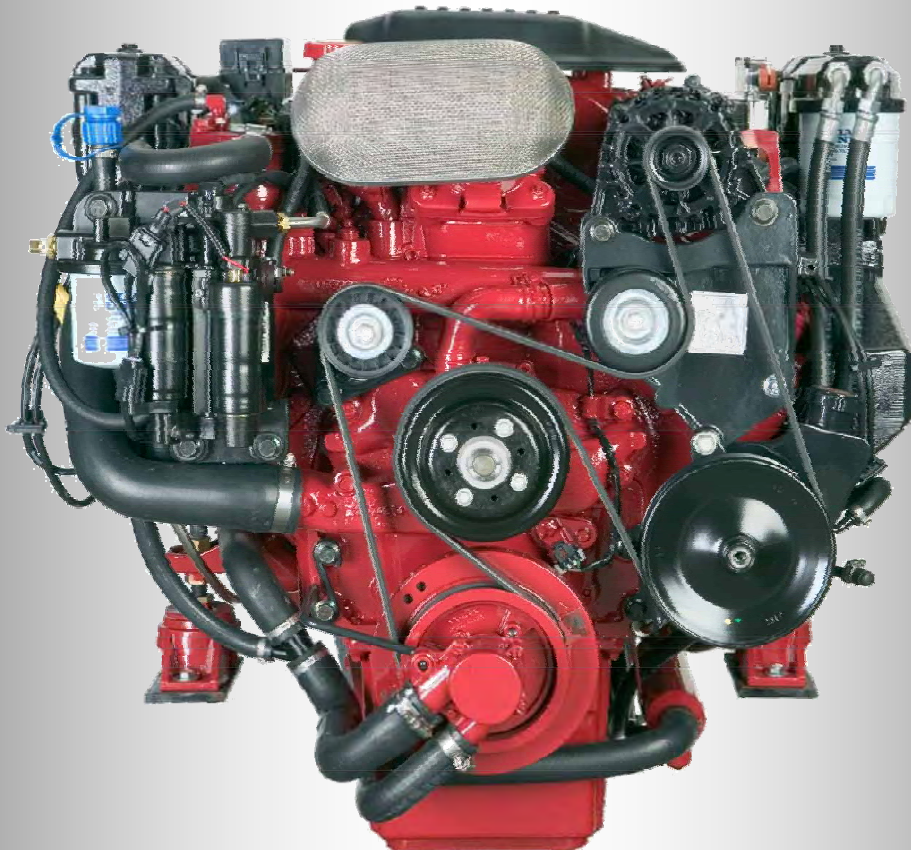


VOLVO PENTA



GAS ENGINE OVERHEAT DIAGNOSIS

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Overheat Diagnosis

Introduction

This short course is designed to assist the technician in the diagnosis of an EGC engine that has/is overheating.

Overheat Diagnosis

Six Step Troubleshooting Method

The six step troubleshooting method is a proven method that if used properly ensures that the problem is resolved in a timely and orderly manner. The steps are listed and explained below.

Step 1: Verify the customer's concern

Make sure that the customer's concern isn't a normal condition. If it is an abnormal condition, check for any stored overheat DTC's. Record the DTC number, name and the number of engine starts since the code last set. Take or test the boat and see if it overheats.

Step 2: Determine any related symptoms

Is there anything else happening at the same time that might be related and if so, how could it be related?

Does it only overheat when on a plane? Does it only overheat after a long run when pulled back to idle?

Step 3: Analyze the symptoms

How or do the symptoms relate? What are the possible causes?

Step 4: Isolate the problem

Use approved diagnostic methods and tests (such as clear hose testing) to arrive at a logical diagnosis. Ensure that you have found the "root cause" of the problem not just the damage that resulted from the problem.

Step 5: Repair the problem

Repair or replace the broken or damaged part or parts.

Step 6: Verify the repair

Re-run the boat under the same conditions that it failed previously to ensure that what you did fixed the problem. Nothing destroys customer confidence faster than having to make repeat visits to the repair shop to have the same problem "repaired" again.

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There is no set time that each one of these steps will take. Each problem is different. One problem may only take 5 minutes to get from step 1 to step 5, others may take hours.

Diagnostic Tips

At some point during the testing, the following items will have to be checked. The problem must be diagnosed before repairs are made. Do as much non-destructive testing as possible. Destructive testing is defined as: “let’s take the water pump apart and see if it looks ok”, or “let’s split the drive apart and see if the sealing between the two halves looks ok”. Non-destructive testing includes but is not limited to: installing clear hose to see water flow, installing a gauge on the engine block to see what pressure the cooling system has or using an infrared heat gun to find hot spots or a hot riser.

- **At some point, always check the raw water pump impeller for damage.**
 - The Volvo Penta maintenance schedule requires the raw water pump impeller be replaced every 50 operating hours or once per season, whichever comes first.
 - If the engine has overheated the odds are high that the impeller has suffered some kind of damage.
- **Check the ECM for DTC’s**
 - There are three different overheat DTC’s that could be stored in the ECM
 - All three are “never forget” codes
 - DTC 2428 EGT (exhaust gas temp) High
 - This code sets when riser switches close
 - DTC 0116 ECT higher than expected 1
 - This is a mild overheat
 - DTC 0217 ECT higher than expected 2
 - This indicates a serious overheat
 - The number of times the engine has been started (and run) since the DTC set is also recorded with the DTC

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- **Check the riser temperature switch circuit operation**
 - The circuit status can be viewed with the scan tool as “EGT Switch Input Volts”
 - 5 volts indicates that both switches are open. They are normally open switches that close when riser temp gets too hot.
 - 0 volts indicates that one or more of the switches is closed or the circuit is shorted to ground
 - Disconnect one switch at a time while watching the scan tool and see if the voltage returns to 5 volts
 - If both switches have to be disconnected before the voltage returns to 5 volts, then both switches are closed (overheat condition)
- **Inspect all hoses for cracks and/or loose hose clamps**
 - Scheduled maintenance requires that they be inspected and tightened every 50 hours
- **Ensure that the blue flush cap is secure and not leaking.**
 - A leak at this cap will cause an overheat condition because the raw water pump will suck air at this point.

Clear Hose Testing Equipment

The following equipment is needed for clear hose testing:

- 2 - 4” pieces of 1 ¼ ID, clear, reinforced hose.
- 2 - 3” pieces of 1” ID schedule 40 PVC pipe.
- 2 - 4” pieces of ¾” ID clear, reinforced hose.
- 2 - 2” pieces of ½ inch ID schedule 40 PVC pipe.
- Hose clamps to fit the 4 hoses (8 clamps total)
- 1 - 0-30psi pressure gauge plus fittings to connect to hose.
- 1 - 0-30”Hg vacuum gauge plus fittings to connect to hose.
- 9 to 10 feet of ¼ inch hose
- Two 1/8” NPT hose barbs (¼” hose)
- Shrink wrap tape or duct tape
- Hose pinch off pliers

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Clear Hose Setup (Pump)

Install the large clear hose and large PVC pipe, from the list above, as depicted in figure 1 below.



Figure 1 Installing Clear Hose at Raw Water Pump

This installation will allow the technician to see either water flow or air going into the pump or coming out of the pump. The gauges are used to see if there is proper pressure in the system.

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Clear Hose Setup (Engine)

Additional clear hose can be added between the thermostat housing and the exhaust riser(s) as shown in figure 2. This setup is useful in determining if there is air being injected in the cooling system from inside the engine.



Figure 2 Clear Hose Setup on the Engine

Gauge Readings at the Raw Water Pump

Pressure and vacuum readings should be taken with the vessel moving at idle and at 3000 rpm's. If equipped with an SX-M or DP-SM drive, readings should be between 2"-19"hg (vacuum) on the inlet and between 2-10 psi on the outlet (with the low reading being at idle and the high at 3000 rpm's). XDP-B drives should read between 1"-5"hg (vacuum) at the inlet and between 2-12 psi at the outlet.

Troubleshooting Raw Water Cooled Engines with Clear Hoses and Gauges

Start the engine and warm it up. Bring the RPM to a high idle. Look for air coming in or out of the raw water pump through the clear hoses. You can now determine if you have an air

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leak *before* the pump by seeing air present on the inlet side. If air bubbles are seen on the outlet side *only*, the seals in the seawater pump are drawing air.

If the pump impeller is slipping its hub, there would be no air in either clear hose but the inlet and the outlet pressure gauges would show a problem due to the low outlet pressure.

If the vacuum is high, there may be a restriction on the suction side. Inlet system flushing and inspection will need to be performed. If the vacuum is low and or there is air coming into the pump, then you will need to pressure test the pump's inlet system. If the outlet pressure is high, there could be a restriction in the pump's outlet system. Hoses, manifolds, risers or engine block could be the cause. The engine block may be full of sand from a grounding.

If there is no air in or out of the pump, but you have air coming out of the thermostat housing clear plastic hoses, the problem may be a leaking head gasket, cracked head or cracked block.

Before the engine gets disassembled looking for the cause, further nondestructive diagnostic testing must be done to determine the exact location of the problem. To do this, disconnect and tie up the two bypass hoses as shown in figure 3. Top off the water in the block through these hoses.



Figure 3 Preparing to Leak Check Engine

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Next, use a cylinder leakdown tester to pressurize each cylinder, one at a time, using the tester's operating instructions. As each cylinder is pressurized, watch the water level in the bypass hoses. If the water level rises when pressurizing a cylinder, then that cylinder is leaking compression into the cooling system. Be sure to conduct the test on all cylinders and record the results for future reference. If a leak is found during this test, engine disassembly will be required to pinpoint the exact cause of the leak.

Troubleshooting Closed Cooling System Engines with Clear Hoses and Gauges

One tool that can be used on this type of cooling system is a cooling system pressure tester (VP P/N 885531 or equivalent). This type of tester screws on in place of the reservoir cap (figure 4). **CAUTION: the reservoir operates under pressure and the contents are hot. Do not remove the cap from an engine that has been run recently. Serious injury could result.**



Figure 4 Reservoir Cap

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Once the tool has been installed, and the system has been refilled to half full in the reservoir, the cooling system can be pressurized with the tool and the gauge watched for any significant decrease in pressure. Rapid pressure drops indicate leaks. The leak(s) could be external, internal in the engine (cracked block), internal in the cooler or internal/external at any installed accessory.

This type of testing is good for finding low pressure leaks since the cooling system operates at less than approximately 11 psi (75 Kpa). This test will NOT reliably detect leaks between a cylinder and the cooling system. This type of leak results in cylinder compression leaking into the cooling system while the engine is running.

The proper test to find this type of leak is to hook up a cylinder leakdown tester to each cylinder, one at a time, and conduct a leakdown test while watching the coolant level in the reservoir (with the cap removed and the reservoir half full). As air is applied to the cylinder any leak into the cooling jacket will result in air being pushed into the cooling jacket. This will cause a rise in coolant level in the reservoir. If the coolant level rises when pressurizing a cylinder, then that cylinder is leaking compression into the cooling system. Be sure to conduct the test on all cylinders and record the results for future reference.

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Water Inlet System Flushing

If the engine has overheated or if the raw water pump has been disassembled and the impeller has been found to be missing pieces, the pump inlet system should be flushed. To do this, remove the inlet hose from the raw water pump and from the power steering cooler as in figure 5. Then attach a garden hose as shown in figure 6, open the water valve for the hose slightly and allow water to flow. Any pieces of impeller that have fallen into the inlet hose will be flushed out into the bilge. Once this hose has been cleared of any debris the hose can then be reconnected at the power steering cooler and now the drive can be flushed.

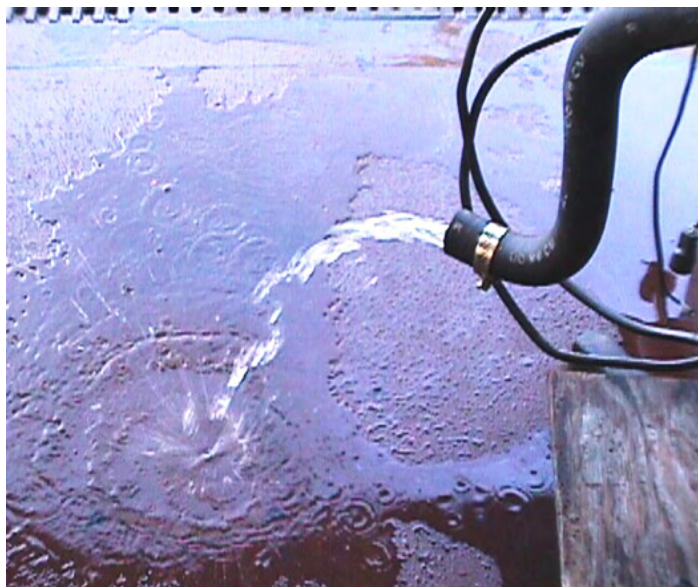


Figure 5 Inlet Hose Disconnected From P/S Cooler

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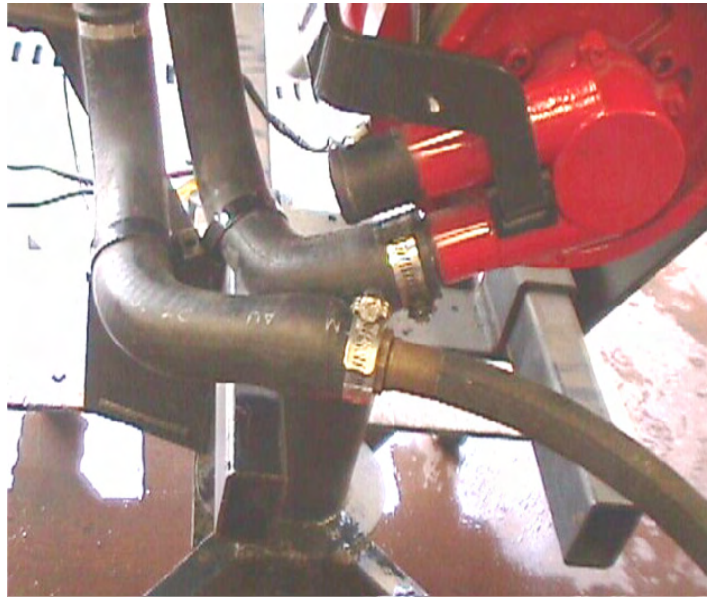


Figure 6 Pump Inlet Hose Hookup for Flushing

When flushing the drive it may be necessary to remove the cleanout cover on DP-SM or SX-M drives to check for any foreign debris or to ensure that the flushing was successful (see figure 7). Ensure that the cover is properly resealed during cover reinstallation.

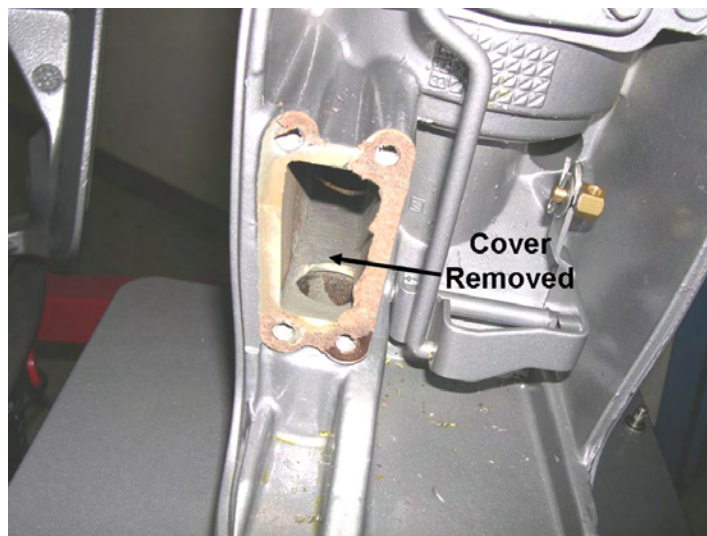


Figure 7 SX-M/DP-SM Drive Cleanout Cover

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Water Inlet System Testing

If during the initial testing air was found to be entering the inlet system, then that leak must be found. To find this leak disconnect the raw water pump inlet hose and connect a water hose as shown in figure 6. Tape off the water inlets on the lower drive housing in a fashion similar to that shown in figure 8. Crack open the faucet for the water hose, you don't want to apply full water system pressure into the hose as the high pressure may damage components. Just fill the inlet system with water under a slight pressure and look for water escaping. Anywhere water escapes, air can get sucked in by the raw water pump.



Figure 8 Drive Inlet Ports Taped Off (Duct or Shrink Wrap Tape)

Leak Checking and Flow Checking Exhaust Manifolds and Risers

Exhaust risers and exhaust manifolds can become plugged and cause overheating. They can also crack and or leak at the riser gasket. These leaks can either leak externally into the engineroom or they can leak internally into the exhaust stream. If they leak into the exhaust stream, the water ends up in the cylinder. To flush a riser, disconnect the raw water line feeding the riser and allow the water to drain from the manifold. Then using a freshwater hose, connect the hose to the riser cooling water inlet previously disconnected and flush the manifold and riser. Periodically remove the hose and let the water flow out of the manifold backwards to help dislodge any debris that may be trapped in the manifold.

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Leak checking the manifolds and risers is done in a similar fashion. Either, remove all the spark plugs from the side of the engine to be tested or loosen the manifold from the cylinder head and then flow water through the manifold with a freshwater hose as discussed earlier. If any water accumulates in the cylinder or runs down the exhaust passage inside the manifold, then there is a leak that needs to be fixed. Either the manifold is leaking at the gasket surface between the manifold and the riser or one of the two components is cracked. Repair or replace accordingly.

Conclusion

Hopefully this course has given you some useful tips to help diagnose engine overheats. Remember, these are guidelines and not all of these tests may be need to be performed. Always use logical and methodical diagnostic processes to determine the root cause of the overheat problem not just the damage done by the overheat. Each test result will dictate which and if any further tests are needed. Always follow Volvo Penta approved repair procedures.
