



MAINTENANCE INFORMATION

MI21-06

DATE :	November 2021	SECTION : 03 FUEL
SUBJECT :	Diesel Exhaust Fluid (DEF) Contamination In Fuel System, Inspection And Repair – From US10 to newer engine generation	

First release

November 2021

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OVERVIEW

DEF in the fuel system can cause a multitude of problems. DEF can crystallize in fuel as it warms, which can result in blockages in several different locations of the fuel system. DEF is also corrosive and will cause damage to several different types of metal, including carbon steel, brass, aluminum, copper, magnesium, nickel and zinc. This includes electrical components that DEF comes into contact with. DEF passage through fuel injectors will normally cause misfires and short or open circuits as the internal components corrode and become clogged with crystallized DEF. If a chassis has electrical codes (voltage, open circuit, short circuit) logged for multiple injectors, DEF contamination should be one of the possible causes considered. The corrosion and buildup of crystal can also cause fuel pressure issues in both high and low pressure circuits as valves clog or stick in position due to damage caused by the DEF.

SYMPTOMS

In cases where multiple Injector electrical and/or open or short circuit, or high and/or low fuel pressure Diagnostic Trouble Codes (DTC) have logged, DEF contamination is a possible cause that should be considered.

For the common rail fuel system (US17 and newer), DEF presence in the fuel rail can lead to no-start conditions. Often, low pressure system pressure will be within spec, but there may or may not be pressure present in the high pressure system. In addition, it is possible for DEF contamination to be present without any accompanying DTCs, and the possibility should not be eliminated because of a clear DTC readout if there are symptoms present.

SYMPTOMS LIST

- Engine misfire
- No-start
- Uneven operation
- Multiple injector codes
- Fuel pressure codes



DANGER

Park vehicle safely, apply parking brake, stop the engine. Prior to working on the vehicle, set the ignition switch to the OFF position and trip the main circuit breakers equipped with a trip button. On Commuter type vehicles, set the battery master switch (master cut-out) to the OFF position.

Lockout & Tag out (LOTO) must be performed during set-up, maintenance or repair activities. Refer to your local procedure for detailed information regarding the control of hazardous energy.

INSPECTION

Before undertaking any repair on the engine, you must confirm if DEF is well and truly present in the fuel.

There are several locations where the effects of DEF contamination can be observed.

Fuel tank

Smell of ammonia through the fuel filler neck and presence of DEF crystals can reveal presence of DEF in the fuel.

Diesel fuel is less dense than DEF. When allowed to separate, diesel will float on top of DEF which prevents direct visual confirmation. A sample will need to be taken from the tank.

Visual Inspection of Fuel Sample

1. Allow the vehicle to sit on a reasonably level surface with the engine off or at least one hour to give fuel tank content a chance to settle.
2. Using an appropriate clear container (a beaker is a good example), obtain a fuel sample from the bottom of the fuel tank.
 - The depth the sample is taken from is important. Both samples in the picture below were taken from the same tank. A sample taken from the middle or top of the tank (left) may not show an issue, when a sample taken from the bottom of the tank (right) does.



Figure 1

3. Allow the sample to settle 10-15 minutes. In many cases there will be a visible separation of DEF and fuel as shown below:
 - Shining a light through the sample can help highlight the separation, as seen in the photo.

- Although clear separation may not be present, discoloration or cloudiness of the sample may still indicate contamination, as seen in the right sample in step 2.



Figure 2

Alternate Visual Inspection with Kolor Cut Water Finding Paste

Applied to a rod / length of string with bottom weight, the yellow/brown paste changes color to brilliant red where it comes into contact with water (DEF is a 50/50 water and urea), giving you a visual indication as to the depth of the water present.

1. Allow the vehicle to sit on a reasonably level surface with the engine off or at least one hour to give fuel tank contents a chance to settle. The front of the vehicle can be lifted to allow the DEF to separate and gather on the back side of the tank.
2. Apply Kolor Kut Water Finding Paste on an appropriate dipstick. Dip in the fuel tank or in the sample bottle. Kolor Kut Water Finding Paste will turn to red in presence of water / DEF.

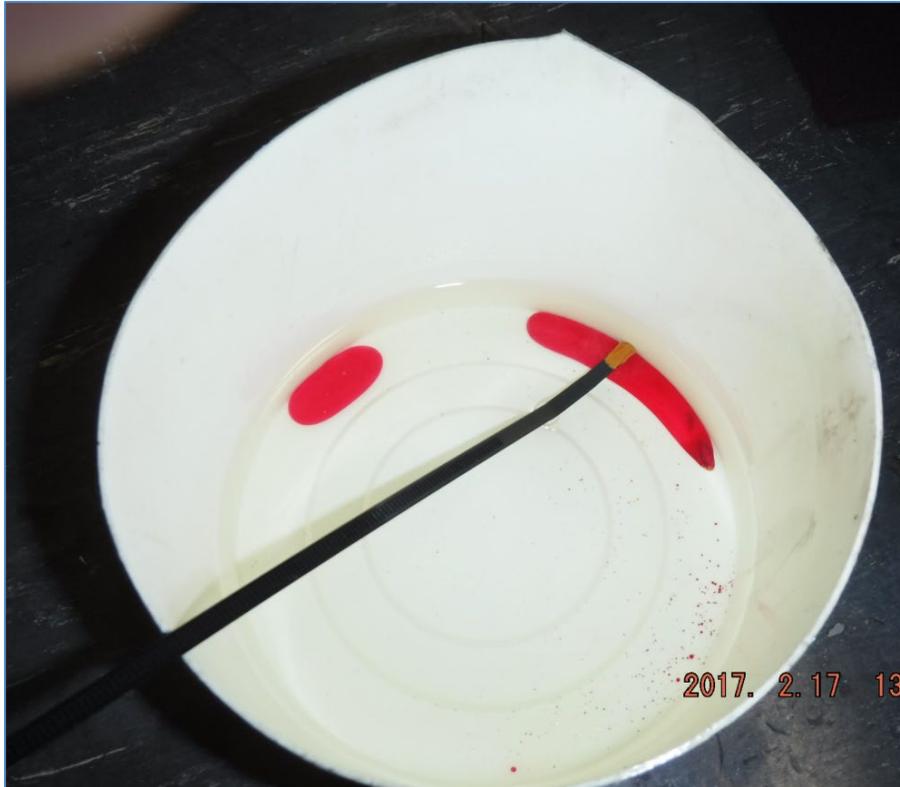


Figure 3: FUEL SAMPLE WITH DEF TURNING RED

See this video about Kolor Kut Water Finding Paste:

<https://www.youtube.com/watch?v=WsdIrpyMUcA>

Where to find Kolor Kut Water Finding Paste:

<http://www.fuequipmentspecialists.com.au/water-finding-paste/kolor-kut-water-finding-paste/>

Fuel Filters

1. Remove both the primary and secondary fuel filters from the housing. Allow them to dry.
2. Check for the presence of crystal buildup or corrosion on the filter face as seen below:



Figure 4: CRYSTAL BUILDUP AND CORROSION/RUST PRESENT ON PRIMARY FILTER. CORROSION/RUST ON SECONDARY FILTER

- If the filters are allowed to dry, white crystal residue may be observed on the filter face.

Fuel Injectors

1. Connect to the vehicle with Premium Tech Tool (PTT) and confirm the codes.
2. Follow Guided Diagnostics through checking injector circuit resistance.
3. If resistance is found to be out of spec, the valve cover needs to be removed and resistance rechecked at the injector connector.

If the resistance is within specs when checked at the injector connectors, there is a poor connection or short in the Engine Harness that should be addressed first. Function will need to be rechecked after the harness is repaired or replaced.

If the same readings are observed at the injector connectors, the harness is not likely a problem and the injectors will need to be removed and physically inspected.

4. Once injectors are pulled, dry the lower portion of the injector that is in contact with fuel using a heat gun.
5. Check for the presence of DEF crystal or residue on the injector using a UV light (blacklight). DEF will fluoresce (glow) under UV light as shown below.



Figure 5

US17 and newer: If there are DTCs or symptoms that lead to injector inspection, the *Common Rail Injector Electrical Test* should be performed prior to injector removal. If DEF presence is confirmed from another of the checks the test is not necessary, as the injectors will need to be replaced regardless of the test results.

The low pressure fuel port in the side of the injector may show presence of pitting or crystal deposits as shown below:



Figure 6

NOTE: When checking for DEF presence on earlier versions of fuel injectors, it was common to observe a white haze on the injector body after drying. Common Rail injectors **may or may not** display this condition with DEF contamination present, and this check should not be used by itself to conclude that the fuel system is free of DEF.

Fuel supply pump

Corrosion and crystal buildup may be observed in the fuel supply pump as shown below:



Figure 7

REPAIR

If DEF is confirmed to be present in the fuel...

The following operations will need to be performed:

- The fuel tanks need to be completely drained and thoroughly flushed with water. The presence of pitting on the inside of a steel tank may require tank replacement. The tank will need to be inspected following cleaning.
- The complete fuel system will need to be thoroughly flushed.
- The system should be dried as thoroughly as possible prior to reassembly.

The following parts will need to be replaced - US17 and newer (Common Rail Fuel System)

- Fuel Injectors and cups
- Fuel supply pump
- Fuel filter housing
- High pressure fuel supply tubes
- Fuel return line (from the cylinder head to filter housing) assembly
- Fuel rail
- Fuel rail pressure sensor
- Fuel rail pressure relief valve, **perform COMMON RAIL EPRV VALVE SUPPRESSION SCI21-04**
- Aftertreatment Hydrocarbon Injector (AHI) Module
- AHI nozzle
- AHI fuel/air supply line (line between AHI module and nozzle)
- Any other fittings where corrosion or clogging is observed.

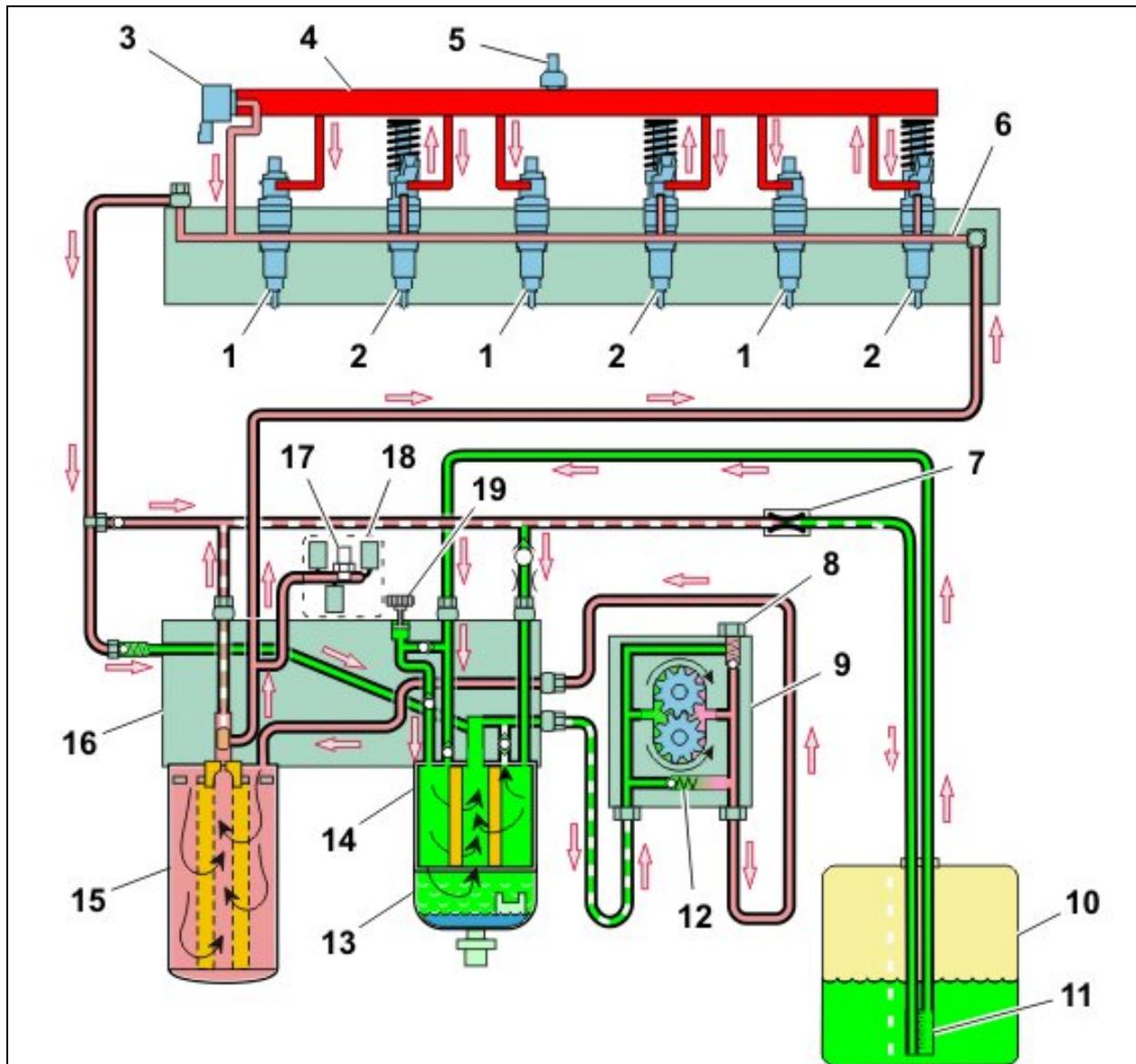


Figure 8: FUEL SYSTEM SCHEMATIC (VOLVO D13 ENGINE GHG17 AND NEWER)

1	Non-pumping injector	11	Pickup tube in the tank
2	Pumping injector	12	Check valve
3	Fuel pressure relief valve	13	Bowl (fuel/water separator)
4	Common rail	14	Primary Filter
5	Rail pressure sensor	15	Secondary filter
6	Fuel channel (gallery)	16	Fuel filter housing
7	Restrictor	17	Fuel pressure sensor (low pressure system)
8	Overpressure relief valve	18	Aftertreatment hydrocarbon injector module
9	Fuel pump	19	Hand pump (fuel primer pump)
10	Fuel tank		

The following parts will need to be replaced - US10 to US14 (Non-Common Rail Fuel System)

- Fuel Injectors and cups
- Fuel supply pump
- Fuel filter housing
- Overflow valve in the cylinder head
- Aftertreatment Hydrocarbon Injector (AHI) Module
- AHI nozzle
- AHI fuel/air supply line (line between AHI module and nozzle)

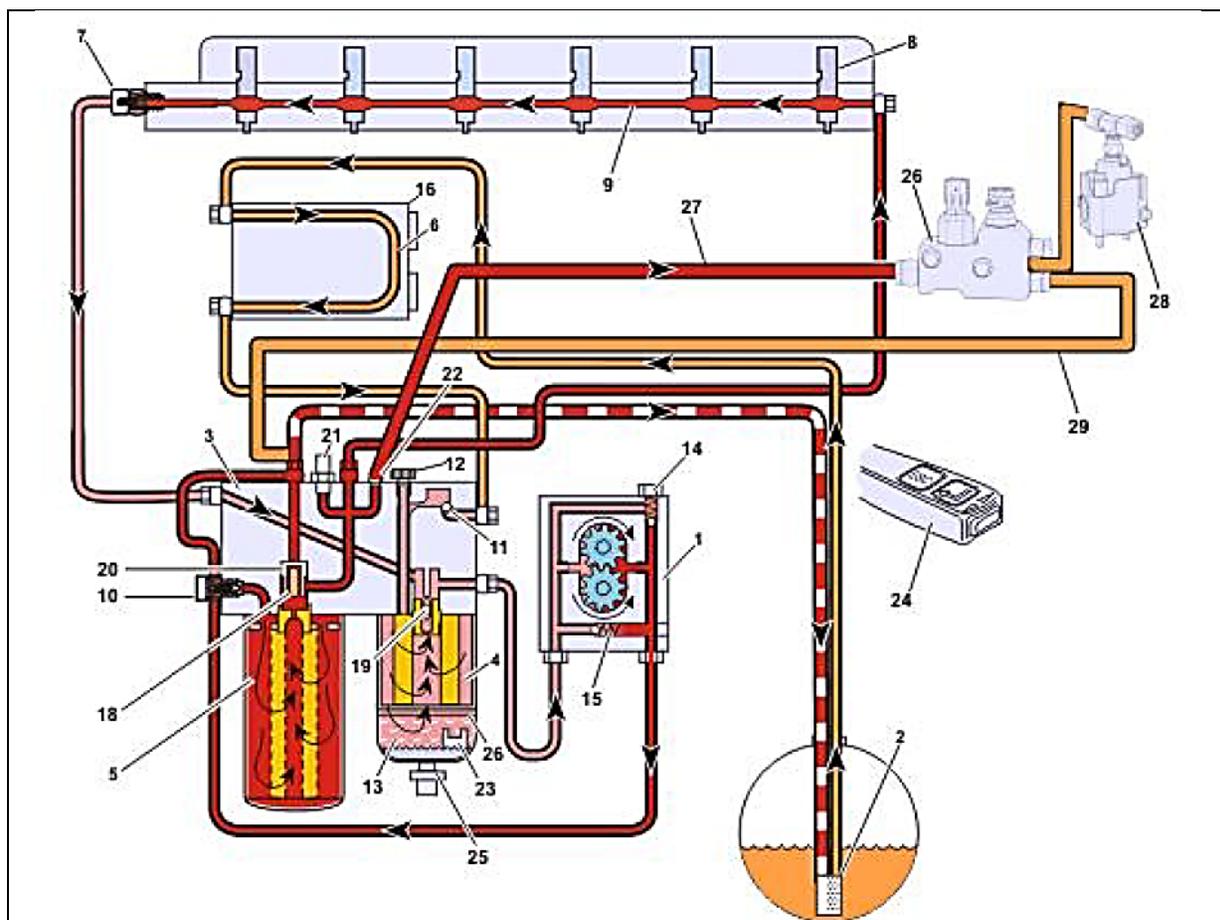


Figure 9: FUEL SYSTEM SCHEMATIC (VOLVO D13 US10 to US14 ENGINE)

Fuel pump (1)	Water separator (13)
Strainer (2)	Safety valve (14)
Fuel filter housing (3)	Non-return valve (15)
Pre-filter (4)	Engine control module (ecm) (16)
Main fuel filter (5)	Changing filters close valves (18 and 19)
EMS cooling plate / engine electronic control unit (EECU) cooling loop (6)	Fuel pressure sensor (21)
	Plugged outlet for external pressure gauge (22)

Overflow valve (7)	Level sensor (23)
Injector (8)	Valve block (26)
Longitudinal fuel non-common rail (9)	Fuel line (27)
Bleed valve (10)	AHI injector/doser (28)
Non-return valve (11)	Return line (29)
Manual fuel pump (12)	

REFER TO IMPACT FOR SPECIFIC MODEL YEARS REMOVAL/INSTALLATION
PROCEDURES AND REPLACEMENT PARTS

1. Drain the fuel tank.
2. Flush the fuel filler neck.
3. Disconnect the fuel supply line at the tank and place in a 5-gallon bucket of clean fuel. Run the engine until all fuel has been sucked in. This will purge the fuel system of any DEF prior to repair. Recover the fuel coming from the return-to-tank hose and consider as contaminated.
4. Thoroughly flush/clean the fuel tank with water.
5. Drain and clean the Davco Fuel Pro 382 primary fuel filter. Clean thoroughly. Replace filter element. Refer to the latest version of the Maintenance Manual Sec: 03 Fuel on the Technical Publications site.
6. Replace all 6 injectors & injector cups. Clean the fuel gallery thoroughly. Adjust valve clearance and perform injector programming.

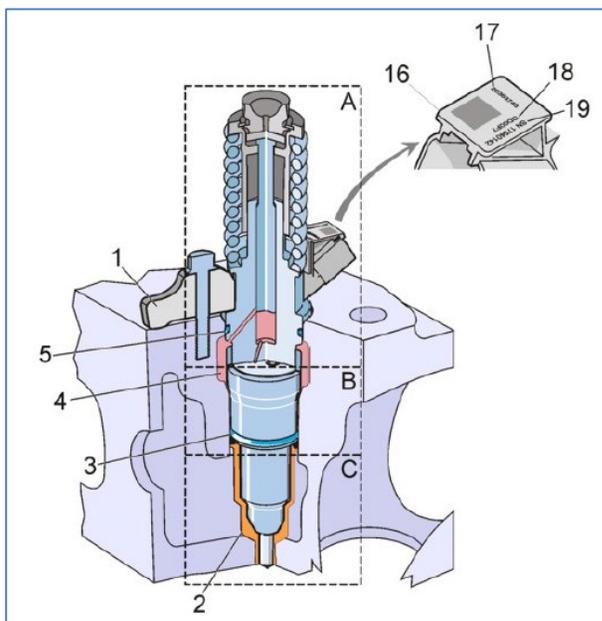


Figure 10: UNIT INJECTOR & CUP (2)

There are three markings on the injector electrical connector (16) — part number (17), trim code (18) and manufacturing number (19). When replacing one or more injectors, the engine control module (ECM) must be programmed with the new injector trim code, since each injector is unique and the engine is trimmed for optimal fuel injection and as low emission as possible. The trim code is programmed in using the parameter programming section of Tech Tool. Programming only needs to be carried out for the replacement injector(s).

7. Replace the fuel pump.

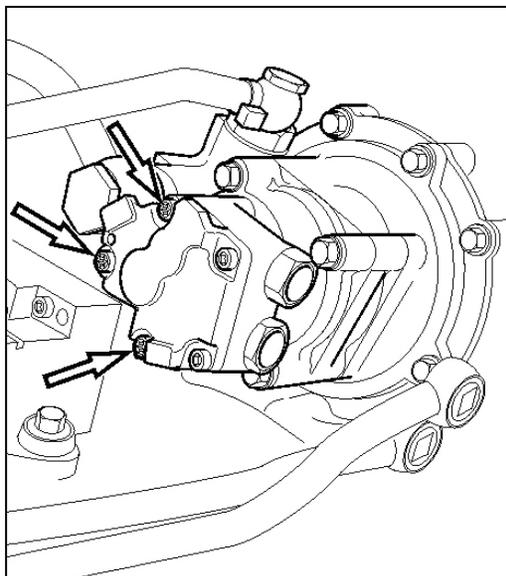


FIGURE 11: FUEL PUMP

8. Replace engine fuel filter housing and filters.
9. **US10** - Replace 7th injector (Figure 12), AHI fuel shut off valve (FIGURE 18), check valve and manifold (FIGURE 13).

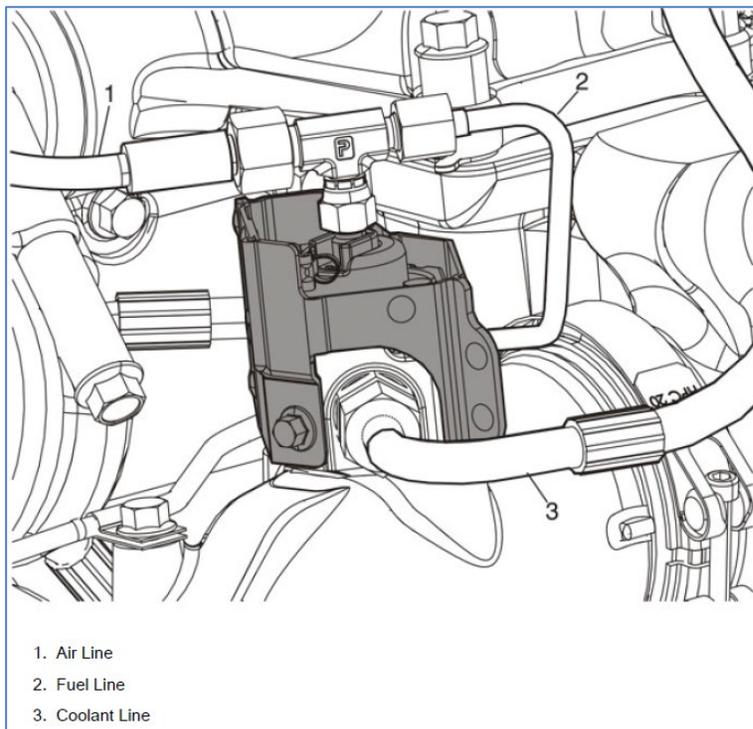


Figure 12

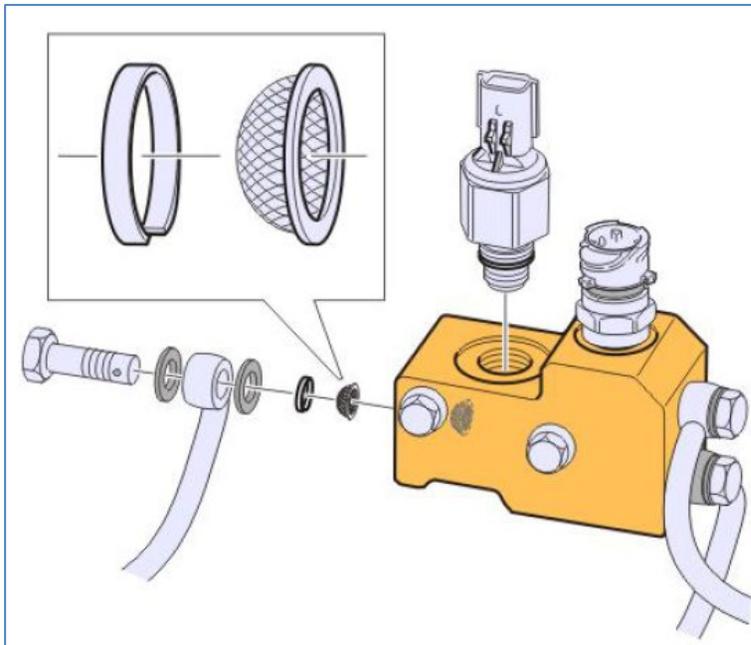
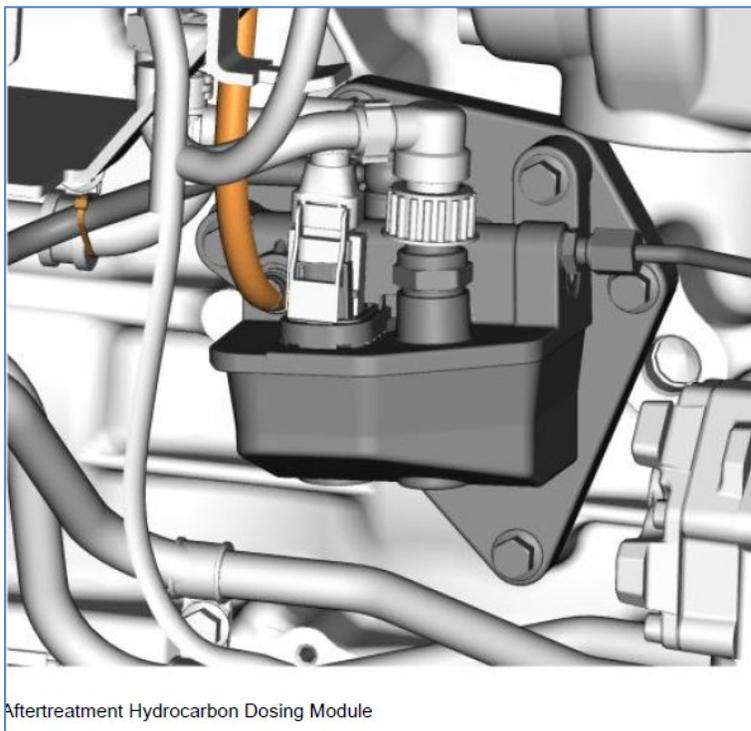


FIGURE 13: MANIFOLD

10. **US10+6 and newer** - Replace the Parker AHI module (FIGURE 14) and fuel nozzle (FIGURE 15).



Aftertreatment Hydrocarbon Dosing Module

FIGURE 14: US10+6 AND NEWER - AHI MODULE

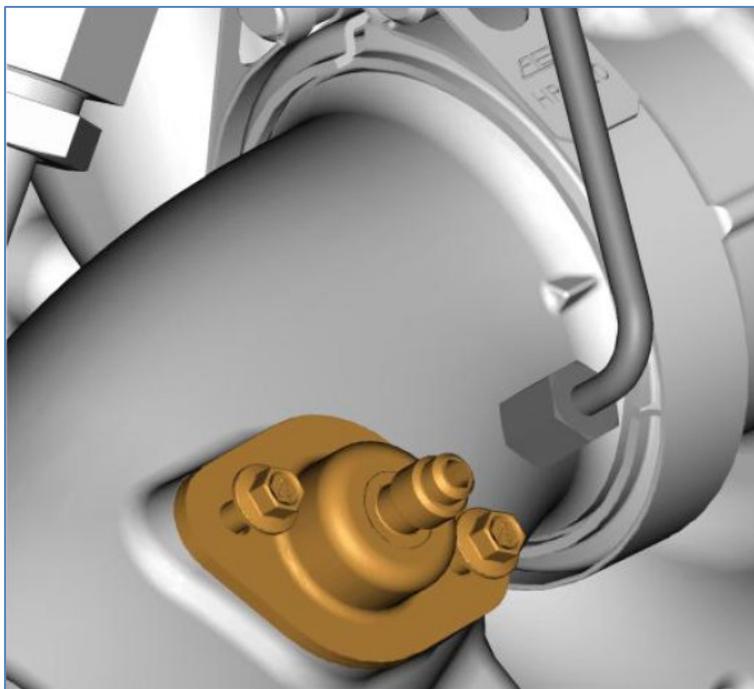


FIGURE 15: US10+6 AND NEWER - PARKER FUEL NOZZLE

11. Replace both engine fuel pressure sensor (FIGURE 16, Figure 17) and AHI fuel pressure sensor (FIGURE 18).

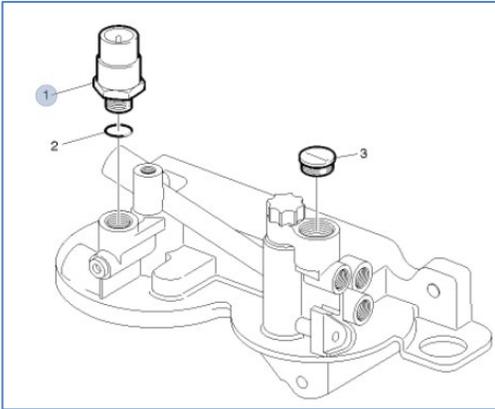


FIGURE 16: FUEL FILTER HOUSING - VOLVO D13 US10 to US14

Pos	A	Description
1	1	pressure sensor; Fuel & Oil
2	1	> O-ring
3	1	cap

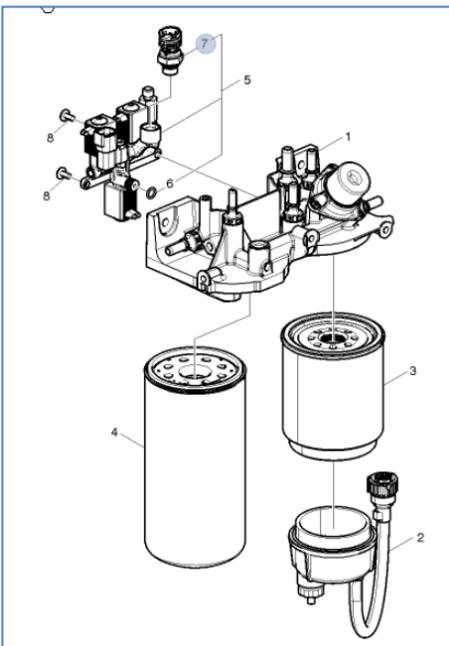


Figure 17: FUEL FILTER HOUSING - VOLVO D13 US17 AND NEWER. REFER TO IMPACT AS DESIGN VARIES

Pos	A	Description
1	1	fuel filter housing
2	1	bowl
3	1	fuel filter; primary
4	1	fuel filter; Long life
5	1	fuel control module
6	2	> O-ring
7	1	> pressure sensor; Fuel & Oil
8	2	six point socket screw

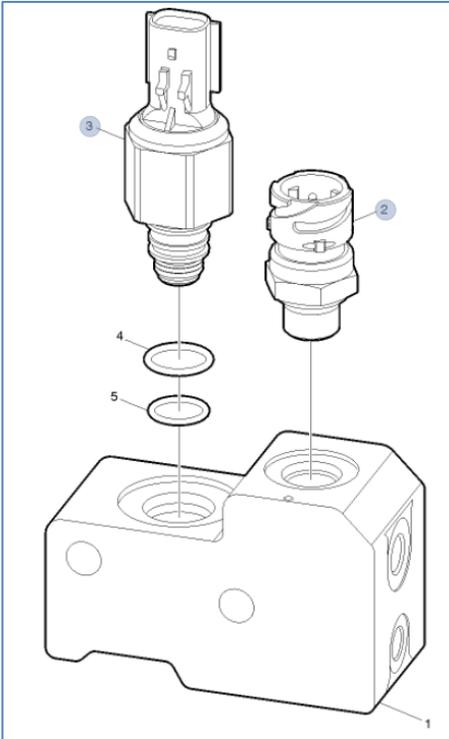


FIGURE 18

Pos	A	PS	Description
1	1		manifold
2	1		pressure sensor; Fuel & Oil
3	1		shut-off valve
4	1		> O-ring
5	1	OP	> O-ring

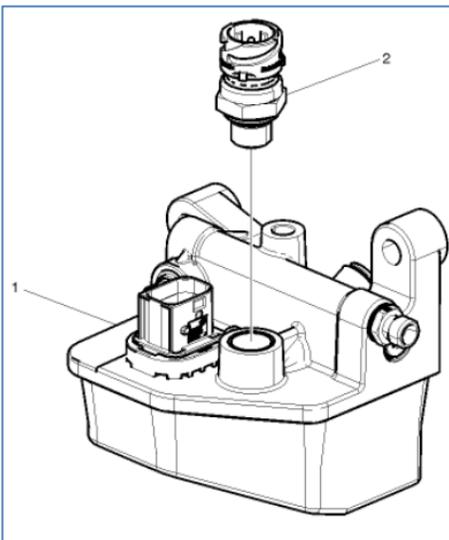


Figure 19: US10+6 AND NEWER - AHI MODULE WITH FUEL PRESSURE SENSOR

	Pos	Description
<input type="checkbox"/>	1	module
<input type="checkbox"/>	2	pressure sensor; Fuel & Oil

12. Replace the overflow valve.

13. Replace the fuel return vent valve on the filter housing (US10 to US14).

14. Replace the fuel shutoff valve.

A manual shutoff valve is located at the inlet side of the primary fuel filter or at the inlet side of Davco Fuel Pro 382 fuel filter.

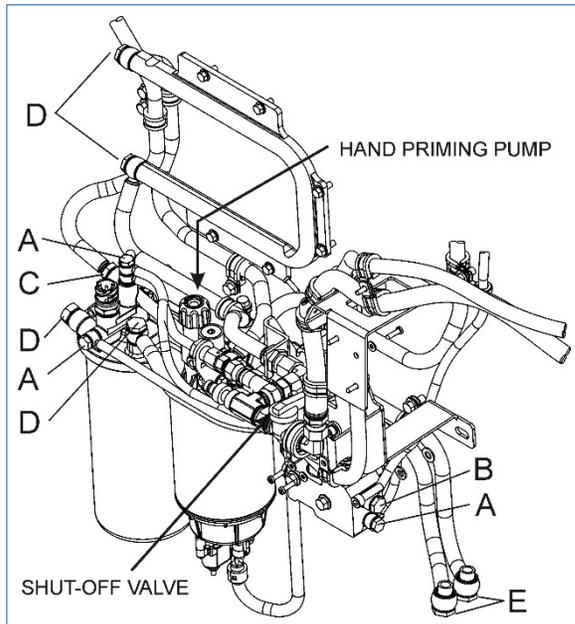


Figure 20: MANUAL SHUT-OFF VALVE (VOLVO D13 US10 to US14 ENGINE)

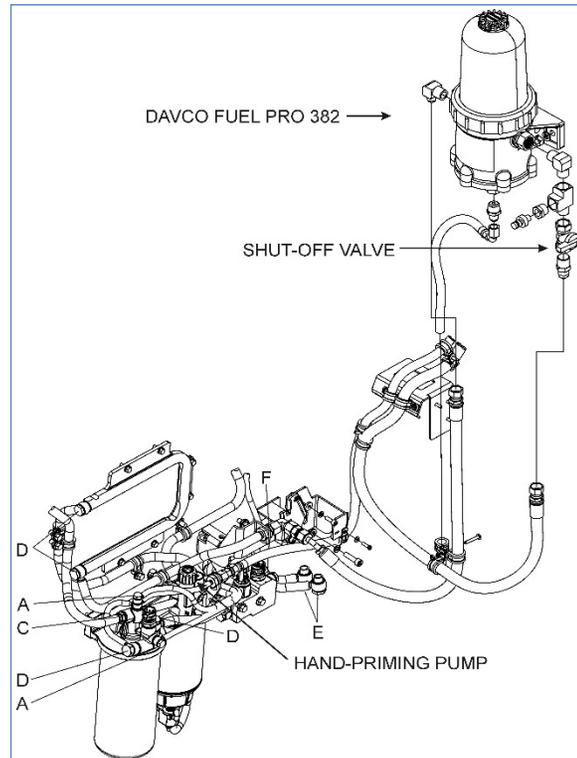


Figure 21: MANUAL SHUT-OFF VALVE LOCATION WITH DAVCO FUEL PRO 382

15. Check for corrosion inside the EMS cooling plate.

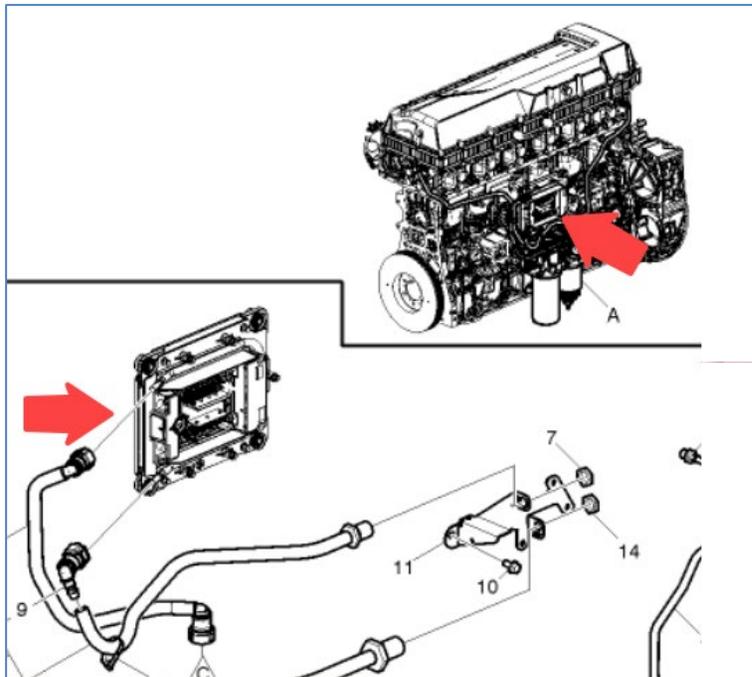


FIGURE 22: THE COOLING LOOP ON THE COLD SIDE OF THE ENGINE COOLS THE ENGINE CONTROL MODULE (ECM) USING FUEL FROM THE SUCTION SIDE

16. Drain and clean the preheater fuel lines. Replace the preheater fuel filter.
17. Once repair completed, start the engine and perform a road test. Check for DTCs. Start the preheater and check for DTCs.

Note that DEF in the fuel system is a non-warrantable failure

PARTS / WASTE DISPOSAL

Discard according to applicable environmental regulations (Municipal/State[Prov.]/ Federal)

Access all our Service Bulletins on <http://techpub.prevostcar.com/en/>
Or scan the QR-Code with your smart phone

Are you a Vehicle owner?
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receive warranty bulletins applicable to your vehicle(s) by e-mail.

