

HOW TO DIAGNOSE VP44 FUEL SYSTEM ISSUES

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Overview

I feel qualified to help you as I owned a full service diesel performance shop specializing in ONLY Dodge Diesels, and Freightliner and Ford trucks with the Cummins B series engine, from 1993 through 2006, when I became a website only to specialize in the often misunderstood VP44 fuel system. In 1999 my brother and I were the first to offer a power enhancement device for the VP44 fuel system. During the development of this product we received the only US Patent for enhancing fuel delivery for electronically controlled diesel engines. I felt back then that this experience probably made us a bit smarter than most, but I have to admit that the experience I have gained SINCE then has made me a lot smarter and a much better teacher. As I still answer the phone every chance I get, I am still learning from all of you, to give me way more REAL WORLD EXPERIENCE than others in the industry. I am happy to share this knowledge and experience to help you make an accurate diagnosis of your truck's VP44 fuel system and direct you to purchase the right part the first time. As I learn more, or gain more experience, I rewrite this amazing document to make it even better, so keep checking the update date so you are assured of the latest and greatest information.

My REAL WORLD EXPERIENCE has allowed me to really fine tune what works and doesn't work for diagnosing this fuel system. To diagnose this fuel system requires a unique approach and a sense of humor as you can't just plug in scan tool for all the RIGHT answers. You can't get what you need from a shop manual either as it was probably written before the author had the experience necessary to diagnose this unique fuel system. The best news is that the mechanically inclined back-yarder CAN diagnose this fuel system accurately, WITHOUT A SCAN TOOL, with only a few simple tools and a cheap analog voltmeter. The codes that are in the ECM are a help, but in MOST cases mean nothing unless accompanied by a certain symptom. You only need to read the codes in the ECM as

that is the only computer that runs the fuel system. The PCM is for all other systems in the truck. In SOME cases the codes we DON'T get are the most important part of determining an accurate diagnosis. If you follow these diagnostic procedures below you WILL get accurate answers, but not necessarily the answers you like! I am so confident in what I am about to share with you, that I make this promise. If you buy an Injection Pump from me that I have diagnosed with you via email, or you email me and I verify your diagnosis, and our pump doesn't fix the problem, I'll take it back within the first week!

There are six components in the fuel system in a VP44 fueled truck. They are the ECM (Engine Control Module), Fuel Injectors, APPS (Accelerator Pedal Position Sensor, also known as a TPS or Throttle Position Sensor), Manifold Air Pressure Sensor or MAP Sensor (also known as a Boost Sensor), Fuel Filter, Lift Pump and lastly the VP44 Injection Pump. The ECM and OEM Injectors almost never give any problem in my experience. In fact up until 2009 I had never heard of a bad ECM, even at crazy high mileages, but now that these trucks are getting older I have to change my tune. The APPS and MAP Sensor rarely are a problem, and can be diagnosed with the info below. The Fuel Filter and the Lift Pump have their own diagnostic page that can be accessed by clicking on DIAGNOSTIC HELP and then LIFT PUMP DIAGNOSTICS, on the Home Page. The VP44 Injection Pump is almost always the cause of a drivability issue and or symptom, and can be accurately diagnosed by reading below.

HOW THIS FUEL SYSTEM WORKS IN SIMPLE TERMS

I feel you are likely to understand the following diagnostics better if you have a better understanding of how the fuel system actually works. Now that you know what components exist, and which ones are generally trouble free and which are not, here is HOW and WHEN they do their thing.

When CRANKING OR STARTING the injection pump is operating in what is called Open Loop" electrically. That means the INJECTION pump is only using 12 volt power and ground. It does NOT pay any attention to, or require ANY other component, **including the electric lift pump**, in the VP44 fuel system to ONLY start and idle.

(More info on this phenomenon is explained in the Lift Pump Diagnostic page.) When the ECM sees idle RPM, then it runs the injection pump in "Closed Loop" and turns on the electric lift pump to run continuously, and pays attention to all the sensors, computers, etcetera to meet desired parameters preset in the ECM, like fueling rates and emissions.

To get more RPM or power you step on the throttle which is connected via a cable to the TPS, which Chrysler calls an APPS. When you press the throttle down the APPS sends an increased analog voltage to the ECM which commands the VP44 to deliver more fuel. The more you move the pedal the more voltage is seen by the ECM and the more fuel is commanded. The VP44 takes ALL of its commands, other than starting, from the ECM, which monitors a bunch of signals from inside the VP44 too, like pump timing and a pulse width signal from the fuel solenoid inside the VP44, to compare with the pulsed signals from the Crankshaft and or Cam Sensors. The signal from the MAP or Boost Sensor is used by the ECM to control fueling rate. It tells the ECM how much boost pressure is being made by the turbocharger, and the ECM determines how much fuel is actually being burned compared to load or command, and how much smoke or emissions are likely present. This is how the ECM controls performance and or emission standards. If the analog signal voltage from the MAP Sensor seen by the ECM is within appropriate voltage parameters, then more fuel will be added until the command from the APPS is met. If the appropriate MAP signal voltage parameters are exceeded or too low, then the ECM tells the injection pump to adjust and limit fuel volume. This is what some call "Limp Mode". I don't consider the IAT or Intake Air Temperature sender a part of the fuel system, as it only tells the ECM whether or not to turn on the intake heating ribbons, for a cold start.

Now for the fun part, the VP44. It is a rotary style medium high pressure injection pump that is mostly mechanical with two electronically controlled components in it. One is the timing solenoid, which is pulse width modulated by the ECM to control timing piston travel against a spring in the housing of the VP44. This piston moves the wavy ring inside the pump which is what forces the pistons in the rotor inward as it turns and creates high pressure to pop off, or open, the injector that the rotor is pointed

to, to get fuel to flow. Fuel only flows through the injector as long as its pop off pressure is exceeded. If the high spot on the wavy ring is moved one way to the point where pop off pressure is exceeded and fuel flows sooner, the injection event is advanced. If it moves the other way it makes pop off pressure come later and therefore retards the injection event timing. The distributor portion of an injection pump is basically the same as a distributor cap in a gas scenario except that it has holes in it going to each delivery valve and injector line in the correct firing order in direction of rotation. The rotor in this pump does the same job as a rotor in a distributor in a gas car application. Instead of directing electricity to the contact in the distributor cap and spark plug wire, in an injection pump it is hydraulic and the rotor turns past a round hole in the so called distributor so fuel flows to the individual injector. The hole in the rotor, that mates up to the round distributor hole, is slotted so fuel can flow for a period of time as the rotor turns. The other electronically controlled part in the VP44 is the fuel solenoid that is both the fuel fill valve and the pressure relief valve for the rotor. The rotor is hollow with three pistons mounted radially in it, that mate up with and run over the highs and lows of the wavy ring on the inside of the pump housing. The solenoid is actually a valve on the end of the rotor. When it is open, low fuel pressure fills the hollow part of the rotor with fuel as centrifugal force and fuel pressure push the pistons outward to the lowest spot on the wavy ring allowing the rotor to completely fill with fuel. At a computer determined magic moment, the solenoid closes the fill point or fuel solenoid, and then as the rotor turns, the wavy ring makes the pistons compress as they go over the high spots. When the pistons are compressed, pressure builds up in the rotor and when it exceeds injector pop off pressure, fuel flows through the injector until the computer on the top of the injection pump shuts off the solenoid valve, allowing it to open, which relieves the pressure in the rotor to below pop off pressure and fuel stops flowing. As the solenoid is now open, the rotor is refilled for the next injection event. The longer the fuel solenoid is kept closed during each injection event, the more fuel is injected into the cylinder. This is how you make more or less fuel come out of this pump. A fueling style performance box like our Fuel Management System works on this principle. The performance box holds the solenoid closed longer

than the computer on the pump tells it to, and fuel continues to flow, making more power until the rotor is empty or the solenoid is shut off by the box and the fill valve is opened!

PERTINENT CODES

In my experience the 216 code is not a "Death Code" as some people say. It only tells you the Injection Pump can't attain full timing advance to provide good fuel mileage and power. If this is the ONLY code and you don't have any drivability issues, the VP44 does not need to be replaced, and most likely will not put you on the side of the road. If you DO have the 216 code you should check your Lift Pump pressure UNDER LOAD as Lift Pump pressure is what moves the timing piston and advances timing, so if Lift Pump pressure is low, that may be the cause of the 216 code. If the pressure is good, then the code means the housing of the Injection Pump is worn out, which all by itself, still isn't a good enough reason to replace it, in my mind.

If the engine won't start, **AND YOU HAVEN'T OPENED ANY FUEL LINES OR REPLACED THE FUEL FILTER SINCE IT LAST RAN**, and you have either or both a 1688 or 1689 code, the truck will never start until you replace the injection pump, 99% of the time. If you want to be 100% sure of your diagnosis, follow the No Start diagnosis below. These codes indicate either a serious internal mechanical failure, such as a seized rotor, or that the computer on the top of the Injection Pump is not communicating with the ECM, thereby turning on the high pressure fuel to the injectors. Other circumstances like stray RF (radio interference) can set these codes and therefore confuse or misdirect an accurate diagnosis, so this is where symptoms have more merit than just codes, when diagnosing this fuel system. Code 1693 only means there is at least one code in the other computer, the PCM, which has NOTHING to do with the fuel system or fuel system drivability problems. Sometimes an automatic transmission can cause a drivability issue and appear to be a fuel system issue. In this case codes in the ECM and the PCM should be noted, and COMBINED with the drivability SYMPTOMS and a phone call to me, I can help you differentiate and diagnose the problem. To come up with an accurate diagnosis of this fuel system sometimes, you have to prove all the other components that could cause your problem are indeed good, and therefore NOT the cause

of your problem. After you have done that, you have no choice but to condemn the Injection Pump.

Code 123 is truly rare and usually means an ECM problem. 234 means the MAP signal voltage is too high. 237 means the MAP signal voltage is too low. 251 and 253 means the fuel solenoid is not working correctly and when associated with a drivability issue is a very compelling reason to replace the VP44. Code 1690 or 336 indicates a signal issue with the Crankshaft Position Sensor, and when associated with a drivability problem, necessitates replacement.

WHY YOU SHOULD CHECK FUEL SUPPLY FIRST

You may think that low fuel supply pressure will cause many or all drivability problems, but NOT SO with this fuel system. Human nature also makes us want to take the path of least resistance, by replacing the less expensive components first, before diagnosing this fuel system correctly. Please know that Lift Pumps have their own problems, but are RARELY the cause of a catastrophic Injection Pump failure, or a drivability complaint, contrary to what a lot of people want you to believe.

A weak or failed Lift Pump or a restricted Fuel Filter will NOT give any other drivability issues OTHER than a skip, miss or buck at high load/high RPM operation. If you DO experience ONLY these symptoms, replace the Fuel Filter and if you can't bleed the system, or if changing the filter doesn't fix the problem, go to our Home Page, then Diagnostic Help, and then to Lift Pump Diagnostics for more answers.

You MAY have to do a Lift Pump diagnosis and or replace the Fuel Filter after you put on a rebuilt Injection Pump because it may make more power than the old one, therefore using more fuel, and therefore lowering the fuel delivery pressure to the point that you then have a skip or miss at high rpm/load. Be sure that you have at least 5 PSI Lift Pump pressure, UNDER LOAD, to be sure it isn't preventing full power or timing advance, and or causing any harm to an old style diaphragm in your VP44. We strongly suggest installing our Low Fuel Pressure Warning Kit to monitor fuel pressure as a diagnostic tool and a future money saver. It will tell you when restriction in the filter necessitates replacement, which

means you will change your filter by restriction, rather than the seat of your pants, and save replacement filter costs! It will also tell you if the Lift Pump fails mechanically or electrically. Go to [Products](#) for more info about this money saving product.

READING CODES

If you have a late model year 2000 – 2002 Dodge truck you can read the codes by turning the ignition switch to the “run” position from the “off” position 3 times within 5 seconds and leave it in the “run” position and stare at the odometer. To help your diagnosis, write down the information displayed, so you don’t forget. To be sure the codes read are pertinent to the current issue, I recommend that you clear the codes after you read them, to see if they come back when the problem reappears. As some scanners, as well as the disconnecting both batteries for half an hour trick, do not dependably clear all the codes, I suggest that you **REREAD THE CODES BEFORE YOU START THE ENGINE** to be sure they are actually cleared. Then drive the truck until the problem reappears, and then reread the codes. If there is no new code, that is very valuable information, and if you do have a newly set code, it is most likely relevant to your symptom. If you have a 1998 - 99 or a grumpy 2000, reading codes this way will not work, so you’ll have to read the codes with any OBD II compatible scan tool. Most auto parts stores will do this for free for you.

FOR HELP DIAGNOSING EACH COMPONENT OF THIS FUEL SYTEM INDIVIDUALLY, GO TO END OF SYMPTOM DIAGNOSTICS.

THE SYMPTOMS LISTED BELOW IN RED ARE LISTED IN FREQUENCY OF OCCURRENCE, MOST FREQUENT TO LESS FREQUENT, TOP TO BOTTOM

WHEN DOING THE FOLLOWING TESTS, PLEASE FOLLOW THE DIRECTIONS EXACTLY, AS THEY ARE TRIED AND TRUE AND PROVEN ACCURATE FROM OUR EXPERIENCE. WE WANT YOU TO GET ACCURATE RESULTS!

DEAD PEDAL, OR INTERMITTENT LOSS OF POWER

This is THE MOST COMMON DRIVABILITY COMPLAINT and is an intermittent one that happens most often when the truck is hot or working harder, but can occur when cold too. My experience tells me that 4 times out of 5, Dead Pedal is worse hot, but 1 time in 5 it is worse cold! The symptom of Dead Pedal is rarely caused by the APPS (Accelerator Pedal Position aka Throttle Position Sensor) and 90% of the time it is caused by a faulty computer on the top of VP44 Injection Pump. These numbers are NOT an exaggeration. Computer failures are due to the "Lead Free" solder connections on the circuit board in the computer becoming crystalline over time, which causes an intermittent electrical connection and intermittent Dead Pedal symptoms. Its use is mandated by the Federal Government!

There are no codes that specifically diagnose Dead Pedal or that will condemn the computer and therefore the VP44. This is an instance where a lack of codes is most important, and where you have to prove that the only other component that could cause this symptom, the APPS, IS or IS NOT the cause of Dead Pedal.

The lazy inaccurate way to diagnose the APPS or TPS as the cause of this drivability issue is to scan or read the ECM (not the PCM) to check for any codes pertaining to the APPS, such as a 121 or 122. Codes 121 and 122 only indicate that the voltage going in or coming out of the sensor was outside of the desired parameters, at least once, since the codes were last cleared. Therefore these codes do NOT tell you what happens to the signal when they ARE within appropriate parameters, which is what really matters. If you DO have either or both of these codes you MAY OR MAY NOT need an APPS. To diagnose the APPS accurately you need to use an oscilloscope or an ANALOG voltmeter, one with a needle, to measure and monitor the signal voltage on the blue wire with a black tracer, on a Dodge, in the APPS electrical harness plug. A scan tool or a digital voltmeter has too much averaging or buffering of the signal to be useful for this test. First verify the appropriate voltage range and voltage apply rate with the engine off. Turn the ignition key to the "on" position and slowly press on the throttle and slowly release it. You should see voltages from about .6 volt to 3.5

volts, and not ever see a jump in voltage, or the needle bounce. It should go up and down smoothly, directly related to throttle movement. If it repeatedly or intermittently jumps up or down, then replace the APPS. The adjustment of low voltage at idle, or "resetting" or "recalibrating" the APPS is NOT as important as some people want you to think, and does NOT cause Dead Pedal. The ECM learns the range when you do the install of the APPS correctly and does NOT cause any drivability issue in my experience.

As this sensor can be very intermittent, I strongly suggest you ALSO do the same test when driving the truck to prove the APPS is or isn't the cause of your Dead Pedal OR DRIVABILITY issue. Extend the signal wire used in the previous test up to the dash of the truck, hooked to the analog voltmeter, and drive it until Dead Pedal or naughty thing happens and look at the voltage on your voltmeter. If you are holding the pedal still and the voltage drops when the engine drops power, or the needle quivers at the same frequency as the stutter, skip, or miss, you need an APPS. If the voltage stays the same and the power drops, you need an Injection Pump!

IF YOU DON'T NEED AN APPS, AND YOU HAVE DEAD PEDAL SYMPTOMS, YOU FOR SURE NEED A VP44!

If you don't have access to a scan tool, or more importantly, an analog voltmeter, and want to trust my experience, let me explain the difference in symptoms between a bad APPS and a bad computer on the Injection Pump. A bad APPS usually is just a flat spot at a certain throttle opening, usually 65-70 MPH, and smacking the pedal to the floor a few times, usually clears it up. If pushing the throttle just a bit more makes it take right off, or if going back to a lesser throttle opening makes the engine run fine, then it is most likely a bad APPS. This usually occurs most frequently, but not always, in cold and or wet conditions. If it is caused by the computer on the VP44, the Dead Pedal or power drop occurs at ALL throttle positions and power comes back only if you let the throttle pedal go to idle for a brief time to re-establish Idle Validation and reset the computer, or push the clutch in, or shut off and restart the engine, or just wait. This kind of Dead Pedal happens most often hot or towing, but sometimes when cold.

TRUCK DIES GOING DOWN THE ROAD

Another frequent VP44 failure is when the truck dies driving down the road for no apparent reason, or when you let off the throttle at high RPM, and the engine won't restart. This is usually a seized rotor in the Injection Pump and is most common on 1998 and 1999 trucks, or rebuilt pumps that don't have the upgraded rotor and distributor. The cause of this failure is a poorly "de-burred" rotor according to Bosch. This machining problem has been addressed and apparently solved in later years of production. All of our rebuilt units have these updated upgraded parts. If you run any rotary style pump like a VP44 out of fuel at high RPM you CAN seize the rotor because it runs out of lubrication! This symptom can also be due to contaminated fuel and related corrosion on internal parts of the pump, or an electrical failure of the computer on top of the VP44.

**IMPORTANT DIAGNOSTIC FACT:
TO MAKE THE ENGINE START AND IDLE ONLY,
YOU DON'T NEED ANY SENSORS OR
COMPUTERS OR ELECTRIC LIFT PUMP. YOU
ONLY NEED 12 VOLT POWER, GROUND, AND
FUEL TO THE VP44.**

NO START – TEST #1

FUEL SUPPLY TEST

If the fuel gauge reads 1/8 – 1/4 of a tank, put a few gallons in the tank and bleed the fuel system. I say this because of the famous Dodge fuel tank sender problem. Your gauge may have just failed and be out of calibration for the first time and the tank is actually empty. In this situation air AND fuel is what you are trying to start the engine with! Pressure indicators don't know the difference between air and fuel pressure, so they make you falsely think all is OK. You will be very glad you did this if your truck runs again and you don't need an Injection Pump!

If the engine **was** running **BEFORE** you **CHANGED THE FUEL FILTER** or **OPENED A FUEL LINE**, and it **HASN'T STARTED SINCE**, or, it started and stalled after doing this, and it **WON'T BLEED** or restart, and you can hear the Lift Pump running, but won't fill the filter canister, you most likely have a bad electric Lift Pump. That's a long complicated sentence, so reread it again slowly for

clarification! Please remember when you are doing this diagnosis that the ECM turns on the electrical power to the Lift Pump **only** for 4 seconds when the key is in the "on" or "run" position. When the ECM sees the "start" signal from the ignition switch it runs the lift pump for 25 seconds, and when it sees idle RPM it runs continuously. If the lift pump doesn't come on, or doesn't pump fuel into the filter canister when you click the key to the "start" and release it to the "run" position, you can bleed the system to get fuel to the VP44 and get the engine to run again by pressurizing the fuel tank with air pressure, or diagnosing and replacing the electric Lift Pump. The reason this strange scenario happens, is because there is a mechanical lift pump built into the VP44 which works fine UNTIL air gets into the system. This explains why VP44 fueled engines don't die on the side of the road when the electric one fails.

NO START – TEST #2

FUEL SYSTEM ELECTRICAL TEST

Next test the electrical wiring and verify that there is battery voltage getting to the VP44 with the key in the "run" AND "start" positions. Remove the big plug on the back of the injection pump by wiggling the plug with your right hand pulling toward the firewall and the left hand pulling the indented locking tab toward the fender. When you have the plug in your hand, hold it so it looks like a smiley face, with six pins below the smile and three pins above. Using a test light or voltmeter with its ground connection on the engine, verify battery voltage on the bottom right pin (pin #7, which is a red wire with a light green tracer on a Dodge), during both "run" and "start" key functions. Then verify the ground on the bottom left pin (pin#6, which is a black wire with a tan tracer on a Dodge), by doing the voltage test again at pin 7 with the ground connector of your test instrument on pin 6 in the plug. If you see no voltage then, it means there is no ground! Use only pin positions, not wire color, when diagnosing a Ford or Freightliner. If you don't have power at the plug, check the fuse in the PDC (Power Distribution Center, aka fuse box under the hood) for the fuel system, and if that is good, check fuse #9 in the fuse box on the left side of the dash. If they are both good, then try swapping the fuel system relay in the PDC with the one for the horn. Hopefully you find your problem this easily, but if not, get out the schematic for this circuit. If you don't have one, go to ALLDATAdiy.com . If you

have battery voltage on pin #7 in both key positions, and a known good ground on pin 6, cut the black tape off the VP44 plug harness to access the wires going into the plug and reinstall plug. On a Dodge find the light blue wire with a red tracer (pin #5 on other trucks) and verify that there is NOT battery voltage there during either the "run" or the "start" functions of the ignition switch, WITH THE PLUG PLUGGED IN. The ONLY time there should be battery voltage on pin 5, is for about three seconds after turning the key to the "off" position. If there is **battery voltage** there at any other time, the engine is being told to not start or run, by a pissed off ECM. This test is accurate 99% of the time in my experience. It is not unusual and OK to see low voltage, like .2 - 2.4 volts at pin 5. The important thing here is to NOT have battery voltage there, and if you do have it at the wrong times, I have found cutting that wire fixes the problem and running the truck forever that way, causes no harm!

NO START TEST #3

HOT WIRE TEST - THE "FOR SURE TEST" TO DETERMINE IF THE VP44 IS WHY THE ENGINE WON'T START

It is very rare, but possible, for a problem with the wiring harness or the CAN Bus wires to prevent the engine from starting, so ***if you want to be 100% sure it IS the Injection Pump*** causing the no start, follow the following directions exactly, to be sure of not damaging a possibly good pump. This test POSITIVELY eliminates the possibility of overlooking an electrical problem caused by other components that could affect the start or run function of the VP44, as long as you have verified fuel delivery to the Injection Pump. Remove the electrical plug at the back of the Injection Pump and hot wire the pins on the pump as follows. Get two wires long enough to reach from the battery to the VP44. Install an INSULATED ¼ inch female spade connector onto one end of each wire. Connect one INSULATED connector to pin 7 on the pump, which is the pin on the BOTTOM row of the socket on the Injection Pump, closest to the engine, to preferably fused (10 amp is fine) positive battery power in the PDC (Fuse box under the hood), or directly to the positive battery terminal if you like to take risks!

Connect the other INSULATED connector to the pin directly above the previous connection, the top row of pins, the one closest to the engine, and attach the other end to battery ground. Now try to start

the engine and if it doesn't start, you absolutely positively 100% need an Injection Pump! If the engine starts this way but NOT with the big plug installed on the pump, you know there is something in the harness or CAN bus wiring to the ECM telling or causing the engine to not start. Call me for help if this is the case.

IF YOU HAVE FUEL, POWER AND GROUND, PROVEN BY THE ABOVE TESTS AND STILL HAVE NO START AFTER TEST 3, YOU ABSOLUTELY POSITIVELY NEED AN INJECTION PUMP!

If you want more proof, or really want to know WHY it won't start, loosen all of the injector lines at the valve cover. Crank the engine for 30 seconds, and if fuel comes out of only one line, better than the others, this indicates a seized rotor, and the engine will never run again until you change the VP44, because only one cylinder is getting fuel. For the engine to start you need HIGH PRESSURE fuel, AND NOT AIR, to POP OFF at least three of the injectors. If you have only a feeble fuel flow from the open lines, you are looking at only Lift Pump pressure, and the engine will never start. To determine if it is or is not HIGH pressure, look for a puddle on the ground after 60 seconds of cranking. No puddle, no high pressure. If high pressure fuel doesn't come out of the open lines when cranking, the solenoid pintle valve may be stuck, or the pistons may be stuck compressed in the rotor, due to fuel contamination or corrosion. Low pressure can also be caused by an electrical issue in the computer, where the computer doesn't energize and close the fuel solenoid to make high pressure, so low fuel pressure going through the injector lines is WHY the engine won't start. Any of these situations confirms that the engine will not start until you replace the VP44, as long as you have done the other tests above.

LOW POWER, COLD ONLY

If the truck is gutless when driving for the first little while after start up cold, and then all of a sudden takes off and runs fine, this is almost always a bad computer on top of the Injection Pump. This means replace the Injection Pump. If you have a code 237 with this symptom, address that first by checking MAP sensor signal voltage, as described below. If you can predict when it is going to do this

naughty thing, try heating the computer on top of the pump with a hair dryer for a few minutes, and if it runs fine right off, you know I am right. If that doesn't fix it, do the APPS test as described in "Dead Pedal" above to determine if the voltages are doing what they should when cold, to make sure it is not caused by low voltage from the APPS. If the voltage doesn't go up when the pedal is pressed, then the ECM won't tell the injection pump to deliver more fuel, so you can blame the APPS. If the voltage goes up when you press on the pedal, then the APPS is working correctly, and it IS most likely caused by the computer on the top of the injection pump, or some mechanical issue inside it.

HARD START WARM OR HOT, LONG CRANK TIMES

We have learned this past summer that long crank times when warm or hot are not always caused by a worn-out distributor on the injection pump. Before you replace the injection pump for this symptom be sure that the starter cranking speed is adequate. This is important as it is a mechanical pump in the injection pump that makes more pressure and flow the faster it turns, and when the pressure created during cranking is not enough to pop off at least three injectors, the engine will not start. So there may be as many as two causes for this symptom. One, is that it's not cranking fast enough to make enough pressure, the other is the pressure is being lost in a worn-out distributor that is expanded due to heat soak, OR BOTH. Before buying a pump we suggest that you first check electrical parameters for the starting system. A good starter at operating temperature can draw from 450-700 amps, and the battery voltage should never go below 10 volts during cranking. If your starter draws more than these specs, or the battery voltage goes below 10 volts when cranking, you need to fix the starting system, FIRST.

When you have determined that the electrical system is up to snuff, then you can try our clever trick of running cold water from the garden hose over the injection pump when it's hot, for a few minutes, and if that makes it start right away, then you know cranking pressure is the issue, because you shrunk the metal in the distributor and it fits tighter to the rotor and makes more pressure. This indicates a worn out distributor, and a replacement VP44 is

needed. If you have just replaced the injection pump and the problem did not go away, then most likely you have a slow crank problem. If you didn't have the problem before the pump swap, then most likely it is a pump issue, BUT,,,,,the sad truth here is that a replacement pump may have a worn-out distributor just like the previous pump did. No one wants to put a new distributor on every pump, as it is SO EXPENSIVE. As of this moment in the industry, there is no good test available to the rebuilder to accurately determine if a distributor will perform correctly in hot conditions. The best any rebuilder can do is check pressure and fuel volume from the VP44 at cranking speed on the test stand and if it passes Bosch specs, then it has to be presumed good. This test is performed in a 70° air-conditioned pump room and in the real world pumps are subjected to the latent heat transfer from a 195° engine! The bottom line is you REALLY have to test the starter and batteries first to make an accurate diagnosis for this frustrating symptom.

Another cause of this issue that we have run into recently, is a delay getting 12 volts to the primary side of the fuel system relay. This shows up as a delayed battery voltage on pin seven (red wire with a green tracer on Dodges) in the plug going into the VP44. First test for the delay by removing the big plug on the injection pump and verifying the time it takes to get battery voltage on pin 7 of the plug or on the red wire with a green tracer. To accomplish this, pull the locking slide in the plug toward the fender. There are two half round indents on the slide lock and you will need to pull pretty hard toward the fender while wiggling the main plug with the other hand pulling toward the firewall. When you have the plug in your hand, hold it so it looks like a smiley face, with six pins below the smile and three pins above. Use a test light or voltmeter to verify how soon you see battery voltage on the bottom right pin (Pin 7) after putting the ignition switch in both the "run" and "start" key functions. When you reinstall plug and push in the slide lock, push the plug toward the pump and you will see that when the lock moves in, it pulls the plug in towards the pump. When you think it is on correctly try to remove the plug by pulling on it. If it comes off you didn't get plug on far enough before you slid the locking slide in. This test tells you when the injection pump is getting electrical power from the fuel system relay in the PDC (Fuse-box under the hood). The ECM not only turns on this relay but this relay also

powers another part of the ECM that turns on the lift pump too. The electric lift pump is powered directly from the ECM, not the relay, to control WHEN it comes on. An audible indicator of this delayed voltage or start problem is when you don't hear the electric lift pump come on for 4 seconds when the key is first turned on and for 25 seconds when it is turned to the start function. The relay enable power goes through two connectors, #125 and #130 between the ECM and the relay. The delay problem can be caused by a delayed signal on the brown wire with a white tracer at the ECM connector, indicating a bad ECM, OR a loose connector #125 on the firewall. We have not heard of #130 being a problem yet! Working on these old trucks nowadays is getting pretty interesting, eh?

HARD START COLD, LONG CRANK TIMES, AND INSTANTLY RUNS SMOOTHLY

This is typically due to a cracked or broken diaphragm inside the Injection Pump. To test for this try disconnecting the electrical power from the Lift Pump BEFORE turning the key on, and see if it starts better. This happens because the electric lift pump pushes air which is always in the fuel chamber inside the VP44 pump, through the crack or break in the diaphragm, into the mechanical high pressure pump and it becomes air-bound until it rotates enough times to bleed out the air. If it starts better without an electric Lift Pump, it is because the electric Lift Pump hasn't forced air into the mechanical high pressure pump through the crack or break in the diaphragm, which is what separates the fuel chamber from the high pressure pump. This failure requires a VP44 replacement to fix the problem.

HARD START, LONG CRANK TIMES, USUALLY WHEN COLD BUT SOMETIMES HOT, RUNS ROUGH FOR A FEW SECONDS AFTER START AND THEN CLEARS UP AND RUNS SMOOTHLY, OR, ENGINE SOUNDS DIFFERENT OR LOUDER UNDER LOAD, OR MAKES A CRACKLING SORT OF SOUND

AIR IN FUEL TEST

If the engine runs rough for a brief period of time after starting, just a few seconds, or sounds funny when running, this usually indicates air in the fuel supply system, caused by either fuel drain back or air getting into the fuel supply line somewhere. This symptom is NOT caused by the Injection Pump. Please know that good fuel pressure does NOT mean that there is no air in the supply line, as the pressure sensor doesn't know the difference between fuel and or air pressure! My latest trick to accurately determine if air is a problem or not, is to get a 12 foot section of clear polyethylene or vinyl 3/8" hose from the hardware store and put it in the steel line between the Fuel Filter and the Injection Pump where the rubber section is. For aftermarket plumbing upgrades, figure out how to install it between the Fuel Filter and the Injection Pump. Loop it up under the windshield wiper for easy observation while driving and starting. Bleed the system to get all the air out of the newly installed line, and when you know the engine will be hard to start, monitor the line before, during, and after starting, and even driving, to determine if air ever gets into the pump. Be sure to drive the truck even if you don't see air under no start or no load conditions, as air can be ingested intermittently from various sources only when the engine is under load. The hose under the wiper allows you to drive and diagnose the air situation under any and all circumstances you like, to see when it does or does not happen. This test positively tells you that you DO or DO NOT have an air issue which can be very important when diagnosing the VP44 fuel system. If you do have air in the clear line, run the engine from a can of diesel in the bed of the truck with a rubber hose stuck in it, connected to the inlet of the Lift Pump, and do the same test under the same conditions that saw air in the fuel, again. If the air goes away, the problem is behind the Lift Pump. If it is still there, the cause is forward of the inlet of the Lift Pump. This can be the Lift Pump itself, if it is a Fass with a leaky o-ring inside, leaking sealing washers, the water drain seal on the filter canister, or it can be leaking o-rings on the "Fuel Tubes" in the cylinder head. This last one is cool, as it shows its symptoms in a very unique way. If you park the truck facing up hill, overnight, on a fairly steep grade, it will start hard the next morning, but if you face it the other way on the same hill overnight, it will start fine! This is because of fuel drain back, and air getting into the system through leaky fuel tube

o-rings and going to the highest place in the fuel system. When it faces up hill, the air goes into the fuel filter. When it faces down hill, it goes to the fuel tank! Call me if you need more help determining where the air is coming from.

ROUGH OR ERRATIC IDLE OR SKIP AT IDLE ONLY

Do the "Hot Wire" test #3 above and if the engine runs smoothly and fine at idle with the big plug disconnected from the injection pump, but runs badly when it IS connected, then you KNOW that the pump is being told to run badly by some other component of the fuel system, UNLESS YOU HAVE AIR IN THE FUEL SUPPLY. Do the "Air in Fuel Test" above for sure if it still runs badly when hot-wired, to be sure it is NOT air. Typically an erratic skip above idle is caused by a "Dirty" or erratic signal from the APPS. Do the "Dead Pedal" test above to see if the skip AND the needle quiver at the same frequency as the skip. If so, then clean the connector to the APPS or replace the APPS.

INTERMITTENT MISS ABOVE IDLE, AT HIGHER RPM AT LIGHT TO MODERATE LOAD AND THROTTLE POSITIONS

This symptom is RARELY caused by an electrical problem with the Injection Pump. It can be a mechanical issue inside the pump caused by WVO or Biodiesel damage or even a blown head gasket. First, be sure that there is no air in the fuel supply and no relevant codes by doing the appropriate tests. If a relevant code exists, like a 336 or 1690, replace the crank sensor first to be sure to eliminate it as the cause of the skip. If you have a 251, 253, 1688 or 1689 code these only pertain to the Injection Pump and are strong indications the electronics in the VP44 are BAD, and that the pump is bad. With one or any combination of those codes, and an intermittent miss, I would replace the pump ONLY AFTER DOING THE TESTS BELOW. A 216, 234 or a 237 code CANNOT cause a skip or miss, so they are not relevant to THIS symptom. If you want to prove the skip is caused by an electrical issue THE MOST ACCURATE WAY, hook up an oscilloscope to the ground side of the fuel solenoid and watch the duty cycle, which is the solenoid energized or closed time. The wire you want to find for the scope probe, is the wire

closest to the engine in the top pair of wires coming out of the injection pump top cover plate. This is the same wire used to attach performance devices. You MAY have to increase and hold the RPM at the point to where it is missing, to see if the pulse width changes erratically on the scope. If the pattern on the scope looks different on the oscilloscope when the skip is occurring, then look at the APPS signal wire, which is the blue with a black tracer in the APPS plug, with the oscilloscope to see if that signal is inconsistent, or "dirty" when the skip is evident. If it is, that would prove the VP44 is being told to do the skip because of the APPS signal. If the APPS signal is OK then you have to condemn the VP44 computer and replace the pump.

If you don't have access to an oscilloscope, and the skip is ALSO evident at idle, and you do NOT have air in the fuel supply, do the Hot Wire test above, and if it idles fine, it means the VP44 is being told to skip. Then you need to diagnose the APPS as best as you can with an analog voltmeter as explained in Dead Pedal, looking for needle quiver at the same frequency as the skip. A scan tool or a digital volt meter DOES NOT WORK for this test, because they have too much averaging or buffering in them to indicate the problem dependably. If the skip only occurs at higher RPMs, then you have to hold the throttle at the point where the skip is evident, and then watch the needle for any quivering. If NO quiver, it most likely is not a bad APPS, and if you have codes that could explain the problem, it most likely is a bad Injection Pump.

Another way to narrow down the possible reasons for the miss or skip WHEN THE ENGINE IS SKIPPING, is to loosen each injector line, one at a time, until you find one that makes the RPM or sound of the engine change LESS than another. The less the change, the less that cylinder is contributing, indicating that that is the problem cylinder. If the skip appears to move from one cylinder to another while doing the crack injector test, that is what I call a rolling skip and if it is NOT an electrical issue, like a bad APPS, it means it is most likely a mechanical issue inside the injection pump, like a sticky piston in the rotor from contaminated fuel, and therefore means a bad Injection Pump. This is why you have to do the APPS test to condemn the injection pump. If it is consistently one cylinder, it might be explained by being a lazy delivery valve on the Injection Pump, but I've never heard of it in a VP44, and it may be

caused by some mechanical problem in the engine. If you think you have a bad injector, which is virtually unheard of with OEM injectors, swap the indicated cylinder's injector with the one next to it and redo the test. If the problem moves, it is the injector. If it doesn't move, it is something else.

DOGGY ON TAKE-OFF OR LOW POWER, USUALLY COLD BUT SOMETIMES HOT, OR CAN'T MAKE THE BOOST YOU ARE USED TO SEEING

Before doing the voltage tests below, be sure all the silicone boots are securely fastened to the intercooler plumbing, and that you aren't just experiencing a boost leak somewhere. Don't assume they are fine just by looking at them, as they may be delaminating. Try to twist each one on the pipe to be sure. Look at the intercooler itself, looking for oil stains anywhere in the plumbing indicating a leak. Check the o-ring at the turbo outlet elbow. Check that the sealing plugs under the heating ribbon electrical connections at the intake tube are both there, and check all intercooler plumbing for any signs of a leak. Often, but not always, a leaky intercooler system will make a whistling sound under load, which is a really good indicator of a leak!

MAP SENSOR, KEY ON SIGNAL VOLTAGE, TEST ONE:

The ECM wants to **only** see MAP signal voltage on 1998 - 2000 trucks between .5 and 1.74 volts and 1.0 to 2.2 volts on 2001 - 2002 trucks. These voltages are the same for a Freightliner or a Ford. If the MAP signal voltage at the sensor on the grey wire with a red tracer on a Dodge, or the MAP signal wire on other trucks, is low to start with, this can cause this symptom, and typically sets a 237 code. To be sure this isn't the cause of low power, check the signal voltage with the key in the "on" position and the engine NOT running. If it is lower than the lower voltage above, it is RARELY be due to a bad MAP or BOOST sensor, but more likely it is because the truck has a device on it that attaches to the MAP sensor harness, like a timing box, performance device, or electronic gauge component, that draws the supply voltage down below the desired parameters. To determine if one of these components is the cause of the low voltage, disconnect the wires of the device(s) from the engine's MAP sensor harness. You can't just turn it (them) off to see

if the problem goes away because any device connected to either the 5 volt supply wire or the signal wire at the MAP sensor can draw either voltage down, even if the add-on device isn't turned on. If the MAP signal voltage is still lower than spec after disconnecting the device(s), the devices are NOT to blame. Then check the plug of the sensor with the key on, looking for a 5 volt supply. If it is less, then you have to look at the ECM output voltage, as rarely an ECM can cause erratic low or high supply voltage to the sensor, which of course causes low or high signal voltages. Look at the ECM section below to address that problem. If you have good supply voltage to the sensor, but the signal is too low still, you can do my "enema" fix before buying a MAP sensor. That is to remove the sensor, plug it back into the factory harness, turn the key to on and read the signal voltage while you push on a little screwdriver in the hole of the sensor. When you push on it the voltage will go up, and when you let go it will come down. What you need to do now is keep pushing a little harder each time you push, and sooner or later you will actually bend the diaphragm inside the sensor and the low voltage will be higher the more you bend the diaphragm. This is a neat way to recalibrate it, eh? Take your time doing this as you can't unbend it! Stop when the low voltage is just at or above the specs for your year truck, and the ECM will be happy to command fuel when it should. If the voltage is way too high, two things will happen. One is the ECM will get grumpy and defuel the VP44 when it sees too high a voltage at the high end, and two, if you have an electrical boost gauge, it will lie optimistically. So patience is a virtue here. The worst thing you could do here doing this, is ruin a bad sensor, and you will have to pay for a new one!

**IF KEY ON VOLTAGE IS HIGH ENOUGH,
THEN DO TEST TWO:**

Remember that the ECM wants to **only** see MAP signal voltage on 1998 - 2000 trucks between .5 and 1.74 volts and 1.0 to 2.2 volts on 2001 - 2002 trucks. If the signal voltage is outside of these parameters, a code 234 or 237 may be set, but for sure the ECM will cut back fuel delivery commands to the VP44 and make the engine run in a de-rated or "Limp" mode. To do this electrical test, make an extension wire connected to the grey with a red tracer wire, or MAP signal wire, at the sensor go up to any kind of voltmeter on the dash of the truck and DRIVE THE TRUCK. You

should see close to 1.74 volts on 2000 and older trucks, and close to 2.2 volts on 2001 - 2002 trucks when **driving under hard load and high RPM**, with NO power enhancement devices plugged in. If the voltages are within limits, then monitor the MAP signal voltage AT THE SAME PLACE ON THE FACTORY HARNESS, with the device(s) back in the system, and if still OK, then the MAP sensor or circuit is NOT the cause of Doggy on Take Off, and you have bad computer on your VP44. This is usually worse when cold, right after start up, in the morning.

RPM GOES UP ON ITS OWN, OR WAIT TO START LIGHT IS DUMB, OR THE SUPPLY VOLTAGE TO THE APPS AND MAP SENSORS IS ERRATIC OR OUT OF RANGE, OR YOU HAVE DELAYED 12V POWER TO THE LIFT PUMP AND INJECTION PUMP, OR YOU HAVE A 606 CODE

A few callers have remarked that the RPM goes up on its own, typically above idle, so we have them check that the voltage on the blue with a black tracer signal wire (on Dodges) coming from the APPS, doesn't go up when the RPM goes up, which confirms it is NOT the APPS. Do the same test if the engine tries to run away as soon as you step on the throttle. No it won't blow up. This test is described under "Dead Pedal" above. If the idle speed goes up on its own, or the RPM runs away when revving up off idle, AND you have a GOOD APPS, then you do have a bad ECM. If it revs up on its own from an idle, you can also do the "No Start" test three, and if it idles smoothly and at the same speed dependably, then it means the ECM is the cause of the problem. If it does it above idle, you'll have to read the APPS signal voltage when driving.

The other strange symptom or indicator of a bad ECM is when the truck won't start until the wait to start light goes out, or it comes on when driving, or when it shouldn't.

New for 2012 is a problem where the sensors that get their supply voltage from the ECM are lower or higher than the required 5.0 volts. SOME of the time a bad ECM with any of these symptoms will set a 606 code to make you feel more confident in your diagnosis!

Another new one for the summer of 2012 is delayed start, caused by the ECM delaying the signal voltage to the fuel system relay,

which is described in "Hard Start Hot....." above. Do that test and you will know if the ECM is to blame.

These are the only four symptoms that I have seen or heard of, SO FAR, that necessitates replacing or repairing the ECM. The good news is that these unique symptoms have been eliminated every time by repairing or replacing the ECM. You only need one of the symptoms described above to determine that the ECM is bad. The only other way to diagnose an ECM is to try a replacement, if diagnosing a Dodge. It doesn't seem to matter what transmission, year or engine rating the test ECM comes from, with or without a crank sensor, as long as the above symptoms go away with the borrowed test unit. I have had many callers do it this way, so I feel confident you won't hurt anything as long as you remember one thing, PLEASE. When installing any ECM, be SURE to ground it to the engine FIRST, before connecting the big plug. This prevents any problem from static electricity or a voltage spike getting into the ECM which can blow away the software and or computer inside. Yes the test ECM may set codes, but if it doesn't have the above symptoms any more, then you know a replacement or repaired ECM is in your future. I don't have any experience with Ford or Freightliner ECMs, which may indicate they are better quality, but they are very different and not interchangeable with Dodges as they have twice the number of wires going into them.

CONTAMINATED FUEL AND ALTERNATE FUELS

Lastly, is the internal Injection Pump damage caused from using any kind of WVO, more than 5% Biodiesel or contaminated pump fuel. The resulting corrosion causes the close tolerance parts inside to gall, seize or stick and cause drivability complaints, such as a low or high speed skip, low power cold, low power always, or no start. These problems can rarely be cured by some sort of fuel additive being put in the fuel AFTER the problem is observed.

These corrosion problems are the most common reason Bosch denies a warranty claim. Most often if there are drivability issues due to contaminated fuel, ALL the internal parts of the injection pump will be ruined and have to be thrown out, which usually means the pump is not worth rebuilding, and possibly not even eligible to be a core! These situations are so hard for me to deal with and explain to customers, because typically they don't know

they have a contaminated fuel issue until too late, when we open up the pump for warranty consideration, failure diagnosis, or repair.

HOW TO DIAGNOSE INDIVIDUAL COMPONENTS OF THE VP44 FUEL SYSTEM TO SEE IF THEY WORK CORRECTLY!

To test an **APPS SENSOR** to see if it is working properly, follow the directions exactly under "Dead Pedal" above.

The only way to diagnose an **INJECTION PUMP** is to read above. Don't forget you only need one symptom to condemn the injection pump! I get a few calls each month telling me they think it can't be the pump because when it runs it runs fine, or it ran when they shut it off. Oh,,,,, if only this were true!

To test an **ENGINE CONTROL MODULE** on the engine is impossible. The only way I know of to test an ECM is to swap it out with another to compare the operation of each one. As they fail very infrequently and ALL of them that I have found to be bad, have had at least one of the symptoms described above in the "RPM GOES UP ON ITS OWN OR WAIT TO START LIGHT IS DUMB..." section, I feel you can be very confident it IS a bad ECM if you have any ONE of the unique symptoms described above. A 606 code, MAY add credibility to your diagnosis.

A MAINFOLD AIR PRESSURE SENSOR, OR MAP OR BOOST SENSOR can be determined to be good or bad by doing the "Doggy on Takeoff....." tests above. Don't forget to check the supply voltage at the sensor, because if the supply voltage is low or high, the signal voltage will be low or high too!

INJECTORS can be accurately tested by removing them and having a qualified shop test them for pop off pressure, spray pattern, and fuel volume, to determine if they are within tolerance or very close to all being the same, which is what you want. If you have a skip at idle or at a specific RPM, and think it might be an injector, which is VERY VERY RARE with OEM injectors with up to a million miles on them, and can dependably demonstrate and maintain the RPM AND THE SKIP, loosen one injector line at the valve cover at a time with the skip occurring and when you crack a line where the RPM or sound doesn't change as much as another, THAT may be the problem injector. To be sure if it is the injector, and not some other mechanical gremlin, swap that injector with the one next to it and

retest. If the problem moves it IS the injector. If the problem stays with the same cylinder it is NOT the injector. If you have what I call a rolling skip, I mean one that seems to be one cylinder this time tested, and another next time, or is not clearly the same cylinder every time its line is loosened, that always means a bad injection pump, in the VP44 fuel system, if it is NOT air.

Complete **Lift Pump Diagnostics** are available on its own diagnostic page on the Home Page of www.bluechipdiesel.com

A great resource for wiring diagrams, connector locations, and general electrical and general diagnostic help, can be accessed from ALLDATAdiy.com for a truly reasonable price.

IN CLOSING

To all of you that have spoken with me over the many years to help me get this education and get me to this place, I humbly say THANK YOU!

If you DO or DON'T speak with me and you have a weird or rare symptom that I haven't described above or heard of before, PLEASE call me to share your frustration and or enlightenment so I can include it here, or share it with the next person that would benefit from YOUR experience. Let's help each other make this "The Authority", or the "GO TO" website.

It has taken me many dollars and 14 years to collect all the information here, research it, and prove what works efficiently and accurately. I hope you can learn almost as much as I know in only the time it takes to read this. I keep updating and or simplifying this as I get more experienced, in an effort to help my potential customers make accurate diagnostic and wise purchase decisions from reading this website. If you think you might need a replacement part or component, but aren't sure of, or want to confirm, your diagnosis after reading the above, or just want to hear it from "The Horse's Mouth", please feel free to call and I'll be happy to help you. Some days I am on the phone non-stop, seemingly forever, so please leave a message and I'll get back to you in the order that I receive the calls. Mondays and Fridays are the worst to get a hold of me, but I usually return all calls before I go home, which may be after hours a lot of times. My customers, or potential customers come first! It is my sincerest hope that readers of this MONUMENTAL document and website will feel obliged for all

the good information contained herein, and show their appreciation by becoming a customer.

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