3.0L POWER STROKE DIESEL ENGINE

Direct Injection Turbocharged Diesel Engine

Engine Description • Systems Overview • Component Locations

REPAIR TECHNIQUES

Appropriate service methods and procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This manual provides general directions for performing service with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedure, techniques, tools and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that they compromise neither their personal safety nor the vehicle integrity by their choice of methods, tools or parts.

NOTE, NOTICE, CAUTION AND WARNING

As you read through this manual, you may come across a **NOTE**, **NOTICE**, **CAUTION** or **WARNING**. Each one is there for a specific purpose. A **NOTE** calls attention to unique, additional or essential information related to the subject procedure. A **NOTICE** identifies a hazard that could damage the vehicle or property. A **CAUTION** identifies a hazard that could result in minor personal injury to yourself or others. A **WARNING** identifies a hazard that could result in severe personal injury or death to yourself or others. Some general **WARNINGS** that you should follow when you work on a vehicle are listed below.

- **ALWAYS WEAR SAFETY GLASSES FOR EYE PROTECTION.**
- **KEEP SOLVENTS AWAY FROM IGNITION SOURCES. SOLVENTS MAY BE FLAMMABLE AND COULD IGNITE OR EXPLODE IF NOT HANDLED CORRECTLY.**
- **USE SAFETY STANDS WHENEVER A PROCEDURE REQUIRES YOU TO BE UNDER THE VEHICLE.**
- **MAKE SURE THAT THE IGNITION SWITCH IS ALWAYS IN THE OFF POSITION, UNLESS OTHERWISE REQUIRED BY THE PROCEDURE.**
- **SET THE PARKING BRAKE WHEN WORKING ON THE VEHICLE. IF YOU HAVE AN AUTOMATIC TRANSMISSION, SET IN PARK UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. IF YOU HAVE A MANUAL TRANSMISSION, IT SHOULD BE IN REVERSE (ENGINE OFF) OR NEUTRAL (ENGINE ON) UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. PLACE WOOD BLOCKS (4” X 4” OR LARGER) OR WHEEL CHOCKS AGAINST THE FRONT AND REAR SURFACES OF THE TIRES TO HELP PREVENT THE VEHICLE FROM MOVING.**
- **OPERATE THE ENGINE ONLY IN A WELL-VENTILATED AREA TO AVOID THE DANGER OF CARBON MONOXIDE POISONING.**
- **KEEP YOURSELF AND YOUR CLOTHING AWAY FROM MOVING PARTS WHEN THE ENGINE IS RUNNING, ESPECIALLY THE DRIVE BELTS.**
- **TO PREVENT SERIOUS BURNS, AVOID CONTACT WITH HOT METAL PARTS SUCH AS THE RADIATOR, EXHAUST MANIFOLD, TAIL PIPE, THREE-WAY CATALYTIC CONVERTER AND MUFFLER.**
- **DO NOT SMOKE WHILE WORKING ON A VEHICLE.**
- **TO AVOID INJURY, ALWAYS REMOVE RINGS, WATCHES, LOOSE HANGING JEWELRY AND LOOSE CLOTHING BEFORE BEGINNING TO WORK ON A VEHICLE.**
- **WHEN IT IS NECESSARY TO WORK UNDER THE HOOD, KEEP HANDS AND OTHER OBJECTS CLEAR OF THE COOLING FAN BLADES!**

TOOLS

Commercially available hand tools and equipment are used along with Essential Special Service Tools (ESST) and Rotunda equipment. Power tools have become the acceptable industry standard and are used for disassembly only where applicable, unless specified otherwise in the Workshop Manual. The only exception to this policy is installing wheels in conjunction with the use of torque sticks, when possible.

NOTE: The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring any obligation.

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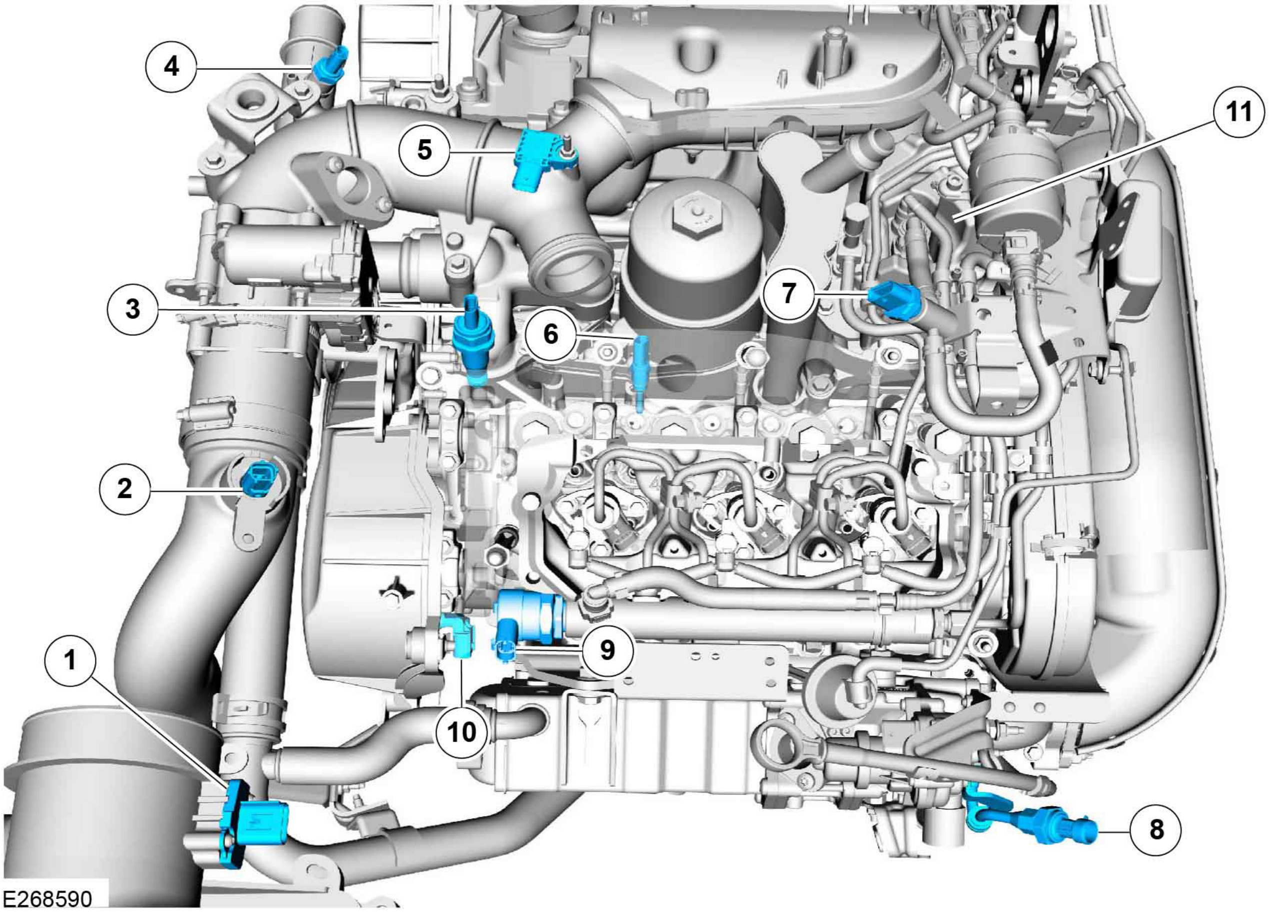
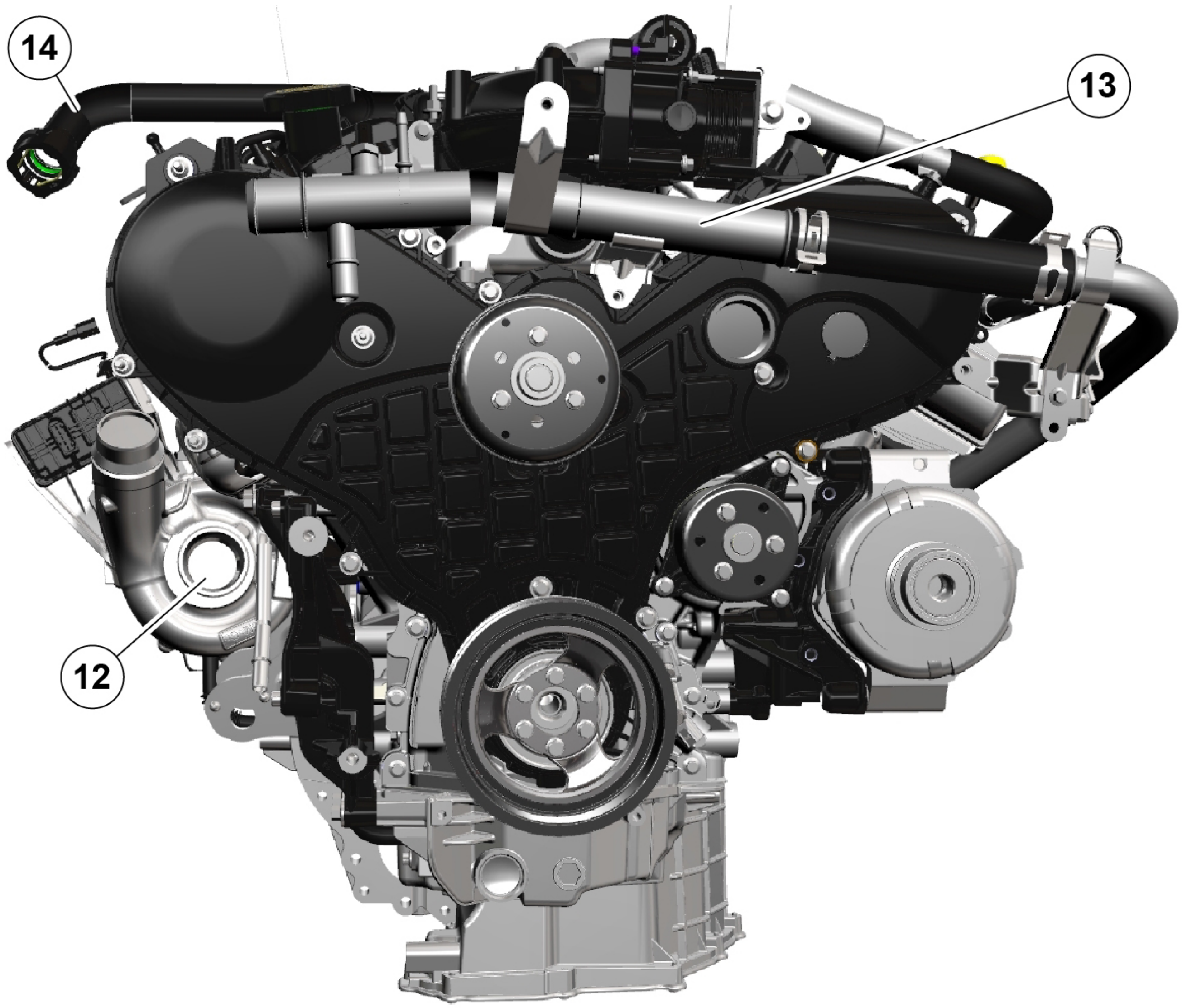


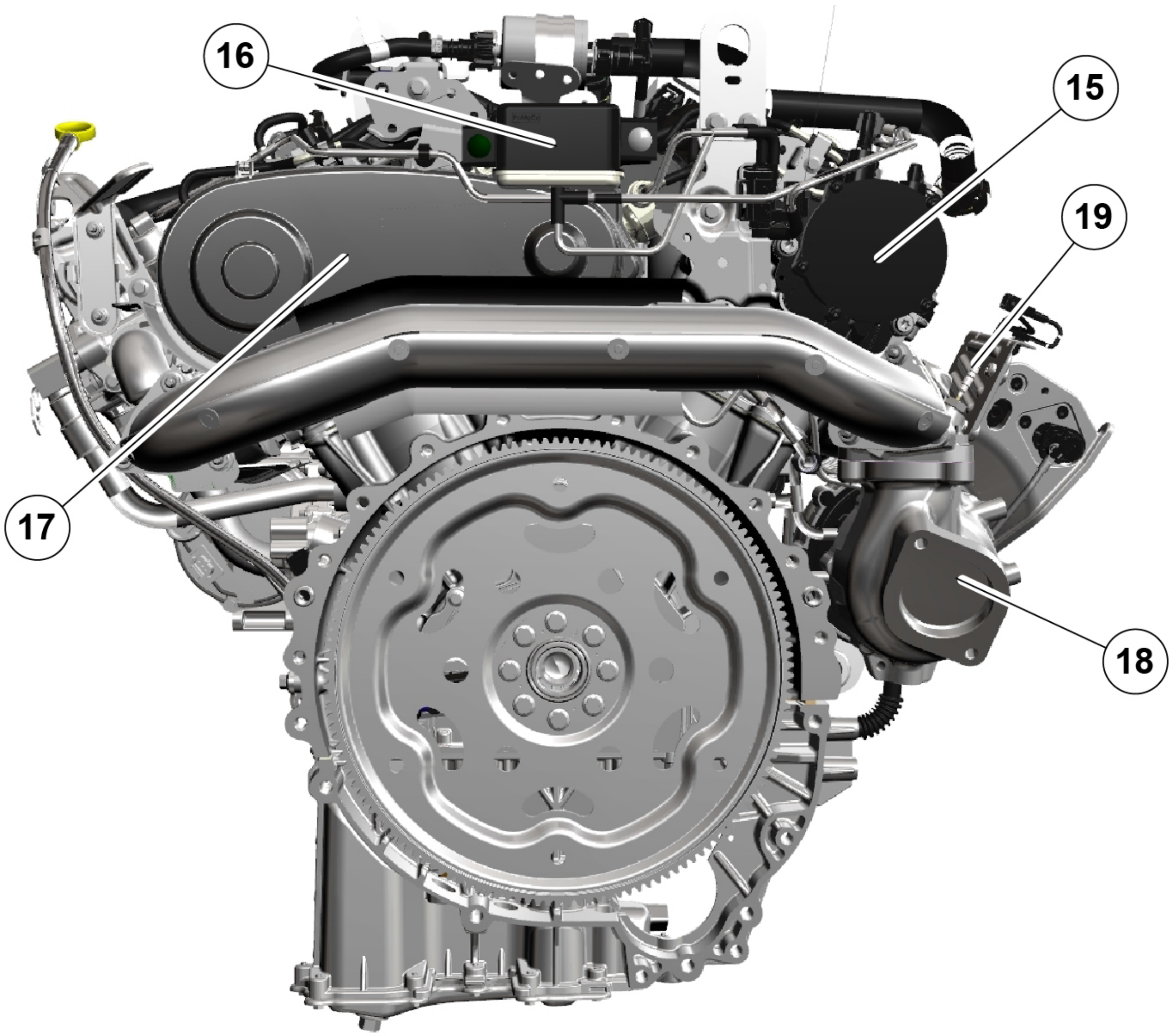
Component Location - Engine Top View	
1	MAF (mass air flow) sensor
2	CAC (charge air cooler) temperature sensor
3	EOP (engine oil pressure) sensor
4	ECT (engine coolant temperature) sensor
5	MAP (manifold absolute pressure) sensor
6	CHT (cylinder head temperature) sensor
7	Fuel Pressure and Temperature sensor
8	Exhaust Pressure sensor
9	Fuel Pressure Control Valve
10	CMP (camshaft position) sensor
11	High pressure fuel pump

3.0L Overview



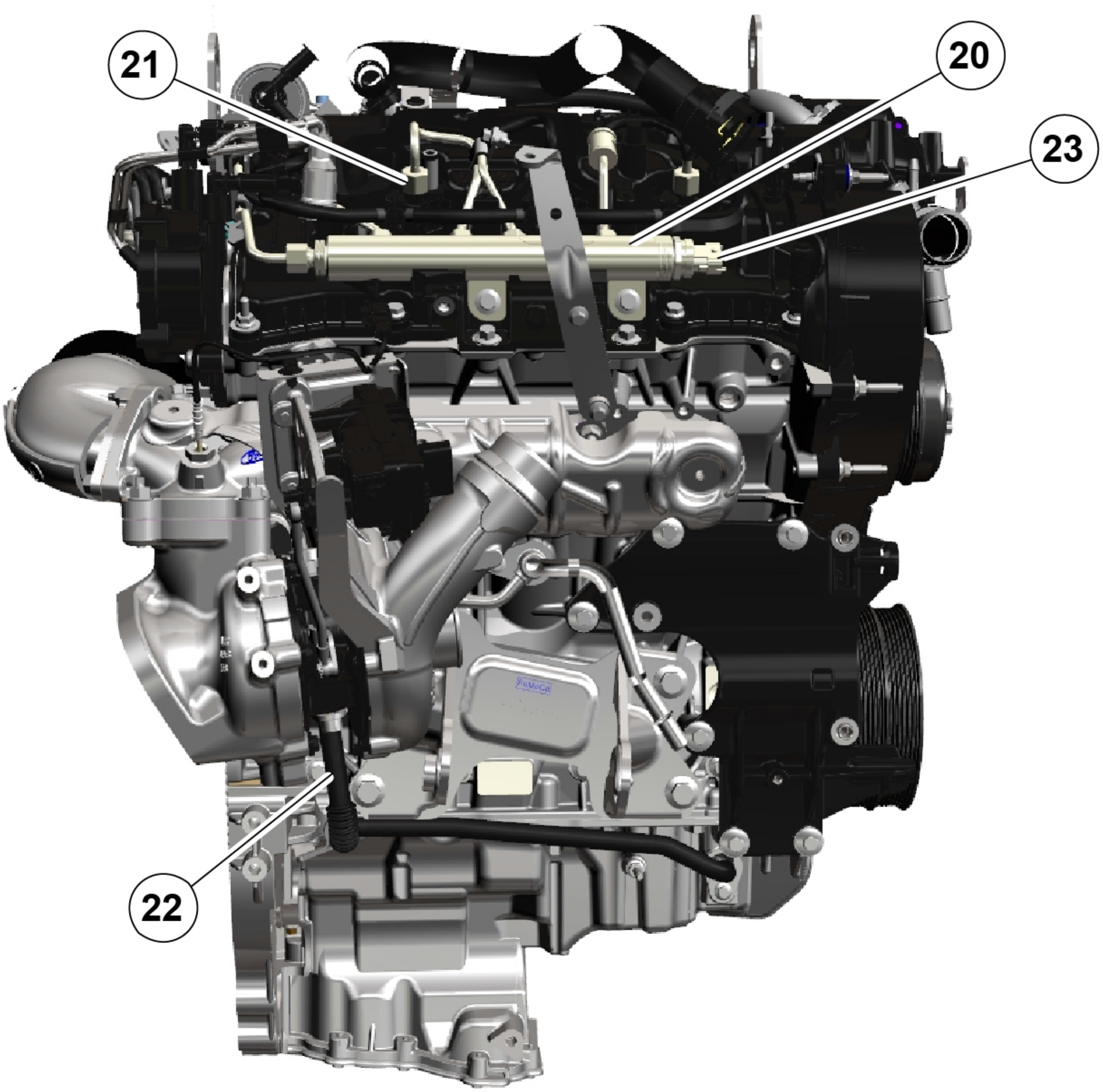
Component Location - Engine Front View	
12	Turbocharger
13	EGR cooler feed tube
14	Crankcase ventilation hose assembly

3.0L Overview



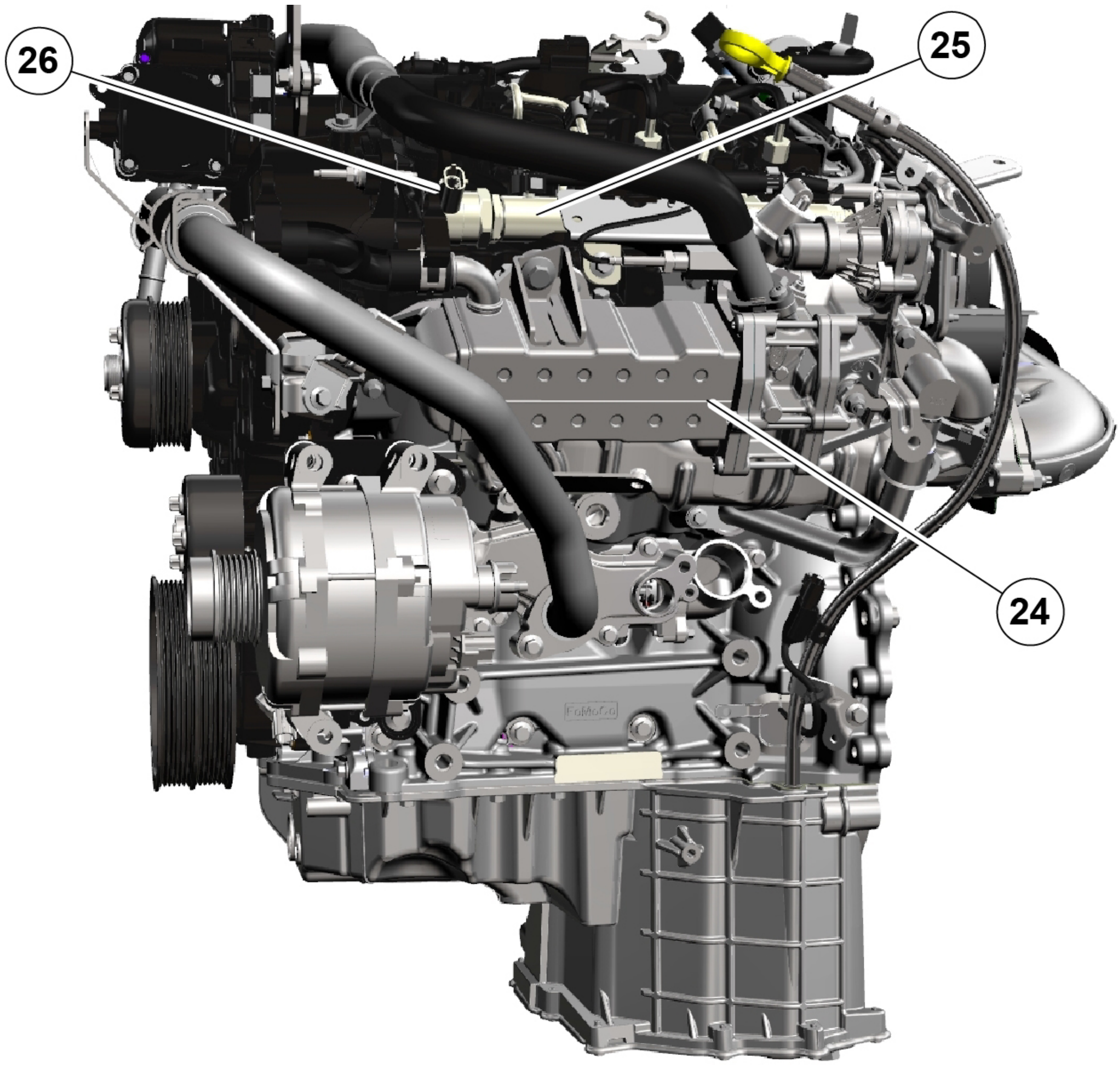
\Component Location - Engine Rear View	
15	Vacuum pump
16	Vacuum reservoir
17	High pressure fuel pump drive belt cover
18	Turbocharger
19	Exhaust Gas Recirculation Temperature sensor bank 1 sensor 1 (EGRT11)

3.0L Overview



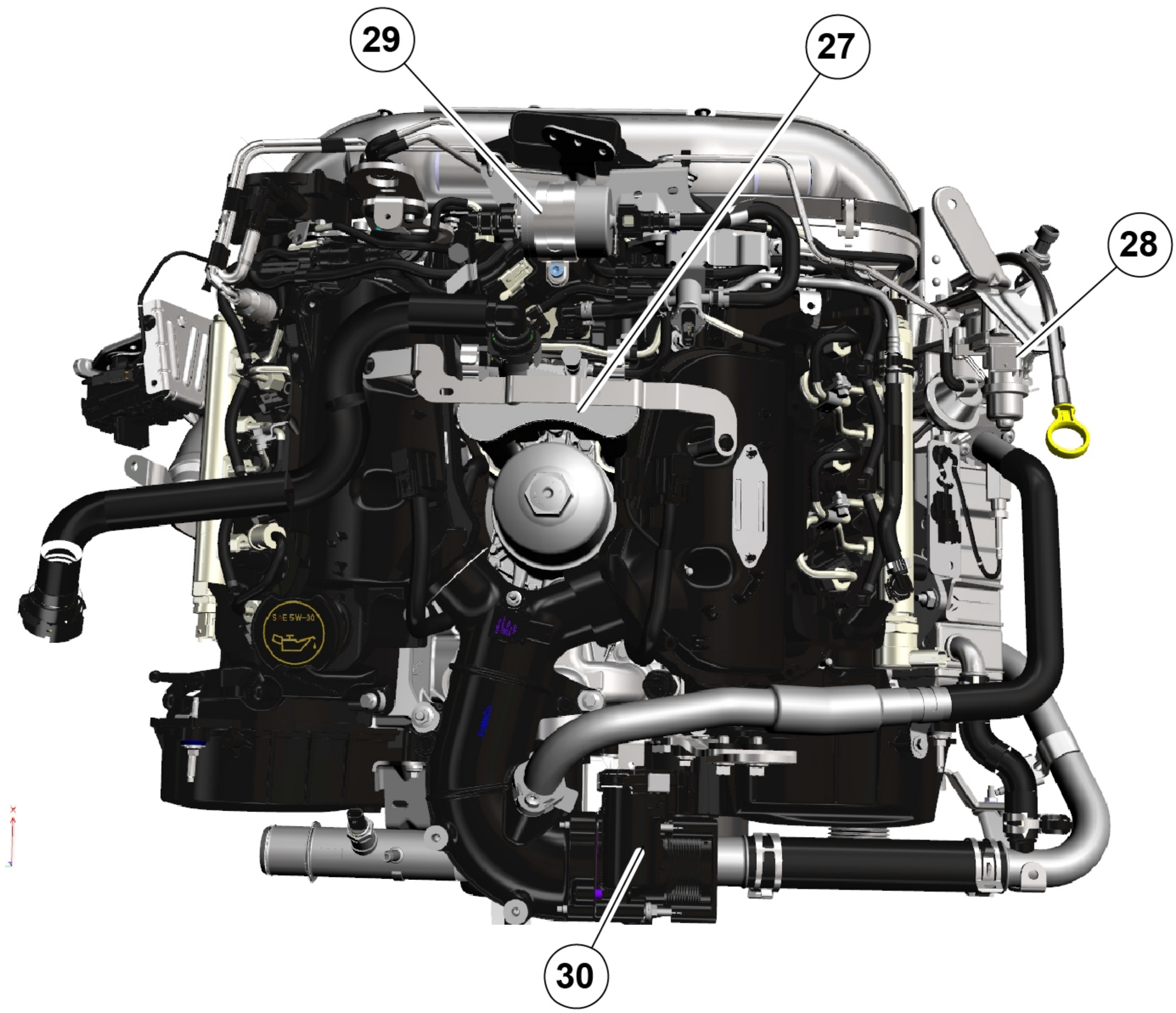
Component Location - Engine RH Side View	
20	RH fuel rail
21	High pressure fuel lines to injectors
22	Oil pressure feed for turbocharger
23	Fuel Rail Pressure (FRP) sensor

3.0L Overview



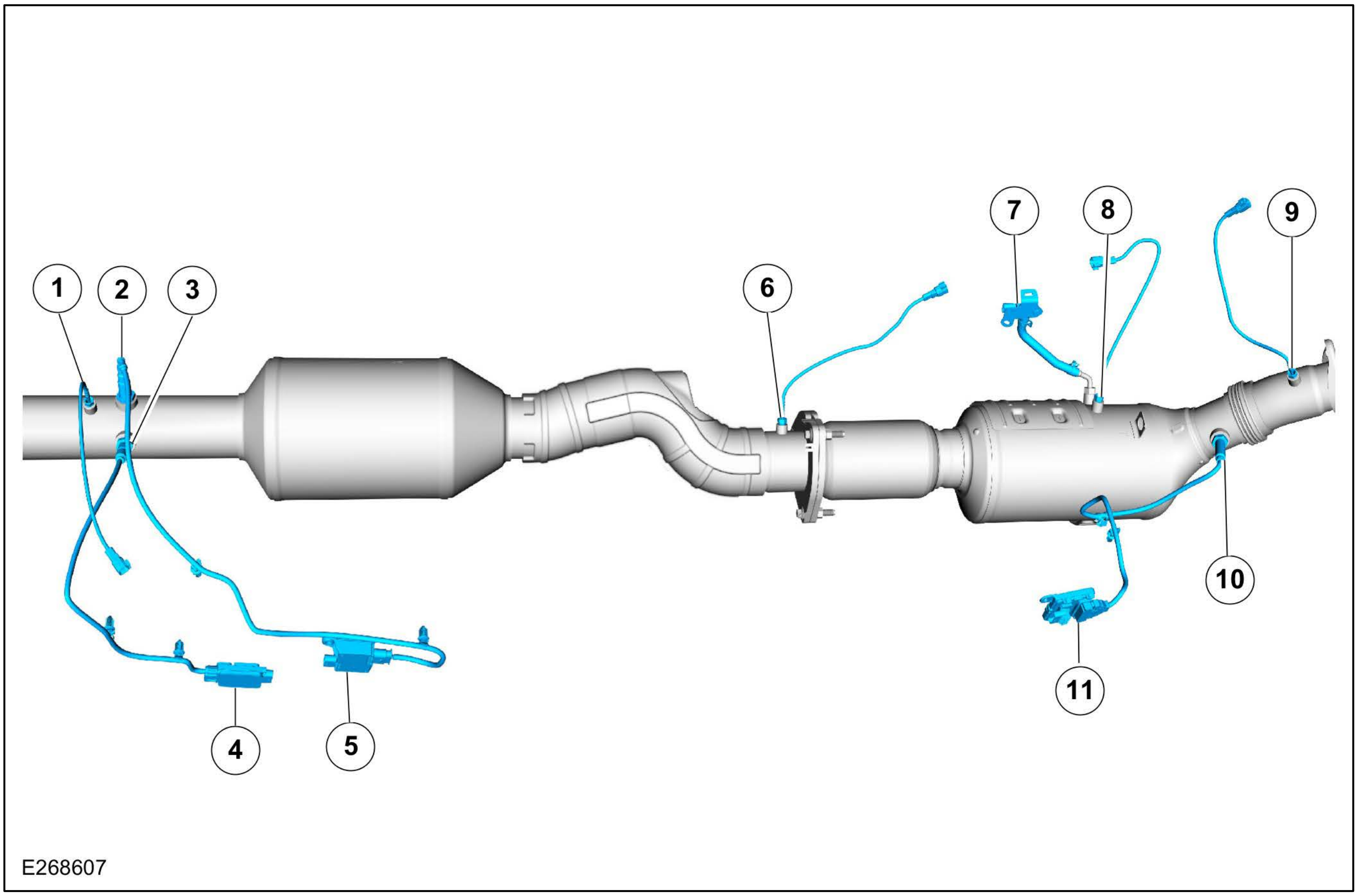
Component Location - Engine LH Side View	
24	EGR cooler assembly
25	LH fuel rail
26	Fuel Pressure Control Valve (FPCV)

3.0L Overview



Component Location - Engine Top View	
27	Oil separator assembly
28	EGR valve
29	Secondary low pressure fuel filter
30	Throttle body assembly

3.0L Overview



Component Location - Engine Exhaust View	
1	Exhaust Gas Temperature sensor 14
2	Particulate Matter sensor 11
3	NOX (oxides of nitrogen) sensor 12
4	NOX12 (nitrogen oxides sensor module 12)
5	Particulate Matter sensor Module 11
6	Exhaust Gas Temperature sensor 13
7	Diesel Particulate Filter (DPF) Differential Pressure sensor
8	Exhaust Gas Temperature sensor 12
9	Exhaust Gas Temperature sensor 11
10	NOX (oxides of nitrogen) sensor 11
11	NOX11 (nitrogen oxides sensor module 11)

3.0L Overview

The 3.0L V-6 Turbo Diesel Commonrail Injection (TDCI)engine is a common rail, turbo charged diesel engine. It is a member of the Global Lion engine family.

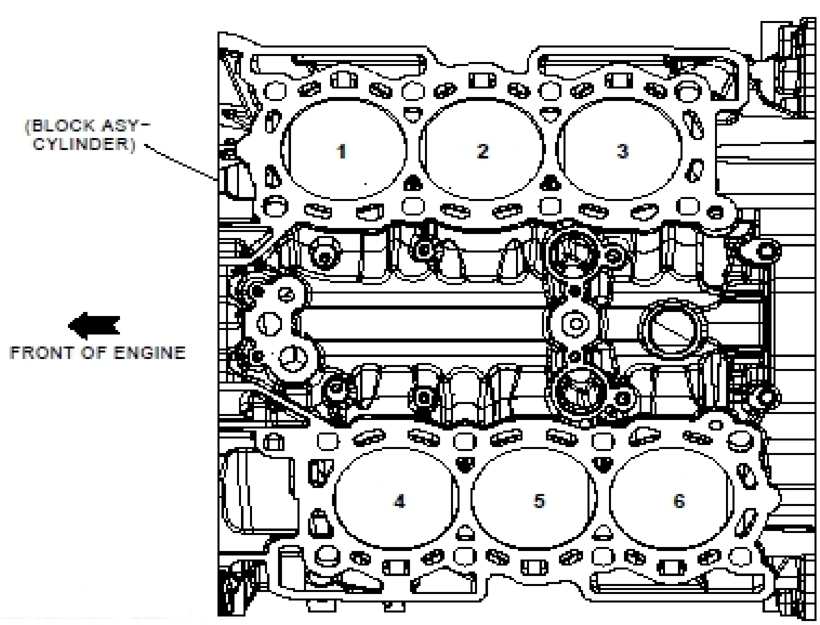
The engine is a cast iron V6-cylinder block. The cylinder heads are constructed of aluminum and consist of upper and lower cylinder head assemblies. There are 4 valves per cylinder and twin overhead camshafts that are driven via a timing belt. The high pressure fuel pump is driven by a separate toothed belt at the rear of the engine.

Engine Features

- Dual overhead camshafts
- 4 valves per cylinder
- Composite intake manifold
- Aluminum cylinder head
- Cast iron cylinder block
- Common rail fuel system
- Turbocharger
- Camshaft timing belt
- Belt driven secondary fuel pump

3.0L Overview

3.0L Power Stroke® Diesel Specifications	
Engine Type	TDCI V-6 Diesel
Configuration	4 OHV/DOHC – V6
Displacement	2.99L (182 cu. In.)
Bore and Stroke	84x90 mm (3.31x3.54 in.
Compression Ratio	16:1
Induction	Variable Geometry Turbocharger
Rated Power @ RPM	250 hp @ 3,250 rpm
Peak Torque @ RPM	440 ft-lb. @ 1,750 rpm
Engine Rotation, Facing Flywheel	Counterclockwise
Combustion System	High Pressure Common Rail Direct Injection
Total Engine Weight (auto with oil)	227 kg (501 lbs)
Cooling System Capacity	13L (3.43qts)
Lube System Capacity (including filter)	7.0L (7.4 qts)
Firing Order	1-4-2-5-3-6
Cylinder Order	RH – 1,2,3 LH – 4,5,6



3.0L Oil Specification

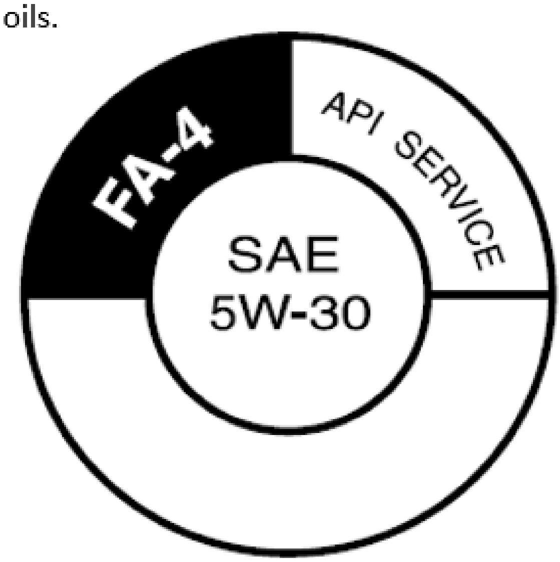
3.0L Power Stroke® Diesel Engine Specifications

Oil Specification

API FA-4 Oil

The 2018 F-150 3.0L diesel engine will have the newer API FA-4 oil specification. API FA-4 oil describes certain XW-30 oils specifically formulated for use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards.

API FA-4 oils are neither interchangeable nor backward compatible with API CK-4, CJ-4, CI-4 with CI-4 PLUS, CI-4, and CH-4 oils.



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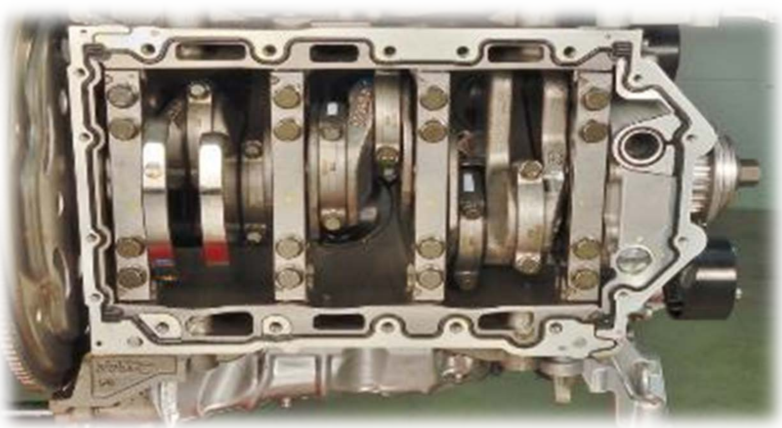
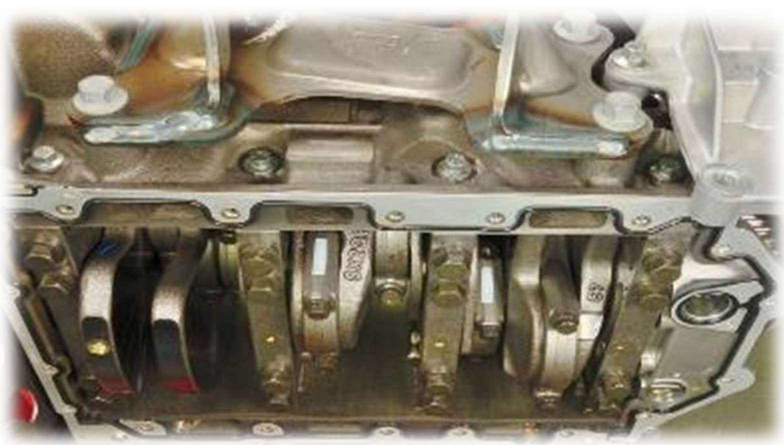
Engine Internal/External Components

<table>
<tr><td></td><td><u>Block</u>
The cylinder block is Compacted Graphic Iron design.</td></tr>
<tr><td></td><td rowspan="2"><u>Crankshaft</u>
Each crankshaft main bearings is secured with six bolts. Four on the bottom and two bolts fasten through each side of the block. These bolts help to make the block more rigid similar to a ladder frame design.</td></tr>
<tr><td></td></tr>
</table>

Engine Internal/External Components

Piston

The pistons have a cupped shape on the top with a dome in the center. This cupped area acts as the combustion chamber and allows for better swirling and mixing of the air and fuel.

The arrow marked on each piston indicates the direction for assembly. The arrows should all be pointing toward the front of the engine.

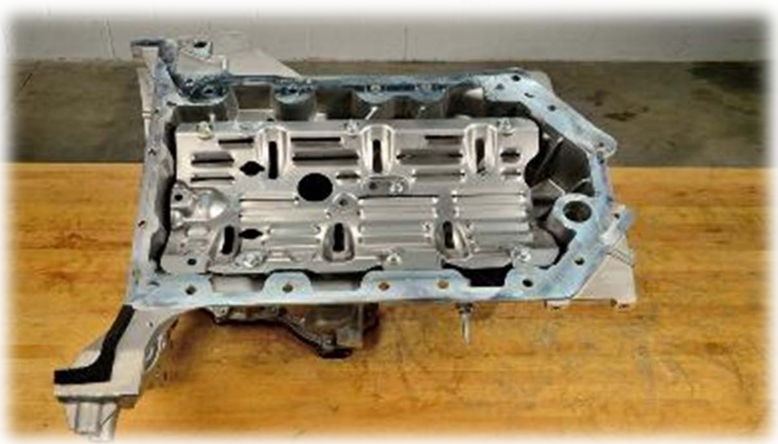
The pistons are cooled by oil jets mounted in the block that spray oil onto the bottom of the pistons as they move in the cylinders.

Connecting Rod

The connecting rod is an offset design that allows for the sharp angle of the 6 cylinder block.

Engine Internal/External Components

<u>Oil Pickup</u>
The oil pickup is mounted to the oil pan and reaches into the deepest part of the oil pan to pull oil through a screen and then into the engine oil pump.



<u>Oil Pan</u>
The oil pan is the reservoir for the engine oil. It incorporates a baffle to keep the engine oil from splashing which prevents aeration and foaming.

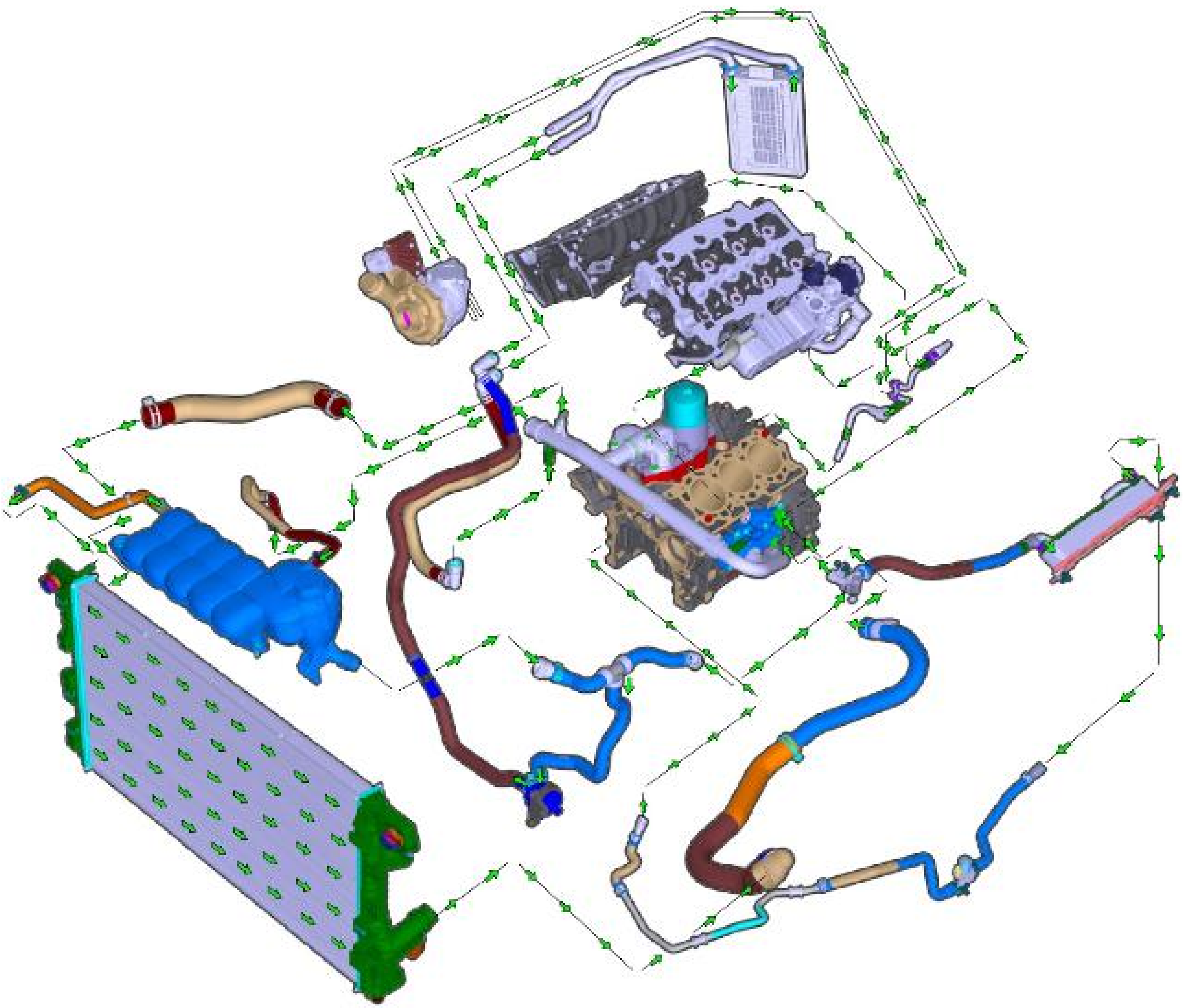
Engine Internal/External Components

	**Camshafts** There are four camshafts, two for the intake valves and two for the exhaust valves.
	**Rocker Arm And Adjuster Assemblies** The rocker arm assemblies are the roller rocker type. The hydraulic adjuster prevents play between the roller and the camshaft.

Engine Cooling

The cooling system includes the following:

- Radiator
- Coolant pump
- Engine driven fan assembly
- Degas bottle
- Coolant thermostat
- Coolant hoses
- Engine oil cooler
- Exhaust Gas Recirculation (EGR) cooler



Engine Cooling

Engine Oil Cooler

The engine oil cooler is mounted on top of the engine and in front of the high pressure fuel pump. As engine oil passes through the filter and cooler assembly, it is cooled by engine coolant passing through the assembly as well.

Coolant Pump

The coolant pump is belt driven by the engine and circulates coolant through the engine.

EGR Cooler

Located on the left side of the engine, the EGR cooler removes heat from the exhaust gases before they enter the intake manifold. When the exhaust gases are directed through the EGR cooler, engine coolant reduces the temperature of the gases. The exhaust gases are directed through the EGR cooler by a PCM-controlled EGR cooler bypass valve solenoid that provides or vents vacuum to the EGR cooler bypass valve actuator.

Engine Cooling

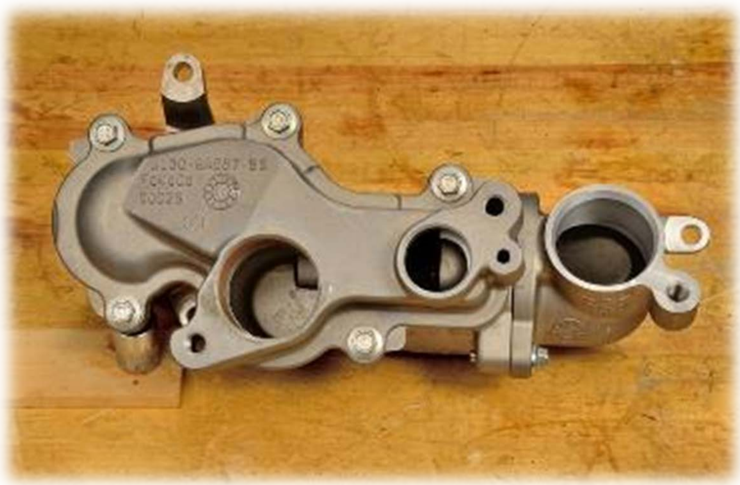
EGR Cooler Inlet Tube

The EGR Cooler Inlet Tube is located on the front of the engine. Engine coolant flows through the inlet tube to the EGR cooler.

Engine Cooling

Thermostat Housing

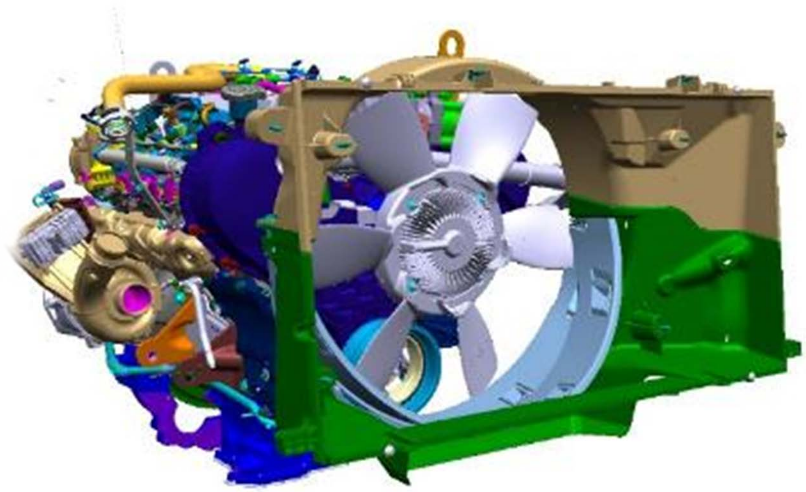
The thermostat housing is located at the front of the engine and contains the thermostat along with coolant passages that allow coolant to flow and bypass the thermostat for quicker passenger compartment heating. The thermostat regulates engine coolant temperature. The thermostat opens and closes based on engine coolant temperature to maintain a constant running temperature in the engine.



Engine Cooling

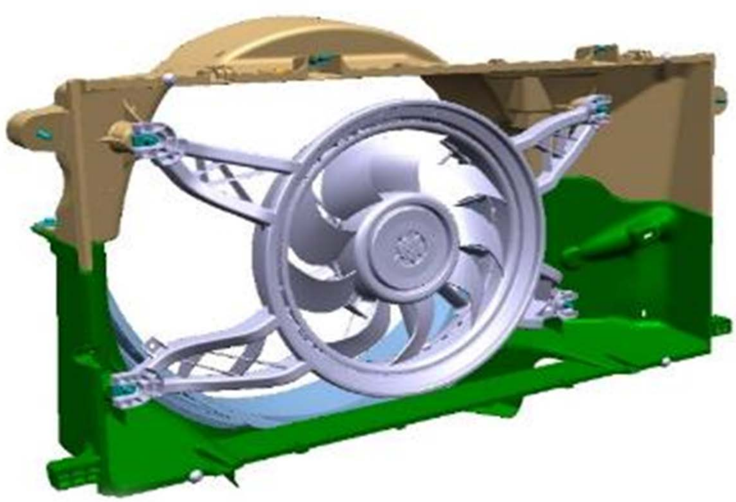
Thermostat Housing Connector

The Thermostat housing connector is located at the top front of the engine. It connects the thermostat housing with other ports on the engine assembly. These ports allow coolant to flow in different directions during engine cooling.



Engine Cooling Fan

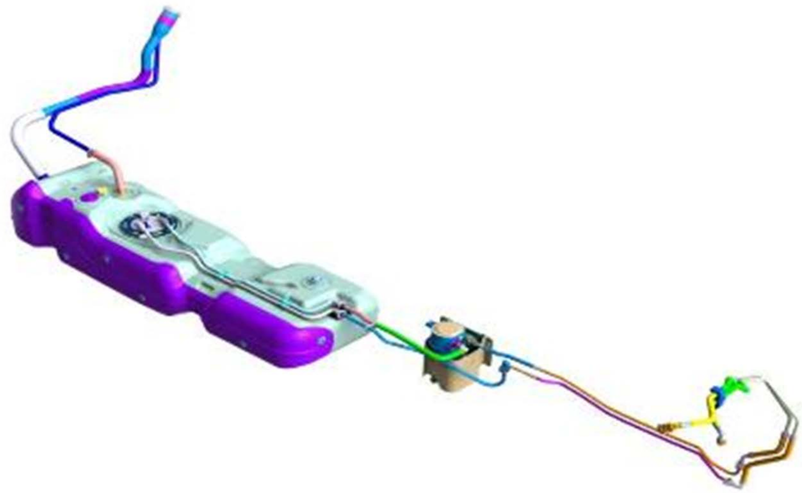
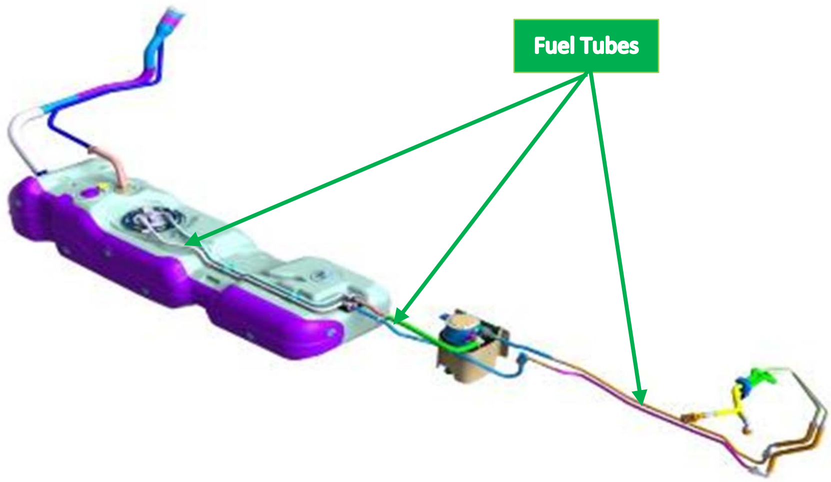
The primary cooling fan is driven by the engine. The fan speed is relative to engine RPM.



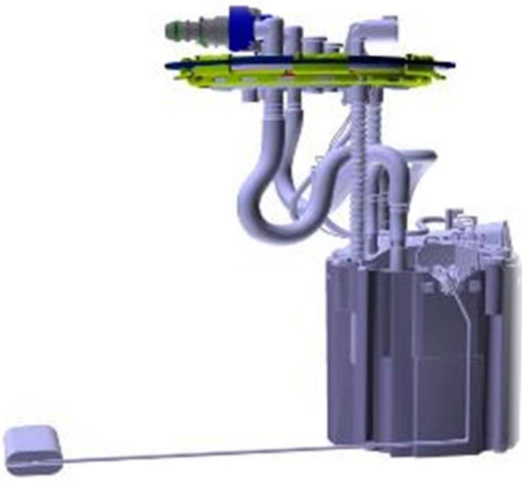
Engine Secondary Cooling Fan

The secondary cooling fan is located directly in front of the radiator. The fan is electric and controlled by the PCM.

Fuel Charging and Controls

<table>
<tr><td><u>Fuel Tank and Filler Pipe Assembly</u>
The fuel tank utilizes the Easy Fuel™ (capless) fuel tank filler pipe assembly. With miss-fueling prevention the filler door will open only when the correct diesel sized refueling nozzle is used.</td><td></td></tr>
<tr><td><u>Fuel Tubes</u>
The fuel tubes carry the low pressure fuel to the high pressure fuel pump.</td><td></td></tr>
<tr><td><u>Fuel Filter/Water Separator</u>
The fuel filter and water separator assembly is located in front of the fuel tank. The water separator will need periodic servicing to empty the water from the fuel system. Drain during oil change intervals or when the “water in fuel “message illuminates. Change filters at the specified intervals or when the low fuel pressure message appears on the instrument cluster.</td><td></td></tr>
</table>

Fuel Charging and Controls

<table>
<tr>
<td></td>
<td><u>Low Pressure Fuel Pump and Level Sensor</u>
The low pressure (LP) fuel pump and level sensor are part of the Diesel Delivery Module (DDM) assembly located in the fuel tank. This low-pressure pump supplies fuel to the high-pressure fuel system. The fuel pump is serviced by replacing the DDM assembly. The fuel level sender can be serviced independently.</td>
</tr>
</table>

Fuel Charging and Controls

Fuel Pump Control Conditioning Module

The fuel pump control conditioning module is located on the frame in the low pressure fuel supply line. It is controlled by the Engine Control Module (ECM) with a Pulse Width Modulated Signal. It provides the voltage necessary for the fuel pump. The system is designed to operate at two pump speeds: low and high speed. At low fuel demand (below 1400 rpm) it will operate at low speed/pump voltage and should deliver a minimum of 120 LPH and 51 psi. At higher loads and engine RPM the system will operate at high speed and deliver a minimum of 150 LPH and 51 psi. Pressure readings above the 51 psi indicate adequate flow is being delivered to the HP pump.

Fuel Charging and Controls

High Pressure Fuel Pump
The high pressure fuel pump is driven by a separate belt at the rear of the engine and houses two pumps. The main shaft has two actuating lobes that are offset 180 degrees from each other. Each pump piston is actuated twice per crankshaft revolution.

Piston Assemblies
The pistons are actuated via the actuating lobes and are returned to rest via spring pressure. The pistons receive fuel from the one-way check valve. Fuel is drawn into the cylinder while the piston is returning to rest. The fuel flow to the cylinders of the pump are metered by the VCV.

Piston Assembly Check Valves
The outlet check valve closes while fuel is being drawn in due to a pressure difference on the two sides of the check valve. Once the piston starts its compression stroke, the inlet check valve closes via the spring and fuel pressure and the outlet check valve opens due to increasing fuel pressure, forcing the check valve off its seat.

Fuel Charging and Controls

H.P. Fuel Pump Timing Drive Belt The High Pressure Fuel Pump is belt driven by the left intake camshaft. The fuel pump must be timed correctly to the camshaft rotation.	

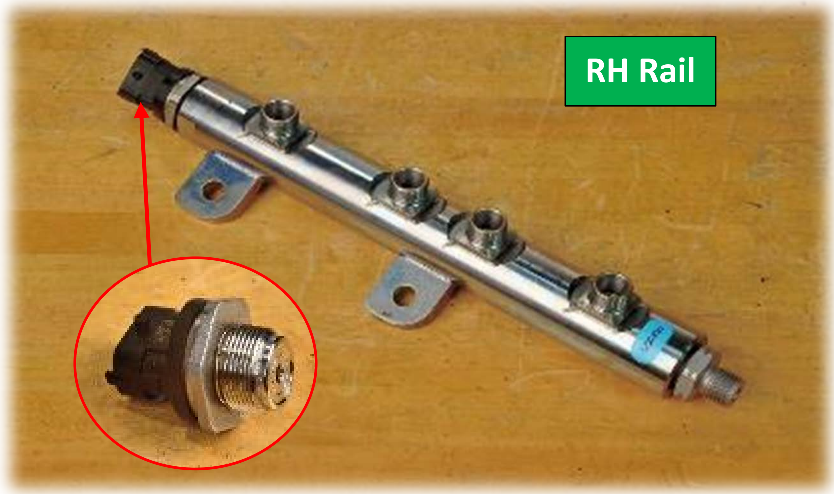
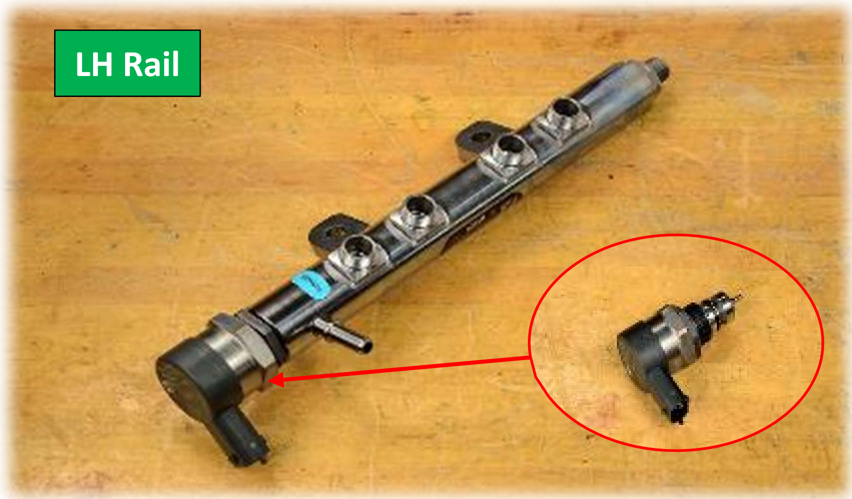
Fuel Charging and Controls

Engine Timing Belt

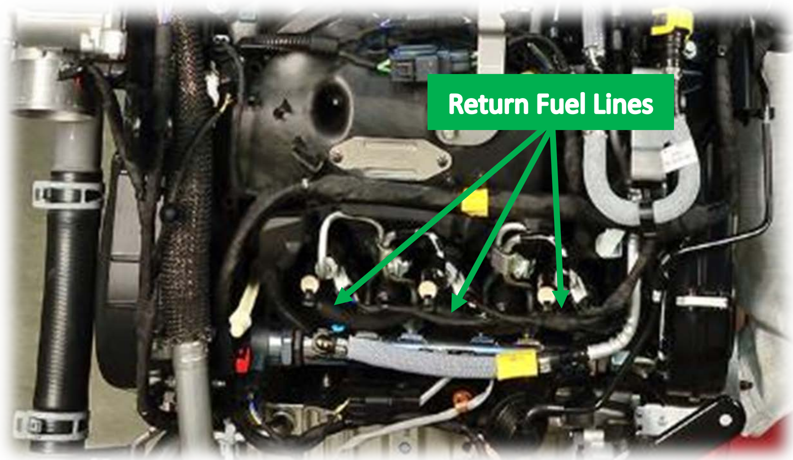
The engine timing belt drive allows the crankshaft to drive all four camshafts. A tensioner Maintains correct tension on the timing belt.

See the WSM for the procedure and special tools needed to set the timing correctly.

Fuel Charging and Controls

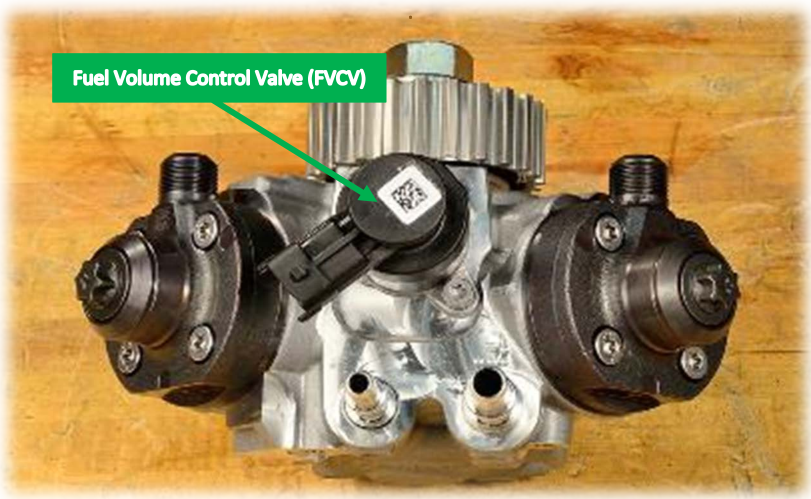
Fuel Rail The fuel rails are made from forged steel and secured to the camshaft carriers by support brackets. The fuel is delivered by high-pressure fuel supply lines from the fuel pump to each of the fuel rails. Pressure can be as high as 2000 bar. A balance pipe runs from one fuel rail to the other. From the fuel rail, the fuel travels through high-pressure fuel supply lines to the fuel injectors. At the end of the RH fuel rail is the Fuel Rail Pressure (FRP) sensor. **If the FRP fails, the fuel rail and FRP sensor must be replaced as an assembly.**	
At the end of the LH fuel rail is the Fuel Pressure Control Valve (FPCV) The FPCV is a two wire normally open Pulse Width Modulated (PWM) solenoid. The PCM relay supplies system voltage to one wire of the solenoid. The PCM pulse width modulates the ground to control the PCV in order to maintain the desired fuel pressure under various operating conditions. The PCM monitors fuel pressure using information from the FRP sensor.	
High Pressure Fuel lines High pressure fuel lines carry the high pressure fuel to the injectors. If a high pressure fuel line is loosened or removed it must be replaced. This ensures a good seal.	

Fuel Charging and Controls



Return Fuel Lines/Hoses

The return fuel lines and hoses return fuel from the injectors to the fuel conditioning module



Fuel Volume Control Valve (FVCV)

The PCM regulates fuel volume by controlling the duty cycle of the FVCV. The FVCV is a normally closed valve. A high duty cycle indicates low fuel volume is being admitted to the high pressure portion of the fuel injection pump. A low duty cycle indicates high volume is being admitted to the high pressure portion of the HP fuel injection pump. The FVCV is mounted on the high pressure fuel injection pump.

The FVCV works in conjunction with the FPCV to regulate fuel flow and pressure.

Fuel Charging and Controls

Fuel Injectors

The piezo injectors, are connected to the fuel rail. They inject the amount of fuel necessary into the combustion chamber for all operating conditions of the engine. The injector is centralized in the combustion chamber. The injection quantity is composed of pre-injection, main-injection, and post-injection. The injectors are controlled by the PCM.

Fuel Correction Code

On top of the fuel injector is a correction code. Whenever a fuel injector is replaced, the new fuel injector's fuel correction code must be entered using the scan tool. The correction code allows for subtle differences in fuel flow between injectors. With an incorrect code, the engine may lack power and/or run rough.

Fuel Charging and Controls

Variable Geometry Turbocharger

The turbocharger increases the mass of charge air for the engine by supplying it under pressure to the intake system, which increases the power and torque output of the engine.

The turbine rides on a shaft that connects it to a compressor located in the intake air stream. The compressor is driven by the turbine and compresses the filtered air supplied via the intake duct.

Hot, expanding exhaust gases drive the turbine in the turbocharger. Under higher load conditions, the temperature of the exhaust gases increases. This means the rate of expansion of the exhaust gases also increases, causing the speed of the turbine and compressor to increase.

The hot compressed charge air is routed through an intercooler after leaving the turbocharger to improve volumetric efficiency by increasing air density. The compressed and cooled intake air is supplied to the intake manifold.

The variable geometry turbocharger is fitted with a VGT actuator module that controls the angle of metal vanes surrounding the turbocharger turbine. The metal vanes control the boost pressure in the intake tract by controlling the velocity of exhaust gases that may spin the turbine. The turbine’s speed affects boost pressure. The VGT actuator module is controlled by the PCM. The actuator contains a position sensor to provide feedback to the PCM/ECM.

The turbocharger uses ball bearings on the turbine/impeller shaft to decrease spool-up times.

Fuel Charging and Controls

Crankcase Ventilation Heater

The crankcase ventilation heater is used to heat the crankcase ventilation system vapor to prevent any oil that may be present from sludging in the charge air cooler, turbocharger and intake manifold. The crankcase ventilation heater is located on the crankcase ventilation hose, between the crankcase ventilation sensor and the fresh air inlet.

Low Pressure Fuel Pressure/temperature Sensor

The low pressure fuel line connects the secondary fuel filter to the low pressure fuel system. It contains a pressure sensor. The fuel line is located at the upper rear of the engine.

The fuel pressure sensor has a 331-400 kPa (48-58 psi) gauge setpoint for detection of a low pressure fuel supply. The PCM de-rates the engine’s power by 30% if the switch is triggered. The fuel pressure sensor protects the high pressure fuel system from damage due to low fuel pressure supply.

LOW FUEL PRESSURE displays in the message center to advise the customer of a low fuel pressure

Glow Plug System

Glow Plugs

Because diesel engines operate on heat from compression glow plugs are used to increase the temperature of the combustion chamber to aid in cold starting.

The glow plugs also reduce emissions during engine warm-up.

Glow Plug System

Glow Plug Control Module (GPCM)

Glow plug on time is controlled by the GPCM. The module takes into account the following:

- Engine's RPM
- Engine's torque
- Engine coolant temperature
- Ambient air temperature
- Atmospheric pressure (BARO sensor input)
- Battery voltage

The GPCM controls the individual glow plugs using a pulse-width modulation (PWM) signal. The glow plug control module provides battery voltage for approximately 2 seconds, at nearly 100% duty cycle, to control in-rush current and heat up the glow plugs, then drops back to 7 volts, which also lowers the amperage. Glow plug on-time (duty cycle) will vary, depending on battery voltage and engine coolant temperature. In the preheat phase (before starting), the glow plugs will operate at engine temperatures below 176 °F (80 °C) for a maximum of 8 seconds.

The GPCM may command the glow plugs on when the engine is on an extended idle under cold ambient conditions, to assist with the reduction of exhaust emissions.

After starting, there may be an after-glow phase, where the glow plugs will function for a maximum of 30 seconds, as long as the engine temperature is less than 122^{o}F (50 °C) and the engine speed is less than 2500 rpm. This aids the reduction of emissions.

Engine Emission Controls

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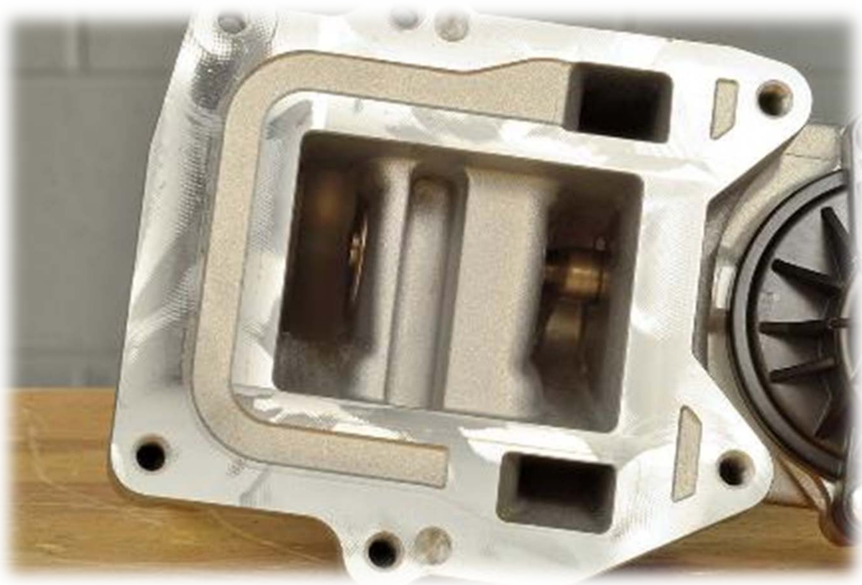
<tr><td></td><td>

Exhaust Gas Recirculation (EGR) valve

The EGR valve helps reduce the levels of Nitrogen Oxides (NOx) produced during combustion, particularly at light load and during cruise. This is important because NOx is a primary component of smog.

The EGR valve is mounted behind the intake manifold. The EGR assembly extends from the exhaust manifold to the inlet manifold behind the cylinder head. A portion of the exhaust gas is recirculated via the EGR system into the fresh air flow in the inlet manifold. The proportion of recirculated exhaust gas no longer directly participates in the combustion; significantly reducing the proportion of NOx. The exhaust gas recirculation rate depends to a large extent on the engine speed and engine load. The exhaust gas can be recirculated particularly efficiently in the lower partial load range.
</td></tr>
<tr><td></td><td>

EGR Motor

The PCM controls the EGR motor. Based on engine information sent to the PCM, it determines the open and closed position of the valve.
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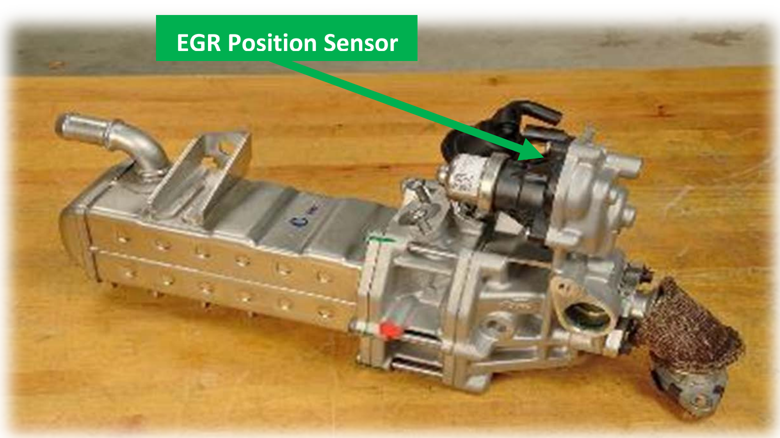
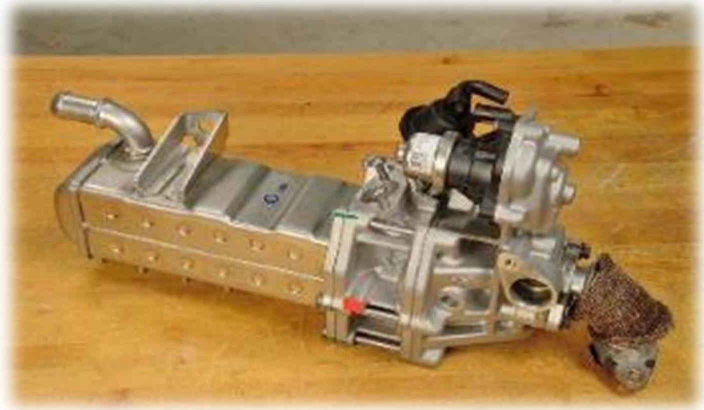
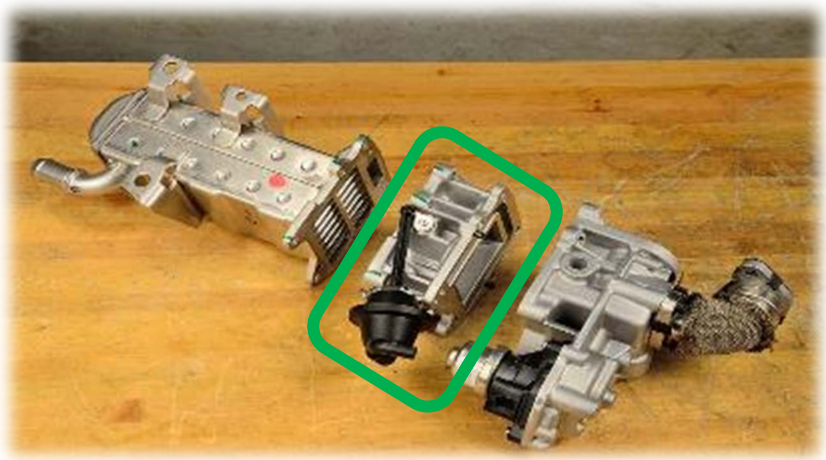
<tr><td>
</td><td>

EGR Position Sensor

The EGR position sensor sends data to the PCM to let it know what position (open – closed) the valve is in.
</td></tr>
</table>

Engine Emission Controls

EGR Cooler The EGR cooler removes heat from the exhaust gas before the exhaust gas enters the EGR valve and the intake manifold. The EGR cooler is located at the back of the engine. When the exhaust gas is directed through the EGR cooler, the engine coolant reduces the exhaust gas temperature. The exhaust gas is directed through the EGR cooler by a PCM controlled EGR cooler bypass valve.	
EGR Cooler Bypass Valve The exhaust gas is directed through the EGR cooler by the EGR cooler bypass valve to remove heat before entering the intake manifold. The EGR cooler bypass valve is internal to the EGR cooler. The operation of the EGR cooler bypass valve is as follows: • When the EGR cooler bypass valve solenoid is commanded off by the PCM, closing the EGR cooler bypass valve. • The exhaust gasses pass through the EGR cooler to the intake manifold. • The cooler bypass valve solenoid is commanded on by the PCM, opening the EGR cooler bypass valve. • The EGR cooler bypass valve is open, allowing the exhaust gasses to pass directly to the intake manifold without passing through the EGR cooler.	
EGR Tube w/EGRT12 Sensor The EGR tube allows exhaust gasses to route to the EGR valve and cooler. This tube includes the Exhaust Gas Recirculation Temperature (EGRT) bank 1 sensor 2 (EGRT12)	

Engine Emission Controls

Reductant or Diesel Exhaust Fluid (DEF)

Reductant, also known as Diesel Exhaust Fluid (DEF) is 32.5% urea/water solution. When injected into the exhaust, there is a chemical reaction that converts NO_x into N_2 and H_2O.

The freezing point of reductant is -11°C (12°F).

Reductant is very caustic; take care not to spill onto connectors, wiring harnesses or the vehicle's paint.

Engine Emission Controls

Regeneration Process

As soot gathers in the aftertreatment system, the exhaust begins to become restricted. Regeneration is the process in which soot is burned off from the inside of the DPF. Regeneration can be commanded by the PCM or the scan tool.
The PCM starts regeneration of the DPF if the soot load exceeds a calibrated value. The PCM determines the load condition of the DPF, based on the exhaust gas pressure upstream of the DPF. The DPF pressure sensor provides the pressure input to the PCM.
This soot can be cleaned by passive, active, or manual regeneration. Manual regeneration is performed using the IDS.

Passive Regeneration

Passive regeneration takes place when exhaust temperatures exceed 300°C (572°F). This process does not affect engine performance and is transparent to the driver.

Active Regeneration

Active regeneration occurs when exhaust temperatures are insufficient to achieve passive regeneration and the DPF pressure sensor is indicating the need for regeneration.
The PCM automatically injects fuel late in the combustion process to Raise the exhaust temperature to regenerate the DPF while the vehicle is in motion.
Engine performance is not affected by active regeneration; however, the engine or exhaust tone may change.

Manual Regeneration

The scan tool can be used to perform a manual regeneration of the DPF to clean the system. The manual DPF Regeneration can be performed in a stationary location or can be run while driving the vehicle, if needed, to try to reproduce customer issues. The Malfunction Indicator Lamp (MIL) may illuminate when service or maintenance of the DPF is necessary.

CAUTION: The manual regeneration of the DPF produces high temperatures in the exhaust system. Due to high exhaust gas temperatures, always follow the Workshop Manual Cautions, Warnings, and procedures when performing a manual DPF regeneration.

Frequency of Regeneration

The mileage between regenerations varies significantly, depending on vehicle usage.

Post Regeneration

After regeneration, the PCM reads the pressure at the DPF pressure sensor and compares it with a calibrated value. From this comparison, the PCM determines the ash quantity inside the DPF.

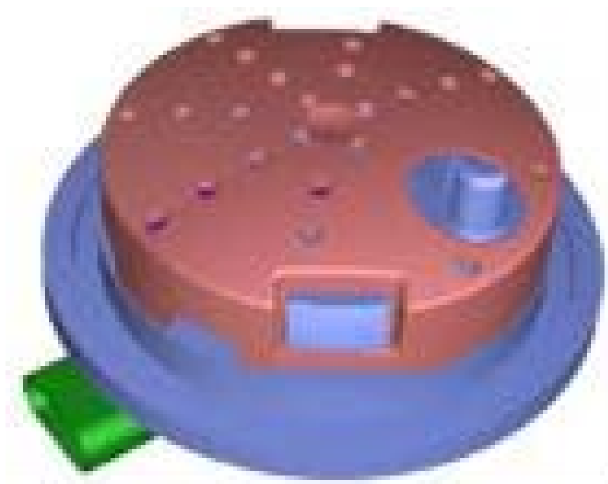
Non-Burnable Ash

Over time a slight amount of non-burnable ash builds up in the DPF which is not removed during the regeneration process. Ash comes from the fuel, oils and other materials that remain after the DPF regeneration process. The DPF may need to be removed for ash cleaning and replaced with a new or remanufactured part.
Handle the DPF with care. Dropping the DPF may cause internal damage.

Engine Emission Controls

Reductant Tank

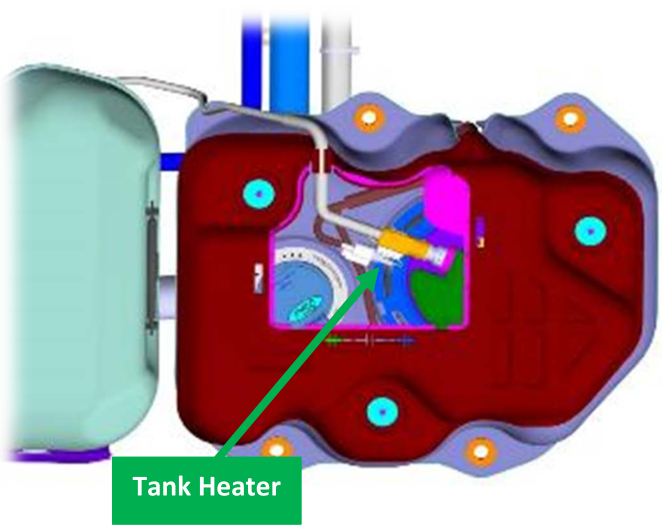
The reductant tank is the reservoir that holds the Diesel Exhaust Fluid (DEF).



Reductant Tank Level Sensor

The DEF level sensing and DEF concentration sensing is accomplished utilizing an ultrasonic sensor in the bottom of the tank. The sensor sends an ultrasonic signal from the sender to two points on a reflector on top of the sensor to determine the speed of sound of the signal through the medium. There is a direct correlation between the speed of sound and the DEF concentration. Once the speed of sound is established, the sender unit sends an ultrasonic signal towards the top of the tank. This signal reflects back to the sender unit from the fluid surface, and based on the travel time of the signal, the fluid level in the tank is established. The fluid level is converted to a percentage of fill and sent to the gauge on the cluster.

The reductant tank level sensor also measures the temperature of the fluid in the tank.



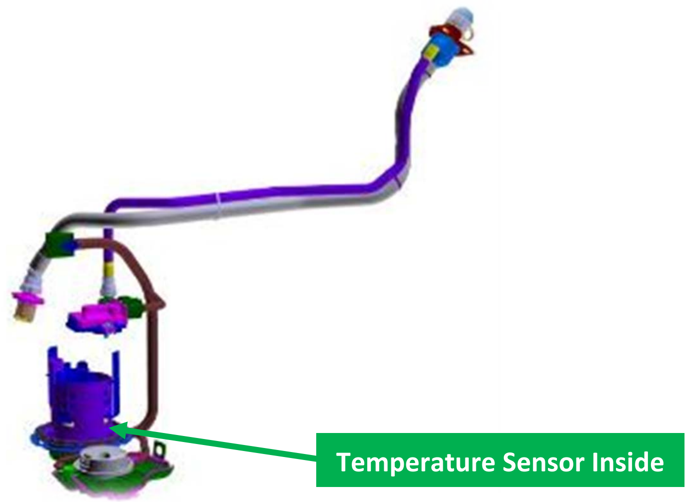
Reductant Tank Heater

The reductant tank heater prevents the DEF from freezing during cold ambient temperatures. When the reductant temperature sensor detects the DEF temperature dropping to its freezing point of -11°C (12°F), the reductant dosage control module provides voltage to the heating element. The reductant tank heater is integral to the reductant heater and sender assembly, located directly above the pickup tube inlet filter.

Engine Emission Controls

Reductant Temperature Sensor

The reductant temperature sensor is integrated into the reductant tank level sensor.



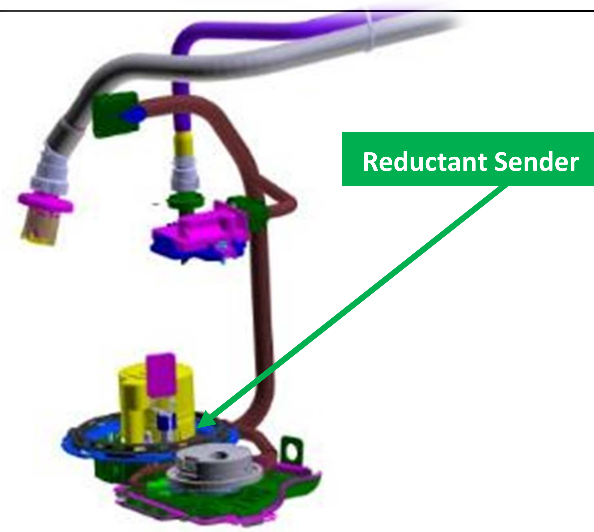
Reductant Tank Filler Hose

The reductant tank filler hose allows the tank to be filled with DEF.

Reductant Heater and Sender Assembly

The reductant heater and sender assembly consists of:

- Pickup tube for the reductant pump assembly
- Reductant tank heater
- Reductant temperature sender
- Reductant level sensor.



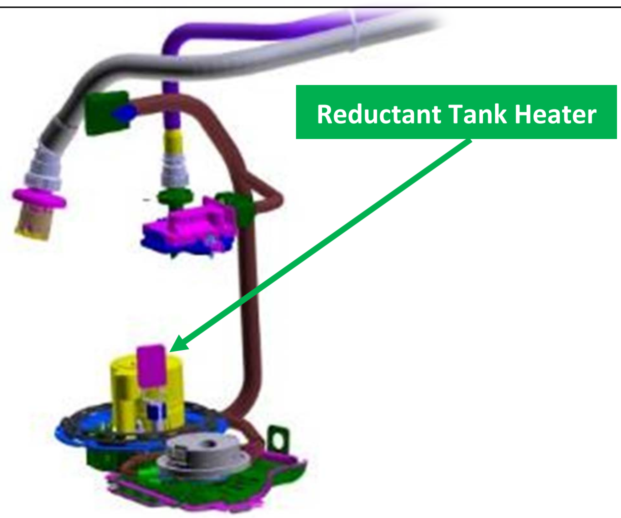
Engine Emission Controls

Reductant Pump Assembly

The reductant pump assembly consists of:

- A diaphragm pressure pump
- Reductant pressure sensor
- Reductant purge valve
- Reductant pump heater
- Outlet filter

The reductant dosage control module regulates system pressure by controlling pump speed using Pulse Width Modulation (PWM).



Reductant Pump Heater

The reductant pump heater prevents the DEF from freezing during cold ambient temperatures. When the reductant temperature sensor detects the DEF temperature dropping to its freezing point of -11°C (12°F), the reductant dosage control module provides voltage to the heating element. The reductant pump heater is integral to the reductant pump assembly.

Reductant Purge Valve

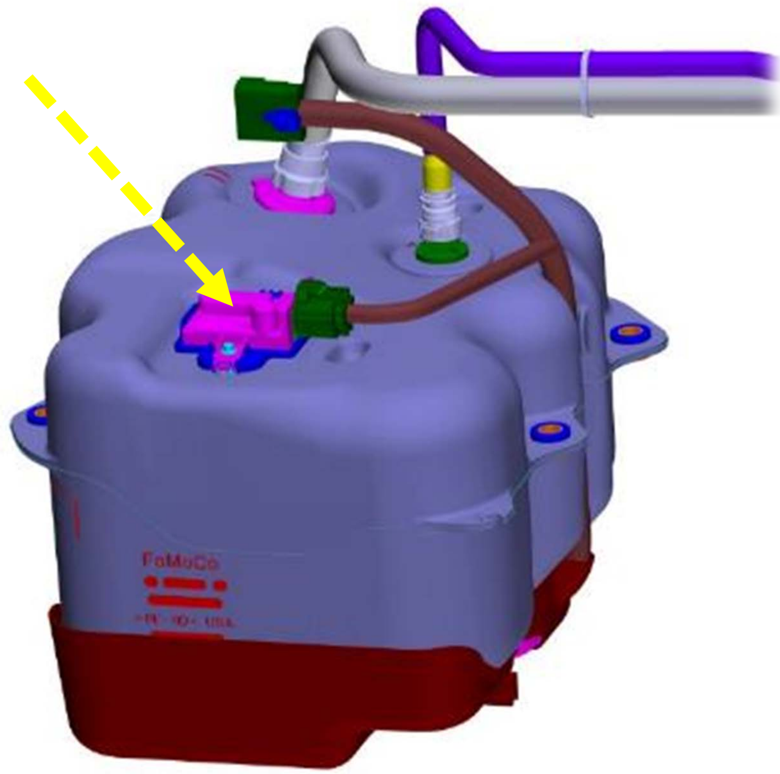
The reductant purge valve controls flow direction within the reductant injection system when commanded by the reductant dosage control module.

When the reductant dosage control module requests reductant injection, the reductant injector opens and the pump operates, filling the reductant pressure line and injector and purging air from the system.

When all air is purged, the injector closes and the pump builds pressure to 500 kPa (73 psi). The system is then primed and the injector provides DEF to the Selective Catalytic Reduction (SCR) catalyst as commanded by the reductant dosage control module.

When the vehicle is shut down, the reductant dosage control module closes the injector and actuates the reductant purge valve, causing the pump to reverse flow and bleed down pressure on the reductant pressure line.

The reductant dosage control module then opens the injector to allow gas to enter the reductant pressure line, allowing the pump to purge all remaining DEF from the system and return it to the reductant tank. The reductant dosage control module closes the injector and returns the purge valve to the forward position. The reductant purge valve is integral to the reductant pump assembly.



Engine Emission Controls

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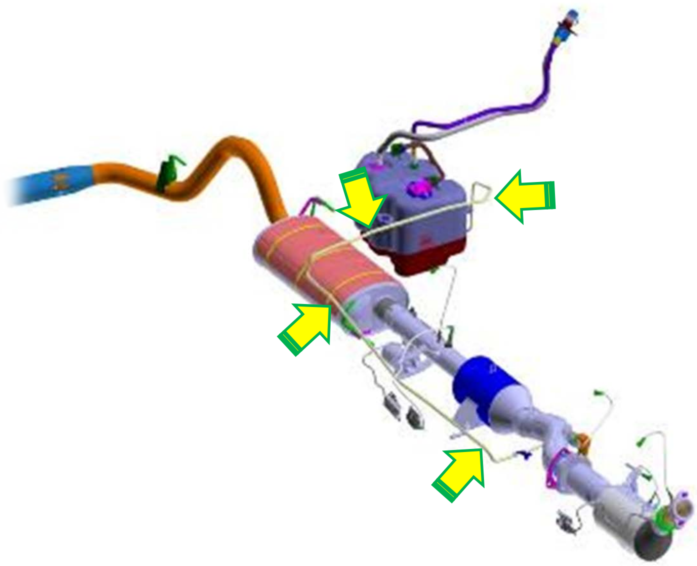
<td></td>
<td><u>Reductant Pressure Line</u>
The reductant pressure line carries the reductant under pressure to the reductant injector.</td>
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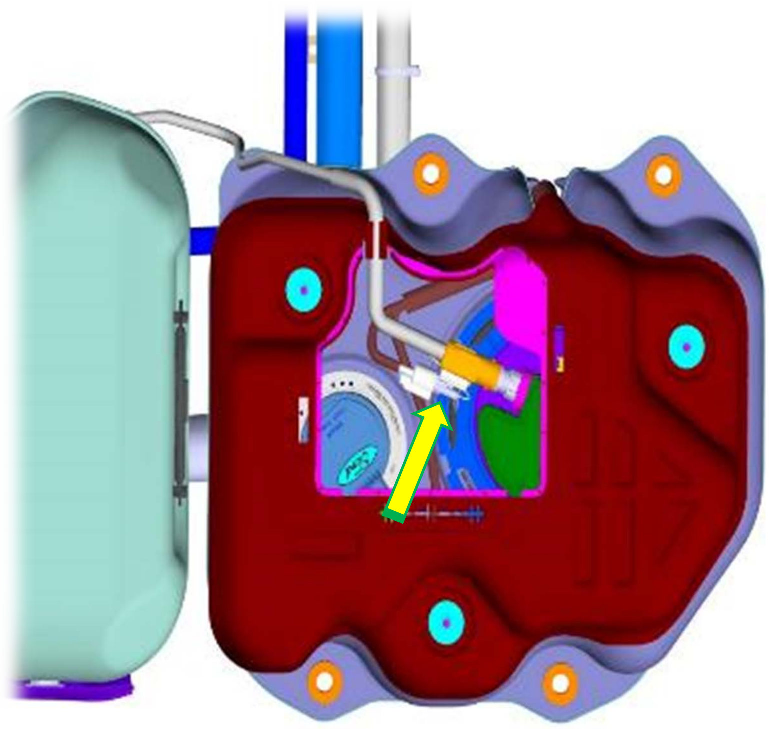
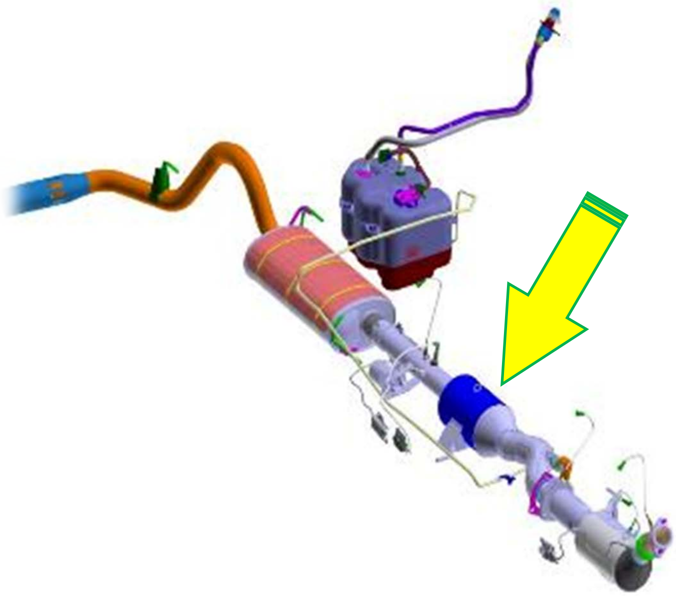
<tr>
<td></td>
<td><u>Reductant Pressure Line Heater</u>
The reductant pressure line heater prevents the DEF from freezing during cold ambient temperatures. When the reductant temperature sensor detects the DEF temperature dropping to its freezing point of -11°C (12°F), the reductant dosage control module provides voltage to the heating element. The reductant pressure line heater is integral to the reductant pressure line assembly.</td>
</tr>
</table>

Engine Emission Controls

Reductant Injector The reductant injector is a PWM solenoid controlled directly by the reductant dosage control module. The injector receives DEF from the reductant pressure line and sprays it into the exhaust stream, where it is mixed into the exhaust gas before entering the SCR catalyst.	



Selective Catalytic Reduction (SCR) Catalyst

The SCR catalyst reduces NOx present in the exhaust stream to Nitrogen (N_2) and Water (H_2O). The SCR catalyst contains a copper catalyst washcoated on a zeolite substrate.

At the inlet of the SCR catalyst is a port for the reductant injector, followed by a louvered diffuser and a twist mixer.

The reductant DEF is a solution of urea in deionized water. The urea solution percentage for correct SCR catalyst system operation is 28 to 35%. When the DEF is introduced into the system, it finely atomizes in the louvered diffuser and mixes evenly with exhaust gas in the twist mixer. During this time, the heat of the exhaust gas causes the urea to split into Carbon Dioxide (CO_2) and Ammonia (NH_3). As the ammonia and NOx pass over the SCR catalyst, a reduction reaction takes place and the ammonia and NOx are converted to N_2 and H_2O. This reaction occurs at up to 95% efficiency and allows the engine to run leaner and more efficiently, since the high NOx levels that are produced under lean conditions are eliminated.

Engine Emission Controls

Oxides of Nitrogen (NOx) Sensors

There are two NOx sensors located in the exhaust system;

- The Nitrogen Oxides Bank 1, Sensor 1 (NOx11) is located upstream of the SCR catalyst. This sensor is used to detect the presence of NOx concentration in the exhaust system.
- The Nitrogen Oxides Bank 1, Sensor 2 (NOx12) is located downstream of the SCR catalyst. This sensor is used to detect the presence of Oxygen and NOx concentration in the exhaust system.

The NOx11 sensor has two measurement chambers.

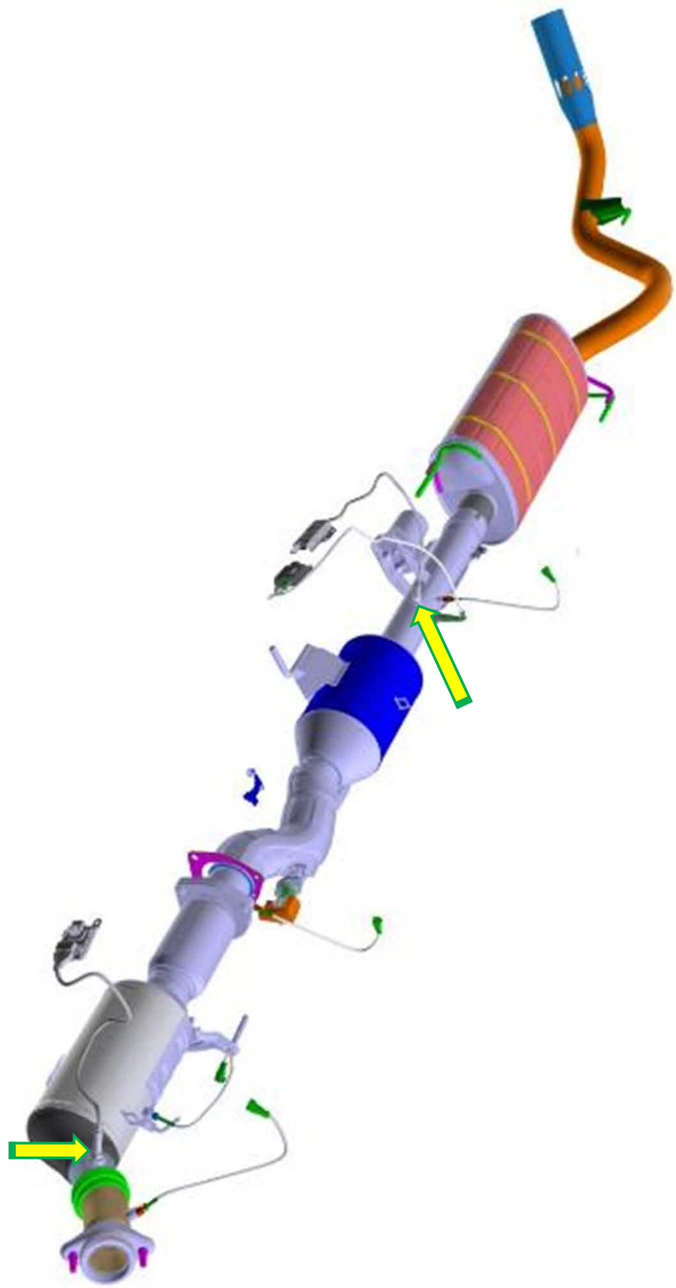
- The first measurement chamber is for O_2 concentration and is not used. The NOx concentration measurement takes place in the second measurement chamber. The exhaust gas passes from the first measurement chamber through a second diffusion barrier into the second measurement chamber.
- The NOx present in the second measurement chamber is dissociated into Nitrogen (N_2) and Oxygen (O_2). The excess O_2 is pumped out of the measurement chamber by the pumping current. The amount of current required to pump the oxygen ions out of the measurement chamber calculates the NOx content. The calculated NOx content is the output from the pumping current controller in the NOx11 module and not a signal directly from the NOx11 sensor.

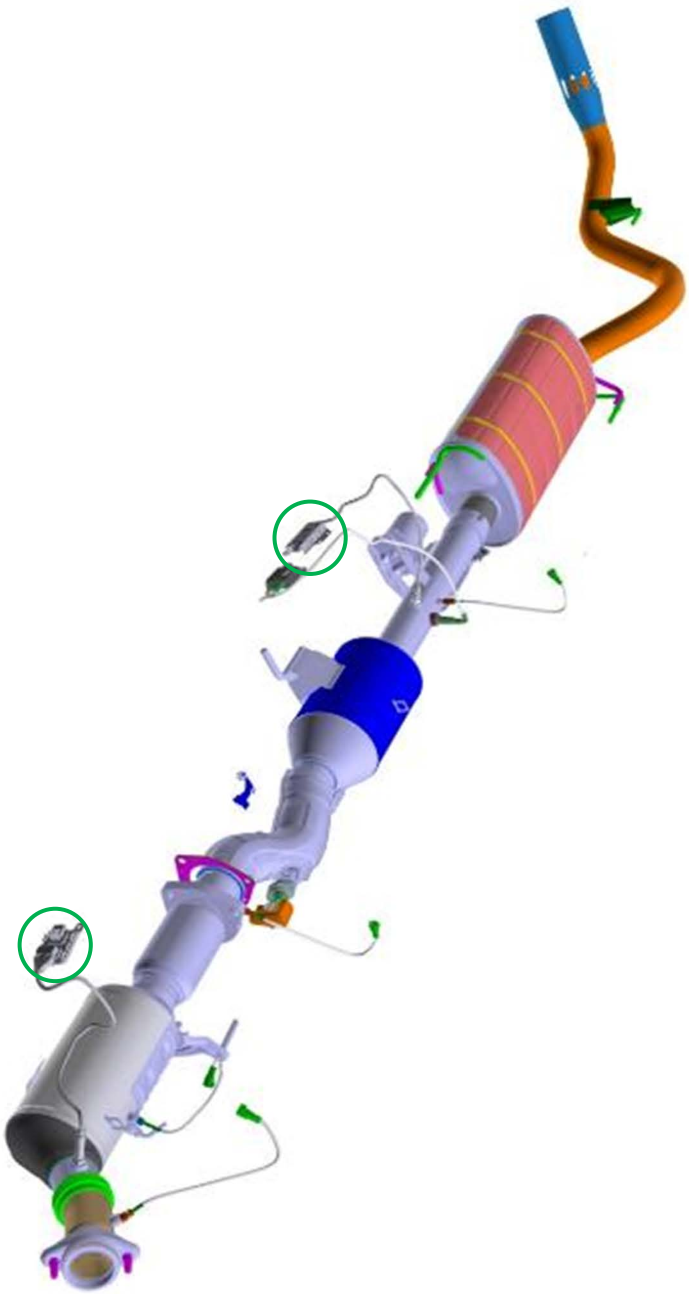
The NOx12 sensor uses two measurement chambers to determine O_2 and NOx concentrations.

- The O_2 concentration is measured in the first measurement chamber. The exhaust gas enters the first chamber through a diffusion barrier. The NOx12 sensor infers an air to fuel ratio relative to the stoichiometric air to fuel ratio by balancing the amount of oxygen pumped in or out of the measurement chamber.

As the exhaust gas becomes richer or leaner, the amount of oxygen that must be pumped in or out to maintain a stoichiometric air to fuel ratio in the measurement chamber varies in proportion to the air to fuel ratio. The amount of current required to pump the oxygen in or out of the measurement chamber calculates the air to fuel ratio. The calculated air to fuel ratio is the output from the pumping current controller in the NOx12 module and not a signal directly from the NOx12 sensor.

- The NOx concentration measurement takes place in the second measurement chamber. The exhaust gas passes from the first measurement chamber through a second diffusion barrier into the second measurement chamber. The NOx present in the second measurement chamber is dissociated into nitrogen (N_2) and O_2. The excess O_2 is pumped out of the measurement chamber by the pumping current. The amount of current required to pump the oxygen ions out of the measurement chamber calculates the NOx content. The calculated NOx content is the output from the pumping current controller in the NOx12 module and not a signal directly from the NOx12 sensor.





Nitrogen Oxides (NOx) Modules

There are two NOx modules for the exhaust system:

- The Nitrogen Oxides Bank 1, Sensor 1 (NOx11) module located on the right hand frame rail upstream of the selective catalytic reduction (SCR) catalyst.
- The Nitrogen Oxides Bank 1, Sensor 2 (NOx12) module located on the right hand frame rail downstream of the SCR catalyst.

The NOx modules monitor the NOx sensors and control the heater element of NOx sensors. The NOx modules communicate with the PCM over the Controller Area Network (CAN) to report NOx concentrations, Oxygen (O_2) concentrations, and NOx sensor system concerns.

The NOx module consists of the following:

- Microprocessor – processes all of the inputs from the sensor and communicates the information to the PCM.
- RAM
- ROM
- EEPROM – Stores the module calibration.
- Heater driver – Supplies a PWM voltage to the heater portion of the sensor to maintain operational temperature.
- Temperature sensor – Used for compensating the temperature dependency of circuit components and for NOx module and NOx sensor rationality checks.

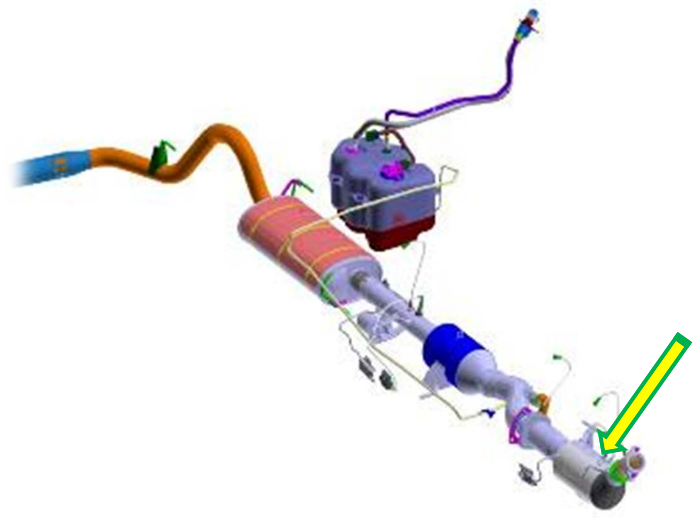
Engine Emission Controls

Diesel Particulate Filter (DPF)

The DPF collects the soot and ash particles present in the exhaust gas of the diesel engine.

The DPF assembly consists of active precious metals deposited on a substrate filter. The exhaust gas is forced to flow through the walls of the porous substrate and exit through the adjoining channels. The particulates that are larger than the pore size of the walls are trapped for regeneration.

During regeneration the temperature in the DPF increases to greater than 550°C (1,022°F). The precious metal washcoat promotes the regeneration of the trapped particulates through the heat-generating reaction and catalyzes the untreated exhaust gas. The substrate filter is held in the metal shell by a ceramic fiber support system. The support system makes up the size differences that occur due to thermal expansion and maintains a uniform holding force on the substrate filter.



Vacuum Pump

The mechanical vacuum pump is driven by the exhaust camshaft. The vacuum pump is mounted on the rear of the cylinder head and provides the brake booster with vacuum to assist with braking.

Engine Emission Controls

Crankcase Vent Oil Separator

The crankcase vent oil separator is attached to the right rear of the valve cover. The engine crankcase vent oil separator separates the oil from crankcase vapors and returns the oil to the crankcase through the center of the engine block. The vapors are routed to the air tube before the turbo inlet.

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Intake Air Distribution and Filtering

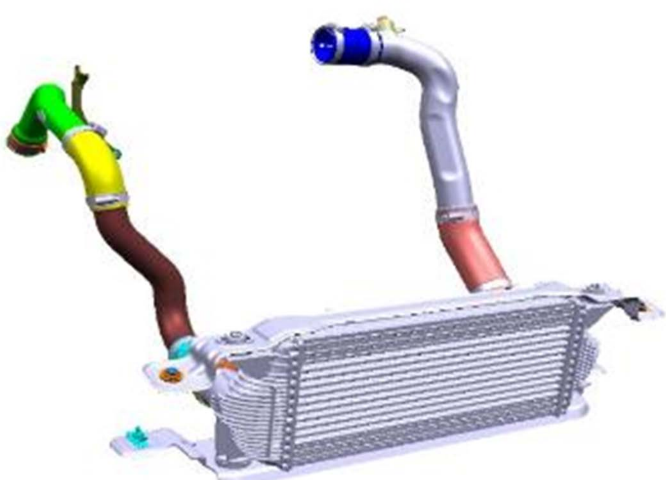
Throttle Body

The throttle body is mounted on the intake manifold and houses a servo- controlled flap, called the throttle blade. The throttle body assembly has the following functions:

- Meters the flow of air into the engine, under all operating conditions
- Prevents serious engine judder when the engine is stopped
- Throttling of the intake air during the DPF regeneration process

The throttle blade is actuated by a DC motor. Actuation is performed via Pulse Width Modulation (PWM), which is controlled by the PCM/ECM. The position of the throttle blade is monitored by a Throttle Position (TP) sensor assembly. This sensor is actually two sensors, each of which is a potentiometer, in a single housing. The output signals are analog voltage signals and are mirror images of each other going in opposite directions.

The throttle blade closes on shutdown and then remains closed for about 2 seconds before reopening.

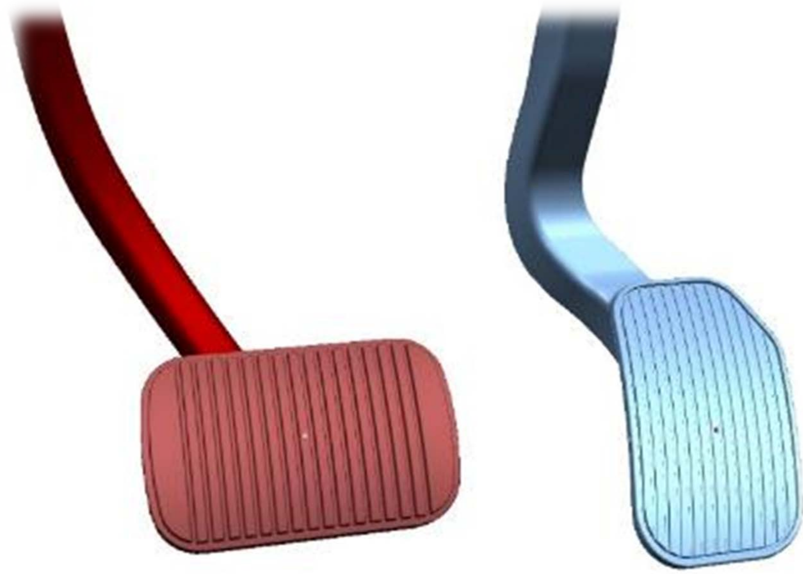
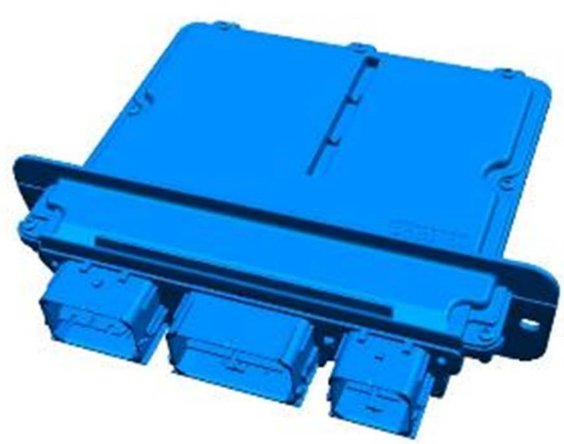


Charge Air Cooler (CAC)

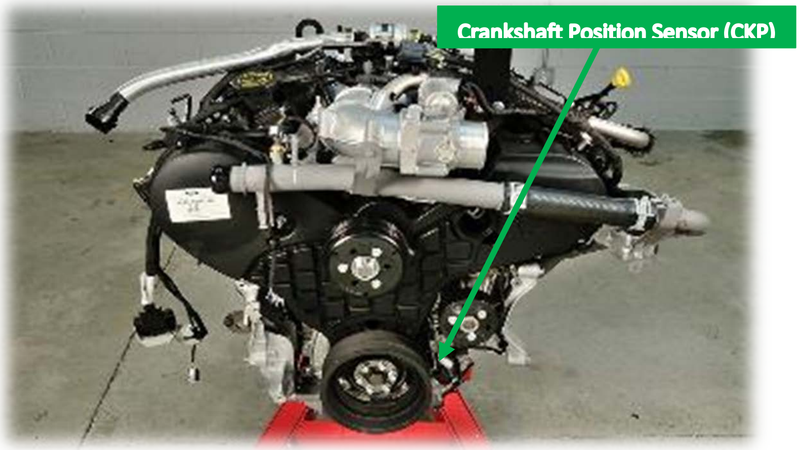
The CAC is composed of a heat exchanger and the tubing used to connect the output of the turbocharger to the intake of the engine. The CAC is designed to cool the induction air which has been heated by the turbocharger. As the heated air flows through the CAC, the heat is transferred from the intake air entering the intake manifold to the air flowing over the outside of the CAC.

The CAC subsystem cools and increases the density of the compressed turbocharged air.

Electronic Engine Controls

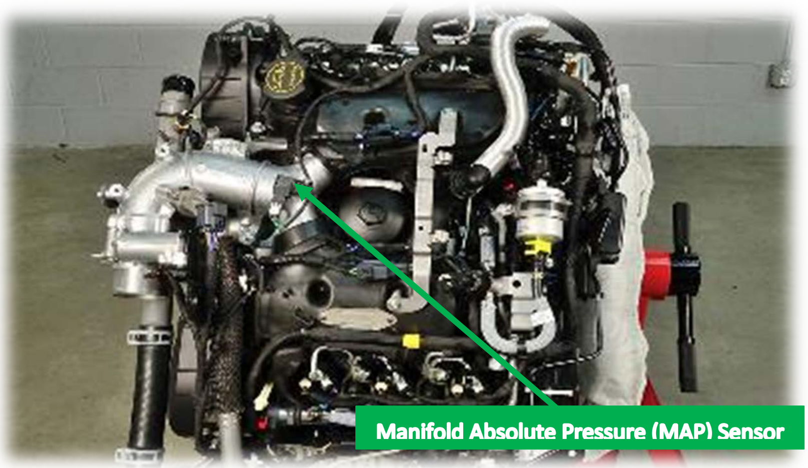
Brake Over Accelerator In the event the accelerator pedal becomes trapped, for example by an object becoming lodged against the pedal, the brake over accelerator feature will reduce the engine power when the brake pedal is applied. The brake over accelerator feature will be active at speeds greater than 16 km/h (10 mph). The brake over accelerator feature may not be active during low speed operating conditions. This enables unique drive maneuvers, such as trailer tow, boat launch and retrieval, or operation in hilly environments, where the operator may require the application of both the accelerator pedal and the brake pedal during low speed maneuvering. The brake activation is detected by the PCM/ECM via an input from the Brake On/Off (BOO) switch. In addition to brake over accelerator activity, the vehicle may also exhibit conditions such as hesitation/stumble or a lack/loss of power due to brake over accelerator activation. In the event of a hesitation/stumble or a lack/loss of power concern, carry out normal vehicle diagnostics. Additionally, make sure the driver is aware that resting a foot on the brake pedal while driving may cause the activation of this feature. This behavior also results in activation of the brake lights on the vehicle while driving.	
Computer Controlled Shut Down The PCM/ECM software monitors the parameters for the controlled systems to make sure that all values have met a threshold for shutdown. The PCM controls the PCM power relay when the ignition is turned to either Pos II or Pos III position, by grounding the PCM relay control circuit. After the ignition is turned to the Pos 0, Pos I or LOCK position, the PCM stays powered up until the correct engine shutdown occurs.	

PCM Inputs



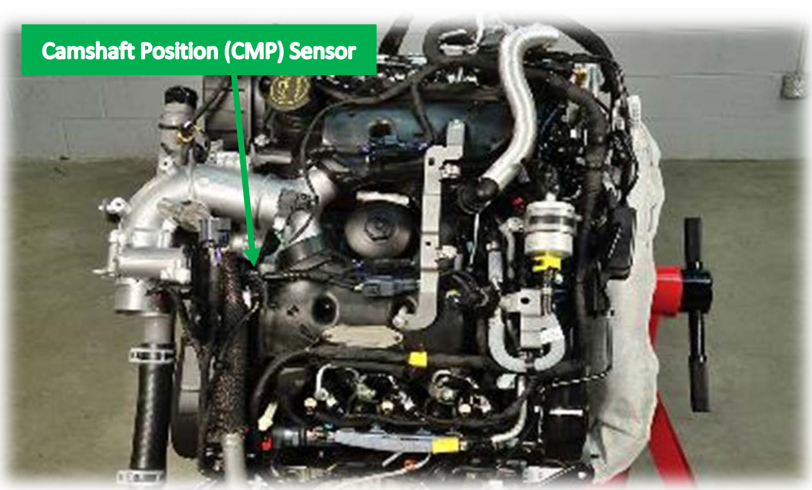
Crankshaft Position (CKP) Sensor

The CKP sensor is a Hall-effect sensor. The PCM filters the information from the sensor which indicates the tooth edges of the magnetic trigger wheel. There are 2 teeth removed to allow the PCM to determine the crankshaft and piston position. The PCM uses the CKP sensor for engine speed and crankshaft position calculation.



Manifold Absolute Pressure (MAP) Sensor

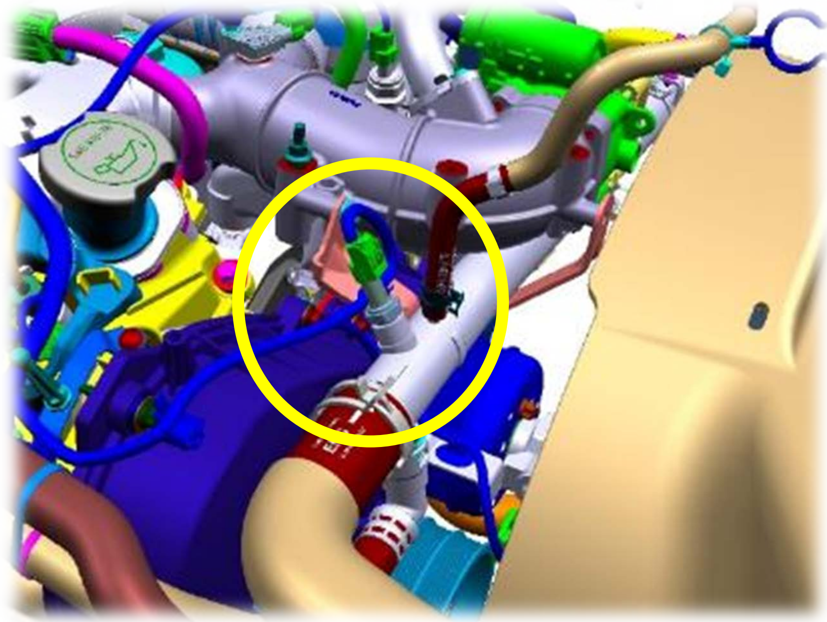
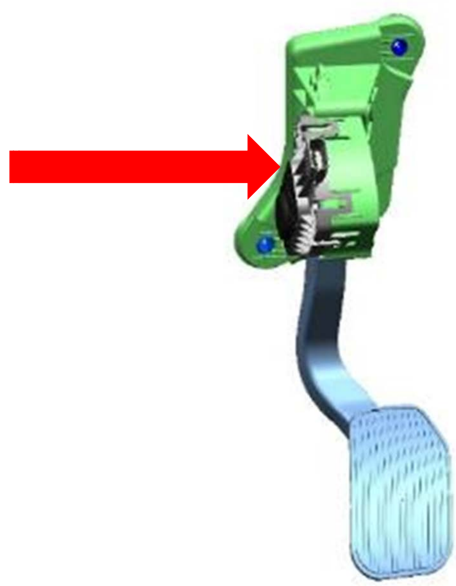
The MAP sensor is a 3-wire variable capacitance sensor. The PCM supplies a 5 volt reference (VREF) signal which the MAP sensor uses to produce a linear analog voltage that indicates pressure.
The MAP sensor is used for turbocharger, exhaust gas recirculation, and regeneration control.



Camshaft Position (CMP) Sensor

The CMP sensor is a Hall-effect sensor. The PCM filters the information from the sensor which reads a camshaft lobe off the intake camshaft. The PCM uses the CMP sensor for diagnostics, cylinder position and as a backup for the CKP sensor in the event of failure.

Electronic Engine Controls

Engine Coolant Temperature (ECT) Sensor The ECT sensor is a 2 -wire thermistor-type sensor. The PCM applies 5 volts to the ECT sensor circuit. The sensor changes the internal resistance as the coolant temperature changes. The PCM uses the ECT sensor for engine temperature protection, input for EGR function, fuel control, and engine fan operation. The ECT sensor measures the temperature of the cooling system.	
Accelerator Pedal Position (APP) Sensor The APP sensor is a 2-track position pedal. The accelerator pedal has 2 potentiometers providing pedal position to the PCM. This is a safety feature.	

Diesel Particulate Filter (DPF) Pressure Sensors

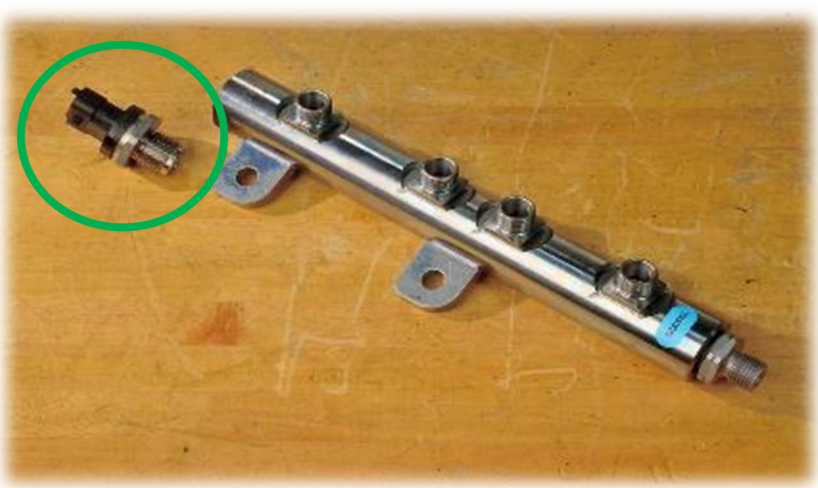
There are two DPF pressure sensors. The first sensor is a single point, Diesel Particulate Filter Pressure Bank 1 Sensor 2 (DPFP12) used in the calculation to determine when regeneration is required. The second sensor, Diesel Particulate Filter Pressure Bank 1 Sensor 1 (DPFP11) is a delta pressure sensor used in diagnosing the integrity of the Single Brick System (SBS) exhaust.

Refer to page 12 for component location.

Exhaust Gas Temperature (EGT) Sensor

The EGT sensors are Resistance Temperature Detector (RTD) type sensors. The electrical resistance of the sensor increases as the temperature increases, and resistance decreases as the temperature decreases.
There are four EGT sensors used as part of the regeneration reductant injection strategy.

Refer to page 12 for component location.



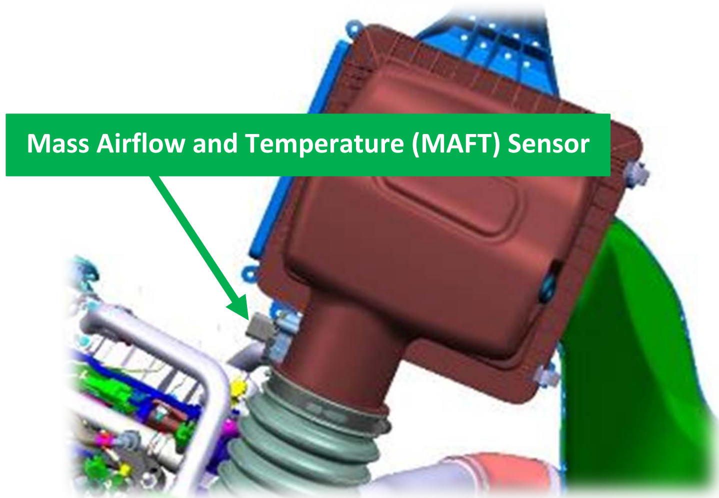
Fuel Rail Pressure (FRP) Sensor

The FRP sensor is threaded into the rear of the fuel rail. The FRP sensor is a 3 wire variable capacitance sensor. The PCM supplies a 5 volt reference signal which the FRP sensor uses to produce a linear analog voltage that indicates pressure. The FRP sensor actively monitors fuel rail pressure to provide a feedback signal to the PCM.

Electronic Engine Controls

Fuel Rail Temperature (FRT) Sensor
The FRT sensor is a 2-wire thermistor-type sensor. The PCM supplies 5 volts to the FRT sensor circuit. The sensor's internal resistance changes as the fuel temperature changes. The PCM uses the fuel temperature for fuel delivery.

Mass Airflow and Temperature (MAFT) Sensor
The MAFT sensor uses a hot wire sensing element to measure the air flow rate entering the engine. The hot wire is maintained at a constant temperature. The temperature of the hot wire changes with varying air flow. The current required to keep the constant temperature is measured and converted to a frequency which is converted by the PCM to an air flow value. PCM uses the MAFT sensor to measure the air flow into the engine. MAFT sensor input is used for EGR, fuel system, and regeneration control.



Intake Air Temperature (IAT) Sensor
The IAT sensor is a 2-wire thermistor-type sensor. The PCM applies 5 volts to the IAT sensor circuit. The sensor changes the internal resistance as the intake air temperature changes. The intake air temperature is used for MAF sensor correction and as an input for engine control, particularly engine coolant fan operation and diagnostics.

Electronic Engine Controls

Throttle Position (TP) Sensor

The intake throttle modulates the intake airflow from the charge air cooler (CAC) into the intake manifold system. The intake throttle uses an electric motor to open and close a throttle plate, based upon inputs from the PCM. The intake throttle actuator is controlled by a PWM signal to attain the desired position using the TACM+ and TACM- circuits. The throttle position ranges between 0%, or fully open, and 100%, or fully closed.

The PCM senses the intake throttle plate position by monitoring the TP circuit. If the PCM detects an intake throttle plate position concern, a DTC sets indicating the throttle plate is either not at the desired position or the TP circuit is out of range.

Cold Idle Kicker

The cold idle kicker strategy provides an increase in idle speed during cold engine warm up. The PCM/ECM uses sensor inputs to determine temperature and adjusts the RPM accordingly, to a maximum of 1,175 RPM to help bring the engine to operating temperature quicker.

Electronic Engine Controls

Diesel Engine Power Monitor

The diesel engine power monitor checks the engine operation for unwanted fuel injections without a driver demand. During the diesel engine power monitor operation, the PCM/ECM checks the commanded fuel injections and engine speed, compares those readings to actual fuel injections and engine speed, and computes the results.

Engine RPM and Vehicle Speed Limiter

The PCM/ECM monitors the engine RPM when the engine is running. If the PCM/ECM detects that engine RPMs are exceeding the pre-programmed RPM limit it will cut off fuel delivery. The purpose of the engine RPM and vehicle speed limiter is to prevent damage to the powertrain from over speed conditions.

Failure Mode Effects Management (FMEM) System

The FMEM system is an alternative strategy in the PCM/ECM software designed to maintain vehicle operation if one or more critical sensor inputs fail. When a sensor input is perceived to be out of limits by the PCM/ECM, an alternate strategy is initiated. The PCM/ECM substitutes a fixed value and continues to monitor the incorrect sensor input. If the suspect sensor begins to operate within limits, the PCM/ECM returns to the normal engine running strategy.

Electronic Engine Controls

Fuel Balancing and Control

Fuel balancing and control is an algorithm designed to reduce differences in injected fuel quantity from cylinder to cylinder. The increase in crankshaft speed due to individual cylinder combustion events is measured. The amount of fuel injected to each cylinder is then adjusted up or down to minimize the difference in increase in crankshaft speed from cylinder to cylinder. Fuel balancing and control operates in closed loop control, when the engine is operating within a range of 500 to 1,150 RPM and the commanded injection quantity of fuel is 3.5 to 50 mg per stroke.

Fuel Trim

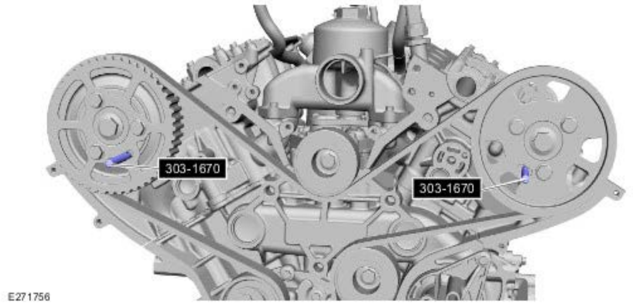
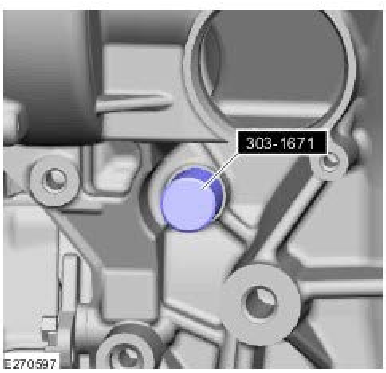
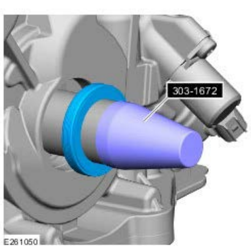
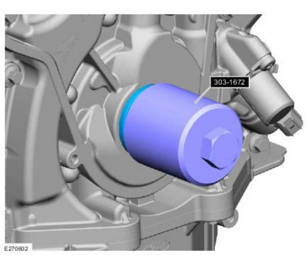
The fuel control system uses fuel trim tables to compensate for the variability that occurs in fuel system components due to normal wear and aging. Fuel trim tables are based on fuel mass.

The scan tool allows the technician to view long term and short term fuel trim data. Fuel trim data is displayed as a positive or negative percentage. What the data represents are actual fuel adjustments as they are compared to the default values. The default value is how much fuel the PCM/ECM should command under existing conditions, (such as ambient temperature, engine and transmission temperatures, engine load and altitude).

The PCM/ECM also monitors the Oxygen (O^2)sensors to determine how efficiently the engine is operating. The PCM/ECM will then adjust the fuel delivery commands accordingly.

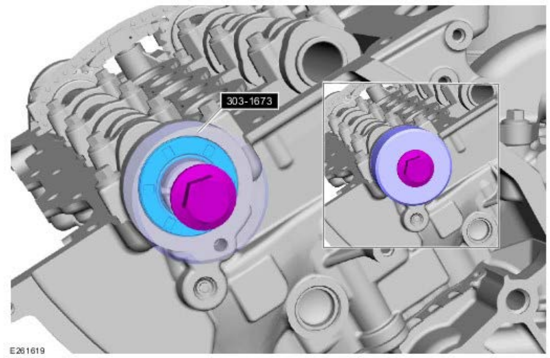
If the PCM/ECM is delivering more fuel than what the default value is, the fuel trim data will be displayed as a positive number, and will show the percentage of fuel that is being delivered above the default value. If the PCM/ECM is delivering less fuel than what the default value is, the fuel trim data will be displayed as a negative number, and will show the percentage of fuel that is being delivered below the default value. Fuel trim for long and short term data can indicate how the engine is running under certain conditions and can show potential problems that need to be addressed to keep the engine running efficiently. For example, a plugged air filter would generally result in a richer running engine condition. A turbocharger with - coked-up - bearings may also show a rich running engine.

Special Tools and Equipment

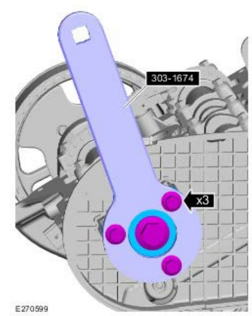
Sr-300187 Pins, Camshaft Locking Tools are installed through slots in the camshaft pulleys to lock the pulleys and camshafts in the proper position for timing. 	
Sr-300188 Pin, Locking Crankshaft Replaces the timing bolt, located in the side of the block, to lock the crankshaft into timing position. 	
Sr-300189 R1, R2 Installer, Crankshaft Seal Used to install the crankshaft seal into the oil pump housing. The cone shaped tool (R1) is used to properly align the seal. While using the cone shaped tool the seal should be rotated while pushed onto the crankshaft, to avoid damaging the seal. The round tool (R2) is then used to push the seal into the oil pump housing and seat it to its proper depth.  	

Special Tools and Equipment

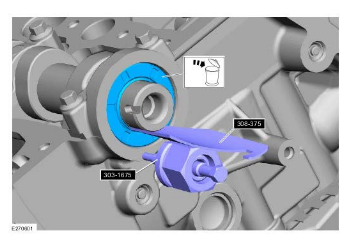
Sr-300190 Installer, Camshaft Seal
This tool requires the use of the camshaft sprocket bolt to pull the camshaft seal into correct position.

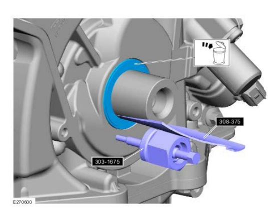


Sr-300191Tool, Holding Camshaft Sprocket
Use the existing camshaft sprocket bolts (3) to secure the tool in place. The holding tool is used to secure the camshaft while the torqueing procedure is accomplished.



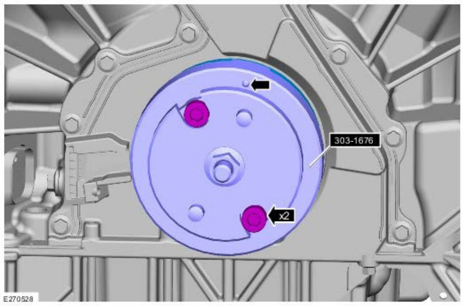
Sr-300192 Adapter, Seal Remover
These tools are used to remove the camshaft and crankshaft seals without causing damage to the camshafts, crankshaft, camshaft carrier or the oil pump housing.



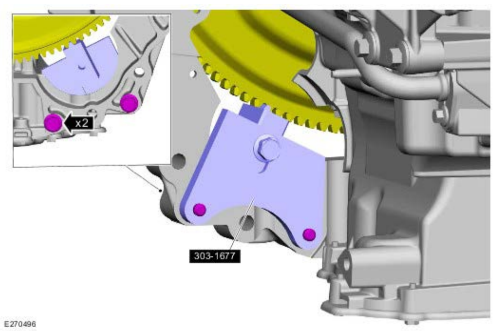


Special Tools and Equipment

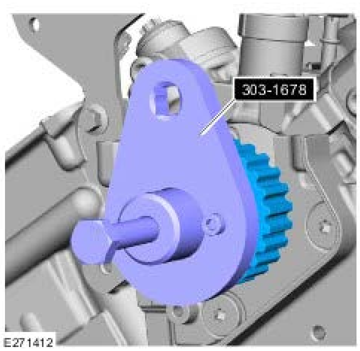
Sr-300209 Crankshaft Position Sensor Ring
This tool is used to install the CKP ring in proper alignment for the sensor. The pin on the tool must be aligned with the hole on the sensor ring for correct alignment.



Sr-300210 Locking Tool, Flywheel
The tool bolts onto the skirt stiffener where the starter would normally be secured. The tool holds the flexplate in place.



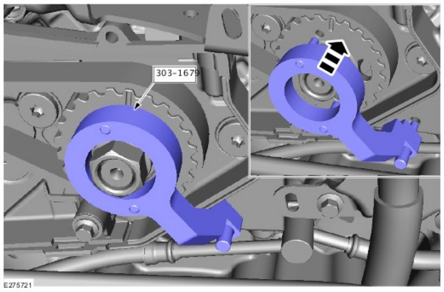
Sr-300211 Remover, Fuel Pump Pulley Holding Tool
This tool is used to hold the high pressure fuel pump pulley so that the center bolt can be removed. It is also used as a puller to remove the pump pulley from the pump shaft.



Special Tools and Equipment

Sr-300212 Timing Tool, Fuel Pump Rear Access

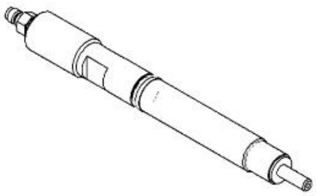
This tool is used to hold the fuel injection pump sprocket in the proper position to set the correct timing when installing the drive belt. The tool is used when repairs are being made with the engine installed in the vehicle. Because the sprocket and belt cannot be seen with the engine installed, this tool locates the sprocket by feel instead of sight.



Sr-300214 Adapter for 303-1511

This tool works in conjunction with the 6.7L EGR Pressure Tester to allow the 3.0L EGR cooler to be pressure tested.

303-1511 EGR Pressure Tester



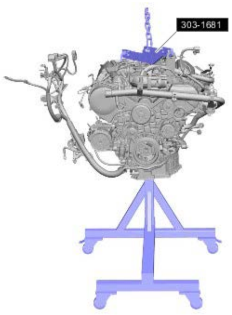
Sr-300215 Adapter, Compression Tester

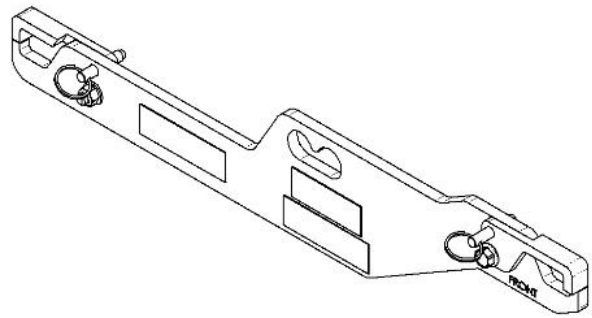
This tool replaces an injector so that a compression gauge can be installed.

Special Tools and Equipment

Sr-300238 Spreader Bar

This tool is designed for removal and installation of the engine assembly. It allows a chain fall or floor crane to balance the load of the engine. It is designed specifically for the F-150 with a 3.0L diesel engine.

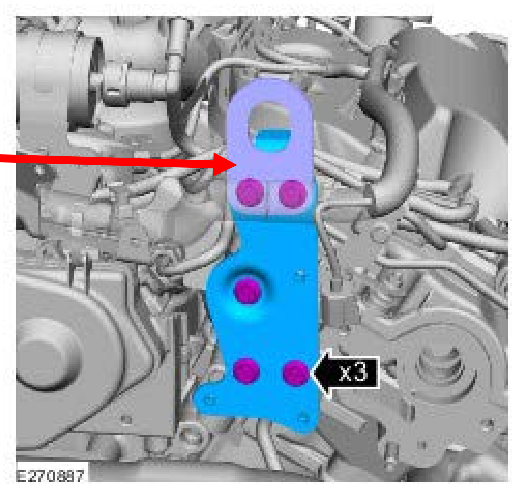




Sr-300284 Lifting Eye

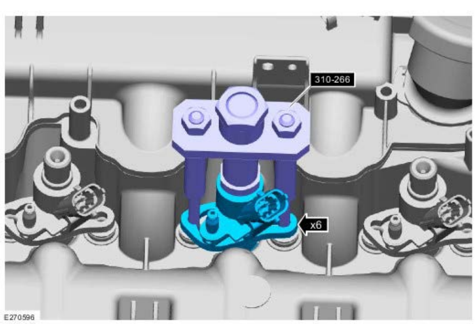
This tool is designed to replace the factory lifting point at the rear of the engine. The factory lifting eye is larger and must be replaced with this lifting eye to gain the proper clearance when removing or installing the engine.

Lifting Eye



Sr-300213 Remover, Fuel Injector

This tool is threaded on top of the injector, along with guide pins to maintain placement, it removes the injector so as not to cause damage to the injector or its mounting.



Special Tools and Equipment

HP Fuel Pump Belt Tensioner Pin
This tool is used with the Sr-300212 Timing Tool, Fuel Pump Rear Access.

Tensioner Pin

BUILT Ford TOUGH

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