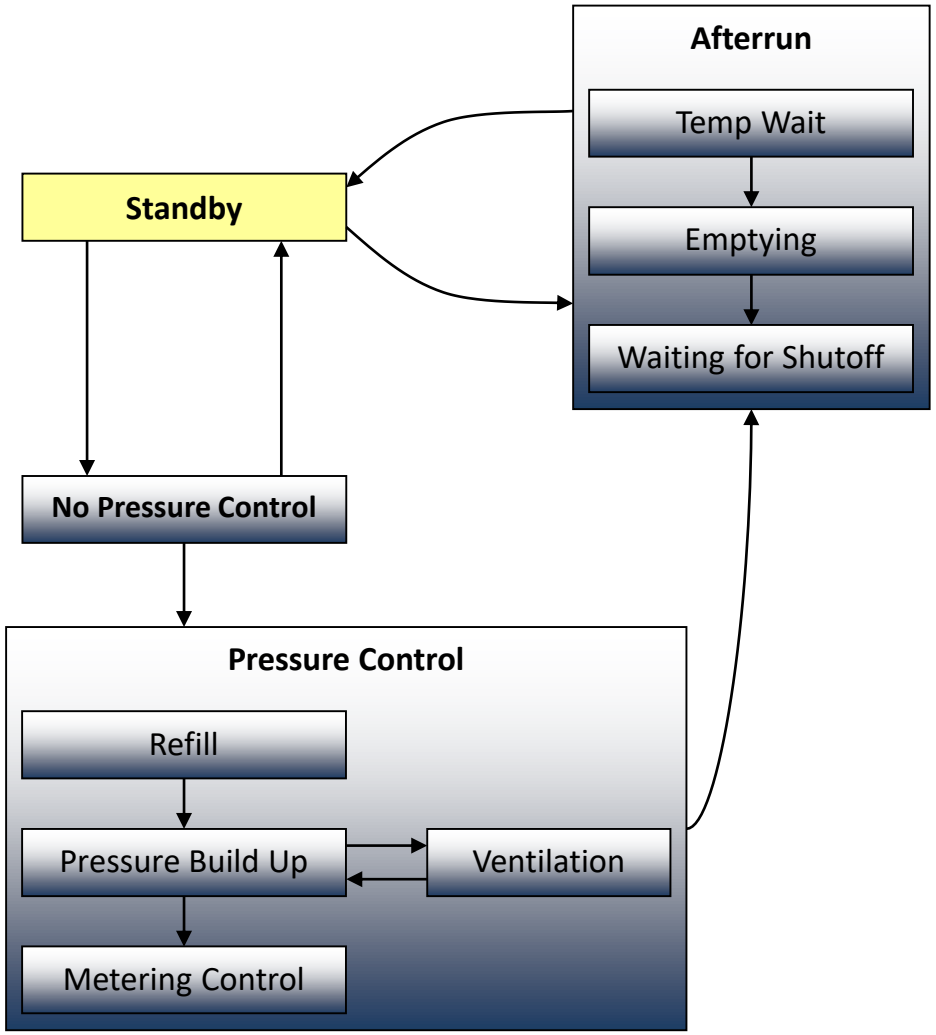
- **STANDBY:** State before the system is ready, and steady state for errors that do not result in a direct shut-off.

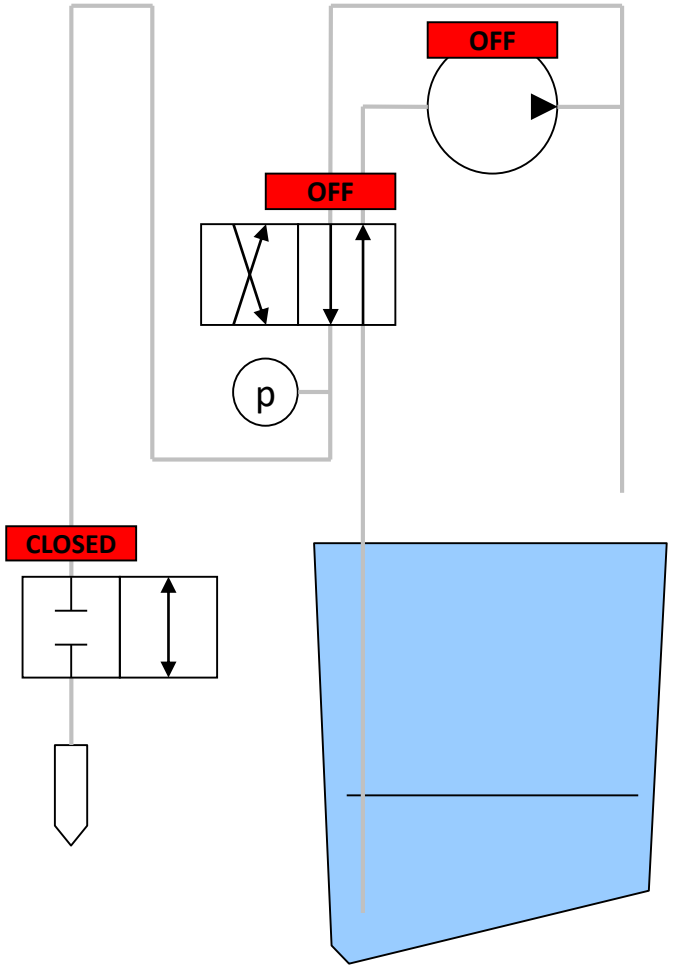
- **NO PRESSURE CONTROL:** The system can heat up but does not yet have a release for pressure control (e.g. reducing agent not yet defrosted).

- **PRESSURE CONTROL:** System with released open/closed loop pressure control.
  - Sub States: Refill, Pressure Buildup, Ventilation, Metering Control.

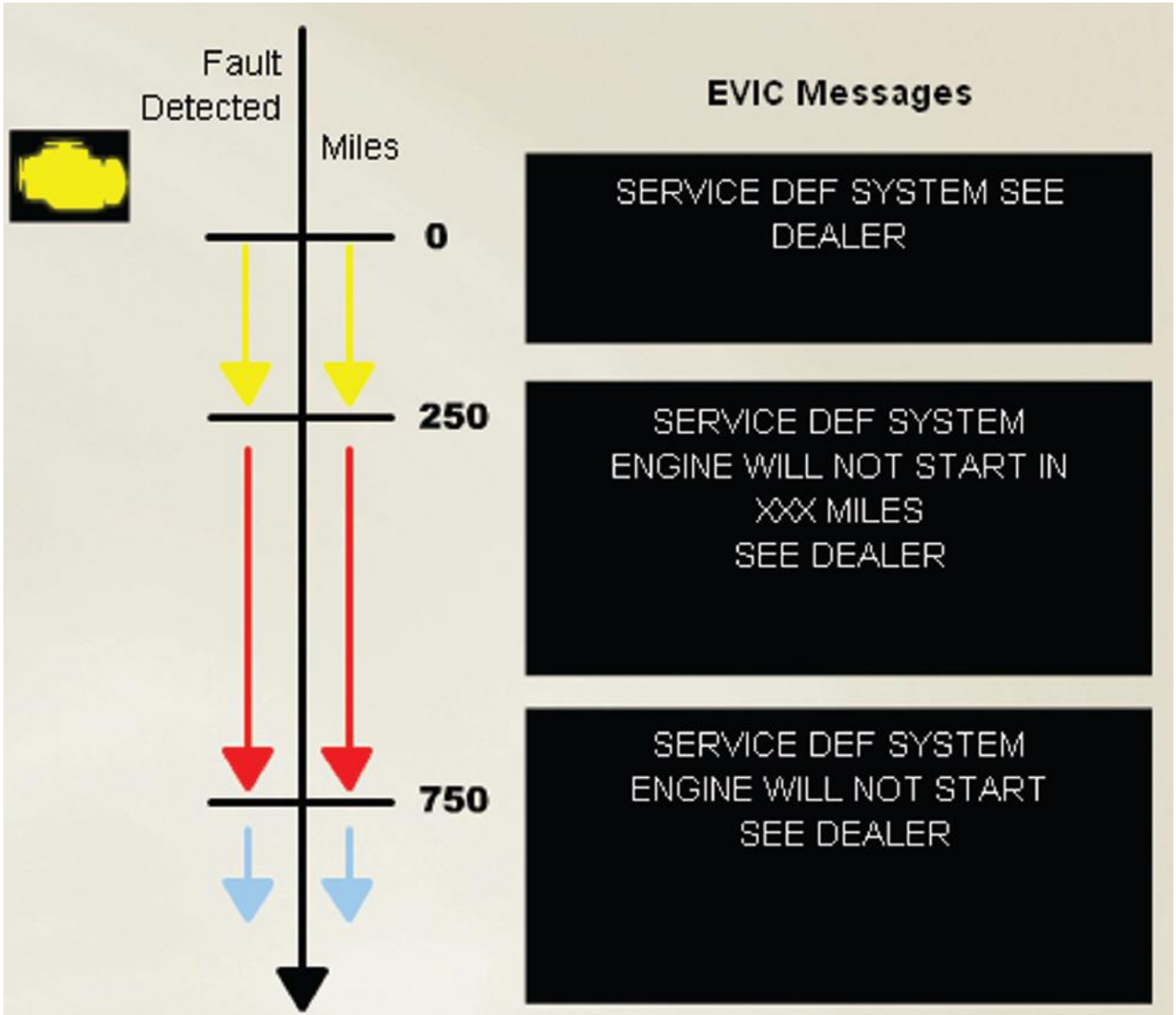
- **AFTERRUN:** System is emptied and switched off, fault code memory is written and therefore errors can no longer be healed.
  - Sub States: Temp Wait, Emptying, Waiting for Shutoff.

DEF Fluid Animation


Afterrun
Temp Wait
Emptying
Waiting for Shutoff
Standby
No Pressure Control
Pressure Control
Refill
Pressure Build Up
Ventilation
Metering Control


OFF
OFF
p
CLOSED


40%
35%
32,5%
25%
20%
15%
Waterline
07/08


Fault
Detected
Miles
0
250
750
EVIC Messages
SERVICE DEF SYSTEM SEE DEALER
SERVICE DEF SYSTEM ENGINE WILL NOT START IN XXX MILES SEE DEALER
SERVICE DEF SYSTEM ENGINE WILL NOT START SEE DEALER

Temperature °C	Temperature °F	Estimated Shelf Life
0	32	infinity
10	50	75 years
20	68	11 years
30	86	23 months
35	95	10 months
40	104	4 months
50	122	1 month
60	140	1 week

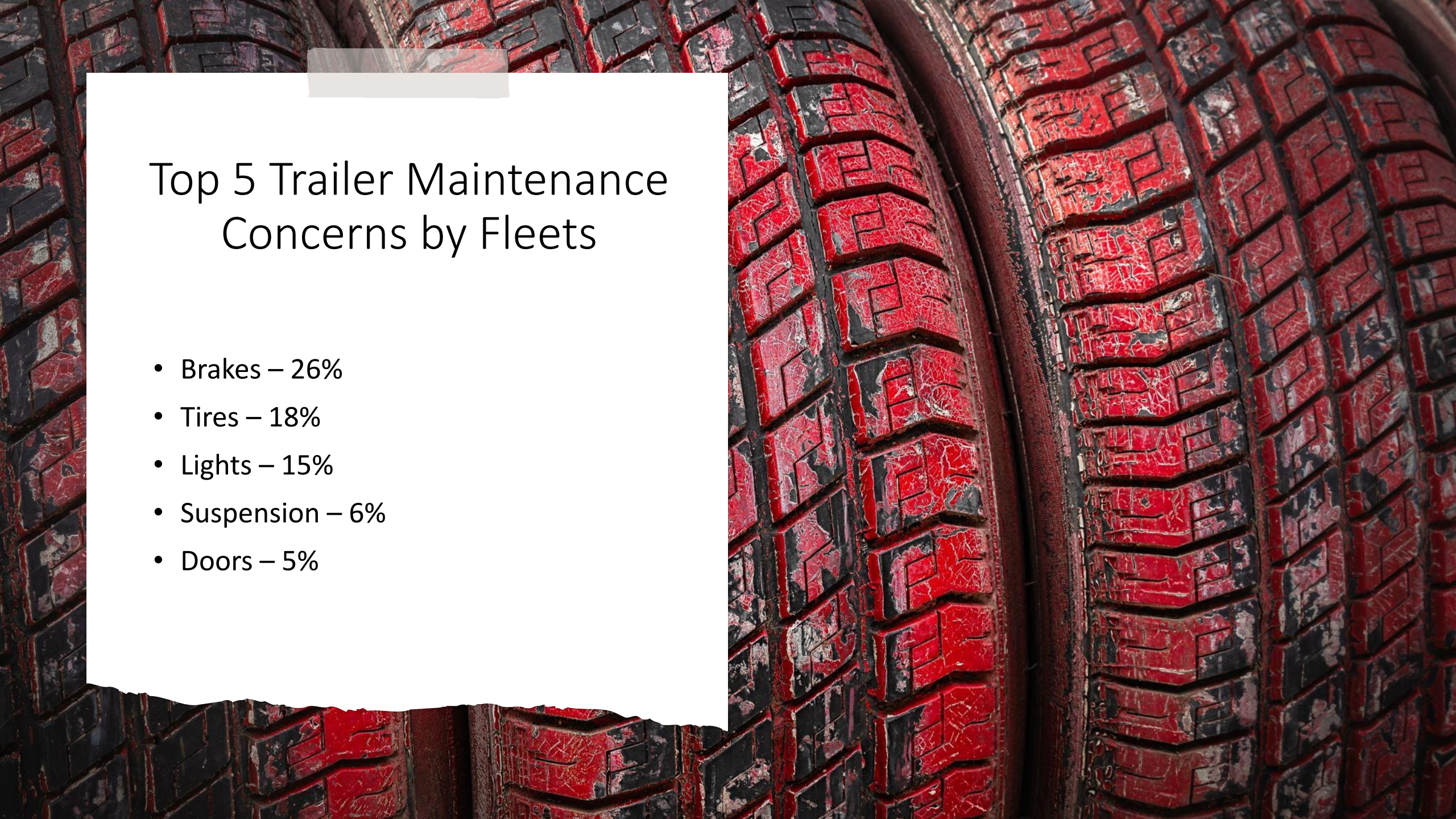
Heavy Truck/Bus

Class	Gross Vehicle Weight (GVW) lb (kg)
1	6000 lb (2721.6 kg) or less
2	6001–10,000 lb (2722–4535.9 kg)
3	10,001–14,000 lb (4536.4–6350.3 kg)
4	14,001–16,000 lb (6350.7–7257.5 kg)
5	16,001–19,500 lb (7257.9–8845.1 kg)
6	19,501–26,000 lb (8845.5–11,793.4 kg)
7	26,001–33,000 lb (11,793.9 kg–14,968.5 kg)
8	33,001 lb (14,969 kg) or more

Defining OOS

- **In-House OOS**
- Set by the business that owns the truck
- Determined to make good business sense for drivers/customers/profits

- **CVSA OOS**
- Published each April
- 7 levels – L1-L7
- Logged electronically
- Query Central = access program
- Electronic screening and roadside inspections



Top 5 Trailer Maintenance Concerns by Fleets

- Brakes – 26%
- Tires – 18%
- Lights – 15%
- Suspension – 6%
- Doors – 5%

Software to Map an Alogrithm

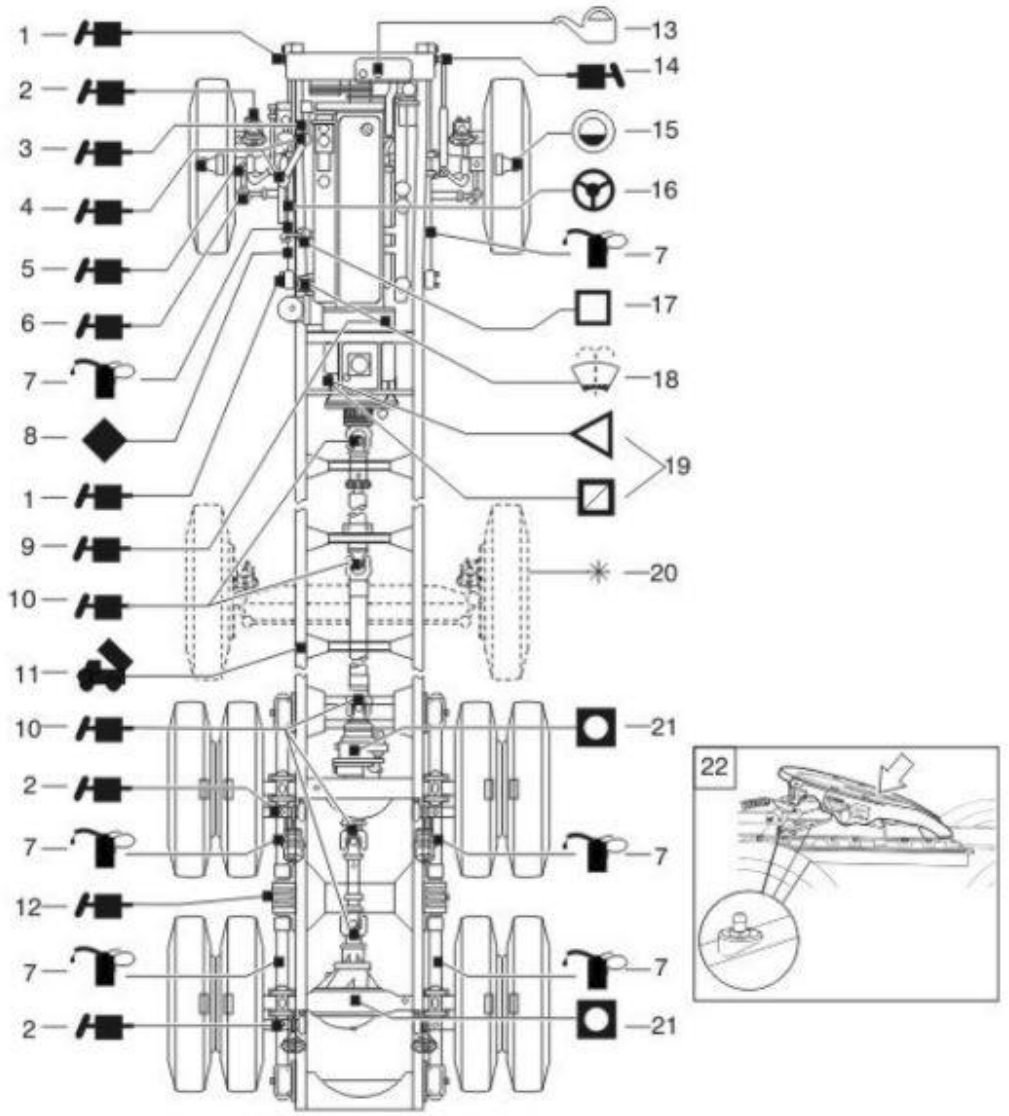
- Reliable life cycles
- Predicted wear rates
- Component risk management

This creates Condition or Predictive Maintenance Schedules

American Trucking Association develops universal coding for component failures

- The nature of the work performed
- Reason a service procedure is undertaken
- Identification of the exact nature of a component failure
- 30,000 items listed
- EX: a DPF is 043-006-017
- VMRS – Vehicle Maintenance Reporting Standards
- Useful to fleets for “predictive maintenance”

Much More to Grease than a Car



TRUCK BRAKES

Air Brake Basics

- Uses an air brake system instead of the hydraulic system found in cars
- Air brakes have a short lag time between foot application and actual braking
- Use the air around them instead of hydraulic fluid to transfer pressure and create the friction needed to brake

Air Brake Components: Air Compressor

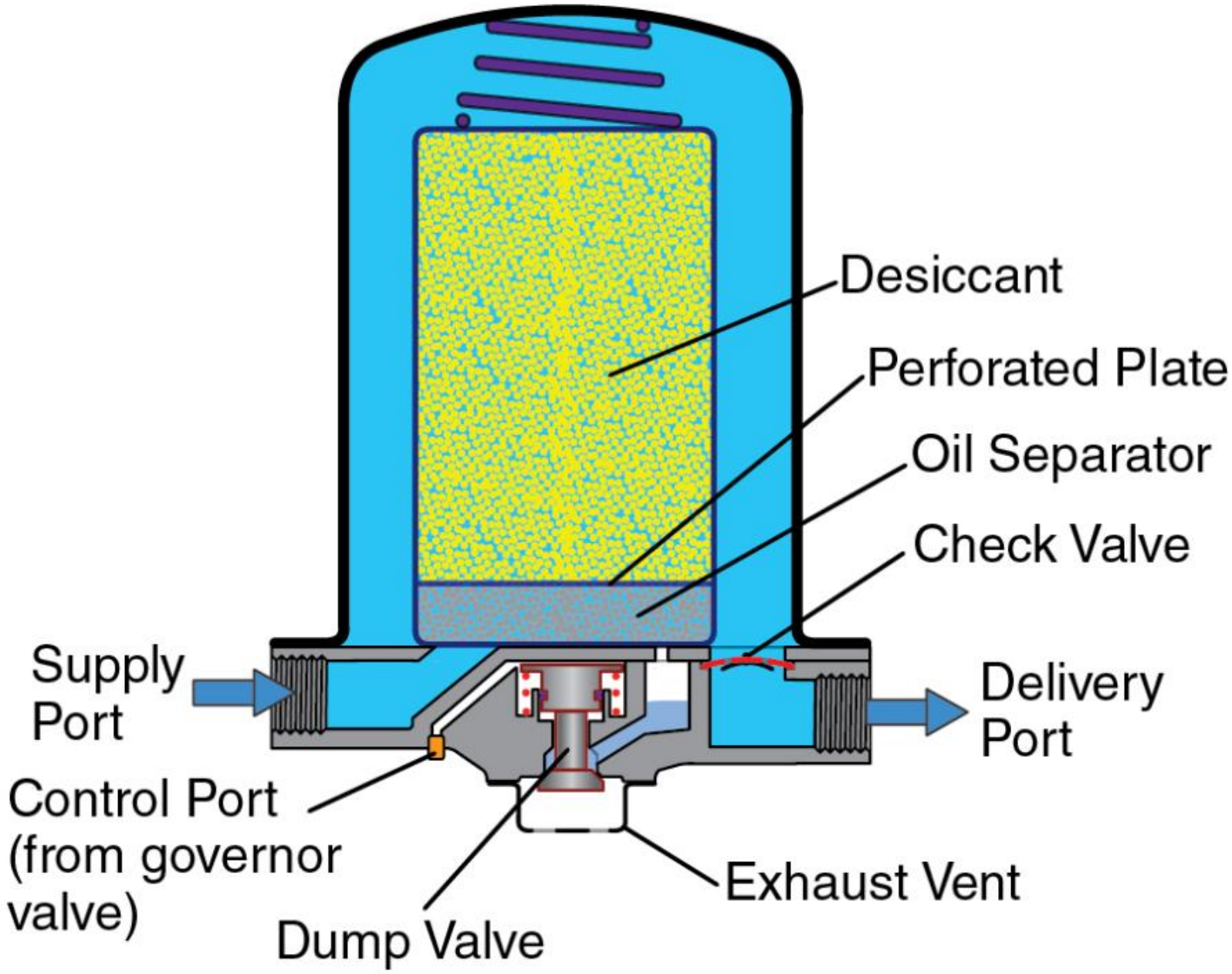
- Takes air from around it and pressurizes it within a tank
- Air compressor governor controls the amount of air the compressor compresses
- Allows the compressor to operate when pressure is too low, below around 100 PSI, and stopping operation when pressure is high enough, around 125 PSI

Air Brake Components: Reservoir Tanks

- Stored in air reservoir tanks
- Holds the pressurized air to be used by the braking system
- Water and oil may collect in the bottom of the reservoir tank
- Equipped with a drain valve
- Water freezing in the tank could lead to malfunction of the system

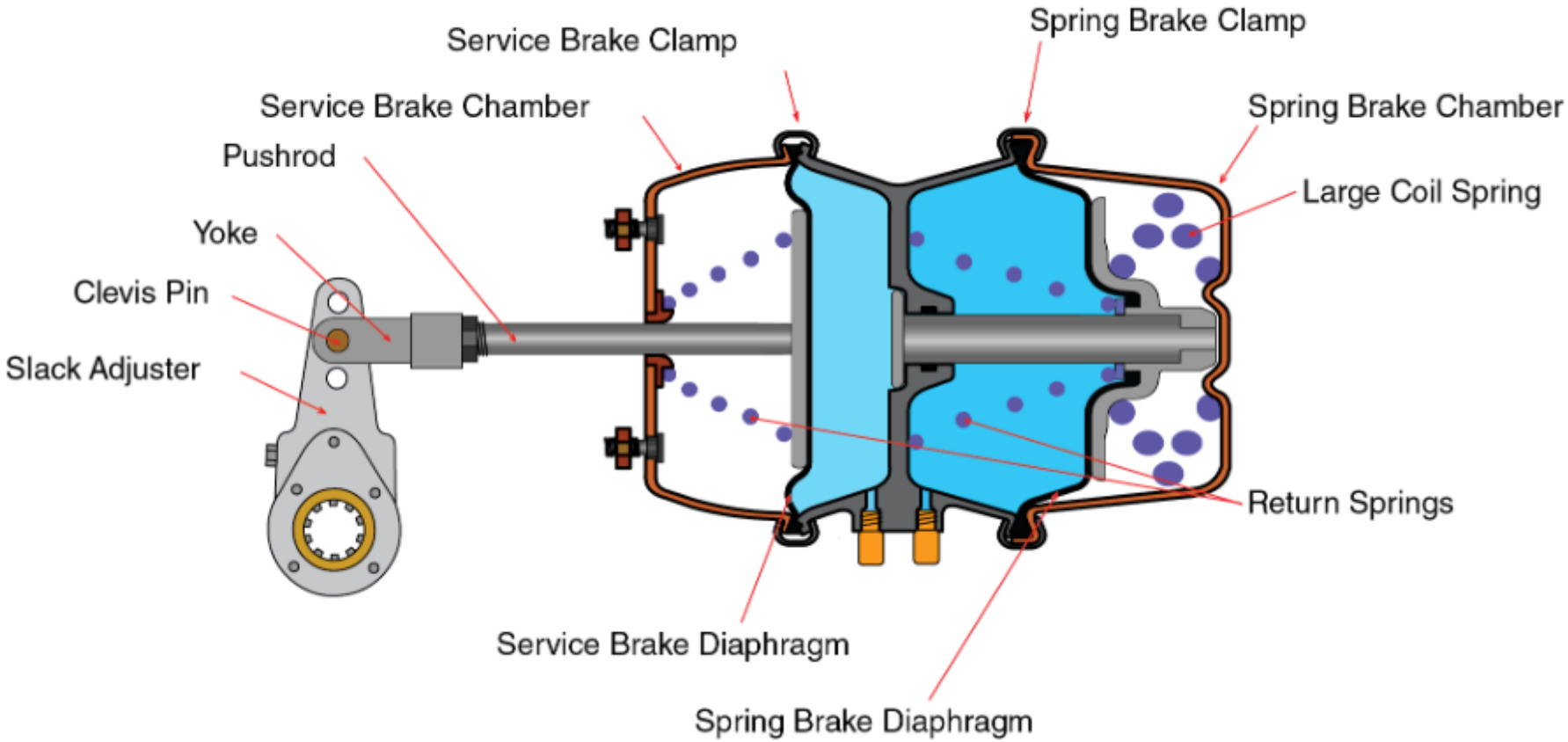
Air Brake Components: Air Dryer

- Located between the compressor and reservoir tank
- Filters with a desiccant that removes contaminants from the air
- Safety valve that prevents the pressure in the system from getting too high
- One-way check valve prevents air from traveling backwards from the tank to the compressor

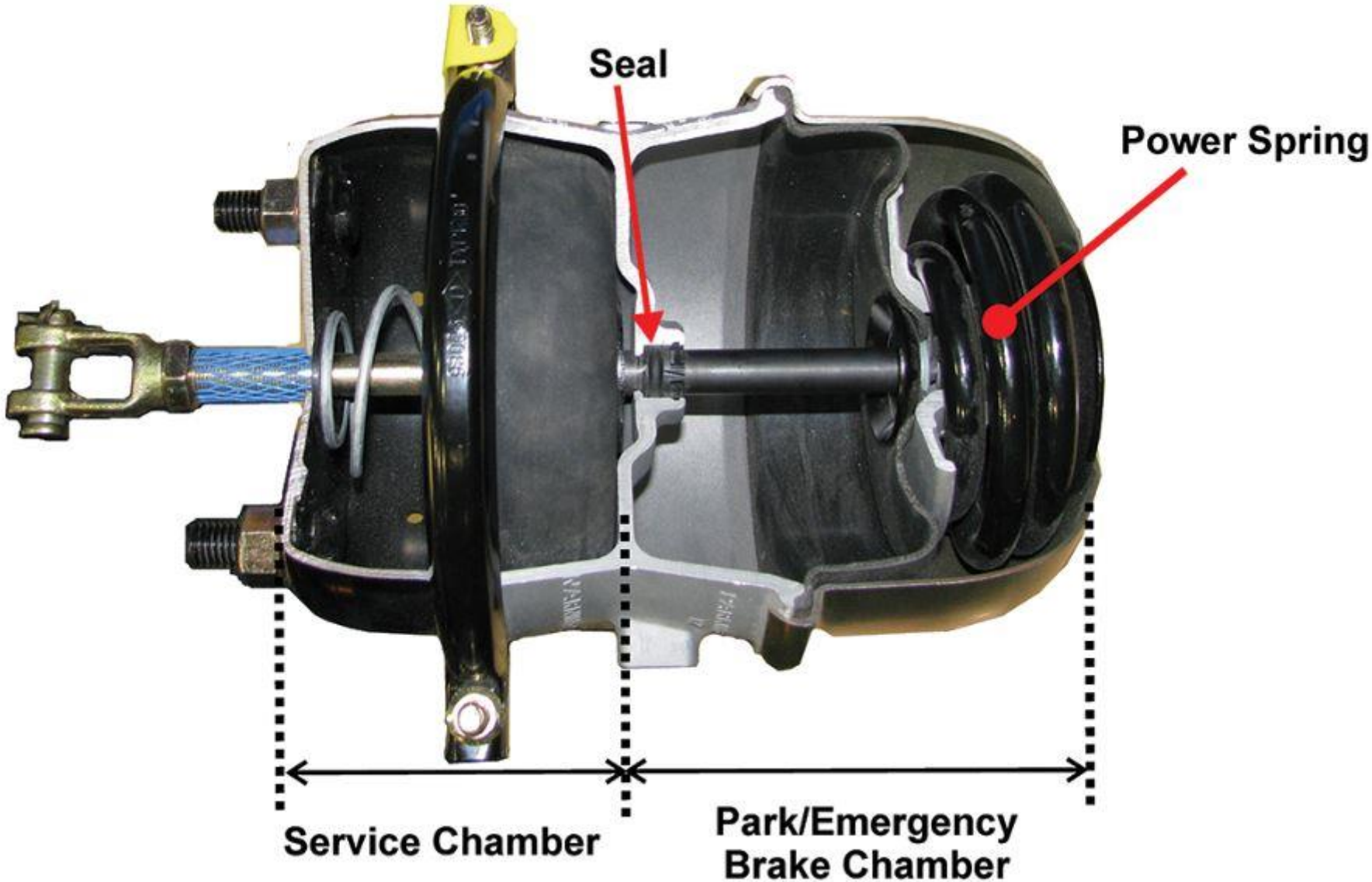

Desiccant
Perforated Plate
Oil Separator
Check Valve
Supply Port
Delivery Port
Control Port (from governor valve)
Dump Valve
Exhaust Vent

Air Brake Components: Braking Mechanisms

- Foot valve (brake pedal)
- Brake chambers are the components that convert air pressure into mechanical force
- Push rod connects the brake chamber to the braking mechanism
- Types of braking mechanism: drum brakes and disc brakes

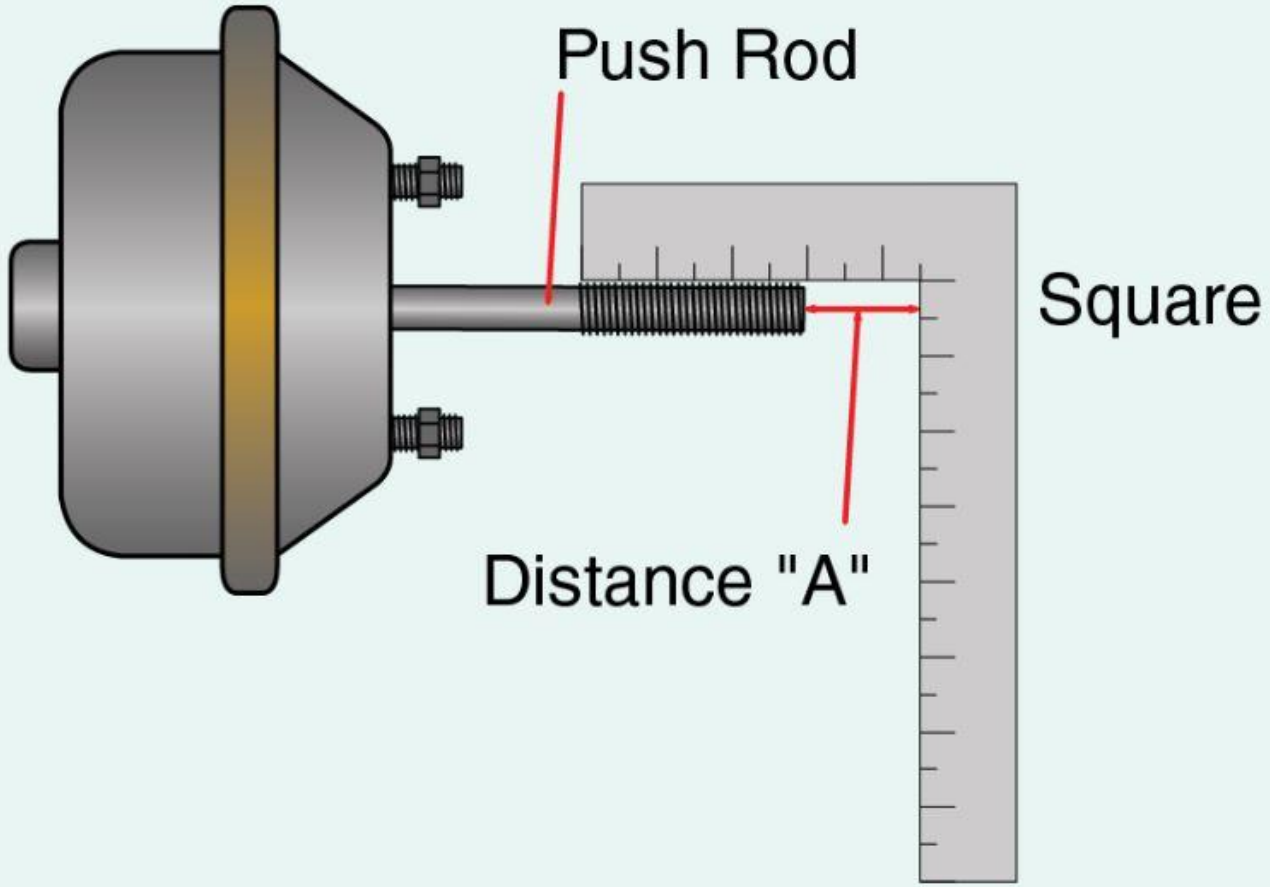

Service Brake Clamp
Spring Brake Clamp
Service Brake Chamber
Spring Brake Chamber
Pushrod
Large Coil Spring
Yoke
Clevis Pin
Slack Adjuster
Return Springs
Service Brake Diaphragm
Spring Brake Diaphragm

the truck/trailer or tractor if air pressure is lost.

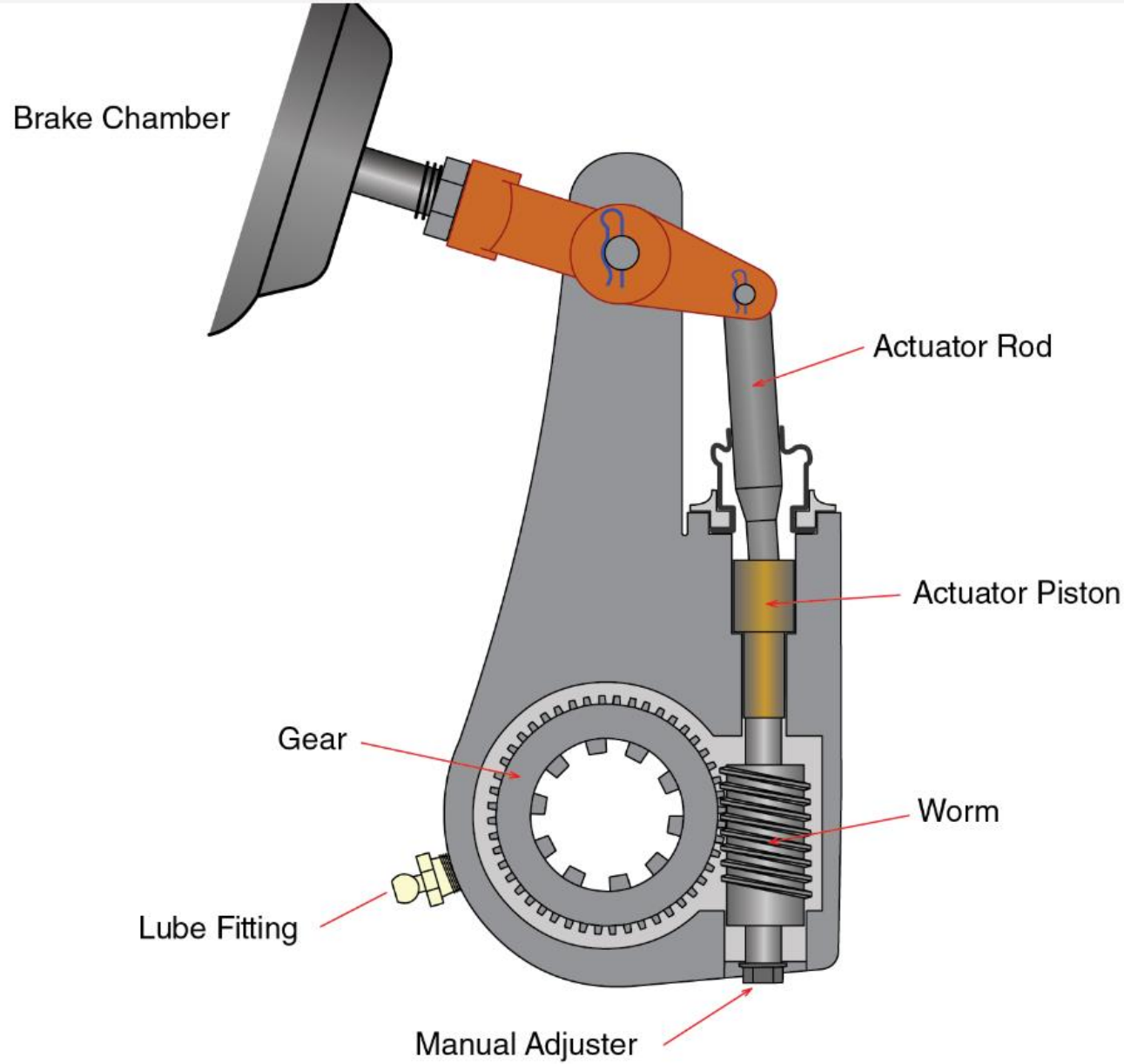


Air Usage	Compressor Duty Cycle	Example of Vehicle Type
Low Air Use 5 axles or less	Less than 15% (% of engine running time that the compressor builds up air pressure)	- Line haul single trailer without air suspension - Air-over-hydraulic brakes
Low Air Use 5 axles or less	Up to 25 %	- Line haul single trailer with air suspension - School bus
High Air Use 8 axles or less	Up to 25%	- Double/triple trailer. / Open highway Coach/RV / Yard/terminal jockey - Off highway / construction. - Concrete mixer / Dump truck / Fire truck, etc.
High Air Use 12 axles or less	Up to 25%	- City transit bus - Refuse truck - Bulk unloaders - Low boys, etc.

FIGURE 34-7 An air compressor's capacity must be selected to limit the cycle time (on/off time). Undersized compressors build air pressure too slowly and wear out prematurely.



Slack Adjuster Arm Length	"A" Std Quick Connector or Easy-ON Adaptor	"A" Extended Easy-ON Adaptor
5"	1 15/16"–3 1/32"	2 7/16"–3 17/32"
5 1/2"	1 15/16"–3 3/16"	2 7/16"–3 11/16"
6"	1 3/16"–3 1/16"	2 11/16"–3 11/16"



An example of a stroke-sensing ASA. When pushrod travel becomes excessive, the actuator rod lifts and rotates the slacks adjusting mechanism. While this slack can adjust for wear in brake foundation parts, it can also over-adjust when brake drums expand after becoming hot. These conditions cause the brakes to drag when the drum cools and contracts.

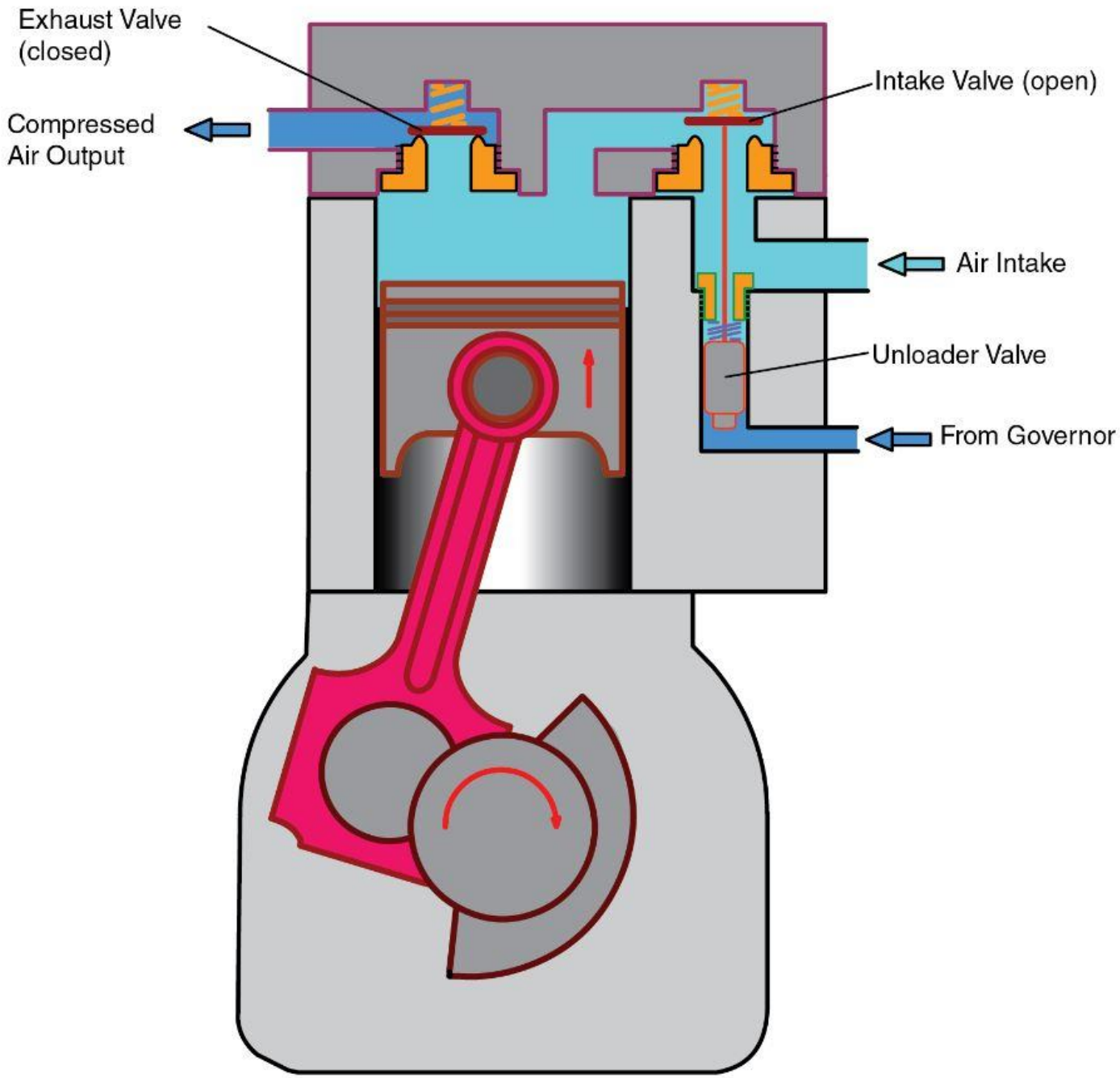


FIGURE 34-14 Supplying air pressure to the unloader valve forces the air inlet check valve open and

Gauges

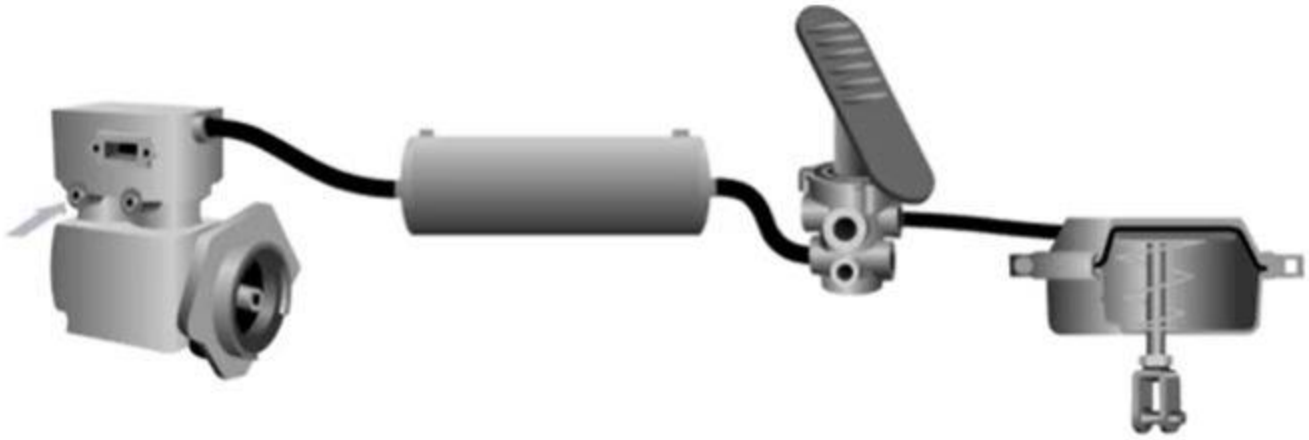
- Application pressure gauge measures the amount of air pressure applied to the brakes
- Air supply pressure gauge measures the pressure within the air reservoir tanks
- Low air pressure warning gauge is a requirement for any vehicle that uses air brakes, it displays a red light when the air supply pressure

Air Braking Process

Step 1

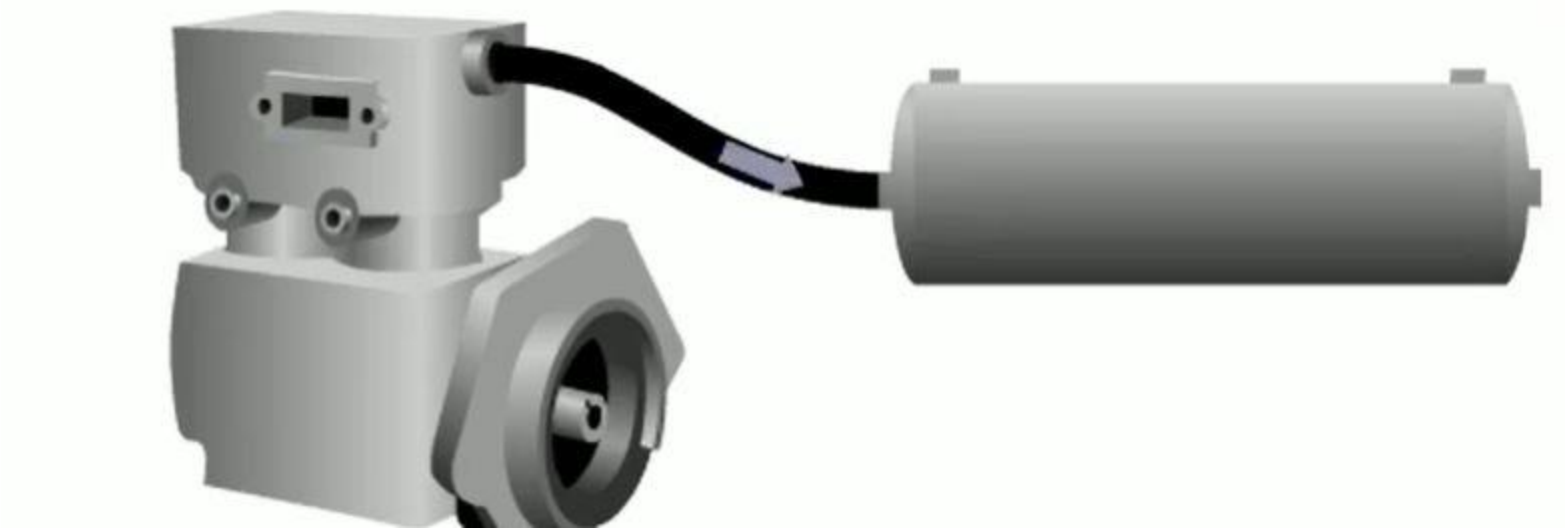
Introduction

When the brake pedal is pressed, a series of events take place to slow the truck.



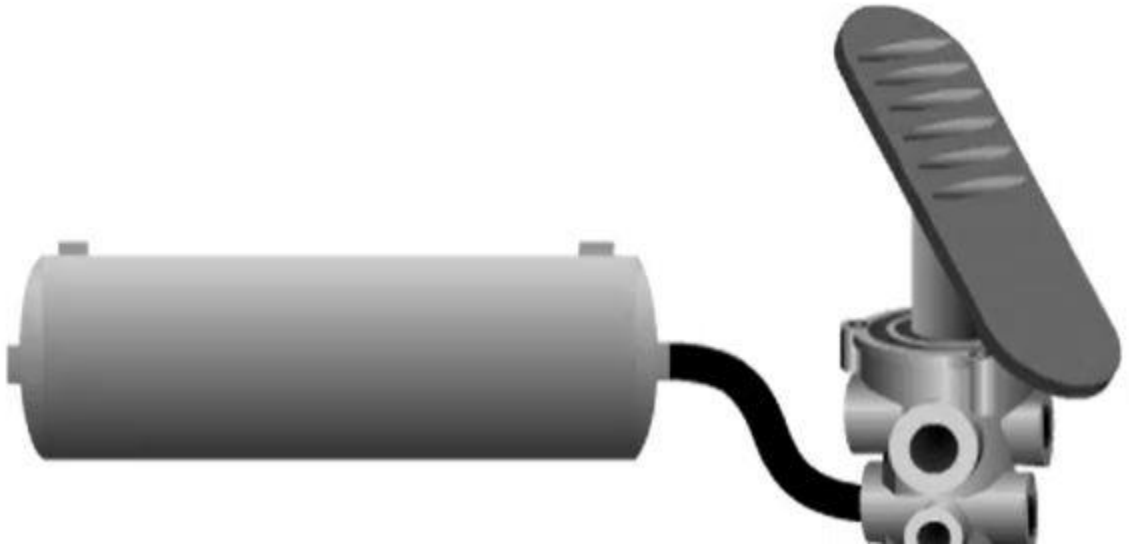
Compressor

First, the compressor must compress air to be stored in the reservoir tank. When not in use, the truck releases the air from the brake system, so the system must be charged to achieve the optimal air pressure.



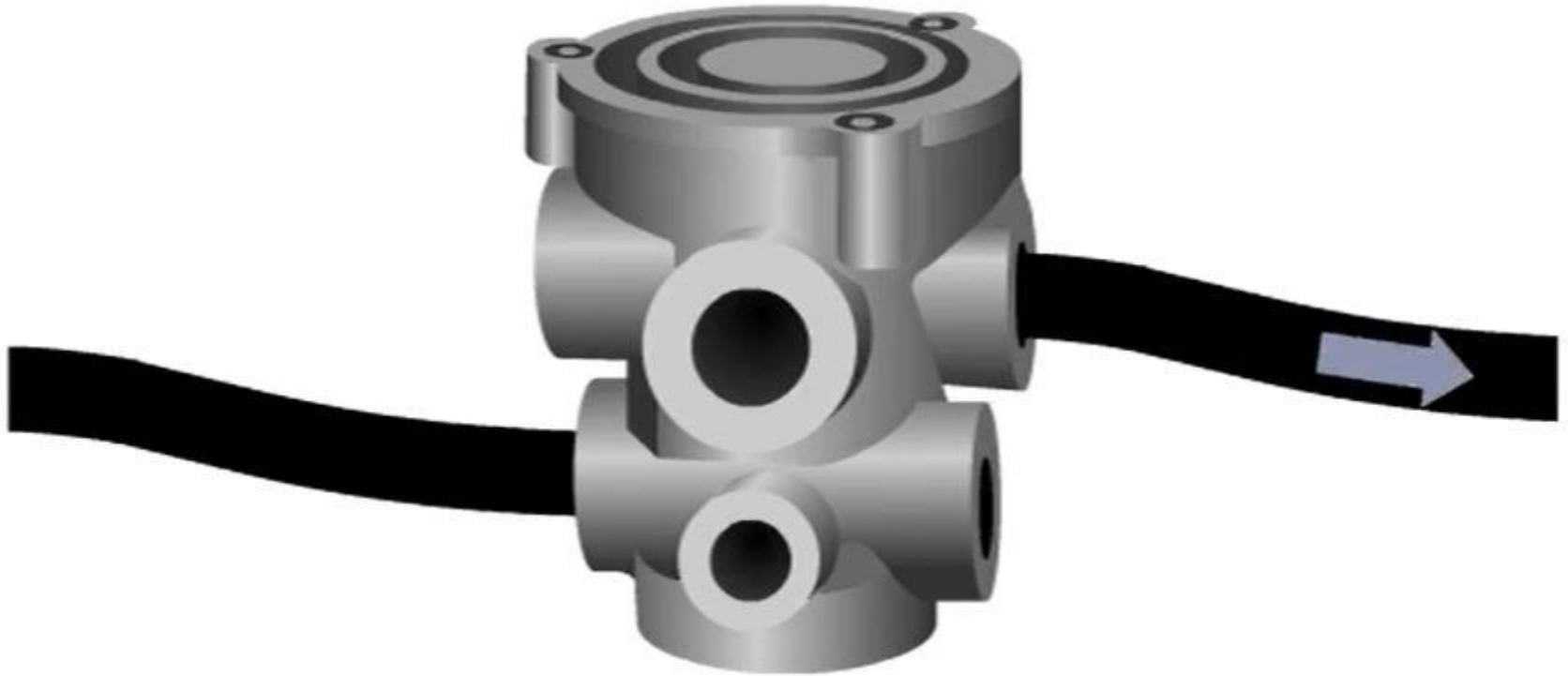
Brake Pedal Pressed

Once the system is charged, the service brakes can be applied by pressing down on the brake pedal.



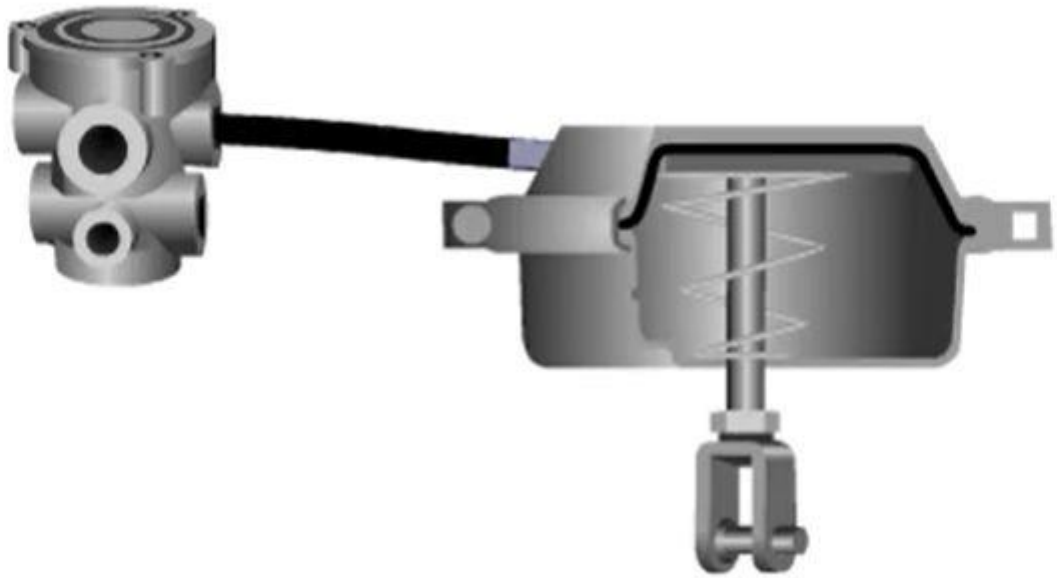
Foot Valve

When the brake pedal is pressed, the air travels through the brake-regulated foot valve from the reservoir tank to the brake chambers.



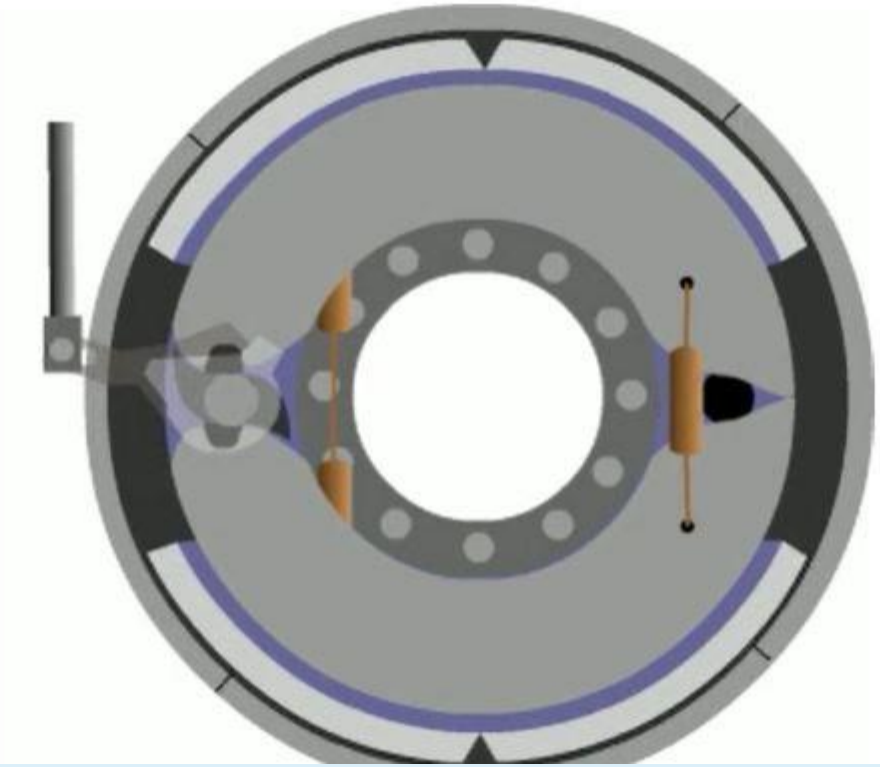
Brake Chamber

As air enters the brake chamber from the foot valve, the air pressure in the brake chambers moves the push rods outwards.



Braking Mechanism

The push rod activates the braking mechanisms and presses the brake pads against the rotors. This creates sliding friction that slows the vehicle.



Brake Pedal Released

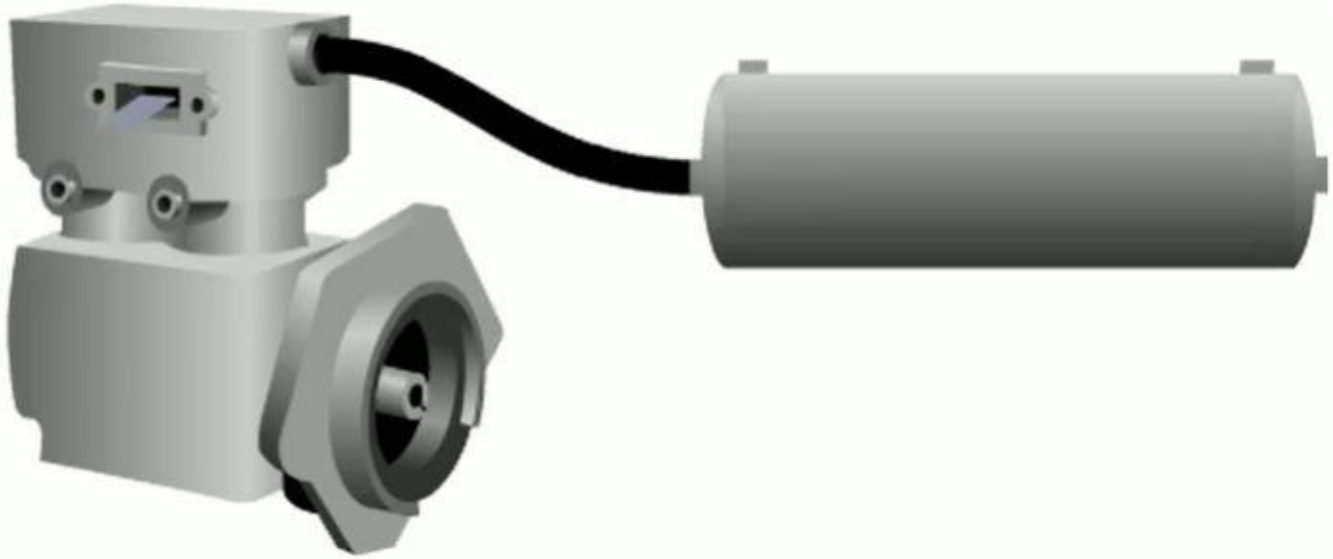
When finished braking, the brake pedal is released, resetting the foot valve.

Air Released

When the foot valve is reset, air is released out of the brake chamber. Since the chamber is no longer pressurized, the push rod is pulled back into the chamber.

System Recharged

More air is compressed by the compressor into the reservoir tanks to compensate for loss of pressure. The system is ready to brake again. If the brake pedal is applied and released too much and too quickly, the air will be released too fast for the system to keep the correct air pressure, and the service brakes will stop working.



Air System Accessories

Air ride suspensions

Air fifth wheel releases

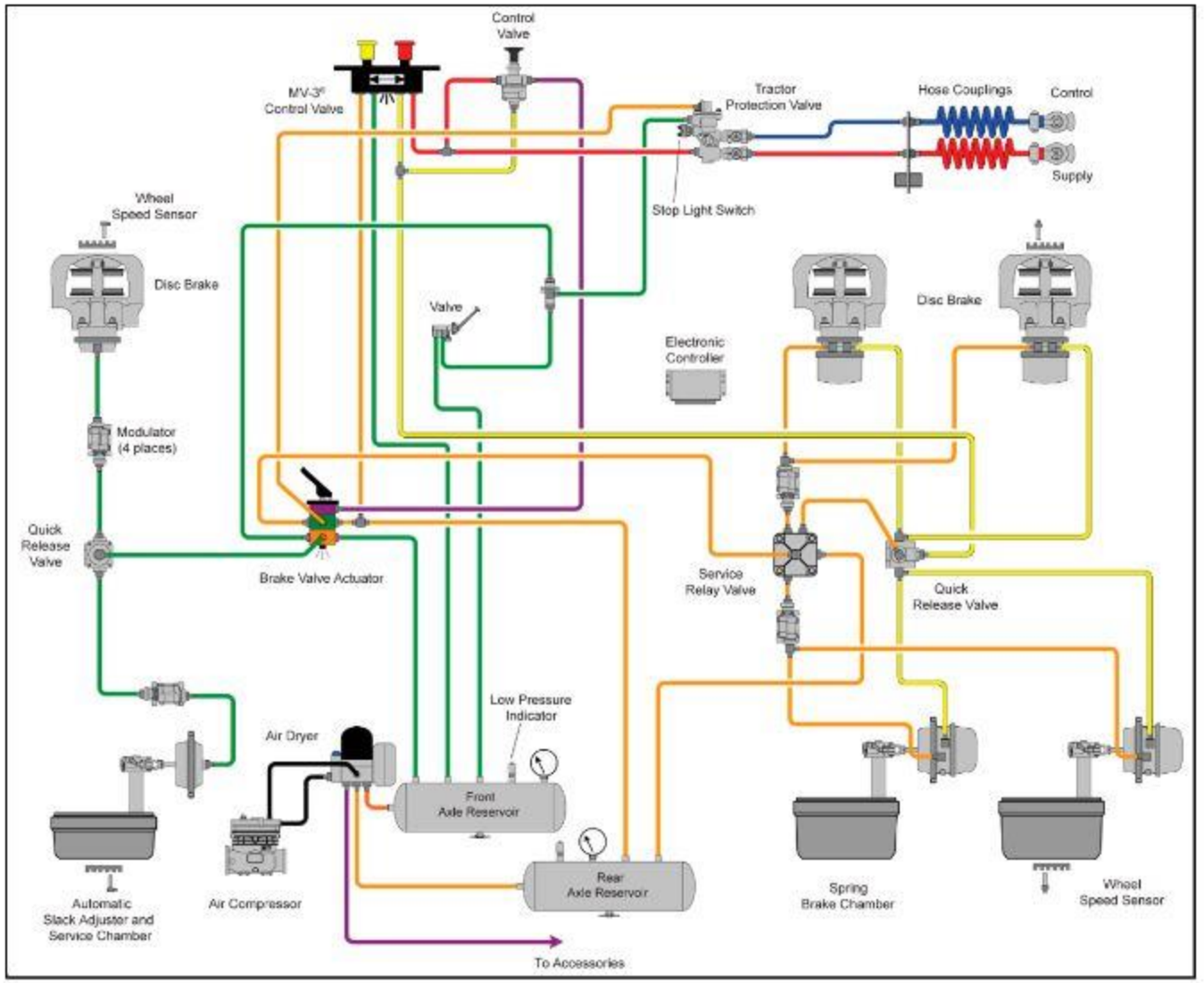
Air lift axles

Air horns

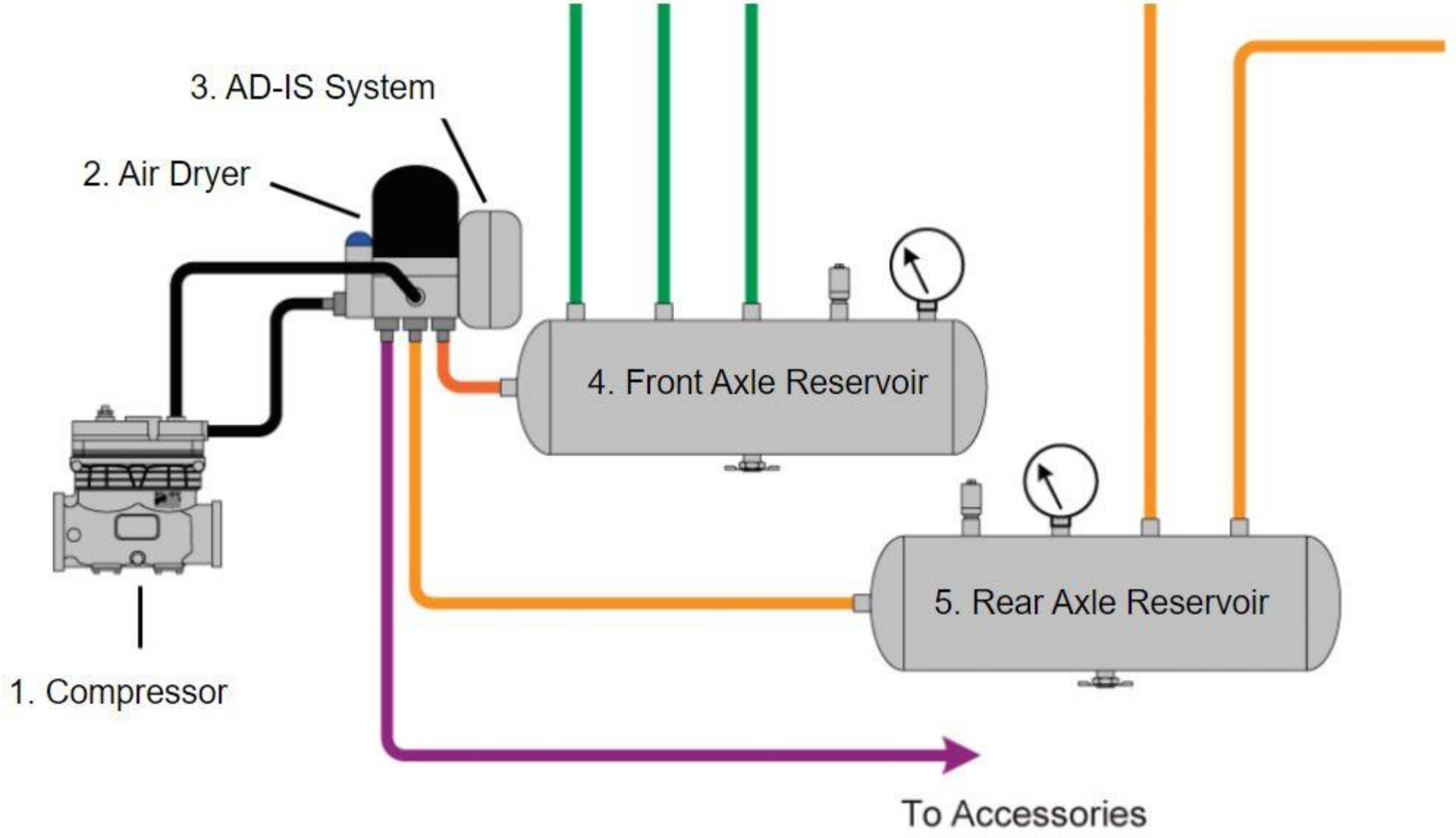
Air Brakes

- Control truck
- Slow or stop truck
- Hold truck stationary

Typical Air System

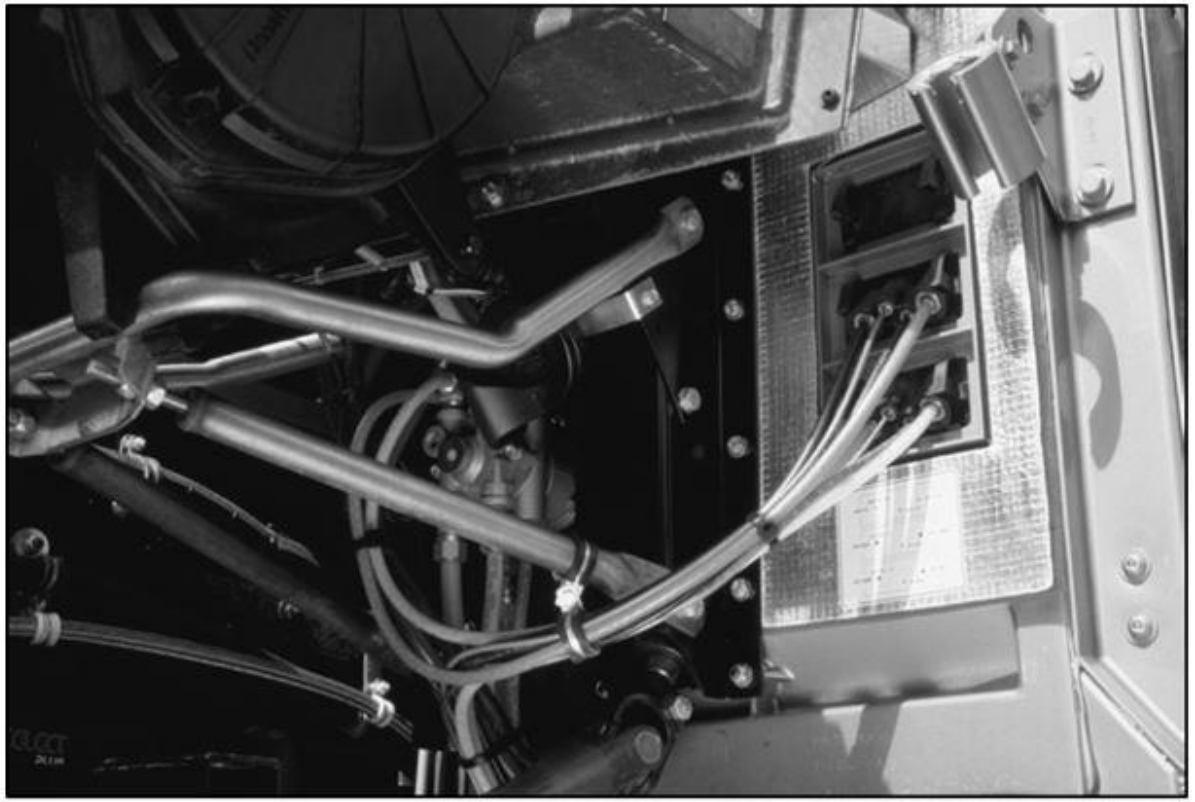


Air System Components



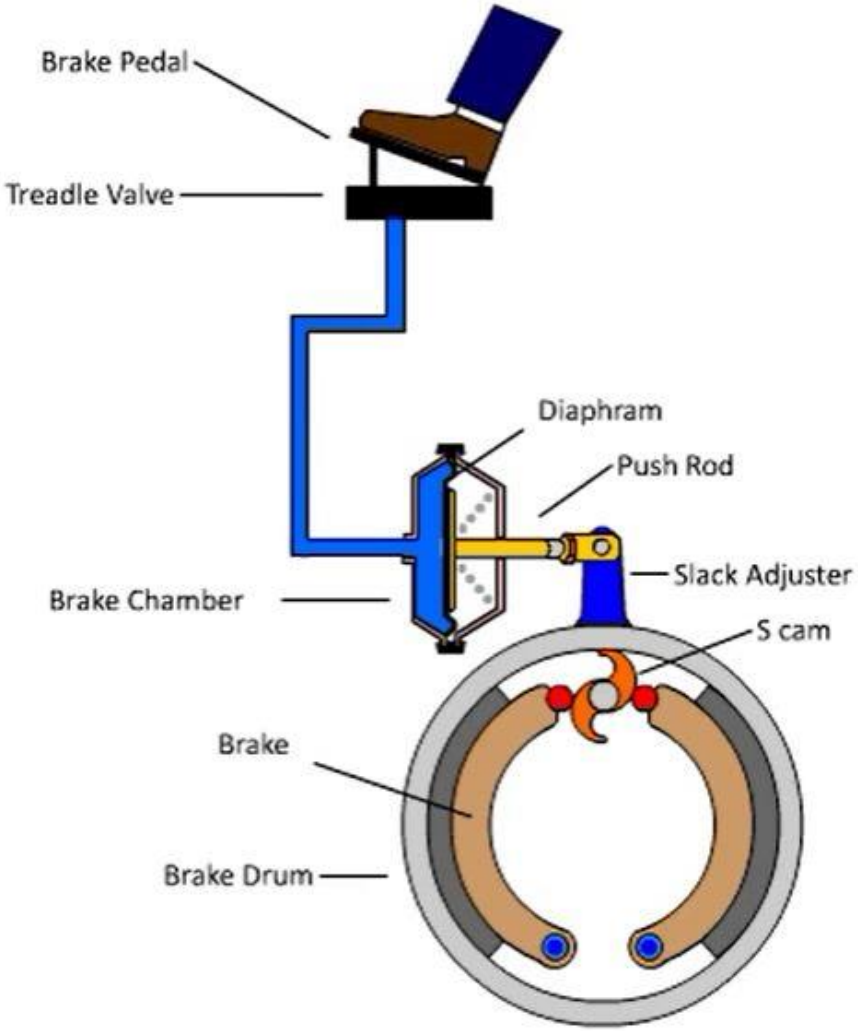
Air Systems Distribution: Manifolds And Piping

- Manifolds collect and distribute air to various systems
- Located on the engine firewall and behind the cab
- Air is distributed through the system using numbered and color-coded piping



Service Brake Operation

- The driver pushes down on the brake pedal, connected to a treadle valve. Air pressure fills the volume of the service brake chambers.
- The force of the air pressure in the brake chamber is multiplied when it pushes against a large diameter diaphragm that is attached to a push rod and slack adjuster.
- The force of the push rod is again multiplied as it pushes against the brake S-cam.

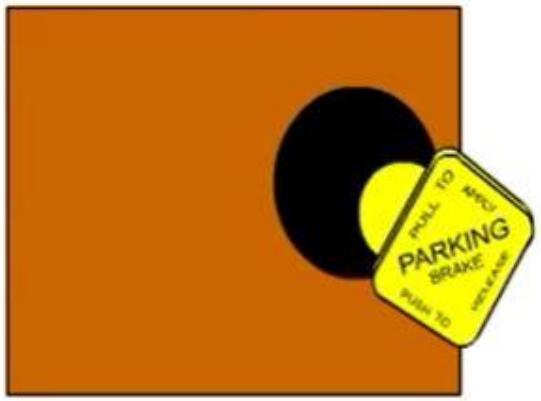


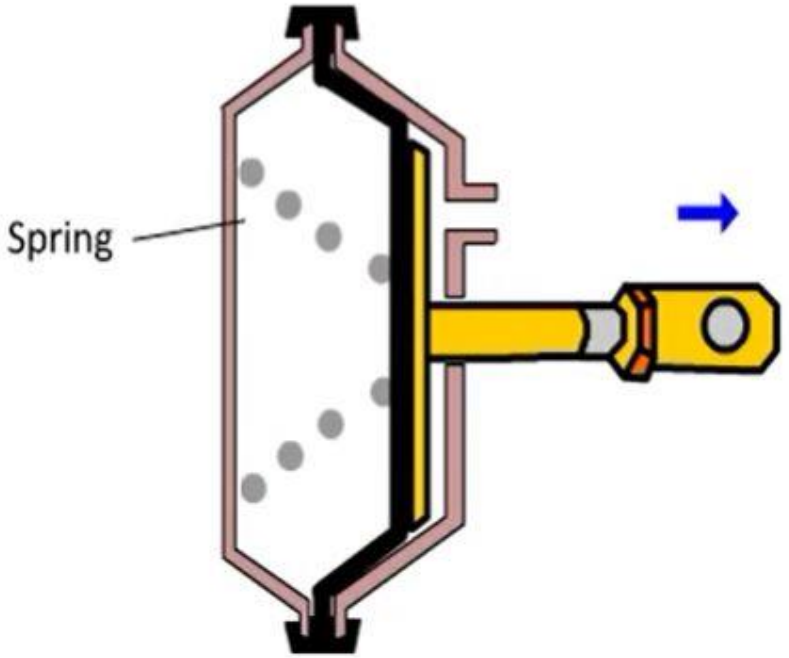
Emergency/Parking Brakes

- Fail-safe device
- Act as parking brakes
- Air pressure releases the emergency and parking brakes
- Parking valve has two controls: one for the tractor and one for the trailer

Emergency Brakes Operation

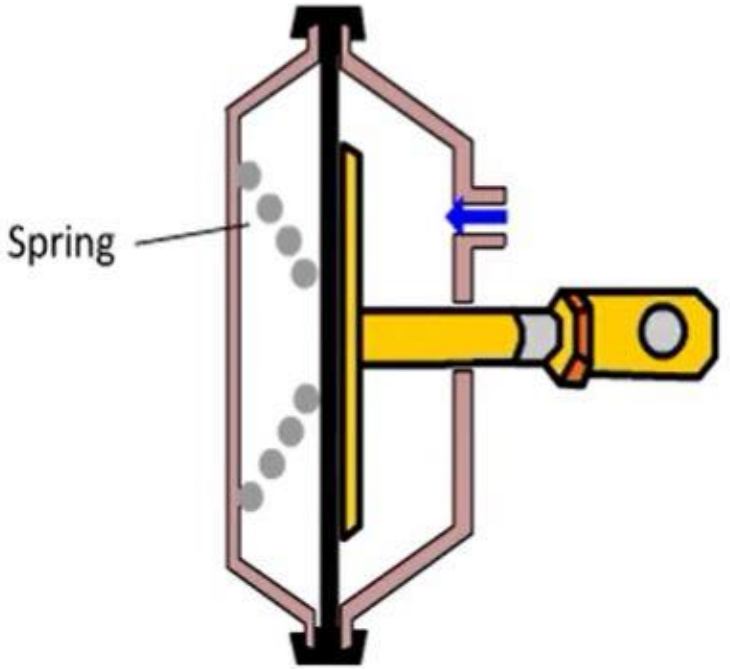
- Parking valve is pulled OUT; air is released from the spring brake chambers on the rear brakes. Inside the chambers, a powerful spring extends the push rod, applying the brakes.



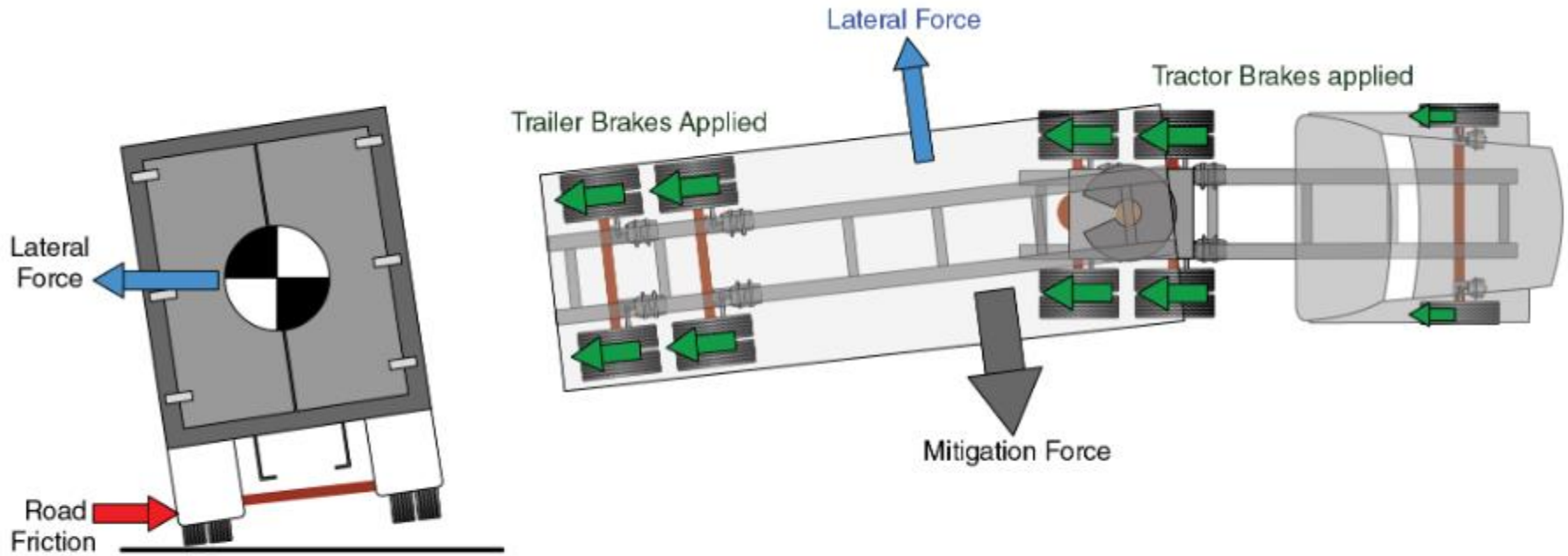


Emergency Brakes Operation

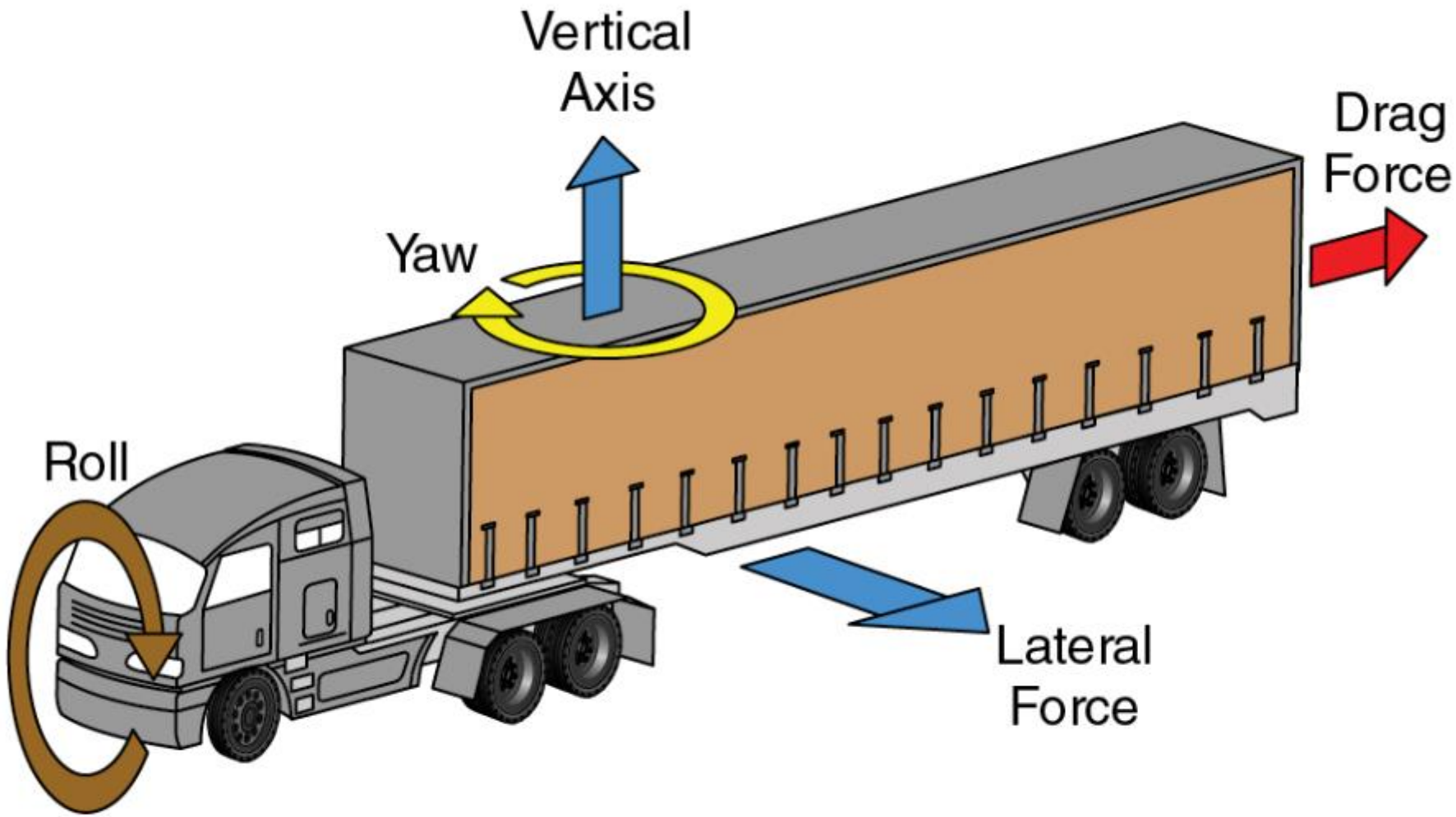
- Parking valve is pulled OUT; air is released from the spring brake chambers on the rear brakes. Inside the chambers, a powerful spring extends the push rod, applying the brakes.
- Parking valve is pulled IN; air flows into the spring brake chamber on the rear brakes and retracts the push rod against the spring, releasing the brakes.



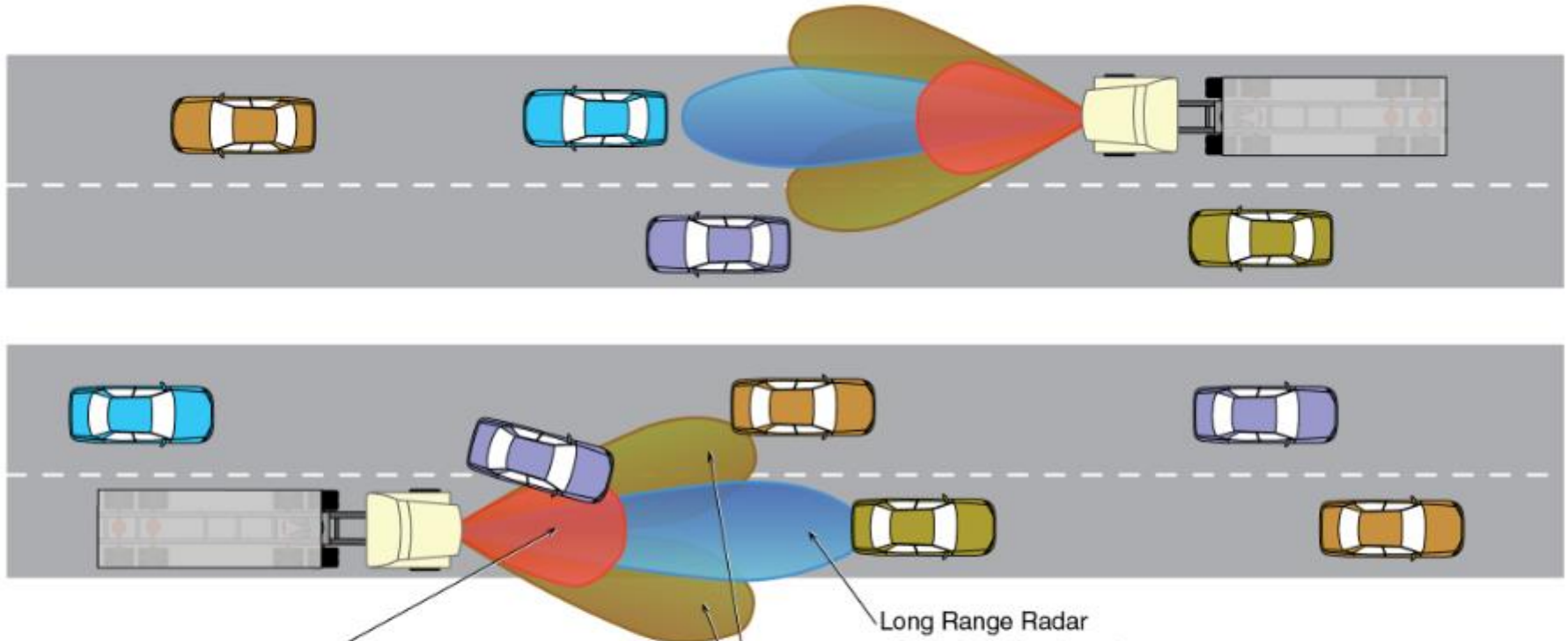
ABS/Trac Ctrl/ESC/ACC



By applying the trailer brakes and engine brakes, the vehicle speed is reduced to prevent a rollover.



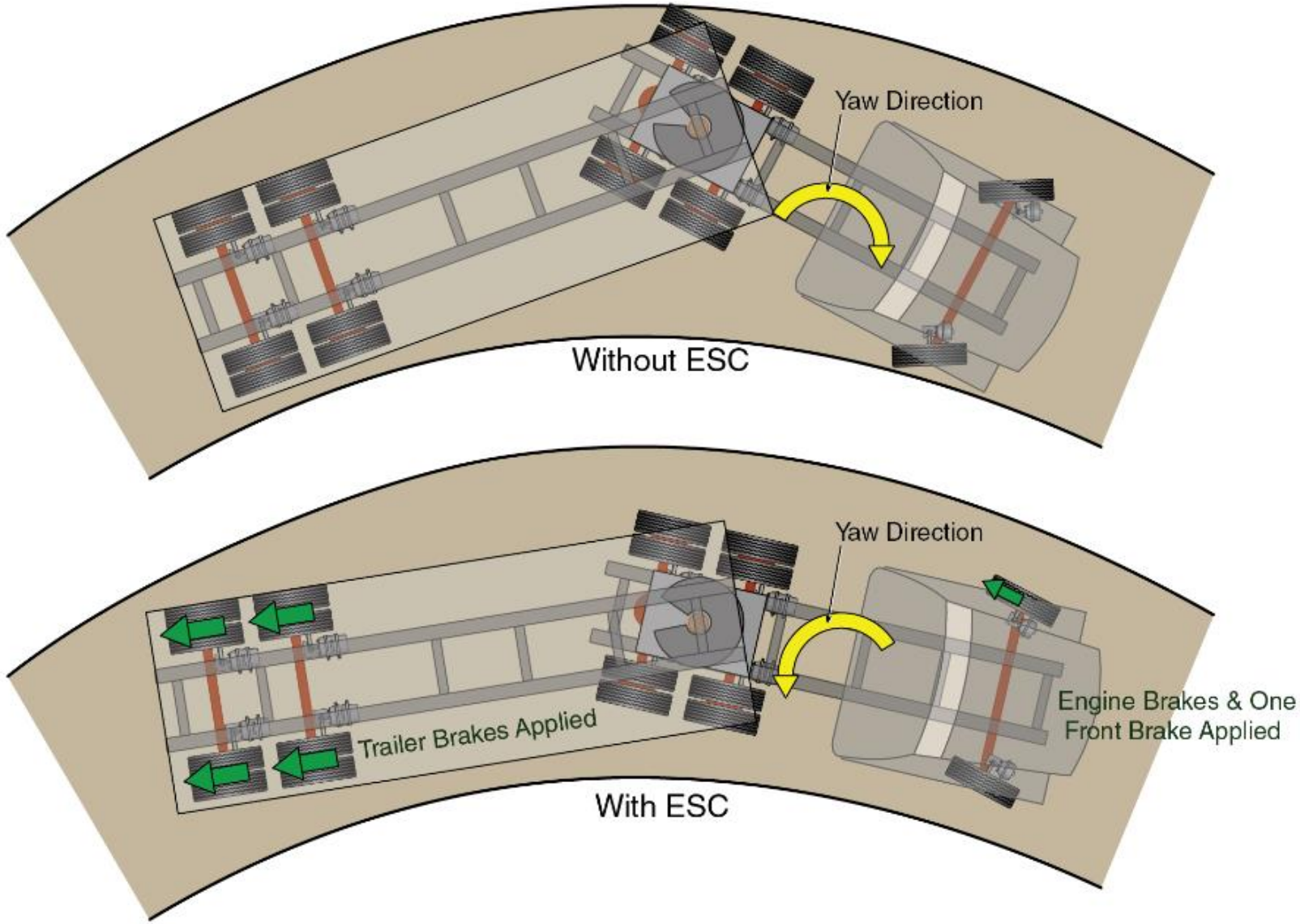
ESC can apply individual brakes at wheel ends to create a force reversing the tendency of an unstable vehicle to rotate around its center point.



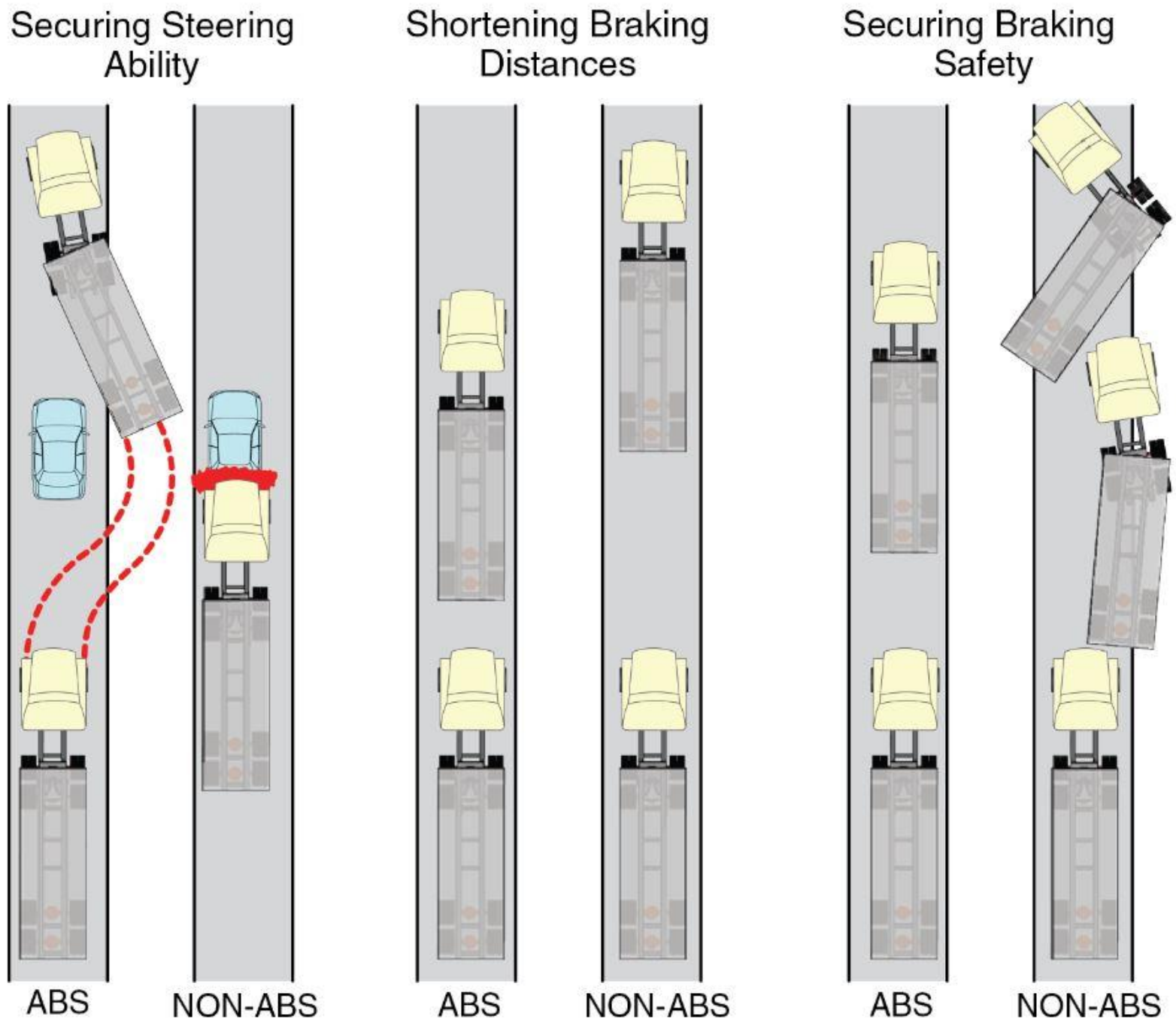
Short Range Radar
Helps to prevent imminent collisions
with moving and stationary vehicles.
- Driver alert, visual, audible and haptic signals.
- Direct intervention, active braking to stop the vehicle.

Long Range Radar
- Early identifaction of
potential rear-end collisions.

Medium Range Radar
Helps to prevent imminent collisions with moving and
stationary vehicles.
- Driver alert, visual, audible and haptic signals.
- Direct intervention, active braking to avoid impending collision.



Yaw rotation is a movement in the center of a truck or bus around its vertical axis. Excessive yaw force changes the direction the vehicle is pointing, moving it either to the left or right of its intended direction of travel.


Securing Steering Ability
Shortening Braking Distances
Securing Braking Safety
ABS
NON-ABS
ABS
NON-ABS
ABS
NON-ABS

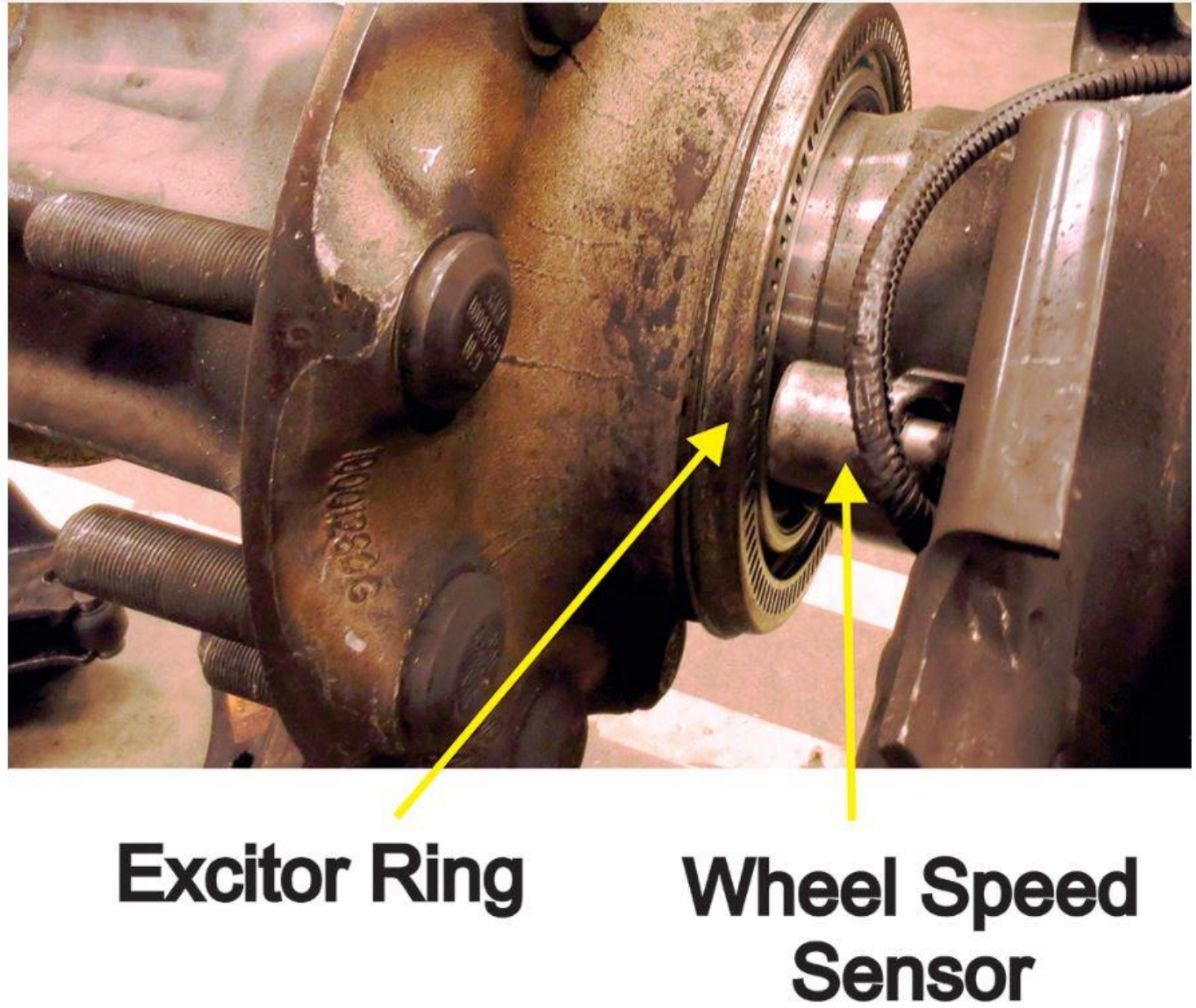
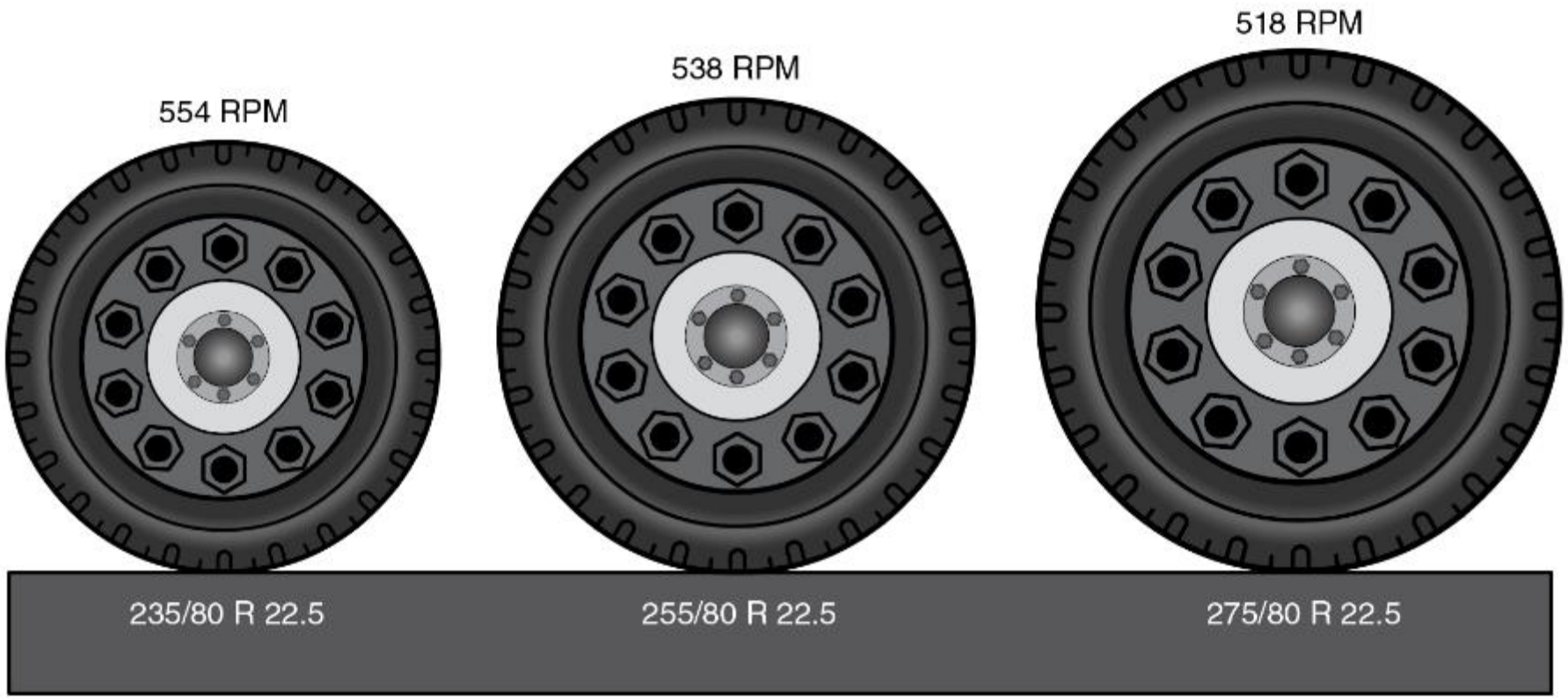
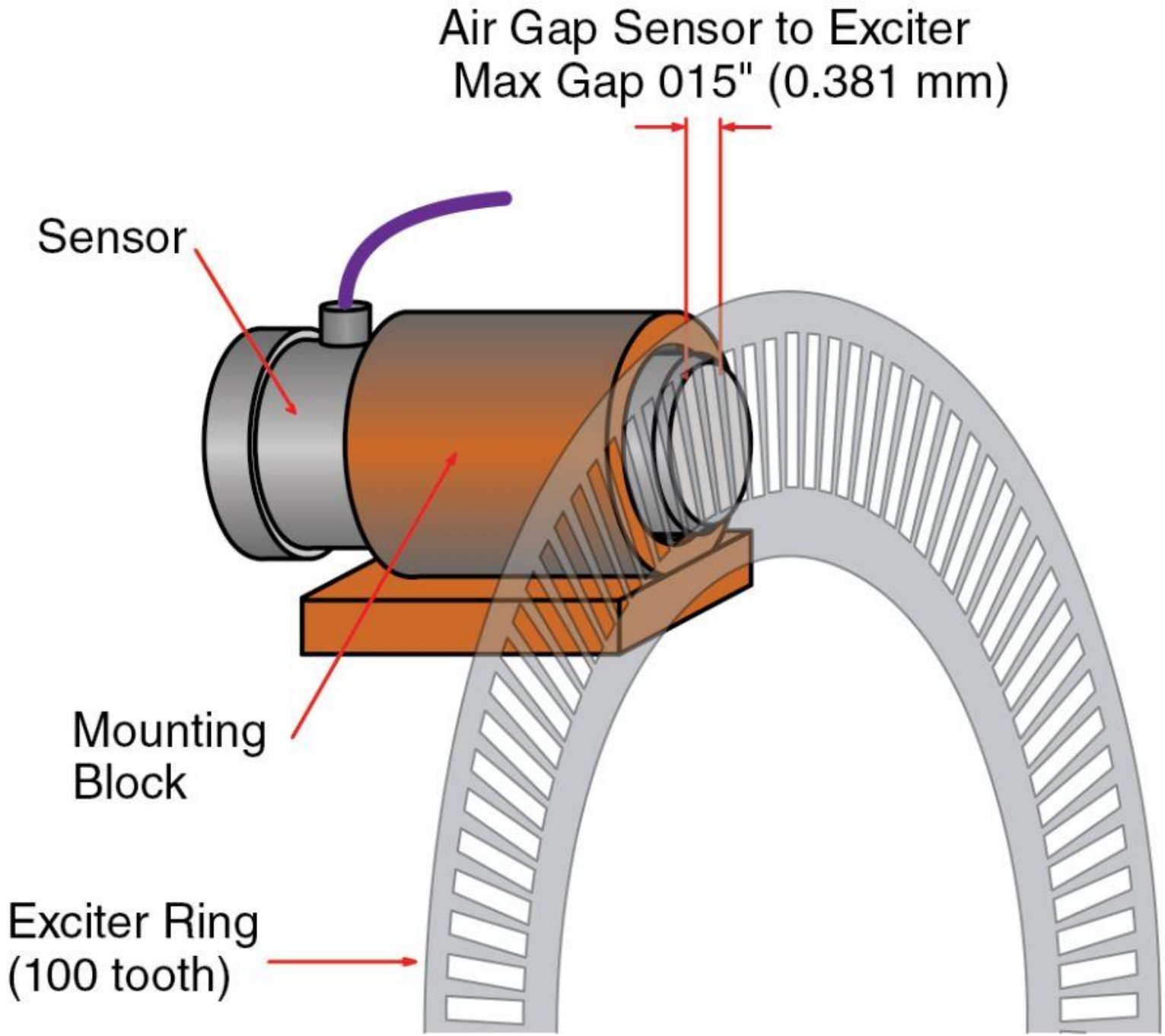


FIGURE 37-12 Wheel speed sensors are typically located on the axle hub and are either a straight or elbow-shaped design. Sensors use a variable reluctance-type design to generate an AC voltage. **A.** Wheel speed sensor. **B.** Wheel end reluctor or exciter ring.

Wheel Rotational Speed @ 62 mph (100 kph)



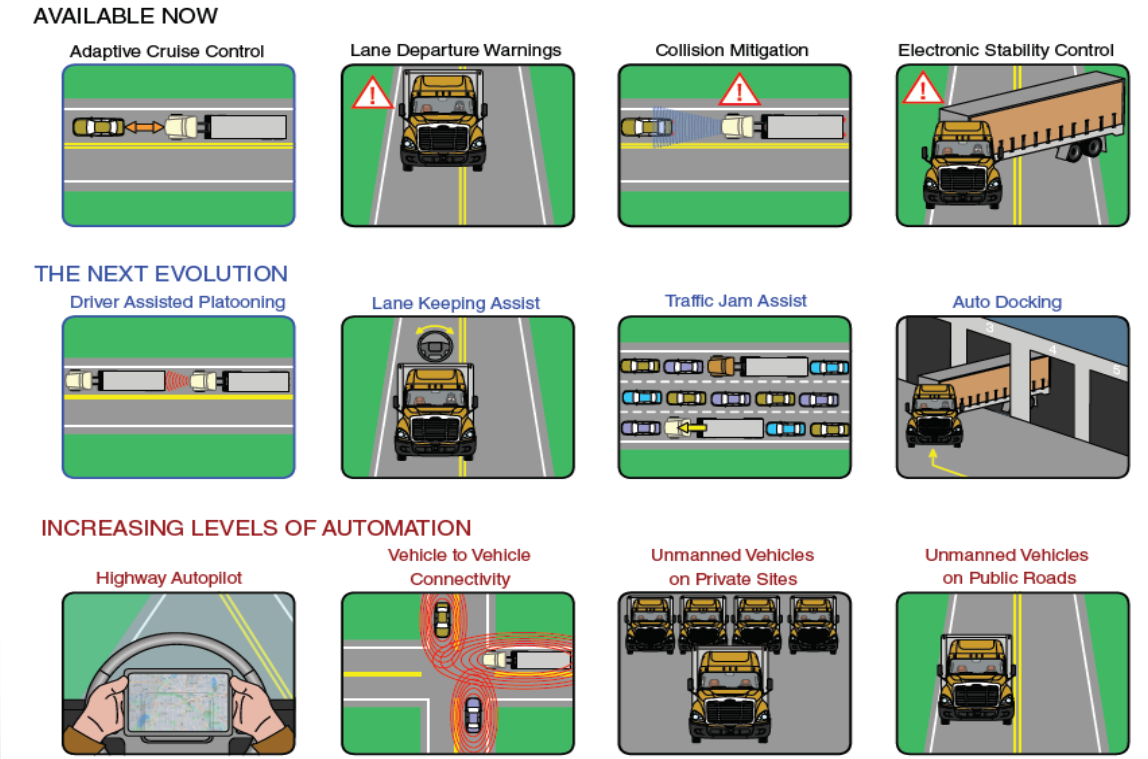
Tire size changes the number of sensor pulses per mile from wheel speed sensors. It is recommended that tires vary no more than 0.75″ (19.05 mm) diameter on 100 tooth reluctor rings.


Air Gap Sensor to Exciter
Max Gap 015" (0.381 mm)
Sensor
Mounting
Block
Exciter Ring
(100 tooth)


ABS Control
Solenoids

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Advanced Driver Assistance Systems (ADAS) or Advanced Driving Systems (ADS)
    - Current and future trends



The current state of ADAS and future direction of autonomous driving technology.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Examples of autonomous, self-driving capabilities
  - Collision avoidance, adaptive cruise control, and stability control systems
- Service and maintenance practices
  - Identify and explain the operation of the system elements in order to effectively diagnose and service these systems

This Mercedes Sprinter with ADAS uses switches on the steering wheel to engage either an advanced automated driving system or conventional cruise control.

A review operators' manual message. Before servicing ADAS, its normal operation needs to be understood to verify a complaint or determine whether the system is functioning normally.

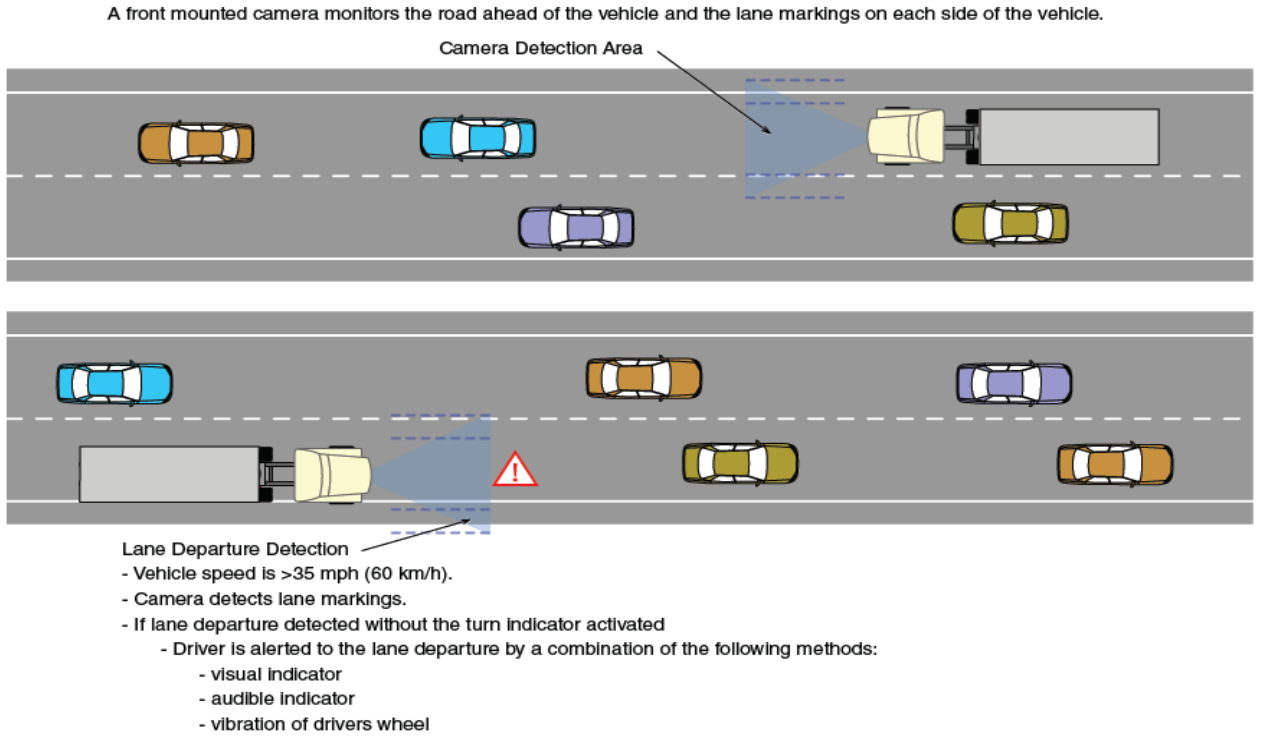
LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Fully automated vehicles have;
  - Advanced software combined with environmental sensors operate dynamic driving outputs, such as braking, steering, engine speed, powertrain, and safety system accessories.

This WABCO brake relay valve has electrical actuators to provide ADAS control or electronic control of the braking system by the autonomous driving system with mechanical control redundancy.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

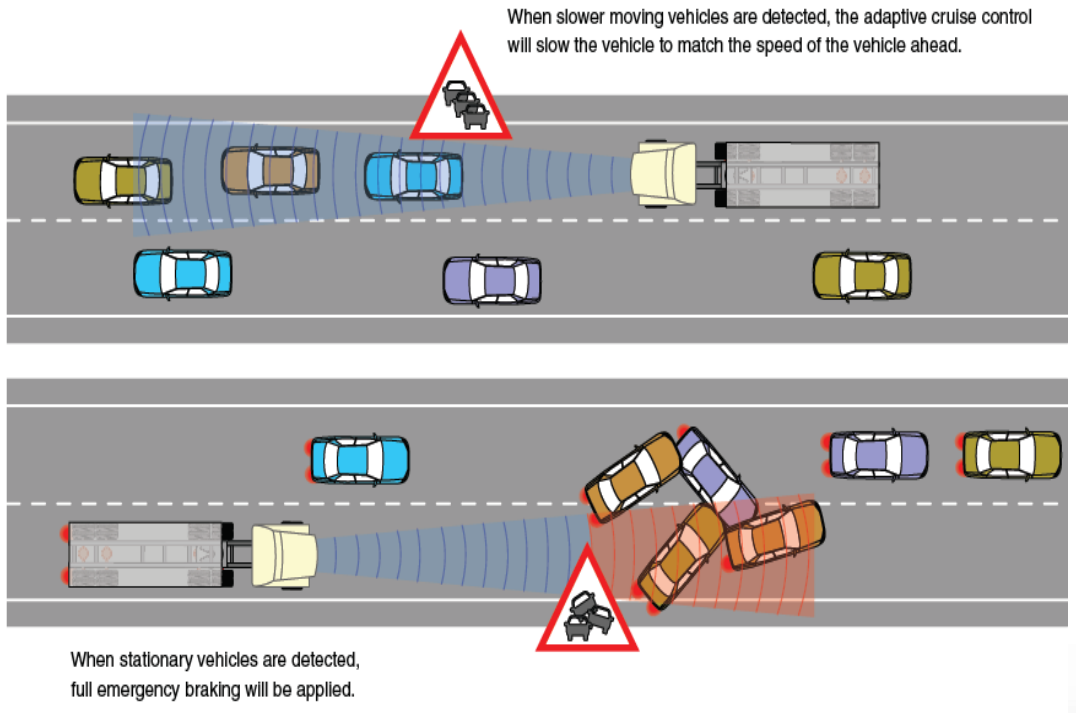
- Collision-avoidance systems
  - Faulty conditions may prevent safe automated system operation
    - May prevent trucks and buses from accurately identifying pedestrians and groups of people
    - Lane-centering systems can fail to recognize road markings or pedestrians and bicyclists, which can result in fatal contact



Lane-centering and departure-warning systems rely on a camera to identify lane markings, which are used to center the vehicle steering.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Automatic braking systems
  - The SAE J-3045 is a current standard that measures the effectiveness of automatic braking and lane-centering systems
  - Several radar-based automatic braking systems measure the distances and speeds of objects to warn the driver of an impending collision and automatically apply the brakes



The automatic emergency braking system applies the brakes when a collision is imminent. Several versions of this system are used with different marketing names.

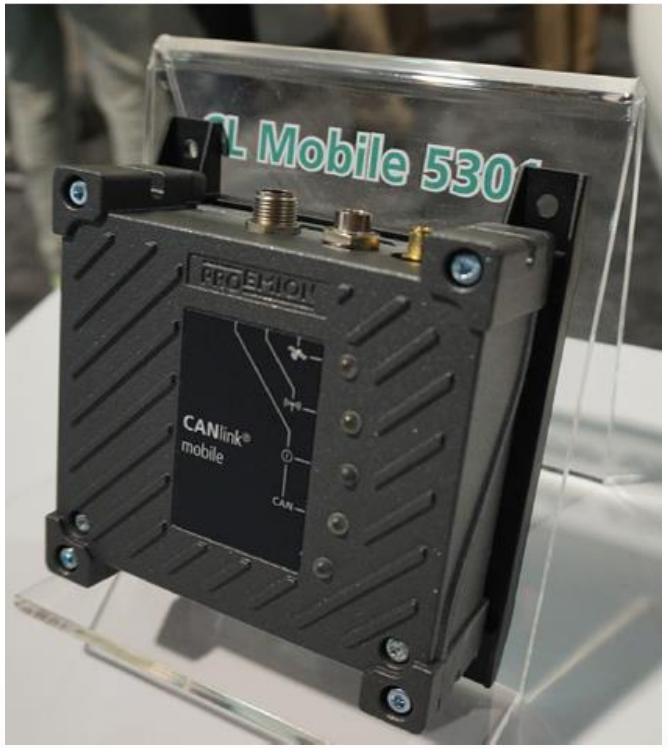
LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Telematics
  - The transmission and receiving of information from remote objects over cell phone or satellite communication networks

A cell phone module that connects the CAN to a mobile telematics network.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Telematics
  - CAN communication data, combined with global positioning system (GPS) signals capable of tracking and navigating equipment anywhere, is typically viewed through web portals after it's analyzed with special software applications



A CAN module that receives GPS signals and broadcasts them over the CAN.

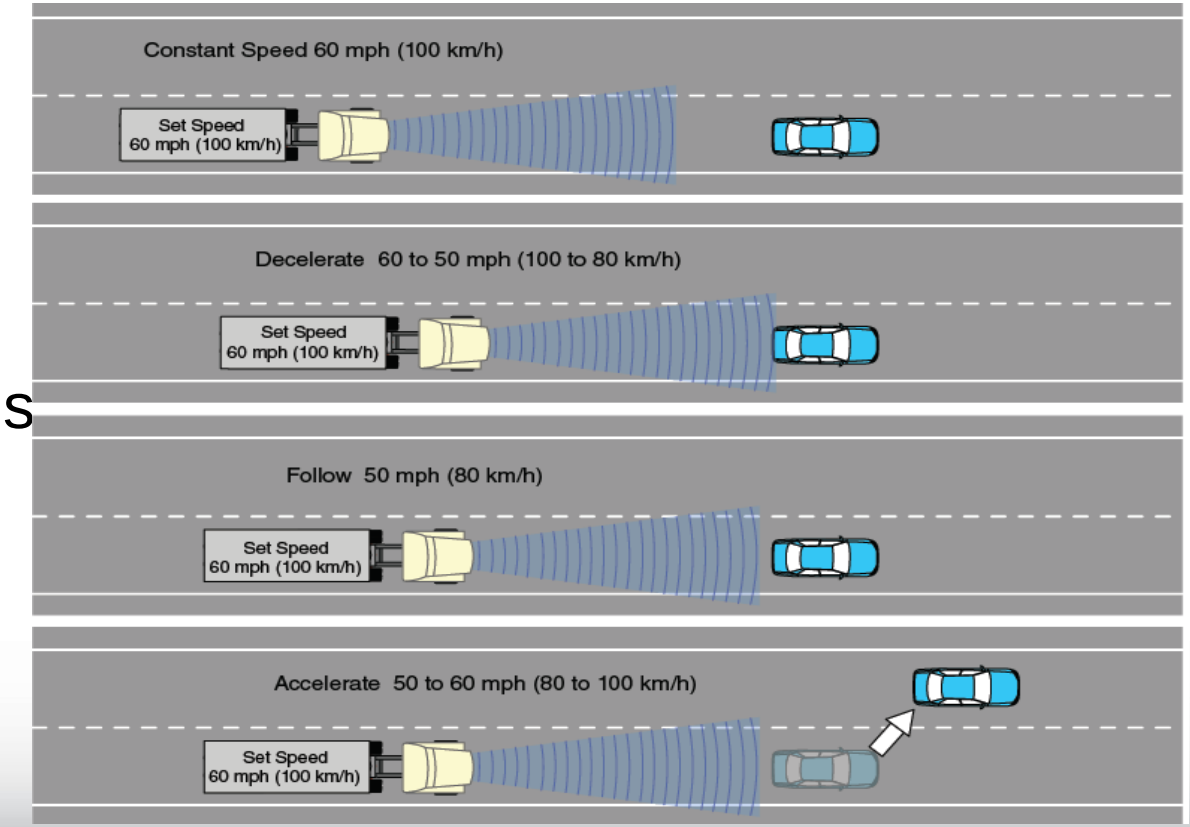
LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Telematics
  - Map data provided by GPS satellites provides drivers with improved situational awareness of the road ahead to help understand the type of driving conditions that can be expected, the presence of resources, such as fueling stations and rest stops, or whether to take an alternative route

GPS data supplies the vehicle map. Location is tracked by a telematics service provider.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

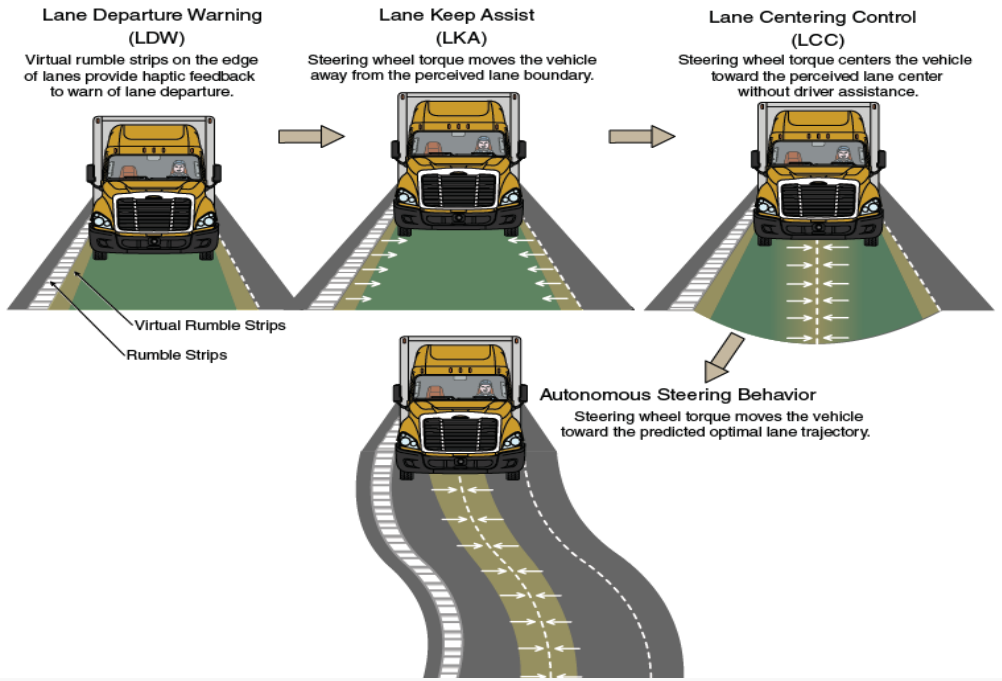
- Adaptive Cruise Control (ACC)
  - Uses front radar and cameras to help maintain road speed and safe driving distances
  - Traveling distance behind a lead vehicle is automatically adjusted to obtain a safe following distance
  - ACC can currently help achieve SAE Level 3 automated driving



Operating modes of an adaptive cruise control as an ADAS feature.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Lane Departure or Centering System
  - Uses cameras to identify road markings and center the vehicle in the road lane
  - Uses cameras and radar to warn the driver and prevent collisions if other traffic or objects interfere with the predicted pathway while changing lanes



Various names are given to lane-control systems that steer the truck to the lane center and warn the driver the truck is drifting from the lane.

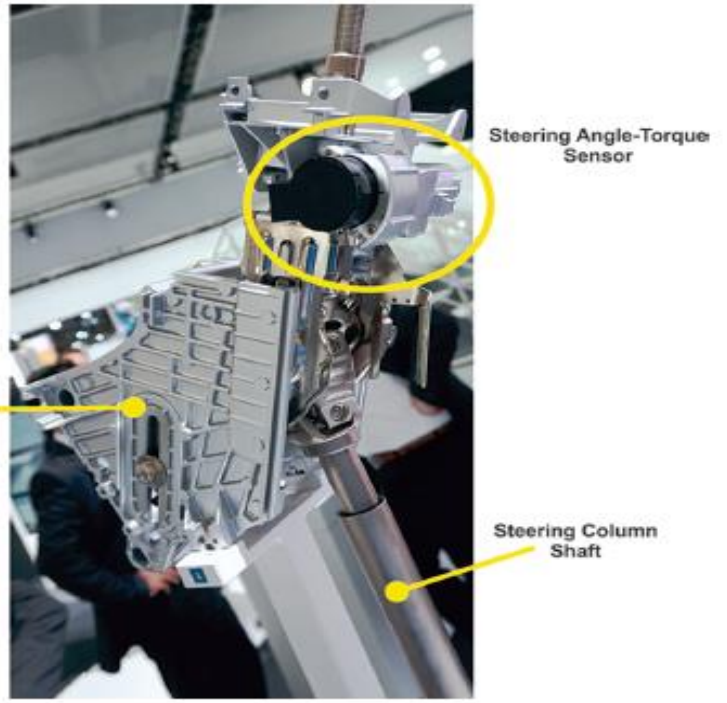
LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Autonomous Emergency Braking (AEB)
  - Uses radar and cameras as a collision mitigation or avoidance system to apply the vehicle brakes
  - Usually used with forward collision avoidance system
  - The service brakes or the park brake circuit may be activated by AEB

This SR-7 spring brake valve is configured to allow the AEB control system to electrically apply the spring or emergency brakes. Electric-over-air solenoids are on the Park and control port of the valve.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

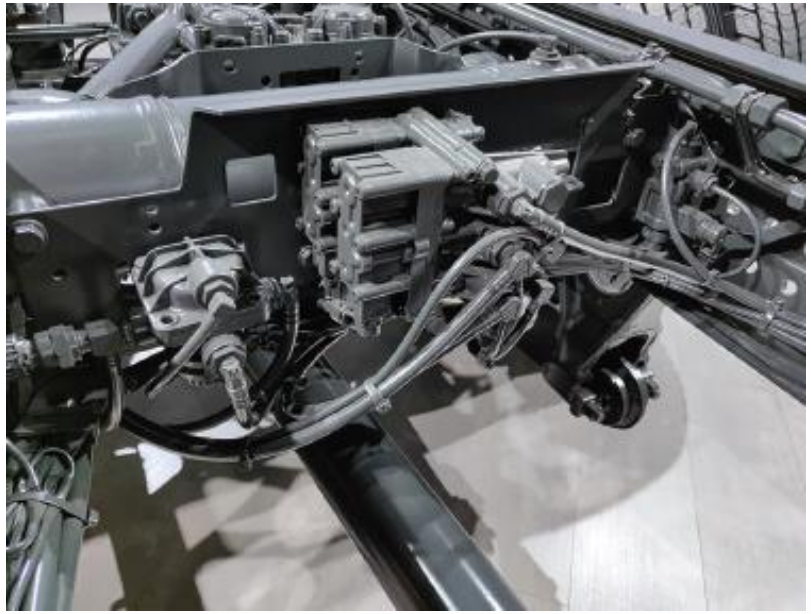
- Vehicle electronic stability control (ESC) systems
  - Added steering angle, YAW, and lateral acceleration sensors to the ABS system, along with more sophisticated control modules processing advanced algorithms



Adding a steering angle sensor enables new stability control capabilities when combined with ABS.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

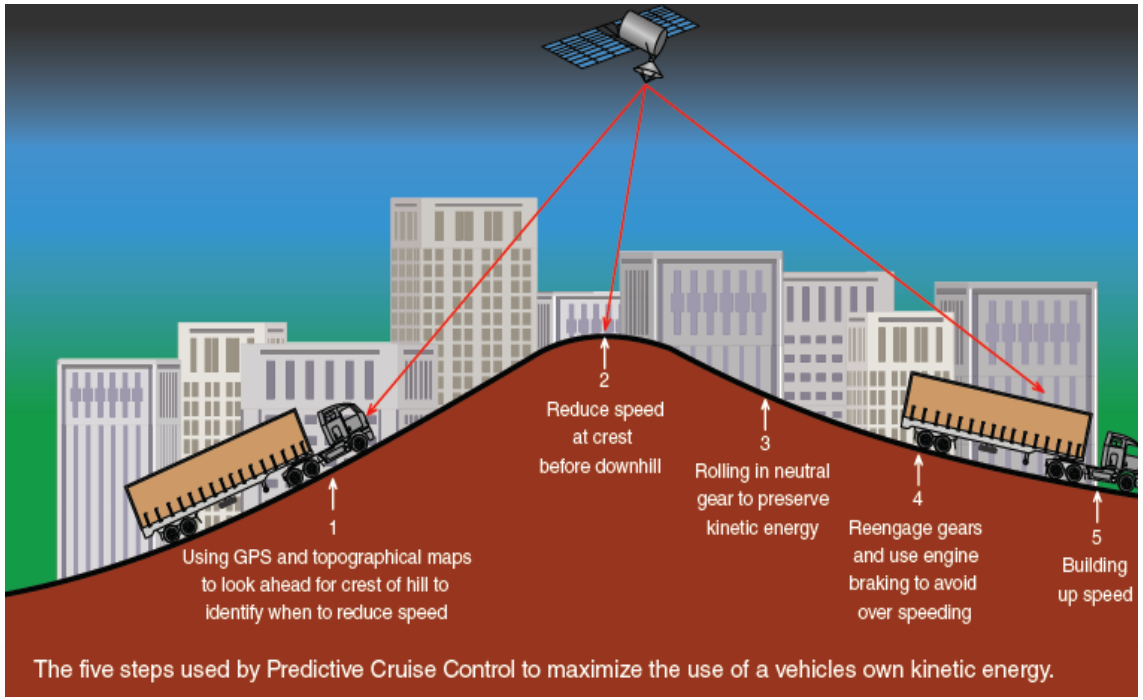
- ESC system
  - An ESC system that prevents loss of stability control, jackknifing, and roll-over accidents is an automatic intervention system that applies brakes on a straight truck, tractor, or trailer
  - ACC uses the radar to enable the driver to set the cruise control yet maintain a safe following distance



An advanced electronic brake system control module and valving on a European HD chassis. Also called ABS in North America.

LO 55-1 Identify and describe the current state of implementation of automated driving systems in commercial vehicles.

- Predictive Cruise Control
  - Using data from GPS maps, engine load, and tractor trailer weight, the control system calculates transmission shift schedules and new vehicle speed
  - Vehicle cruise speed is changed to allow acceleration before climbing hills to avoid downshifts
  - The vehicle arrives at its destination in the same amount of time after using less fuel

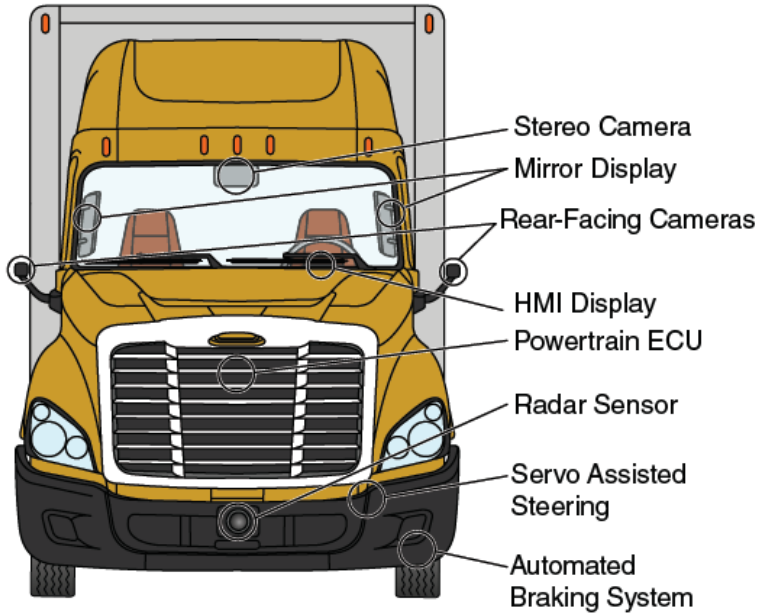


The five steps used by Predictive Cruise Control to maximize the use of a vehicles own kinetic energy.

Using GPS data to provide topographical information, the vehicle control systems can adjust vehicle speed and transmission shift schedules to improve fuel economy with no loss of travel time.

LO 55-2 Identify and describe autonomous control-enabling technologies.

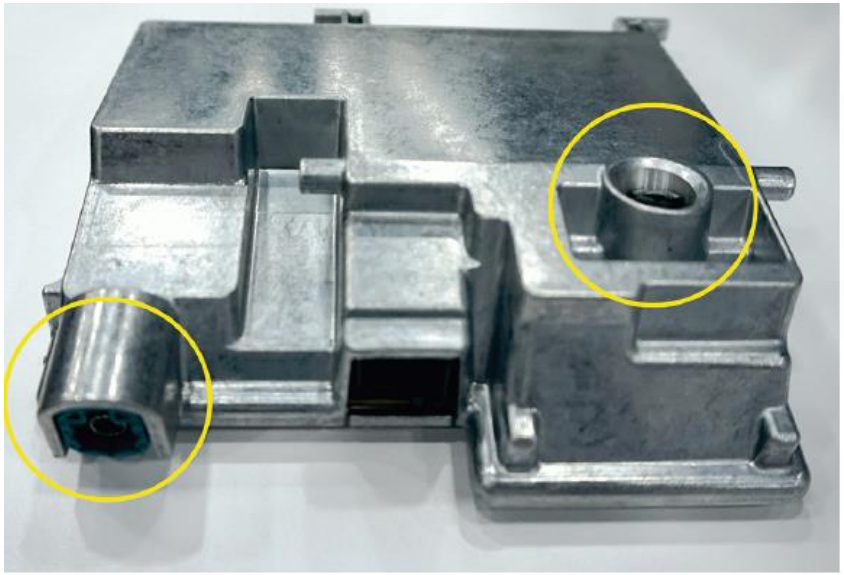
- Variety of vehicle sensors support ADAS
  - High-Definition Cameras
  - RADAR
  - LIDAR
  - Satellite Global Positioning Systems (GPS)



Locations of critical ADAS and automated driving system sensors.

LO 55-2 Identify and describe autonomous control-enabling technologies.

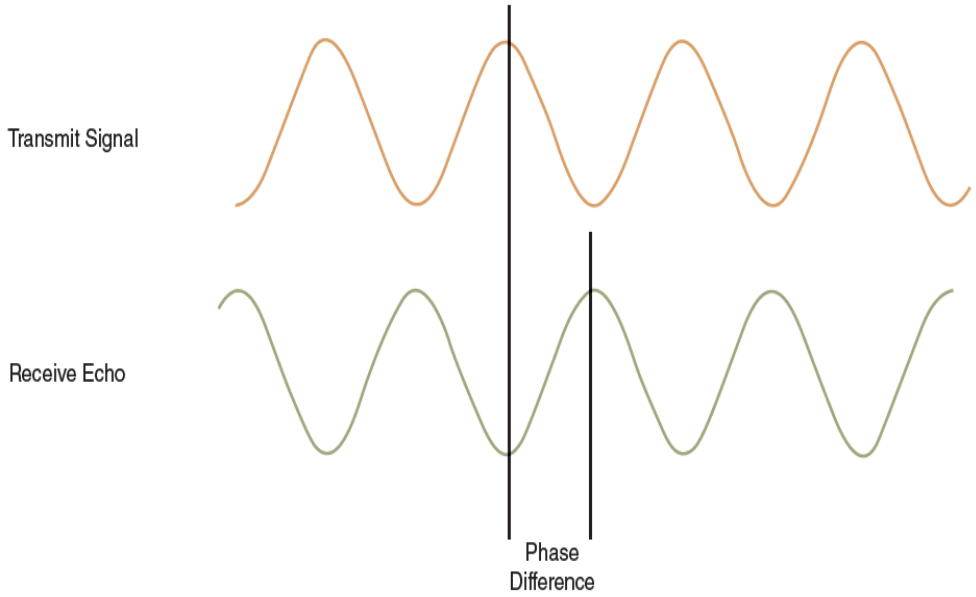
- High-Definition Cameras
  - Have one to two megapixels sensors capable of low-light level image detection
  - They read road signs, identify lane markings for lane detection systems, and combine their images with a radar system to identify objects
  - Distance estimates require the use of two cameras



A dual-lens camera in an image processing unit. In this image, one lens monitors the road, the other monitors the driver.

LO 55-2 Identify and describe autonomous control-enabling technologies.

- Radio Detection And Ranging (Radar)
  - An object detection system that uses radio waves to determine the range, angle, or velocity of objects
  - Can be used for either short-range or long range object detection



Radar bounces radio waves off objects and measures how much time it takes before they return to estimate object distance, size, and speed.

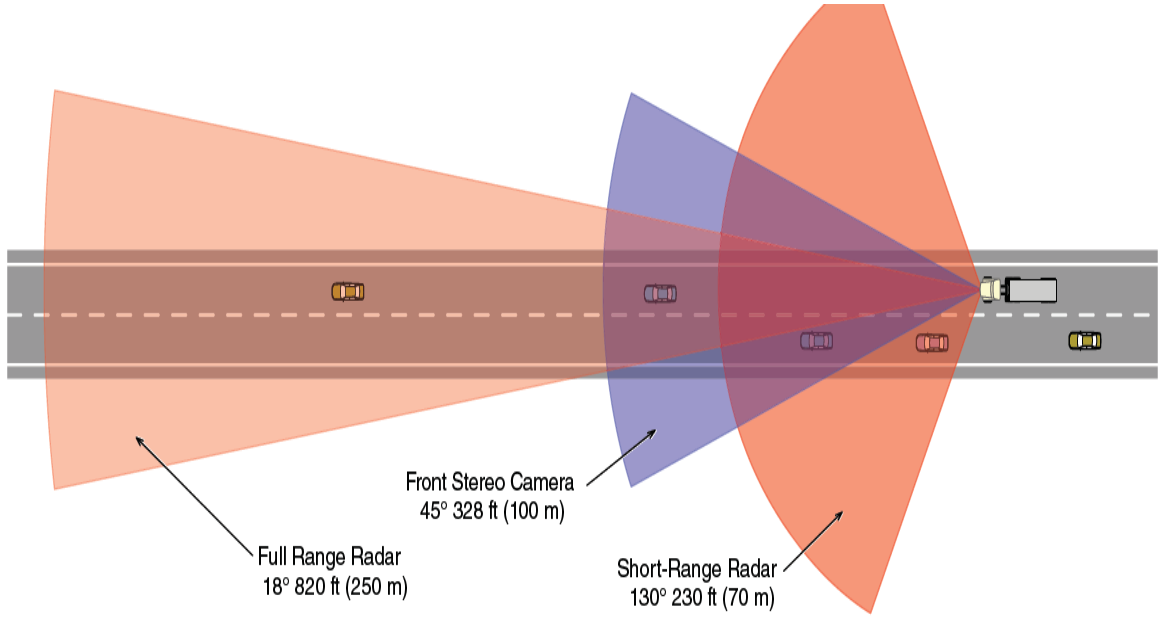
LO 55-2 Identify and describe autonomous control-enabling technologies.

- Front Radar
  - Radar transmitters and receivers, which are combined in a single unit, are located in the front and side of the vehicle to monitor traffic
  - Short-range object detection (24 GHz with better image resolution) or long range detection (77 GHz)

Front radar transceivers for a variety of heavy-duty trucks and buses.

LO 55-2 Identify and describe autonomous control-enabling technologies.

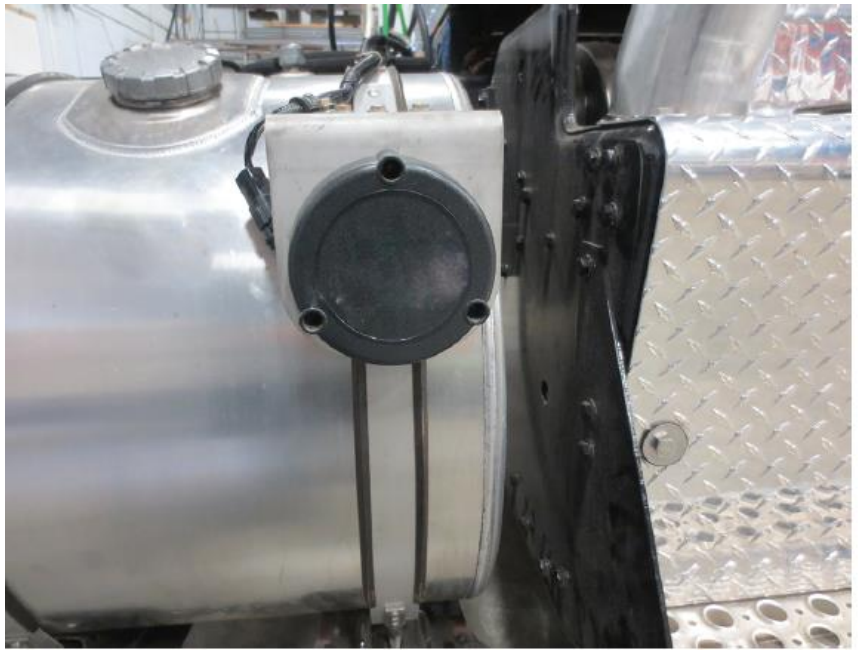
- Radar range
  - Long-range radar has a current range of 820 feet (250 meters) with a narrow window to view the pathway directly ahead of the vehicle
  - Short-range radar uses a wider field of view to check for vehicles that may cut in front of a truck or bus, but has a useful working range of only 230 feet (70 meters)



The range and type of forward-looking radars and cameras.

LO 55-2 Identify and describe autonomous control-enabling technologies.

- Side mounted Radar
  - Side-mounted radar monitoring the blind spot is short-range, sweeping an area 20" in front and behind the transceiver and extending 10' feet to the right



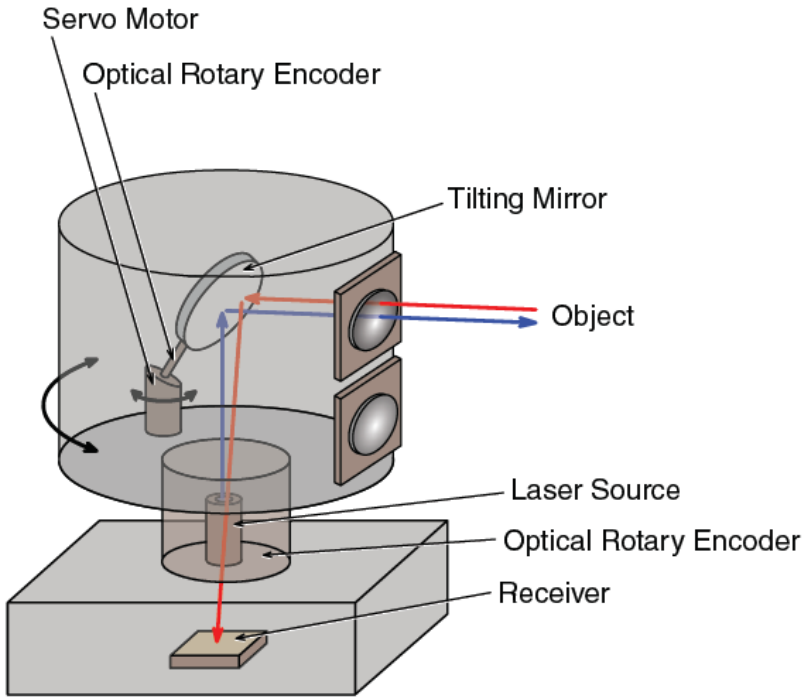
A side-mounted radar transceiver for a Bendix Wingman.

LO 55-2 Identify and describe autonomous control-enabling technologies.

- Radar can also be used for
  - Blind spot monitoring
  - Lane centering and the lane-change assistant
  - Collision warning or collision avoidance
  - Cross-traffic monitoring
  - Automatic emergency braking
  - Automatic distance control in cruise mode

LO 55-2 Identify and describe autonomous control-enabling technologies.

- LIDAR
  - Light Detection and Ranging operates like radar but uses narrow laser light beams rathe than radio waves
  - Rapidly sweeping around a vehicle enables LIDAR to render a three dimensional (3D) representation of objects around the vehicle
  - Unaffected by light level and has better poor weather performance



A cross-sectional view of a LIDAR with an older rotating beam and mirror.

LO 55-2 Identify and describe autonomous control-enabling technologies.

- LIDAR
  - Better at estimating distances and is accurate over a longer distance range
  - Requires less intensive signal processing than a video camera
  - Rotating-mirror LIDAR designs have morphed into low-cost solid-state LIDAR using semiconductor technology

A LIDAR sensor provides better images in adverse weather conditions and can more accurately estimate distances.

LO 55-2 Identify and describe autonomous control-enabling technologies.

- Satellite Global Positioning Systems (GPS) and Inertial guidance systems
  - Sense vehicle position and locate it on a map
  - Inertial guidance systems use dead reckoning navigation
    - tracks movement from a starting point using vehicle sensors measuring speed, direction, and rate of acceleration
  - The distance and direction traveled from the last known position are used to update the vehicle position when GPS signals are not available

LO 55-2 Identify and describe autonomous control-enabling technologies.

- Autonomous Drive Processing Systems
  - Software algorithms take sensor data and process the information through a specific sets of logic steps, procedures, and rules
  - The system response determines whether the vehicle should steer around an object, stop, or change the speed
  - ACC in Detroit's Assurance driving systems is used by Daimler in Freightliner trucks to control acceleration and deceleration, while Active Lane Assist handles automated steering input

This snow plow truck has a set of switches to allow it to re-center the lane-assist system.

LO 55-2 Identify and describe autonomous control-enabling technologies.

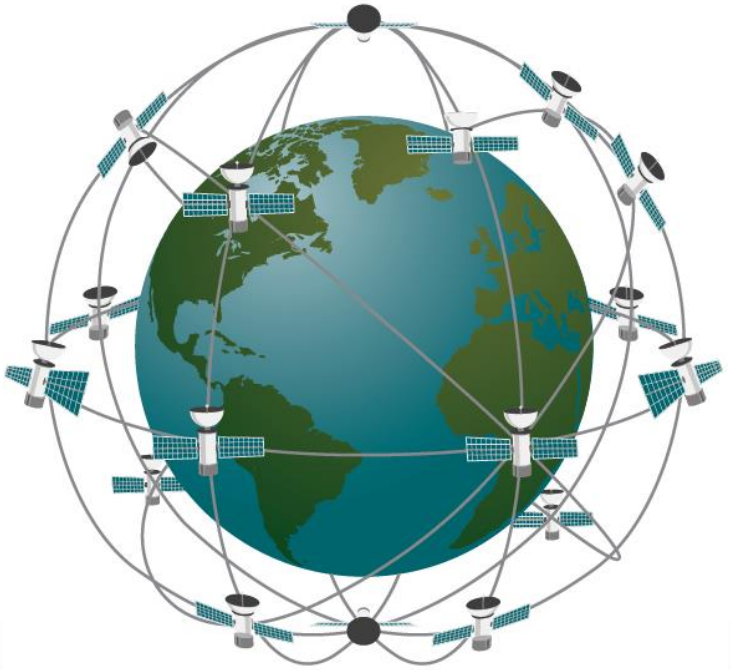
- Autonomous Drive Processing Systems
  - Steering wheel torque sensors are used to verify the driver has hands on the steering wheel
    - Allows the driver to override any action of the driving system
  - The autonomous driving system used in Freightliner Inspiration Truck series is called Highway Pilot
    - Integrates a set of cameras, radar systems with lane stability, collision avoidance, speed control, braking, steering, and other safety monitoring systems to create a Level 3 autonomous driving system

LO 55-3 Describe the purpose and operation of GPS and applications to automated driving systems and commercial vehicles.

- GPS
  - Global navigation satellite system (GNSS), is a worldwide radio-navigation system that significantly accelerates the advancement of autonomous driving and navigation
  - All GPS use dual-frequency receivers receiving two different GPS signals—satellite position and orbiting information
  - When integrated together, the accuracy of the signal to locate a position is significantly enhanced

LO 55-3 Describe the purpose and operation of GPS and applications to automated driving systems and commercial vehicles.

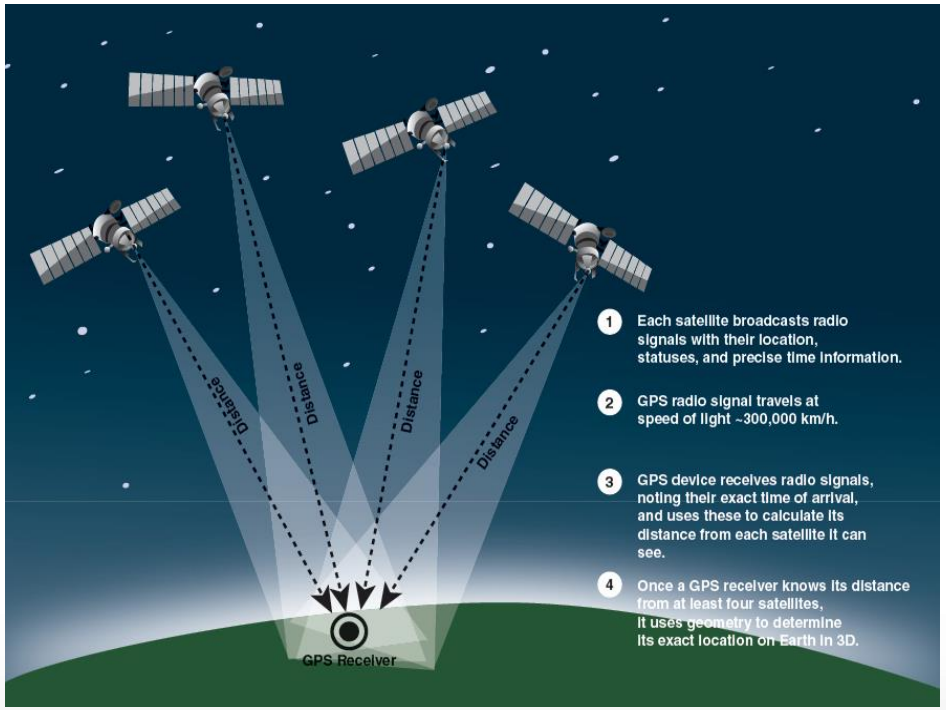
- GPS
  - The GPS used in North America consists of a constellation of 30 satellites orbiting the earth with 24 or more satellites visible to receivers on earth
  - To identify any position on earth, a GPS receiver needs to receive signals from three or more of these satellites



GPS signals are received from orbiting satellites

LO 55-3 Describe the purpose and operation of GPS and applications to automated driving systems and commercial vehicles.

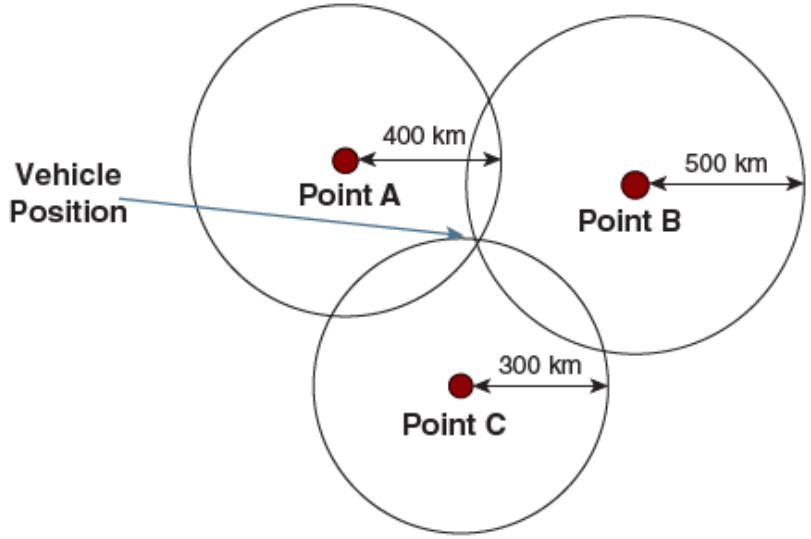
- Triangulation
  - A receiver connects with signals transmitted from each satellite at precisely the same time
  - A time stamp on each signal allows the receiver to calculate how far it is from each satellite
    - If the receiver knows the position of the satellites, the intersection point of signals form a 3D position with calculated coordinates indicating how far east or west (longitude) and north or south (latitude) the receiver is



GPS receivers receive satellite position data to calculate the distance and the altitude to each satellite.

LO 55-3 Describe the purpose and operation of GPS and applications to automated driving systems and commercial vehicles.

- Triangulation
  - Without signals from at least three different satellites, significant error has to be factored into the receiver's location
    - If the receiver is located at a high altitude and three signals are not received, the receiver may use sea level as a reference point for location and locate the receiver a distance at least equal to the altitude away from the actual location



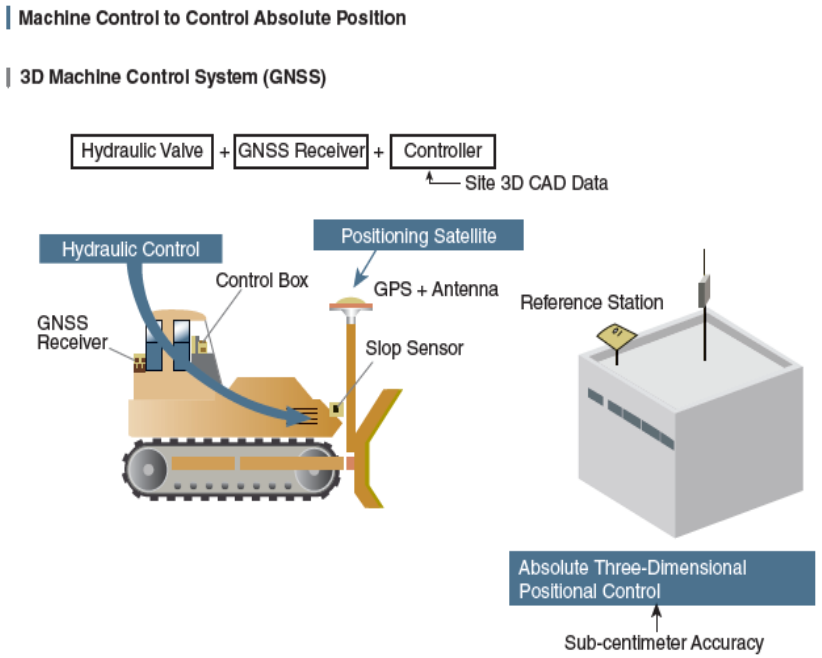
When at least three GPS signals are received, the GPS unit can triangulate the vehicle position and altitude by measuring the distance and angle to each satellite.

LO 55-3 Describe the purpose and operation of GPS and applications to automated driving systems and commercial vehicles.

- GPS Signals
  - Two types of satellite data are required by the GPS receiver
    - The almanac and the ephemeris
    - The receiver may need as long as 15 minutes to update almanac data and two hours for ephemeris information
  - Some routes cannot receive satellite signals so cannot be used to provide steering or route guidance
  - Unless the signal data is corrected, error in a conventional GPS unit may prevent a GPS from precisely centering a vehicle in lane or identifying a stop sign
  - GPS CAN units data-supplement satellite information with GPS from cell phone networks connected to the Internet

LO 55-3 Describe the purpose and operation of GPS and applications to automated driving systems and commercial vehicles.

- Corrected GPS
  - GPS signals can be corrected using one of several supplemental ground-based reference stations
  - These supplemental correction systems can obtain positional accuracy to less than ½ inch or 1.27 cm for computer-aided construction equipment or autonomous machinery operating in farm fields navigating between rows requiring high positional accuracy



Computer-aided construction equipment is a current example of the use of corrected GPS signals necessary for precise positional accuracy to within less than 2" or 5 cm

LO 55-3 Describe the purpose and operation of GPS and applications to automated driving systems and commercial vehicles.

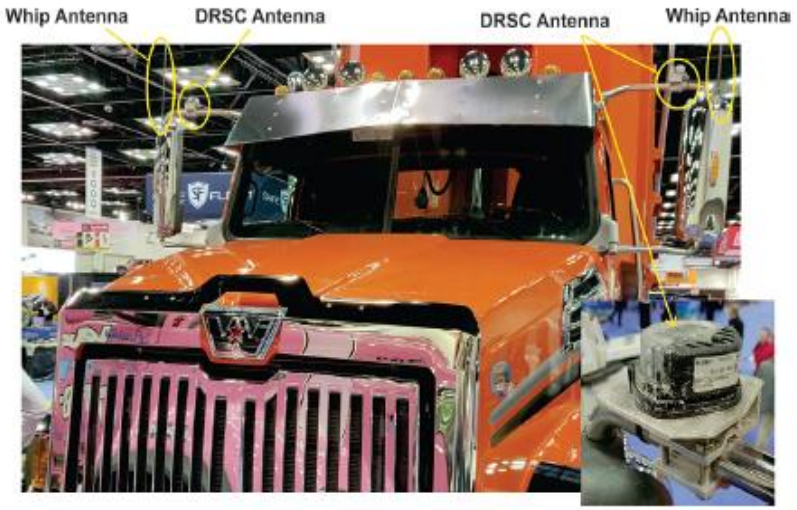
- Correcting GPS errors
  - Differential global positioning system (DGPS), wide-area augmentation system (WAAS), real-time kinematic (RTK), and dual-frequency receivers are terms used to categorize third-party suppliers of supplemental GPS information needed to correct satellite GPS error
  - A corrected GPS allows one truck to drive a route (with a human driver) and "map" it, then transfer that data map to other trucks driving the route
    - Additional trucks follow a mapped route with little to no driver intervention required

LO 55-4 Identify and explain the purpose of autonomous vehicle communication technology.

- Communication between autonomous vehicles and other vehicles
  - Vehicle-to-vehicle or V2V communication enables vehicles within a 328 yd (300 m) radius to exchange information
    - This communication standard, defined by the IEEE as 802.11p wireless communication, and the SAE-J2735 standard are likely to become regulation
  - Basic Safety Message (BSM) are required to include vehicle size, position, speed, direction, acceleration rate, and brake system status

LO 55-4 Identify and explain the purpose of autonomous vehicle communication technology.

- Dedicated Short-Range Communications (DSRC)
  - Bidirectional short-to-medium range wireless communication that operates on the radio frequency of 5.725 MHz to 5.875 MHz
  - Is capable of transmitting 10–20 gigabytes/second (Gbps) of information per second
  - Similar to WiFi signals

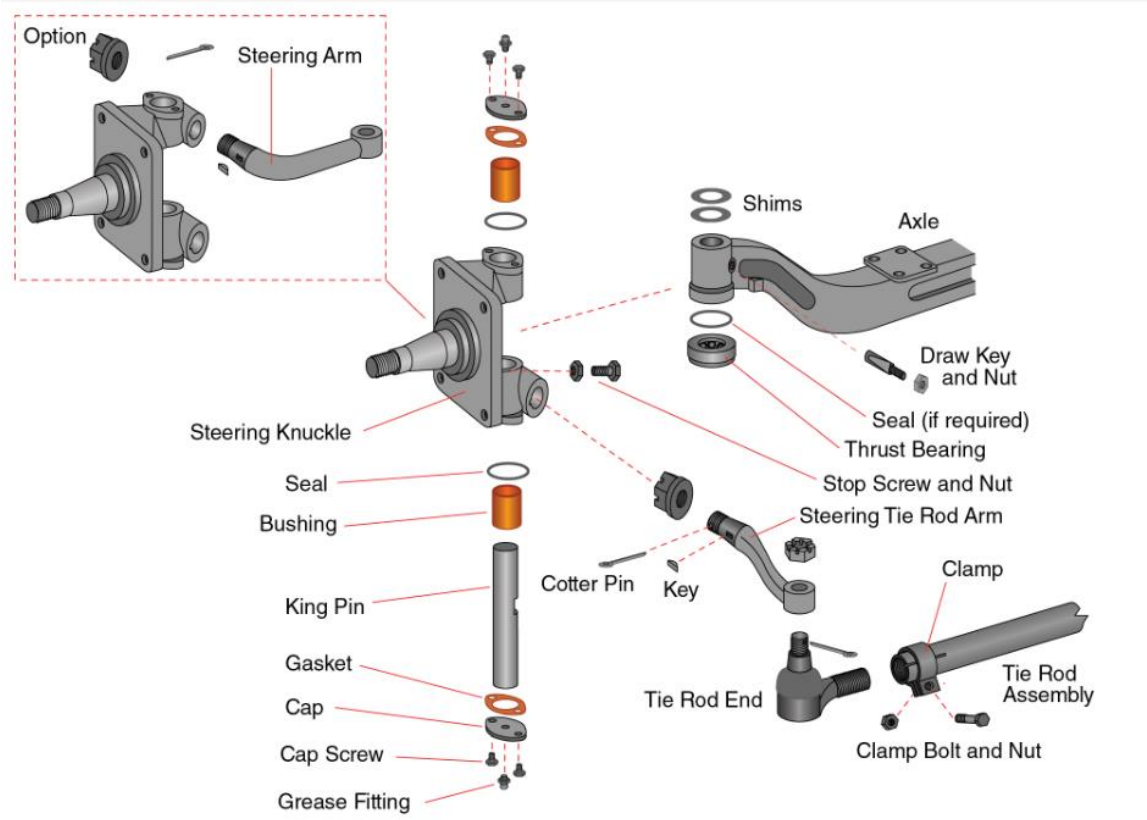


Dedicated Short-Range Communications, or DSRC, radio antennas are used for a vehicle-to-vehicle communication system. DRSC antennas are critical to the ability of trucks to platoon.

LO 55-4 Identify and explain the purpose of autonomous vehicle communication technology.

- V2V communications
  - V2V will operate like a mesh network, which means every node, whether it is a truck, bus, car, or signal light can transmit, receive, and retransmit signals
  - The signals can pass along several nodes and, after passing from five to 10 vehicles, traffic conditions and messages are collected from over a mile
  - DSRC radio antennas are critical for V2V communication systems
    - Antennas enable trucks to platoon and communicate wirelessly between trucks

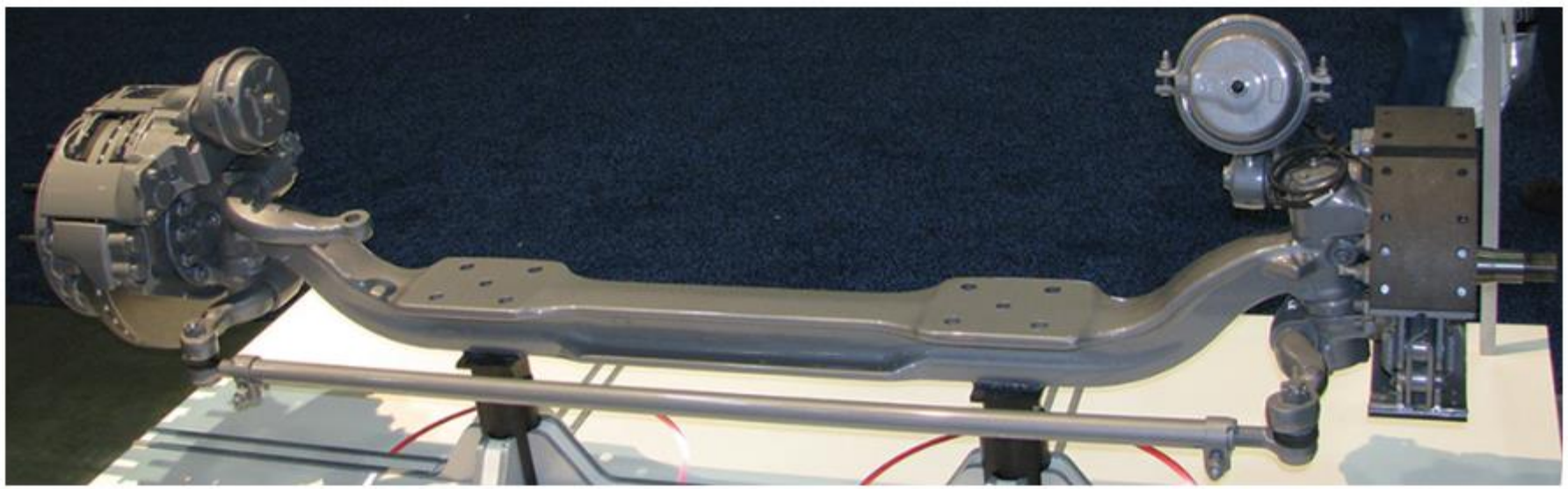
Steering and Suspension

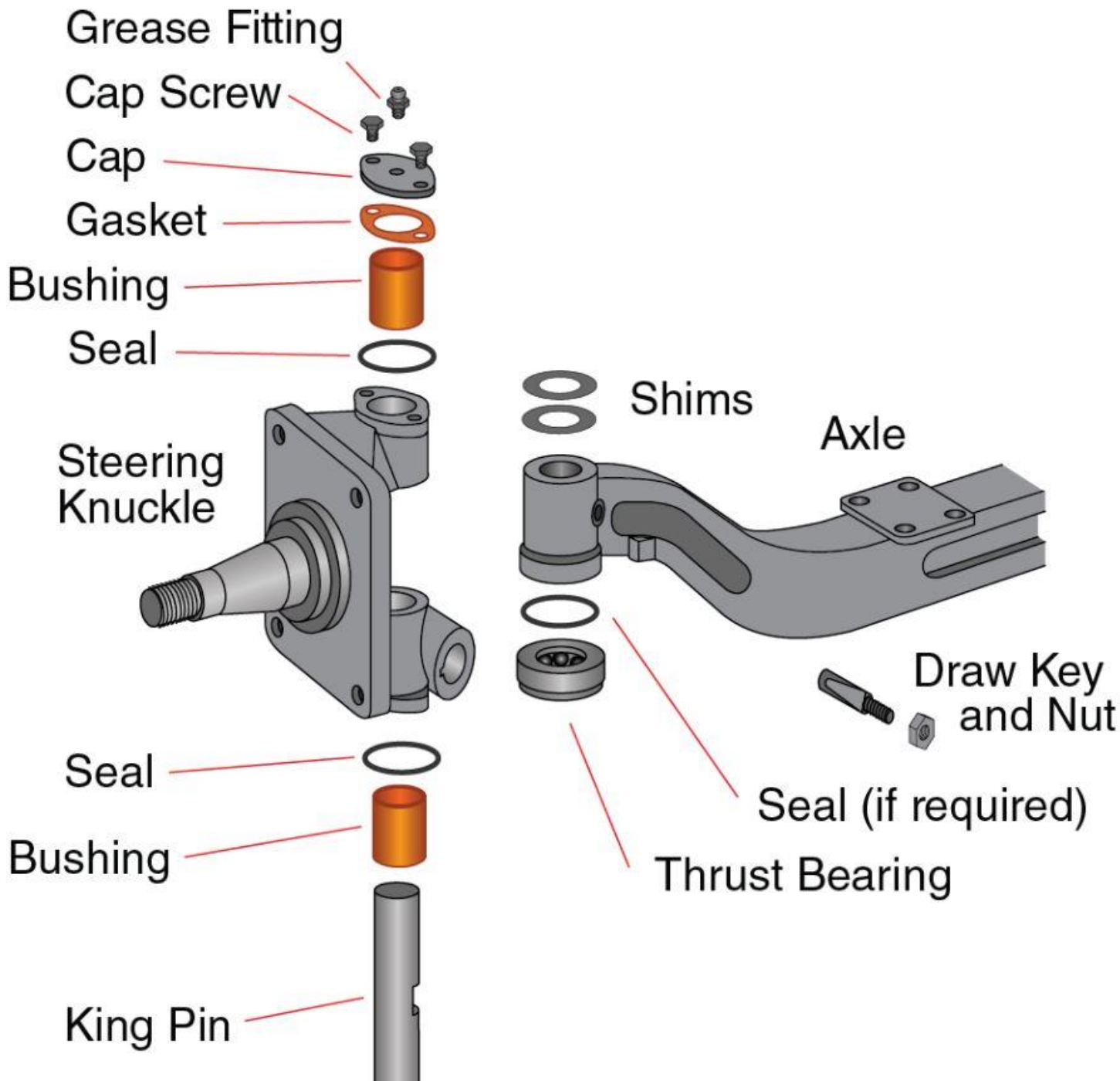


Typical medium- and heavy-duty steering system.

Steering Axles

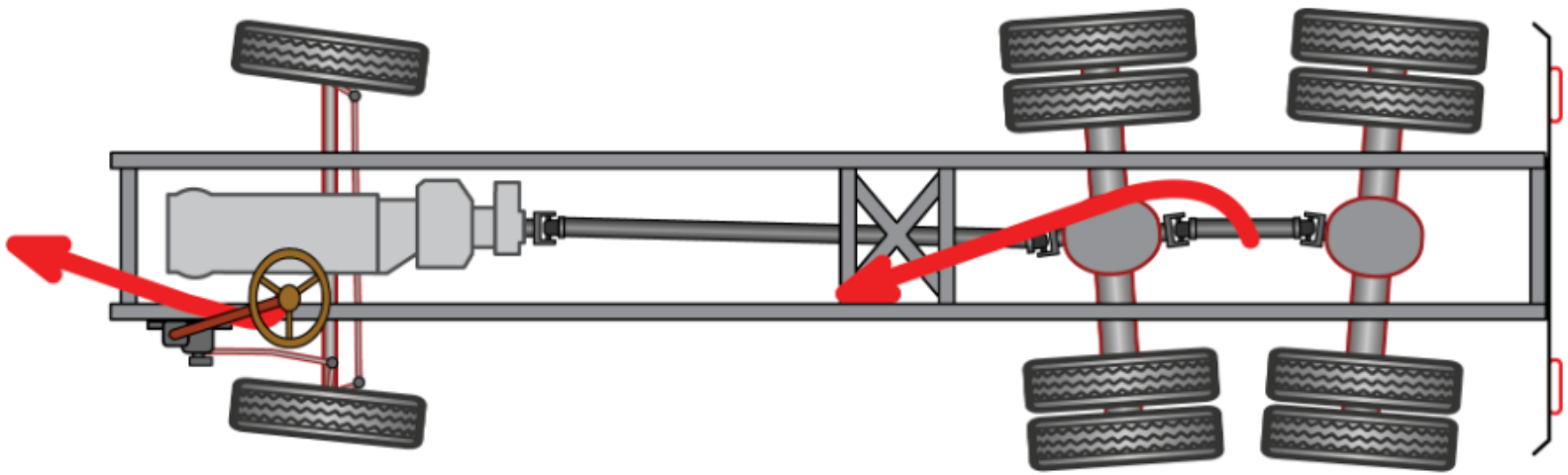
Steering axles are used for the front axle of medium- and heavy-duty commercial vehicles. The most common configuration is the **solid I-beam**, also called a forged I-beam design named for its rigid I-shaped profile Nominal axle weight capacities for steering axles typically range from 6000 lb (2722 kg) to 26,500 lb (12,020 kg). Very heavy commercial vehicles, such as concrete mixers and mobile cranes, often use two steering axles



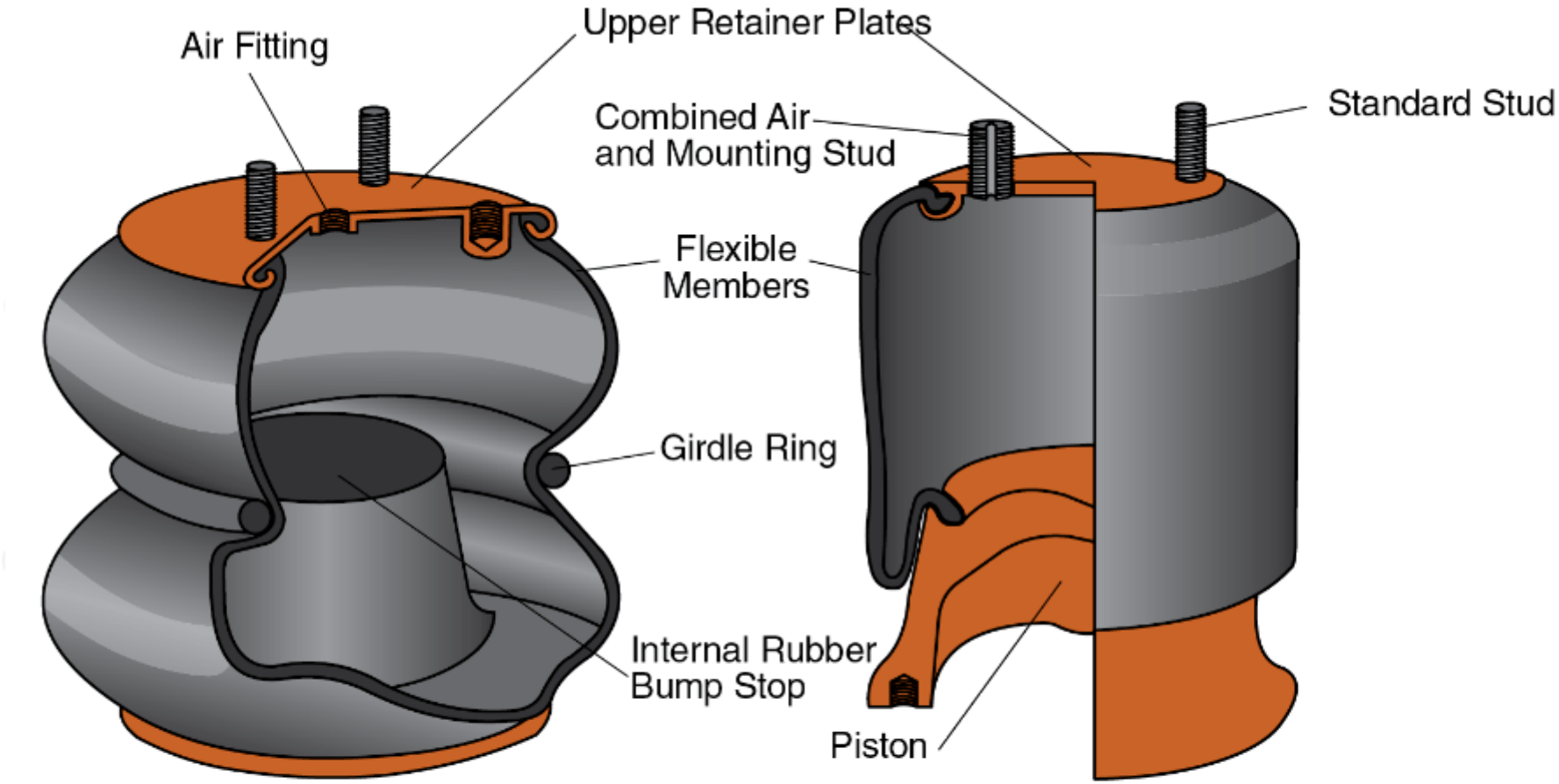

Grease Fitting
Cap Screw
Cap
Gasket
Bushing
Seal
Steering Knuckle
Shims
Axle
Draw Key and Nut
Seal (if required)
Thrust Bearing
Seal
Bushing
King Pin

Wheel alignment, sometimes called **tracking**, refers to the positioning of the tires relative to the vehicle. The purpose of aligning and adjusting wheel position is to give heavy-duty commercial vehicles predictable, straight-line directional stability, and the ability to correctly turn, while minimizing tire wear and improving vehicle handling characteristics. Changes in vehicle loading and uneven loading alter wheel alignment, so those variables need to be taken into account by various alignment factors. Without correct wheel alignment vehicles:

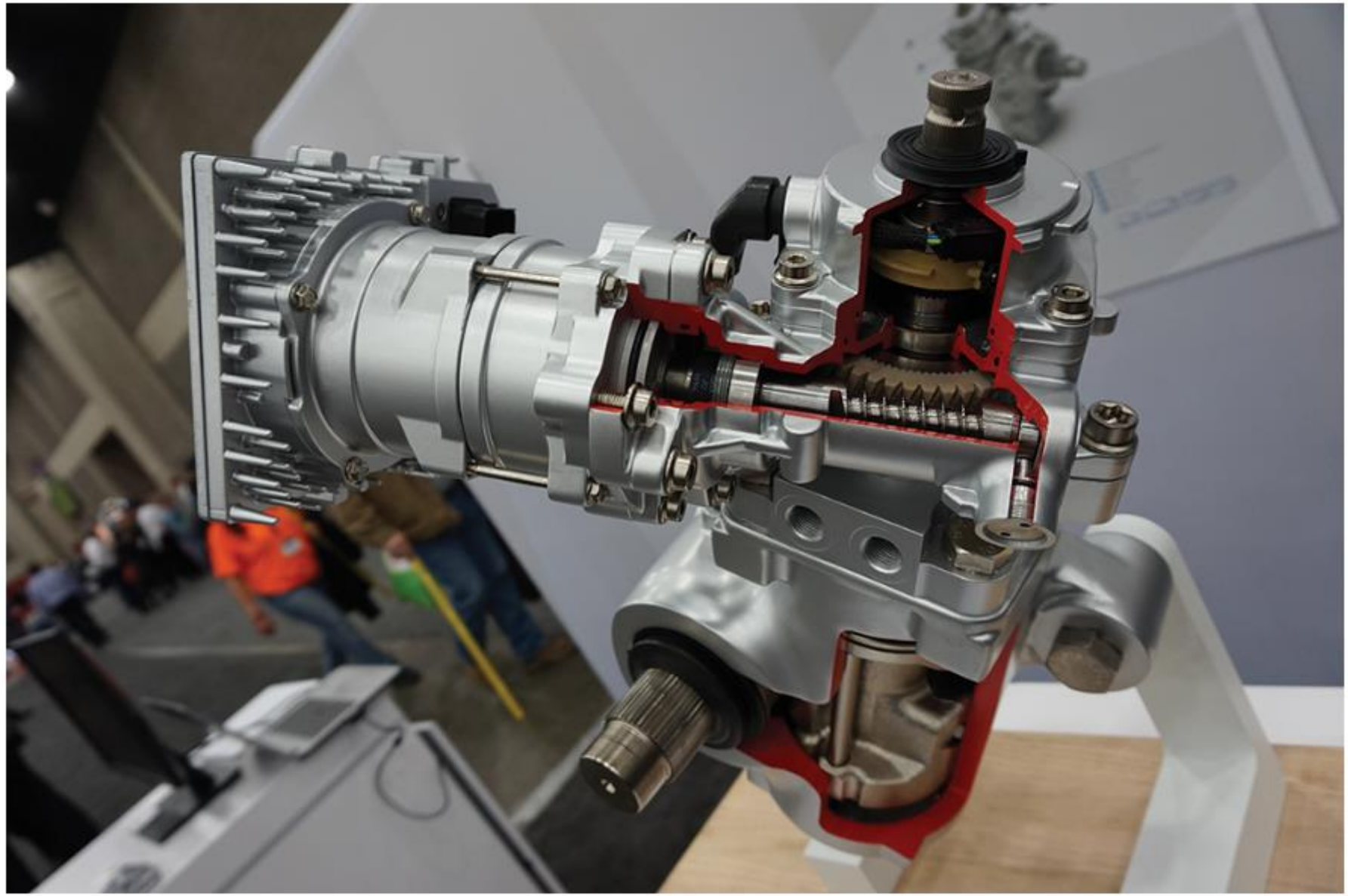
- Consume more fuel due to additional rolling resistance
- Wear tires faster since misalignment produces uneven pressure and drag forces on tires
- Experience directional instability, as alignment strongly influences steering control
- Experience premature suspension and steering-component wear due to excessive forces applied to the components from wheel drag
- Cause increased driver fatigue due to the need to continuously correct vehicle direction, a condition known as counter-steer and cause increased effort required to steering the vehicle



Misalignments require counter-steer to keep the vehicle straight.



Cut away of a convoluted air spring with internal stop bumper and a reversible sleeve type, the shape of the reversible sleeve piston determines the spring rate of the air spring as it compresses.

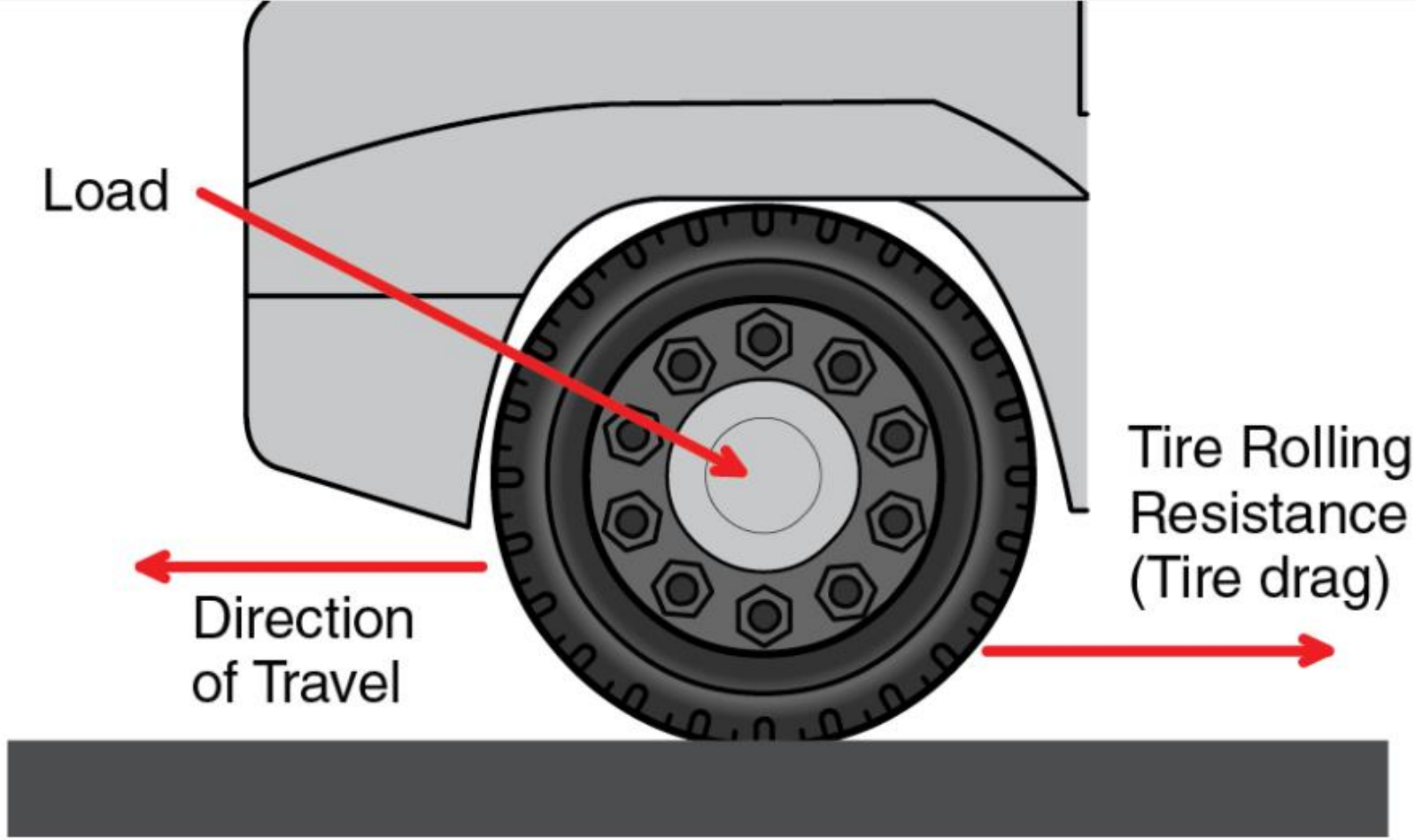


An electric motor replaces driver input to the steering gear for autonomous and semi-autonomous drive trucks.

TABLE 27-1 Ranking of Reasons for Roadside Service Calls

Reason for Service Call	Percentage of All Service Calls
Tires	51.3%
Jump or pull start	7.6%
Air line or hose	4.7%
Alternator	4.1%
Wiring	3.9%
Fuel filter	3.7%
Fuel	3.5%
Brakes	2.4%
All other issues	Less than 1%

Source: www.Truckinfo.net/trucking/stats.htm

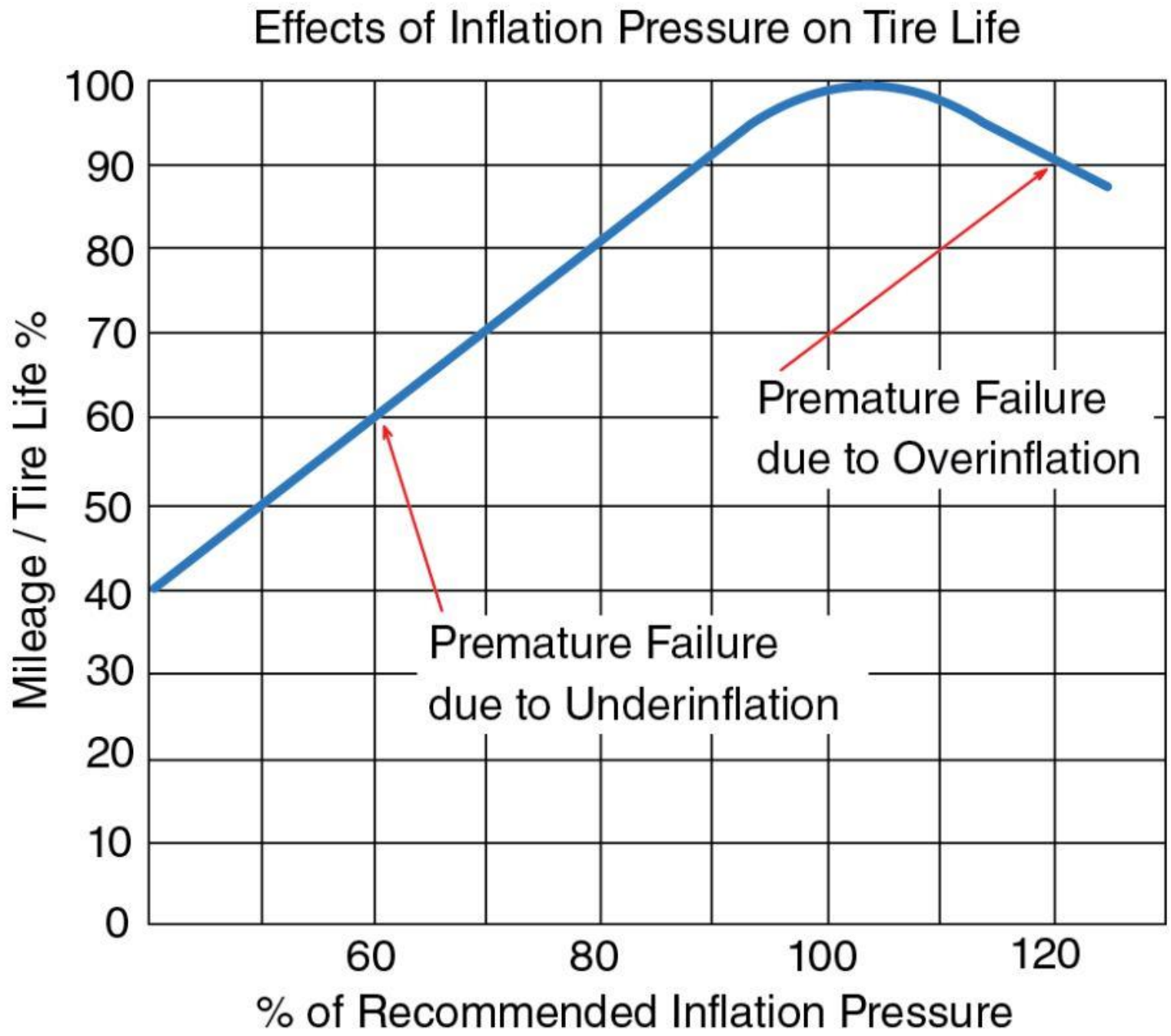


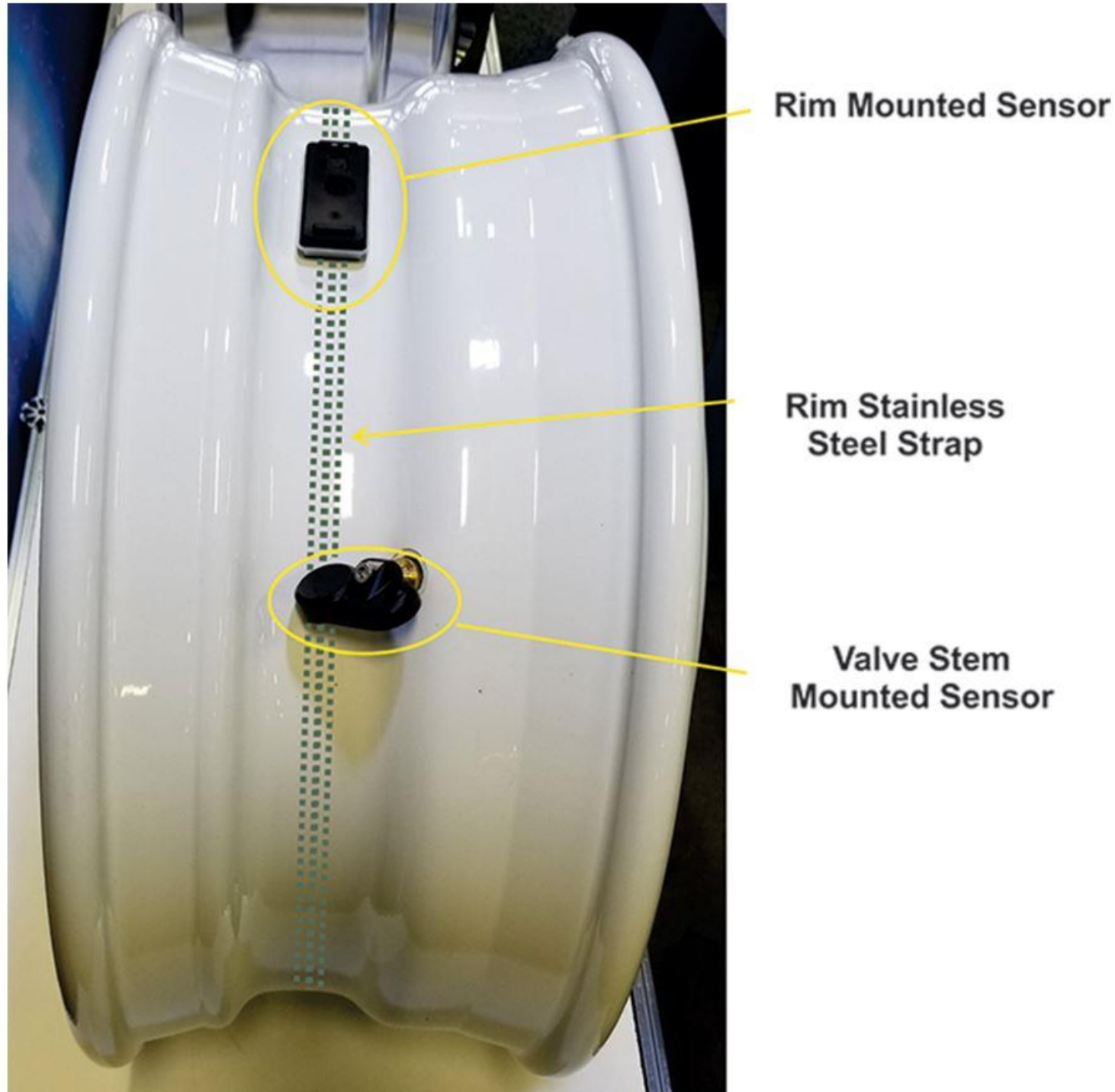
Tires support the vehicle load, transmit braking and traction forces to the road surface, absorb road shock, and provide directional control of the vehicle.

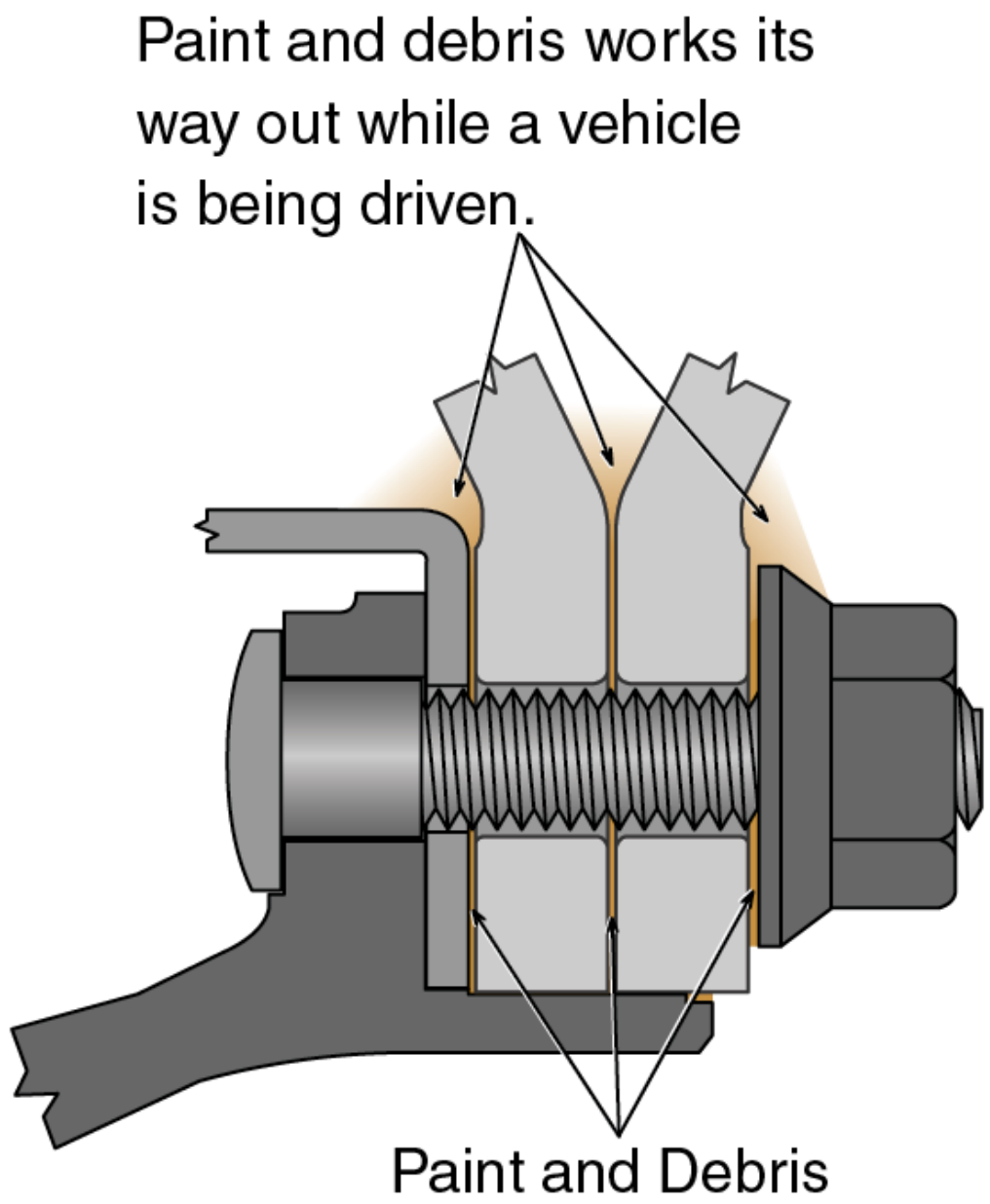
- Supporting the vehicle load
- Transmitting braking and traction forces to the road surface
- Absorbing road shocks
- Providing directional control of the vehicle.

TABLE 27-4 Comparison of Common Tread Design

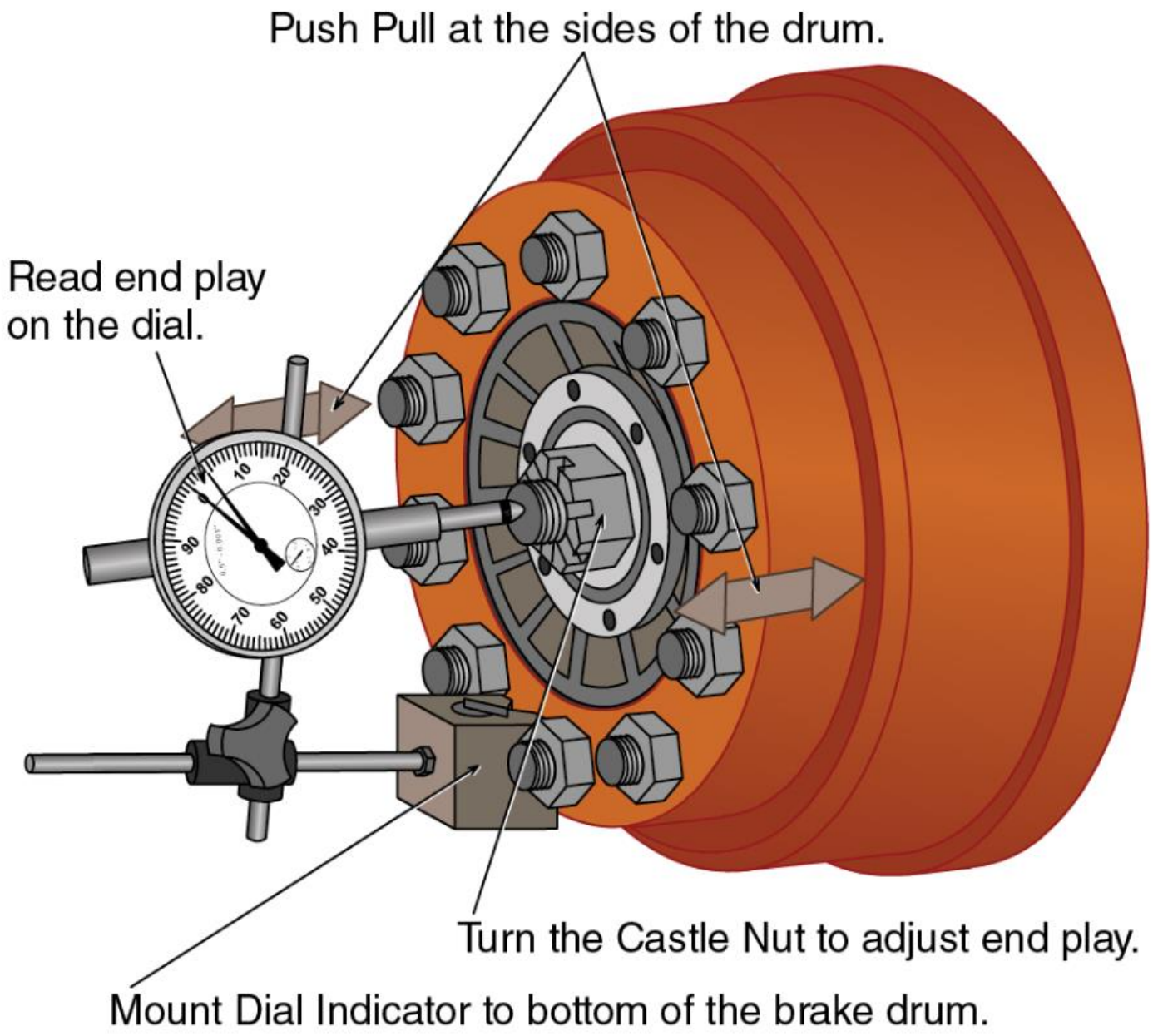
Type	Rib	Block	Rib-Block	Rib-Lug	Lug
Pattern					
Profile	Grooves cut around the circumference of a tire	Tread is chunked into individual blocks that are arranged in a pattern	Pattern combines block-type tread in the center with a shoulder rib	Combination of rib and lug patterns	Grooves cut in a lateral direction across tread
Features	• Improved driving stability • Lower rolling resistance • Lowest tread noise • Best water drainage performance for less skidding and hydroplaning	• Good drive and braking forces • Best traction on normal paved road	• Low rolling resistance • Smooth comfortable ride • Relatively low noise production • Good traction on snow or muddy terrain	• Rib-type pattern increases steering stability and prevents skidding • Lug-type pattern transfers traction drive and braking forces effectively	• Excellent drive and braking forces • Strongest traction force • Better resistance to tread cuts
Applications	• Best for driving on smooth cemented roads and highways • Ideal for steering or trailer tires	• Good traction performance when driving on asphalt and cement roads	• Good performance when driving on normal cemented roads • Improves fuel economy and has low tread wear	• Suitable for driving on normal cemented, asphalt roads and gravel roads at a middle/low speed	• Suitable for driving on all normal surfaces and best for muddy, off-road surfaces


Effects of Inflation Pressure on Tire Life
Mileage / Tire Life %
100
90
80
70
60
50
40
30
20
10
0
60
80
100
120
% of Recommended Inflation Pressure
Premature Failure
due to Overinflation
Premature Failure
due to Underinflation

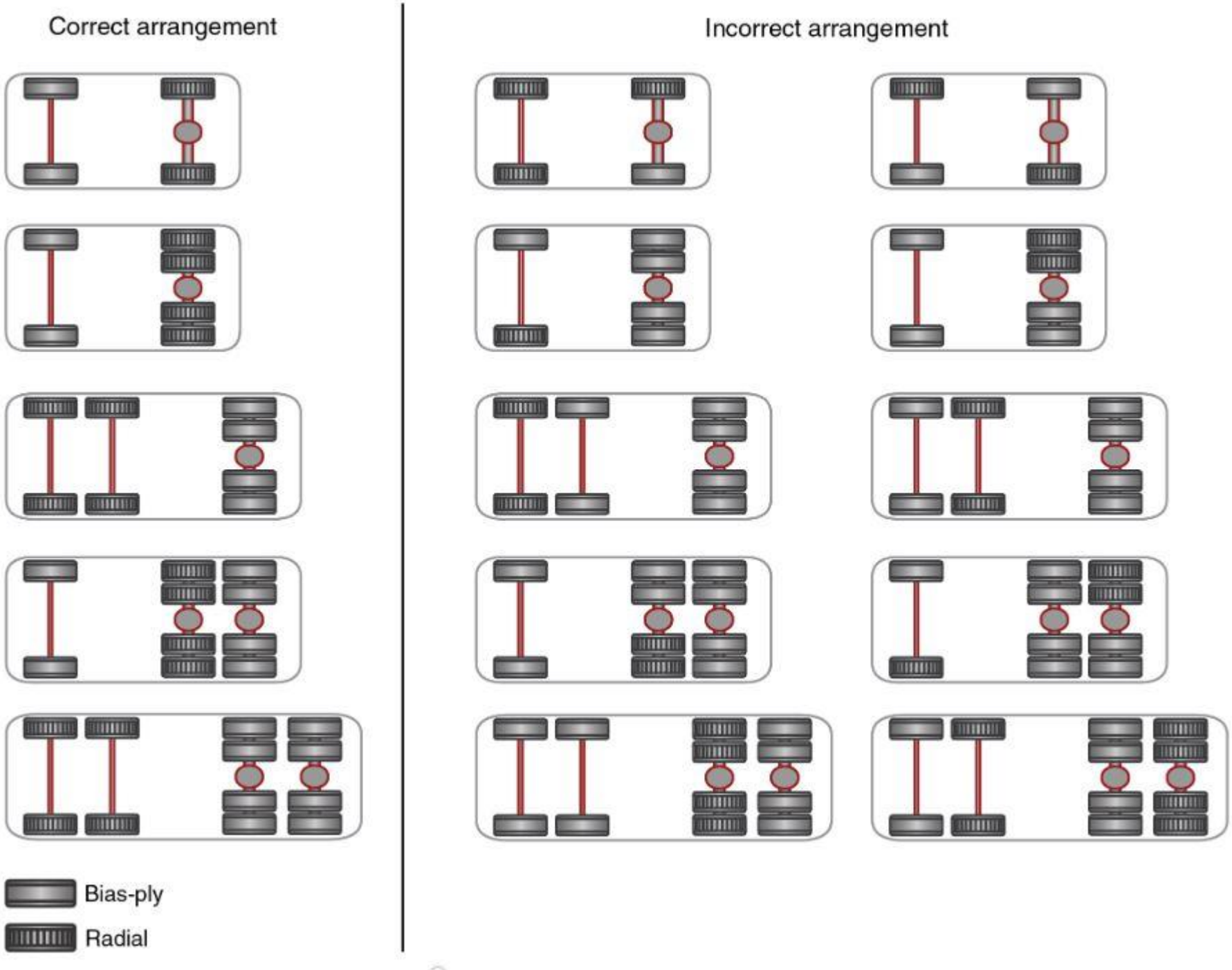

Rim Mounted Sensor
Rim Stainless
Steel Strap
Valve Stem
Mounted Sensor



Areas where dirt, grease, and paint can squeeze out between wheels and hubs, causing wheel nuts to loosen.

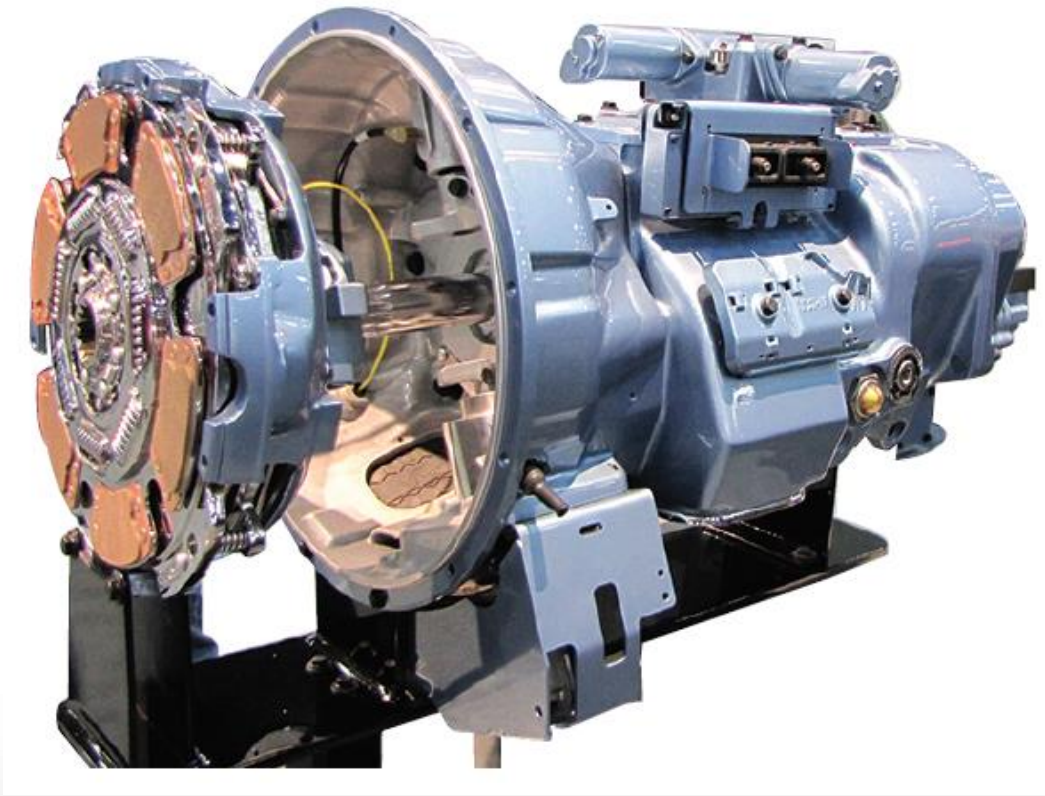


Bearing endplay measured with a dial indicator. The hub is pushed in and out while the dial indicator's needle measures movement at the end of the spindle.


Correct arrangement
Incorrect arrangement
Bias-ply
Radial

LO 45-1 Explain the purpose and benefits of automated manual transmissions (AMTs).

- The shifting process for an AMT is controlled by the electronic control unit (ECU), also known as the transmission control module (TCM).
- The ECU works in concert with the engine's control module to optimize shift points and strategies to maximize fuel efficiency.



Eaton Corporation's UltraShift transmission.

LO 45-1 Explain the purpose and benefits of automated manual transmissions (AMTs).

- The electronically automated transmission comes in many varieties
  - With clutch pedal
  - Without clutch pedal
- Shifting is controlled completely by the transmission electronic control.

Most AMTs have no clutch pedal.

LO 45-1 Explain the purpose and benefits of automated manual transmissions (AMTs).

- The primary benefits of AMTs
  - Improved fuel economy by 5–7% over conventional standard transmissions because of their ability to use optimized shift strategies
  - The driver can keep both hands on the steering wheel and AMTs are less tiring to operate because no shifting, clutching, or double clutching is necessary
  - AMTs experience longer transmission life, less down time for repairs, and higher vehicle resale value
  - Due to the electronic control system's self-diagnostic capability, easy troubleshooting of problems is possible

LO 45-1 Explain the purpose and benefits of automated manual transmissions (AMTs).

- Breaking torque means the engine must be throttled back, and the throttle must be reapplied when the shift is complete, causing delay in overall vehicle acceleration.
- Dual-clutch transmissions, which have two separate input shafts controlled by two separate clutches, are capable of shifting without breaking torque, thereby improving fuel economy.
- Most automated transmissions use a gear jamming technique; they use computer controls to break torque and the computer then matches the shaft speeds without gear clash and with no damage to the transmission.

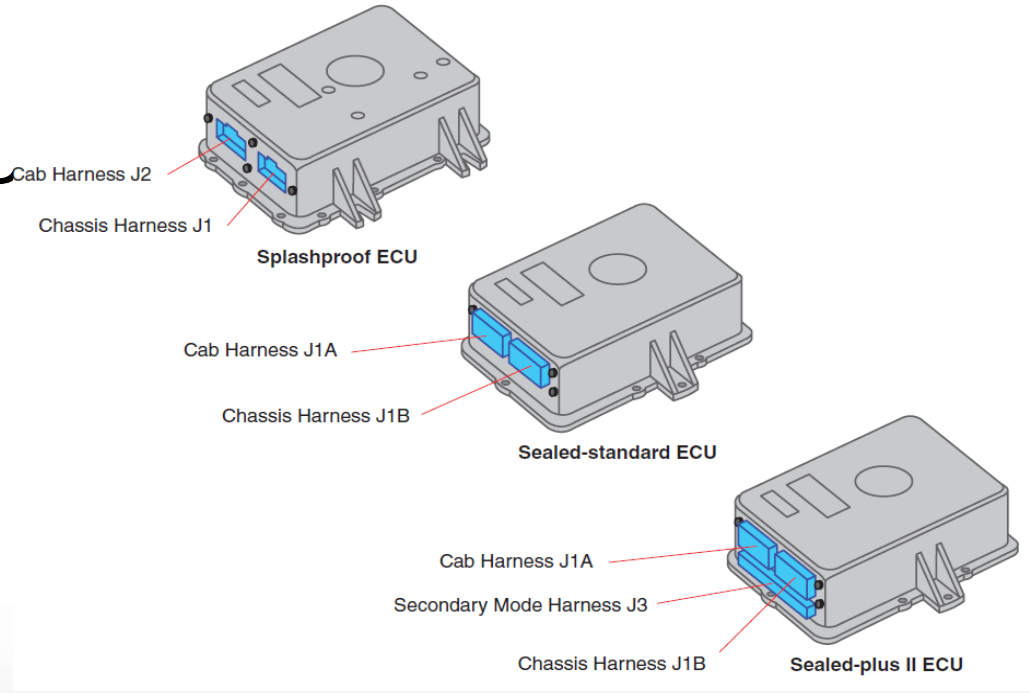
LO 45-1 Explain the purpose and benefits of automated manual transmissions (AMTs).

- The first fully automated standard transmission to hit the North American market was the Eaton AutoShift which was a 10-speed model with a standard dry double-disc clutch.
- Once the vehicle was moving, its transmission was capable of automatic shifting through the entire vehicle operating range—all the way to tenth gear and back down again, as necessary.

Eaton Fuller AutoShift 10-speed transmission.

LO 49-1 Describe the operation of Allison Automatic Transmission Electronic Control (ATEC) and Commercial Electronic Control (CEC).

- Transmission Electronic Control Unit (ECU) or Transmission Control Unit (TCU
  - Types of ECU used by the Allison CEC
    - Splash proof model ECU
    - Sealed standard ECU
    - Sealed plus II



The ATEC/CEC electronic control unit had three generations.

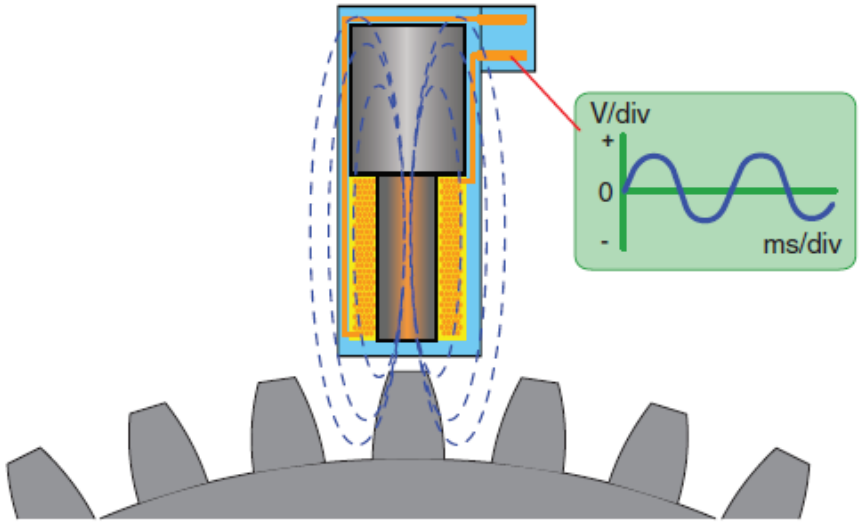
LO 49-1 Describe the operation of Allison Automatic Transmission Electronic Control (ATEC) and Commercial Electronic Control (CEC).

- The shift control can be a push button unit used to activate gear changes.
- The Hall-effect switches send a corresponding signal to the transmission ECU.

The driver's input can be a push button control as shown or a shift lever type.

LO 49-1 Describe the operation of Allison Automatic Transmission Electronic Control (ATEC) and Commercial Electronic Control (CEC).

- The vehicle speed sensor (VSS) is an inductive pick-up sensor that reads the speed of the transmission output shaft.
- An inductive pick-up is simply a coil of wire wrapped around a permanent magnet core.



A vehicle speed sensor (VSS) produces an AC voltage signal that rises in frequency and amplitude as speed increases.

LO 50-3 Describe automatic transmission maintenance procedures.

- The most important check for any automatic transmission complaint is transmission fluid level.
- It is important to identify visible transmission fluid leaks.
- Leaks can be hard to pinpoint as air movement and vehicle vibration can spread the fluid far from the original leak point.
- A leak detection dye can be helpful in finding the leak.

SKILL DRILL 50-1 Checking Fluid Level and Inspecting Fluid Loss

1. Look up the procedure for checking the transmission fluid level in the appropriate service information.
2. Locate the transmission dipstick (if equipped). Most, but not all, transmissions are checked with the engine at operating temperature, idling, and the transmission in park. If the transmission has a dipstick, wipe it off and reinsert it into the transmission before checking the level of fluid on the dipstick.

SKILL DRILL 50-1 Checking Fluid Level and Inspecting Fluid Loss

Check both sides of the dipstick; the side that is the lowest is the accurate fluid level. On some transmissions, the fluid returning to the transmission pan splashes up on one side of the dipstick, resulting in a high reading on that side.

3. If the transmission fluid level is low, add the recommended type and amount of transmission fluid. Be careful not to overfill the transmission.

SKILL DRILL 50-1 Checking Fluid Level and Inspecting Fluid Loss

4. Inspect the transmission for signs of leakage. Some places to check are the transmission pan, area around the entrance of the filler tube to the transmission, extension housing gasket, output shaft seals, selector shaft seal, area around the electrical connectors that go into the transmission case, front pump seals, fluid cooler lines, and the fittings. Also, if the vehicle has a vacuum modulator, remove the vacuum hose from the modulator and see if there is any transmission fluid in the hose. If there is, the modulator diaphragm is leaking: replace the modulator.

SKILL DRILL 50-1 Checking Fluid Level and Inspecting Fluid Loss

5. If fluid level is low and no external leakage is visible, check coolant overflow tank for contamination with transmission fluid, remove the radiator cap (with vehicle cold), and check for any transmission fluid in the radiator; if fluid is present in either location, it is an indication that the transmission cooler is leaking internally and must be replaced. Note: If there is a cooler leak, the transmission likely has been contaminated with engine coolant and requires overhaul.

SKILL DRILL 50-1 Checking Fluid Level and Inspecting Fluid Loss

6. If the transmission has a large amount of transmission fluid or engine oil covering it, you may need to clean it with a pressure washer, some engine degreaser, or use a leak detection dye in the transmission fluid.
7. Restart the vehicle and allow it to run for a while. The leak detection dye is easy to spot using a black light, or look for fresh transmission fluid leaking.
8. Record the location of the leak and inform the customer to obtain approval for repairs.

LO 50-1 Explain the fundamentals of transmission fluids.

- Transmission fluid is the life blood of all automatic transmissions.
- Friction modifiers
  - Change the coefficient of friction of the transmission clutch pack
  - Change the clutch pack's engagement and disengagement characteristics
  - Using fluids with friction modifiers in transmissions that are not designed for them can lead to severe oxidation issues, clutch pack slippage, and outright failure of the transmission.

Transmission fluid requirements can vary by manufacturer, so always follow OEM recommendations.

LO 50-1 Explain the fundamentals of transmission fluids.

- Incorrect fluid level can cause problems
  - If too low, the hydraulic pump is starved of fluid during operation, drawing air into the pump intake leading to aeration and loss of pressure; if the transmission vent is not clear, the pump inlet can create very low pressures, which can further cause cavitation.
  - If too high, aeration again becomes a problem; it can also lead to a fluid leakage from the vent and dipstick tube.
- Low pressures can cause cavitation, which is the formation of air bubbles in the transmission fluid as a result of the low pressure.

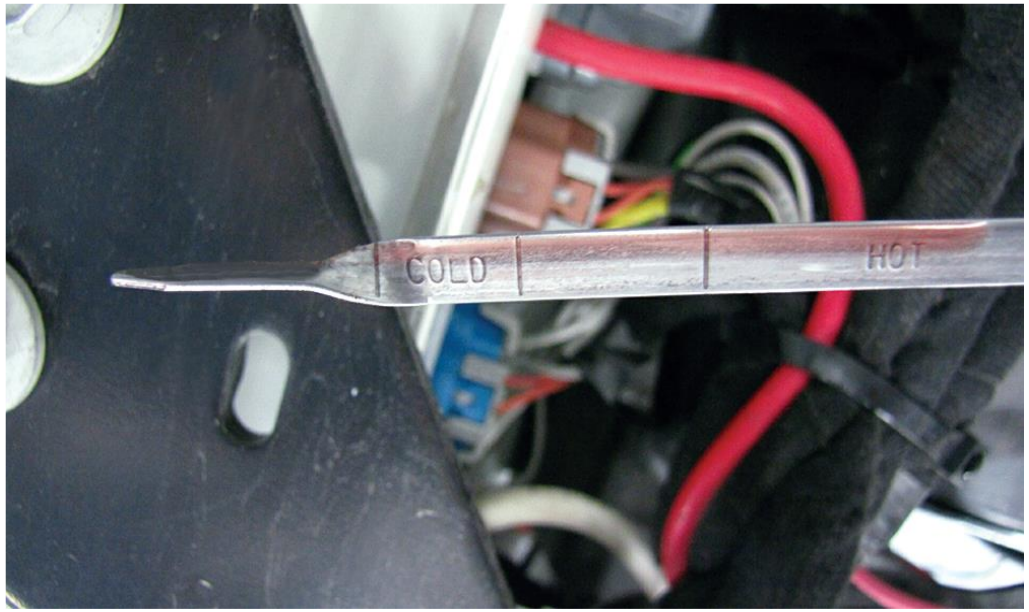
LO 50-1 Explain the fundamentals of transmission fluids.

- If the fluid is aerated because the fluid level is too high, the fluid may continue to foam and expand until it starts to leak from the vent and the dipstick tube.
- A missing or defective seal ring on the transmission filter can also lead to aeration.

Always clean around the dipstick tube before checking oil level.

LO 50-1 Explain the fundamentals of transmission fluids.

- The engine should be running while checking the transmission fluid levels.
- Moving through the neutral, reverse, and forward ensures that the fluid passages are full.
- The fluid level in the engine can be measured against the dispstick markings.



The temperature of the fluid is critical to getting a correct level reading.

LO 50-1 Explain the fundamentals of transmission fluids.

- Check the fluid level as per proper procedures
  - Read the manufacturer's recommendation for fluid temperature.
    - Cold fluid level check—when the fluid is between 60°F and 120°F
    - Hot level check—after the transmission reaches normal operating temperature of 160°F to 200°F
- In cold ambient temperatures the fluid may need preheating for safe transmission operation.
- Preheating can be done by installing a sump heater or by allowing the transmission to warm up in neutral for minimum 20 minutes at idle.

THANKS!!!!

The End