

Dave Atherton's Seminar on CAT Engines

Jan 18, 2018, Jan 16, 2019

IF YOU NEED ASSISTANCE:

For Dave, or any CAT / Cummins diesel expert to assist you, there is information that can assist them in the diagnosis of an engine problem. Following are the items;

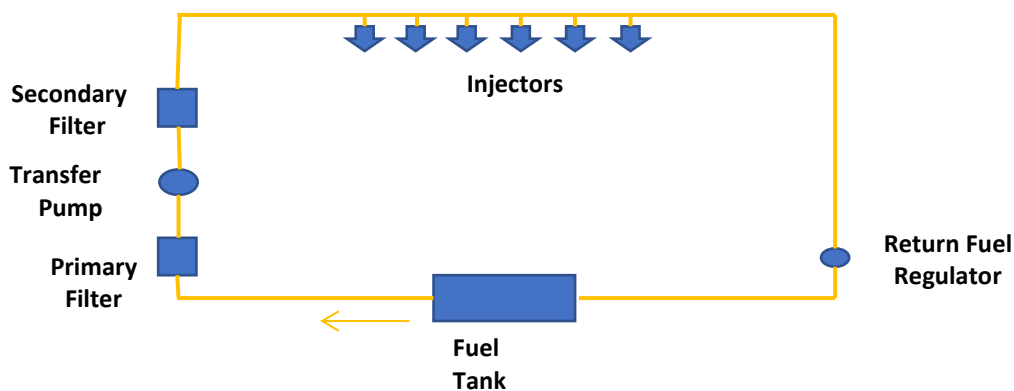
1. Engine model, Miles on engine, Engine serial # and model #. Both are available on the engine sticker in the engine compartment.
2. Color of exhaust smoke, e.g. white, blue, or black.
3. Engine symptoms; temperature, driving conditions, engine performance at time of failure, etc.
4. Location of coach; on road, at repair shop, etc.
5. Can coach be driven?

IMPORTANT OF OIL SAMPLES:

Oil sample diagnosis is like a blood test for your engine. It will tell you if the engine is experiencing normal or abnormal wear. Considering the cost of a new engine (~\$38,000) it is very economical preventive maintenance. 2 excellent sample services are CAT and Blackstone. Both provide a complete analysis and will track changes over time and successive samples. The sample is analyzed for metal content, liquid contaminants such as fuel and water, viscosity, etc.. The amount and type of metal will indicate where the wear is occurring; e.g aluminum=pistons and bearings, iron=cylinders, rotating shafts, etc.. Water or antifreeze=possible cracked head. The key is to pick a service and stick so you can track changes from sample to sample.

Both services supply sample bottles and accept mailed samples. Take the sample as the oil is being drained during a change. Try to get oil from "midstream" rather than the initial or final flow from the pan. One can also use a pump to pull oil from the pan via the fill tube. Sample analysis normally takes about a week. If your maintenance shop delivers the samples for analysis and interprets the results, it is suggested that you ask them for a copy of each report for your records.

FUEL SYSTEMS:



Simplified Fuel System diagram

Air in the fuel flow and lack of proper fuel volume to injectors are leading causes for lack of power and poor performance of a diesel engine. Air can enter the system at any of the connectors in the fuel line.

AIR IN FUEL SYSTEM:

If one suspects air is entering the fuel system, temporarily connect a clear line between the engine and the return line going back to the fuel tank. For 3126 and C9 engines, open up your hatch cover in bedroom and looking at the rear of the engine you will see a hex fitting on rear of the head about 4 inches long with a hose connected to the bottom of the hex fitting (this hex fitting is the return fuel pressure regulator). The hose connected to it returns fuel to the fuel tank. Disconnect the hose at hex fitting or regulator and connect a clear plastic hose about 12" long to the male end on the hex fitting. Put the other end of the hose in a container to collect the fuel.



C12 Engine (C9 regulator in same location)

Start the engine. The clear line should fill with fuel with no air bubbles. Run the engine at low, medium and high idle. If any bubbles are seen in the line, a leak is present.

Locating the Leak:

To locate the leak, temporarily attach a clear line between the fuel line from the tank and the input of the primary filter. If air is seen with the engine running, the leak is between the primary filter input and the tank. The fitting at the fuel tank is the only fitting in the line from the tank and is often the cause. On many coaches the connection between the fuel line and the tank fitting is a plastic material. This fitting is prone to leaking and should be replaced with a brass fitting. (On many coaches the tank may need to be dropped to access this fitting).

If no air is seen in this line when the engine is running, the leak is between the primary filter and the engine. Areas to check include fittings and O rings, especially at the filters. This link http://beaveramb.org/acadp_listings/cat-or-racor-primary-fuel-filter-system/ discussing CAT and Racor Fuel filters has a good description and pictures of air leaks at the fuel filter itself.

LOW FUEL FLOW:

The transfer pump on a C9 engine can be the cause of poor fuel volume delivered to the injectors.



The picture shows the impellers for C9 and C12 fuel pumps. Both engines are rated at 400 hp. The C9 impeller is .125 thick while the C12 is .500 thick. Consider that both pumps have to supply sufficient fuel to generate 400 hp. This is not poor C9 engineering on CAT's part. The C9 is designed to be less than 10 feet from the fuel tank. In motorhomes with the tank 30-35 feet from the pump, one can begin to understand the reason for degraded performance and why the electric fuel pump CAT #206-5756 is recommended to improve fuel flow and pressure for your C9. A writeup with instructions, parts list and a discussion of this modification is located on the BAC website Technical, Common Problems at http://beaveramb.org/acadp_listings/cat-electric-fuel-pump-installation/

FUEL PRESSURE:

Check fuel pressure at the base of the fuel filter. With the engine running at high idle, pressure should be ~90 PSI. If pressure is 75 PSI or lower, check the fuel supply in the tank. Verify the fuel tank cap vent and supply lines are open. Also verify that the return line is intact and not collapsed (can occur due to heat). Other causes can be a partially clogged fuel filter or faulty transfer pump (re: C9 discussion above).

If pressure is 100 PSI or greater, remove the return fuel regulator valve and clean it. Verify open orifices near the tip. Also check for a clogged fuel filter return line.

If low pressure on a C12; the C12 uses a gear type transfer pump to provide fuel to the injectors. This pump has a check valve that permits fuel to flow around it during manual priming and a pressure valve protect the system from over pressure. You should hear this valve clicking when manual priming. This valve sticking open will result in low pressure.

INJECTOR PROBLEMS:

Injectors deliver fuel to the cylinders. Failure will cause missing / low power or engine shutdown, depending on the severity of the problem. Many shops tend to replace injectors when the actual problem is air / fuel flow as previously discussed or a faulty electrical circuit in HEUI (3126-C9) engines. If the shop diagnosis a failed injector, consider requesting that they switch the electrical connections between the "failed" injector and an adjacent injector. If the fail stays with the "failed" injector, the problem is indeed at that injector. However, if the problem now occurs at the adjacent injector, the problem is with the electrical signal to the injector and not the injector itself.

When troubleshooting an injector related problem, service shops often remove the electrical connection but fail to check the connection or inspect the rubber boot that was designed to protect the connection. Since the connector is in the injector socket it gets soaked in hot engine oil, leading to failure at some point.

In the HEUI injection system, excess engine oil returns back to oil pan from top of the rocker assembly. Over time the little sealing boot that seals engine oil out of electrical connection at injector breaks down. The boot is only about ¼ inch and simply protects the interface where the connector is mated with the socket. The hot engine oil at the electrical connection pins can kill the electrical power to the injector. This will generate diagnostic code 164-11 (Injector Actuation Pressure Fault) on your Silver Leaf or Aladdin. (This fault may be intermittent due to the electrical connection making and breaking). Many shops will replace the injector since the code indicates a failed injector without ever checking the electrical connection.

Once the boot has failed, it cannot be re-used. The rubber boots cannot be bought without buying a wiring harness for injectors, which can get expensive. CAT does not supply the boots on current engines. There is an on-the-road repair that is fairly easy (and far less costly).

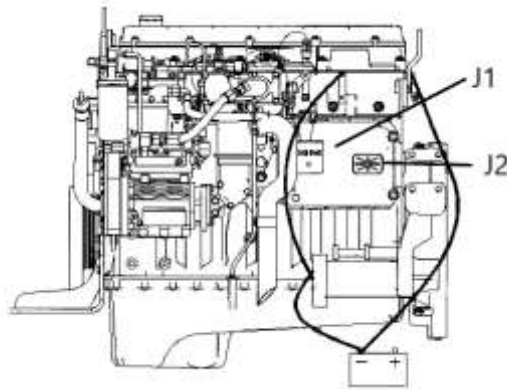
Remove the valve cover to access the injectors and electrical connectors at each injector. Disconnect the connector as shown in the first picture. Apply spray on brake cleaner to clean and dry the connectors, especially the pins and sockets. Next slide 2 small o-rings over the connector on the right (in first picture). This should result in a tight fit when the plug mates to the socket. The o-rings need to be tight enough to seal the gap. Then replace the metal clip and use zip ties (will break down over time) or mechanic's wire to hold the clip in place by connecting the tie/wire across the 2 loops of the clip on either side below the connector.



If one injector fails consider this fix to all injectors at that time. The injectors themselves are designed to run 300,000 miles without problems. This repair should cost you less than \$10 in parts.

ELECTRICAL PROBLEMS:

Many electrical problems can be caused by faulty ground connections. This diagram illustrates the proper ground



connections from the chassis batteries to the engine. Note there are 3 connections; battery to starter to engine block and battery directly to engine block. Be sure these are clean and tight.

The ECU has 2 connector receptacles, J1 and J2 (shown above). J1 is the output of the ECU and has a mating connector plug installed. J2 is the output for CAT diagnostic equipment. Over time these connections may get compromised by heat or oil due to the harsh environment. Check for tightness and consider cleaning with a good quality contact cleaner. Chassis battery voltage will be present at the ECU unless the battery cables are disconnected. The battery cut-off switch does not interrupt voltage to the ECU.

WASTE-GATE:

The Waste-Gate is a venting mechanism for the Turbo. If it fails, the Turbo can overheat and fail. There is a relatively easy check for proper operation. On a C9, the waste gate is located just behind the turbo (driver's side of engine). There is a tube that extends down from the waste gate that provides exhaust venting. Insert the end of the tube into a clear bottle with water in it while the engine is running. If you see bubbles, the waste gate is functioning. The only preventive maintenance recommended for the Waste-Gate is to coat the shaft with CAT Anti Seize lube.

CAT ENGINE UPGRADES:

Date	Engine	Upgrade #	Upgrade
6/16/2004	C7	294-8620	Fuel Pressure Regulator (replaces 229-8870). 90 micron screen elbow before regulator.
	C9	294-8621	Fuel Pressure Regulator (replaces 229-8871). 90 micron screen elbow before regulator.
1/12/2005		224-4536	Replace 194-6726 Injection Actuation Sensor.
1/10/2006	C9	284-5421	Water Temperature Small Regulator (thermostat). Replaced to omit "jiggle pin" on thermostat that could stick open, resulting in engine remaining in "cold mode".
1/7/2008	3126E, C7, C9		Fuel Transfer Pump Upgrade Kit
	3126E	326-1006	Replaces 178-2357
	C7	326-1007	Replaces 272-0617
	C9	206-5756	RV upgrade to Fuel Priming pump (24 volt Electric Fuel Pump) (See instructions elsewhere in "Common Problems")
1/9/2008	3126E, C7, C9		HEUI Pump Upgrade
		REHS-3844	Details of Upgrade
		REHS- 3819	Troubleshooting
12/23/10	3126 A-E, C7, C9	366-9748	Injector Wiring Harness (Replaces 156-7106). CAT Info SEBD-6845

ENGINE FAULT CODES:

Mech Code	Elec Code	CAT #	Function
108-01		161-1703	Atmosphere Pressure Sensor
102-00		161-1704	Boost Pressure Sensor not responding. Could be caused by 102-1,102-7, 32-05
102-3	32-05		
102-4	32-04		
102-7	32-03		
94-01		161-1705	Fuel Pressure Sensor
102-7		230-9944	Boost Pressure Regulator
100-1			Oil Pressure Sensor (Low Pressure)
164-1		32-05	Wastegate Solenoid Current Low
		32-06	Wastegate Solenoid Current High
164-11 42-11			3126-C9 Injection Actuation Pressure Fault
			C12 Injection Actuation Pressure Fault
			C10-C15 Injection Actuation Pressure Fault
164-02			Injection Actuation Signal Erratic

FILTERS:

CAT #	Engine	Function
1R-0751	3126 – C9	Fuel Filter
1R-0749	C10-C15	Fuel Filter
1R- 1808	C12	Oil Filter