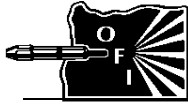


6.0L Diagnostic Information

The 6.0L Powerstroke diesel engine was an update over the previous generation 7.3L diesel engine. There is really no commonality between the two engines besides the name. The 6.0L uses a second generation HEUI injection system which also utilizes high pressure oil to actuate the injectors. The turbocharger was changed to a Variable Geometry (VGT) type turbo and Exhaust Gas Recirculation (EGR) was added to improve emissions performance. These changes make for a very different diagnostic process from the 7.3L Powerstroke Engine.

Some important notes:

- You must be able to use the Ford factory IDS scan tool for 6.0L diagnostics due to the number of PCM updates. There are so many drivability issues that are solved with a new PCM calibration that attempting repairs without the IDS scan tool is an exercise in futility. Be aware that after the PCM is re-flashed it may take up to 1000 miles for the PCM to re-learn how you drive. During this re-learn procedure it is very likely that your mileage will drop. Ford does not have a quick learn procedure like GM or Chrysler, they are “slow learners”.
- There have been many changes to the 6.0L and getting the correct parts for it depends on the engine serial number range. The serial number is located on the FICM which is on the top of the left valve cover. If the FICM has been replaced you may need to get the serial number off of the engine block. The serial number is stamped into the block at the left rear of the engine just under the head.
- Diagnosing starting problems and drivability problems requires that you start at the basics. The HEUI system uses engine oil to actuate the injectors; if you are low on oil you will have problems.
- Check the oil and change the oil if it is due. If the oil is worn out from excessive change interval, you will have problems. Oil change intervals are critical.
- Fuel filter plugging will cause issues. Has it been more than 10,000 miles since you changed the fuel filters? Change the filters before proceeding with further diagnostics.
- Air in the fuel will cause injector failures. Inspect the fuel for signs of contamination and/or air intrusion when you change the filters.
- Avoid long idle times; long idle times will cause the EGR and turbo to carbon up excessively.



Resources

-Besides the proper scan tool you will need good service information and the correct tools to work on the 6.0L. There are many TSB related to drivability issues that you need current service information for, besides the ability to re-flash the PCM.

- www.fordspecialtools.com Ford/Rotunda/SPX special tools
- www.motorcraftservice.com Scan tool information and service information, you can purchase three days, a month or year.
- Mitchell, Motors, and Identifix also offer online service information
- www.helminc.com Printed publications such as manuals and TSB, as well as online subscription choices.
- <http://www.forddoctorsdts.com/articles/> Many different articles to help with diagnosing the Ford Powerstroke
- If you don't have service information you can buy a subscription online at alldatadiy.com or eAutorepair.net.

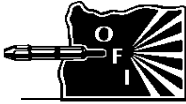
No Crank

- Check batteries and connections, voltage should stay above 10 volts during cranking
- The PCM controls the starter, so if PCM voltage drops below 9.5v the PCM shuts off and won't control the starter.
- If the fan clutch shorts out it will draw the PCM voltage to zero, and thus you will have a no crank situation.
- If the EBP sensor (or other 5 volt reference sensor) is shorted out it will cause the PCM to shut down.

No Start

Several parameters are necessary for starting, not including glow plug operation and good compression. Perform the following steps to diagnose a "No Start" concern.

1. Initial tests will require monitoring several data PIDs on your scan tool.
 1. FICM SYNC (needs to say "yes" when cranking)
 2. FICM L power (needs to be above 11.5 volts)
 3. FICM V power (needs to be above 11.5 volts)
 4. FICM M power (needs to be 45 volts or above)
 5. ICP or injection control pressure, needs to match the ICP Desired reading.
 6. IPR or injection pressure regulator (should not reach and maintain 85%)
2. If the FICM SYNC always says no, there is a loss of camshaft position signal or crankshaft position signal.
3. If FICM L or V power is below 11.5, load test the batteries.



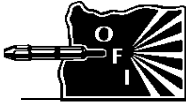
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4. If FICM M power is significantly below 45 volts and L and V power were above 11.5, suspect a FICM module concern. The voltage would have to be quite low to create no start, 35 volts or lower may create a no start condition. [Buy 6.0 Powerstroke FICM and Related Parts](#)
5. If the ICP pressure is not matching the ICP Desired reading, and the IPR is 85%, the high pressure oil system is the cause of the no start, the high pressure oil system will need to be tested. [Buy 6.0 Powerstroke High Pressure Oil System Parts](#)
6. If all of the above tests pass, yet the engine still will not start, check the fuel pressure. See the attached picture for the fuel pressure port. The fuel pressure should be 45 PSI or higher.
7. If all is good so far, then run an injector self test and see if there are any codes. If there are no codes, access the fuel injector connectors, put an inductive amp probe around each wire, one at a time at the injectors, leave the connector plugged in. Then crank the engine, if the FICM is firing the injectors, there should be a 20 amp pulse going to each injector.
8. Also amp current check the glow plugs, each glow plug should draw about 17 to 20 amps.
9. If the injectors are being pulsed properly, the fuel pressure and high pressure oil is all pas testing, perform a bubble test to check for compression getting into the fuel system.
10. If all is passing, but the engine still won't start, drop the exhaust. If it still won't start, pull the glow plugs out to check engine compression. Compression will usually range between 300 and 400 PSI.
11. If all tests have passed but the engine will not start and you have good quality diesel fuel, then the injectors will have to be flow tested or replaced to rule out injectors as the cause of the no start.
 - The fuel supply pump has an inertia switch in the circuit, located under the passenger side kick panel. The switch can sometimes trip if the truck hits a violent bump or is kicked from the inside of the vehicle. It is reset by simply pushing the button on the top of the switch.
 - Try unplugging the ICP sensor it can cause a not start problem without setting any codes

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- Monitor the oil pressure gauge on the dash, it should move up during cranking. If it shows no oil pressure then there could be a problem with the low oil pressure side.
- IPR duty cycle of 14% or less during cranking means no crank (CKP) signal (and no sync)
- Check for loose connections at the FICM- the harness connector retainers tend to break during repairs and, if not repaired, can allow the connectors to back out of the FICM
- A shorted EBP sensor (or any 5 volt reference sensor) can cause the PCM to shutdown
- Glow Plug control module connector problems (pin tension, water intrusion, bent pins)
- EGR valve, if stuck open over 60% can cause a no start.

Hard Start Cold or Hot

- Leak in the high pressure oil circuit, takes excessive cranking to build minimum ICP pressure, see ICP.
- Cranking speed should be 175 rpm cold and 215 rpm warm.
- The glow plugs should pull approximately 160 amps total on a cold start, which will drop to about 120 amps after about 15 seconds. If the amp draw is below 17-20 amps per glow plug then you will need to replace some glow plugs. CAUTION; upon removal of the glow plugs, the glow plug sleeve will sometimes pull out with the glow plug. This will require that the head be pulled in order to replace the glow plug sleeve.
- Injector spool valves sticky (stiction)
- A 2004 model year with an intake throttle plate that is stuck closed can cause a hard start or no start.
- Glow plug harness chaffing
- Glow Plug control module connector problems (pin tension, water intrusion, bent pins)
- Low or no fuel supply pressure

ICP pressure and IPR information

The IPR valve is normally open; it takes a 12 volt pulse width modulated ground signal to actuate the IPR. [Buy 6.0 Powerstroke High Pressure Oil System Parts](#)

- Monitor the ICP and IPR while cranking. If ICP is .4v to .5v (200 psi) and IPR is 85%, it is possibly a stuck IPR. The system will build 200 psi even if the IPR is open. Make sure that oil pressure registers on the dash gauge while cranking, if not you may not have enough low oil pressure.

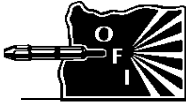
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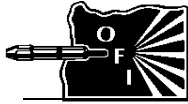
- If the ICP is .6v to .7v (400 psi) and the IPR is at 85% then it is very likely that you have a high pressure leak
- Compare actual to desired ICP on the scan tool, if actual is below desired use shop air (in the rail on 2003 through early 2004, through the ICP sensor hole on 2004 and later engines) to pressurize the oil system and find the leaks. The IPR valve must be commanded closed with a scan tool or forced closed with battery voltage and ground applied via an IPR connector pigtail ([Purchase IPR Pigtail Here](#)). If this is not done air will just dump into the crankcase. When the IPR is commanded from open to closed position there should be a noticeable decrease in air noise coming from the IPR. If not, the IPR is most likely stuck and should be inspected. (see below) Common leak points are at the injectors, stand pipes, rail plugs, high pressure pump connection (STC fitting, on 2005 and up), at the high pressure pump on the 2003 models. It is normal to have a slight hiss from the injector spool valves.
- If the IPR fails the air test, remove it and check for metal on the screen. If you have metal on the IPR screen then the high pressure pump and IPR will need to be replaced. You will also need to check the screen under the oil cooler, toward the front of the valley, and clean or replace as necessary. The oil rails and check valves will need to be flushed to remove any debris. Of course the debris may have gotten into the injectors as well and could cause problems with a miss or rough run.
- The ICP should be stable and not erratic. If it is erratic, then you could have a defective ICP sensor, ICP sensor pigtail, high pressure side leak, a sticky IPR valve (requires replacement), or debris in the oil rail (03-04) or stand pipe check valves (04 ¼ up) which will require replacement as well.
- The ICP sensor can leak oil, if this happens replace both the sensor and the ICP pigtail connector
- ICP sensor should read .16 - .28 volts (less than 70 psi) KOEO at normal operating temperature after the engine has been off for at least 2 minutes.
- 2004 ¼ and up should be updated to the latest oil standpipe design if removed for other repairs.
- It is a good idea to replace the oil rail nipple seals when the rails are removed to service other parts. If the seals are leaking it can lead to erosion of the upper injector o rings.
- It is normal to see oil or hear/feel air coming out of the IPR drain hole on the high pressure pump while testing for leaks. The hole location is shown in the below picture.

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Miss, rough run, vibration or flutter

- Make sure the PCM and FICM are flashed to the latest calibration.
- Injectors can cause a miss, rough run or surge when cold if the spool valves are sticking and/or FICM voltage is low. There is currently a re-flash to operate the injector spool valves during the glow plug cycle time in order to heat and free up the spool valves. Excessive oil change intervals can cause the spool valves to stick. [Buy 6.0 Powerstroke Injectors](#)
- Perform a relative compression test and a power balance test to verify a miss on a particular cylinder. If relative compression is OK, the problem is most likely injector related.
- Low fuel supply pressure, particularly when cold. Supply pressure should be 45 psi minimum KOEO and 45 psi minimum on hard acceleration.
- Check valves in the high pressure oil circuit that feeds each injector rail can break. The check valve (snubber) plates have 3 small tabs; if any of the tabs are broken they can stick in the oil inlet to the injectors. You will need to flush the oil rail to find any missing tabs.
- Dual mass flywheel bad (used in 2003 & 2004)
- If the FICM has low voltage it will often cause a hard start and rough run when cold, but the problem may clear up as the engine warms. The symptoms are very similar to stiction. [Buy 6.0 Ford FICM and Related Parts](#)

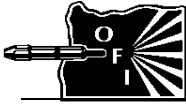
Low Power

- Make sure the PCM and FICM are flashed to the latest calibration.
- Dirty or plugged air filter
- Boost leaks: The charge air hoses at the turbo compressor outlet commonly tear and leak. Other common areas are the plastic charge air tubes on the drivers side and the plastic end tanks on the intercooler.
- Exhaust leaks, often accompanied by a hiss, squeal or exhaust smell. The expansion bellows on the turbocharger inlet pipes commonly crack and leak. The inlet to the EGR cooler and turbocharger are also problem areas.

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- Injector spool valves sticking
- Biased MAP sensor
- Low ICP due to oil dilution, aeration, ICP leaks, skewed ICP sensor, ETC.
- Fuel aeration and/or low fuel supply pressure
- Low FICM voltage

Injectors

- Make sure the PCM and FICM are flashed to the latest calibration.
- Bad injectors can cause a surge, hard start, cold rough run, low power, black smoke or a miss. Address oil and fuel maintenance issues and aeration before replacing injectors.
- Injector installation is critical, improper torque will cause injector chamber gasket failures.
- Injector chamber gasket failures will result in aeration in the fuel galley from combustion gases. Perform the compression bubble test to check for air in the fuel system, information on how to perform the test can be found here; <http://www.forddoctorsdts.com/articles/>
- Failure to remove the oil from the hold down bolt hole will result in improper torque.
- Broken injector stator housings, when the two bolts that holds the stator housing to the injector body break, are caused by aeration.
- 2004 ¼ and up vehicles need to update the stand pipes when replacing injectors.
- There have been cases of the injectors causing fuel to leak into the engine oil, either from excessive plunger clearance or nozzle nut o-rings degrading.
- [Buy 6.0 Powerstroke Injectors](#)

Turbo failure diagnostics

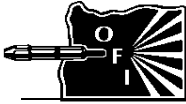
- **The 2003 and early 2004 engines need to perform a VGT “learn” function before the turbo will work correctly. This needs to be done after clearing codes, reprogramming the PCM, ETC. When the conditions are correct, the engine needs to sit and idle for a few minutes to learn VGT operation. If this is not done the turbo will exhibit symptoms similar to a sticking turbo.**
- Normal boost 25 – 29 psi (22-25 psi in 3rd gear at WOT, per Ford)
- The Variable Vane Turbo (VGT) that is on the 6.0L uses engine oil to move the vane positions in order to improve turbo response and control turbo boost.
- If you have a squealing noise, particularly when using a scan tool to close the vanes, look for leaks at the EGR cooler connections, turbine inlet and turbine outlet. If the turbo has been recently replaced check for misaligned pipes and

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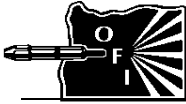
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- other leak points as noted above. If the turbo is responsible for a squealing noise, expect to find the wheels rubbing the housings and bearing failure.
- A “bark” or “chuffing” sound from the turbo usually indicates the turbo vane unison ring is stuck or sticky. Often caused by excessive idle time, low load operation, failing injectors, failing FICM, and EGR related problems.
 - Turbo vane unison ring failures (sticking) can cause EGR codes to set.
 - Run the KOER EGR and VGT test multiple times to check for erratic operation or sticking.
 - Sticky vanes can cause exhaust back pressure as high as 80 psi, which can cause EGR cooler failures.
 - There is no vane position sensor in the turbocharger and the PCM ignores actual EBP readings in favor of inferred readings on the 03-05 models. If boost is low the PCM tells the vanes to close in order to create more turbo boost (MAP), causing excessive drive pressures and turbo over speed conditions.
 - The oil line feeding the turbo can plug which will result in actuator or turbo bearing failure. Turbo bearing failure due to oil starvation from plugged oil feed line will repeat itself and is not a warrant-able turbo failure.
 - A squealing noise could be vanes sticking closed, a boost leak or an exhaust leak. The left side “Y” pipe is known to crack and cause a squeal.
 - [Buy 6.0 Powerstroke Turbo and Parts](#)

EGR and EGR codes

- Make sure the PCM and FICM are flashed to the latest calibration.
- Check the turbo (see “Turbo failure diagnostics”), if the vanes are sticky, that will affect MAF and possibly set EGR codes, such as P0404
- Check the air filter, a dirty air filter will affect MAF and could cause EGR codes to set.
- Some performance air intake systems will set EGR and MAF codes (they affect MAF right?)
- A dirty IAT2 sensor in the intake manifold can cause EGR codes because the PCM expects to see and increased temp reading when the EGR is turned on. If the temperature increase doesn’t change fast enough it can effect turbo operation as well as EGR operation.
- EGR coking can be reduced by using a crankcase vent filter kit (such as the BD 1032175) to remove the oil vapor from the intake system.
- EGR coking can be caused by excessive idle time.
- EGR coking can also be reduced by using Stanadyne Performance formula to improve combustion and reduce carbon in the exhaust.
- If the EGR valve fails the system test, replace it DO NOT just clean it. It will fail again.
- [Buy 6.0 Powerstroke EGR system Components](#)



Coolant loss

Do not continue to drive the vehicle if you are losing coolant and don't see any leaks. The longer you put off getting it checked, the more likely a bad EGR cooler will lead to head gasket and/or other engine failures.

- Refer to Ford TSB 08-3-7 and TSB 07-21-5 for the Ford recommended diagnostic procedures.
- Check the EGR cooler; remove the EGR valve and inspect, is it wet with coolant? Raise the rear of the vehicle to see if any coolant flows into the EGR hole from the EGR cooler. Pressurize the coolant system using the proper tools and inspect for leaks.
- If the EGR cooler is leaking, many times it was caused by excessive back pressure. See the turbo section for diagnosing excessive back pressure. [Buy 6.0 Upgraded HD EGR Cooler](#)
- EGR cooler failure is also caused by a restriction in the engine oil cooler, resulting in reduced coolant flow to the EGR cooler. This causes overheating and cracking of the EGR cooler. The maximum difference in temperature between the engine oil and the coolant, under hard acceleration, is 15 degrees. If the oil temperature is too high it will lead to early EGR cooler and head gasket failures. [Buy 6.0 Powerstroke Engine Oil Cooler](#)
- A howling or "blowing through a reed" sound under load is usually caused by the cooling system venting pressure through the cap on the reservoir. Another good indication is coolant or coolant residue on and around the overflow bottle after driving.
- The 2003 and early 2004 engines seem to have more of a tendency to crack heads. When this happens cooling system pressures spike very quickly and cause the coolant to vent from the overflow bottle.

Stalling/Dies, No start or Hard start

- Cracked/stuck open injector nozzle or leaking chamber gasket. Either will cause aeration of the fuel galley.
- High pressure oil system leak, which will usually happen more often when the oil is warm because it is thinner.
- Fuel in the oil, crank case over full. The combination of too much oil and the oil being too thin will cause the engine to die from aerating and thinning the oil. This usually happens at high RPM, high load conditions.

Surge

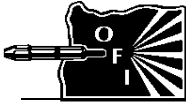
- Make sure the PCM and FICM are flashed to the latest calibration.
- Injector spool valves (see injector section)
- Turbo (see the turbo section)
- ICP sensor. Check for oil leaking through the sensor causing the connector to short out. [Buy 6.0 ICP Sensor](#)

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- Low fuel supply pressure. Fuel supply pressure should maintain at 45 PSI minimum.

White Smoke Cold

- White smoke cold could be caused by the spool valves sticking in the injectors, see “Miss Rough Run” section for more information.
- Low FICM voltage
- Defective glow plugs and/or controller
- Low compression

White Smoke Hot/At all times

- Leaking EGR cooler
- Cracked or stuck open injector nozzle
- Improperly torqued injector(s)
- Injector Chamber gasket not seated, allowing combustion gasses to aerate the fuel galley.
- Low compression

Wire Chaffing Issues

Wire chaffing can cause a variety of drivability problems, common locations are valve cover bolts, near the FICM, or intake bolts where the wire harness is routed under the air intake hose. Other possible problem areas are the thermostat housing, idler pulleys, glow plug relay brace, relay box braces, and near the PCM by the battery.

Common DTC (trouble codes)

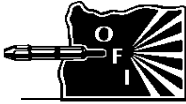
- P0263 #1 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.
- P0266 #2 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.
- P0269 #3 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.
- P0272 #4 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.
- P0275 #5 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.

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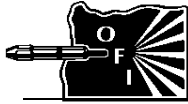
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- P0276 #6 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.
- P0281 #7 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.
- P0284 #8 Cylinder Contribution/Balance
 - Typically caused by injector spool valve stiction or FICM failures.
- P0299 Turbocharger under boost
 - See turbo info above and P132B
 - Can be caused by sticking vanes, boost leaks, exhaust leaks, or sometimes injector, fuel system or high pressure oil system failures.
- P0401 EGR Insufficient flow
 - (see EGR info)
 - A defective EGR valve may cause this code to set
 - EGR deletes will cause this code to set
- P0402 EGR Excessive flow
 - (see EGR info)
 - Almost always sets due to an EGR valve that is stuck open
- P0611 FICM Performance
 - Typically sets when FICM injector output voltage drops below specification. Often sets in conjunction with injector circuit/performance codes.
 - Check FICM voltage either with a scan tool (best) or manually with a DVOM.
 - Make sure battery voltage is over 11 volts at the FICM.
 - If at any time voltage drops below 45, replace the FICM.
- P0671-P0678 Glow Plug circuit codes
 - Ohm through the glow plug harness connectors. If the glow plugs ohm open or have very high resistance (more than 3 ohms), replace the glow plug(s). If the glow plugs are OK, the controller is likely bad.
- P132B Turbocharger/Supercharger Boost Control A Performance
 - Almost always sets due to sticking turbo vanes, but it can also be caused by boost leaks, exhaust leaks, or other engine issues.
 1. Check the intercooler, tubes, and hoses to verify none are leaking.
 2. Check very closely for any exhaust leaks, especially at the Y-pipe that connects the exhaust from the manifolds to the turbo inlet. It is very common

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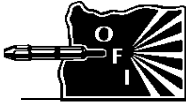
for this pipe to crack or leak at a connection point and even the smallest of exhaust leaks will cause the Powertrain Control Module (PCM) to not learn the turbo operation properly and cause low boost.

3. Drive the engine to load it and when the turbo is building 3 PSI of boost, the exhaust back pressure should not be over roughly 25 PSI (it is typical for the exhaust back pressure to increase about 1 PSI for every pound of turbo boost). The voltage at 25 PSI (15 PSI of atmospheric pressure and 10 PSI of back pressure) should be roughly 2.0 V.
 4. If the exhaust back pressure reading is high, check for a malfunctioning Variable Geometry Turbocharger (VGT). Refer to TSB 08-16-13 for information on cleaning/inspecting the turbo if it is the problem.
 5. If the exhaust back pressure is not going abnormally high, verify the Exhaust Gas Recirculation (EGR) valve is closed (should show a voltage around 0.8 V when closed) and that it's not opening when not commanded. If it is stuck open or opening when it should not, clean or replace it as needed and re-check operation.
- P1334 EGR Throttle MIN Stop Performance
 - 2004 Model year only. Sets when the intake throttle plate is stuck in a closed position.
 - P2269 Water in fuel condition
 - Change fuel filters and check for signs of water contamination.
 - Disassemble the HFCM and clean. Debris tend to build up around the water in fuel sensor and can cause this code to set along with the WIF light.
 - P2284 ICP sensor CKT range/performance
 - see ICP info above
 - see P2285
 - P2285 ICP sensor circuit low
 - see ICP info above
 - 1. Access the Injection Control Pressure (ICP) sensor and disconnect it. Inspect the wire harness connector and sensor for any signs of oil, indicating a leaking sensor. If found, replace the sensor and connector as necessary.
 - 2. If the sensor is not leaking, monitor the ICP sensor voltage on the scanner. The voltage should be about 0.2 volts key on engine off, around 1 volt at idle, and increase under load. If the voltage ever drops below 0.2 volts, check for an intermittent short to ground on the Dark Blue/Light Green wire between the ICP sensor and Powertrain Control Module (PCM).
 - 3. If the wire is not shorting to ground, check for an intermittent open in the connector terminals, and if OK, replace the ICP sensor.

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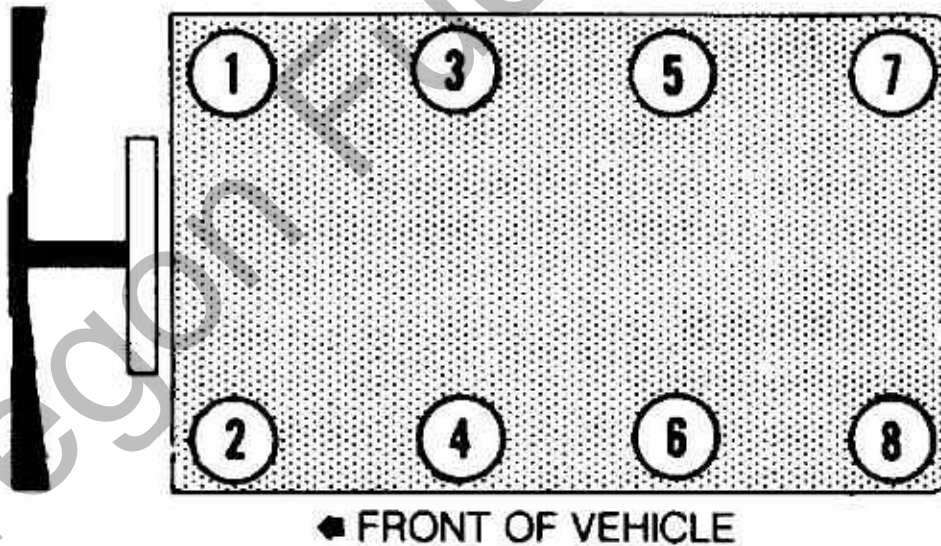
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- P2290 ICP too low, P2291 ICP too low- cranking
 - Indicates a high pressure oil system failure.
 - See “ICP” above
- P2614 Camshaft position output circuit, P2617 Crankshaft position output circuit
 - If set with other codes diagnose other codes first. These codes can set when cranking an engine that won't start.
 - Monitor FICM sync while cranking. If it says “Yes”, these circuits are OK.

Ford 6.0 L Cylinder location and Firing Order

Ford Diesel 7.3L IDI, 7.3L
& 6.0L Powerstroke

Firing Order 1-2-7-3-4-5-6-8



EUGENE
4036 West 1st Ave.
Eugene, OR 97402
(541) 485-1434

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