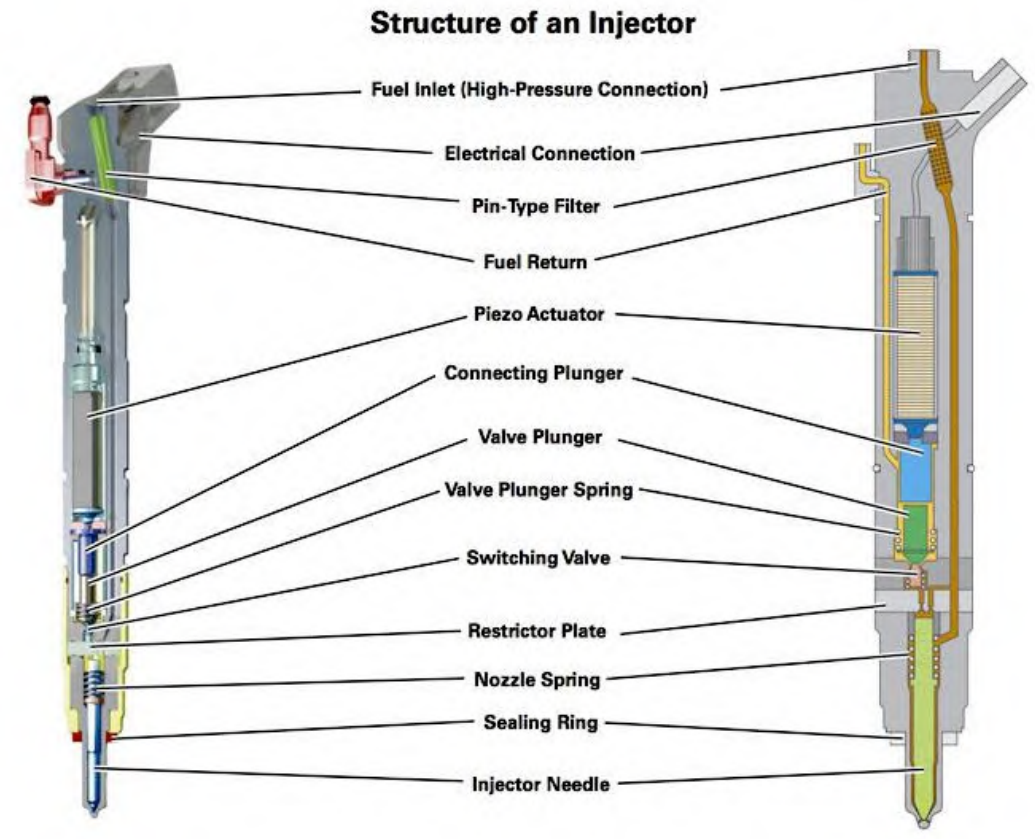
2011 – 2016 6.7L Ford Powerstroke Diagnostics

In order to do proper diagnostics, you will need a scan tool, diagnostic service information and some special tools available from Ford SPX or Freedom Racing Tool and Equipment. Also note that 1 MPa (megapascal) is equal to approximately 145 PSI, 100 kpa is about 14.5 PSI.

If you don't have service information you can buy a subscription online at alldatadiy.com or eAutorepair.net.

Piezo High Pressure Common Rail Basic Information

The high-pressure pump builds rail pressure and delivers it to the fuel rail manifold where it flows through the injector lines to the injectors. The fuel pressure regulator in the high-pressure pump and the pressure regulating valve in the rail control rail pressure. The injectors have a piezo stack instead of an electro-magnetic solenoid. When energized, the piezo crystals expand, lifting the control valve off of its seat via a hydraulic coupler (connecting plunger below) to begin injection. If the valve seat in the injector is leaking or the pressure regulating valve leaks then it will not build enough rail pressure to start the engine.



CAUTION

The fuel system contains high pressure fuel up to 29,000 PSI. Do not use you fingers to find fuel leaks! High pressure fuel entering your bloodstream may result in amputation or loss of life.

Check and record any DTC, look at snapshot data or save, do not erase codes prior to doing repairs, you will erase the snapshot and other relevant data.

No Start or Hard Start

1. This system needs 5000 PSI of fuel pressure to open the injectors. Use a scan tool to monitor rail pressure while cranking. Actual pressure should meet desired pressure under all conditions. If actual meets desired and the engine still won't start, diagnose any other codes that are in the PCM.
2. If your scan tool shows low fuel pressure cranking, check the low-pressure fuel supply first. This can be done by monitoring the fuel delivery switch on your scan tool. This switch will read "low" if the low fuel pressure is not correct. If the low side pressure is good, it will read "not low". It is also a good idea to check supply pressure with a gauge. The minimum pressure allowed before the fuel delivery switch engages is 52 PSI. Normal pressure is between 53-73 PSI per Ford.
3. If the low side is good, inspect the fuel filters, see TSB 11-10-10 for contaminated fuel if the fuel filters appear to be plugged and/or contaminated. Buy OEM Quality Fuel Filters
4. If there is no contamination, remove the return hose from the Pressure Control Valve in the left fuel rail. Plug the hose leading to the fuel return system. Crank the engine and watch for fuel flow from the valve. If there is a measurable amount of return, the valve is bad. If not, the valve is holding pressure. Buy a Pressure Control Valve.
5. Check the injectors for excessive return. Remove the return rails and plug the rails with a suitable tool, then crank the engine while watching the injector returns. A small amount of return is normal, but more than 3 ml in 15 seconds while cranking or at idle is considered excessive. (GM LML Duramax spec. Ford does not specify a return specification or injector return diagnostic procedures.) Buy Genuine Bosch 6.7 Ford Injectors.
6. Verify the fuel injector return line pressure is greater than 3 BAR (see “Fuel Injectors” for more information).
7. Remove the high-pressure regulator from the high pressure pump and check for metal debris. If there is metal found, the entire high pressure fuel system must be checked for metal and replaced as needed. Ford recommends replacing the injection pump, rails, high pressure fuel lines, fuel injectors and fuel return rails if metal is found.(See picture under High Pressure Pump). Buy 6.7 Powerstroke Fuel System Components

8. Start and die, then no start. Engine sounds like it is cranking faster than usual. Check the EGR Throttle Plate for a sticking butterfly, causing an air restriction and loss of compression.

Black Smoke

******Diagnosing smoke related issues on trucks equipped with diesel particulate filters may require temporarily disconnecting the filter or installing a test pipe to see the smoke. Excessive smoke from the tailpipe with a DPF installed usually means the DPF is damaged and may need replaced.**

1. If at idle, use the scan tool to cut out one cylinder at a time and see if the smoke disappears.
2. Dirty air filter
3. Exhaust leaks or Boost leaks, you can usually hear a boost leak as a high-pitched squeal or unusual rushing or whooshing air sound under load.
4. Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage.
5. Inspect for the EGR valve sticking open.
6. Inspect the turbo to be sure the VGT actuator is functioning normally. (see P1247)

Buy 6.7 Powerstroke Turbocharger and Install parts

Misses /Cuts Out

1. Use scan tool to isolate one cylinder at a time. Monitor power balance to find a suspect injector.
2. A missing or damaged chamber gasket or low compression could cause a miss.
3. Crankcase overfull (fuel dilution) can cause a rough run and balance rates out of specification.
4. Inspect for an intermittent Fuel Rail Pressure sensor signal by wiggling the harness between the sensor and the ECM with the ignition ON and the engine OFF, while monitoring the parameter with a scan tool.

Knock

1. Use scan tool to isolate one cylinder at a time. Monitor power balance to find a suspect injector.
2. Use cap off tools to block off one injector at a time.
3. A slight knock can start occurring due to injector problems, often after a contaminated fuel problem.

Surge or Lope at idle

1. Fuel pressure regulator: Watch actual vs. desired rail pressure. If the actual deviates more than +-300 PSI from desired, the regulator could be sticky.
2. Inspect for an intermittent FRP sensor signal by wiggling the harness between the sensor and the ECM with the ignition ON and the engine OFF, while monitoring the parameter with a scan tool.
3. Air or other contamination in the fuel system

White or blue smoke at idle

******Diagnosing smoke related issues on trucks equipped with diesel particulate filters may require temporarily disconnecting the filter or installing a test pipe to see the smoke. Excessive smoke from the tailpipe with a DPF installed usually means the DPF is damaged and may need replaced.**

If the smoke clears in less than 1 minute, this could be normal depending on temperature and altitude. Blue, white smoke that burns your eyes is un-burnt fuel; cold temperatures, high altitude and excessive idle time all mean cold combustion and white smoke.

1. Possible bad injector, use the scan tool to cancel one cylinder at a time and see if the smoke clears up. However, using the scan tool to kill the injector does not reduce rail pressure in the injector and the tip can still leak fuel, cap off lines one at a time to pinpoint injector. Also look at the balance rates, if the tip is leaking fuel then the balance rates may be out of specification. Try increasing the rail pressure, we find injector nozzles that leak at idle pressure, but do not leak at higher pressure. Buy Genuine Bosch 6.7 Powerstroke Injectors.
2. Check glow plug operation when cold.
3. Inspect the engine coolant temperature (ECT) sensor. Use the scan tool in order to compare the ECT with the ambient air temperature on a cold engine. The readings should be within 5 degrees on one another.
4. Check the coolant level in the reservoir. White coolant smoke may be mistaken for blue/gray smoke. If the coolant level is low, diagnose the cooling system. Coolant smoke will smell sweet and not burn your eyes like fuel smoke.
5. Excessive idle time can cause white smoke when cold due to carbon build up on injector tips. More than 20% idle time is excessive. If the injectors have excessive carbon on the nozzle tip then balance rates should be high on that cylinder.
6. In cold ambient temperatures it is normal to see some white vapor from the exhaust when the PCM is performing a regeneration due to the very high exhaust temperatures.

Dilution

1. Some dilution is normal for DPF equipped engines. Regeneration cycles will cause some fuel to leak past the piston rings in the cylinder and drain into the oil. Normal oil change intervals are critical for this reason.
2. Leak at the high-pressure pump drive shaft seal.

Fuel Supply and Fuel Filter Housing

The electric fuel pump in the fuel conditioning module draws fuel from the fuel tank through the fuel supply line. When the fuel enters the fuel conditioning module, water is separated from the fuel before it flows through the 10-micron fuel filter which separates particles from the fuel. The separated water collects at the bottom of the pump. If enough water is collected, the WIF sensor detects it and the PCM illuminates the WIF indicator. The conditioned fuel is then delivered to the secondary fuel filter.

The vented fuel from the fuel pressure control valve returns from the secondary fuel filter through the fuel return port and enters the unfiltered side of the fuel conditioning module. Depending on the fuel temperature returning from the secondary fuel filter, the recirculation thermostat directs the fuel to the fuel tank or through the fuel conditioning module back to the inlet of the primary filter.

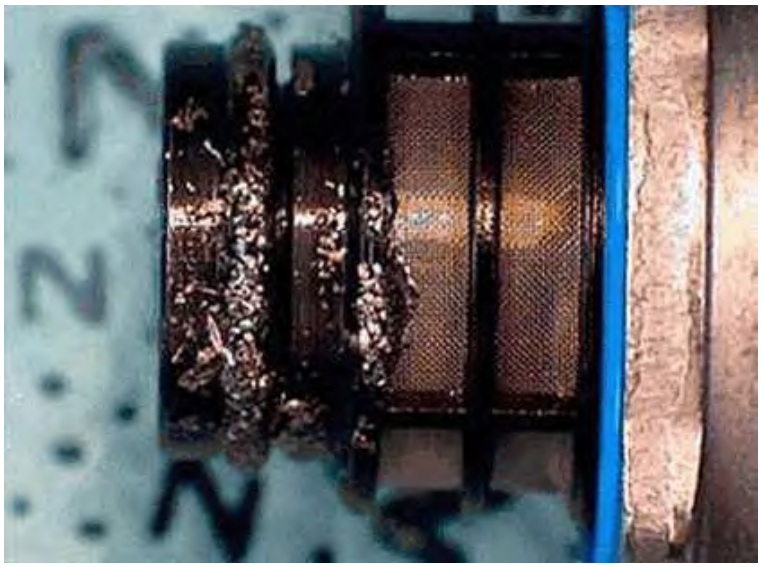
The 11-14 6.7L engines use a "fuel delivery pressure switch" to monitor fuel supply pressure and to warn the driver if the pressure drops below a threshold. This helps to protect the CP4 high pressure pump, which is susceptible to damage from a lack of fuel supply pressure. It is a normally closed switch that monitors the fuel delivery system pressure prior to the high-pressure fuel injection pump. The fuel delivery pressure switch opens when the fuel system pressure reaches 365 kPa (53 psi) or above. If the fuel delivery system pressure drops below 365 kPa (53 psi) the switch closes, and if the fuel delivery pressure switch remains closed for more than 60 seconds, the PCM notifies the driver by displaying a low fuel pressure warning in the message center, and an engine derate occurs. The fuel delivery pressure switch is located at the top left of the engine in the fuel injection pump supply tube, forward of the secondary fuel filter.

2015 and newer 6.7L engines use an "integrated fuel pressure and temperature sensor" in the tube assembly that supplies fuel to the high-pressure pump. The integrated fuel pressure and temperature sensor provides fuel temperature input to the PCM to control fuel system operating parameters and makes sure the minimum fuel supply pressure required by the high pressure fuel injection pump is being achieved.

High Pressure Injection Pump (CP4.2 Pump)
Note: The CP4.2 pumps are not as durable as the CP3 pumps. Poor fuel supply, contamination, and/or running them out of fuel (plugged fuel filter) will cause them to fail. When they fail it is often catastrophic and they send metal particles throughout the high-pressure side of the fuel system, causing further damage.

1. Check the fuel supply system first: see "Fuel Supply" above.
2. Before condemning the pump for a starting issue, you need to be certain that the high pressure fuel system is not leaking the pressure. Check the injector return and the pressure control valve in the fuel rail.
3. If there has been a major contamination issue with dirt and or water, then it is very likely that the high pressure pump will need to be replaced. The injectors are typically damaged as well if the pump is damaged.
4. If the pump will not build the desired pressure while cranking and everything else checks OK, remove the regulator from the pump and inspect for metal (see picture below). If there is metal debris, the entire fuel system will need to be cleaned and/or replaced.

Buy a Bosch CP4 pump and mount kit, for 6.7 Powerstroke.



Metal contaminated fuel pressure regulator
(Courtesy GM)

Fuel Injectors

Note: The injectors are a piezo type of CR injector (see first page). Diagnosis is much different than the earlier generations.

The engine control module (ECM) supplies a high voltage supply circuit and a high voltage control circuit for each fuel injector. The injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit and supplying each fuel injector with up to 250 V and 20 amps on the voltage supply circuit to activate the piezo type fuel injectors. This is controlled by boost capacitors in the ECM. During the 250 V boost phase the capacitor is used to charge the injector piezo stack allowing for injector opening. The injector is then held open with this high voltage. At the end of the injection event the ECM closes the injector by discharging the injector piezo stack.

1. The injectors are cooled by a calibrated amount of fuel flow through the injector body to the injector return lines. If the injectors are worn, damaged, or contaminated, the amount of fuel flowing through the injector body may increase, resulting in improper injector performance. The maximum allowable leakage for one injector is 3 ml in 15 seconds, cranking or at idle.
2. The injectors require a minimum of 3 BAR (45 psi) of pressure in the return system. The return fuel from the fuel injectors flows through the injector return hose to a tee containing an orifice controlling the backpressure on the injectors, and from the tee back into the secondary fuel filter inlet fitting. During engine cranking, fuel pressure from the diesel fuel conditioning module is applied to the injector return connectors through this return hose to create the backpressure necessary for the injectors to function. During normal operation, injector return fuel flowing though the orifice creates the required backpressure.

3. Other Injector Notes

- Power balance, when checked in Park or Drive, should indicate bad injectors or cylinder performance issues.
- Miss, smoke or rough run usually indicate that the injectors are the cause. 6.7L engines with a DPF may not show any smoke, but frequent DPF regen events would suggest poor combustion.
- The PCM uses a strategy called “zero fuel calibration” to determine injector wear and adjust accordingly. Zero fuel calibration is an algorithm used to detect deviations in individual fuel injector performance from nominal. In an overrun deceleration fuel shut off condition, fuel rail pressure is set to 3000 kPa (4351 psi) and small injections are made from a single fuel injector. The observed acceleration in crankshaft speed is detected and compared to the expected acceleration. If the observed acceleration deviates from the expected acceleration by more than 50%, then an additional routine is called that adjusts the injection energizing time until observed acceleration matches expected. This information is then used to adjust all injections on that fuel injector for a correct fuel delivery. If the absolute energizing time observed for the test injection to yield the expected acceleration exceeds minimum or maximum limits, a DTC sets.

Buy OEM 6.7 Powerstroke Injectors.

Turbo

The dual boost turbo used on the wide frame vehicles (pick-up) through 2014 model year is a 3-wheel design with a single turbine and 2 compressors placed back-to-back. The 2 compressor wheels are similar to each other. They have the same diameter and are optimized to reduce pressure differences that could cause noise or air flow issues. The standard 2-wheel design is used on the narrow frame (chassis cab) vehicles.

The turbocharger uses variable vanes that surround the turbine wheel to dynamically adjust turbo speed using exhaust gases. During engine operation at low speeds and load, the vanes are closed to accelerate exhaust gases across the turbine wheel to help quickly increase turbo wheel speed. At high speeds the vanes open to prevent turbocharger overspeed conditions.

The turbocharger uses a ball bearing cartridge that surrounds the turbocharger shaft to help provide a decrease in spool up times. Separate oil and water feeds flow through the turbo mounting pedestal to lubricate and cool the turbocharger to eliminate as many external connections as possible. The front of the pedestal houses the turbocharger oil filter.

The turbocharger provides up to approximately 206.84 kPa (30 psi) boost at up to 130,000 RPM.

The 2015 and newer model year F-250/350 pick-ups use a more conventional Garrett VGT turbo similar to those used on the 6.0L Powerstroke and LLY through LML Duramax engines.

Buy 6.7 Powerstroke Turbocharger and Install parts

Diesel Exhaust Fluid

Diesel exhaust fluid (DEF), AKA reductant or urea, is injected into the exhaust gases prior to entering the SCR (selective catalyst reduction) stage. Within the SCR, No_2 (Nitrogen dioxide) is converted to nitrogen, carbon dioxide, and water vapor through a catalytic reduction fueled by the injected DEF.

DEF is a mixture of 66% deionized water and 34% urea and will freeze at temperatures below 32 degrees. There are 3 reductant heaters. Reductant heater 1 is in the reductant reservoir, reductant heater 2 is in the supply line to the reductant injector, and reductant heater 3 is at the reductant pump. The ECM monitors the reductant temperature sensor located within the reservoir in order to determine if reductant temperature is below its freeze point. If the ECM determines that the reductant may be frozen, it signals the Glow Plug Control Module (GPCM) to energize the reductant heaters.

Optimum NOx reduction occurs at SCR temperatures above 250°C (480°F). At temperatures below 250°C, the incomplete conversion of urea forms sulfates that can poison the catalyst. To prevent this poisoning, the ECM suspends DEF injection when exhaust temperature falls below a calibrated limit. Because of this, any issues with the EGT sensors will affect DEF system operation. **EGT sensor and DEF system codes set at the same time are likely related.**

In order to properly diagnose and repair the DEF system, a Ford IDS scan tool and Ford service information is required. There are many safeguards and reset procedures that must be completed when repairs are made in order for the systems to function normally.

Other notes:

- A leak in the reductant system can be located by inspecting for a build-up of crystallized diesel exhaust fluid.

Diesel Particulate Filter

The diesel particulate filter traps soot from the exhaust to lower particulate emissions. During certain driving conditions the engine will perform a regeneration cycle, which will use additional fuel injections and the catalyst to heat up the exhaust temperatures to the point where the soot will be burnt out and form ash. Over time the DPF will become "ash loaded" and need replaced or cleaned.

Any engine drive-ability issues or fuel system failures will cause premature plugging or failure of the DPF. If the DPF is plugging repeatedly or requiring excessive regeneration cycles there is probably another problem with the engine, turbocharger,

fuel system, or EGR system. Repair all other problems PRIOR to addressing the DPF issues.

1. DO NOT reset the DPF unless the DPF has been replaced or cleaned (removed and cleaned, not regenerated in the vehicle) or the service information instructs you to. The ECM keeps track of fuel used, soot, and ash load. Excess soot and ash load will result if the timer is reset without replacing or cleaning the DPF.
2. If the DPF has been deleted, customers will have run-ability issues if they do not have the correct software. We have also seen EGR related issues that do not set codes with delete software installed. These problems may cause heavy smoke and low power, as well as some other symptoms.
3. A plugged DPF can cause a turbo failure by forcing exhaust under excess pressure around the turbine shaft seals. Low boost/low power complaints must be diagnosed properly and completely prior to repairs!
4. Excessive idle time will also cause DPF restriction due to particulate build up at idle. This will cause poor mileage (zero MPG when idling) due to more frequent regeneration events. Excess idle time could be defined as leaving the pickup running while hooking up a trailer.
5. Using Stanadyne Performance Formula fuel additive, which improves cetane, will reduce regeneration events and improve mileage around town. This is due to a better burn when cold and fewer particulates getting to the DPF.

Secondary Cooling System

One of the unique features of the 6.7L Powerstroke engine is the secondary cooling system. The secondary cooling system uses coolant flowing in a circuit separate from the primary engine cooling system. This system cools the exhaust gasses for the EGR system, the transmission fluid, the fuel, and the air charge entering the engine via the air/water charge air cooler (CAC). A secondary engine-driven coolant pump provides for coolant flow. A secondary, 2-stage radiator is mounted in front of the primary engine cooling system radiator. Two thermostats, one mounted on each side of the secondary radiator, operate independently to regulate the temperature of the coolant flowing to the various components.

System coolant provides freeze protection, boil protection, cooling efficiency and corrosion protection to the cooling components. To obtain these protections, maintain the coolant at the correct concentration and fluid level in the degas bottle.

Use the following information regarding common diagnostic trouble codes in addition to the normal diagnostic procedures outlined in the service manual or technical service bulletins.

DTC Codes

P008A Low Pressure Fuel System Pressure- Too Low

- Commonly sets when the fuel filters are plugged, the fuel supply pump has failed, or after replacing fuel filters and not bleeding the system correctly. Buy OEM Quality Fuel Filters
- See Hard Start/No Start above

P0087 Fuel Rail Pressure Too Low

- See P008A
- See Hard Start/No Start above
- Check the primary fuel filter (on frame rail) to be sure lid is fully seated and sealed properly.
- Some aftermarket secondary filters (on engine) have been known to collapse under pressure and cause a restriction. Use OEM fuel filters and re-test.

P04E3 Crankcase Ventilation Hose Connection Sensor Circuit High

- Usually caused by a defective crank case vent pressure sensor. The vent assembly must be replaced.

P0401 EGR Insufficient Flow

- Refer to Ford TSB 13-6-5
- The most common theory for the issue of plugging EGR coolers is that the secondary cooling system, which cools the EGR cooler, runs too cool and allows the carbon build up to occur in the cooler.

1. Check for ECM updates, update as required.
2. Using a scan tool, check all continuous memory DTCs to verify that P0401 is set.
3. If it is, use a scan tool to perform a key on engine running (KOER) self test. If DTC P2457 sets, replace the EGR cooler core. It is also a good idea to replace the EGR valve.

P1247 Turbocharger Boost Pressure Low

- Diagnose any DPF or Fuel System related codes first if there is any
- Check for a restricted air filter and/or air intake. Snow can pack into the air intake in some cases and cause a restriction.
- Inspect charge air (intercooler) hoses and tubes for damage causing boost leaks.
- If no other problems are found, it is likely a turbo issue.

P1291 Injector High Side Short to GND Or VBATT - Bank 1

- Refer to Ford TSB 11-10-10. An internally shorted fuel injector can be caused by DEF contamination in the fuel or by fuel gelling.

1. To check for DEF contamination in the fuel, remove the conditioning module mounted fuel filter and bowl. Allow them to dry for 2 hours and then inspect for a white powdery/crystalline material. If this is observed, there is DEF in the fuel. The fuel system will need to be replaced.

P1292 Injector High Side Short to GND Or VBATT - Bank 2

- See P1291

P132B Turbocharger/Supercharger Boost Control A Performance

- See P1247

P200C Diesel Particulate Filter Over Temperature (Bank 1)

- This code may cause a no start/no crank condition.

1. Before extensive testing, allow the vehicle to get to ambient temperature.
2. Then, monitor the 4 exhaust gas temperature sensors. They should all read close to ambient temperature.
3. If one of the four reads out of range compared to the others, swap that sensor with one of the other 3. If the bad reading moves, replace the failed sensor.
4. If it does not move, perform further diagnostics of the wire harness.

P200E Catalyst System Over Temperature (Bank 1)

- See P200C

P20BA Reductant Heater A Control Performance

- Most often caused by a failed DEF heater element in the DEF tank. Check the resistance across terminals 1 (Blue/Orange) and 2 (Black/White) of C3616 at Diesel Exhaust Fluid (DEF) tank. The resistance should be 1.0-2.5 ohms. If not, the heater will most likely need replaced.

P20E8 Reductant Pressure Too Low / Too High

- There is a pressure sensor that monitors how much pressure the pump produces. It needs to produce 51 PSI within 45 seconds from the time the pump is commanded on. Code P20E8 suggests the pump did not reach that target.

1. If the vehicle was built before 8/3/2011, reference Ford Technical Service Bulletin (TSB) 11-12-3 for these codes and the concern.
2. Using the IDS scan tool, activate the pump and see how much pressure it is producing. If the pump is running, but does not achieve the target goal, replace the pump as per the TSB.
3. If the pump is still not reaching its target goal, unplug the reductant dosing module (injector), remove it, and see if it leaks when the pump is commanded on.

If it does, replace the injector.

P2033 EGT Sensor 2 Circuit High Voltage

- Sensor 2 is between the DOC and SCR/DPF

1. Using the scan tool, monitor all the EGT sensors with the exhaust system at ambient temperature. Any sensor that does not fall in line with the others is likely defective and needs replaced.
2. Unplug this sensor and put your voltmeter across the connector coming to the sensor. With the key on, your voltmeter should read close to 5 volts. Wiggle test the harness all the way back to the PCM to ensure this voltage does not change.
3. If the voltage is OK, clear the codes, road test and recheck. If the P2033 code resets right away, suspect a failed sensor.

P207F Reductant Quality Performance

- Check the Diesel Exhaust Fluid (DEF) for hydrocarbons (fuel). If there is fuel in the system, the entire DEF system will need to be replaced. If there is no diesel fuel in the DEF system, drain the tank and refill with new DEF fluid. Clear the code and drive the vehicle to clear the warning message. In some cases, it may be necessary to reset the DEF system using a scan tool. If the code resets, reference TSB 13-11-6 for this concern.

P2073 Manifold Absolute Pressure/Mass Air Flow - Throttle Position Correlation at Idle

1. Carefully check the air intake system. Air box, filter, tubes. Look for damaged, loose, or aftermarket components that may affect airflow through the MAF sensor.
2. Use a scan tool to monitor the MAF hertz at idle and at 2000 RPM. Ensure the EGR valve and the turbo are unplugged. With the EGR valve closed, the MAF hertz at idle should be 3.5 to 3.8 kilohertz, and at 2000 RPM 5.9 to 6.2.
3. If the value is outside this range, check for a stuck open EGR valve before suspecting a failed MAF sensor.

P2269 Water In Fuel Condition

- The engine may have very low power, similar to a limp mode. The P2269 code sets right away after clearing.

1. Access and unplug the water in fuel sensor.
2. Use a voltmeter to check voltage on the harness side of the connector. There should be reference voltage of about 5 volts. If there is no voltage the wires are likely damaged between the PCM and the sensor.
3. If the harness side checks OK, the water in fuel sensor may be at fault or there is contaminated fuel in the system.

P2291 Injector Control Pressure Too Low - Engine Cranking

- See Hard Start/No Start above

P2463 DPF Soot Level Accumulation

1. Perform stationary regeneration procedure, then recheck for the issue.
2. The DPF may need to be removed and cleaned or replaced.

P259F Turbocharger A Boost Control Position At High Limit

- Most commonly caused by a dirty air filter or a poor-quality aftermarket filter that is too restrictive. May also be caused by boost leaks, exhaust leaks, or other air flow related problems.

Other Useful Tips

- On regular pickups, the EGT sensors are in a logical sequence of 1, 2, 3 and 4, with the front most sensor being #1. On cab and chassis vehicles however, the sequence is 1, 2, 4 and 3 front to rear.

Ford 6.7L Cylinder Position