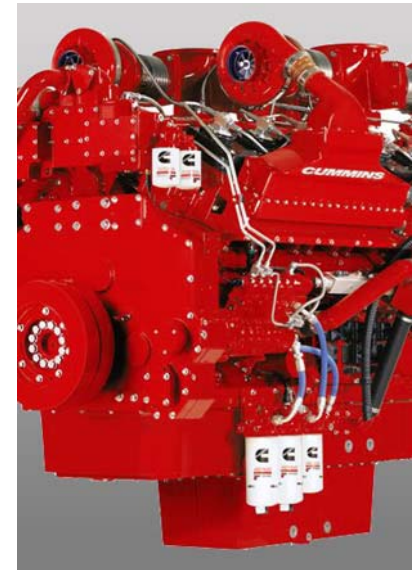
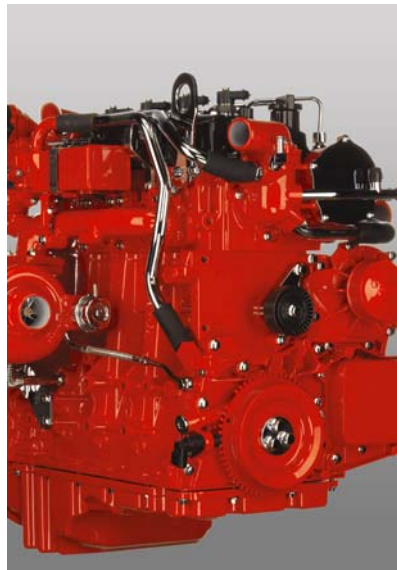




Fuel System

ISB6.7 CM2350 B101

Version 1.1



HPCR Fuel System Safety



Wear your safety glasses

Use cardboard or paper for identifying/troubleshooting high-pressure leaks ... Never use your hands or fingers

1800 bar = 26,106 PSI

2.068 Bar (30 PSI) is enough to penetrate human skin and cause a pressure injection.

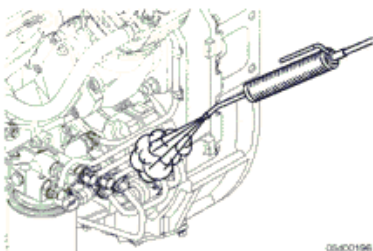
Always wait at least 10 minutes following engine shut down before opening the high pressure fuel system

If possible, use INSITE to monitor the fuel pressure to ensure it is safe to open the system

Never place your hands near fuel system fittings when loosening them.



Fuel System Cleanliness During Repairs Is Very Important

<p>! WARNING !</p> <p>Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.</p>	 <p>SMALL MEDIUM LARGE</p> <p>05400196</p>
<p>! WARNING !</p> <p>When using a steam cleaner, wear safety glasses or a face shield, as well as protective clothing. Hot steam can cause serious personal injury.</p> <p>Steam clean the fuel pump and the area around the fuel pump.</p> <p>Dry with compressed air.</p>	

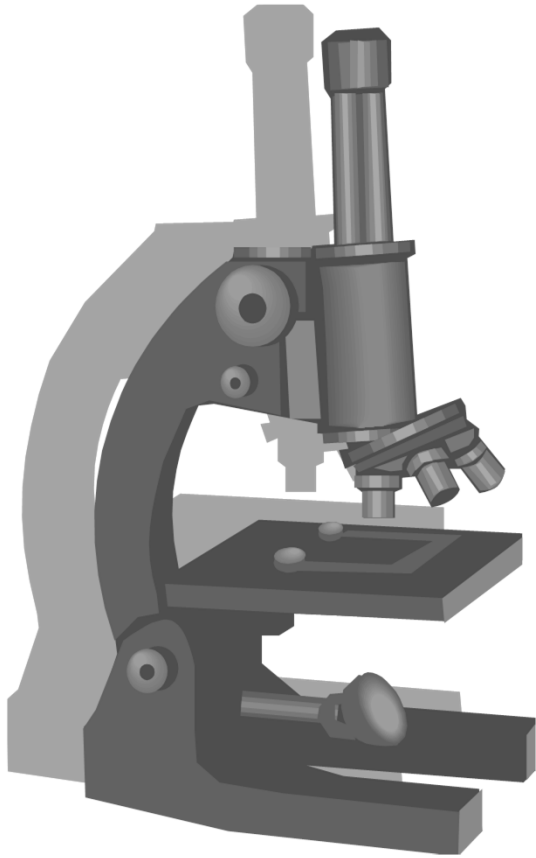
Clean all fuel system fittings, lines, and components before disassembly.

Make sure that no dirt or debris enters the fuel system components to prevent the passing of contaminants to the high pressure fuel rail and injectors.

Small amounts of dirt and debris can cause a malfunction of these components.



Clean Care Review



Questions:

- ✓ What is a micron?
- ✓ What are potential sources of fuel system contamination?
- ✓ What can you as the technician do to prevent fuel system contamination?
- ✓ Can you always pre-fill fuel filters?



Introduction

The fuel system on the ISB6.7 CM2350 B101 engine is a Bosch high-pressure common rail (HPCR) system 1800 Bar with full authority electronic control.

Comparison to ISB6.7 CM2150 & CM2250

- Fuel system is identical to '07 & '10

Fuel Quality Specifications

Ultra Low Sulfur Diesel (ULSD) fuel is required

B20 biodiesel blend is suitable for use

Refer to the fuels service bulletin #3379001 for more details.

Pressure side fuel filter: 5 micron

Suction Side fuel filter: 25 micron

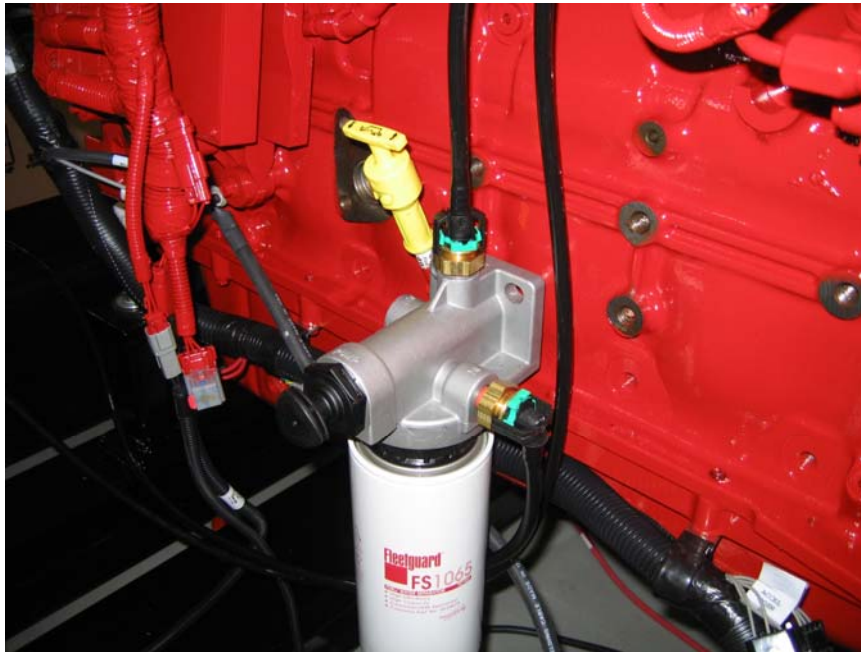


Fuel System Specifications

- High-pressure common rail (HPCR) system
- 1800 Bar System Pressure
- Single-Stage High Pressure Relief Valve
- Full authority electronic control of injectors
- Manually primed fuel system
- Engine mounted and off engine mounted suction side fuel filter options
- The suction side fuel filter must include:
 - Water separator
 - Water-in-fuel (WIF) sensing features
- Optional 12 or 24 VDC fuel heater with integral thermostatic control is available from Cummins



Priming Pump



ISB CM2250 engines do not utilize an electric motor driven lift pump.

The OEM installed hand priming pump is used to prime the fuel system. It can be remote or mounted on the engine.

During normal engine operation, the gear pump mounted on the fuel pump will draw fuel from the OEM fuel tank



Fuel Filter (Suction side)



The priming pump fuel filter (25 micron) and water separator is on the suction side of the fuel system.

- Requires an extension harness to connect the water in fuel (WIF) sensor
- Can be pre-filled

Priming

- Pump the primer handle until resistance is felt and the handle cannot be pumped anymore (approximately 140 to 150 strokes for dry filters, or 20 to 60 strokes for pre-filled filter).
- Lock the manual priming pump handle.
- Crank engine. If the engine does not start after 30 seconds, turn key to OFF position.
- Pump the priming pump again, repeating the previous steps until engine starts



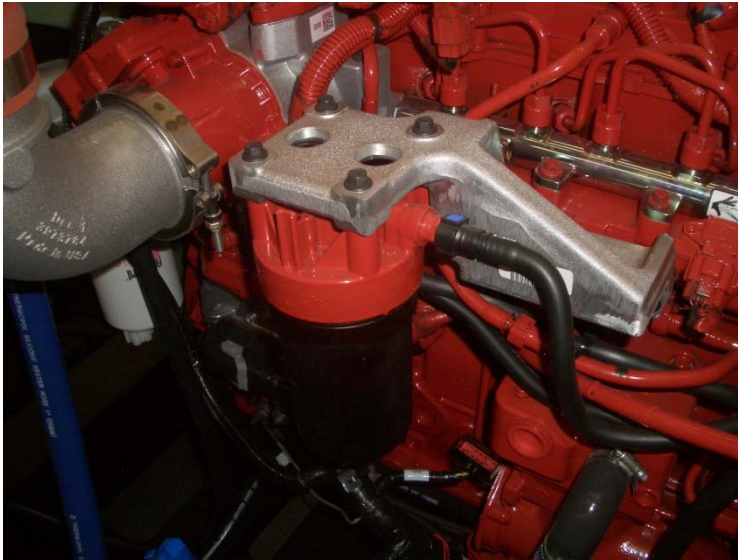
Fuel Heater (Optional)



The fuel heater is not controlled by the electronic control module (ECM). A bimetallic strip acts as a thermostat.

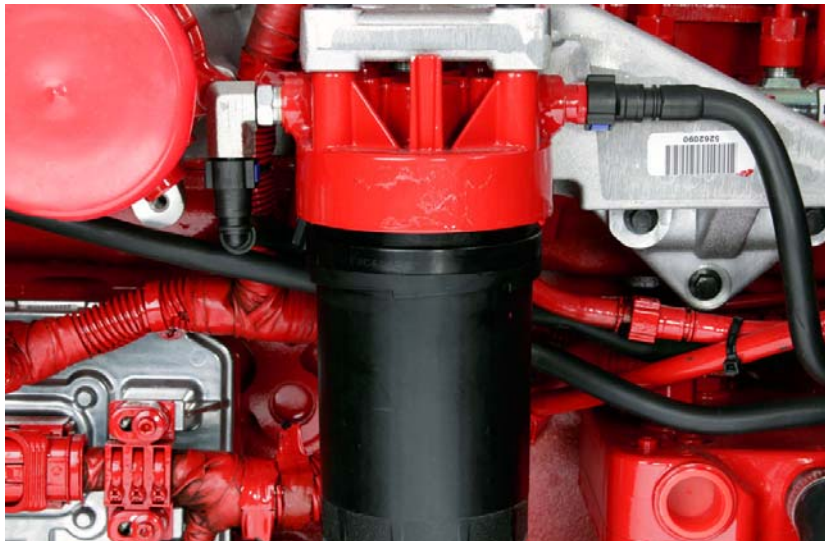
Mounted at the priming pump filter head. The fuel heater will turn on below approximately 35.6°F and turn off above approximately 24°C [75°F].

Fuel Filter Head / Bracket

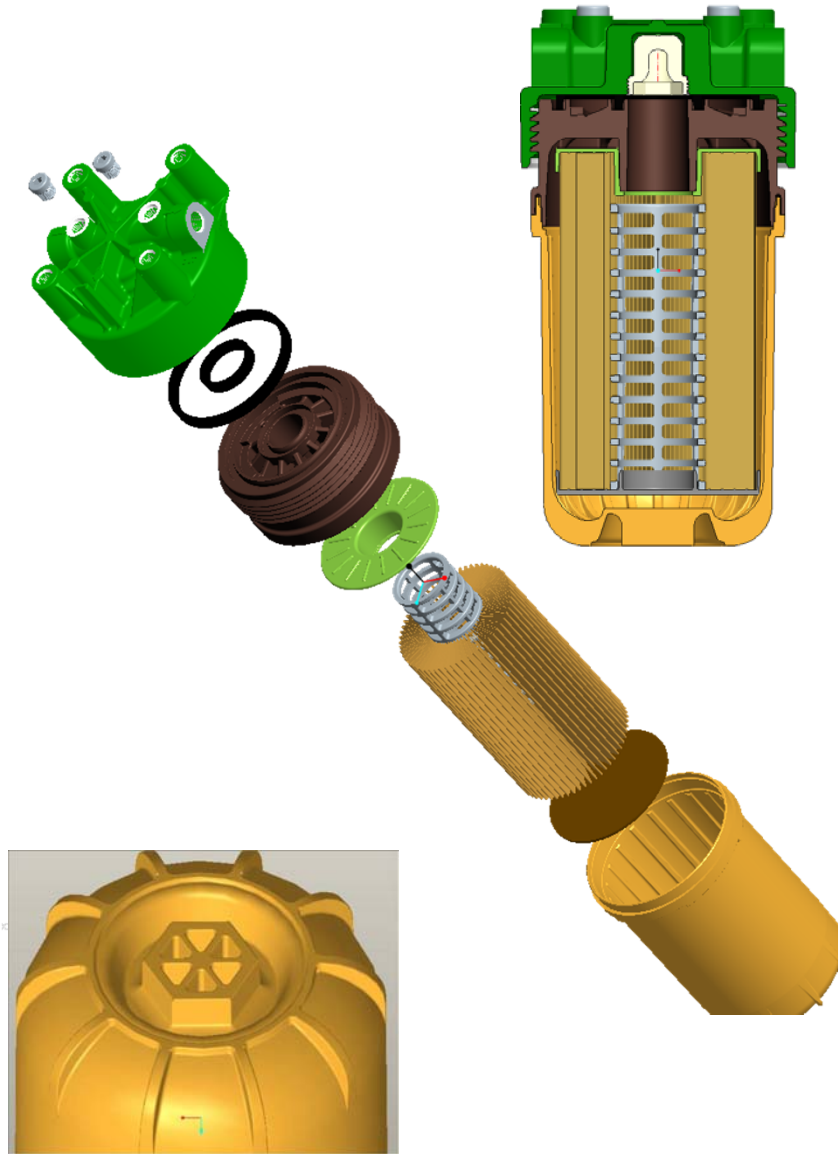


The fuel filter head and bracket are separate pieces.

- The bracket mounts to the intake manifold cover
- The filter head mounts to the filter bracket



Pressure Side Fuel Filtration



Provided by Cummins

- 5 micron rating
- Engine or remote mounted options

NanoNet™ media provides

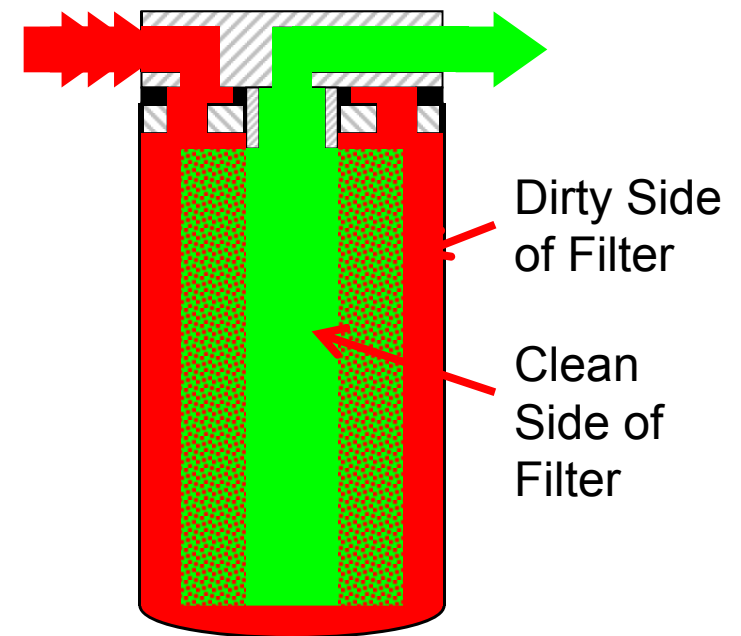
- a substantial improvement in particle efficiency in the 4, 5 and 6micron(c) range.
- a substantial improvement in particle efficiency under vibrations
- A lower ΔP across the media






Why is pre-filling pressure-side fuel filters not recommended?

Normal System operation

Fuel from the suction side filter has been filtered, but not at the micron level the fuel system requires



-  Fuel entering filter head and filter
-  Fuel passing through the filter media
-  Fuel cleaned to the final micron level



Continued ...


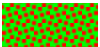
What really happens during pre-filling?

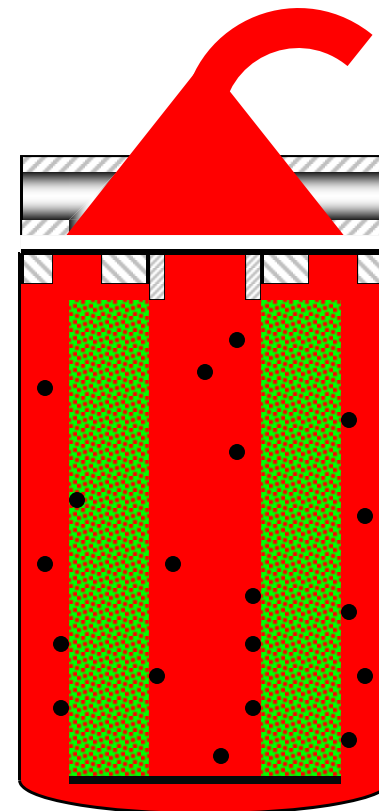
During pre-filling the “clean side” of the filter is exposed to any contamination in the fuel supply source

Contamination happens that quickly

Both sides of the filter media are exposed to unfiltered fuel

Critical system parts are now at risk

-  Fuel from pre-fill source
-  Fuel passing through the filter media

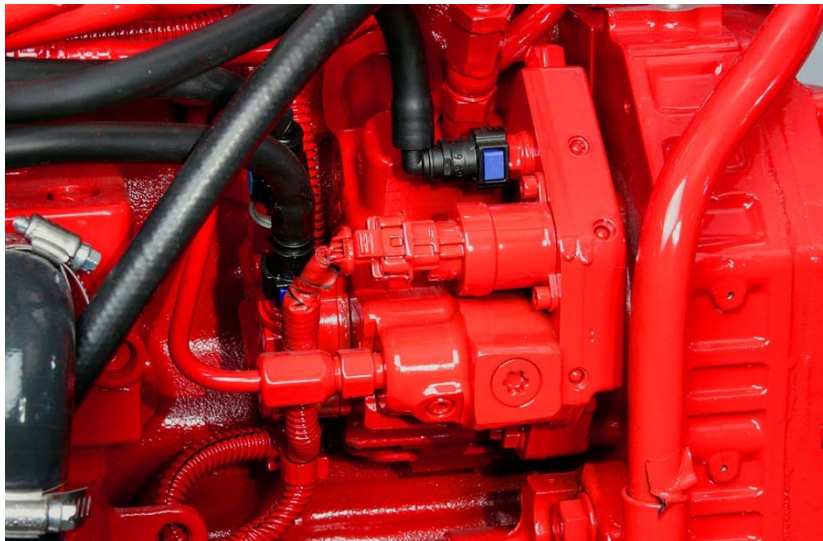


High-Pressure Fuel Pump



Gear driven by the crankshaft gear.

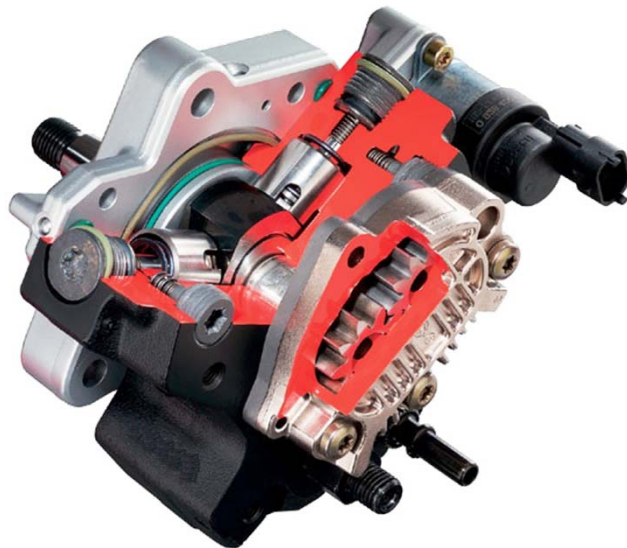
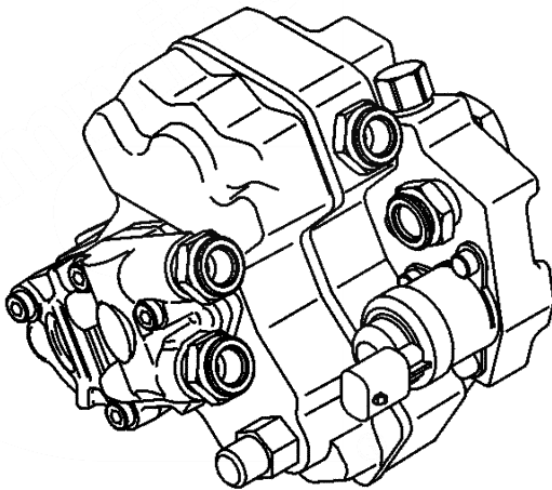
Pump pressure is 1800 bar.



2 mounting locations:

- high position
- low position.

High-Pressure Fuel Pump

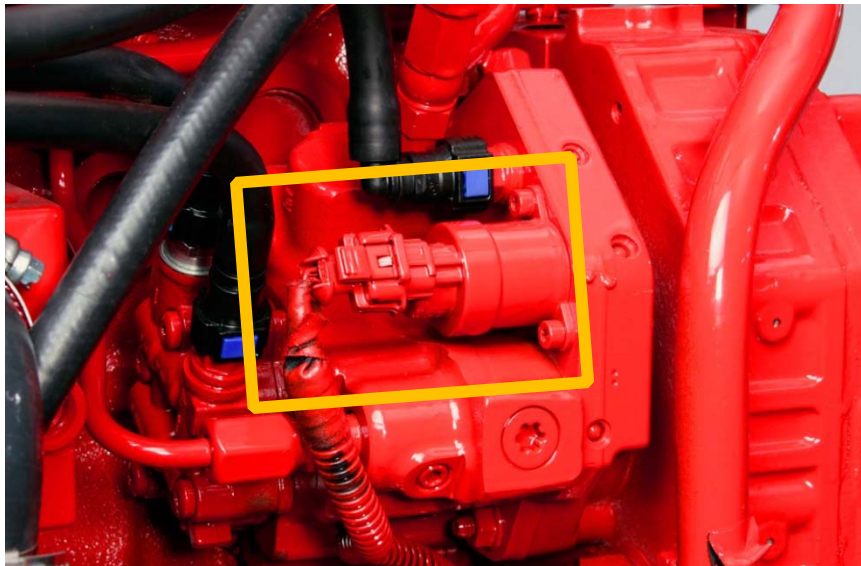


The high-pressure fuel pump consists of 3 main components:

- **Gear pump** - used to increase supply fuel pressure before delivering the fuel to the high-pressure section of the fuel pump. This is not a serviceable component.
- **Fuel pump actuator** - used to control the fuel pressure developed by the fuel pump. This is a serviceable component.
- **Pumping chamber** - uses three radial pumping plungers to build high fuel pressure (250 to 1800 bar [3626 to 26,107 psi]).



Fuel Pump Actuator



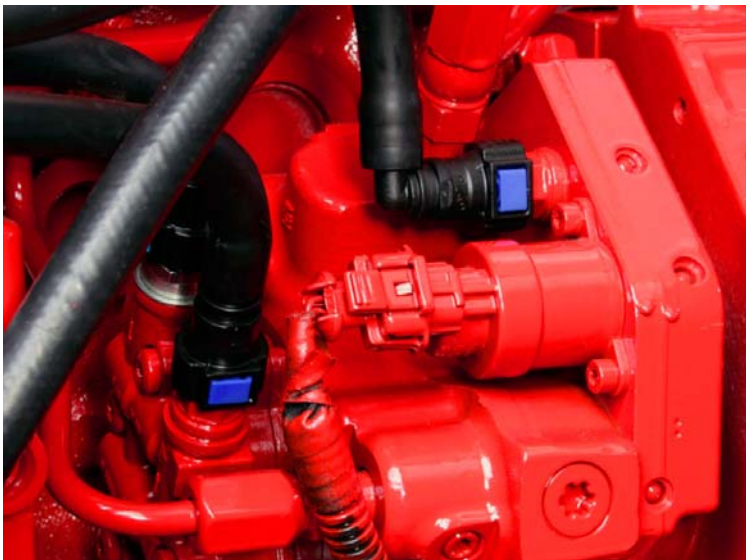
- PWM (Pulse Width Modulated) device driven by the ECM
- “Normally Open”
- The fuel pump actuator is a serviceable part.
- Troubleshooting procedures have been updated to reflect when the fuel pump actuator should be replaced vs. the entire fuel pump assembly



INJECTORS AND FUEL LINES GROUP



Low Pressure Fuel Lines

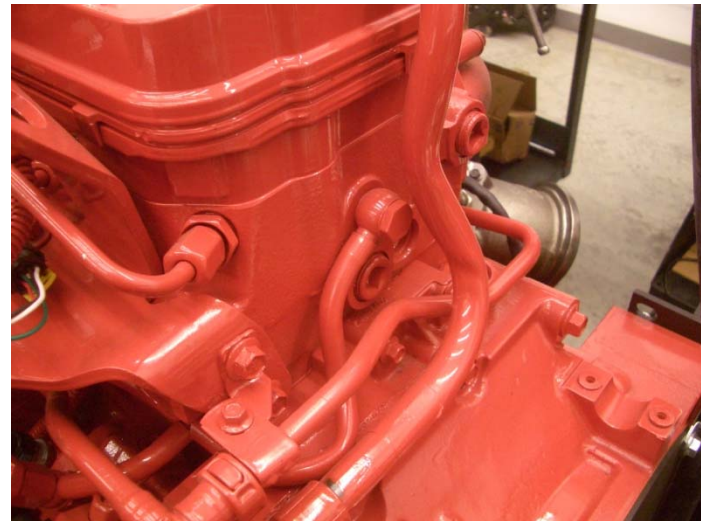
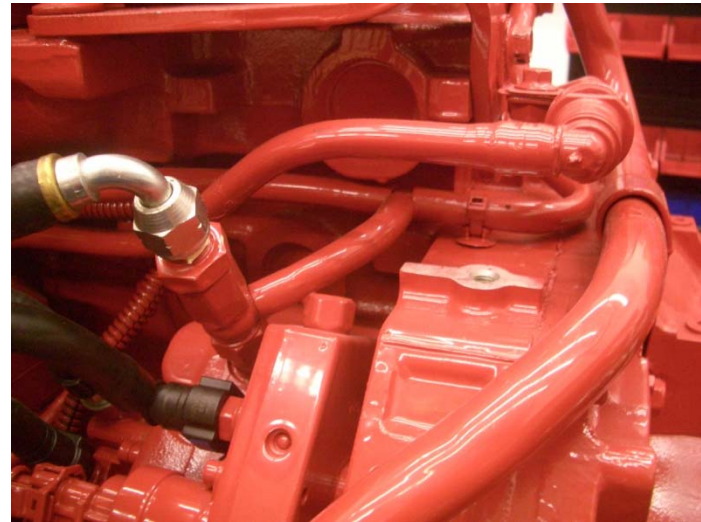
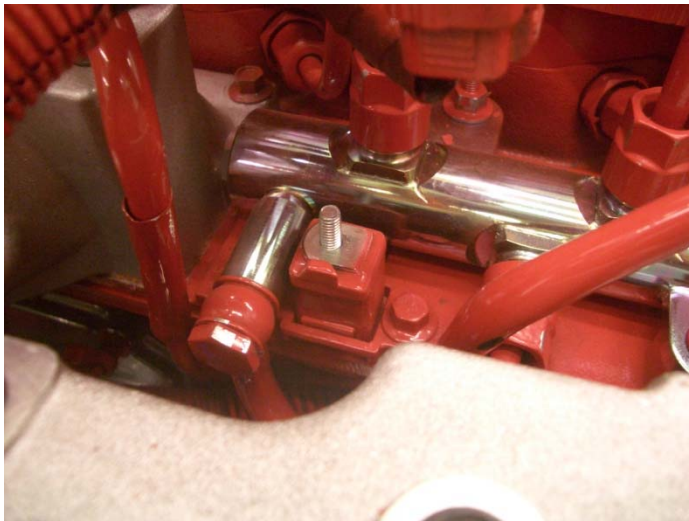


- Quick connect fuel lines are utilized on the low pressure side of the fuel system.
- Fuel supply line connecting the fuel pump outlet to the fuel filter head inlet.
- Fuel supply line connecting the fuel filter head outlet to the fuel pump inlet.

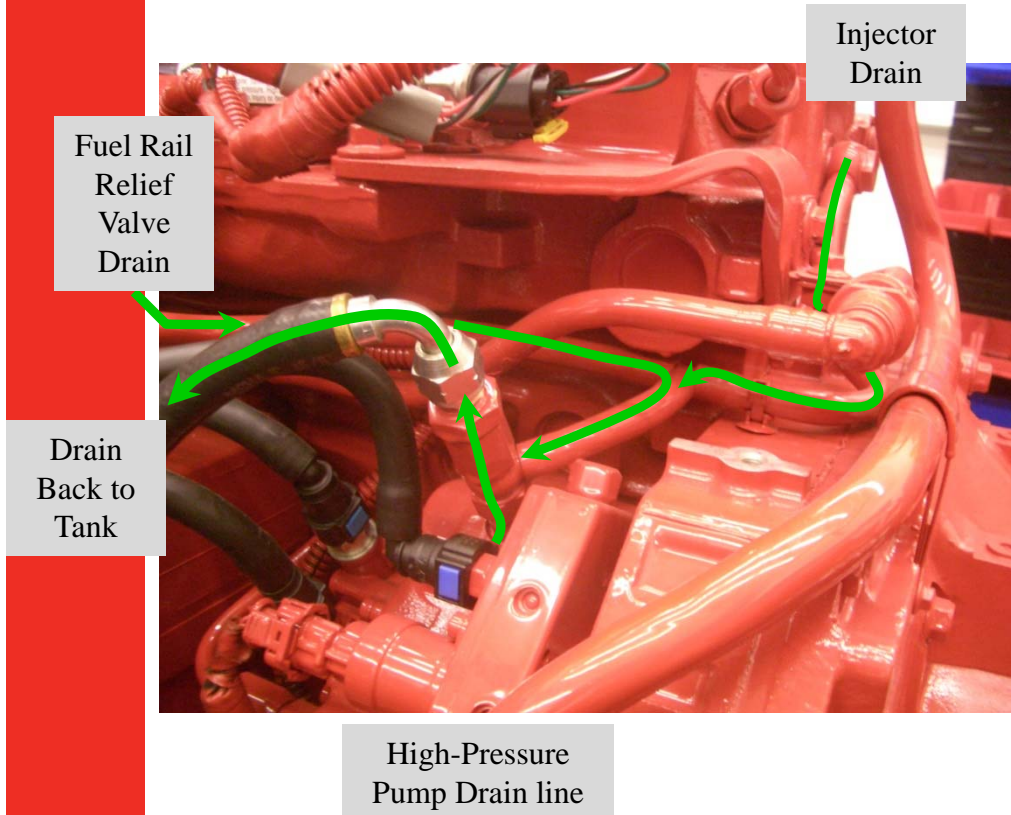


Fuel Drain Lines

- Fuel drain connection from the fuel injection pump.
- Fuel drain line from the fuel rail pressure relief valve.
- Fuel drain line from the injector drain port at the back of the cylinder head.



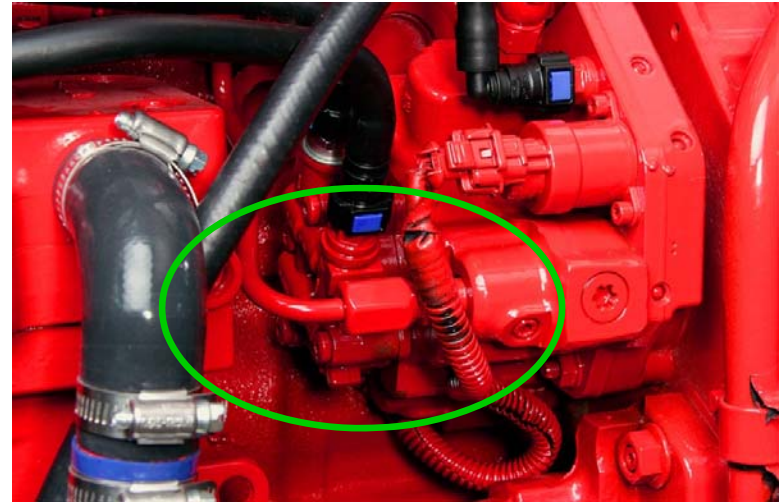
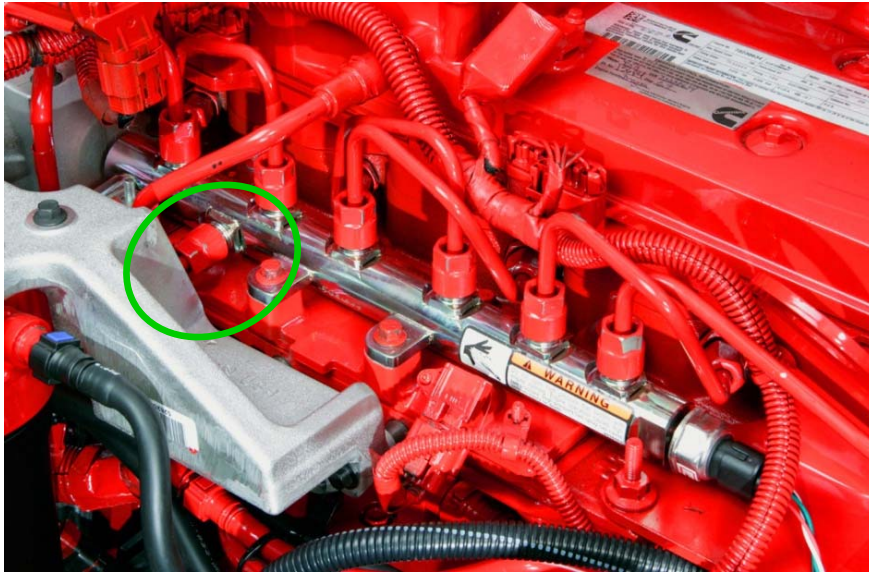
Fuel Manifold



- No fuel return manifold as found on other Cummins HPCR engines
 - The OEM drain line will attach at fuel pump drain connection.
- To aid in separating fuel system drain flows, quick disconnect fittings have been added
 - Critical fuel drain flows for troubleshooting include
 - Fuel Pressure Relief Valve
 - Injector Drain
 - Fuel Pump Drain

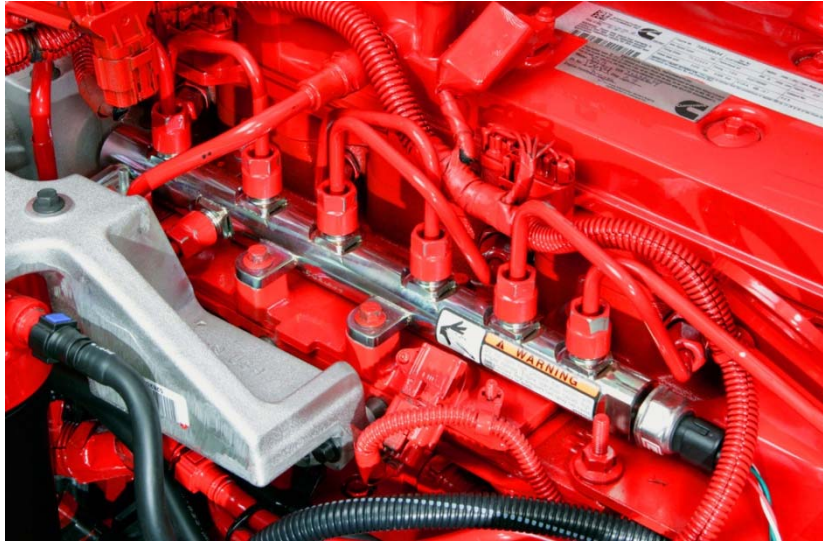


Fuel Rail Supply Line



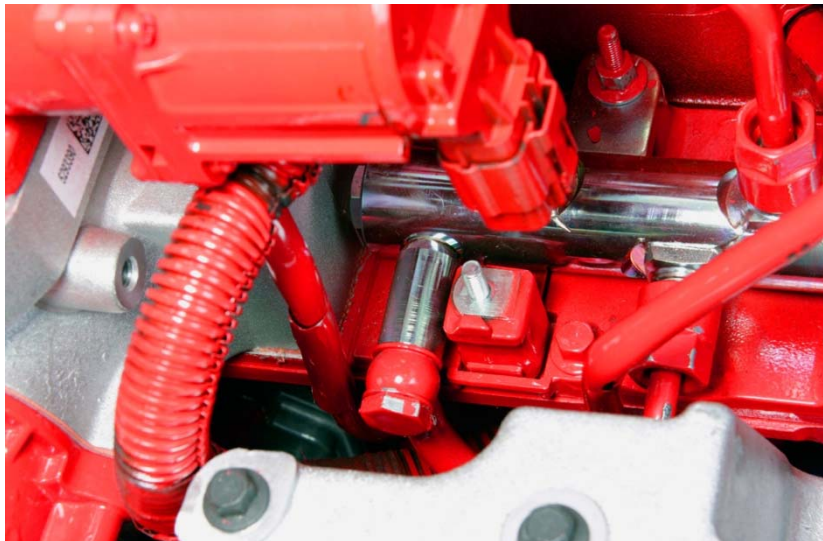
High pressure fuel from the high pressure pump to the fuel rail.

Fuel Rail



The fuel rail contains high pressure fuel from the fuel pump.

The fuel pressure relief valve is a cartridge located at the front end of the fuel rail, Fuel pressure relief valve



- 1) Fuel pressure relief valve drain
- 2) High pressure fuel supply fitting from fuel pump
- 3) Mounting bracket (s)
- 4) High pressure injector supply fitting (s)
- 5) Fuel pressure sensor

Fuel Rail Pressure sensor



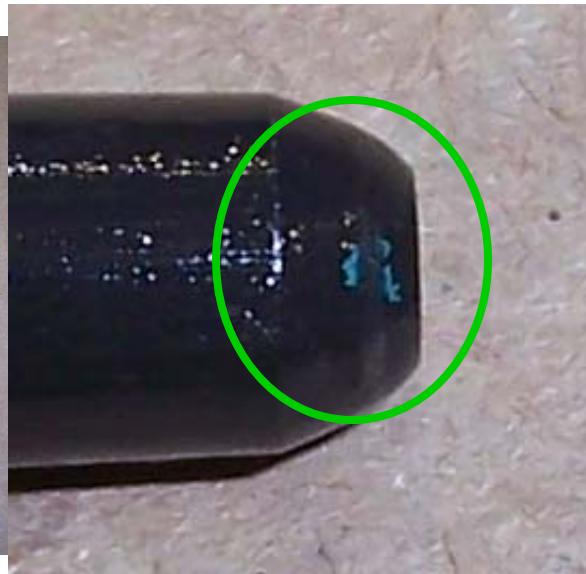
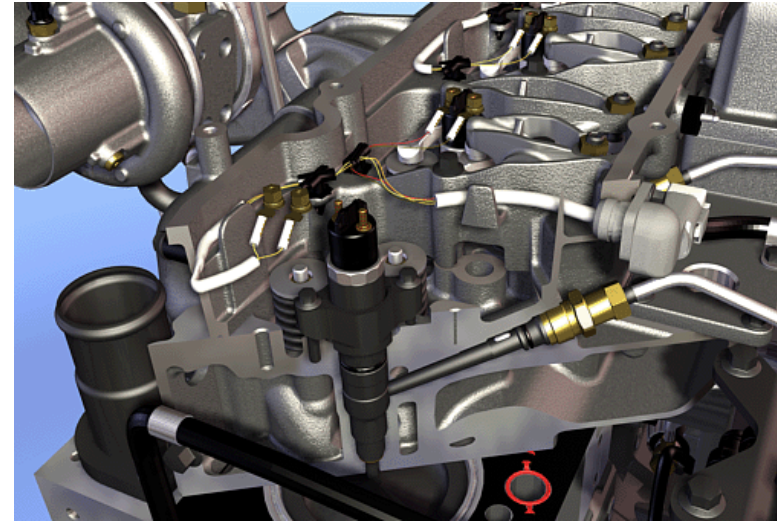
New design and service procedure

Higher torque value to install

Socket must be used



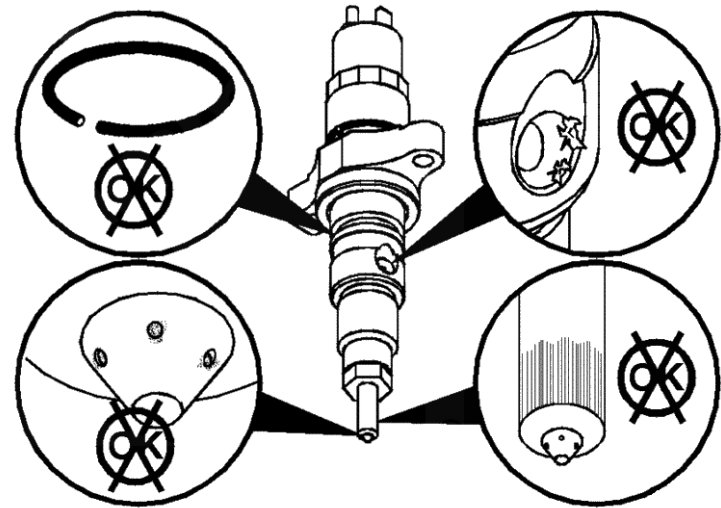
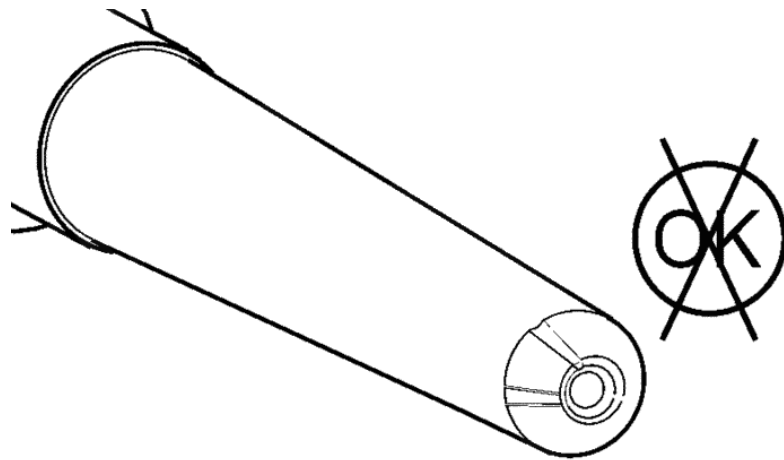
Fuel connector



Why Fuel System Clean Care Really Does Matter?



Fuel Injector / Connector

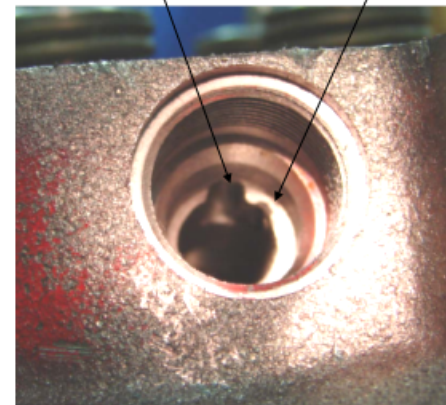


The high-pressure connector and injector must be replaced if failure is observed

- The high-pressure connector should be replaced anytime the injector is replaced

Be sure not to over torque the connector retaining nut. Over torquing the retaining nut may cause the connector to rotate out of the connector retaining slot.

Fuel connector slot, end of rotation (bad)



Fuel Injector



The injector is manufactured by Bosch

The injector retainer is part of the fuel injector



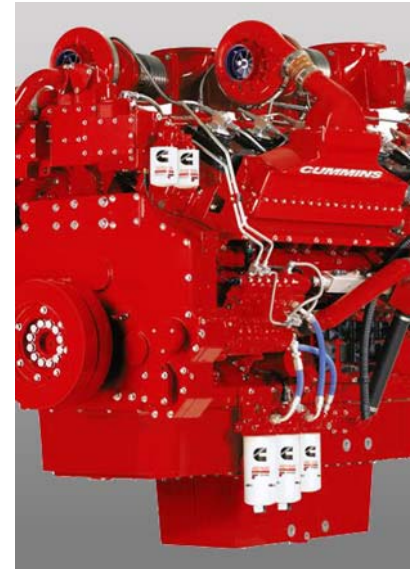
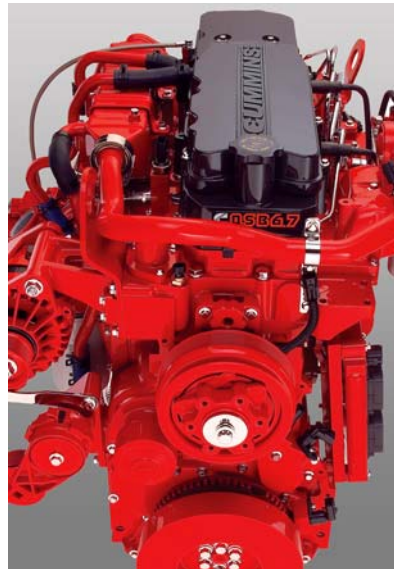
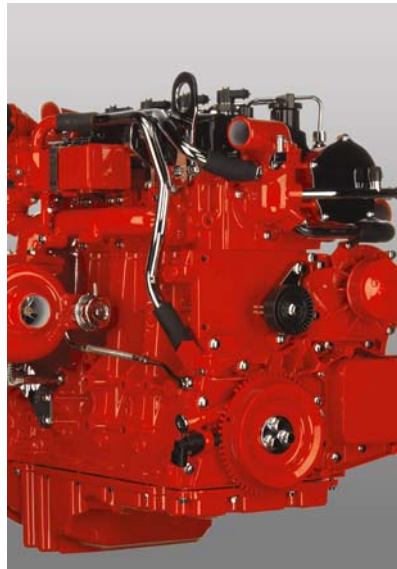
The injectors entrance into the combustion chamber is sealed with a brass seal



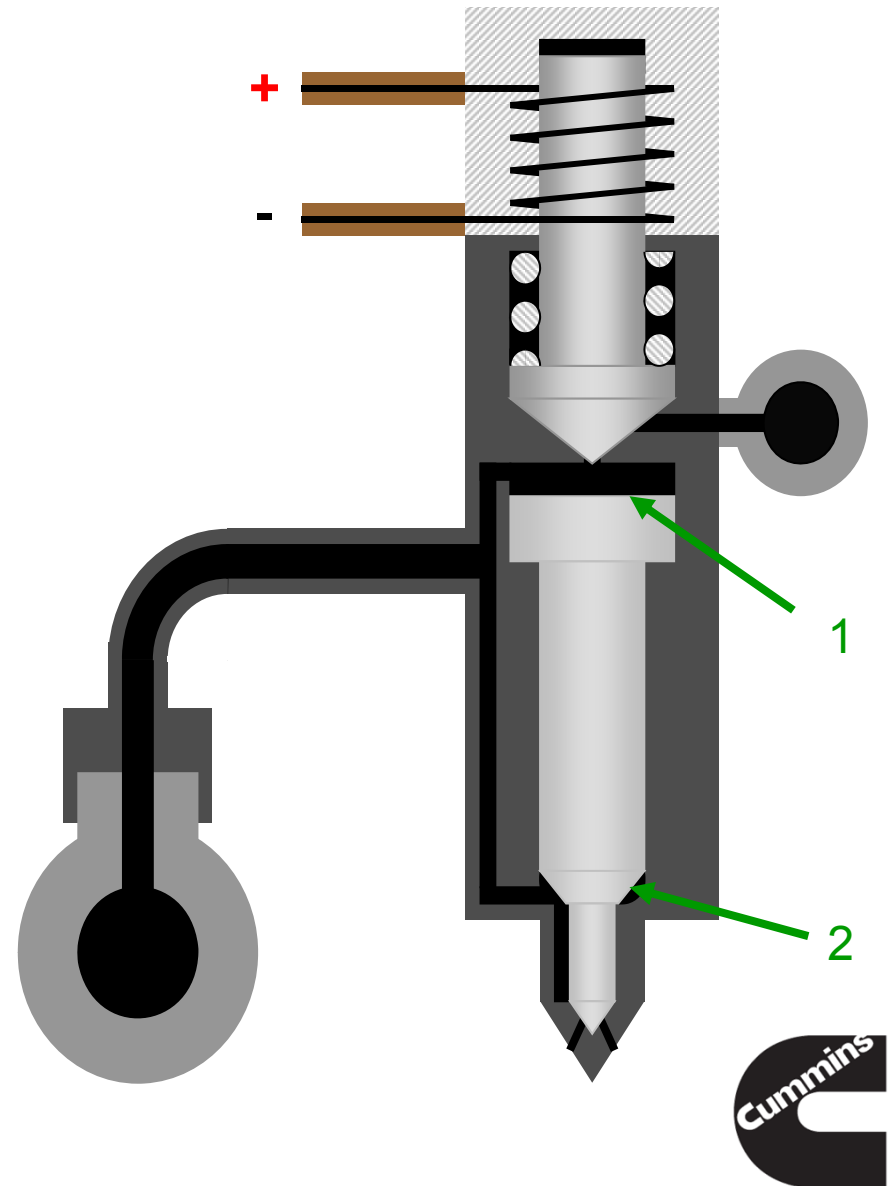


Injector Theory of Operation

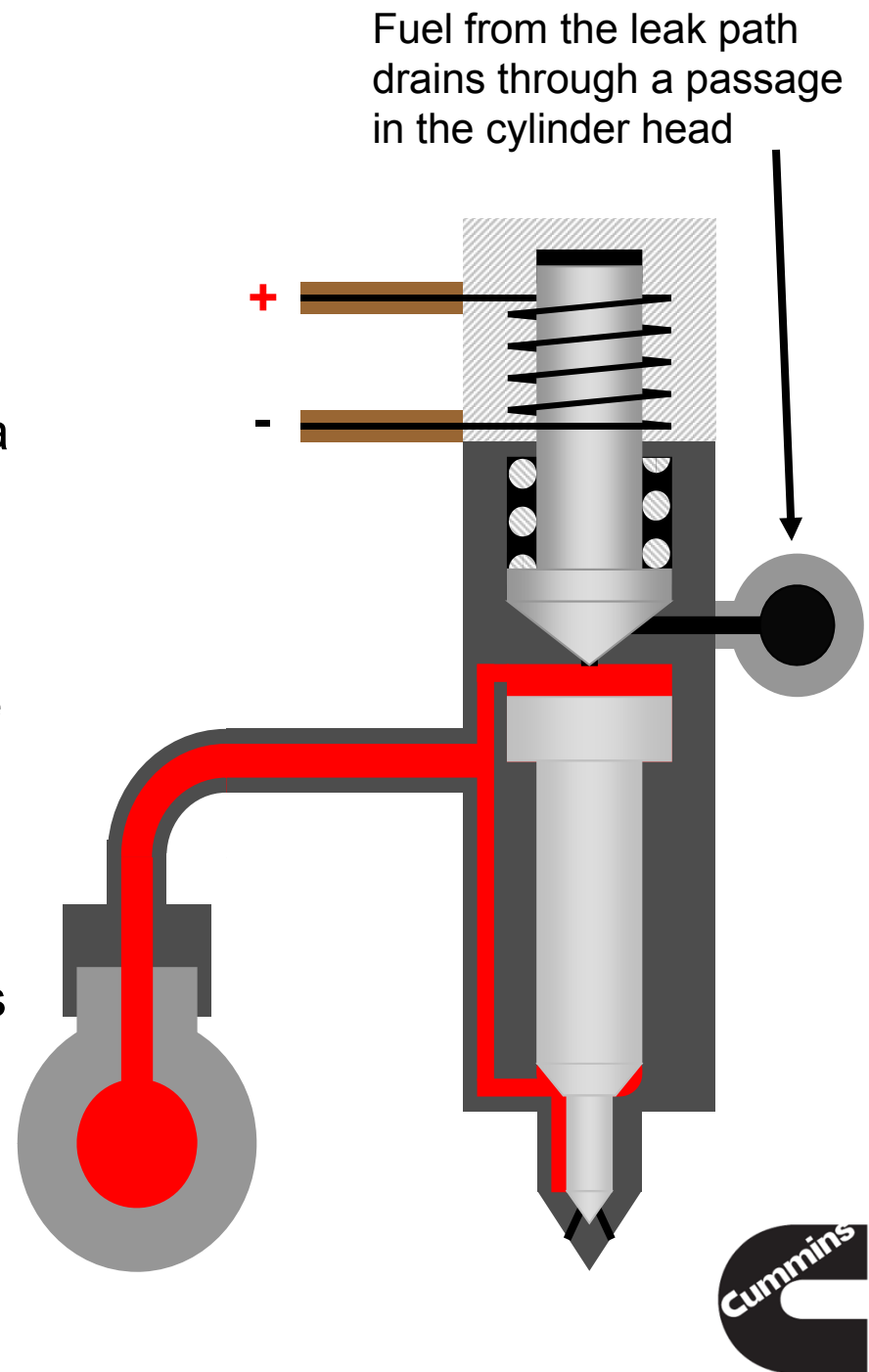
Cummins High Pressure Common Rail



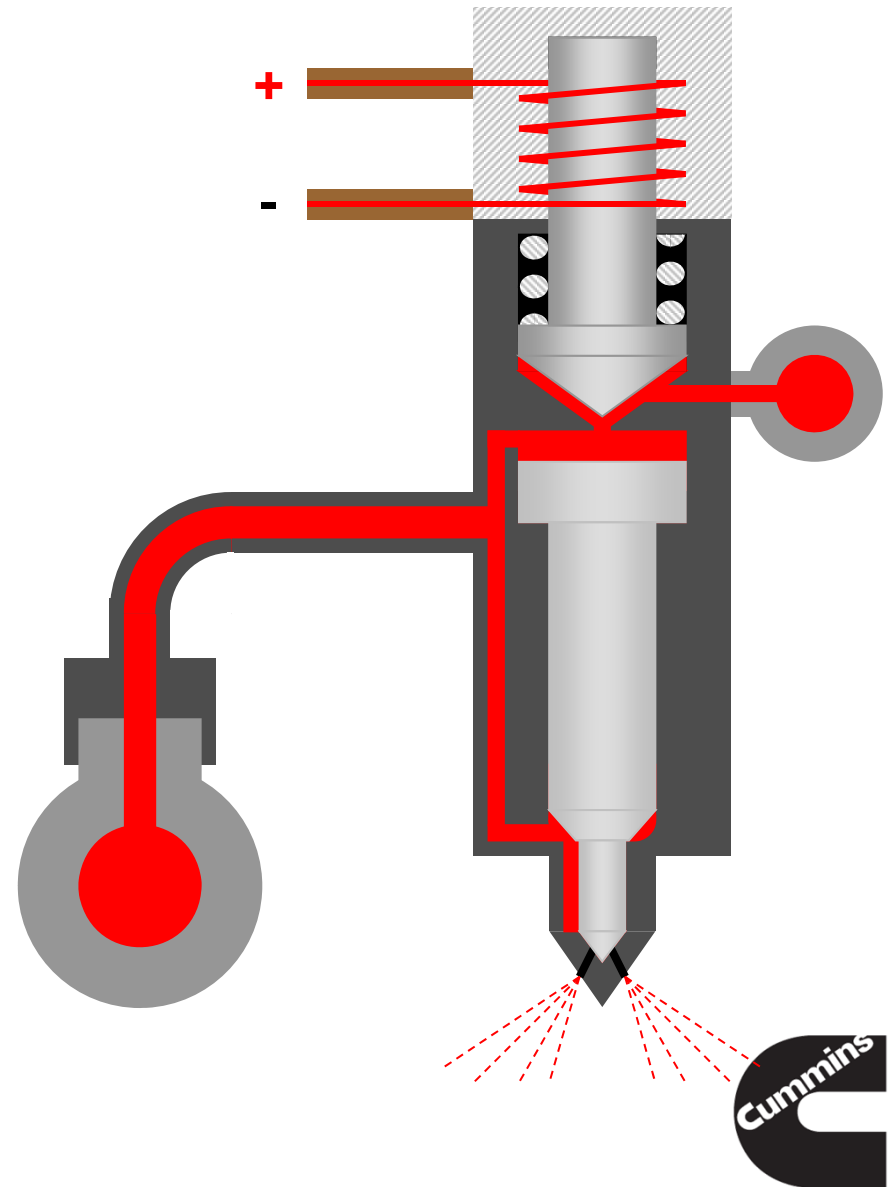
- Injector Solenoid is not energized. The solenoid spring forces the solenoid in the closed position
- Equal fuel pressure is exerted on both the plunger (1) and shoulder area (2) of the needle
- The greater surface area of the plunger (2) results in more hydraulic advantage keeping the injector in the closed position



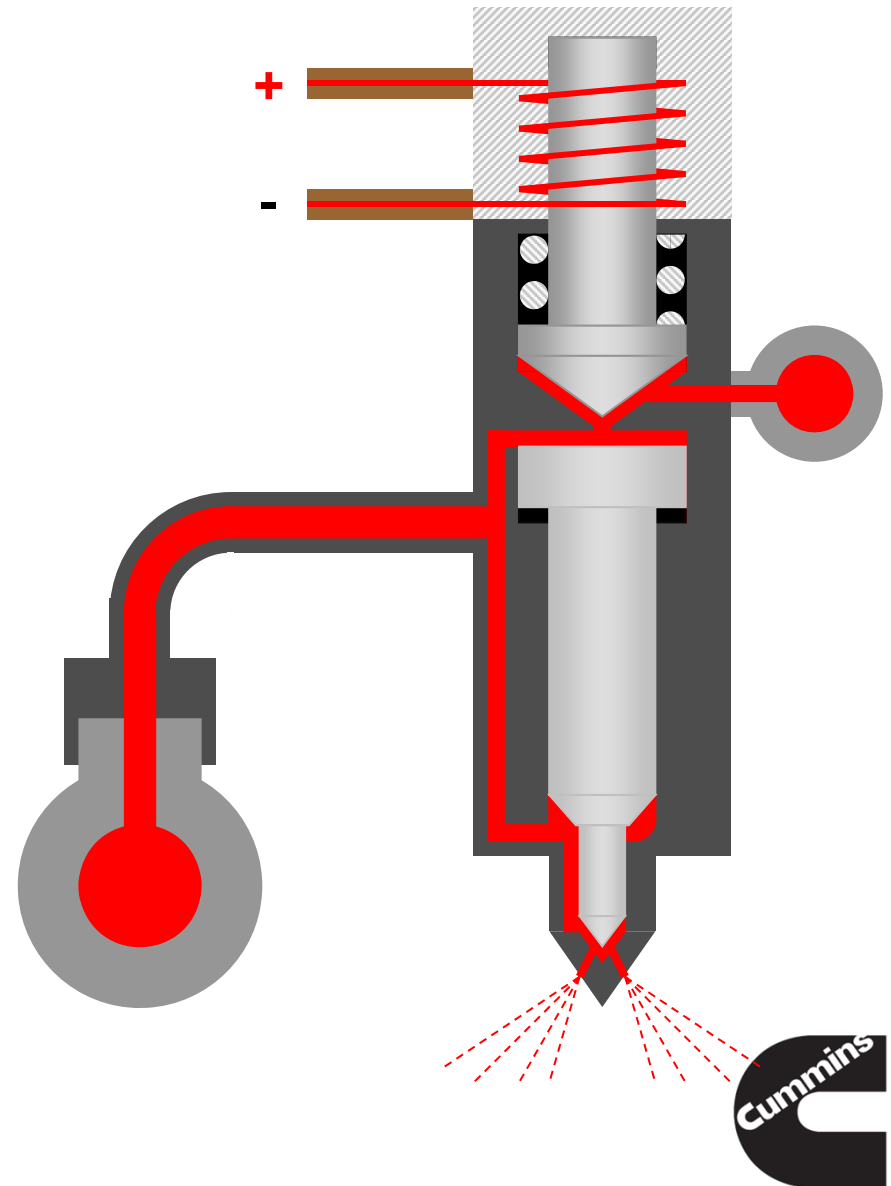
- When the ECM requires fuel for a cylinder a voltage is driven to the injector solenoid
- This creates an electromagnetic force that is greater than the force of the spring
- This forces the solenoid's metal core to move upward
- As the solenoid lifts a leak path is opened in the fuel injector



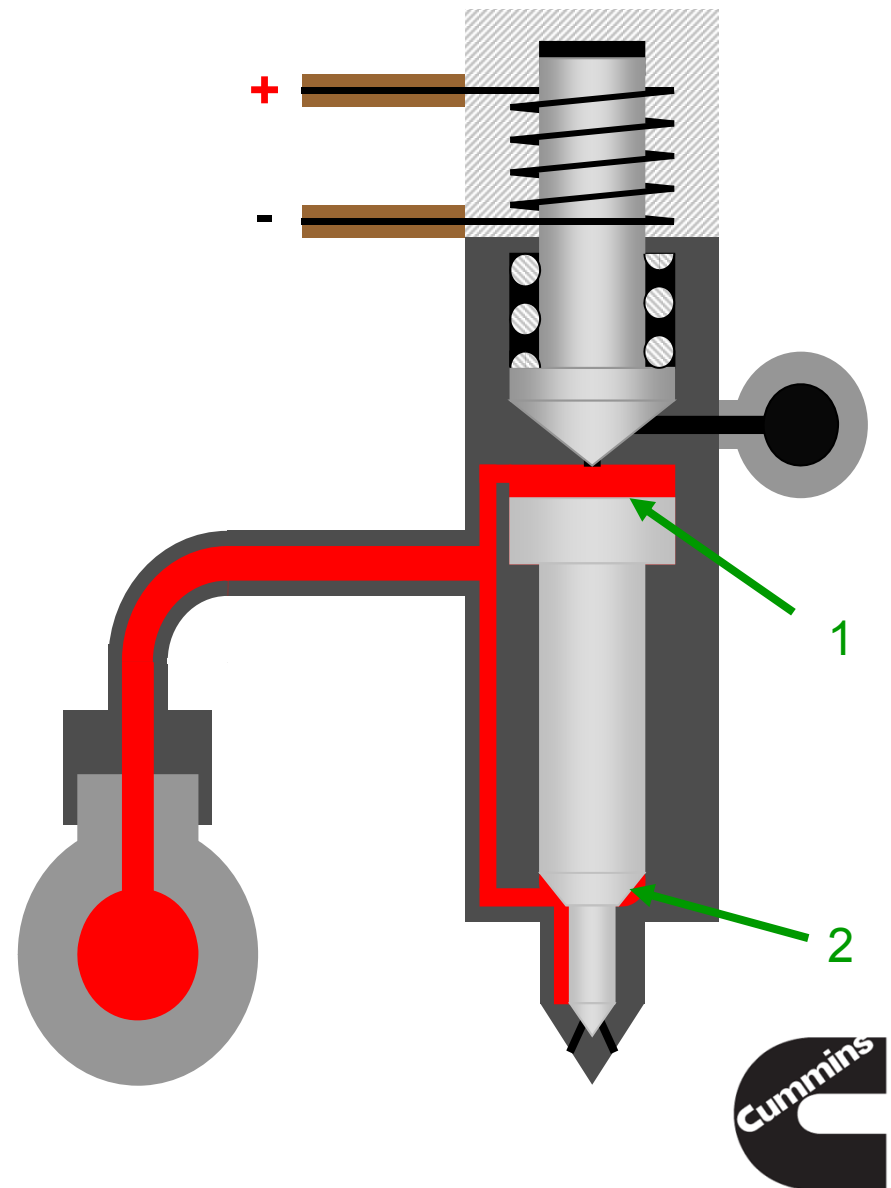
- The leak results in the shoulder of the injector needle now seeing a greater hydraulic force than the plunger (due to the leak path)
- This allows the needle to lift from the closed position
- Fuel is then injected into the cylinder through the nozzles



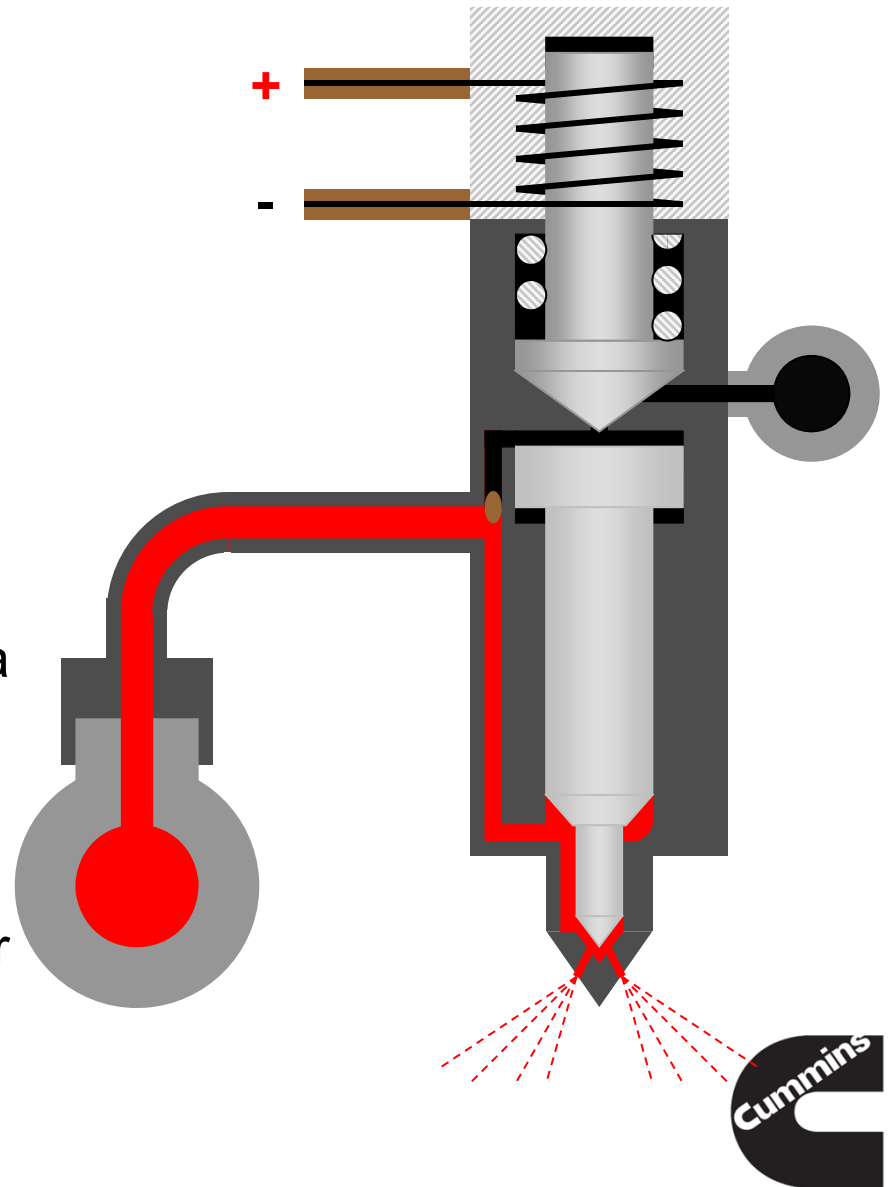
- When fuel is no longer needed the injector solenoid is de-energized by the ECM
- The electromagnetic force is removed allowing the spring to force the solenoid to the closed position
- When the solenoid is in the closed position the leak path is removed
- With the leak path removed the greater surface area of the plunger causes the plunger/needle to reseal and end fuel injection



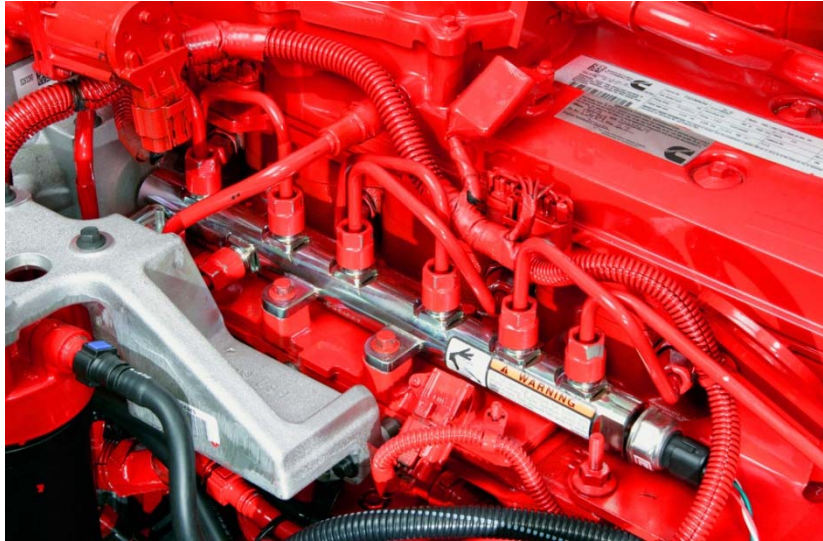
- Equal fuel pressure is again sent to both the plunger (1) and shoulder of the needle (2)
- The greater surface area of the plunger (1) results in more hydraulic force keeping the injector in the closed position until the ECM determines fueling is again needed



- Fuel System cleanliness is very important for High Pressure Common Rail Systems
- Contaminants can lodge in the small passages in the injector preventing critical flows
- If the contaminate particle lodges in the passage to the plunger area
- The result is the injector will remain in the open position and cause engine damage due to uncontrolled fueling of the cylinder

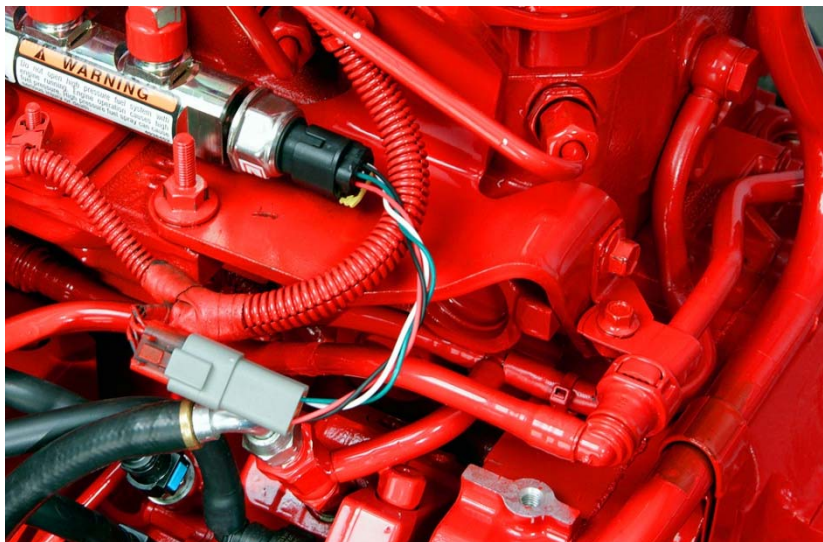


High Pressure Supply Lines



Designed to withstand the 1800 bar fuel pressure and system pressure pulsations

Important to follow the installation procedure in the manual to prevent fuel line failure

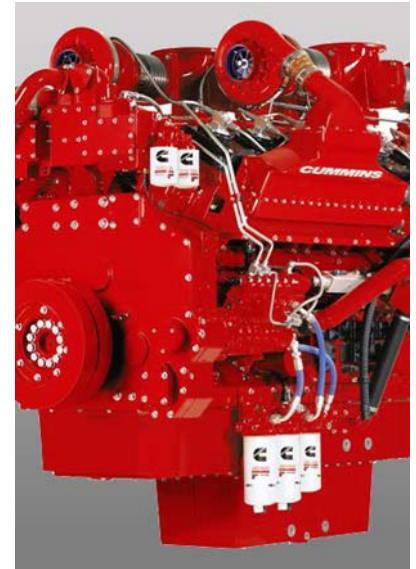
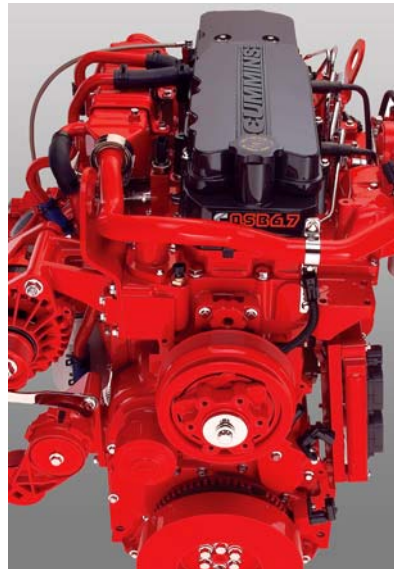
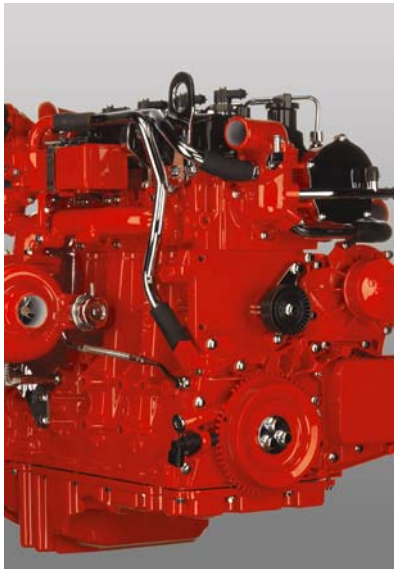


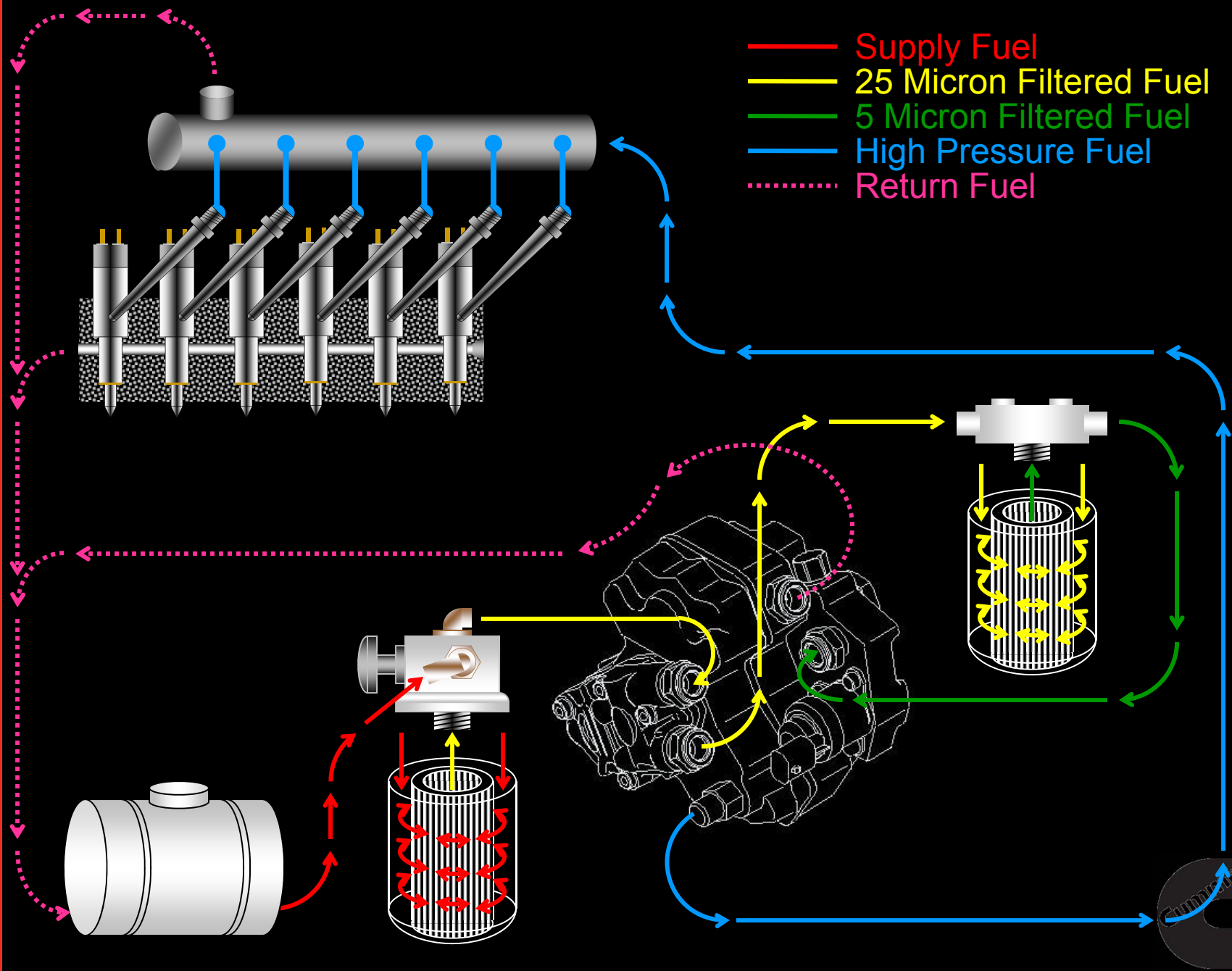
If a leak is suspected never use your hand to find the leak ... use paper or cardboard



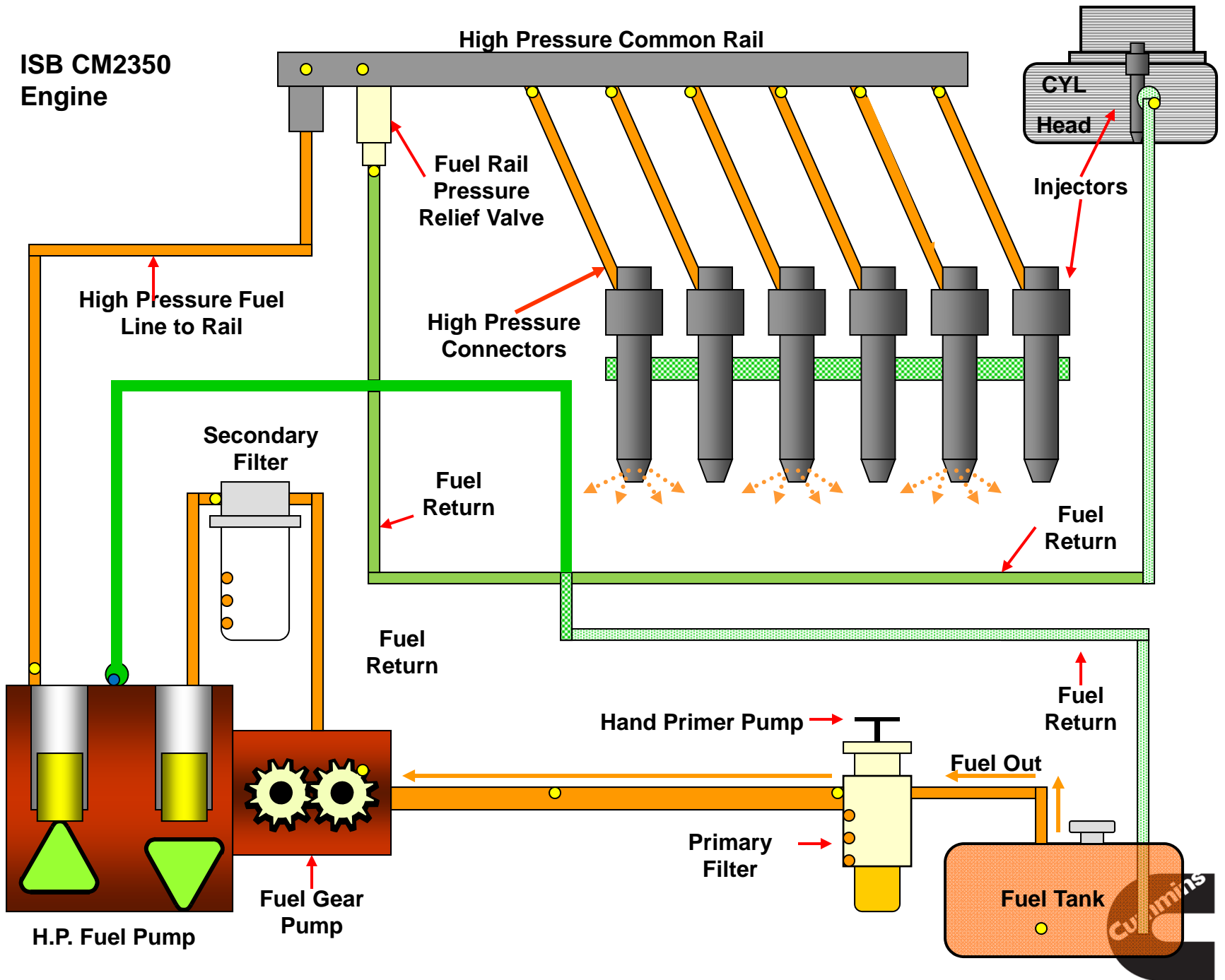


Fuel System Diagnostics





**ISB CM2350
Engine**



Using The Right Tools

Three return flows

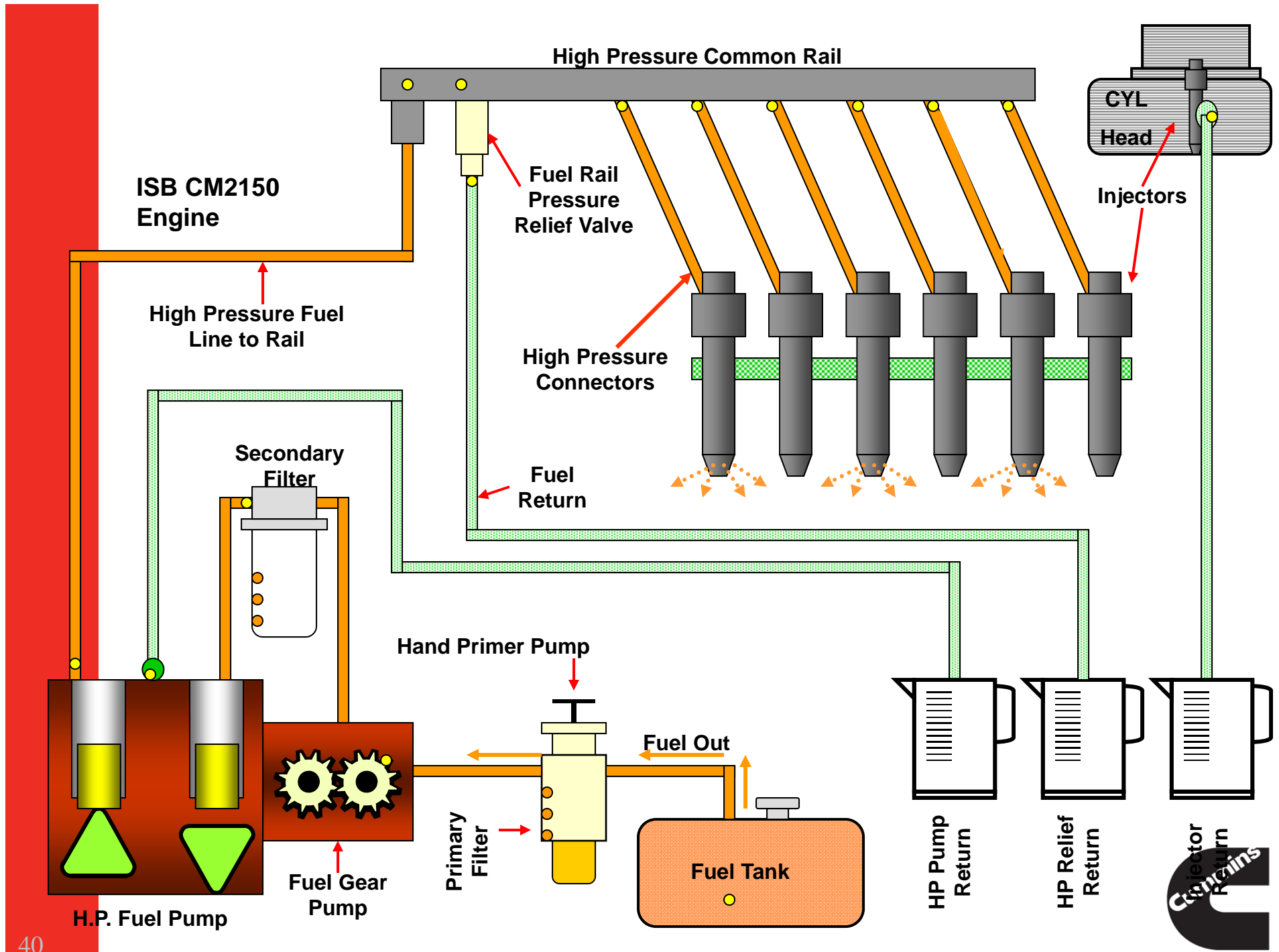
- Injector Return
- High Pressure Pump Return
- High Pressure Relief valve Return

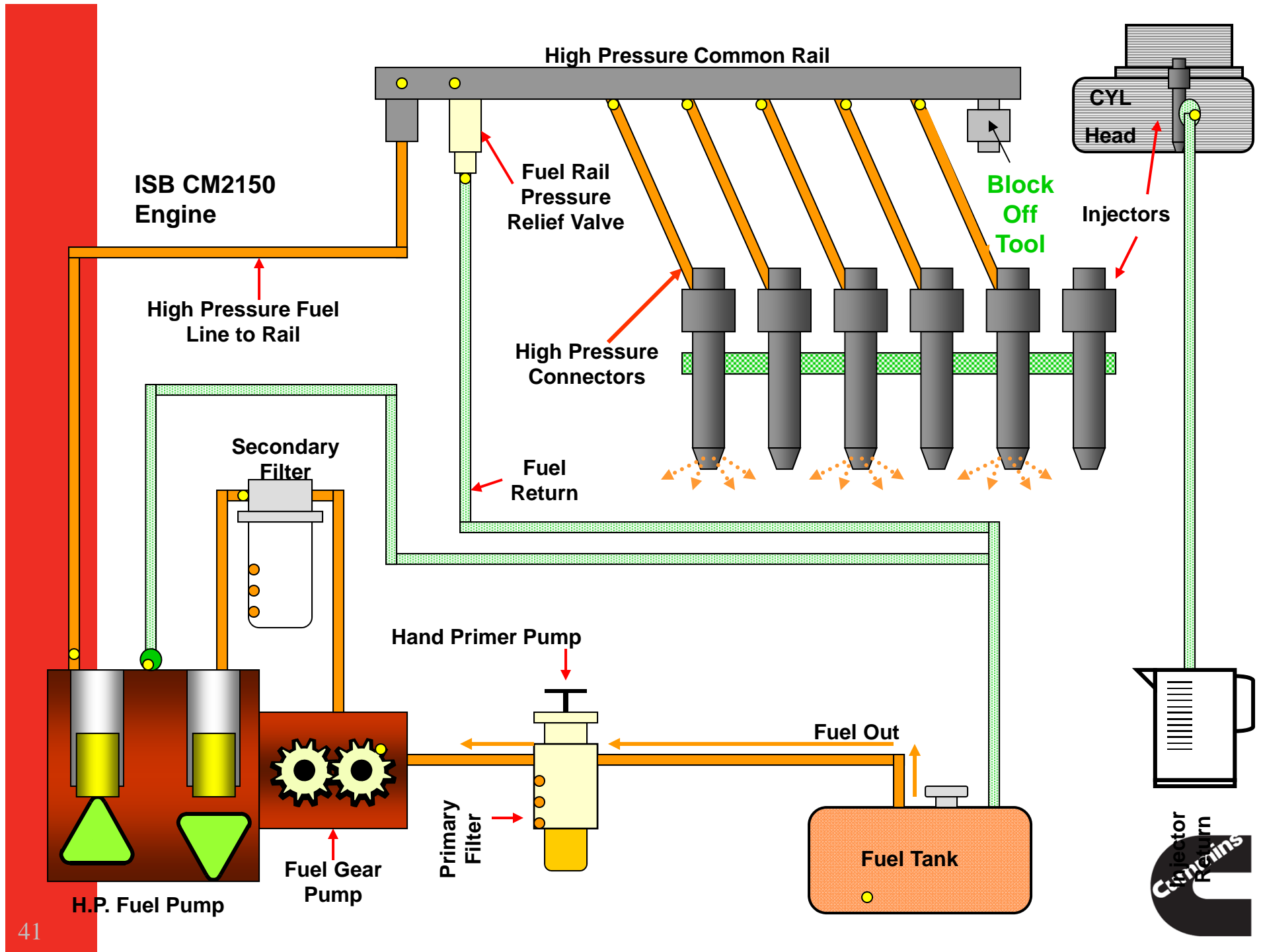
Isolating the flows with the allows us to determine which component is has excessive leakage.

Excessive leakage can cause.

- Hard or no start conditions
- Low power with fault codes indicating low rail pressure







Fuel System Service Strategy

Always replace Fuel Connector (head mounted)

- AKA “High pressure connectors”

Always re-torque the connector retaining nuts when a high pressure supply line is removed

Pre-fill the suction side filter

Pressure side filter can be prefilled if clean side block-off plug used

The fuel pump actuator is a replaceable component



Shop Activity

Perform fuel system tests:

- Inlet Restriction
- Filter Restriction
- Gear Pump
- Pump Return
- High Pressure Relief Valve Return
- Injector Return