

Request 14

Provide responses to each item below:

- a. Identify and describe all fuel system components in the subject vehicles;
- b. Describe in detail the impact of the alleged defect on the fuel system in the subject vehicles;
- c. Describe all changes in the subject component design and operation as it relates to electrical inputs, including, but not limited to, Volt vs. Liters Per Hour (LPH) performance curves;
- d. Provide the minimum operating requirements for each fuel system component as it relates to the subject component;
- e. Describe the design features present in the fuel system of the subject vehicles for extreme driving conditions (i.e., driving off-road on inclined surfaces), and how extreme driving conditions may be related to the alleged defect;
- f. Describe any subject component variations among all drivetrain variations of subject vehicles;
- g. Describe the test fuel solutions used during durability and/or compatibility testing of subject vehicles; and
- h. Explain fuel system operation in subject vehicles in the event low fuel pressure is detected.

Answer

The figure below provides an exploded view of all components found in a Fuel Delivery Module (FDM) used in the subject vehicles. The table below provides a short description of each component listed in the figure.



Component	Description
Fuel pump	Actuator used to pressurize the low-pressure fuel system using an electric motor.
Jet pump	Venturi driven pump that is used to retain fuel within the reservoir. This device retains fuel within the reservoir when the fuel level in the fuel tank is very low.
Jet pump strainer	Provides filtration at the inlet of the jet pump assembly
Retainer	A housing for many of the FDM components such as the fuel pump and filter
Reservoir	A fuel reservoir from which the fuel pump pulls fuel
Fuel Level Vent Valve (FLVV)	Establishes the shut-off height in the fuel tank when re-filling the vehicle. The FLVV is equipped on 5 door variants of subject vehicles. 3 door variants are not equipped with a FLVV.
Crossover tube	Provides the flow path for fuel from the remote side of a saddle fuel tank to the main side of a saddle fuel tank. Also provides a vessel to establish the suction from the FDM to the remote side of the fuel tank.
Fuel tubes	Provides the flow path from the long-life filter assembly to the flange on the supply side, and from the flange to the fuel tank on the return side of the hydraulic schematic.
End cap	Contains and seals the fuel filter into the filter housing in the retainer to direct fuel flow through the filter element.
Fuel filter	This assembly filters fuel as it travels from the fuel pump to the engine.
Pressure Relief Valve (PRV)	Establishes the highest pressure that can possibly be generated by the fuel pump.
Umbrella valve	A valve that allows fuel from the fuel tank to flow into the reservoir when the fuel level is higher than the position of the umbrella valve.
Antisiphon valve	A valve that prevents fuel from flowing from the main side of a saddle fuel tank to the remote side when the vehicle is shut-off on an incline.
Cover flange	Plastic cover for the FDM that seals the opening in the fuel tank. The cover flange also contains an electrical connector and fuel line connections.
Guide rods	Physically connects the reservoir assembly to the cover flange. They also guide the springs that keep the reservoir assembly seated on the floor of the fuel tank.
Spring	The springs keep the reservoir assembly seated on the floor of the fuel tank.
Fuel pump strainer	This is an inlet filter attached to the fuel pump that keeps contaminants larger than 31 micron from entering the fuel pump.
Float arm assembly	A rod that connects the float to the FDM. It also helps establish the rotational angle associated with the various

	fuel fill levels in the tank which enables the fuel level sensor to provide the correct values.
Ceramic card	A card in the fuel level sensor on which conductive ink is deposited. The ink establishes the resistance of the fuel level sensor circuit as the float travels up and down.
Frame	A plastic housing which holds the ceramic card in place with respect to the reservoir bucket and provides the pivot point for the float arm assembly.
Arm support	The arm support provides a robust physical connection between the float arm assembly and the pivot point in the frame, ensuring consistent rotation force as the float travels up and down.
Wiper Arm	Provides the electrical contact between the ceramic card and the fuel level sensor wire harness as the float arm assembly travels up and down.
Fuel pump harness	This provides the electrical contact between the cover flange and the fuel pump.
Fuel Level Sensor (FLS) wire harness	Provides the electrical contact between the fuel level sensor assembly and the cover flange.

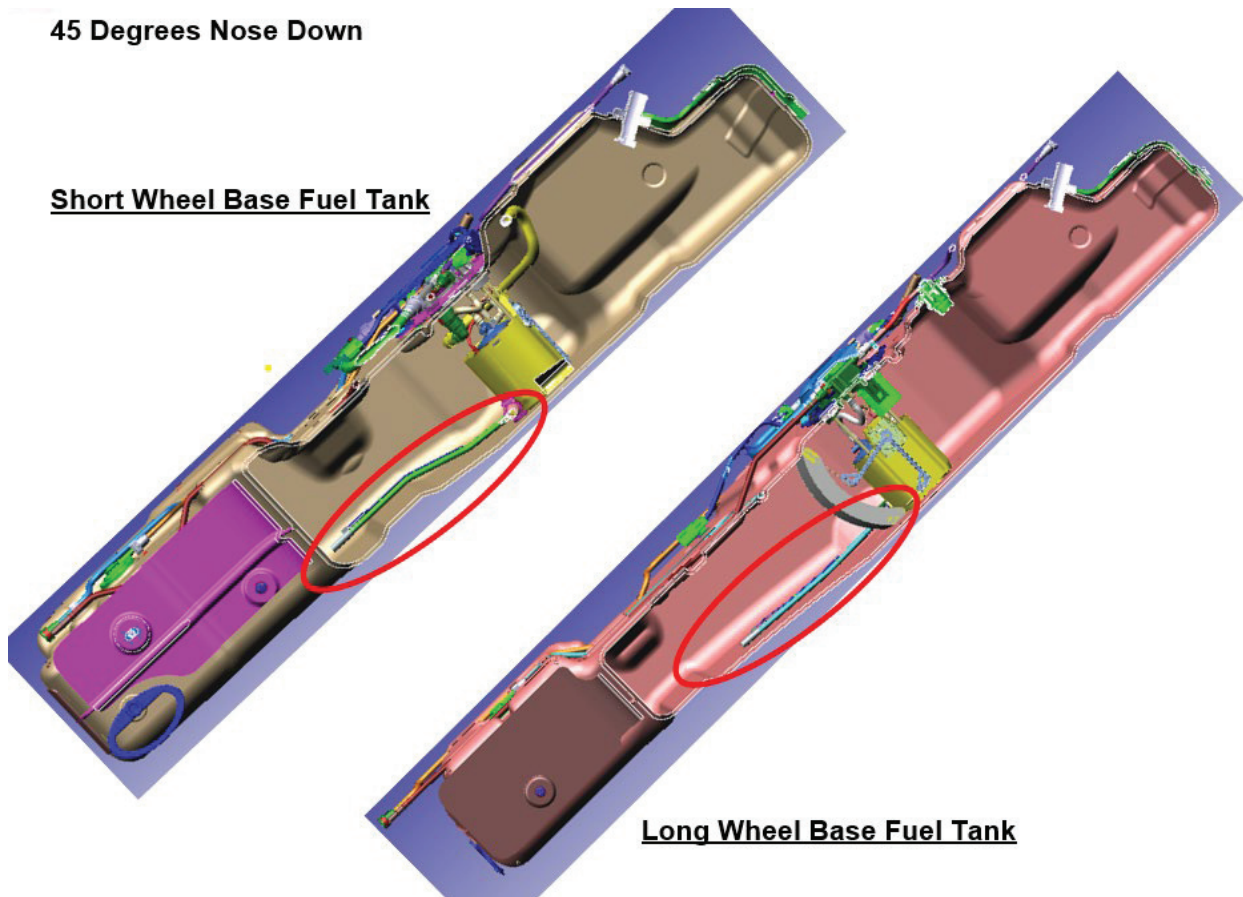
As discussed in response 13, teardown analysis performed by Ford and the FDM supplier showed contaminants blocking the orifice of the jet pump. If the jet pump orifice is blocked, it is possible for the FDM reservoir to become empty when the level of fuel in the fuel tank is low. This causes the fuel pump to “run dry,” and the pump continues to run when there is no fuel in the reservoir. The fuel pump utilizes the fuel flowing through the pump as a cooling effect to prevent the fuel pump from exceeding desired operating temperatures. Without fuel to cool the fuel pump, the impeller and/or the armature of the low-pressure fuel pump can overheat causing irreversible damage to the fuel pump motor. Once this occurs, the fuel pump will no longer be able to provide fuel pressure to the low-pressure fuel system; regardless of how much fuel is in the fuel tank.

In terms of changes in the subject component design and operation as it relates to electrical inputs, a change was made to the commutator in the fuel pump motor. This is listed as fuel pump version 1A in the parts change log. This change causes the fuel flow output from the fuel pump to increase at a given voltage input.

The FDMs used in subject and peer vehicles are a part of a closed loop pressure control system or a mechanical, returnless fuel system. FDMs used in closed loop pressure control systems are specified to operate in a closed loop pressure control system operate on a voltage between 4.5 volts and nominal battery voltage (14 volts), in normal operation. FDMs used in a mechanical, returnless fuel system operate on a voltage between 8 volts and nominal battery voltage. All FDM applications in subject and peer vehicles are specified to operate in ambient temperatures ranging from -40 degrees to 60 degrees centigrade. The specified fuel pressure for the low-pressure fuel system varies depending on the vehicle application. Typical operating range for subject and peer vehicles is between 350 and 520 kilopascals.

The FDM used in the subject vehicles are equipped with a remote fuel pick-up tube on the reservoir of the FDM to access fuel when the vehicle is on an inclined surface. Ford is not aware of any connection between extreme driving conditions and failure or malfunction of the

low-pressure fuel system. The figure below shows the remote fuel pick-up tube circled in red for both fuel tank variations available on the subject vehicle.



There are no changes to the FDM equipped in subject vehicles due to drivetrain variations. Subject vehicles are equipped with one of two variations of FDMs depending on the body configuration of the vehicle. FDMs equipped in three (3) door variants of subject vehicles do not feature a FLVV. FDMs equipped in five (5) door variants of subject vehicles are equipped with a FLVV. Due to the location of the FLVV, the cover flange of the FDMs also differs based on body configuration.

The following test fuels are used during durability testing of the fuel system:

- Unleaded gasoline of EN228 or ASTM D4814 with 0% alcohol content
- E85 summer gasoline with 0.5-1% water, 50-300 micro siemens per meter, <0.5 parts per million of inorganic chloride, and <0.2 parts per million of sodium
- Corrosive fuel with the following parameters: 85% ethanol content, 9000-11000 mg/kg of water, 500 micro S/m max, acidity of 55-65 mk/kg as acetic acid, 5.7 – 6.2 pHe, 1.8-2.0 mg/kg of inorganic chloride, 1.5-2.5 mg/kg of total chlorine as chlorides
- E20 gasoline/ethanol blend that is created by blending U.S. E10 per ASTM D4814 with pure ethanol.

Ford uses the following fuels for fuel compatibility testing:

- CE22 Per SAE J 1681
- ASTM Fuel C with 30% aggressive ethanol
- ASTM Fuel C with 50% aggressive ethanol
- ASTM Fuel C with 85% aggressive ethanol
- ASTM Fuel C with 15% aggressive methanol
- ASTM Fuel C with aggressive sulfur with a 3 silver strip rating per Annex A1 of ASTM D4814
- ASTM Fuel C with peroxide per SAE J 1681 CP with copper content of 6.4 – 50 mMol/L

When low fuel pressure is detected, the subject and peer vehicles will set diagnostic trouble codes P008A, low pressure fuel system pressure – too low, and P0087, fuel rail/system pressure - too low. Both of these diagnostic trouble codes cause the check engine light in the subject and peer vehicles to illuminate. While operating a vehicle with low fuel pressure, customers may notice the vehicle running rough or vehicle hesitation on acceleration. In the rare instance that the fuel tank fuel level is below the FDM umbrella valve, and the jet pump is clogged, a loss of motive power may occur.