

Fuel System

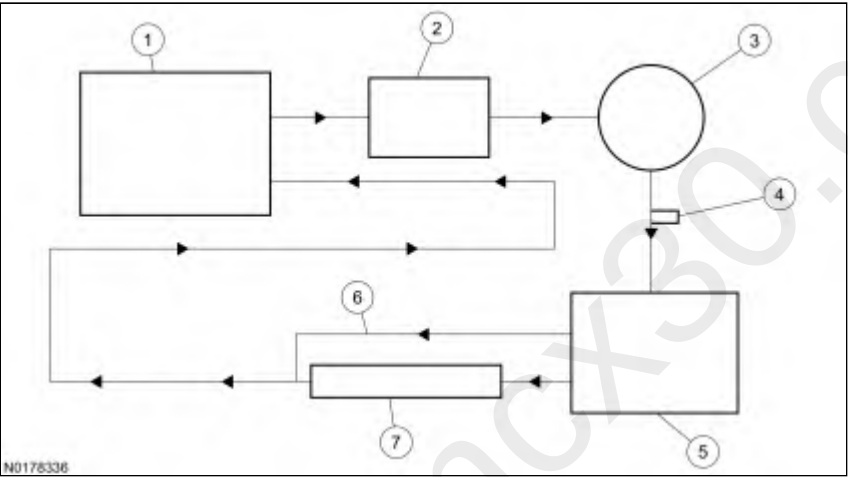
The fuel system includes the following:

- low pressure fuel system that delivers the fuel from the fuel tank to the high pressure pump
- high pressure fuel system that increases the fuel pressure and delivers it to the fuel injectors
- fuel cooling system that cools the fuel returning from the fuel injectors and the high pressure fuel injection pump

Low Pressure Fuel System — F-150

Fuel is pumped from the fuel tank to the primary fuel filter by the electric fuel pump. Pressurized and filtered, approximately 379 kPa (55 psi) during engine idle, the fuel is pumped through the fuel supply line to the secondary fuel filter (the secondary fuel filter is located on the back side of the engine). The filtered fuel leaves the secondary fuel filter and flows to the high pressure pump. Fuel bled off by the high pressure pump and fuel rails returns to the fuel tank. Fuel bled off by the fuel injectors is recycled to the inlet side of the secondary fuel filter.

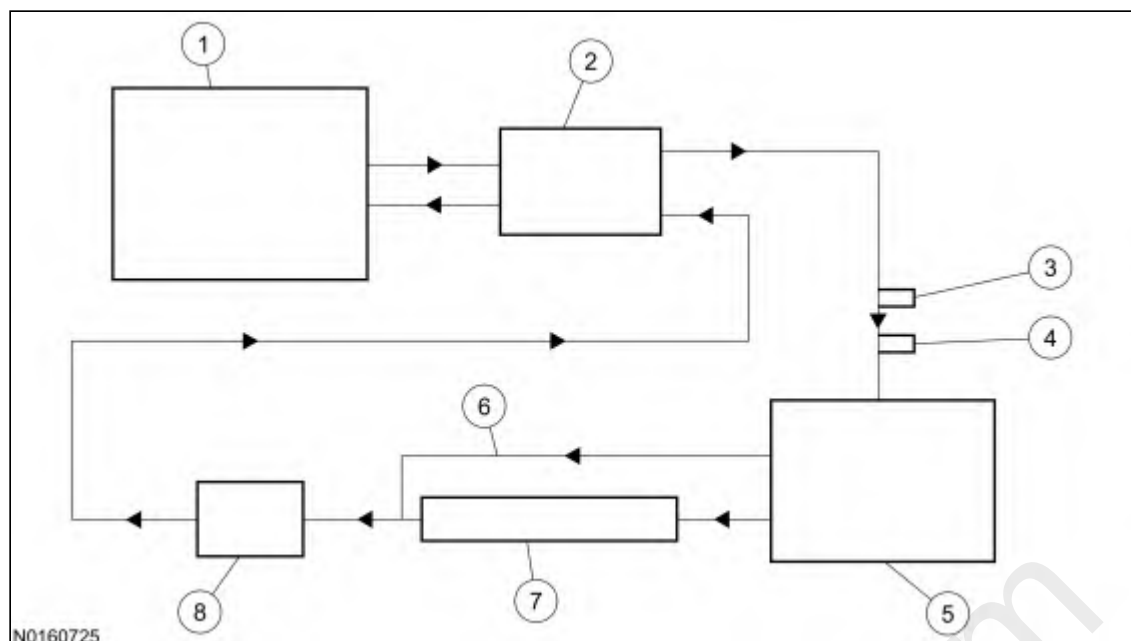
Low Pressure Fuel System (F-150)



Item	Number	Description
1	—	Fuel Tank
2	—	Fuel Conditioning Module
3	—	Secondary Fuel Filter
4	—	Fuel Pressure And Temperature Sensor
5	—	High Pressure Pump
6	—	High Pressure Pump Bypass
7	—	Fuel Rail

Low Pressure Fuel System — Transit

Fuel is pumped by the fuel pump (FP) assembly in the fuel tank to the fuel conditioning module. Pressurized and filtered, approximately 30 kPa (4.4 psi) during engine idle, the fuel is pumped through the fuel supply line to the high pressure fuel injection pump. Fuel passed through the high pressure fuel injection pump and fuel injectors returns to the fuel conditioning module, which then either recycles the fuel to the high pressure fuel injection pump or passes it through the fuel cooler and returns it to the fuel tank, depending on ambient temperature conditions.

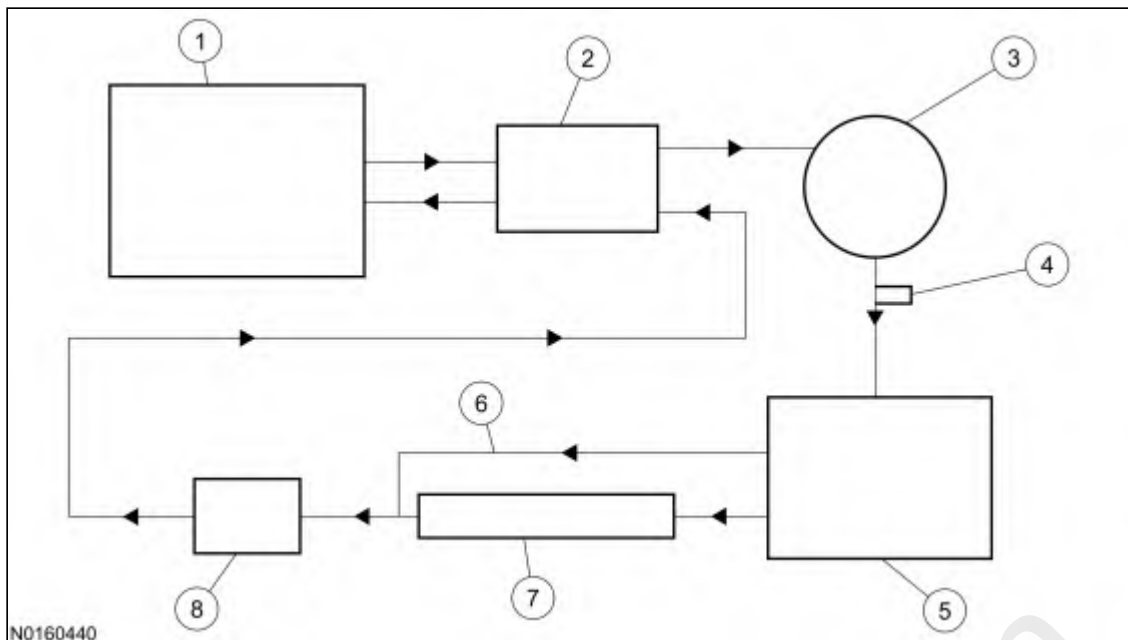
Low Pressure Fuel System (Transit)

Item	Number	Description
1	—	Fuel Tank
2	—	Fuel Conditioning Module
3	—	Fuel Delivery Pressure Switch
4	—	Fuel Rail Temperature (FRT) Sensor
5	—	High Pressure Pump
6	—	High Pressure Pump Bypass
7	—	Fuel Rail
8	—	Fuel Cooler

Low Pressure Fuel System — All Others

Fuel is pumped from the fuel tank to the primary fuel filter by the electric fuel pump. Pressurized and filtered, approximately 379 kPa (55 psi) during engine idle, the fuel is pumped through the fuel supply line to the secondary fuel filter (the secondary fuel filter housing is located on the front left side of the engine). The filtered fuel leaves the secondary fuel filter and flows to the high pressure pump. Fuel bled off by the high pressure pump and fuel rail pass through the fuel cooler before returning to the fuel conditioning module. Fuel bled off by the fuel injectors is recycled to the inlet side of the secondary fuel filter.

Low Pressure Fuel System (All Others)



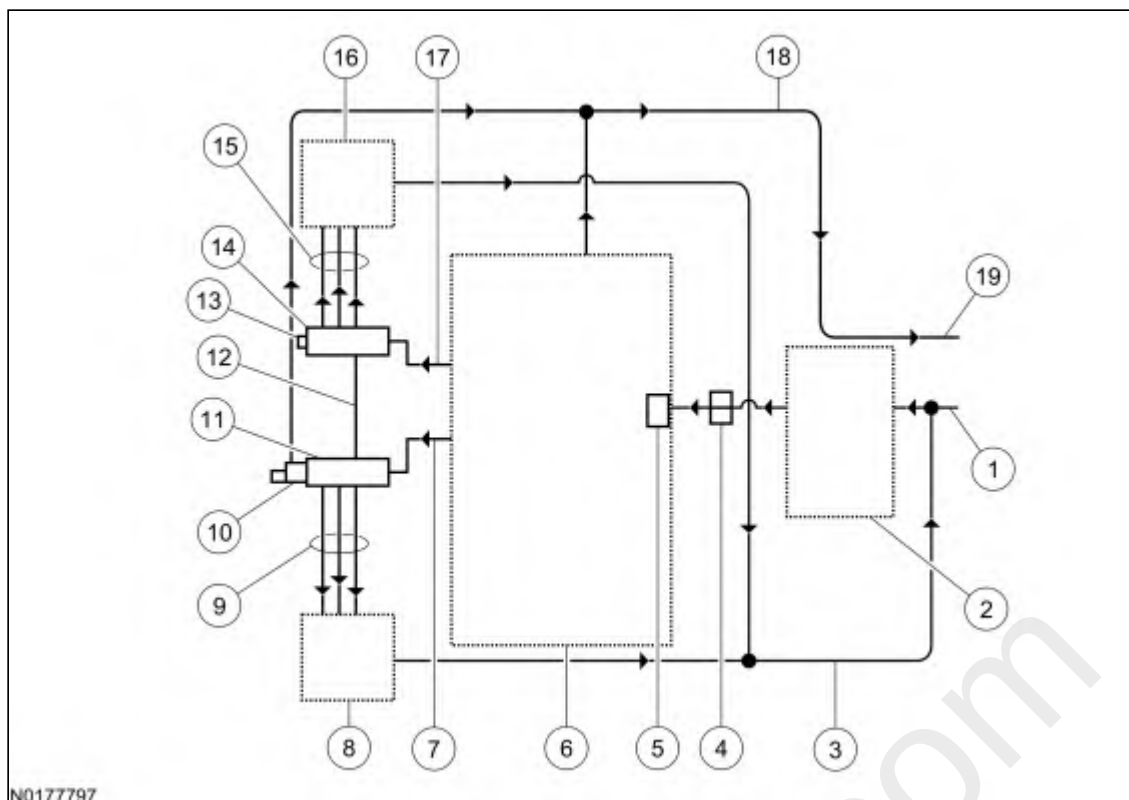
Item	Number	Description
1	—	Fuel Tank
2	—	Fuel Conditioning Module
3	—	Secondary Fuel Filter
4	—	Fuel Pressure And Temperature Sensor
5	—	High Pressure Pump
6	—	High Pressure Pump Bypass
7	—	Fuel Rail
8	—	Fuel Cooler

High Pressure Fuel System

High Pressure Fuel System — F-150

After the filtered fuel leaves the secondary fuel filter it flows to the high pressure fuel injection pump. The high pressure fuel injection pump is belt driven by the camshaft gear and is located in the center at the rear of the engine. For additional information on the high pressure fuel injection pump, refer to the [Engine Control Components](#) High Pressure Fuel Injection Pump in this section. The high pressure fuel injection pump increases the fuel pressure and delivers fuel to the fuel rails through 2 high pressure lines, 1 per bank. The system pressure generated by the high pressure fuel injection pump is constantly adjusted by the PCM for every operational condition. However, due to the storage volume of the fuel rails, the injection pressure remains constant over the duration of the injection process. Each fuel rail is connected to 3 fuel injectors through individual high pressure pipes. The fuel injectors are controlled by the PCM and are capable of delivering precise fuel quantity based on the operational demands. The fuel injectors are operated in 3 stages: fill stage, main injection stage and end of main injection stage. The fill stage reduces the combustion noise, mechanical load and exhaust emissions. For additional information on fuel injector operation, refer to [Engine Control Components](#) Fuel Injectors in this section.

High Pressure Fuel System (F-150)



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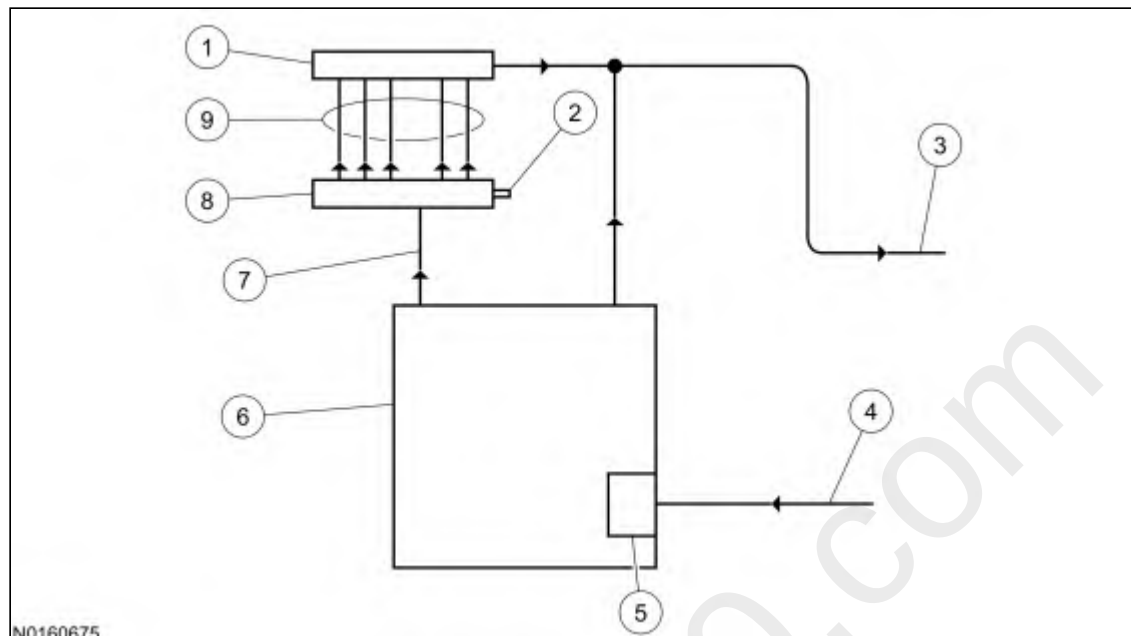
Item	Number	Description
1	—	Low Pressure Fuel Supply From The Fuel Tank
2	—	Engine Mounted Secondary Fuel Filter
3	—	Fuel Injector Return Fuel
4	—	Fuel Pressure And Temperature Sensor
5	—	Fuel Volume Control Valve
6	—	High Pressure Injection Pump
7	—	LH Fuel Rail Supply Tube
8	—	LH Fuel Injectors (3 Required)
9	—	LH Fuel Injector Supply Tubes (3 Required)
10	—	Pressure Control Valve
11	—	LH Fuel Rail
12	—	Fuel Rail Supply Tube
13	—	Fuel Rail Pressure Sensor
14	—	RH Fuel Rail
15	—	RH Fuel Injector Supply Tubes (3 Required)
16	—	RH Fuel Injectors (3 Required)
17	—	LH Fuel Rail Supply Tube
18	—	Fuel Rail And High Pressure Injection Pump Return Fuel
19	—	Fuel Return To The Diesel Fuel Conditioning Module

High Pressure Fuel System — Transit

After the filtered fuel leaves the fuel conditioning module it flows to the high pressure fuel injection pump. The high pressure fuel injection pump is gear driven by the camshaft gear and is located on the left side of the engine. For additional information on the high pressure fuel injection pump, refer to the [Engine Control Components](#) Pressure Fuel Injection

Pump in this section. The high pressure fuel injection pump increases the fuel pressure and delivers fuel to the fuel rail. The system pressure generated by the high pressure fuel injection pump is constantly adjusted by the PCM for every operational condition. The injection pressure remains constant over the duration of the injection process due to the storage volume of the fuel rail. The fuel rail is connected to the fuel injectors through individual high pressure pipes. The fuel injectors are controlled by the PCM and are capable of delivering precise fuel quantity based on the operational demands.

High Pressure Fuel System (Transit)

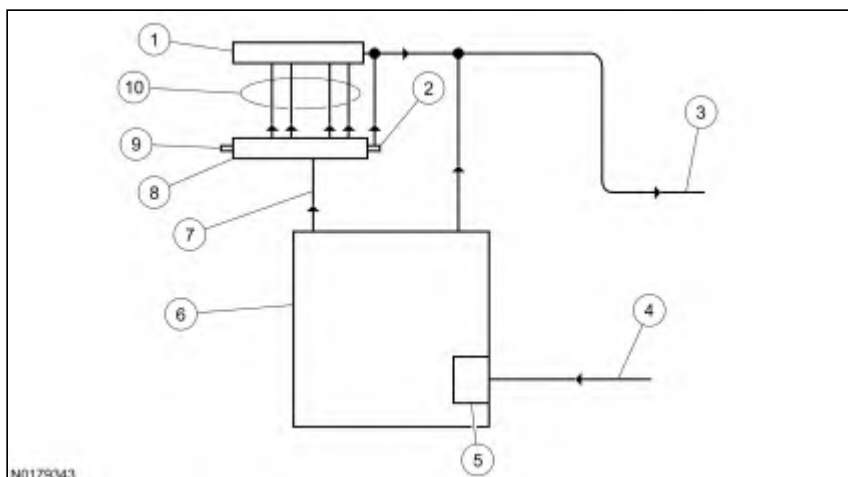


Item	Number	Description
1	—	Fuel Injectors (5 Required)
2	—	Fuel Rail Pressure Sensor
3	—	Low Pressure Fuel Return To The Diesel Fuel Conditioning Module
4	—	Low Pressure Fuel Supply From The Diesel Fuel Conditioning Module
5	—	Fuel Volume Control Valve
6	—	High Pressure Fuel Injection Pump
7	—	High Pressure Fuel Rail Supply Tube
8	—	Fuel Rail
9	—	Fuel Injector Supply Tubes (5 Required)

High Pressure Fuel System — Transit Connect

After the filtered fuel leaves the fuel conditioning module it flows to the high pressure fuel injection pump. The high pressure fuel injection pump is belt driven and is located at the front of the engine. For additional information on the high pressure fuel injection pump, refer to the [Engine Control Components](#) Pressure Fuel Injection Pump in this section. The high pressure fuel injection pump increases the fuel pressure and delivers fuel to the fuel rail. The system pressure generated by the high pressure fuel injection pump is constantly adjusted by the PCM for every operational condition. The injection pressure remains constant over the duration of the injection process due to the storage volume of the fuel rail. The fuel rail is connected to the fuel injectors through individual high pressure pipes. The fuel injectors are controlled by the PCM and are capable of delivering precise fuel quantity based on the operational demands.

High Pressure Fuel System (Transit Connect)

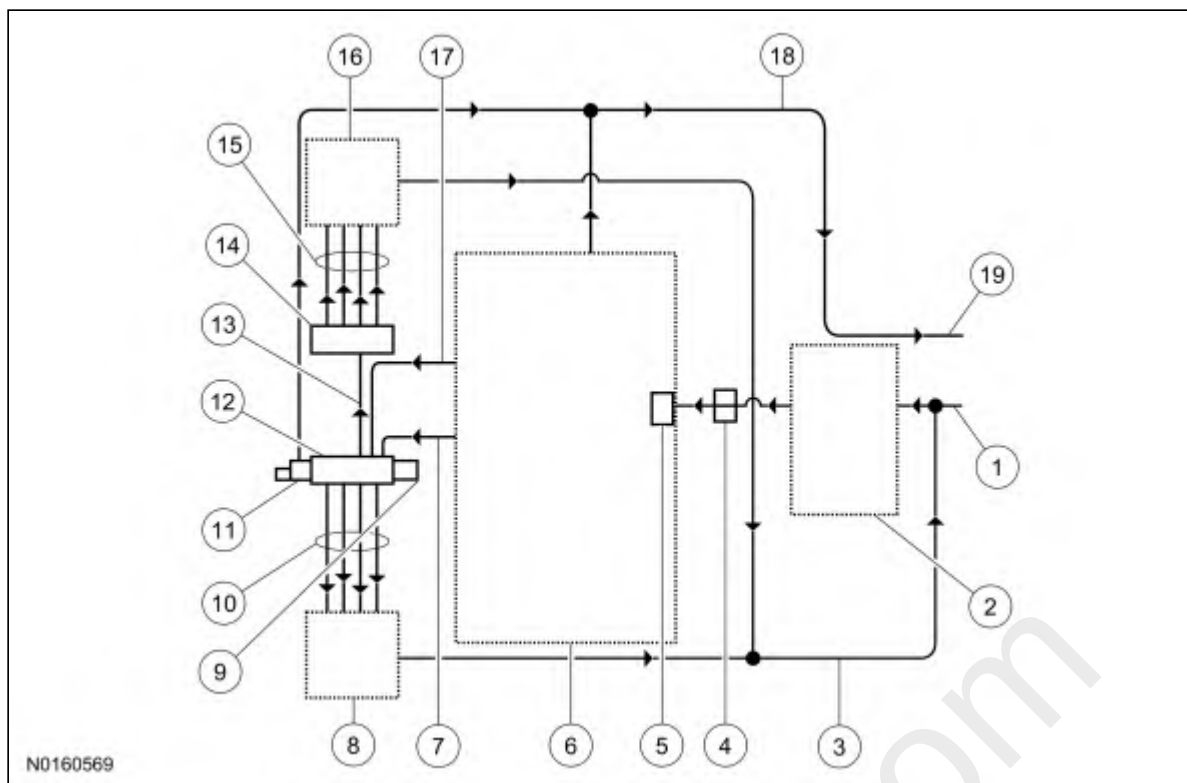


Item	Number	Description
1	—	Fuel Injectors (4 Required)
2	—	Mechanical Fuel Pressure Relief Valve
3	—	Low Pressure Fuel Return To The Fuel Tank
4	—	Low Pressure Fuel Supply From The Diesel Fuel Conditioning Module
5	—	Fuel Volume Control Valve
6	—	High Pressure Fuel Injection Pump
7	—	High Pressure Fuel Rail Supply Tube
8	—	Fuel Rail
9	—	Fuel Rail Pressure Sensor
10	—	Fuel Injector Supply Tubes (4 Required)

High Pressure Fuel System — All Others

After the filtered fuel leaves the secondary fuel filter it flows to the high pressure fuel injection pump. The high pressure fuel injection pump is gear driven by the camshaft gear and is located at the front of the engine. For additional information on the high pressure fuel injection pump, refer to the [Engine Control Components](#) High Pressure Fuel Injection Pump in this section. The high pressure fuel injection pump increases the fuel pressure and delivers fuel to the fuel rails through 2 high pressure lines, 1 per bank. The system pressure generated by the high pressure fuel injection pump is constantly adjusted by the PCM for every operational condition. However, due to the storage volume of the fuel rails, the injection pressure remains constant over the duration of the injection process. Each fuel rail is connected to 4 fuel injectors through individual high pressure pipes. The fuel injectors are controlled by the PCM and are capable of delivering precise fuel quantity based on the operational demands. The fuel injectors are operated in 3 stages: fill stage, main injection stage and end of main injection stage. The fill stage reduces the combustion noise, mechanical load and exhaust emissions. For additional information on fuel injector operation, refer to [Engine Control Components](#) Fuel Injectors in this section. The high pressure pump also delivers fuel to the fuel cooler. For additional information, refer to [Engine Control Components](#) Fuel Cooler in this section.

Typical High Pressure Fuel System (All Others)



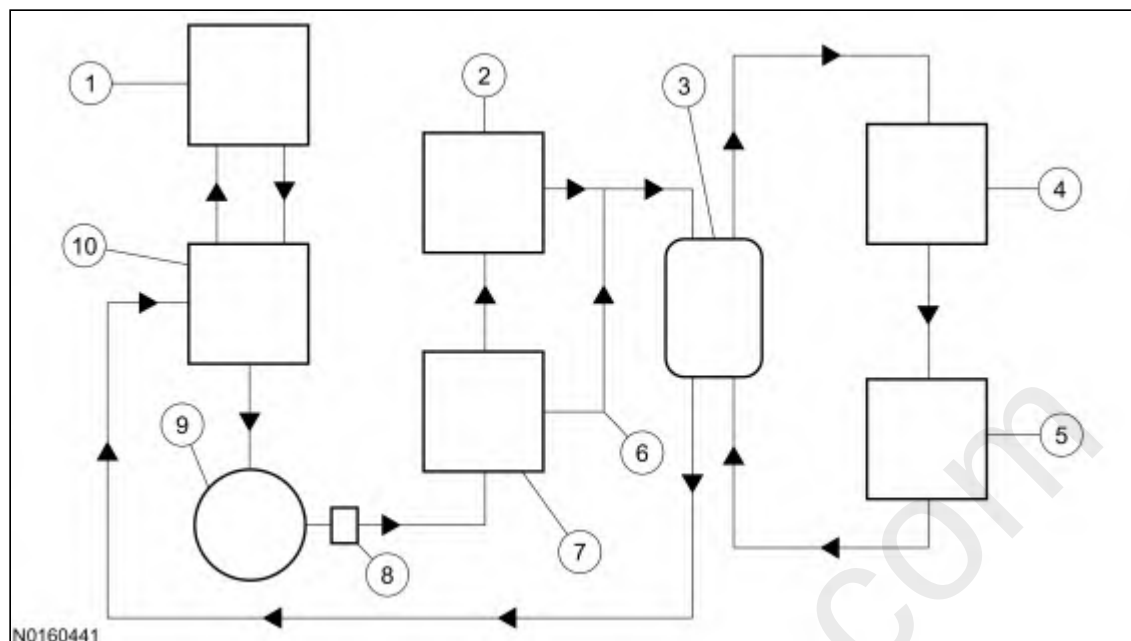
Item	Number	Description
1	—	Low Pressure Fuel Supply From The Fuel Tank (F-Series Super Duty) Or The Diesel Fuel Conditioning Module (All Others)
2	—	Engine Mounted Secondary Fuel Filter
3	—	Fuel Injector Return Fuel
4	—	Fuel Pressure And Temperature Sensor
5	—	Fuel Volume Control Valve
6	—	High Pressure Injection Pump
7	—	LH Fuel Rail Supply Tube
8	—	LH Fuel Injectors (4 Required)
9	—	Fuel Rail Pressure Sensor
10	—	LH Fuel Injector Supply Tubes (4 Required)
11	—	Pressure Control Valve
12	—	LH Fuel Rail
13	—	RH Fuel Rail Supply Tube
14	—	RH Fuel Rail
15	—	RH Fuel Injector Supply Tubes (4 Required)
16	—	RH Fuel Injectors (4 Required)
17	—	LH Fuel Rail Supply Tube
18	—	Fuel Rail And High Pressure Injection Pump Return Fuel
19	—	Fuel Return To The Diesel Fuel Conditioning Module

Fuel Cooling — F-650 / F-750

Fuel cooling is required to maintain an acceptable fuel temperature during engine operation. The fuel system temperature is monitored by the fuel pressure and temperature sensor, which is an input to the PCM. The powertrain secondary cooling

system cools the fuel cooler, in addition to cooling several other auxiliary engine systems. The coolant flows from the fuel cooler to the powertrain secondary cooling system coolant pump to the powertrain secondary cooling system radiator back to the fuel cooler.

Fuel Cooling System (F-650 / F-750)

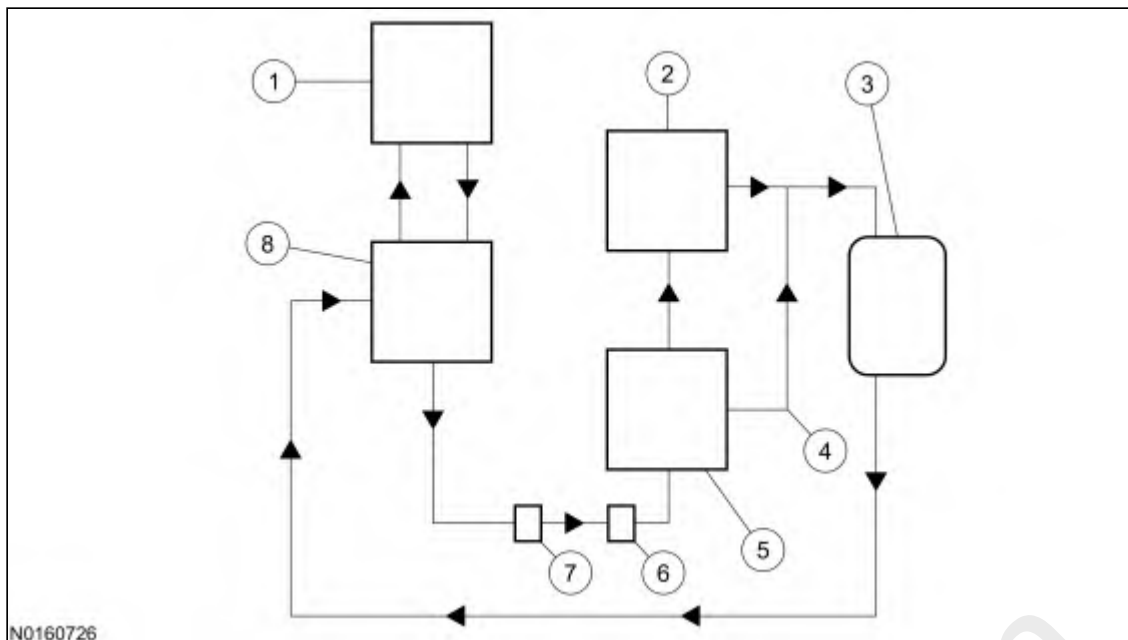


Item	Number	Description
1	—	Fuel Tank
2	—	Fuel Rail
3	—	Fuel Cooler
4	—	Powertrain Secondary Cooling System Coolant Pump
5	—	Powertrain Secondary Cooling System Radiator
6	—	High Pressure Pump Bypass
7	—	High Pressure Pump
8	—	Fuel Pressure And Temperature Sensor
9	—	Secondary Fuel Filter
10	—	Fuel Conditioning Module

Fuel Cooling — Transit

Fuel cooling is required to maintain an acceptable fuel temperature during engine operation. The fuel system temperature is monitored by the fuel rail temperature (FRT) sensor, which is an input to the PCM. The fuel conditioning module thermostat will passively recycle returned fuel from the engine to the inlet of the high pressure fuel injection pump during low fuel temperatures, or pass it through the fuel cooler and return it to the tank for further cooling during high fuel temperatures.

Fuel Cooling System (Transit)



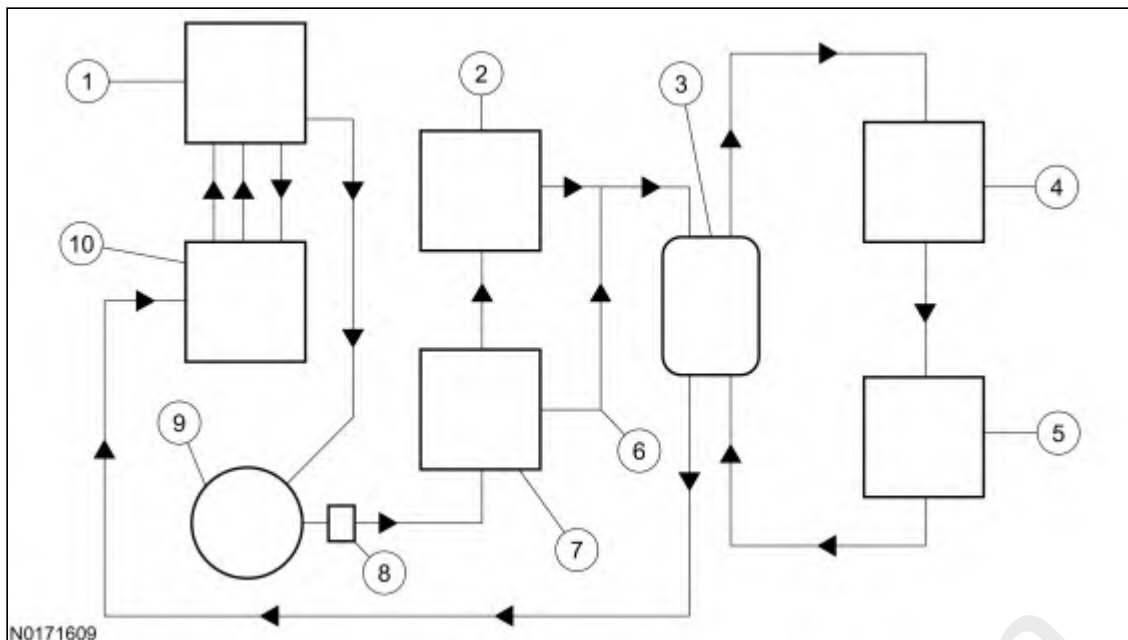
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Item	Number	Description
1	—	Fuel Tank
2	—	Fuel Rail
3	—	Fuel Cooler
4	—	High Pressure Pump Bypass
5	—	High Pressure Pump
6	—	Fuel Rail Temperature (FRT) Sensor
7	—	Fuel Delivery Pressure Switch
8	—	Fuel Conditioning Module

Fuel Cooling — All Others

Fuel cooling is required to maintain an acceptable fuel temperature during engine operation. The fuel system temperature is monitored by the fuel pressure and temperature sensor, which is an input to the PCM. The powertrain secondary cooling system cools the fuel cooler, in addition to cooling several other auxiliary engine systems. The coolant flows from the fuel cooler to the powertrain secondary cooling system coolant pump to the powertrain secondary cooling system radiator back to the fuel cooler.

Typical Fuel Cooling System (All Others)



Item	Number	Description
1	—	Fuel Tank
2	—	Fuel Rail
3	—	Fuel Cooler
4	—	Powertrain Secondary Cooling System Coolant Pump
5	—	Powertrain Secondary Cooling System Radiator
6	—	High Pressure Pump Bypass
7	—	High Pressure Pump
8	—	Fuel Pressure And Temperature Sensor
9	—	Secondary Fuel Filter
10	—	Fuel Conditioning Module

Fuel Pump System — Transit

Fuel Pump Operation

After the low pressure fuel is filtered by the fuel filter, it enters the high pressure fuel injection pump. When the fuel reaches the high pressure pump, a portion of the fuel flows to the lubrication valve allowing the fuel to lubricate the mechanical components of the high pressure injection fuel pump. Fuel that is not used for pump lubrication is directed to the fuel volume control valve. The fuel volume control valve regulates how much fuel enters the inlet one way check valve. For additional information, refer to [Engine Control Components](#), Fuel Volume Control Valve in this section. The outlet check valve ball remains closed while the fuel is drawn in due to suction. Fuel rail pressure is controlled by the fuel volume control valve.

During certain driving conditions the PCM cycles the fuel pump on and off for testing purposes and is considered normal operation.

Fuel Pump System — All Others

Fuel Pump Operation

After the low pressure fuel is filtered by the secondary fuel filter, it enters the high pressure fuel injection pump. When the fuel reaches the high pressure pump, a portion of the fuel flows to the lubrication valve allowing the fuel to lubricate the mechanical components of the high pressure injection fuel pump. Fuel that is not used for pump lubrication is directed to the fuel volume control valve. The fuel volume control valve regulates how much fuel enters the inlet one way check valve and the 2 main pump pistons. For additional information, refer to [Engine Control Components](#), Fuel Volume Control Valve

in this section. The 2 main pump pistons are actuated by the main shaft offset journal. The offset journal of the main shaft uses a free-spinning hub to make contact with the 2 main pump pistons. The pistons start their compression stroke when actuated by the offset journal and are returned to their rest position by the spring pressure. The fuel is drawn into the main cylinder while the piston returns to the rest position. The outlet check valve ball remains closed while the fuel is drawn in due to suction. Once the piston starts its compression stroke, the inlet one-way check valve closes using spring and fuel pressure and the outlet check valve opens due to increasing fuel pressure. After the high pressure fuel leaves the 2 main pump pistons, a portion of the fuel leaves the high pressure fuel injection pump and flows to the fuel cooler and the rest of the fuel is delivered to the high pressure fuel rails and fuel injectors. Fuel rail pressure is controlled at the rear of the left fuel rail by the fuel pressure control valve. The fuel pressure control valve adjusts the fuel pressure by restricting the fuel flow to the return line. For additional information, refer to [Engine Control Components](#), Fuel Pressure Control Valve in this section.

During certain driving conditions the PCM cycles the fuel pump on and off for testing purposes and is considered normal operation.

Cetane Number

The cetane number relates to the auto ignition quality of diesel fuel. The rating applies to diesel fuel similar to octane rating for gasoline. A measure of how readily diesel fuel starts to burn (auto ignites) at a high compression temperature. Diesel fuel with a high cetane number auto ignites shortly after injection into the combustion chamber and has a short ignition delay time. Diesel fuel with a low cetane number resists auto-ignition and has a longer ignition delay time. A minimum cetane of 40 is required for a optimal driveability and performance.
