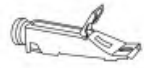


Powertrain Secondary Cooling

Special Tool(s)

 E144764	3-Way HD Antifreeze Coolant Test Kit 328-2050-62291 or equivalent
 E144765	Coolant/Battery Refractometer ROB75240 or equivalent
 E144766	Radiator Tester 014-R1072 or equivalent

Diagnostic Trouble Code (DTC) Chart

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.
REFER to: Diagnostic Methods (100-00 General Information, Description and Operation).

Diagnostic Trouble Code Chart

Module	DTC	Description	Action <i>New: hover over Pinpoint Test links to show title</i>
PCM	P007C:00	Charge Air Cooler Temperature Sensor Circuit Low (Bank 1): No Sub Type Information	GO to Pinpoint Test C
PCM	P007D:00	Charge Air Cooler Temperature Sensor Circuit High (Bank 1): No Sub Type Information	GO to Pinpoint Test B
PCM	P2184:00	Engine Coolant Temperature Sensor 2 Circuit Low: No Sub Type Information	GO to Pinpoint Test C
PCM	P2185:00	Engine Coolant Temperature Sensor 2 Circuit High: No Sub Type Information	GO to Pinpoint Test B

Inspection and Verification

NOTICE: The engine cooling system is filled with Motorcraft® Yellow Antifreeze/Coolant. Always fill the cooling system with the manufacturer's specified coolant. Chemically flush the cooling system if a non-specified coolant has been used. Failure to follow these instructions may damage the engine or cooling system.

NOTICE: During normal vehicle operation, coolant can change color. As long as the engine coolant is clear and uncontaminated, this color change does not indicate the engine coolant has degraded nor does it require the engine coolant to be drained, the system to be flushed, or the engine coolant to be replaced.

1. Verify the customer concern.
2. Visually check the engine coolant level at the degas bottle when the system is cold.

3. Make sure the pressure relief cap is installed correctly.
4. Record any cooling system Diagnostic Trouble Codes (DTCs) retrieved. Refer to the PCM DTC chart in this section for DTC descriptions.
5. **NOTE:** *Take note of any coolant odor or steam coming from cooling system components.*

If the system coolant is filled correctly and no Diagnostic Trouble Codes (DTCs) associated with overheating are retrieved, verify the customer concern by operating the engine to duplicate the condition.
6. Visually inspect for obvious signs of any mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Leaks or weeps at: • Hoses • Tubes • Clamp joints • Quick connect couplings • Gaskets • O-rings • Thermostat housing • Radiator • Pressure relief cap • Coolant pump • Degas bottle • CAC • Fuel cooler • Air compressor • Cracked or damaged: • Hoses • Tubes • Hose clamps • Quick connect couplings • Thermostat housing • Radiator • Pressure relief cap • Coolant pump • Degas bottle • CAC • Fuel cooler	• Inoperative or damaged: • ECT sensor - secondary cooling system ECT 2 • Charge Air Cooler Temperature (CACT) sensor

7. If the inspection reveals an obvious concern that can be readily identified, repair it as necessary.
8. Test the coolant.
REFER to: Coolant Test (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, General Procedures).
9. If an obvious cause for an observed or reported concern is found, correct the cause and test the system for normal operation before proceeding to the next step.

Symptom Chart

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.
REFER to: Diagnostic Methods (100-00 General Information, Description and Operation).

Condition	Possible Sources	Actions
Loss of coolant	Refer to the Pinpoint Test	GO to Pinpoint Test A
The engine overheats.	Refer to the Pinpoint Test	GO to Pinpoint Test B
The engine does not reach normal operating temperature.	Refer to the Pinpoint Test	GO to Pinpoint Test C

Pinpoint Tests

PINPOINT TEST A : LOSS OF COOLANT

Normal Operation and Fault Conditions

The secondary cooling system is a closed system that provides for coolant expansion and contraction and also changes in pressure as coolant warms and cools with engine operation. Various gaskets, seals, hoses and clamps are used to contain coolant within the cooling system and keep other fluids and contaminants from entering the cooling system.

Coolant loss can be attributed to either external or internal leaks anywhere within the cooling system.

Possible Sources

- Coolant hoses or tubes
- Hose clamps
- Thermostat O-ring seal or gasket
- Coolant pump O-ring seal or gasket
- Thermostat housing
- Radiator
- Pressure relief cap
- Coolant pump leaking from weep hole
- Degas bottle
- CAC
- Fuel cooler
- ECT sensor - secondary cooling system ECT 2

WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

A1 CARRY OUT INSPECTION AND VERIFICATION

- Carry out Inspection and Verification.

Are any concerns present?

Yes	REPAIR as needed.
No	GO to A2

A2 CHECK THE COOLANT LEVEL

NOTE: Allow the engine to cool before checking the engine coolant level.

- Ignition OFF
- Visually inspect the engine coolant level at the degas bottle.

Is the coolant level within specifications?

Yes	GO to A3
No	ADJUST the coolant level as necessary. GO to A3

A3 PRESSURE TEST THE POWERTRAIN SECONDARY COOLING SYSTEM

NOTE: Allow the engine to cool before checking the engine coolant level.

- Pressure test the cooling system. Refer to Component Tests, Cooling System Pressure Test in this section.

Does the cooling system leak externally?

Yes	REPAIR or INSTALL new components.
No	ADJUST the coolant level as necessary. GO to A4

A4 CHECK THE COOLANT FOR FUEL

- Inspect the coolant in the degas bottle for signs of fuel.

Is fuel evident in the coolant?

Yes	INSTALL a new fuel cooler. REFER to: Fuel Cooler (310-01B Fuel Tank and Lines - 6.7L Power Stroke Diesel, Removal and Installation).
No	GO to A5

A5 CHECK FOR COOLANT IN THE FUEL

- Drain the fuel from the fuel conditioning module and check for coolant in the fuel.

Is coolant evident in the fuel?

Yes	INSTALL a new fuel cooler. REFER to: Fuel Cooler (310-01B Fuel Tank and Lines - 6.7L Power Stroke Diesel, Removal and Installation).
No	The cooling system is operational.

A6 CHECK THE CAC (CHARGE AIR COOLER) FOR AN INTERNAL LEAK

- CARRY OUT the CAC leak test.
REFER to: Charge Air Cooler (CAC) Leak Test (303-12B Intake Air Distribution and Filtering - 6.7L Power Stroke Diesel, General Procedures).

Does the CAC leak?

Yes	INSTALL a new CAC. REFER to: Charge Air Cooler (CAC) (303-12B Intake Air Distribution and Filtering - 6.7L Power Stroke Diesel, Removal and Installation).
No	The cooling system is operational.

☐ [PINPOINT TEST B : THE ENGINE OVERHEATS](#)

Normal Operation and Fault Conditions

The secondary cooling system maintains temperatures in the CAC and the fuel cooler during operation. Correct coolant flow through the radiator and the remaining components of the system is essential to maintaining correct temperatures.

Coolant flows primarily from the coolant pump to the radiator circuit and then to the CAC and the fuel cooler from the thermostat. The coolant flows from each component to the degas bottle and then back to the coolant pump. The coolant pump is operated by engine rotation through a pulley which is driven by the accessory drive belt to circulate the coolant. The coolant thermostat is a control valve actuated by coolant temperature. When the thermostat is closed, coolant flow bypasses the radiator circuit and flows to the cooling components. When the thermostat is opened, coolant is allowed to flow through the radiator circuit in order to transfer component-generated heat to the outside air.

System overheating generally occurs when there is a disruption in the ability to control either coolant flow at the proper rate, the inability to transfer heat from the cooling components through the coolant (including low coolant) or an inability to transfer component-generated heat to the outside air through the radiator.

DTC Fault Trigger Conditions

DTC	Description	Fault Trigger Condition
PCM P2185:00	Engine Coolant Temperature Sensor 2 Circuit High: No Sub Type Information	Indicates higher than expected coolant temperature as the coolant flows out of the radiator.
PCM P007D:00	Charge Air Cooler Temperature Sensor Circuit High (Bank 1): No Sub Type Information	Indicates a higher than expected air temperature as the air flows out of the CAC.

Possible Sources

- Low coolant level
- Pressure relief cap installation
- Restricted airflow through A/C condenser/radiator
- Coolant condition/concentration
- Accessory drive components
- Non-OEM engine enhancement components
- Thermostat
- ECT sensor - secondary cooling system ECT 2
- Charge Air Cooler Temperature (CACT) sensor
- Coolant pump
- Coolant flow restriction

B1 CARRY OUT INSPECTION AND VERIFICATION

- Carry out the Inspection and Verification procedure in this section.

Are any concerns present?

Yes	REPAIR as needed.
No	GO to B2

B2 CHECK FOR PCM (POWERTRAIN CONTROL MODULE) DTCS

- Ignition ON.
- Using a scan tool, perform PCM self-test.

Is DTC P007D or P2185 present?

Yes	GO to B3
No	Actual engine overheating has not been verified. If any other PCM DTCs are retrieved, REFER to: Electronic Engine Controls (303-14B Electronic Engine Controls - 6.7L Power Stroke Diesel, Diagnosis and Testing).

B3 CHECK FOR NON-OEM ENGINE ENHANCEMENT COMPONENTS

- Ignition ON.
- Check the engine for any non-OEM components.

Are there any non-OEM components on the engine?

Yes	ADVISE the customer the engine modifications may be causing the secondary cooling system to overheat.
No	GO to B4

B4 CHECK FOR AN AIRFLOW OBSTRUCTION

- Check the radiator or A/C condenser for an obstruction such as leaves or cardboard.

Is an obstruction present?

Yes	REMOVE the obstruction.
No	GO to B5

B5 CHECK THE ENGINE COOLANT LEVEL

NOTE: Allow the engine to cool before checking the coolant level.

- Ignition OFF.
- Visually check the system coolant level in the degas bottle.

Is DTC P007D or P2185 present?

Yes	GO to B6
No	ADJUST the coolant level as necessary. GO to B6

B6 PRESSURE TEST THE COOLING SYSTEM

- Pressure test the cooling system. Refer to Component Tests, Cooling System Pressure Test in this section.

Does the cooling system leak?

Yes	REPAIR or INSTALL new components.
No	GO to B7

B7 CHECK THE ENGINE COOLANT FOR AN INTERNAL LEAK

- Inspect the engine coolant in the degas bottle for signs of fuel or transmission fluid.

Is fuel evident in the coolant?

Yes	If fuel is evident, INSTALL a new fuel cooler. REFER to: Fuel Cooler (310-01B Fuel Tank and Lines - 6.7L Power Stroke Diesel, Removal and Installation).
No	GO to B8

B8 CHECK THE FUEL FOR COOLANT

- Drain the fuel from the fuel conditioning module. Remove the oil level indicator from transmission.

Is coolant evident in the fuel?

Yes	INSTALL a new fuel cooler. REFER to: Fuel Cooler (310-01B Fuel Tank and Lines - 6.7L Power Stroke Diesel, Removal and Installation).
No	GO to B9

B9 CHECK THE CAC (CHARGE AIR COOLER) FOR AN INTERNAL LEAK

- Carry out the CAC leak test.
REFER to: Charge Air Cooler (CAC) Leak Test (303-12B Intake Air Distribution and Filtering - 6.7L Power Stroke Diesel, General Procedures).

Is engine oil evident in the coolant?

Yes	INSTALL a new CAC. REFER to: Charge Air Cooler (CAC) (303-12B Intake Air Distribution and Filtering - 6.7L Power Stroke Diesel, Removal and Installation).
No	GO to B10

B10 CHECK COOLANT CONDITION

- Carry out the coolant test.
REFER to: Coolant Test (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, General Procedures).

Is the coolant condition OK?

Yes	GO to B11
No	FLUSH the cooling system. REFER to: Powertrain Secondary Cooling System Flushing - With Fuel Contamination (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, General Procedures). REFER to: Powertrain Secondary Cooling System Flushing - Without Fuel Contamination (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, General Procedures).

B11 CHECK THE COOLANT PUMP OPERATION

- Start the engine.
- Observe the coolant in the degas bottle. The coolant should flow through the bottle. Compare the coolant flow to a known good vehicle.

Does the coolant flow through the degas bottle?

Yes	GO to B12
No	INSTALL a new coolant pump. REFER to: Coolant Pump (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, Removal and Installation).

B12 CHECK THE THERMOSTAT OPERATION

- Start the engine.
- For DTC P007D and P2185 allow the engine to run for 10 minutes. Feel the coolant pump-to-radiator hose at the LH inlet, and the radiator-to- CAC and fuel cooler hose.

Are the hoses approximately the same temperature?

Yes	GO to B13
No	The system is operational. CHECK the operation of the CACT sensor and the ECT sensor - secondary cooling system ECT 2. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.

B13 VISUALLY INSPECT THE THERMOSTAT

- Carry out the Thermostat Visual Inspection in the Component Tests portion of this section.

Is the thermostat damaged?

Yes	INSTALL a new thermostat. REFER to: Thermostat (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, Removal and Installation).
No	GO to B14

B14 CHECK THE COOLING FAN CLUTCH OPERATION

- Ignition OFF.
- Check the cooling fan clutch operation. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.

Is the cooling fan clutch operation OK?

Yes	INSTALL a new radiator. REFER to: Radiator (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, Removal and Installation).
No	INSTALL a new fan clutch. REFER to: Cooling Fan (303-03B Engine Cooling - 6.7L Power Stroke Diesel, Removal and Installation).

PINPOINT TEST C : THE ENGINE DOES NOT REACH NORMAL OPERATING TEMPERATURE

Normal Operation and Fault Conditions

The secondary cooling system maintains temperatures in the CAC and the fuel cooler during operation. Correct coolant flow through the radiator and the remaining components of the system is essential to maintaining correct temperatures.

Coolant flows primarily from the coolant pump to the radiator circuit and then to the CAC and the fuel cooler from the thermostat. The coolant flows from each component to the degas bottle and then back to the coolant pump. The coolant pump is operated by engine rotation through a pulley which is driven by the accessory drive belt to circulate the coolant. The coolant thermostat are control valves actuated by coolant temperature. When the thermostat is closed, coolant flow bypasses the radiator circuit and flows to the 3 cooling components. When the thermostat is opened, coolant is allowed to flow through the radiator circuit in order to transfer component-generated heat to the outside air.

Concerns of an inability to reach normal operating temperature typically occur when the rate of coolant flow through the radiator is more than expected given the conditions. Heat is not allowed to build in the system because a heat exchanger is removing too much heat, including the radiator, CAC , fuel cooler, or transmission fluid cooler.

DTC Fault Trigger Conditions

DTC	Description	Fault Trigger Condition
PCM P2184:00	Engine Coolant Temperature Sensor 2 Circuit Low: No Sub Type Information	Indicates lower than expected coolant temperature as the coolant flows out of the radiator.
PCM P007C:00	Charge Air Cooler Temperature Sensor Circuit Low (Bank 1): No Sub Type Information	Indicates a lower than expected air temperature as the air flows out of the CAC.

Possible Sources

- Low coolant level
- Thermostat

WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

C1 CARRY OUT INSPECTION AND VERIFICATION

- Carry out the Inspection and Verification procedure in this section.

Were any concerns found?

Yes	REPAIR as needed.
No	GO to C2

C2 CHECK FOR DTC P007C OR P2184

- Check for DTCs P007C or P2184.

Is DTC P007C or P2184 present?

Yes	GO to C3
No	The cooling system is operational.

C3 CHECK THE COOLANT LEVEL

NOTE: Allow the engine to cool before checking the coolant expansion tank.

- Visually check the engine coolant level in the coolant expansion tank

Is the engine coolant level within specification?

Yes	INSTALL a new thermostat. REFER to: Thermostat (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, Removal and Installation).
No	GO to Pinpoint Test A

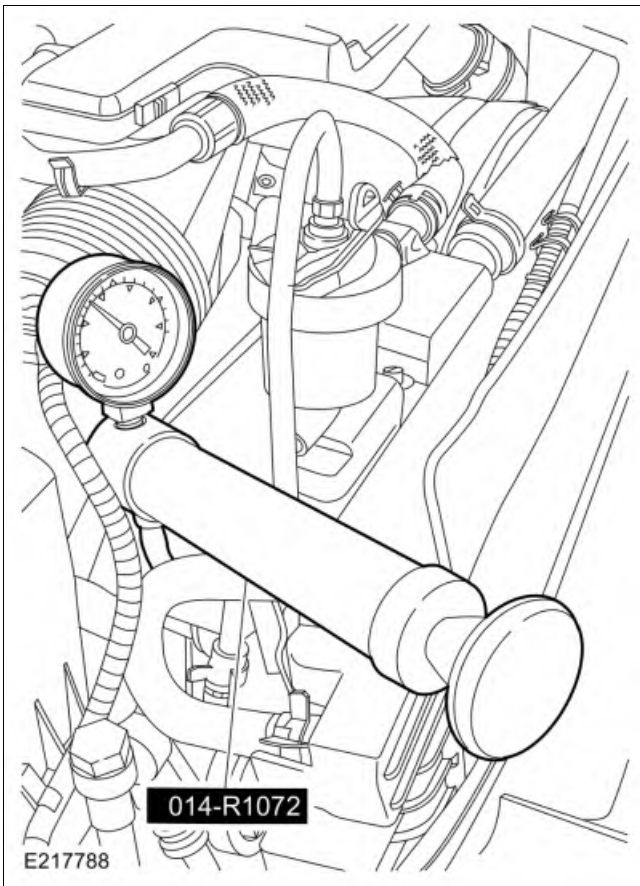
Component Tests

Cooling System Pressure Test

⚠ **WARNING:** Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

NOTE: Vehicles have a pressure relief cap on the degas bottle and no radiator cap.

1. Turn the engine OFF.
2. Check the coolant level. Adjust the coolant level as necessary.



3. Fit the Radiator/Heater Core Pressure Tester from the Pressure Test Kit to the degas bottle fill opening using the correct adapter.

NOTICE: Do not pressurize the cooling system beyond the maximum pressure listed in the specifications table in this section, or cooling system components can be damaged.

NOTE: If the plunger of the pressure tester is pressed too fast, an erroneous pressure reading will result.

4. Pressurize the cooling system to the maximum allowed pressure and hold for 2 minutes. If the pressure drops within this time, inspect for leaks and repair as necessary.
5. If no leaks are found detach the CAC outlet pipe from the CAC and inspect for leaks at the bottom of the CAC. Repair as necessary.
6. If no leaks are found at the CAC , the leak may be internal to the transmission fluid cooler. Check for transmission fluid in the coolant and for coolant in the transmission fluid. Repair as necessary.
7. If no transmission fluid was found in the coolant and no coolant found in the transmission fluid, the leak may be internal to the fuel cooler. Check the coolant for fuel and the fuel in the fuel conditioning module for coolant. Repair as necessary.
8. If no fuel is found in the coolant and no coolant is found in the fuel, the leak may be in the CAC , but too small for coolant to be noticeable at the bottom of the CAC . Leak test the CAC . For additional information, refer to Section 303-12. Repair as necessary.
9. Release the system pressure and remove the Radiator/Heater Core Pressure Tester from the Pressure Test Kit. Check the coolant level and adjust as necessary.

Thermostat

Install a new thermostat only after at least one of the following tests and checks have been carried out:

- Pinpoint Test B or C
- Thermostat Visual Inspection

Thermostat Visual Inspection

1. Remove the thermostat.
REFER to: Thermostat (303-03C Powertrain Secondary Cooling - 6.7L Power Stroke Diesel, Removal and Installation).
2. **NOTE:** The low temperature thermostat starts to open at 20Â°C (68Â°F), therefore the valve may not be fully seated at room temperature.

NOTE: The high temperature thermostat starts to open at 45Â°C (113Â°F), therefore the valve may not be seated if the ambient temperature is at or over this temperature.

- Valve not fully seated (light visible through the valve)
- Foreign material lodged in the main valve
- Bent or broken frame or flange
- Bent or broken spring
- Wax leaking from wax reservoir or a bulge in the reservoir
- Any other damage or distortion

3. **NOTE:** If no damage is found during the inspection, do not attempt to open the thermostat using hot water or other heat sources. This method is not an accurate means to test the function of the thermostat and may damage the thermostat.

If damage is found during the inspection, remove any foreign material or broken pieces and install a new thermostat.

4. If no damage is found during the inspection, continue troubleshooting the system concern. Go to the Symptom Chart for further instructions.

Radiator Leak Test, Removed From Vehicle

NOTICE: Never leak test an aluminum radiator in the same water that copper/brass radiators are tested in. Flux and caustic cleaners may be present in the cleaning tank and they will damage aluminum radiators.

NOTE: Clean the radiator before leak testing to avoid contamination of tank.

1. Leak test the radiator in clean water with air pressurized to the maximum pressure listed in the Specifications table.
-