Engine Cooling

Specifications

Temperature Versus Resistance

°C	°F	Sensor Resistance
Temperature vs Resistance Values (Approximate)		
100	212	155
90	194	208
80	176	283
70	158	392
60	140	552
50	122	793
45	113	958
40	104	1165
35	95	1425

Temperature Versus Resistance (cont'd)

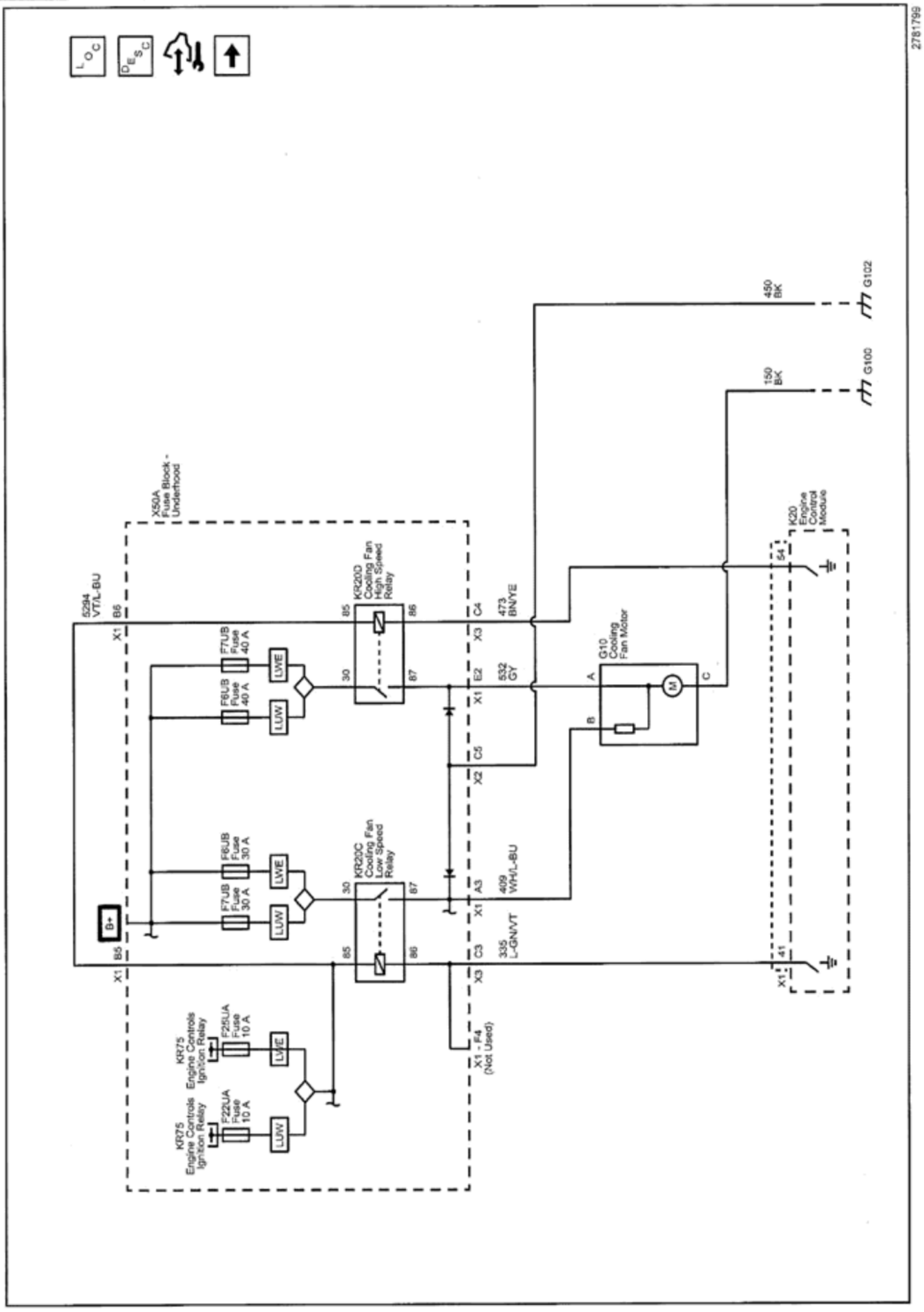
°C	°F	Sensor Resistance
30	86	1755
25	77	2176
20	68	2717
15	59	3428
10	50	4356
5	41	5578
0	32	7198
−5	23	9362
−10	14	12278
−15	5	16229
−20	−4	21653
−30	−22	39631
−40	−40	75532

Fastener Tightening Specifications

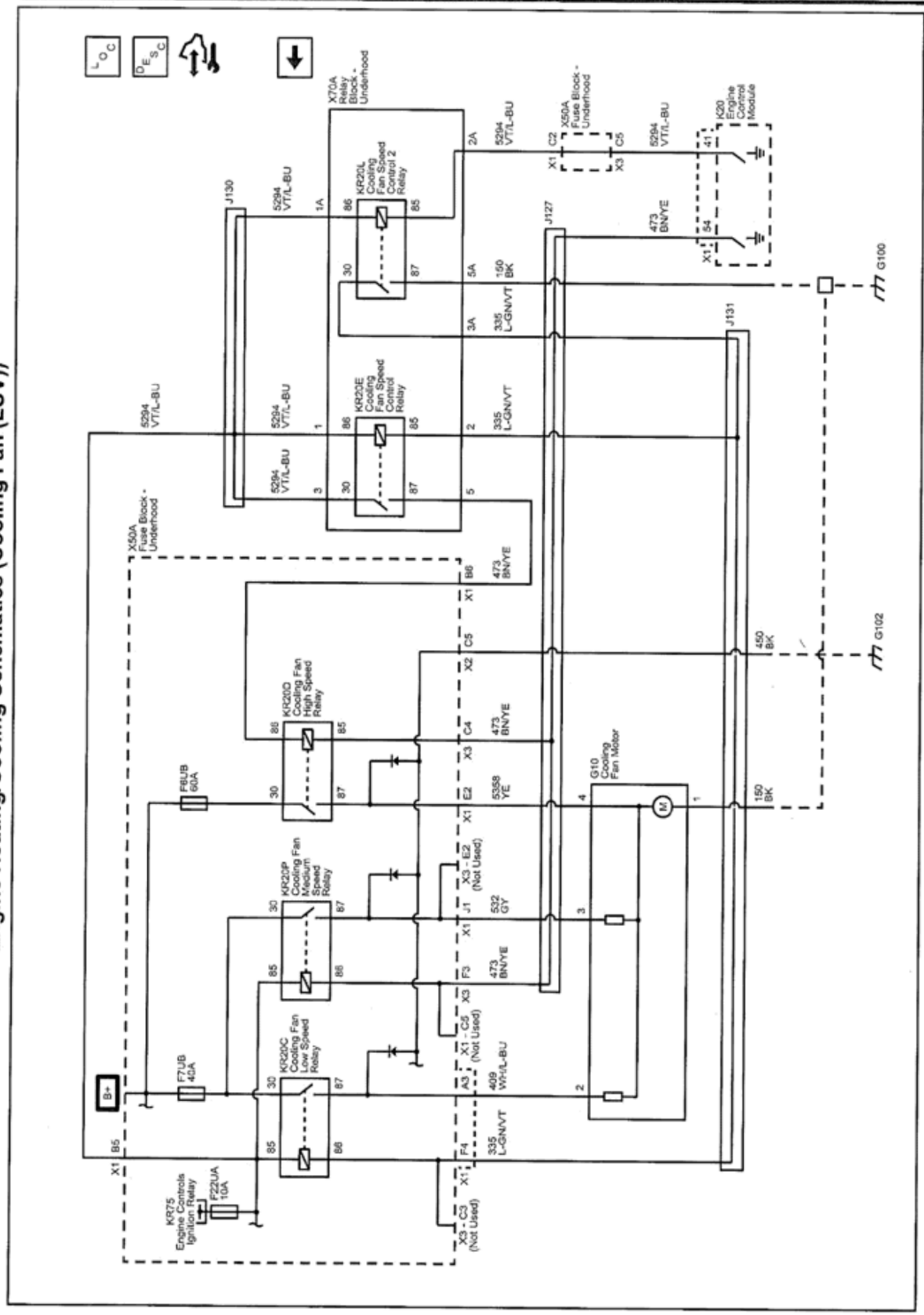
Application	Specification	
	Metric	English
Engine Coolant Fan Engine Bolts	4 N•m	35 lb in
Engine Coolant Thermostat Housing Bolts	8 N•m	71 lb in
Engine Coolant Thermostat Housing Bracket Nut	6 N•m	53 lb in
Engine Oil Cooler Assembly Bolts	25 N•m	19 lb ft
Engine Oil Cooler Bolts	20 N•m	15 lb ft
Engine Oil Cooler Inlet Pipe Bolt	10 N•m	89 lb in
Engine Oil Cooler Outlet Pipe Bolt	8 N•m	71 lb in
Engine Oil Cooler Outlet Pipe Mounting Bolts to ECM bracket to Water Pump Housing	8 N•m	71 lb in
Engine Oil Cooler Pipe Bolts	8 N•m	71 lb in
Engine Oil Cooler Pipe to Thermostat Housing Bolts	8 N•m	71 lb in
Oil Cooler Outlet Pipe Bolt to Engine Block	10 N•m	89 lb in
Oil Pressure Indicator Switch	20 N•m	15 lb ft
Radiator Drain Cock	2 N•m	18 lb in
Radiator Mounting Pin Bolt	5 N•m	44 lb in
Radiator Upper Bracket Fastener	9 N•m	80 lb in
Turbocharger Coolant Return Pipe Bolt	10 N•m	89 lb in
Turbocharger Fastener	8 N•m	71 lb in
Water Inlet Bolts	8 N•m	71 lb in
Water Inlet Pipe Mounting Fasteners	9 N•m	80 lb in
Water Outlet Bolts	8 N•m	71 lb in
Water Pump Bolt	8 N•m	71 lb in
Water Pump Pulley Bolts	22 N•m	16 lb ft
Water Pump Pulley Bolts	20 N•m	15 lb ft

Schematic and Routing Diagrams

Engine Heating/Cooling Schematics (Cooling Fan (LUW or LWE))



Engine Heating/Cooling Schematics (Cooling Fan (LUV))



Diagnostic Information and Procedures

DTC P00B3 or P00B4

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptors

DTC P00B3: Radiator Coolant Temperature (RCT) Sensor Circuit Low Voltage
DTC P00B4: Radiator Coolant Temperature (RCT) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P00B3	P00B4	P00B4*	P00B6
Low Reference	—	P00B4	—	P00B6
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Radiator Coolant Temperature Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running in Closed Loop **Parameter Normal Range:** Varies with ambient temperature			
Signal	140°C (284°F)	−40°C (−40°F)	−40°C (−40°F)*
Low Reference	—	−40°C (−40°F)	—
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The radiator coolant temperature (RCT) sensor is a variable resistor that measures the temperature of the engine coolant in the radiator. The engine control module (ECM) supplies 5 volts to the RCT signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

RCT	RCT Resistance	RCT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

P00B3

- The engine run time is greater than 10 seconds.
- The intake air temperature (IAT) is colder than 70° C (158°F).
- The DTC runs continuously when the above conditions are met.

P00B4

- The engine run time is greater than 60 seconds.
- The intake air temperature (IAT) is warmer than −7°C (19°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P00B3

The ECM detects that the RCT sensor is warmer than 149°C (300°F) for greater than 10 seconds.

P00B4

Note: The scan tool only displays to −40°C (−40°F).

The ECM detects that the RCT sensor is colder than −60°C (−76°F) for greater than 10 seconds.

Action Taken When the DTC Sets

DTC P00B3 and P00B4 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTC P00B3 and P00B4 are Type B DTCs.

Diagnostic Aids

- As the thermostat opens, the RCT sensor temperature should rise steadily, then stabilize once the thermostat opens completely.
- Test the RCT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor.
- If the vehicle has sat for greater than 8 hours, the RCT sensor and the ECT sensor values should display within 3°C (5°F).

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-314

Connector End View Reference

Component Connector End Views on page 11-269

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions on page 6-68

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is between −39 to + 120°C (−38 to +248°F) and changes with engine run time.

⇒ **If not between −39 to + 120°C (−38 to +248°F) or does not change**

Refer to Circuit/System Testing.

⇓ **If between −39 to + 120°C (−38 to +248°F) and changes**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to Circuit/System Testing.

⇓ **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B34B Engine Coolant Temperature Sensor harness connector. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.

⇒ **If 5 Ω or greater**

2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2.2. Test for less than 2 Ω in the low reference circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the K20 Engine Control Module.

⇓ **If less than 5 Ω**

3. Ignition ON.
4. Verify the scan tool RCT Sensor parameter is colder than −39°C (−38°F).

⇒ **If warmer than −39°C (−38°F)**

4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

4.2. Test for infinite resistance between the signal circuit terminal 2 and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K20 Engine Control Module.

⇓ **If colder than -39°C (-38°F)**

5. Ignition OFF, Install a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1.
6. Ignition ON, Verify the scan tool Radiator Coolant Temperature sensor parameter is warmer than 137°C (280°F).

⇒ **If colder than 137°C (280°F)**

6.1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.

6.2. Ignition ON, Test for less than 1 V between the signal circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V

6.3. Ignition OFF

6.4. Test for less than 2 Ω in the signal circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the K20 Engine Control Module.

⇓ **If warmer than 137°C (280°F)**

7. Test or replace the B34B Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34B Engine Coolant Temperature Sensor.
2. Test for refer to *Temperature Versus Resistance on page 9-597* between the signal circuit terminal 2 and the low reference terminal 1.

⇒ **If the temperature versus resistance are not within the specified ranges**

Replace the B34B Engine Coolant Temperature Sensor.

⇓ **If the temperature versus resistance are within the specified ranges**

3. Test for infinite resistance between each terminal and the sensor housing.

⇒ **If less than infinite resistance**

Replace the B34B Engine Coolant Temperature Sensor.

⇓ **If infinite resistance**

4. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

- *Engine Coolant Temperature Sensor Replacement (Water Outlet) on page 9-244* or *Engine Coolant Temperature Sensor Replacement (Thermostat) on page 9-246* or *Engine Coolant Temperature Sensor Replacement (Radiator) on page 9-245*
- *Engine Control Module Replacement on page 9-531* for ECM replacement, setup, and programming

DTC P00B6

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptor

DTC P00B6: Radiator Coolant Temperature (RCT)–Engine Coolant Temperature (ECT) Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Coolant Temperature Sensor Signal	P00B3	P00B4	P00B4*	P00B6
Low Reference	—	P00B4	—	P00B6
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Radiator Coolant Temperature Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running in Closed Loop **Parameter Normal Range:** Varies with ambient temperature			
Coolant Temperature Sensor Signal	140°C (284°F)	−40°C (−40°F)	−40°C (−40°F)*
Low Reference	—	−40°C (−40°F)	−40°C (−40°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The engine coolant temperature sensor is a variable resistor that measures the temperature of the engine coolant in the radiator. The engine control module (ECM) supplies 5 volts to the engine coolant temperature signal circuit and supplies a ground to the low reference circuit. The purpose of this diagnostic is to determine if the input from the RCT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the engine is OFF. If the required engine OFF time is met at start-up, the ECM will compare the temperature difference between the actual measured RCT and ECT sensors.

The following table illustrates the difference between temperature, resistance, and voltage:

RCT	RCT Resistance	RCT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

- DTCs P00B3, P00B4, P00B6, P0112, P0113, P0117, P0118, P0502, P0503 or P2610 are not set.
- The vehicle has been OFF for greater than 8 hours before vehicle ON.
- The vehicle is ON, or the engine is running.
- The intake air temperature (IAT) is warmer than −7°C (19°F).
- The fuel level is greater than 10 percent.
- The DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM determines the absolute difference of temperature between the RCT start up temperature and ECT start up temperature is greater than 20°C (68°F) .

Action Taken When the DTC Sets

DTC P00B6 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P00B6 is a Type B DTC.

Diagnostic Aids

- As the thermostat opens, the radiator coolant temperature sensor signal should rise steadily, then stabilize once the thermostat opens completely.
- Inspect for the correct operation of the engine cooling system and verify the correct coolant level.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-314

Connector End View Reference

Component Connector End Views on page 11-269

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions on page 6-68

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Engine running, observe the DTC information with a scan tool. DTC P00B3, P00B4, P0117, P0118, P0597, P0598, or P0599 should not be set.
   ⇒ If a DTC is set, refer to *Diagnostic Trouble Code (DTC) List - Vehicle on page 6-69* for further diagnosis.
2. Verify the coolant in the radiator surge tank is at the correct level and there are no engine coolant leaks. Refer to *Cooling System Draining and Filling on page 9-628* and *Loss of Coolant on page 9-625*.
3. Engine idling for 15 minutes with the A/C OFF.

Note: Depending on ambient temperature, it may take up to 4 minutes for the temperatures to equalize.

4. Command the engine coolant thermostat heater to 100 percent with a scan tool. Increase the engine speed to 3,000 RPM. Observe the scan tool radiator coolant temperature sensor and ECT sensor parameters. The radiator coolant temperature sensor and the ECT sensor parameters should be within 20°C (68°F).
5. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

Circuit/System Testing

1. Vehicle OFF, disconnect the harness connector at the B34B engine coolant temperature sensor.
2. Vehicle OFF, all systems OFF. This may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
   ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 engine control module.
3. Vehicle ON, verify the scan tool Radiator Coolant Temperature Sensor parameter is at −40° C (−40°F).
   ⇒ If warmer than the specified range, test the signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the K20 engine control module.

Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Install a 1 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1. Verify the scan tool Radiator Coolant Temperature Sensor parameter is at 140° C (284°F).
   ⇒ If less than specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 engine control module.
5. If all circuits test normal, test or replace the B34B engine coolant temperature sensor.

Component Testing

1. Vehicle OFF, remove the B34B engine coolant temperature sensor.

Note: A thermometer can be used to the used to test the sensor off the vehicle.

2. Test the engine coolant temperature sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the *Temperature Versus Resistance on page 9-597* table and verify that the resistance is within 5 percent of the specification.
   ⇒ If not within the specified range, replace the B34B engine coolant temperature sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

- *Engine Coolant Temperature Sensor Replacement (Water Outlet) on page 9-244* or *Engine Coolant Temperature Sensor Replacement (Thermostat) on page 9-246* or *Engine Coolant Temperature Sensor Replacement (Radiator) on page 9-245*
- *Engine Control Module Replacement on page 9-531* for ECM replacement, setup, and programming

DTC P00B7

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptors

DTC P00B7: Engine Coolant Flow Insufficient

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Coolant Temperature Sensor Signal	P00B3	P00B4	P00B4*	P00B6
Low Reference	—	P00B4	P00B4*	P00B6
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Radiator Coolant Temperature Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running in Closed Loop **Parameter Normal Range:** Varies with ambient temperature			
Radiator Coolant Temperature Sensor Signal	140°C (284°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	—	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The engine control module (ECM) monitors the temperature of the engine radiator coolant. The ECM controls the thermostat with a pulse width modulated (PWM) signal. The ECM compares the radiator coolant temperature to the engine coolant temperature in order to determine if there sufficient coolant flow through the thermostat.

Conditions for Running the DTC

- DTCs P00B3, P00B4, P00B6, P0116, P0117, and P0118 are not set.
- The engine run time is greater than 5 m.

  OR
- The engine coolant temperature is greater than 105°C (221°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

Note: The scan tool display range is between -40 and + 150°C (-40 and +302°F).

The ECM detects the difference between the RCT sensor and the ECT sensor is greater than 30°C (86°F) when the ECT sensor is warmer than 117°C (242°F) for greater than 5 s.

Action Taken When the DTC Sets

DTC P00B7 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P00B7 is a Type B DTC.

Diagnostic Aids

- The thermostat has a mechanical fail-safe in case of an electrical condition with the thermostat heater. The mechanical thermostat will open at approximately 80°C (176°F). The mechanical thermostat will cycle from approximately 85°C (185°F) to approximately 102°C (215°F).
- A resistance condition in the RCT sensor circuits may cause this DTC. This condition results in a greater voltage on the RCT sensor signal circuit, which is interpreted by the ECM as a colder RCT.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-314

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*

- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions on page 6-68

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Engine Running, observe the DTC information with a scan tool. DTC P00B3, P00B4, P00B6, P0117, P0118, P0597, P0598, and P0599 should not be set.
   ⇒ If a DTC is set, refer to *Diagnostic Trouble Code (DTC) List - Vehicle on page 6-69* for further diagnosis.
2. Verify the coolant in the radiator surge tank is at the correct level and there are no engine coolant leaks. Refer to *Cooling System Draining and Filling on page 9-628* and *Loss of Coolant on page 9-625*.
3. Verify the engine cooling fan operates. Refer to *Cooling Fan Inoperative (LUV) on page 9-620* or *Cooling Fan Inoperative (LUW, LWE) on page 9-623*.
4. Engine idling for 15 minutes with the A/C OFF.

Note: Depending on ambient temperature, it may take up to 4 minutes for the temperature to decrease less than the specified value.

5. Command the Engine Coolant Thermostat Heater to 100 percent with a scan tool. Increase the engine speed to 3,000 RPM. Observe the scan tool ECT sensor parameter. The temperature should decrease to less than 85°C (185°F).
6. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

Circuit/System Testing

1. Vehicle OFF, inspect the cooling system for the conditions below. Refer to *Symptoms - Engine Cooling on page 9-617*.
   - Weak coolant solution
   - Obstructed radiator air flow or bent radiator fins
   - Blocked cooling system passages
   - Radiator hoses that are restricted, collapsed, or deteriorated
   - Damaged water pump and or belt
   - Loss of cooling system pressure
     – Leaking surge tank cap
     – Radiator hoses
   - Cylinder head or an engine block that is cracked or plugged

   ⇒ If you find any of the above conditions, repair as necessary.
2. If all conditions test normal, replace the E41 engine coolant thermostat heater.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

Engine Coolant Thermostat Replacement (LUV) on page 9-661 or *Engine Coolant Thermostat Replacement (LUW) on page 9-662*

DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUW, LWE)

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480: Cooling Fan Relay 1 Control Circuit
DTC P0481: Cooling Fan Relay 2 Control Circuit
DTC P0691: Cooling Fan Relay 1 Control Circuit Low Voltage
DTC P0692: Cooling Fan Relay 1 Control Circuit High Voltage
DTC P0693: Cooling Fan Relay 2 Control Circuit Low Voltage
DTC P0694: Cooling Fan Relay 2 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Voltage Supply	—	P0480, P0481	—	—
Relay Switch B+	1	1	—	—
KR20C Cooling Fan Low Speed Relay Control	P0691	P0480	P0692, 3	—
KR20D Cooling Fan High Speed Relay Control	P0694	P0481	P0694, 3	—
Relay Controlled Output	1	1	2	—

1. Fans inoperative without a DTC.
2. Fans always ON without a DTC.
3. The ECM must be commanding the relay ON in order for the DTC to set.

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, 2 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes 1 resistor mounted in the cooling fan shroud. This combination of components enables the ECM to operate the cooling fan at 2 speeds using two fan control circuits. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. The ECM will operate the cooling fan at either Low or High speed based on the cooling requirements.

Conditions for Running the DTC

- The ignition voltage is 11–18 volts.
- The engine speed is 400 RPM or greater.
- The ECM has commanded the output driver ON and OFF at least once during the ignition cycle.
- The DTCs run continuously when the conditions above are met.

Conditions for Setting the DTC

The commanded state of the ECM driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates the fan at low speed
  - Cooling Fan Relay 2 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics on page 9-598

Connector End View Reference

- *Component Connector End Views on page 11-269*
- *Electrical Center Identification Views on page 11-240*

Description and Operation

Cooling Fan Description and Operation (LUV) on page 9-679 or *Cooling Fan Description and Operation (LWE, LUW) on page 9-680*

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions on page 6-68

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify an audible click is heard or felt from each cooling fan relay when commanding the cooling fan ON and OFF with a scan tool.

⇒ **If a click is not heard or felt at each of the relays**

Refer to Circuit/System Testing.

⇓ **If a click is heard or felt at each of the relays**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to Circuit/System Testing.

⇓ **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the cooling fan relays listed below:
   - KR20C Cooling Fan Low Speed Relay
   - KR20D Cooling Fan High Speed Relay

Note: The following test must be performed on each of the relay coil ignition circuits.

2. Ignition ON, verify that a test lamp illuminates between the relay coil ignition circuit terminal listed below and ground:
   - KR20C Cooling Fan Low Speed Relay terminal 86
   - KR20D Cooling Fan High Speed Relay terminal 86

⇒ **If the test lamp does not illuminate**

2.1. Ignition OFF, remove the test lamp.

2.2. Test for less than 2 Ω in the ignition circuit of the appropriate cooling fan relay, end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

⇒ **If the test lamp does not illuminate and the circuit fuse is open**

2.1. Ignition OFF, remove the test lamp.

2.2. Test for infinite resistance between the relay coil ignition circuits listed below and ground:
   - KR20C Cooling Fan Low Speed Relay terminal 85
   - KR20D Cooling Fan High Speed Relay terminal 85

⇒ If less than infinite resistance, repair the short to ground in the circuit.

⇒ If infinite resistance, test all of the appropriate cooling fan relays for a shorted condition and replace as necessary.

⇓ **If the test lamp illuminates**

3. Ignition OFF, remove the test lamp, ignition ON.

Note: The following tests must be performed on the two fan relay control circuits.

4. Connect a DMM, set on the diode setting, between a control circuit terminal listed below and ground:
   - KR20C Cooling Fan Low Speed Relay terminal 86
   - KR20D Cooling Fan High Speed relay terminal 86

5. Verify the DMM reading is greater than 2.5 V or displays O.L.

⇒ **If 2.5 V or less**

5.1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.

5.2. Test for infinite resistance between the appropriate relay coil control circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K20 Engine Control Module.

⇓ **If greater than 2.5 V or displays O.L.**

Note: The following test must be performed on the two fan relay circuits.

6. Verify the DMM reading is less than 1 V when commanding the Cooling Fan Relays ON with a scan tool.

⇒ **If 1 V or greater**

6.1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.

6.2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V.

6.3. Ignition OFF.

6.4. Test for less than 2 Ω in the appropriate cooling fan relay control circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the K20 Engine Control Module.

⇓ **If less than 1 V**

7. Test or replace the appropriate cooling fan relay.

Component Testing

1. Ignition OFF.
2. Disconnect a cooling fan relay.
3. Test for 70–110 Ω between terminals 85/2 and 86/1 of the cooling fan relay.

⇒ **If less than or greater than the specified range**

Replace the cooling fan relay.

⇓ **If within the specified range**

4. Test for infinite resistance between following terminals:
   - 30/3 and 86/1
   - 30/3 and 87/5
   - 30/3 and 85/2
   - 85/2 and 87/5

⇒ **If less than infinite resistance**

Replace the cooling fan relay.

⇓ **If infinite resistance**

5. Install a 20 A fused jumper wire between relay terminal 85/2 and 12 V.
6. Install a jumper wire between relay terminal 86/1 and ground.
7. Test for less than 2 Ω between terminals 30/3 and 87/5.

⇒ **If 2 Ω or greater**

Replace the cooling fan relay.

⇓ **If less than 2 Ω**

8. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the repair.

- *Relay Replacement (Within an Electrical Center) on page 11-607* or *Relay Replacement (Attached to Wire Harness) on page 11-607*
- *Control Module References on page 6-3* for ECM replacement, programming, and setup

DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUV)

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480: Cooling Fan Relay 1 Control Circuit
DTC P0481: Cooling Fan Relays 2 and 3 Control Circuit
DTC P0691: Cooling Fan Relay 1 Control Circuit Low Voltage
DTC P0692: Cooling Fan Relay 1 Control Circuit High Voltage
DTC P0693: Cooling Fan Relays 2 and 3 Control Circuit Low Voltage
DTC P0694: Cooling Fan Relays 2 and 3 Control Circuit High Voltage

Diagnostic Fault Information

KR20C Cooling Fan Low Speed Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480, P0481, P0691, P0693	1	—	—
Relay Switch B+	1	1	—	—
Relay Coil Control	2	1	1	—
Relay Controlled Output	1	1	2	—

1. Low speed fan inoperative without a DTC.
2. Low speed fan always ON without a DTC.

KR20D Cooling Fan High Speed Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480, P0481, P0691, P0693	2	1	—
Relay Switch B+	2	2	—	—
Relay Control	P0693	P0481	P0694	—
Relay Controlled Output	2	2	3	—

1. Medium speed fan replaced by high speed fan without a DTC.
2. High speed fan inoperative without a DTC.
3. High speed fan always ON without a DTC.

KR20E Cooling Fan Speed Control Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480, P0481, P0691, P0693	1	—	—
Relay Switch Ignition	P0480, P0481, P0691, P0693	1	—	—
Relay Coil Control	2	1	—	—
Relay Controlled Output	P0480, P0481, P0691, P0693	1	3	—

KR20E Cooling Fan Speed Control Relay (cont'd)

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
1. High speed fan inoperative without a DTC. 2. Low speed fan always ON without a DTC. 3. Medium speed fan inoperative without a DTC.				

KR20F Cooling Fan Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480, P0481, P0691, P0693	P0480	—	—
Relay Switch Ignition	1	2	—	—
Relay Control	P0691	P0480	P0692	—
Relay Controlled Output	—	2	—	—
1. Low speed fan always ON without a DTC. 2. Low speed fan and high speed fan inoperative.				

KR20P Cooling Fan Medium Speed Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480, P0481, P0691, P0693	P0481	—	—
Relay Switch B+	1	1	—	—
Relay Control	P0693	P0481	P0694	—
Relay Controlled Output	1	1	2	—
1. Medium speed fan inoperative without a DTC. 2. Medium speed fan always ON without a DTC.				

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two resistors. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

Conditions for Running the DTC

- The ignition voltage is 11 volts or greater.
- The ECM has commanded the output driver ON and OFF at least once during the ignition cycle.
- The DTCs run continuously when the conditions above are met.

Conditions for Setting the DTC

The commanded state of the ECM driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the DTC Sets

- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs – LUV.
- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type C DTCs – LUJ.

Conditions for Clearing the MIL/DTC

- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs – LUV.
- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type C DTCs – LUJ.

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the scan tool Cooling Fan Relay Command parameters to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates the fan at a low speed
  - Cooling Fan Relay 2 and 3 operates the fan at a medium speed
  - Cooling Fan Relay 1, 2 and 3 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics on page 9-598

Connector End View Reference

- *Component Connector End Views on page 11-269*
- *Electrical Center Identification Views on page 11-240*

Description and Operation

Cooling Fan Description and Operation (LUV) on page 9-679 or *Cooling Fan Description and Operation (LWE, LUW) on page 9-680*

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions on page 6-68

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify an audible click is heard or felt from each cooling fan relay when commanding the cooling fan ON and OFF with a scan tool.

⇒ **If a click is not heard or felt at each of the relays**

Refer to Circuit/System Testing.

⇓ **If a click is heard or felt at each of the relays**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to Circuit/System Testing.

⇓ **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the cooling fan relays listed below:
   - KR20F Cooling Fan Relay
   - KR20P Cooling Fan Medium Speed Relay
   - KR20D Cooling Fan High Speed Relay

Note: The following test must be performed on each of the relay coil ignition circuits.

2. Ignition ON, verify that a test lamp illuminates between ground and the relay coil ignition circuit terminal listed below:
   - KR20F Cooling Fan Relay terminal 85
   - KR20P Cooling Fan Medium Speed Relay terminal 86

⇒ **If the test lamp does not illuminate and the fuse is good.**

2.1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Remove the fuse that supplies ignition voltage to the coil side of the cooling fan relays.

2.2. Test for less than 2 Ω between the ignition circuit terminal of the appropriate cooling fan relay and the fuse.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

⇒ **If the test lamp does not illuminate and the circuit fuse is open**

2.1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.

2.2. Test for infinite resistance between the relay coil ignition circuits listed below and ground:
   - KR20F Cooling Fan Relay terminal 85
   - KR20D Cooling Fan High Speed Relay terminal 86/1

⇒ If less than infinite resistance, repair the short to ground in the circuit.

⇒ If infinite resistance, test all of the appropriate cooling fan relays for a shorted condition and replace as necessary.

⇓ **If the test lamp illuminates**

3. Ignition OFF, remove the test lamp, ignition ON.

Note:

- The following tests must be performed on all three fan relay control circuits.
- The Red test lead should be connected to the control circuit.

4. Connect a DMM, set on the diode setting, between a control circuit terminal listed below and ground:
   - KR20F cooling fan relay terminal 86
   - KR20P cooling fan medium speed relay terminal 85
   - KR20D cooling fan high speed relay terminal 85/2

5. Verify the DMM reading is greater than 2.5 V or displays O.L.

⇒ **If 2.5 V or less**

5.1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector X1 at the K20 Engine Control Module.

5.2. Test for infinite resistance between the appropriate relay coil control circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K20 Engine Control Module.

⇓ **If greater than 2.5 V or displays O.L.**

Note: The following test must be performed on all three fan relay circuits.

6. Verify the DMM reading is less than 1 V when commanding the Cooling Fan Relays ON with a scan tool.

⇒ **If 1 V or greater**

6.1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.

6.2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V.

6.3. Ignition OFF.

6.4. Test for less than 2 Ω in the appropriate cooling fan relay control circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the K20 Engine Control Module.

⇓ **If less than 1 V**

7. Test or replace the appropriate cooling fan relay.

Component Testing

1. Ignition OFF.
2. Disconnect a cooling fan relay.
3. Test for 70–110 Ω between terminals 85/2 and 86/1.

⇒ **If less than or greater than the specified range**

Replace the cooling fan relay.

⇓ **If within the specified range**

4. Test for infinite resistance between the following terminals:
   - 30/3 and 86/1
   - 30/3 and 87/5
   - 30/3 and 85/2
   - 85/2 and 87/5

⇒ **If less than infinite resistance**

Replace the cooling fan relay.

⇓ **If infinite resistance**

5. Install a 20 A fused jumper wire between relay terminal 85/2 and 12 V.
6. Install a jumper wire between relay terminal 86/1 and ground.
7. Test for less than 2 Ω between terminals 30/3 and 87/5.

⇒ **If 2 Ω or greater**

Replace the cooling fan relay.

⇓ **If less than 2 Ω**

8. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

- *Relay Replacement (Within an Electrical Center) on page 11-607* or *Relay Replacement (Attached to Wire Harness) on page 11-607*
- *Control Module References on page 6-3* for ECM replacement, setup, and programming

DTC P0597-P0599

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptor

DTC P0597: Engine Coolant Thermostat Heater Control Circuit
DTC P0598: Engine Coolant Thermostat Heater Control Circuit Low Voltage
DTC P0599: Engine Coolant Thermostat Heater Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Voltage	P0031, P0037, P0135, P0141, P0443, P0597, P0598*, P0660, P0661	P0031, P0037, P0135, P0141, P0443, P0597, P0598*, P0660, P0661	—	—
Thermostat Control Circuit	P0458, P0598	P0597	P0599	—
*Opens the fuse that supplies voltage to the engine coolant thermostat				

Circuit/System Description

The engine control module (ECM) controls the pulse width modulated (PWM) thermostat. The thermostat controls coolant flow and regulates the engine operating temperature. Ignition voltage is supplied directly to the thermostat through a fuse. The ECM controls the thermostat by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTCs

- The ignition is ON, or the engine is running.
- The DTCs run continuously once the above condition is met

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 15 seconds.

Action Taken When the DTC Sets

- DTCs P0597, P0598, and P0599 are Type B DTCs.
- The engine control module commands the engine cooling fans ON.

Conditions for Clearing the DTC

DTCs P0597, P0598, and P0599 are Type B DTCs.

Diagnostic Aids

- A low engine coolant level could cause the thermostat heater to overheat and set a DTC.
- The thermostat has a mechanical fail-safe in case of an electrical condition with the thermostat heater. The mechanical thermostat will open at approximately 80°C (176°F). The mechanical thermostat will cycle from approximately 85°C (185°F) to approximately 102°C (215°F).

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-314

Connector End View Reference

Component Connector End Views on page 11-269

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions on page 6-68

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Verify the coolant in the radiator surge tank is at the correct level and there are no engine coolant leaks.*Loss of Coolant on page 9-625* and *Cooling System Draining and Filling on page 9-628*

⇒ **If the coolant level is not correct**

Repair as necessary

⇓ **If the coolant level is correct**

2. Ignition ON
3. Verify the parameters listed below do not display Malfunction when commanding the Engine Coolant Thermostat Heater ON and OFF with a scan tool.
   - Engine Coolant Thermostat Heater Control Circuit Low Voltage Test Status
   - Engine Coolant Thermostat Heater Control Circuit Open Test Status
   - Engine Coolant Thermostat Heater Control Circuit High Voltage Test Status

⇒ **If Malfunction is displayed**

Refer to Circuit/System Testing.

⇓ **If Malfunction is not displayed**

4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTC does not set.

⇒ **If any DTC sets**

Refer to Circuit/System Testing.

⇓ **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the E41 Engine Coolant Thermostat Heater, Ignition ON.
2. Verify that a test lamp illuminates between the ignition circuit terminal 2 and ground.

⇒ **If the test lamp does not illuminate and the circuit fuse is good**

2.1. Ignition OFF, remove the test lamp.

2.2. Test for less than 2 Ω in the ignition circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω verify the fuse is not open and there is voltage at the fuse.

⇒ **If the test lamp does not illuminate and the circuit fuse is open**

2.1. Ignition OFF, remove the test lamp.

2.2. Test for infinite resistance between the ignition circuit and ground

⇒ If less than infinite resistance, repair the short to ground in the circuit.

⇒ If infinite resistance, test all the components connected to fuse and replace as necessary.

⇓ **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition circuit terminal 2 and the control circuit terminal 1.

⇒ **If the test lamp illuminates**

3.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

3.2. Test for infinite resistance between the control circuit and ground.

⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇒ If infinite resistance, replace the K20 Engine Control Module.

⇓ **If the test lamp does not illuminate**

4. Remove the test lamp, command the E41 Engine Coolant Thermostat Heater ON with a scan tool.
5. Verify the scan tool E41 Engine Coolant Thermostat Heater Control Circuit High Voltage Test Status parameter displays OK.

⇒ **If OK is not displayed**

5.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.

5.2. Test for less than 1 V between the control circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

⇓ **If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 1 and the ignition circuit terminal 2.
7. Verify the scan tool Engine Coolant Thermostat Heater Circuit High Voltage Test Status parameter is displaying Malfunction when commanding the E41 Engine Coolant Thermostat Heater ON with a scan tool.

⇒ **If Malfunction is not displayed**

7.1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module

7.2. Test for less than 2 Ω in the control circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω replace the K20 Engine Control Module

⇓ **If Malfunction is displayed**

8. Test or replace the E41 Engine Coolant Thermostat Heater.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

- *Engine Coolant Thermostat Replacement (LUV) on page 9-661* or *Engine Coolant Thermostat Replacement (LUW) on page 9-662*
- *Control Module References on page 6-3* for engine control module, replacement, programming, and setup.

DTC P2181

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

DTC Descriptor

DTC P2181: Engine Cooling System Performance

Circuit/System Description

The engine control module (ECM) monitors temperature difference between the engine coolant temperature (ECT) sensor and the radiator coolant temperature (RCT) sensor during a cold start-up. The purpose of this diagnostic is to analyze the engine coolant thermostat for being stuck open.

Conditions for Running the DTC

- DTCs P00B3, P00B4, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, or P0118 are not set.
- The engine run time is between 70 s and 30 min.
- The engine coolant temperature (ECT) sensor at start-up is between −10°C to +59°C (14°F to 138°F).
- The intake air temperature (IAT) sensor is between −7°C to +60°C (−4°F to +140°F).
- The airflow into the engine is between 1 to 100 g/s.
- The DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects the engine coolant thermostat is stuck open for at least 2.5 min.

Action Taken When the DTC Sets

DTC P2181 is a Type B DTC

Conditions for Clearing the DTC

DTC P2181 is a Type B DTC

Diagnostic Aids

- Insufficient vehicle interior heating is an indication of improper thermostat operation.
- The scan tool Desired ECT Sensor and the ECT Sensor parameters should be within 5°C (9°F) when the engine is at operating temperature.
- A resistance condition in the ECT sensor circuits may cause this DTC. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-314

Connector End View Reference

Component Connector End Views on page 11-269

Description and Operation

Cooling System Description and Operation on page 9-680

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Engine running, observe the DTC information with a scan tool. DTC P00B3, P00B4, P00B6, P0117, or P0118 should not be set.
   ⇒ If a DTC is set, refer to *Diagnostic Trouble Code (DTC) List - Vehicle on page 6-69* for further diagnosis.
2. Verify the coolant in the radiator surge tank is at the correct level and there are no engine coolant leaks. Refer to *Cooling System Draining and Filling on page 9-628* and *Loss of Coolant on page 9-625*.

Note: Depending on ambient temperature, it may take up to 4 min for the temperature to increase greater than the specified value.

3. Engine idling for 15 min with the A/C OFF. Verify the engine cooling fan is not ON at all times.
4. Command the Engine Coolant Thermostat Heater to 0 % with a scan tool. Increase the engine speed to 3,000 RPM. Observe the scan tool ECT sensor parameter. The temperature should increase to greater than 102°C (215°F).
   ⇒ If less than the specified value, replace the E41 engine coolant thermostat heater.
5. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

Engine Coolant Thermostat Replacement (LUV) on page 9-661 or *Engine Coolant Thermostat Replacement (LUW) on page 9-662*

Symptoms - Engine Cooling

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform *Diagnostic System Check - Vehicle on page 6-66* and verify all of the following items:
  - Engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
  - There are no diagnostic trouble codes (DTCs) stored.
  - Scan tool data is within a normal operating range.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.
- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

Review the entire cooling system operation in order to familiarize yourself with the system functions. Refer to *Cooling Fan Description and Operation (LUV) on page 9-679* or *Cooling Fan Description and Operation (LWE, LUW) on page 9-680* and *Cooling System Description and Operation on page 9-680*.

Visual/Physical Inspection

Caution: Use the connector test adapter kit EL-35616-F for any test that requires probing the following items:

- The control module harness connectors
- The electrical center fuse/relay cavities
- The component terminals
- The component harness connector

Using this kit will prevent damage caused by the improper probing of connector terminals.

Several of the symptom procedures call for a careful visual and physical inspection. This can lead to correcting a condition without further tests and can save time. This inspection should include the following:

- Ensure that the control module grounds are clean, tight, and correctly located.
- Inspect cooling system hoses and pipes for splits, kinks, and improper connections. Inspect thoroughly for any type of leak or restriction.
- Inspect for a dirty or restricted radiator or HVAC condenser.
- Inspect for aftermarket devices which could affect the operation of the cooling system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the surge tank reservoir for proper coolant level.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movement of a component. Refer to the following for a list to help isolate an intermittent condition:

- Water intrusion in connectors, terminals, or components
- Poor connector mating
- Terminal contact
- High circuit or component resistance—High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness' that are routed too tight, or chaffed circuits
- High or low ambient temperatures
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in components or circuits due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surface
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of non-factory, aftermarket, or after factory add on accessories

If an intermittent is detected, refer to *Testing for Intermittent Conditions and Poor Connections on page 11-531* for specific strategies in diagnosing intermittent conditions.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- *Cooling Fan Always On (LUV) on page 9-618* or *Cooling Fan Always On (LUW, LWE) on page 9-619*
- *Cooling Fan Inoperative (LUV) on page 9-620* or *Cooling Fan Inoperative (LUW, LWE) on page 9-623*
- *Engine Overheating on page 9-625*
- *Loss of Coolant on page 9-625*
- *Thermostat Diagnosis on page 9-626*
- *Engine Fails To Reach Normal Operating Temperature on page 9-627*

Cooling Fan Always On (LUV)

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of the diagnostic category.

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two resistors. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates the fan at a low speed
  - Cooling Fan Relay 2 and 3 operates the fan at a medium speed
  - Cooling Fan Relay 1, 2 and 3 operates the fan at a high speed
- Certain resistance conditions with intake air temperature (IAT) or engine coolant temperature (ECT) sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fans ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the Temperature Versus Resistance tables in Specifications of the appropriate engine controls subsection.
- If the cooling fan operates at high speed when the ECM is requesting medium speed operation, test or replace the KR20E Cooling Fan Speed Control Relay.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics on page 9-598

Connector End View Reference

- *Component Connector End Views on page 11-269*
- *Electrical Center Identification Views on page 11-240*

Description and Operation

Cooling Fan Description and Operation (LUV) on page 9-679 or *Cooling Fan Description and Operation (LWE, LUW) on page 9-680*

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that there are no cooling system DTCs set.

⇒ **If any DTCs are set**

Refer to *Diagnostic Trouble Code (DTC) List - Vehicle on page 6-69*.

⇓ **If no DTCs are set**

3. Verify the scan tool parameters listed below display OFF.
   - Cooling Fan Relay 1 Command
   - Cooling Fan Relays 2 and 3 Command

⇒ **If a scan tool parameter displays ON**

Refer to Diagnostic Aids and *Symptoms - Engine Cooling on page 9-617* for further diagnosis.

⇓ **If both scan tool parameters display OFF**

4. Verify that the fan is not activated.

⇒ **If the fan is operating**

Refer to Circuit/System Testing.

⇓ **If the fan is OFF**

5. All OK.

Circuit/System Testing

Note: The following tests must be performed on each cooling fan relay.

1. Ignition OFF, disconnect each cooling fan relay one at a time, in the order listed below, ignition ON:
   - KR20F Cooling Fan Relay
   - KR20C Cooling Fan Low Speed Relay
   - KR20P Cooling Fan Medium Speed Relay
   - KR20D Cooling Fan High Speed Relay
2. Verify that the cooling fan is not activated after each relay is removed.

⇒ **If the cooling fan is ON with all of the listed relays removed**

2.1. Ignition OFF, disconnect the harness connector at the R10 Cooling Fan Resistor, ignition ON.

2.2. Test for less than 1 V between the relay controlled output circuit terminal listed below and ground:
   - KR20C Cooling Fan Low Speed Relay terminal 87
   - KR20P Cooling Fan Medium Speed Relay terminal 87

- KR20D Cooling Fan High Speed Relay terminal 87/5

⇒ If 1 V or greater, repair the short to voltage in the appropriate circuit.

⇓ **If the cooling fan is OFF after a listed relay is removed**

3. Replace the appropriate cooling fan relay.

Component Testing

1. Ignition OFF.
2. Disconnect a cooling fan relay.
3. Test for 70–110 Ω between terminals 85/2 and 86/1.

⇒ **If less than or greater than the specified range**

Replace the cooling fan relay.

⇓ **If within the specified range**

4. Test for infinite resistance between the following terminals:
   - 30/3 and 86/1
   - 30/3 and 87/5
   - 30/3 and 85/2
   - 85/2 and 87/5

⇒ **If less than infinite resistance**

Replace the cooling fan relay.

⇓ **If infinite resistance**

5. Install a 20 A fused jumper wire between relay terminal 85/2 and 12 V.
6. Install a jumper wire between relay terminal 86/1 and ground.
7. Test for less than 2 Ω between terminals 30/3 and 87/5.

⇒ **If 2 Ω or greater**

Replace the cooling fan relay.

⇓ **If less than 2 Ω**

8. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

Relay Replacement (Within an Electrical Center) on page 11-607 or *Relay Replacement (Attached to Wire Harness) on page 11-607*

Cooling Fan Always On (LUW, LWE)

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provide an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing one electric cooling fan. The engine control module (ECM) uses two fan control circuits and a series of two relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, the fan is turned ON at a reduced speed. High speed has the fan turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relay 2 operates one fan at a high speed
- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fans ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate Engine Controls subsection.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics on page 9-598

Connector End View Reference

- *Component Connector End Views on page 11-269*
- *Electrical Center Identification Views on page 11-240*

Description and Operation

Cooling Fan Description and Operation (LUV) on page 9-679 or *Cooling Fan Description and Operation (LWE, LUW) on page 9-680*

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.

⇒ **If any of the DTCs are set**

Refer to *DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUW, LWE) on page 9-607* or *DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUV) on page 9-610*.

⇓ **If none of the DTCs are set**

3. Verify the scan tool parameters listed below display OFF:
   - Cooling Fan Relay 1 Command
   - Cooling Fan Relays 2 Command

⇒ **If a scan tool parameter displays ON**

Refer to Diagnostic Aids and *Symptoms - Engine Cooling on page 9-617* for further diagnosis.

⇓ **If both scan tool parameters display OFF**

4. Verify that the fan is not activated.

⇒ **If a fan is operating**

Refer to Circuit/System Testing.

⇓ **If the fan is OFF**

5. All OK.

Circuit/System Testing

Cooling Fan Always ON

1. Ignition OFF, disconnect KR20C Cooling Fan Low Speed Relay and KR20D Cooling Fan High Speed Relay, ignition ON.
2. Verify that the cooling fan is OFF.

⇒ **If the cooling fan is ON**

2.1. Ignition OFF, disconnect the harness connector at the G10R Cooling Fan Motor, ignition ON.

2.2. Test for less than 1 V between the appropriate output control circuit terminal 87 and ground.

⇒ If 1 V or greater, repair the short to voltage in the circuit.

⇓ **If the cooling fan is OFF**

3. Test or replace the appropriate cooling fan relay.

Component Testing

1. Ignition OFF.
2. Disconnect the KR20 Cooling Fan Relay.
3. Test for 70–110 Ω between terminals 85/2 and 86/1.

⇒ **If less than 70 Ω or greater than 110 Ω**

Replace the appropriate KR20 cooling fan relay.

⇓ **If between 70–110 Ω**

4. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

⇒ **If less than infinite resistance**

Replace the appropriate KR20 Cooling Fan Relay.

⇓ **If infinite resistance**

5. Install a 20 A fused jumper wire between relay terminal 85 or 2 and 12 V.
6. Install a jumper wire between relay terminal 86 or 1 and ground.
7. Test for less than 2 Ω between terminals 3/30 and 5/87.

⇒ **If 2 Ω or greater**

Replace appropriate the KR20 Cooling Fan Relay.

⇓ **If less than 2 Ω**

8. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the repair.

Relay Replacement (Within an Electrical Center) on page 11-607 or *Relay Replacement (Attached to Wire Harness) on page 11-607*

Cooling Fan Inoperative (LUV)

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two resistors. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates the fan at a low speed
  - Cooling Fan Relay 2 and 3 operates the fan at a medium speed
  - Cooling Fan Relay 1, 2 and 3 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics on page 9-598

Connector End View Reference

- *Component Connector End Views on page 11-269*
- *Electrical Center Identification Views on page 11-240*

Description and Operation

Cooling Fan Description and Operation (LUV) on page 9-679 or *Cooling Fan Description and Operation (LWE, LUW) on page 9-680*

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.

⇒ **If a DTC is set**

Refer to *DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUW, LWE) on page 9-607* or *DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUV) on page 9-610*.

⇓ **If no DTC is set**

3. Verify that the G10 Cooling Fan Motor operates at low, medium, and high speed, when commanding the appropriate cooling fan relays ON and OFF with a scan tool.

⇒ **If the cooling fan does not operate at all speeds**

Refer to Circuit/System Testing.

⇓ **If the cooling fan operates at all speeds**

4. All OK.

Circuit/System Testing

Inoperative in All Speeds

1. Ignition OFF, disconnect the harness connector at the R10 Cooling Fan Resistor.
2. Verify a test lamp illuminates between the ground circuit terminal 1 and B+.

⇒ **If the test lamp does not illuminate**

2.1. Ignition OFF, remove the test lamp.

2.2. Test for less than 2 Ω in the ground circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, repair the open/high resistance in the ground connection.

⇓ **If the test lamp illuminates**

3. Test or replace the G10 Cooling Fan Motor. Replace the cooling fan fuses if necessary.

Low, Medium, or High Speed Inoperative

1. Ignition OFF.
2. Disconnect the following cooling fan relays, ignition ON:
   - KR20C Cooling Fan Low Speed Relay
   - KR20D Cooling Fan High Speed Relay
   - KR20E Cooling Fan Speed Control Relay
   - KR20F Cooling Fan Relay
   - KR20P Cooling Fan Medium Speed Relay
3. Verify a test lamp illuminates between ground and each of the cooling fan relay B+ circuit terminals listed below:
   - KR20C Cooling Fan Low Speed Relay terminal 30
   - KR20D Cooling Fan High Speed Relay terminal 30/3
   - KR20P Cooling Fan Medium Speed Relay terminal 30

⇒ **If the test lamp does not illuminate and the circuit fuse is good**

3.1. Ignition OFF, remove the test lamp.

3.2. Test for less than 2 Ω in the appropriate relay B+ circuit, end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

⇓ **If the test lamp does not illuminate and the circuit fuse is open**

3.1. Ignition OFF, disconnect the harness connector at the R10 Cooling Fan Resistor.

3.2. Test for infinite resistance between the appropriate relay controlled output circuit terminal listed below and ground:
   - KR20C Cooling Fan Low Speed Relay terminal 87
   - KR20D Cooling Fan High Speed Relay terminal 87/5
   - KR20P Cooling Fan Medium Speed Relay terminal 87

⇒ If less than infinite resistance, repair the short to ground in the circuit.

⇒ If infinite resistance, test or replace the G10 Cooling Fan Motor, replace the fuse as necessary.

⇓ **If the test lamp illuminates**

4. Verify a test lamp illuminates between the KR20F Cooling Fan Relay output circuit terminal 87 and B+.

⇒ **If the test lamp does not illuminate**

4.1. Ignition OFF, remove the test lamp.

4.2. Test for less than 2 Ω in the ground circuit, end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, repair the open/high resistance in the ground connection.

⇓ **If the test lamp illuminates**

5. Ignition OFF, Install the KR20F Cooling Fan Relay, ignition ON.
6. Verify a test lamp illuminates between each of the cooling fan relay ignition circuit terminals listed below and ground:
   - KR20C Cooling Fan Low Speed Relay terminal 86
   - KR20E Cooling Fan Speed Control Relay terminal 85 and 30

⇒ **If the test lamp does not illuminate at each terminal**

6.1. Ignition OFF, remove the test lamp.

6.2. Test for less than 2 Ω between the appropriate relay ignition circuit terminal and the fuse.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

⇓ **If the test lamp illuminates at each terminal**

7. Command the cooling fan ON at low speed with a scan tool.
8. Verify a test lamp illuminates between B+ and each of the relay control circuit terminals listed below:
   - KR20C Cooling Fan Low Speed Relay terminal 85
   - KR20E Cooling Fan Speed Control Relay terminal 86

⇒ **If the test lamp does not illuminate**

8.1. Ignition OFF, remove the test lamp and disconnect the KR20F Cooling Fan Relay.

8.2. Test for less than 2 Ω between the KR20F Cooling Fan Relay terminal 30 and the relay control circuit terminals listed below:
   - KR20C Cooling Fan Low Speed Relay terminal 85
   - KR20E Cooling Fan Speed Control Relay terminal 86

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the KR20F Cooling Fan Relay.

⇓ **If the test lamp illuminates**

9. Ignition OFF, install the KR20E Cooling Fan Speed Control Relay, ignition ON.
10. Command the cooling fan ON at low speed with a scan tool.
11. Verify a test lamp illuminates between the KR20D Cooling Fan High Speed Relay ignition circuit terminal 85/1 and ground.

⇒ **If the test lamp does not illuminate**

11.1. Ignition OFF, remove the test lamp and disconnect the KR20E Cooling Fan Speed Control Relay.

11.2. Test for less than 2 Ω between the KR20D Cooling Fan High Speed Relay terminal 85/1 and KR20E Cooling Fan Speed Control Relay terminal 87.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, replace the KR20E Cooling Fan Speed Control Relay.

⇓ **If the test lamp illuminates**

12. Ignition OFF, install all of the previously removed cooling fan relays. Disconnect the harness connector at the R10 Cooling Fan Resistor, ignition ON.
13. Command the cooling fan ON at high speed with a scan tool.
14. Verify a test lamp illuminates between ground and each of the R10 Cooling Fan Resistor circuit terminals listed below:
   - R10 Cooling Fan Resistor low speed circuit terminal 2
   - R10 Cooling Fan Resistor medium speed circuit terminal 3
   - R10 Cooling Fan Resistor high speed circuit terminal 4

⇒ **If the test lamp does not illuminate at each terminal**

14.1. Ignition OFF, remove the test lamp.

14.2. Disconnect the appropriate relay from the list below:
   - KR20C Cooling Fan Low Speed Relay
   - KR20D Cooling Fan High Speed Relay
   - KR20P Cooling Fan Medium Speed Relay

14.3. Test for less than 2 Ω in the relay controlled output circuit, end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, test or replace the relay.

⇓ **If the test lamp illuminates at each terminal**

15. Test or replace the G10 Cooling Fan Motor.

Component Testing

Relay Test

1. Ignition OFF.
2. Disconnect a cooling fan relay.
3. Test for 70–110 Ω between terminals 85/2 and 86/1.

⇒ **If less than or greater than the specified range**

Replace the cooling fan relay.

⇓ **If within the specified range**

4. Test for infinite resistance between the following terminals:
   - 30/3 and 86/1
   - 30/3 and 87/5
   - 30/3 and 85/2
   - 85/2 and 87/5

⇒ **If less than infinite resistance**

Replace the cooling fan relay.

⇓ **If infinite resistance**

5. Install a 20 A fused jumper wire between relay terminal 85/2 and 12 V.
6. Install a jumper wire between relay terminal 86/1 and ground.
7. Test for less than 2 Ω between terminals 30/3 and 87/5.

⇒ **If 2 Ω or greater**

Replace the cooling fan relay.

⇓ **If less than 2 Ω**

8. All OK.

Cooling Fan Motor Test

1. Ignition OFF.
2. Disconnect the harness connector at the R10 Cooling Fan Resistor.
3. Connect a jumper wire between the R10 Cooling Fan Resistor terminal 1 and ground.
4. Connect an appropriately fused jumper wire between a R10 Cooling Fan Resistor terminal listed below and B+.
   - R10 Cooling Fan Resistor low speed terminal 2
   - R10 Cooling Fan Resistor medium speed terminal 3
   - R10 Cooling Fan Resistor high speed terminal 4
5. Verify the G10 Cooling Fan Motor operates when voltage is applied to each terminal.

⇒ **The cooling fan does not operate**

Replace the G10 Cooling Fan Motor.

⇓ **The cooling fan operates**

6. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the diagnostic procedure.

- *Relay Replacement (Within an Electrical Center) on page 11-607* or *Relay Replacement (Attached to Wire Harness) on page 11-607*
- *Front Compartment Fuse Block Replacement on page 11-609*
- *Engine Coolant Fan Replacement (LDE/LUW) on page 9-655* or *Engine Coolant Fan Replacement (LUV) on page 9-656*

Cooling Fan Inoperative (LUW, LWE)

Diagnostic Instructions

- Perform the *Diagnostic System Check - Vehicle on page 6-66* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-58* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-59* provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system is composed of one cooling fan, a series of 2 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes one resistor. This combination of components enables the ECM to operate the cooling fan at 2 speeds using two fan control circuits.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates the fan at a low speed
  - Cooling Fan Relay 2 operates the fan at a high speed
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics on page 9-598

Connector End View Reference

- *Component Connector End Views on page 11-269*
- *Electrical Center Identification Views on page 11-240*

Description and Operation

Cooling Fan Description and Operation (LUV) on page 9-679 or *Cooling Fan Description and Operation (LWE, LUW) on page 9-680*

Electrical Information Reference

- *Circuit Testing on page 11-526*
- *Connector Repairs on page 11-548*
- *Testing for Intermittent Conditions and Poor Connections on page 11-531*
- *Wiring Repairs on page 11-537*

Scan Tool Reference

Control Module References on page 6-3 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.

⇒ **If a DTC is set**

Refer to *DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUW, LWE) on page 9-607* or *DTC P0480, P0481, P0691, P0692, P0693, or P0694 (LUV) on page 9-610.*

⇓ **If no DTC is set**

3. Verify that the cooling fan operates at low, medium, and high speed, when commanding the appropriate cooling fan relays ON and OFF with a scan tool.

⇒ **If the cooling fan does not operate at all speeds**

Refer to Circuit/System Testing.

⇓ **If the cooling fan operates at all speeds**

4. All OK.

Circuit/System Testing

Inoperative in All Speeds

1. Ignition OFF, disconnect the harness connector at the G10 Cooling Fan Motor.
2. Verify a test lamp illuminates between the ground circuit terminal C and B+.

⇒ **If the test lamp does not illuminate**

2.1. Ignition OFF, remove the test lamp.

2.2. Test for less than 2 Ω in the ground circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, repair the open/high resistance in the ground connection.

⇓ **If the test lamp illuminates**

3. Test or replace the G10 Cooling Fan Motor. Replace the cooling fan fuses if necessary.

Low or High Speed Inoperative

1. Disconnect the following cooling fan relays, ignition ON:
   - KR20C Cooling Fan Low Speed Relay
   - KR20D Cooling Fan High Speed Relay
2. Verify a test lamp illuminates between ground and each of the cooling fan relay B+ circuit terminals listed below:
   - KR20C Cooling Fan Low Speed Relay terminal 30
   - KR20D Cooling Fan High Speed Relay terminal 30

⇒ **If the test lamp does not illuminate and the circuit fuse is good**

2.1. Ignition OFF, remove the test lamp.

2.2. Test for less than 2 Ω in the appropriate relay B+ circuit, end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

⇓ **If the test lamp does not illuminate and the circuit fuse is open**

2.1. Ignition OFF, disconnect the harness connector at the G10 Cooling Fan Motor.

2.2. Test for infinite resistance between the appropriate relay controlled output circuit terminal listed below and ground:
   - KR20C Cooling Fan Low Speed Relay terminal 87
   - KR20D Cooling Fan High Speed Relay terminal 87

⇒ If less than infinite resistance, repair the short to ground in the circuit.

⇒ If infinite resistance, test or replace the G10 Cooling Fan Motor, replace the fuse as necessary.

⇓ **If the test lamp illuminates**

3. Ignition OFF, install all of the previously removed KR20 Cooling Fan Relays. Disconnect the harness connector at the G10 Cooling Fan Motor, ignition ON.
4. Command the cooling fan ON at high or low speed as appropriate with a scan tool.
5. Verify a test lamp illuminates between ground and appropriate G10 Cooling Fan Motor circuit terminals listed below:
   - G10 Cooling Fan low speed circuit terminal B
   - G10 Cooling Fan high speed circuit terminal A

⇒ **If the test lamp does not illuminate at each terminal**

5.1. Ignition OFF, remove the test lamp.

5.2. Disconnect the appropriate relay from the list below:
   - KR20C Cooling Fan Low Speed Relay
   - KR20D Cooling Fan High Speed Relay

5.3. Test for less than 2 Ω in the relay controlled output circuit, end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω, test or replace the relay.

⇓ **If the test lamp illuminate at each terminal**

6. Test or replace the G10 Cooling Fan Motor.

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70–110 Ω between terminals 85/2 and 86/1.

⇒ **If less than or greater than the specified range**

Replace the KR20 Cooling Fan Relay.

⇓ **If within the specified range**

4. Test for infinite resistance between the following terminals:
   - 30/3 and 86/1
   - 30/3 and 87/5
   - 30/3 and 85/2
   - 85/2 and 87/5

   ⇒ **If less than infinite resistance**

   Replace the KR20 Cooling Fan Relay.

   ⇓ **If infinite resistance**
5. Install a 20 A fused jumper wire between relay terminal 85/2 and 12 V.
6. Install a jumper wire between relay terminal 86/1 and ground.
7. Test for less than 2 Ω between terminals 30/3 and 87/5.

   ⇒ **If 2 Ω or greater**

   Replace the KR20 Cooling Fan Relay.

   ⇓ **If less than 2 Ω**
8. All OK.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-92* after completing the repair.

- *Relay Replacement (Within an Electrical Center) on page 11-607* or *Relay Replacement (Attached to Wire Harness) on page 11-607*
- *Engine Coolant Fan Replacement (LDE/LUW) on page 9-655* or *Engine Coolant Fan Replacement (LUV) on page 9-656*

Engine Overheating

Engine Overheating

Checks	Actions
Check for a loss of the coolant.	Add the coolant.
Check for weak coolant solution.	Confirm that the coolant solution is 50/50 mixture of ethylene glycol and water.
Check the front of the radiator for any dirt, any leaves, or any insects.	Clean the front of the radiator
Check for leakage from the hoses, the coolant pump, the heater, the thermostat housing, the radiator, the core plugs, or the head gasket.	Replace any damaged components.
Check for a faulty thermostat.	Replace a damaged thermostat.
Check for retarded ignition timing.	Perform an ECM code diagnosis. Confirm the integrity of the timing belt.
Check for an improperly operating electric cooling fan.	Replace the electric cooling fan.
Check for radiator hoses that are plugged or rotted.	Replace any damaged radiator hoses.
Check for a faulty water pump.	Replace a faulty water pump.
Check for a faulty surge tank cap.	Replace a faulty surge tank cap.
Check for a cylinder head or an engine block that is cracked or plugged.	Repair the damaged cylinder head or the damaged engine block.

Loss of Coolant

Checks	Actions
Check for a leak in the radiator.	Replace a damaged radiator.
Check for a leak in the following locations: • Surge tank • Hose	Replace the following parts: • Surge tank • Hose
Check for the following loose or damaged parts: • Radiator hoses • Heater hoses • Connections	Reseat the hoses. Replace the hoses or the clamps.

Loss of Coolant (cont'd)

Checks	Actions
Check for leaks in the coolant pump seal.	Replace the coolant pump seal.
Check for leaks in the coolant pump gasket.	Replace the coolant pump gasket.
Check for an improper cylinder head torque.	Tighten the cylinder head bolts to specifications. Replace the cylinder head gasket, if needed.
Check for leaks in the following locations: • Intake manifold • Cylinder head gasket • Cylinder block plug • Heater core • Radiator drain plug	Repair or replace any components, as needed, to correct the leak.

Thermostat Diagnosis

Step	Action	Values	Yes	No
1	1. Pressure test the cooling system and the cap for leaks. 2. Repair any leaks before proceeding. These engines use a 90°C (194°F) thermostat. The ambient temperatures should be within the specified range given. 3. Set the HVAC controls in the OFF position. 4. Run the cold engine at idle (68–70°F) for 15–20 minutes before checking the engine temperature. 5. Check the engine coolant temperature at idle with the scan tool. Is the engine coolant temperature (ECT) between 90–105°C (194–221°F)?	13–38°C (55–100°F)	System OK	Go to *Step 2*
2	Is the ECT below 90°C (194°F)?	—	Go to *Step 3*	Go to *Step 4*
3	The thermostat is opening early, or the thermostat seal is leaking. Replace the thermostat and the thermostat seal. Is the repair complete?	—	System OK	—
4	Is the ECT over 105°C (221°F)?	—	Go to *Step 5*	—
5	Is the radiator inlet hot?	—	Go to *Step 6*	Go to *Step 7*
6	1. Turn ON the heater. 2. Check if hot air is coming from the heater outlets. Is the air hot?	—	Go to *Step 11*	Go to *Step 12*
7	There may be air in the system. 1. Add coolant to the surge tank if the coolant level is low. Refer to *Cooling System Draining and Filling on page 9-628.* 2. Recheck the radiator inlet hose. Is the inlet hose hot?	—	Go to *Step 6*	Go to *Step 8*
8	Inspect for blockage in the following areas: • The cylinder head • The radiator • The radiator hoses Is there a blockage?	—	Go to *Step 9*	Go to *Step 10*
9	1. Repair the blockage. 2. Recheck the coolant temperature with the the scan tool. Is the repair complete?	—	System OK	—

Thermostat Diagnosis (cont'd)

Step	Action	Values	Yes	No
10	1. Replace the thermostat. Refer to *Engine Coolant Thermostat Replacement (LUV) on page 9-661* or *Engine Coolant Thermostat Replacement (LUW) on page 9-662*. 2. Recheck the coolant temperature with the scan tool. Is the repair complete?	—	System OK	—
11	Inspect for blockage in the radiator. Is there any blockage?	—	Go to *Step 9*	Go to *Step 10*
12	1. Accelerate the engine several times in order to remove any air from the system. 2. Inspect for blockage in the heater circuit. 3. Inspect for any pinched or buckled hoses. Is there any blockage?	—	Go to *Step 9*	Go to *Step 13*
13	Is the repair complete?		System OK	—

Engine Fails To Reach Normal Operating Temperature

Step	Action	Yes	No
1	Check the coolant level in the radiator surge tank. Refer to *Cooling System Draining and Filling on page 9-628*. Is the coolant at the proper level?	Go to *Step 3*	Go to *Step 2*
2	Add coolant to the radiator surge tank as necessary. Does the engine still fail to reach normal operating temperatures?	Go to *Step 3*	System OK
3	Check for a blockage in the coolant passages. Are there any blockages in the coolant passages?	Go to *Step 4*	Go to *Step 5*
4	Flush the cooling system or flow check the radiator. Does the engine still fail to reach normal operating temperatures?	Go to *Step 5*	System OK
5	Check to see if the incorrect thermostat was installed or if it is stuck or sticks in the open position. Was the incorrect thermostat installed, or is it stuck or does it stick in the open position?	Go to *Step 6*	—
6	Replace the thermostat. Refer to *Engine Coolant Thermostat Replacement (LUV) on page 9-661* or *Engine Coolant Thermostat Replacement (LUW) on page 9-662*. Does the engine still fail to reach normal operating temperature?	—	System OK

Cooling System Leak Testing

Special Tools

- *EN 471* Adapter
- *EN 6327 A* Cooling System Test Adapter

For equivalent regional Tools, refer to *Special Tools on page 9-681*.

Warning: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

Warning: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

1. Remove the surge tank cap.
2. Check the coolant level.
   Fill the coolant level to the COLD mark if necessary.
3. Pull the coolant expansion tank from the bracket in the direction of the battery.

Note: Follow manufacturer instructions.

4. Attach the coolant system tester with *EN 471* adapter and *EN 6327 A* adapter to the coolant expansion tank.
5. Apply approximately 100 kPa (15 psi) to the cooling system.

6. Check the cooling system for leaks.
7. Remove the cooling system tester.
   - Release the pressure
   - Remove the cooling system tester with *EN 471* adapter
8. Install the surge tank cap.

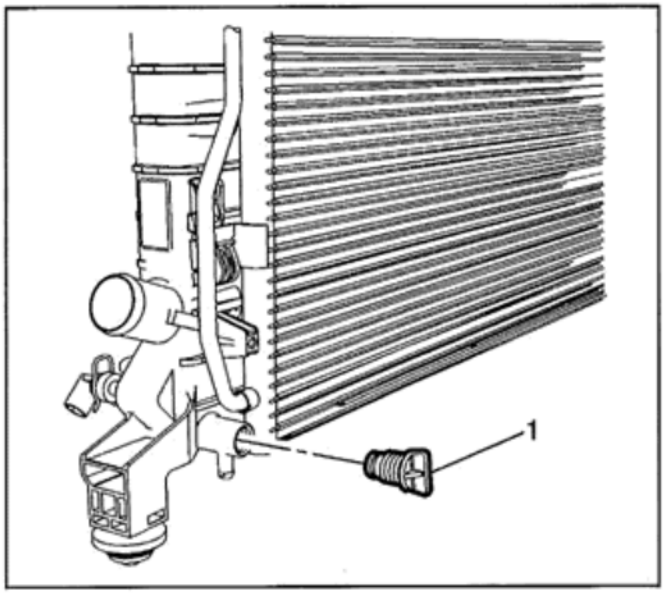
Repair Instructions

Cooling System Draining and Filling

Draining Procedure

Warning: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the coolant pressure cap from the radiator surge tank.
2. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
3. Remove the front compartment front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157*.
4. Place a drain pan under the drain cock.



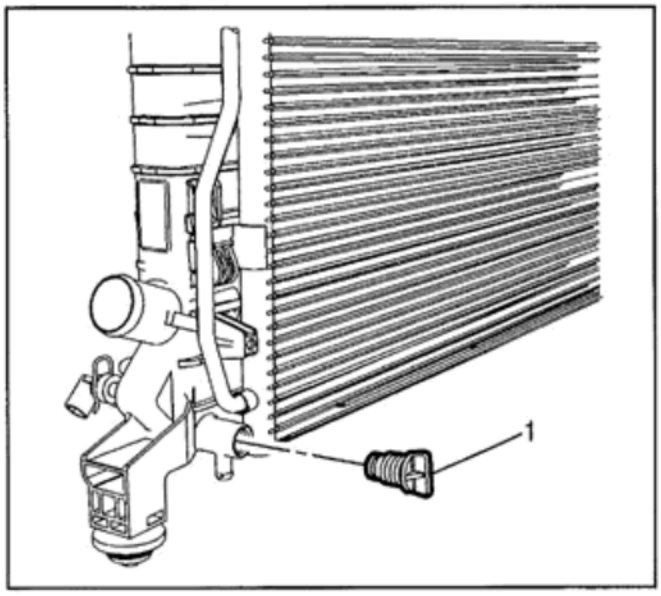
2509236

5. Loosen the radiator drain cock (1).
6. Drain the cooling system.
7. Lower the vehicle.
8. Inspect the coolant.
9. Follow the appropriate procedure based on the condition of the coolant.
   - Normal in appearance—Follow the filling procedure.
   - Discolored—Follow the flush procedure. Refer to *Coolant System Flushing on page 9-629*.

Filling Procedure

Caution: The procedure below must be followed. Improper coolant level could result in a low or high coolant level condition, causing engine damage.

1. Raise and support the vehicle.



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Caution: Refer to *Fastener Caution on page 0-8*.

2. Tighten the radiator drain cock (1) to **2 N·m (18 lb in)**.
3. Install the front compartment front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157*.
4. Lower the vehicle.

Note: Use a 50/50 mixture of DEX-COOL antifreeze and clean drinkable water.

5. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level reaches the base of the radiator surge tank. Refer to *Approximate Fluid Capacities on page 1-35*.
6. Allow 30 seconds for the coolant level to stabilize and continue to fill the coolant filler neck until the level stabilizes for at least 2 minutes.
7. Start the engine and allow to the engine to idle in PARK or NEUTRAL with the parking brake engaged.
8. Slowly fill the coolant mixture until the level stabilizes at the base of the radiator surge tank.
9. Install the coolant pressure cap.
10. Raise the engine RPM to 2500 rpm for 30–40 seconds.
11. Shut the engine OFF.
12. Allow the engine to cool, remove coolant fill cap and repeat steps 4–10 until the coolant level has completely stabilized within the radiator surge tank.
13. Inspect and if necessary, fill the coolant reservoir bottle as necessary.

14. Rinse away any excess coolant from the engine and the engine compartment.
15. Inspect the cooling system for leaks.
16. Top off the radiator surge tank if necessary.

Coolant System Flushing

Note:

- Do not use a chemical flush.
- Store used coolant in the proper manner, such as in a used engine coolant holding tank.
- Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical.
- Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.
- Various methods and equipment can be used to flush the cooling system. If special equipment is used, such as a back flusher, follow the manufactures instruction. However, always remove the thermostat before back flushing the system.

1. Apply the parking brake.
2. Drain the coolant. Refer to *Cooling System Draining and Filling on page 9-628*.
3. Fill the cooling system with clean drinkable water. Refer to *Cooling System Draining and Filling on page 9-628*.
4. Start the engine and run at 2,000 RPM until the thermostat opens.
5. Turn OFF the engine.
6. Drain the coolant system. Refer to *Cooling System Draining and Filling on page 9-628*.
7. Repeat the above procedure until the water from the coolant system is colorless.
8. Drain the coolant system. Refer to *Cooling System Draining and Filling on page 9-628*.
9. Repeat the above procedure until the water from the coolant system is colorless. Refer to *Cooling System Draining and Filling on page 9-628*.

Radiator Cleaning

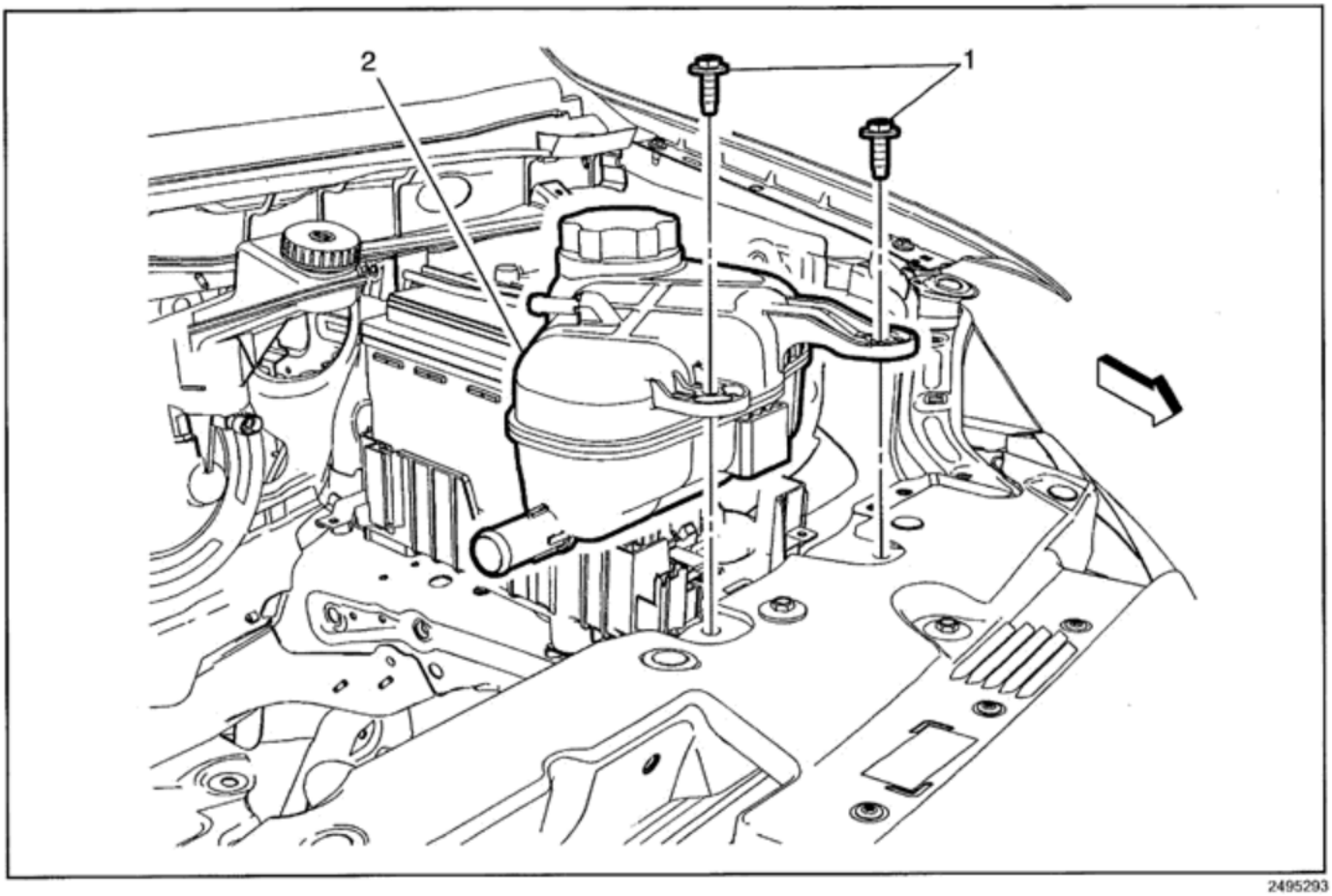
Warning: NEVER spray water on a hot heat exchanger. The resulting steam could cause personal injury.

Caution: The heat exchanger fins are necessary for good heat transfer. Do not brush the fins. This may cause damage to the fins, reducing heat transfer.

Note: Blow compressed air through the engine side of the radiator to remove any foreign material, such as insects, leaves, and dust.

- Warm water and mild soap may be needed in some conditions.
- Wash the A/C condenser fin.
- Wash the A/C condenser and radiator thoroughly.
- Wash the radiator cooling fin.
- Repair any damaged cooling fin.

Radiator Surge Tank Replacement

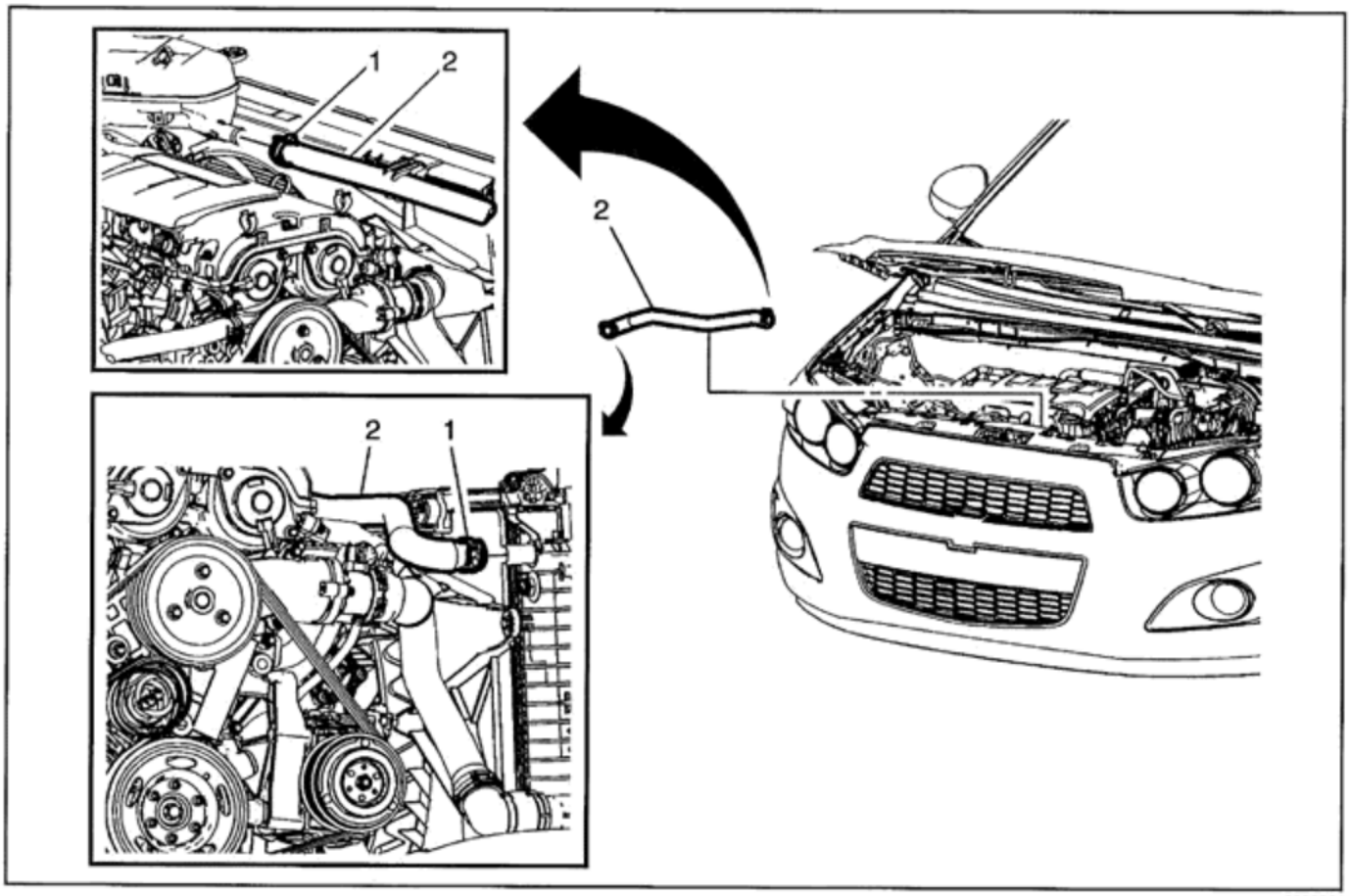


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Radiator Surge Tank Replacement

Callout	Component Name
Preliminary Procedure 1. Drain the coolant. Refer to *Cooling System Draining and Filling on page 9-628* 2. Remove the engine coolant air bleed hose. Refer to *Engine Coolant Air Bleed Hose Replacement (LUV) on page 9-665* 3. Remove the radiator surge tank outlet hose. Refer to *Radiator Surge Tank Outlet Hose Replacement (LUV) on page 9-631* or *Radiator Surge Tank Outlet Hose Replacement (LDE LUW) on page 9-632*	
1	Radiator Surge Tank Bolts (Qty: 2) **Caution:** Refer to *Fastener Caution on page 0-8.*
2	Radiator Surge Tank

Radiator Surge Tank Outlet Hose Replacement (LUV)

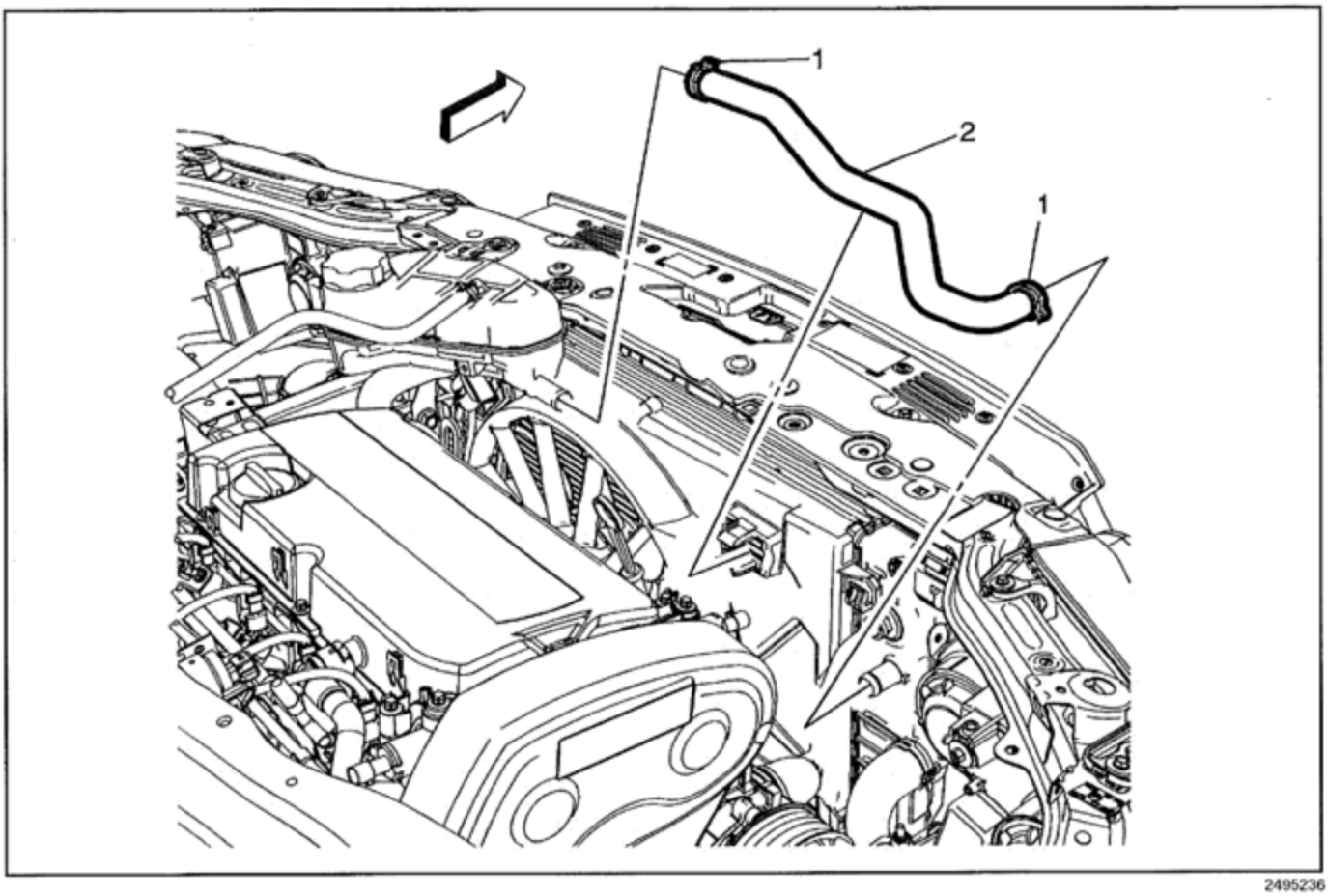


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Radiator Surge Tank Outlet Hose Replacement (LUV)

Callout	Component Name
Preliminary Procedures 1. Drain the engine coolant. Refer to *Cooling System Draining and Filling on page 9-628.* 2. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288.*	
1	Radiator Surge Tank Outlet Hose Clamp (Qty: 2) **Special Tools** *BO-38185* Hose Clamp Pliers For equivalent regional tools, refer to *Special Tools on page 9-681.*
2	Radiator Surge Tank Outlet Hose **Procedure** Unclip the radiator surge tank outlet hose from the engine fan shroud.

Radiator Surge Tank Outlet Hose Replacement (LDE LUW)

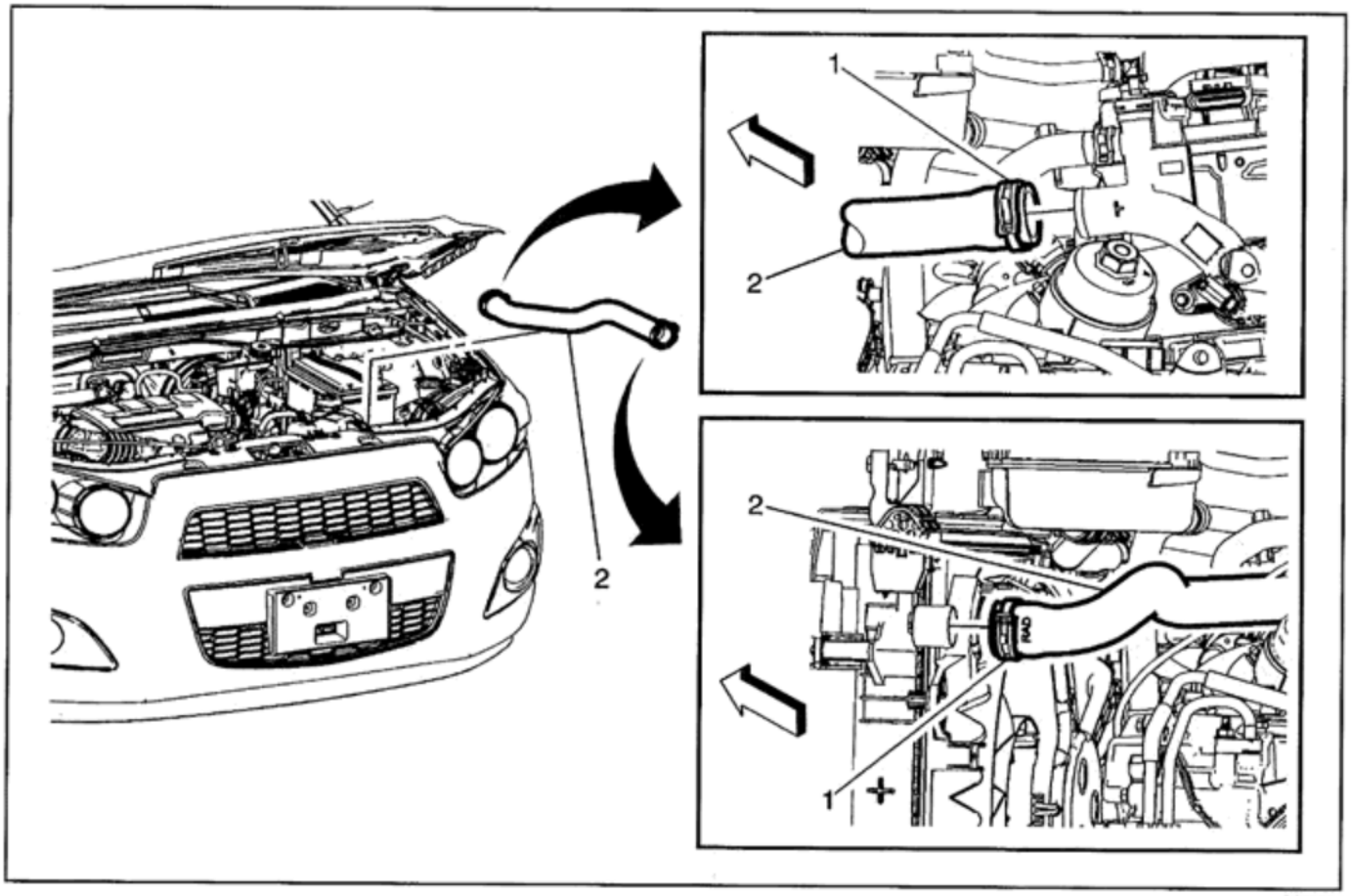


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Radiator Surge Tank Outlet Hose Replacement (LDE LUW)

Callout	Component Name
Preliminary Procedure Drain the coolant. Refer to *Cooling System Draining and Filling on page 9-628*	
1	Radiator Surge Tank Outlet Hose Clamps (Qty: 2) **Procedure** Reposition the radiator surge tank outlet hose clamps using *BO-38185* Hose Clamp Pliers **Special Tools** *BO-38185* Hose Clamp Pliers For equivalent regional tools, Refer to *Special Tools on page 10-61*
2	Radiator Surge Tank Outlet Hose **Procedure** Unclip radiator surge tank outlet hose from fan shroud.

Radiator Inlet Hose Replacement (LUV)



2678204

Radiator Inlet Hose Replacement (LUV)

Callout	Component Name
Preliminary Procedures 1. Drain the engine coolant. Refer to *Cooling System Draining and Filling on page 9-628*. 2. Remove the fasteners securing the radiator surge tank to the vehicle and position the radiator surge tank out of the way. Refer to *Radiator Surge Tank Replacement on page 9-630*.	
1	Radiator Inlet Hose Clamp (Qty: 2) **Special Tools** *BO-38185* Hose Clamp Pliers For equivalent regional tools, refer to *Special Tools on page 9-681*.
2	Radiator Inlet Hose

Radiator Inlet Hose Replacement (LDE LUW)

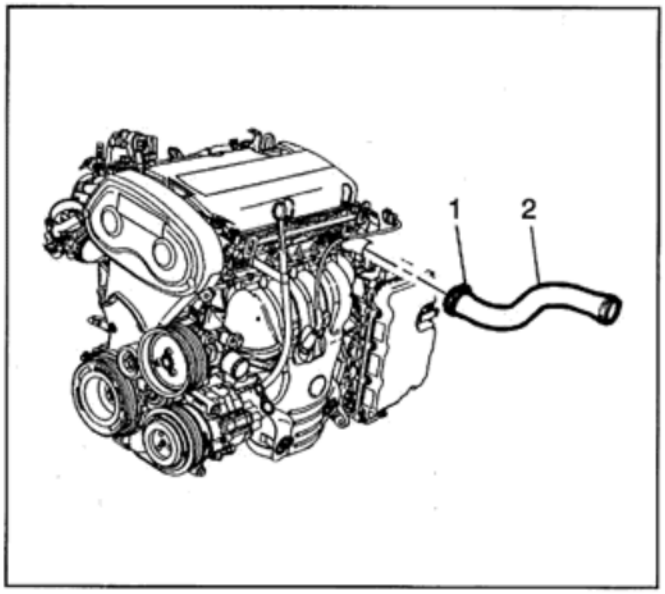
Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, Refer to *Special Tools on page 9-681*.

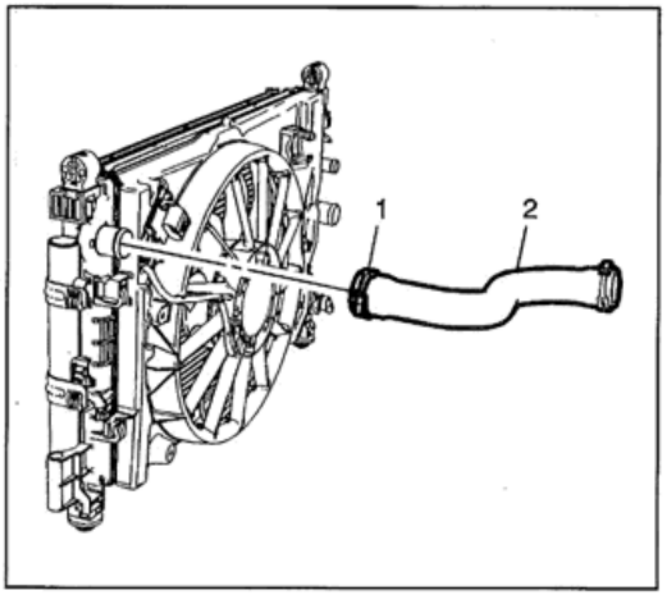
Removal Procedure

1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.



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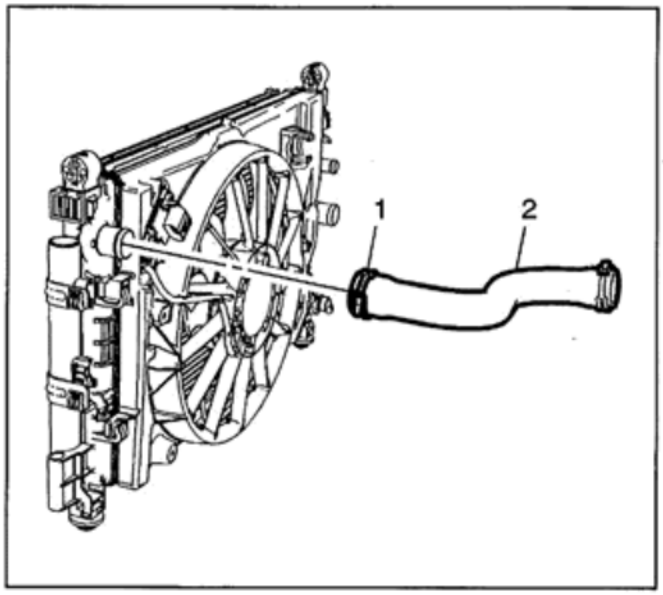
2. Remove the radiator inlet hose clamp (1) at the engine using *BO-38185* Hose Clamp Pliers.
3. Remove the radiator inlet hose (2) from the engine.



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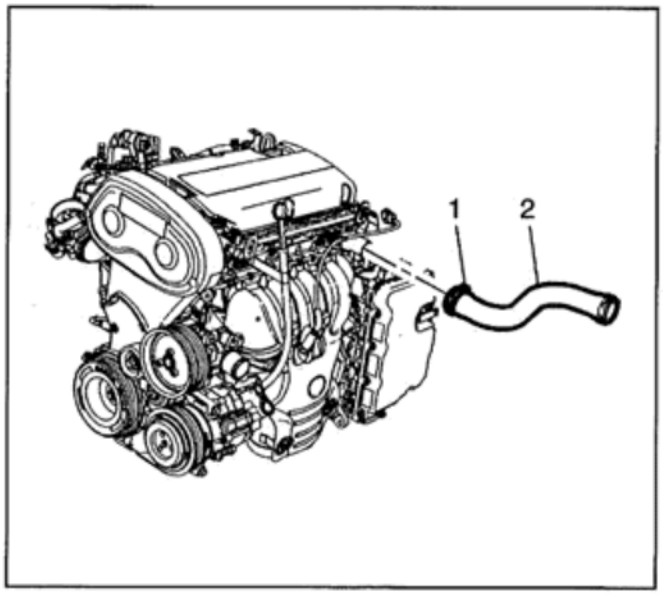
4. Remove the radiator inlet hose clamp (1) at the radiator using *BO-38185* Hose Clamp Pliers.
5. Remove the radiator inlet hose (2) from the radiator.
6. Remove the radiator inlet hose from the vehicle.

Installation Procedure



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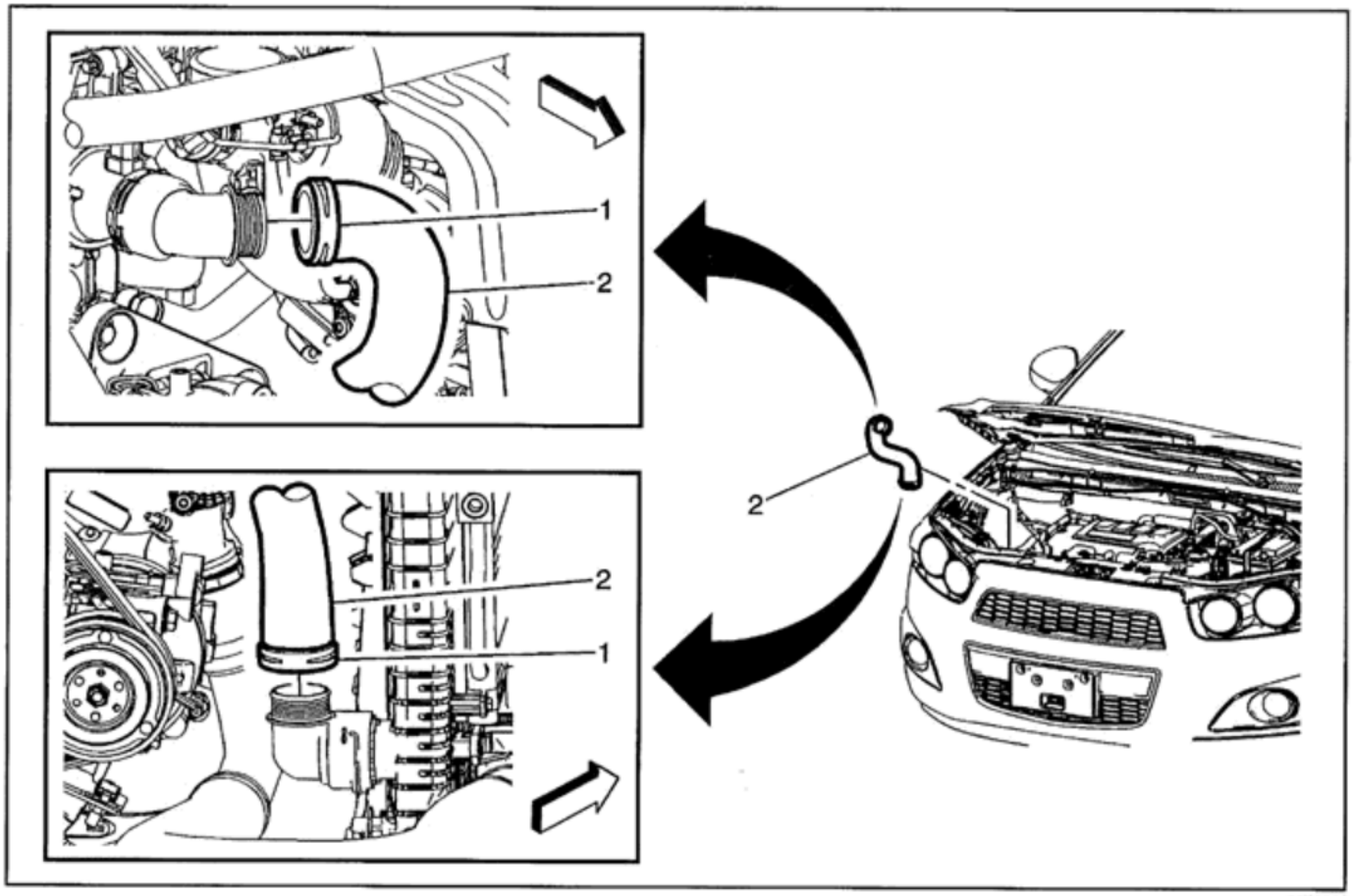
1. Install the radiator inlet hose to the vehicle.
2. Install the radiator inlet hose (2) to the radiator.
3. Install the radiator inlet hose clamp (1) at the radiator using *BO-38185* Hose Clamp Pliers.



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4. Install the radiator inlet hose (2) to the engine.
5. Install the radiator inlet hose clamp (1) at the engine using *BO-38185* Hose Clamp Pliers.
6. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.

Radiator Outlet Hose Replacement (LUV)



2678208

Radiator Outlet Hose Replacement (LUV)

Callout	Component Name
Preliminary Procedures 1. Drain the engine coolant. Refer to *Cooling System Draining and Filling on page 9-628.* 2. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288.* 3. Remove the radiator surge tank outlet hose from the radiator surge tank and position it out of the way. Refer to *Radiator Surge Tank Outlet Hose Replacement (LUV) on page 9-631* or *Radiator Surge Tank Outlet Hose Replacement (LDE LUW) on page 9-632.* 4. Remove the PCV Pipe assembly from the turbocharger and position it out of the way. Refer to *Positive Crankcase Ventilation Hose/Pipe/Tube Replacement on page 9-819.* 5. Remove the front compartment front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157.*	
1	Radiator Outlet Hose Clamp (Qty: 2) **Special Tools** *BO-38185* Hose Clamp Pliers For equivalent regional tools, refer to *Special Tools on page 9-681.*
2	Radiator Outlet Hose

Radiator Outlet Hose Replacement (LDE LUW)

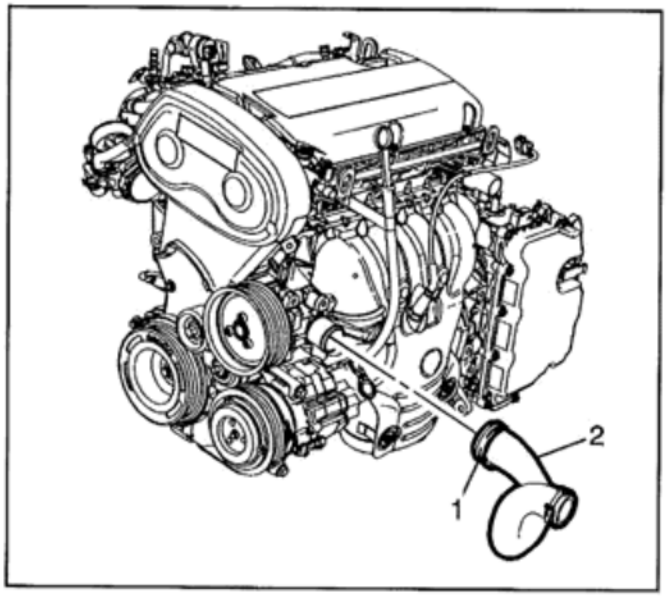
Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, Refer to *Special Tools on page 9-681*.

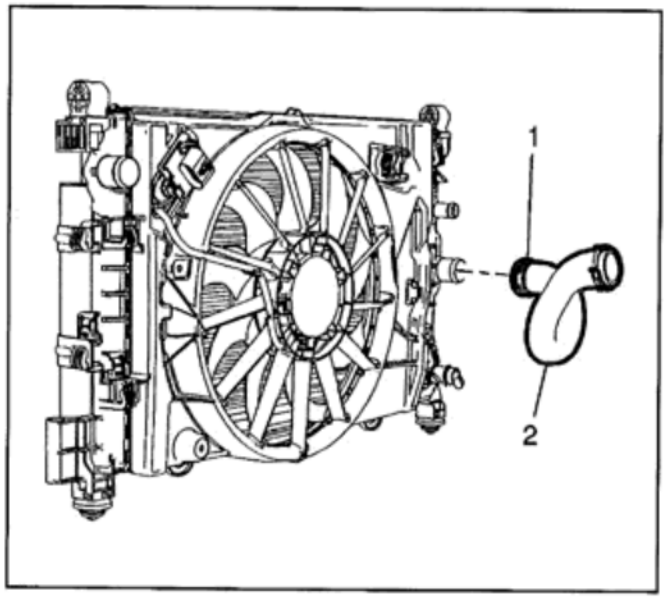
Removal Procedure

1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.



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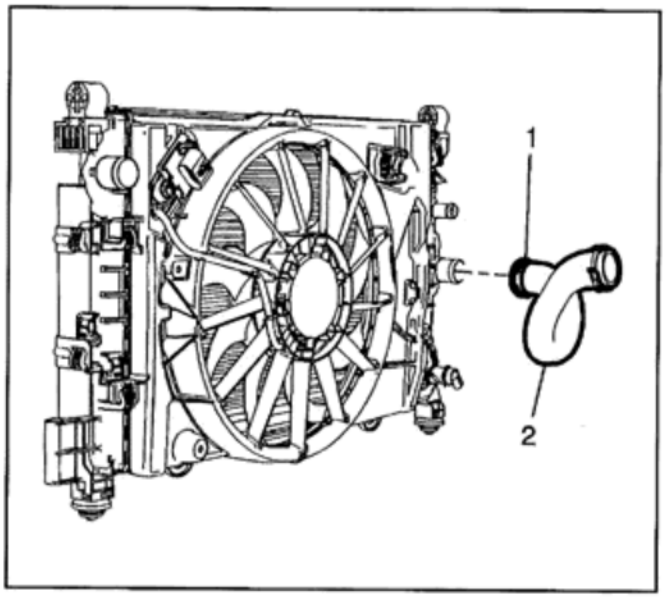
2. Remove the radiator outlet hose clamp (1) at the engine using *BO-38185* Hose Clamp Pliers.
3. Remove the radiator outlet hose (2) from the engine.



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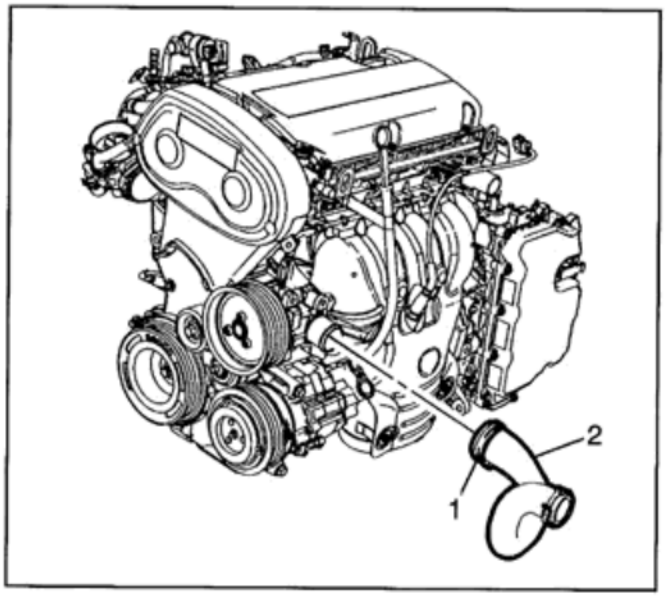
4. Remove the radiator outlet hose clamp (1) at the radiator using *BO-38185* Hose Clamp Pliers.
5. Remove the radiator outlet hose (2) from the radiator.
6. Remove the radiator outlet hose from the vehicle.

Installation Procedure



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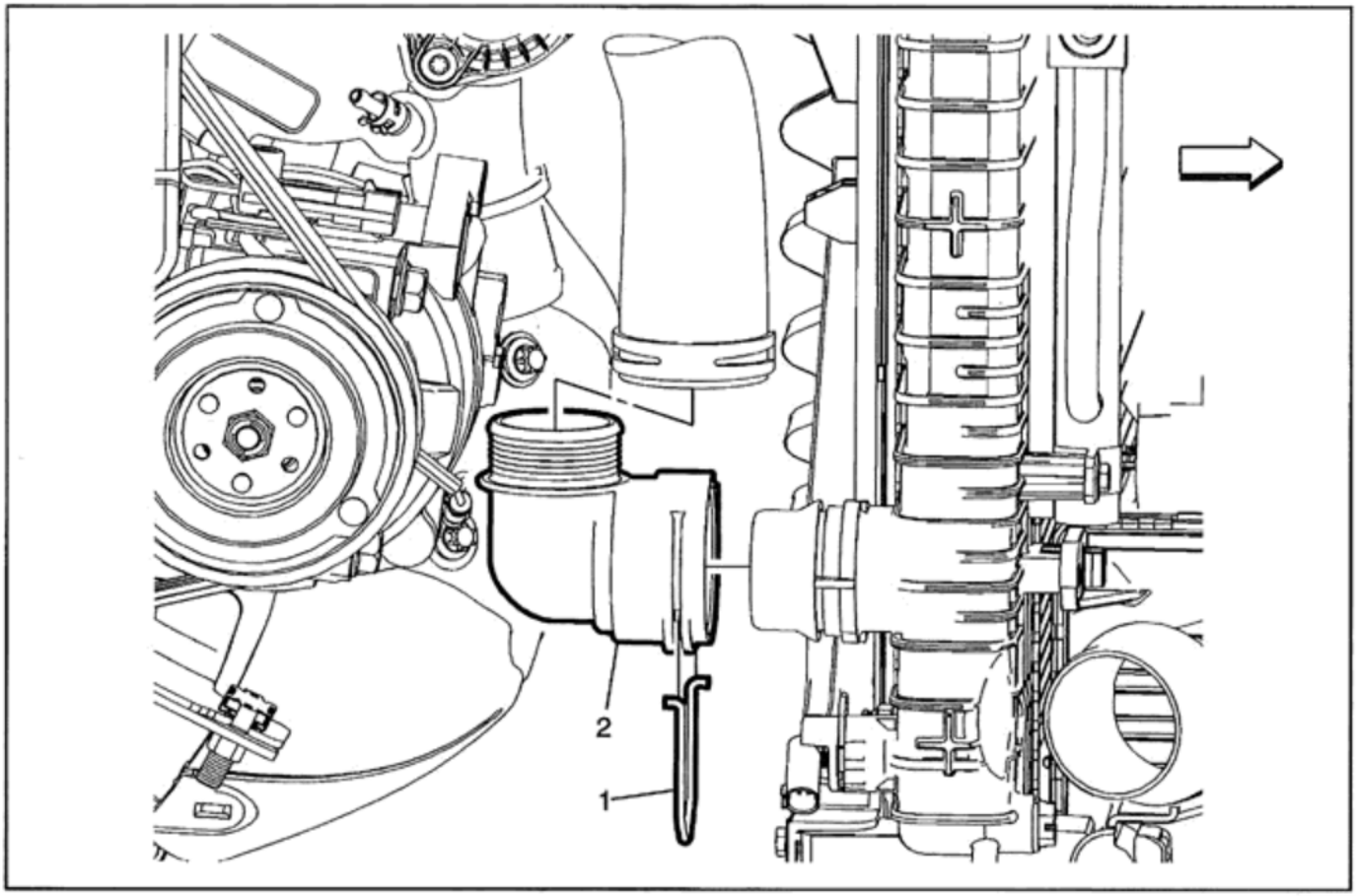
1. Install the radiator outlet hose to the vehicle.
2. Install the radiator outlet hose (2) to the radiator.
3. Install the radiator outlet hose clamp (1) at the radiator using *BO-38185* Hose Clamp Pliers.



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4. Install the radiator outlet hose (2) to the engine.
5. Install the radiator outlet hose clamp (1) at the engine using *BO-38185* Hose Clamp Pliers.
6. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.

Radiator Outlet Hose Connector Replacement - Radiator Side (LUV)

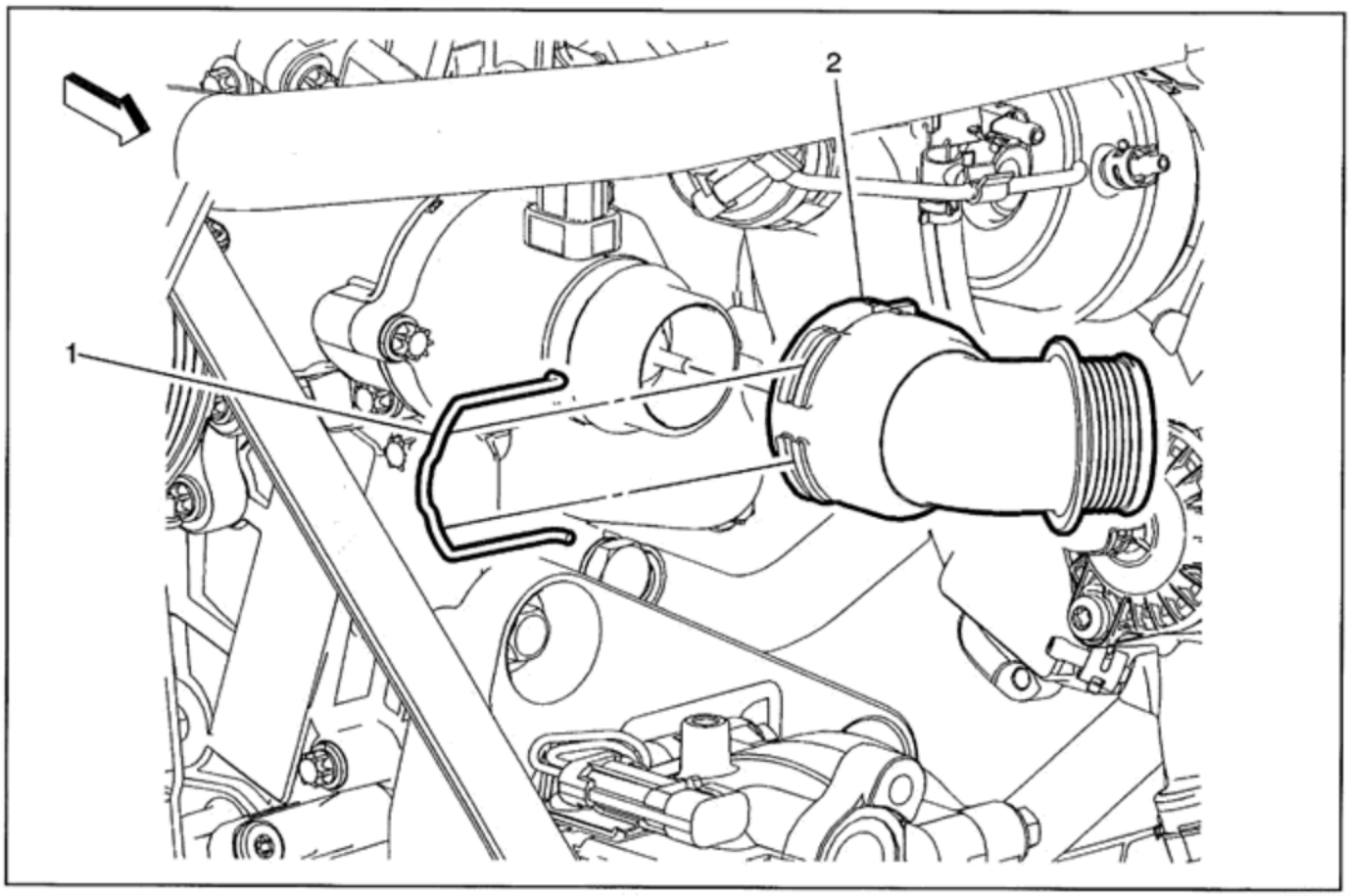


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Radiator Outlet Hose Connector Replacement - Radiator Side (LUV)

Callout	Component Name
Preliminary Procedures 1. Drain the engine coolant. Refer to *Cooling System Draining and Filling on page 9-628*. 2. Remove the front compartment front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157*. 3. Remove the radiator outlet hose from the radiator outlet hose connector and position out of the way. Refer to *Radiator Outlet Hose Replacement (LUV) on page 9-635* or *Radiator Outlet Hose Replacement (LDE LUW) on page 9-636*.	
1	Radiator Outlet Hose Connector Retaining Clip
2	Radiator Outlet Hose Connector

Radiator Outlet Hose Connector Replacement- Engine Side (LUV)



2678207

Radiator Outlet Hose Connector Replacement- Engine Side (LUV)

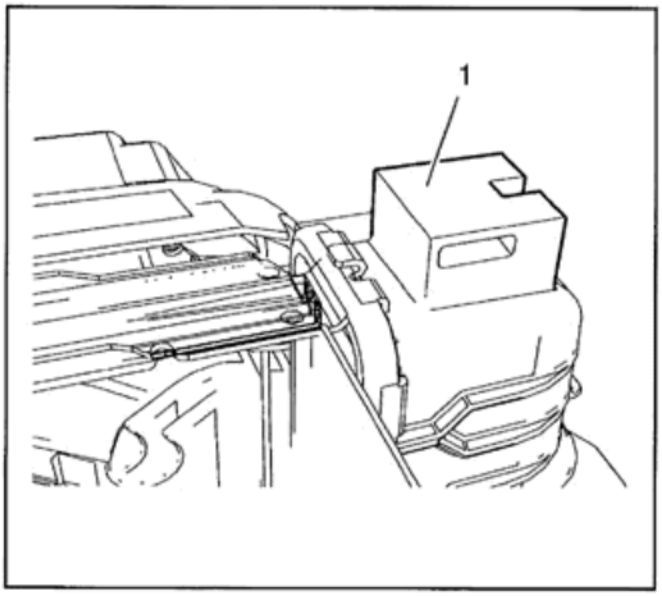
Callout	Component Name
Preliminary Procedures 1. Drain the engine coolant. Refer to *Cooling System Draining and Filling on page 9-628.* 2. Remove the radiator surge tank outlet hose from the radiator surge tank and position it out of the way. Refer to *Radiator Surge Tank Outlet Hose Replacement (LUV) on page 9-631* or *Radiator Surge Tank Outlet Hose Replacement (LDE LUW) on page 9-632.* 3. Remove the PCV Pipe assembly from the turbocharger and position it out of the way. Refer to *Positive Crankcase Ventilation Hose/Pipe/Tube Replacement on page 9-819.*	
1	Radiator Outlet Hose Connector Retaining Clip
2	Radiator Outlet Hose Connector

Radiator Mounting Stud Repair

Repair Procedure

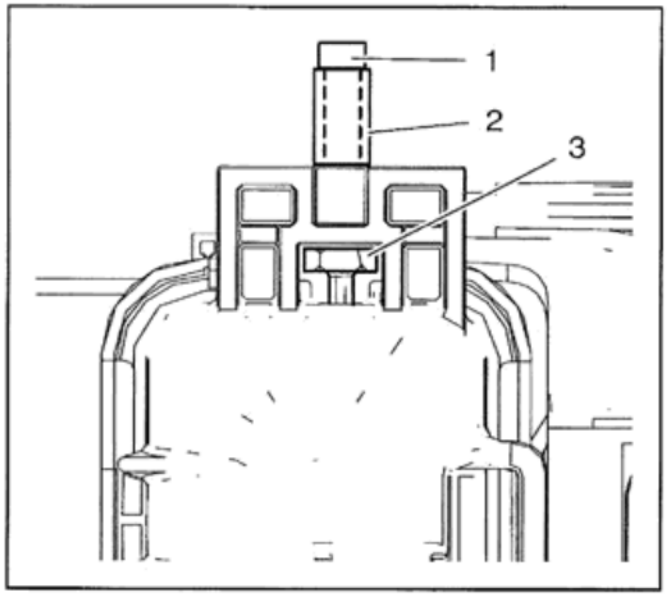
Note: If the radiator is leaky, replace it. Refer to *Radiator Replacement (LUV) on page 9-675* or *Radiator Replacement (LDE LUW) on page 9-678*.

1. Pressure test the cooling system. Refer to *Cooling System Leak Testing on page 9-627*.



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2. Grind the fracture surface (1) with a proper tool.
3. Drill a hole in the center of the fractured surface, using a **6 mm (0.24 in)** drill.



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4. Install the new radiator mounting pin (2).
   - Install the nut (3).

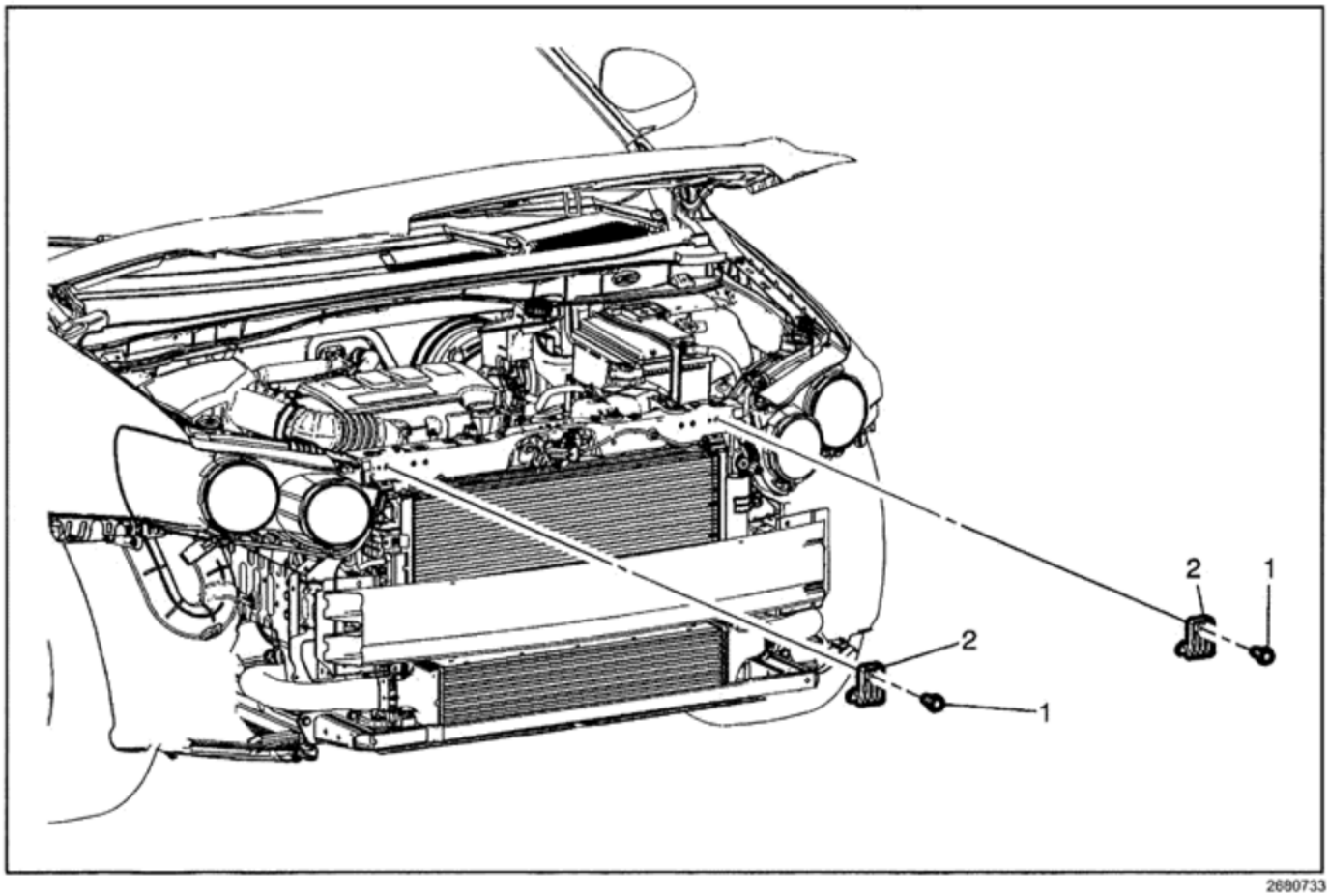
Note: The bolt should not be longer than **35 mm (1.38 in)**.

   - Install the radiator mounting pin (2) with the bolt (1).

Caution: Refer to *Fastener Caution on page 0-8*.

5. Tighten the bolt **5 N·m (44 lb in)**.

Radiator Upper Bracket Replacement

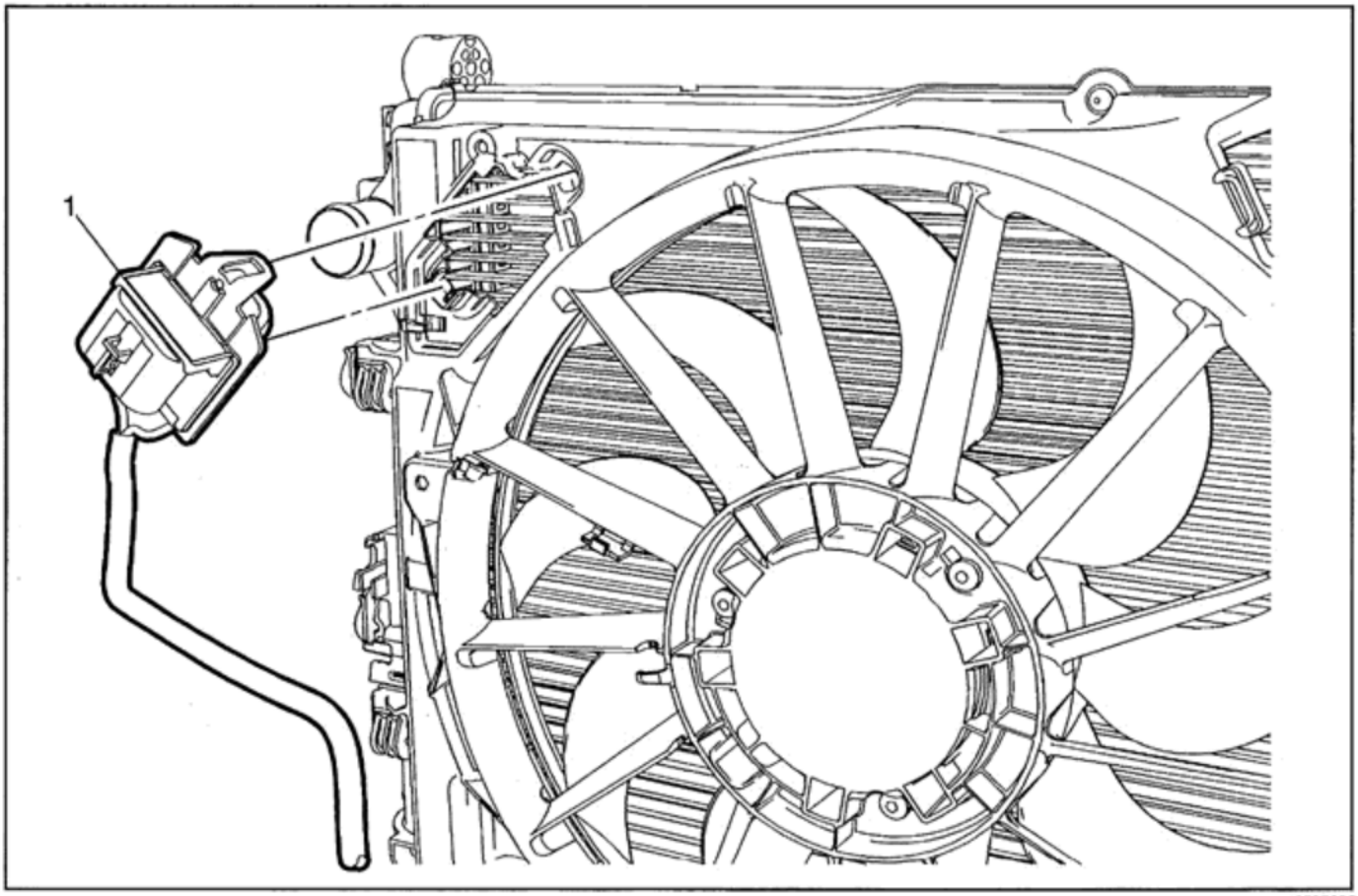


2680733

Radiator Upper Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia assembly. Refer to *Front Bumper Fascia Replacement on page 3-55.*	
1	Radiator Upper Bracket Fasteners (Qty: 2) **Caution:** Refer to *Fastener Caution on page 0-8.* **Tighten** 9N•m(80 lb in)
2	Radiator Upper Bracket (Qty: 2)

Engine Coolant Fan Resistor Mount Repair

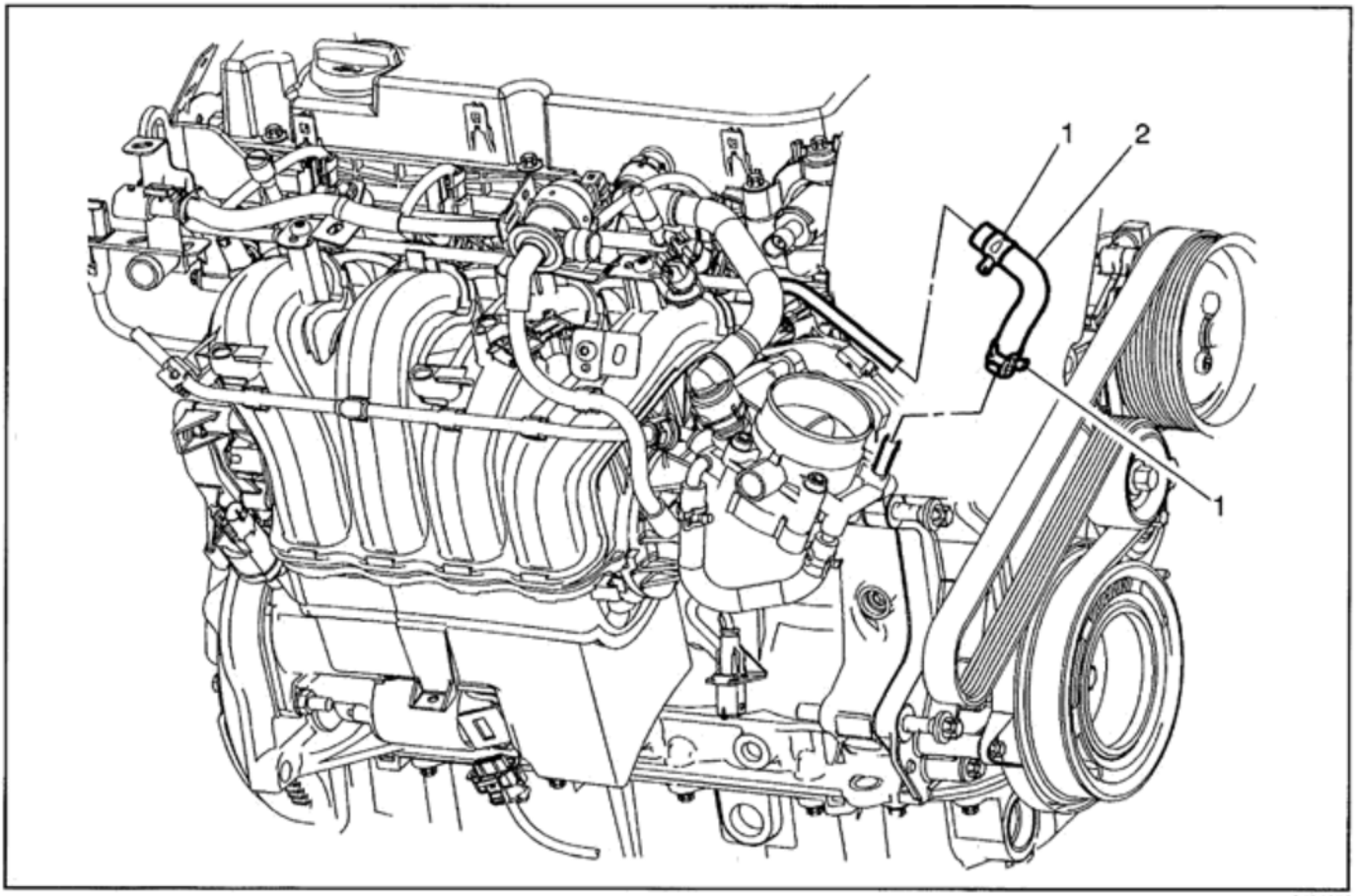


2537265

Engine Coolant Fan Resistor Mount Repair

Callout	Component Name
Preliminary Procedure 1. Remove the fasteners securing the radiator surge tank to the engine shroud and position the surge tank out of the way. Refer to *Radiator Surge Tank Replacement on page 9-630*. 2. Unclip the resistor and mount from the fan shroud.	
1	Engine Coolant Fan Resistor Mount **Procedure** Disconnect the electrical connections.

Throttle Body Heater Inlet Hose Replacement (LUW)

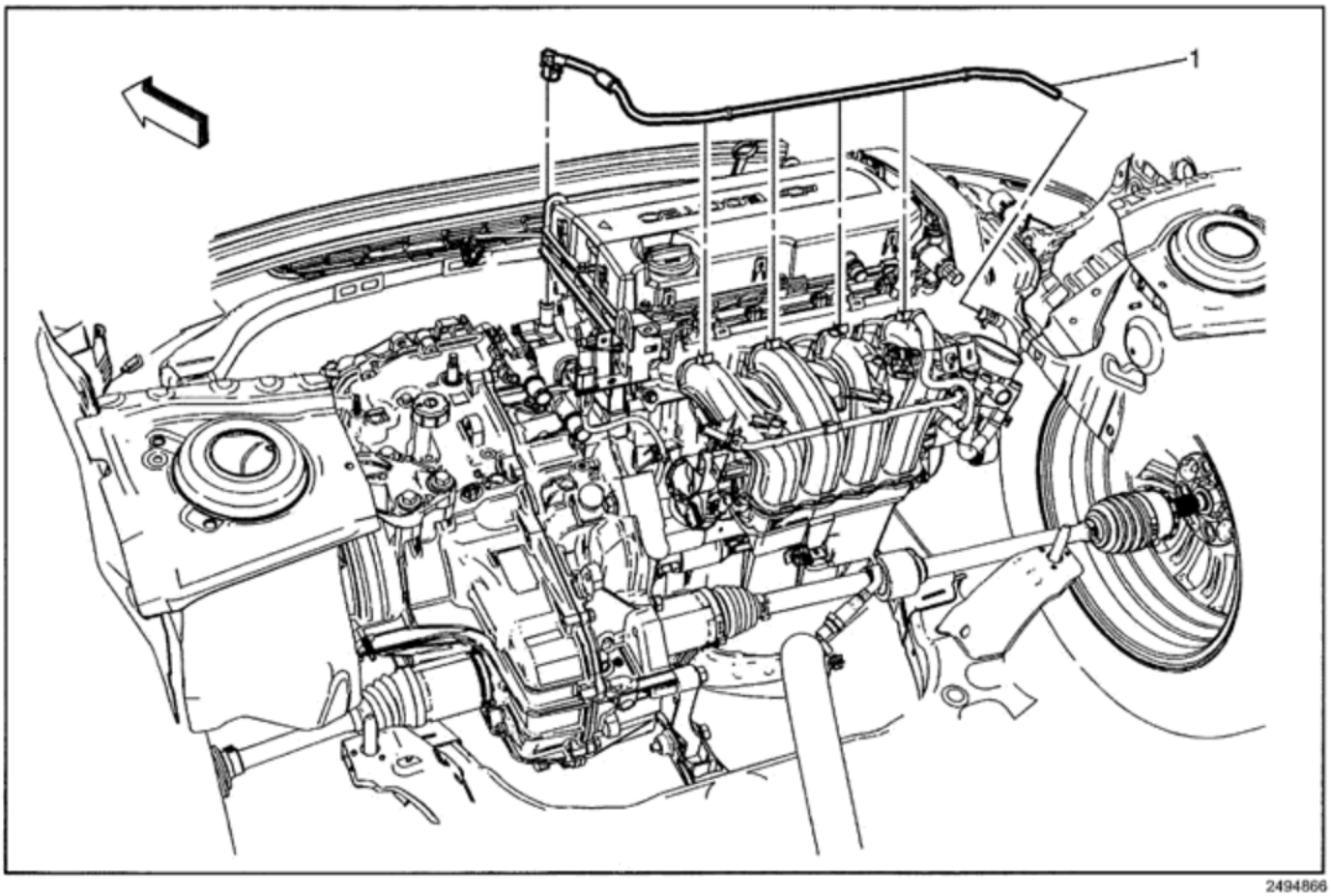


2494859

Throttle Body Heater Inlet Hose Replacement (LUW)

Callout	Component Name
Preliminary Procedure 1. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-580*. 2. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.	
1	Throttle Body Heater Inlet Hose Clamps
2	Throttle Body Heater Inlet Hose **Procedure** Disconnect the throttle body heater inlet hose clamps from the throttle body.

Throttle Body Heater Inlet Pipe Replacement (LUW)

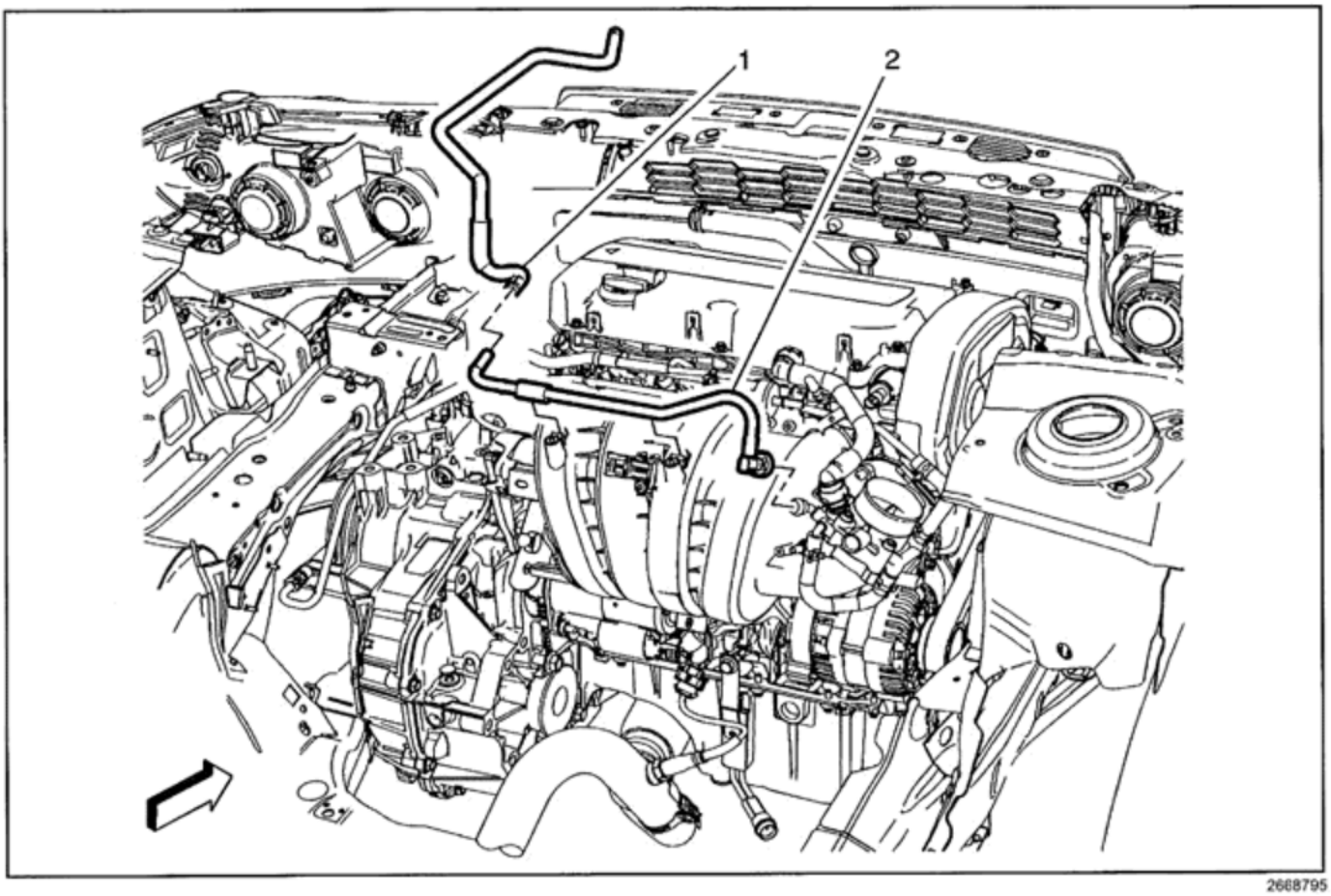


2494866

Throttle Body Heater Inlet Pipe Replacement (LUW)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628.*	
1	Throttle Body Heater Inlet Pipe **Procedure** 1. Disconnect throttle body heater inlet pipe from the thermostat housing. 2. Unclip the throttle body heater inlet pipe from the top of the intake manifold. 3. Remove the throttle body heater inlet pipe from the throttle body heater inlet hose.

Throttle Body Heater Outlet Pipe Replacement (LUW)

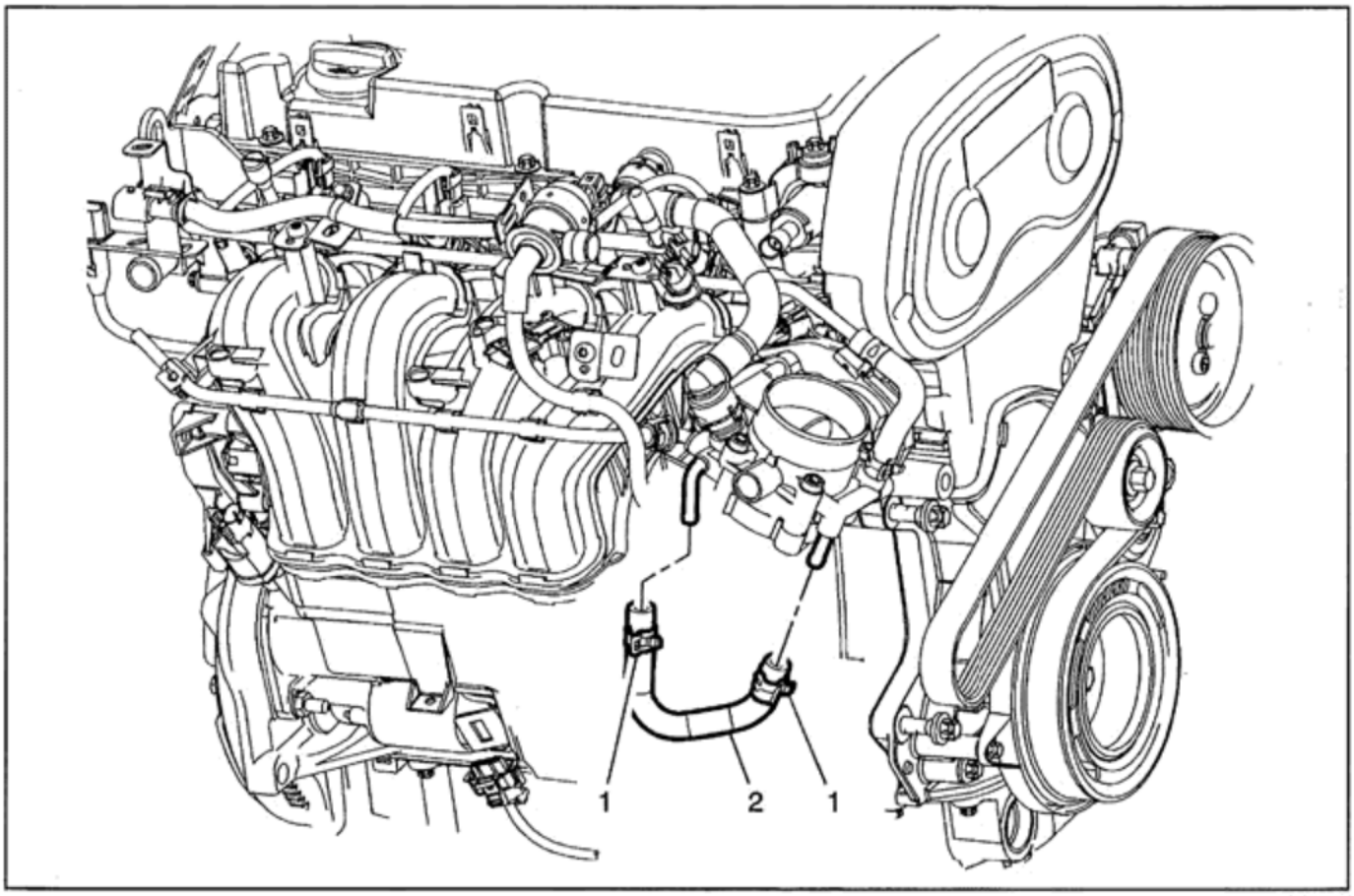


2668795

Throttle Body Heater Outlet Pipe Replacement (LUW)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.	
1	Engine Coolant Air Bleed Hose
2	Throttle Body Heater Outlet Pipe **Procedure** 1. Disconnect throttle body heater outlet pipe from the engine coolant air bleed hose. 2. Unclip the throttle body heater inlet pipe from the middle of the intake manifold. 3. Remove the throttle body heater outlet pipe from the throttle body.

Throttle Body Heater Outlet Hose Replacement (LUW)



2494885

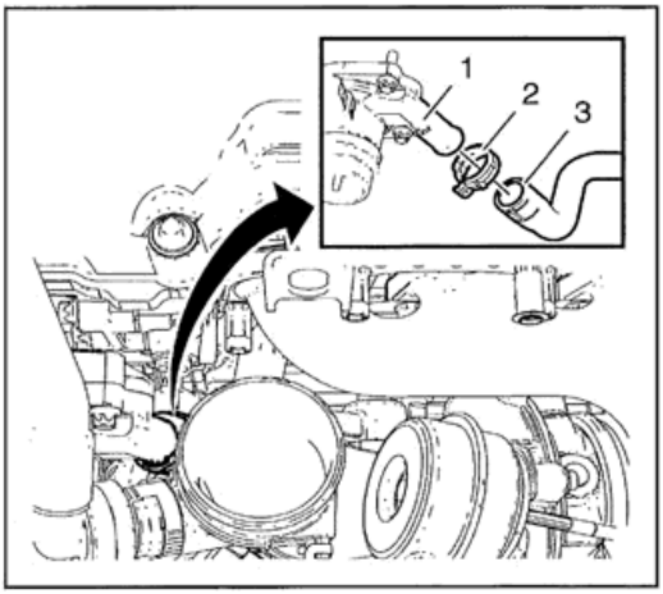
Throttle Body Heater Outlet Hose Replacement (LUW)

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*. 2. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-580*.	
1	Throttle Body Heater Outlet Hose Clamps (Qty: 2)
2	Throttle Body Heater Outlet Hose

Engine Oil Cooler Replacement

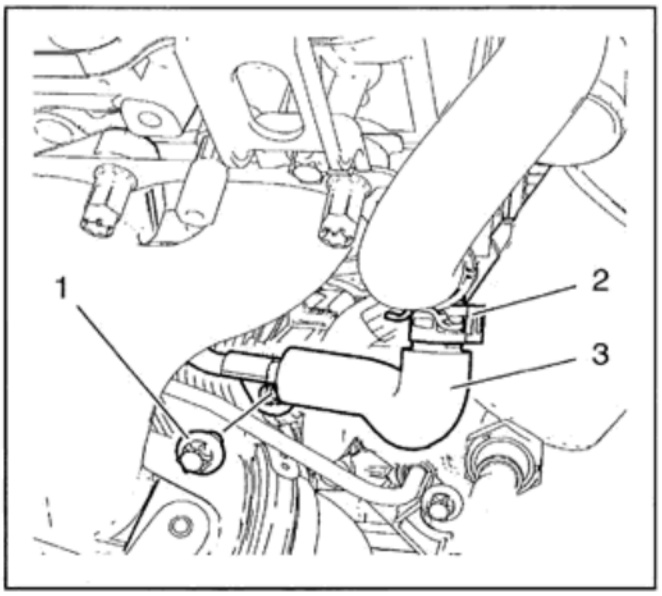
Removal Procedure

1. Disconnect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
2. Drain engine coolant. Refer to *Cooling System Draining and Filling on page 9-628*
3. Remove the turbocharger oil feed pipe. Refer to *Turbocharger Oil Feed Pipe Replacement on page 9-848*.
4. Remove the catalytic converter. Refer to *Catalytic Converter Replacement (LUV) on page 9-742*.
5. Lower vehicle.
6. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.



2371623

7. Remove the oil cooler outlet hose clamp (2).
8. Remove the oil cooler outlet hose (3) from the thermostat housing (1).

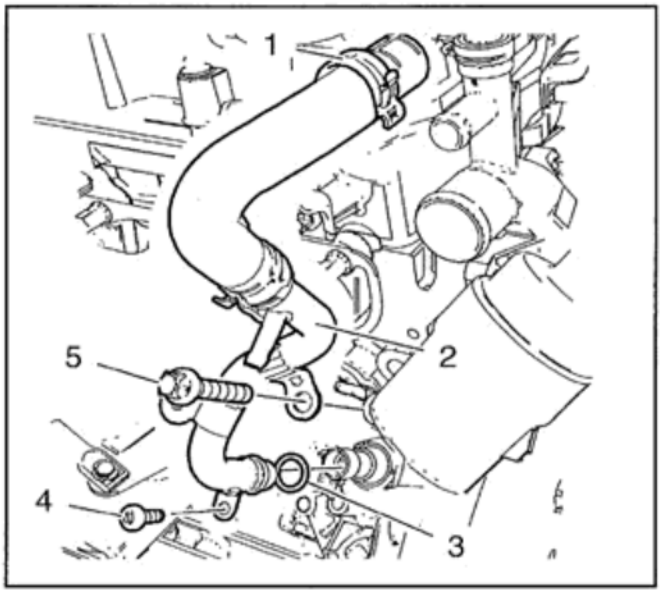


2371624

9. Remove the turbocharger coolant return pipe bolt (1) from the oil cooler housing.
10. Remove the turbocharger coolant return pipe clamp (2).

Note: Do not move the turbocharger coolant return pipe too much. An excessive moving of the turbocharger coolant return pipe could cause leakage.

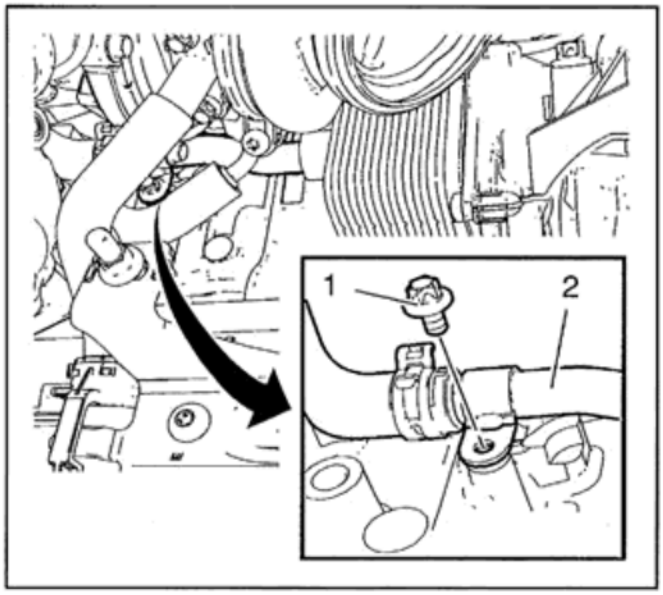
11. Remove the turbocharger coolant return pipe (3) from the oil cooler inlet pipe.
12. Disconnect the oil pressure indicator switch wiring harness plug.



2371629

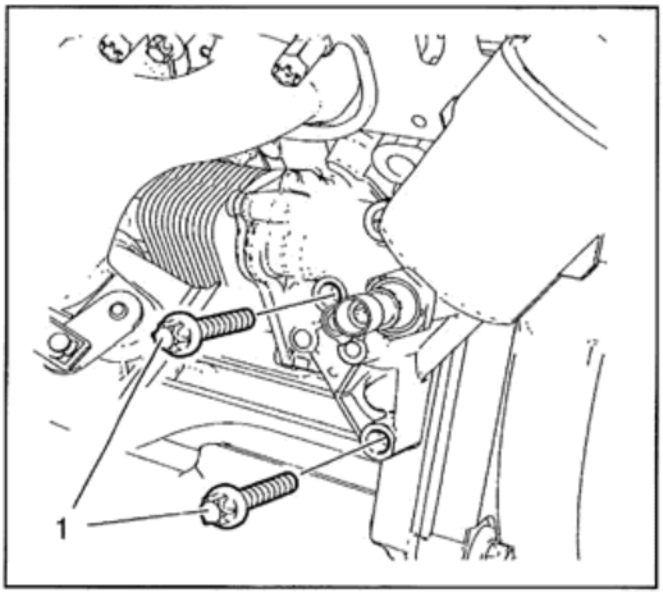
13. Remove the oil cooler inlet hose clamp (1) and remove the oil cooler inlet hose from the water outlet.

14. Remove the engine oil cooler bolt (5).
15. Remove the engine oil cooler inlet pipe bolt (4).
16. Remove the engine oil cooler inlet pipe (2) and the seal ring (3).
17. Raise vehicle.



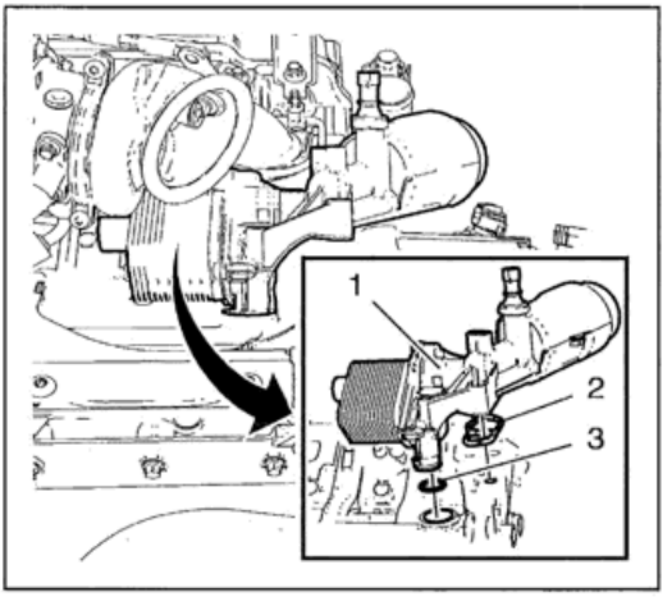
2371625

18. Remove the oil cooler outlet pipe bolt (1) from the engine block.
19. Remove the oil cooler outlet pipe (2) in compound with the oil cooler outlet hose.
20. Lower vehicle.



2371626

21. Remove the 2 oil cooler bolts (1).
22. Raise vehicle.



2371627

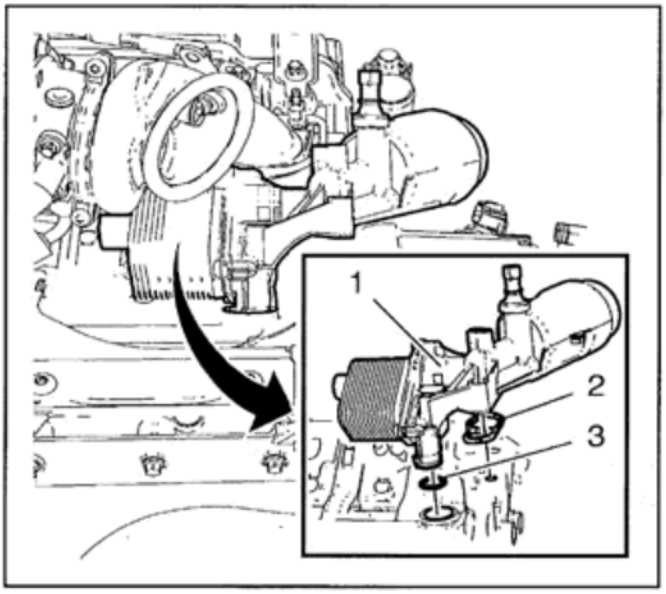
23. Remove the oil cooler (1) in compound with the oil cooler gasket (2) and the seal ring (3).
24. Remove the oil pressure indicator switch from the oil cooler.

Installation Procedure

1. Install the oil pressure indicator switch to the oil cooler. Use a NEW seal ring.

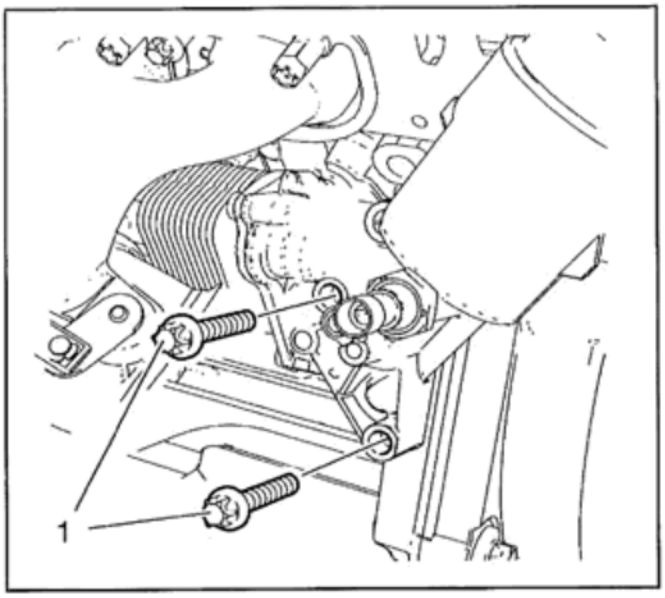
Caution: Refer to *Fastener Caution on page 0-8*.

2. Tighten the oil pressure indicator switch to **20 N•m (15 lb ft)**.



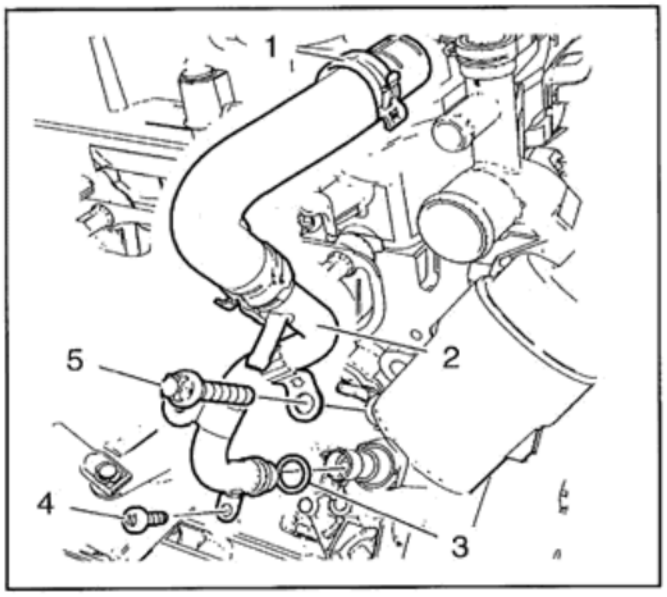
2371627

3. Clean the sealing surfaces.
4. Install the oil cooler (1) in compound with a NEW oil cooler gasket (2) and a NEW seal ring (3).
5. Lower vehicle.



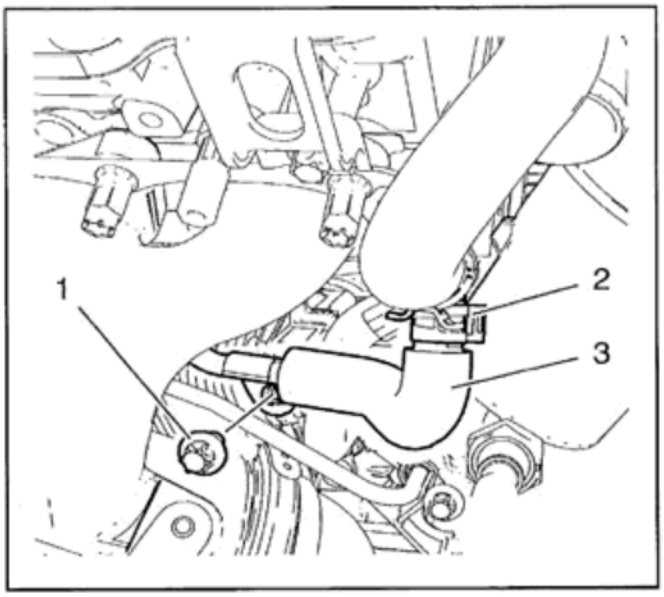
2371626

6. Install the 2 oil cooler bolts (1) and hand tighten.



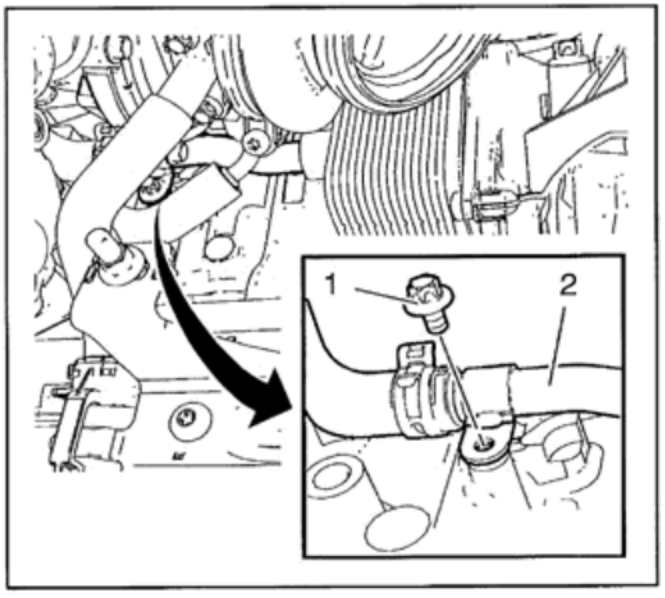
2371629

7. Install the engine oil cooler inlet pipe (2) in compound with a NEW seal ring (3).
8. Install the oil cooler inlet hose to the water outlet and install the oil cooler inlet hose clamp (1).
9. Install the engine oil cooler bolt (5).
10. Install the engine oil cooler inlet pipe bolt (4) and tighten to **10 N•m (89 lb in)**.
11. Tighten the 3 engine oil cooler bolts to **20 N•m (15 lb ft)**.



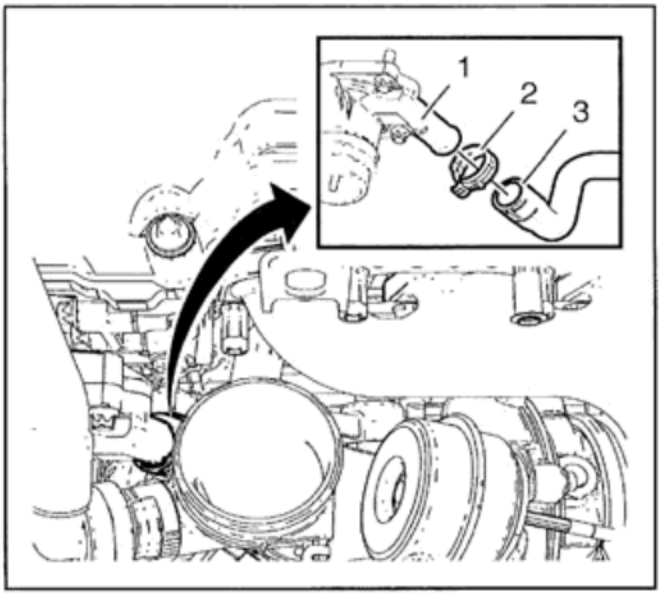
2371624

12. Install the turbocharger coolant return pipe (3) to the oil cooler inlet pipe.
13. Install the turbocharger coolant return pipe clamp (2).
14. Install turbocharger coolant return pipe bolt (1) and tighten to **10 N•m (89 lb in)**.
15. Connect the oil pressure indicator switch wiring harness plug.
16. Raise vehicle.



2371625

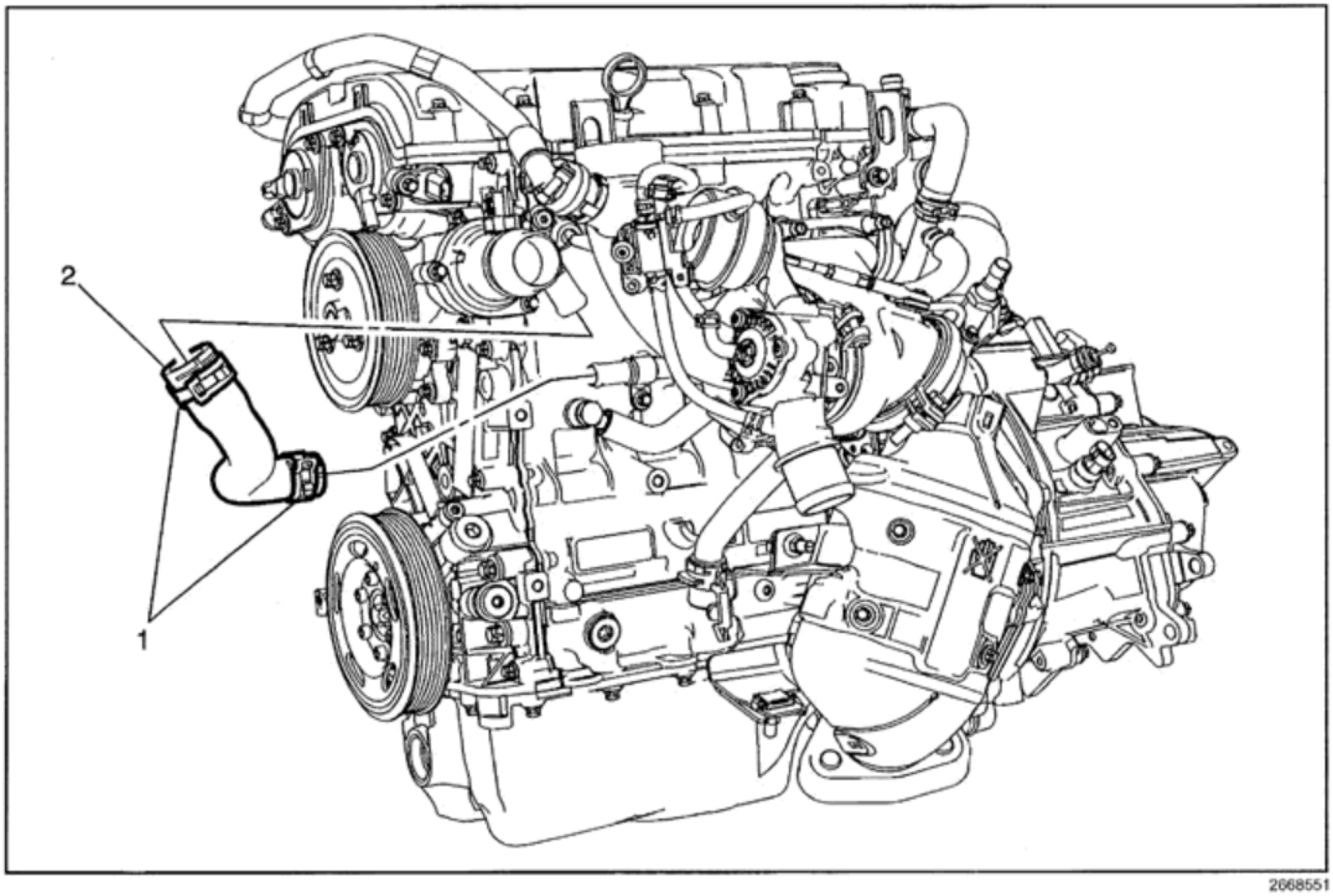
17. Install the oil cooler outlet pipe (2) in compound with the oil cooler outlet hose to the oil cooler.
18. Install the oil cooler outlet pipe bolt (1) to the engine block and tighten to **10 N•m (89 lb in)**.
19. Install the catalytic converter. Refer to *Catalytic Converter Replacement (LUV) on page 9-742*.



2371623

20. Install the oil cooler outlet hose (3) to the thermostat housing (1).
21. Install the oil cooler outlet hose clamp (2).
22. Install the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.
23. Install the turbocharger oil feed pipe and the exhaust manifold heat shield. Refer to *Turbocharger Oil Feed Pipe Replacement on page 9-848*.
24. Connect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
25. Fill engine coolant. Refer to *Cooling System Draining and Filling on page 9-628*.

Engine Oil Cooler Outlet Hose Replacement (LUV)

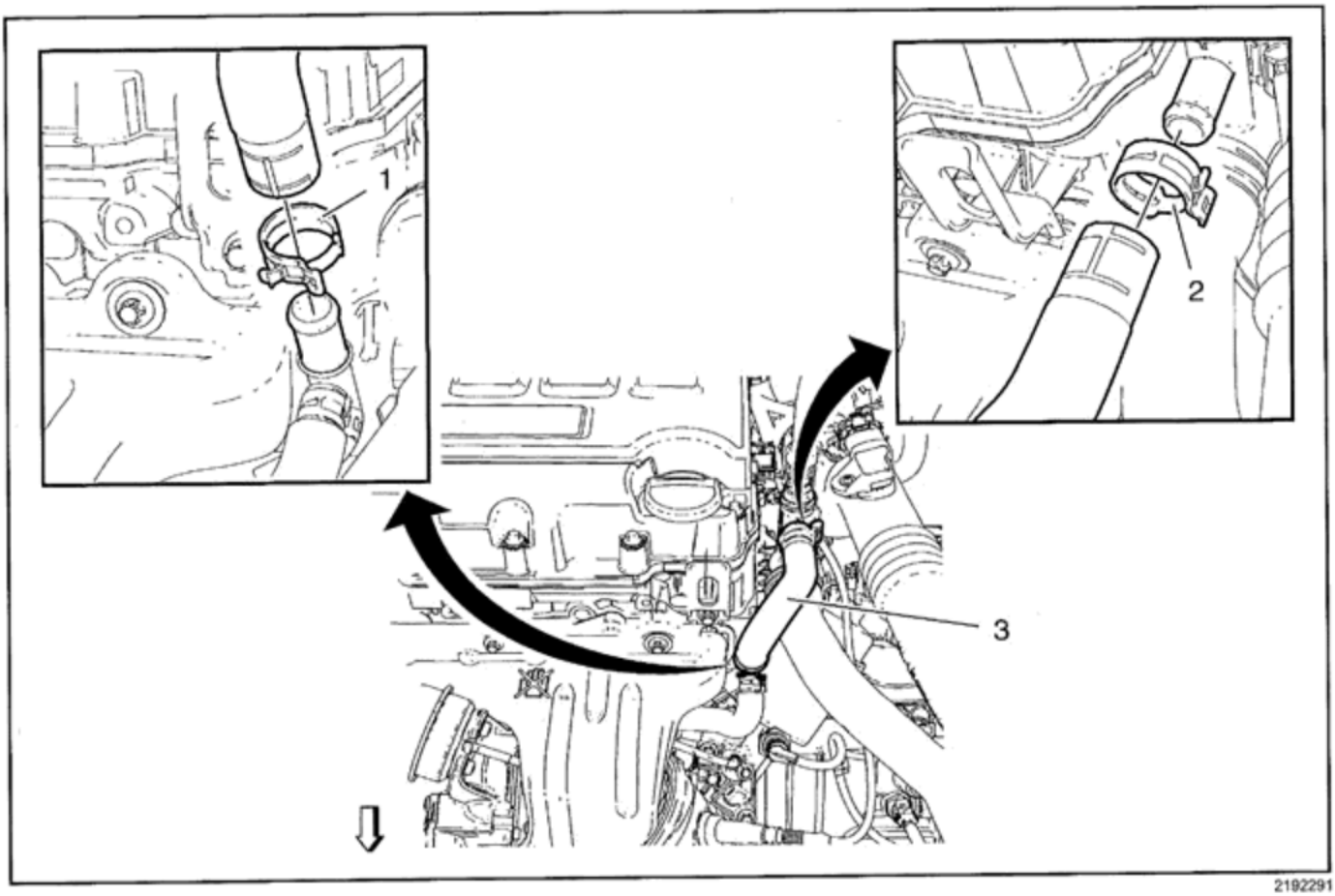


2668551

Engine Oil Cooler Outlet Hose Replacement (LUV)

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628.* 2. Disconnect the radiator outlet hose. Refer to *Radiator Outlet Hose Replacement (LUV) on page 9-635* or *Radiator Outlet Hose Replacement (LDE LUW) on page 9-636.*	
1	Engine Oil Cooler Outlet Hose Clamps (Qty: 2)
2	Engine Oil Cooler Outlet Hose

Engine Oil Cooler Coolant Inlet Hose Replacement (LUV)

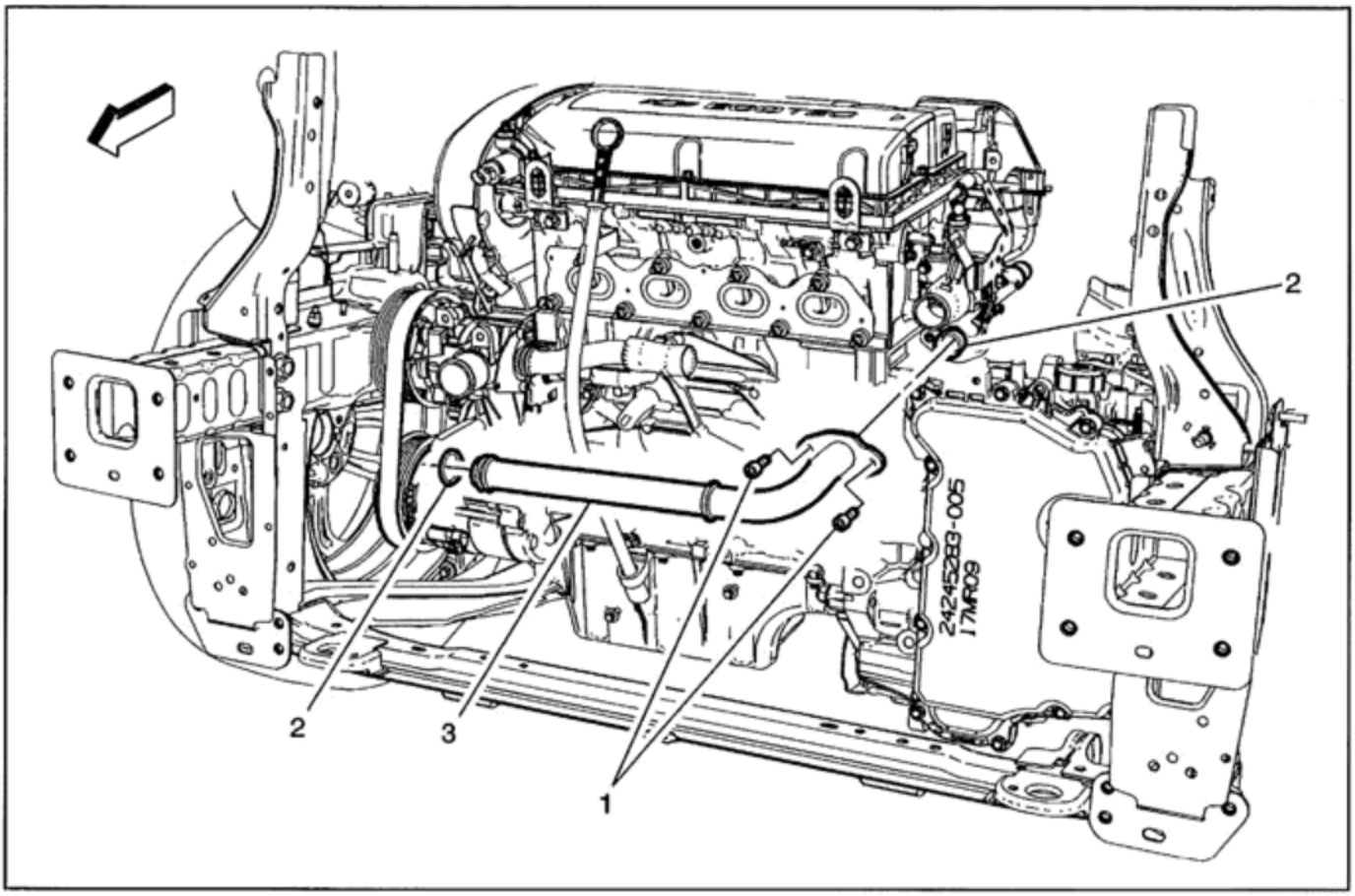


2192291

Engine Oil Cooler Coolant Inlet Hose Replacement (LUV)

Callout	Component Name
Preliminary Procedure 1. Open the hood. 2. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628.*	
1	Oil Cooler Inlet Hose Clamp **Procedure** 1. Place a drain pan below the vehicle. 2. Remove / install engine coolant air bleed hose clamp.
2	Oil Cooler Inlet Hose Clamp **Procedure** 1. Place a drain pan below the vehicle. 2. Remove / install engine coolant air bleed hose clamp.
3	Oil Cooler Inlet Hose

Engine Oil Cooler Pipe Replacement (LUW)



2494879

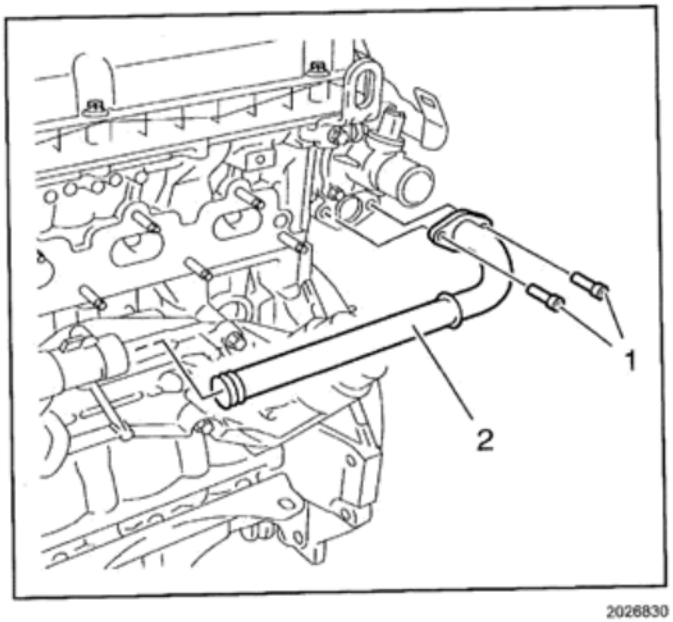
Engine Oil Cooler Pipe Replacement (LUW)

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628.* 2. Remove the exhaust manifold with catalytic converter. Refer to *Exhaust Manifold with Catalytic Converter Replacement (LUW) on page 9-737.*	
1	Engine Oil Cooler Outlet Pipe Fasteners (Qty: 2) **Caution:** Refer to *Fastener Caution on page 0-8.* **Tighten** 8 N•m (71 lb in)
2	Seals **Note:** Replace with NEW seals.
3	Engine Oil Cooler Outlet Pipe

Engine Oil Cooler Inlet Pipe Replacement (LUW)

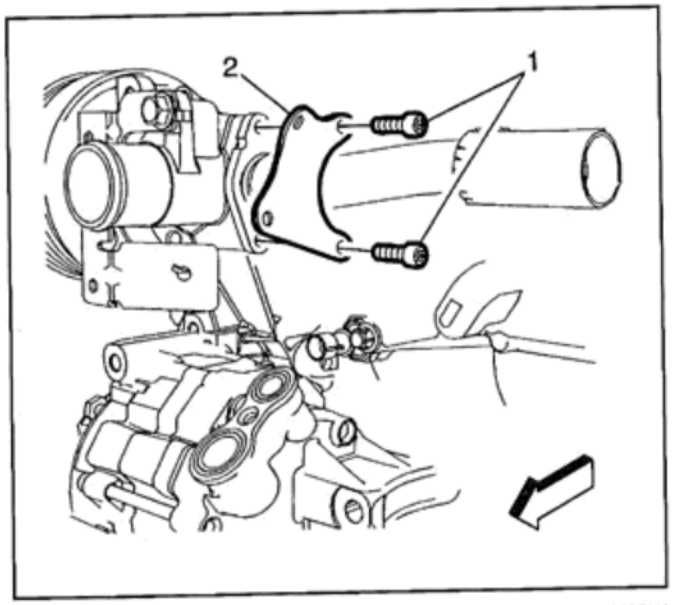
Removal Procedure

1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
2. Remove the exhaust manifold with catalytic converter. Refer to *Exhaust Manifold with Catalytic Converter Replacement (LUW) on page 9-737*.



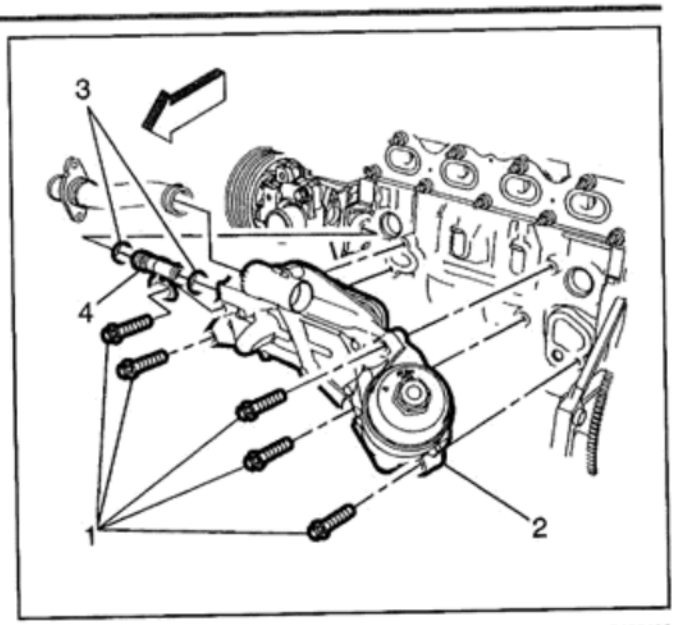
2026830

3. Remove the engine oil cooler pipe bolts (1) and the engine oil cooler pipe (2).



2495111

4. Remove the engine oil cooler outlet pipe bolts (1) and the engine oil cooler outlet pipe bracket (2).

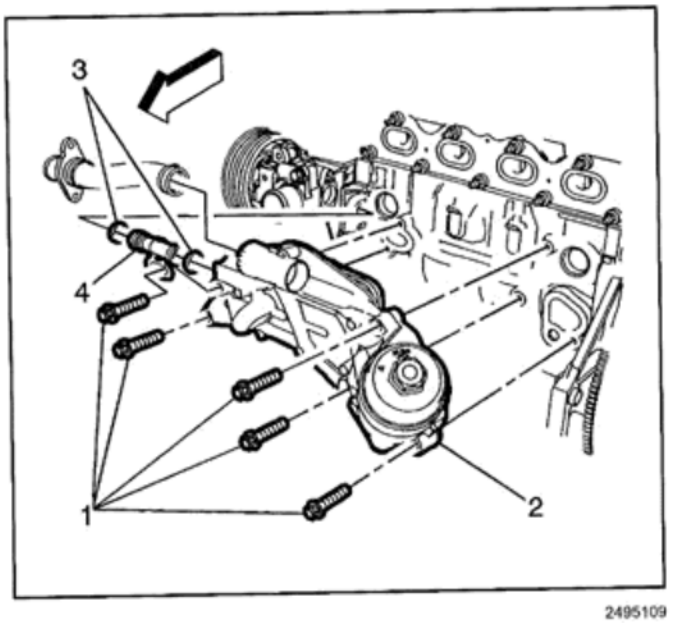


2495109

5. Remove the engine oil cooler assembly bolts (1) and remove the cooler (2).
6. Remove the engine oil cooler inlet pipe (4) and seals (3).

Installation Procedure

1. Replace the seals on the engine oil cooler outlet pipe and the engine oil cooler pipe.

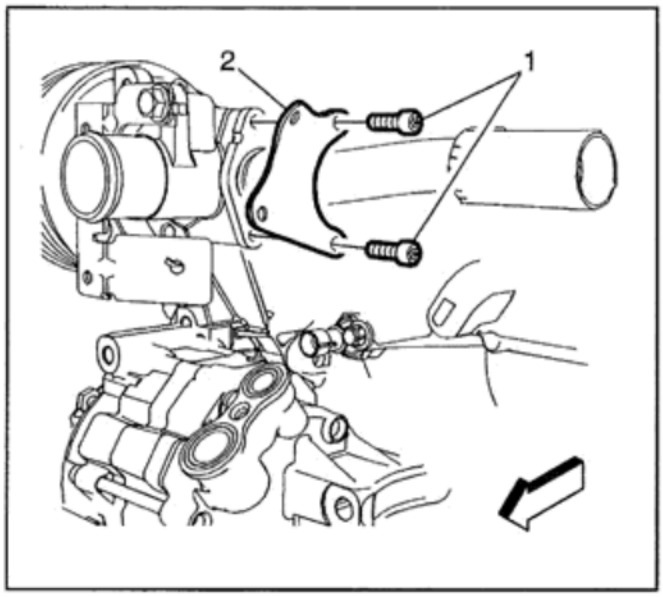


2495109

2. Install the engine oil cooler inlet pipe (4) with NEW seals (3) to the engine oil cooler assembly.
3. Position the engine oil cooler assembly (2) to the engine block.

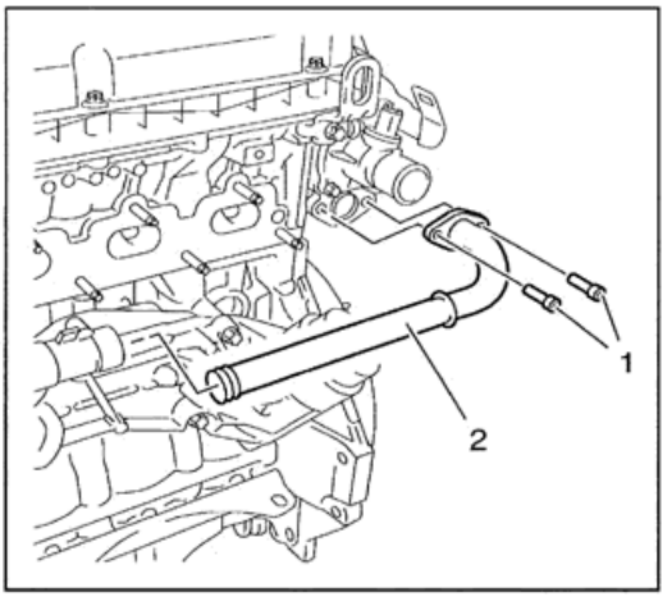
Caution: Refer to *Fastener Caution on page 0-8*.

4. Install the engine oil cooler assembly bolts (1) and tighten to **25** N•m **(19 lb ft)**.



2495111

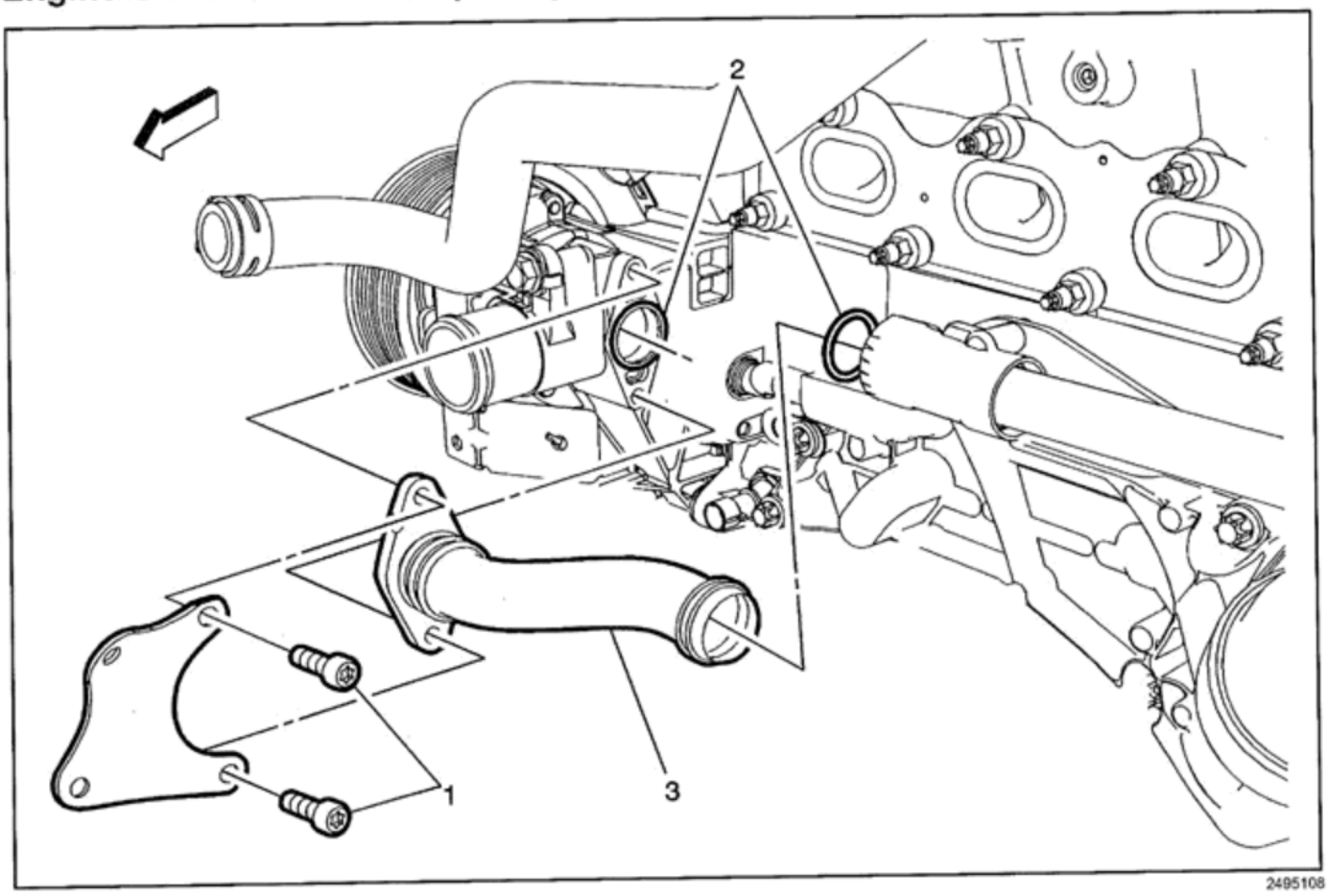
5. Install the engine oil cooler outlet pipe mounting bolts (1) and the bracket (2) to the water pump housing and tighten to **8** N•m **(71 lb in)**.



2026830

6. Install the engine oil cooler pipe (3) to the thermostat housing and tighten bolts (1) to **8** N•m **(71 lb in)**.
7. Install the exhaust manifold with catalytic converter. Refer to *Exhaust Manifold with Catalytic Converter Replacement (LUW) on page 9-737*.
8. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
9. Start the engine and check for coolant leaks.

Engine Oil Cooler Outlet Pipe Replacement (LUW)



2495108

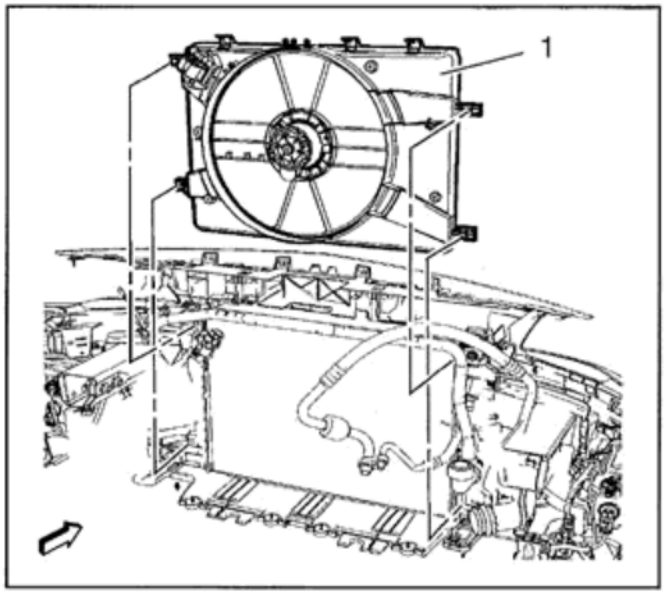
Engine Oil Cooler Outlet Pipe Replacement (LUW)

Callout	Component Name
Preliminary Procedure Remove the engine oil cooler pipe. Refer to *Engine Oil Cooler Pipe Replacement (LUW) on page 9-651*.	
1	Engine Oil Cooler Outlet Pipe Bolt (Qty: 2) **Caution:** Refer to *Fastener Caution on page 0-8*. **Tighten** 8 N•m (71 lb in)
2	Seals **Note:** Replace with NEW seals.
3	Engine Oil Cooler Outlet Pipe

Engine Coolant Fan Replacement (LDE/LUW)

Removal Procedure

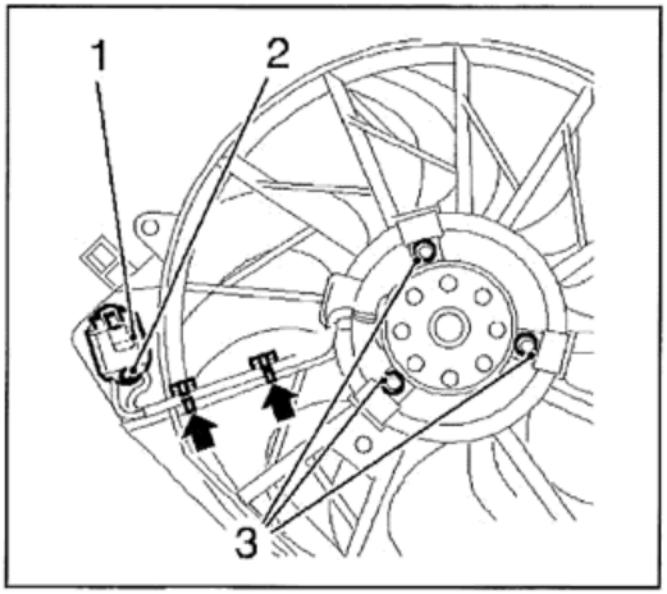
1. Unclip transmission cooler lines from shroud if equipped.
2. Unclip radiator surge tank outlet hose from fan shroud.
3. Disconnect the engine coolant fan wiring harness.



2191512

Note: You stand against driving direction.

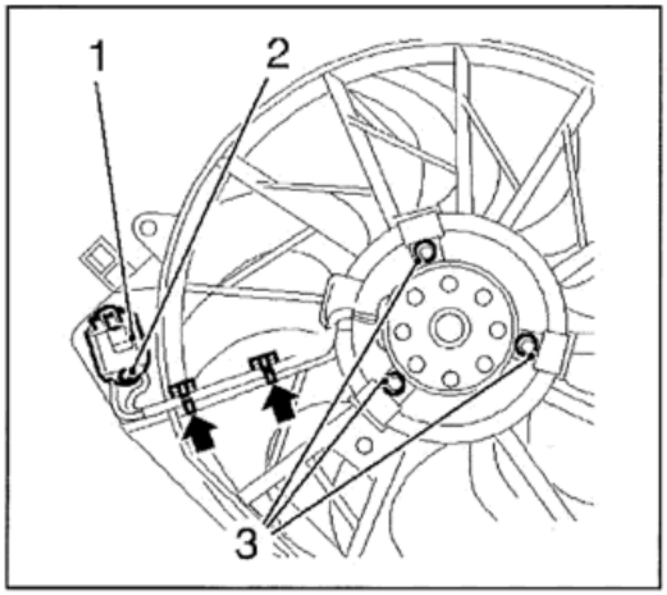
4. Unclip the engine coolant fan shroud (1) at the shown four mounting points.
5. Remove the engine coolant fan shroud (1).



1936663

6. Remove the engine coolant fan resistor (1) by unclipping the retainer clip (2).
7. Unclip the engine coolant fan to engine coolant fan resistor wiring harness (arrows).
8. Remove the 3 engine coolant fan engine bolts (3) from the engine coolant fan.
9. Remove the engine coolant fan.

Installation Procedure

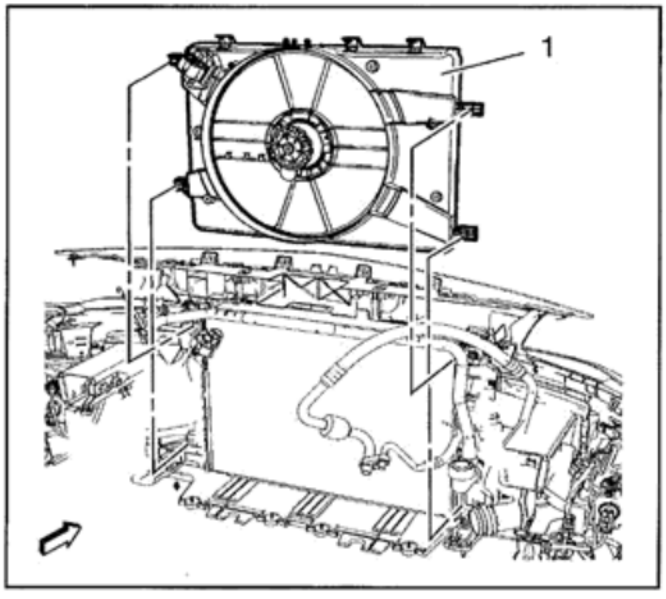


1936663

1. Install the engine coolant fan.

Caution: Refer to *Fastener Caution on page 0-8*

2. Install the 3 engine coolant fan engine bolts (3) to the engine coolant fan and tighten to **4 N•m (35 lb in)**.
3. Clip in the engine coolant fan to the engine coolant fan resistor wiring harness (arrows).
4. Install the engine coolant fan resistor (1) by clipping the retainer clip (2).

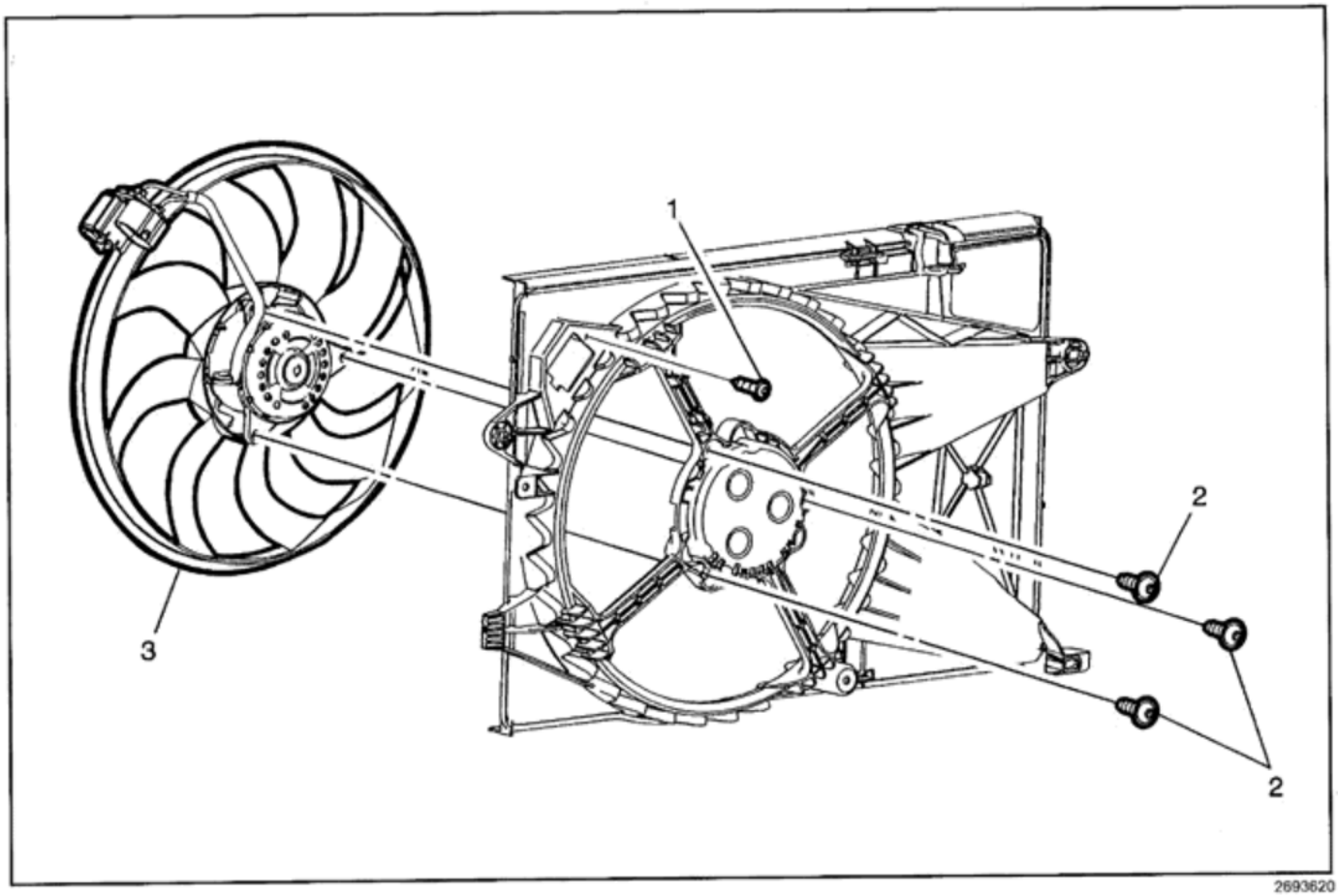


2191512

5. Install the engine coolant fan shroud (1).
6. Clip in the engine coolant fan shroud (1) at the shown four mounting points.

7. Connect the engine coolant fan wiring harness.
8. Clip the radiator surge tank outlet hose to the fan shroud.
9. Clip the transmission cooler lines to the fan shroud if equipped.

Engine Coolant Fan Replacement (LUV)

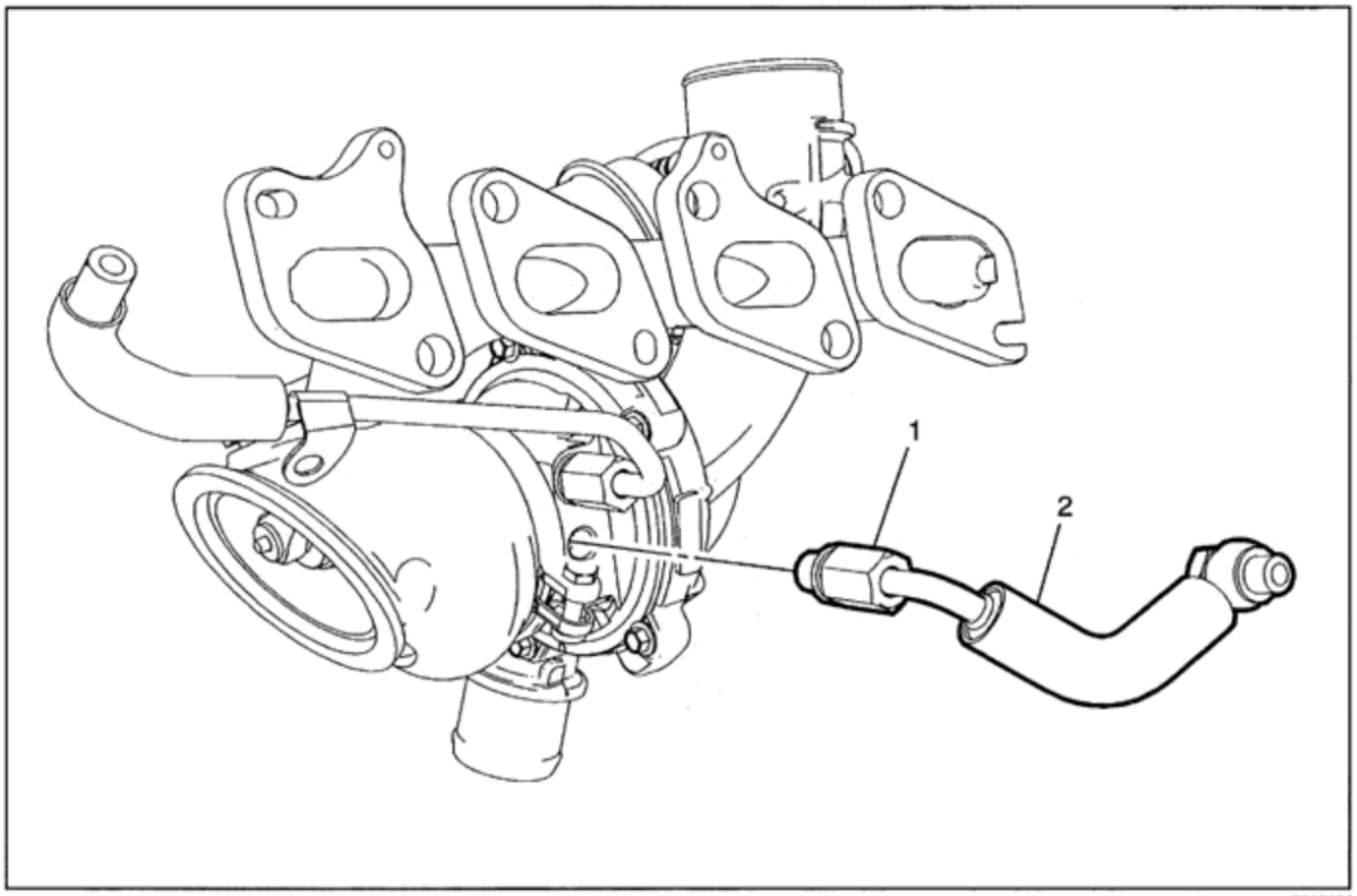


2693620

Engine Coolant Fan Replacement (LUV)

Callout	Component Name
Preliminary Procedure Remove the engine coolant fan shroud. Refer to *Engine Coolant Fan Shroud Replacement (LDE LUW) on page 9-675* or *Engine Coolant Fan Shroud Replacement (LUV) on page 9-674*.	
1	Engine Coolant Fan Motor Electrical Harness Connector Fastener **Caution:** Refer to *Fastener Caution on page 0-8*.
2	Engine Coolant Fan Motor Fastener (Qty: 3)
3	Engine Coolant Fan Motor Assembly

Turbocharger Coolant Feed Pipe Replacement (LUV)

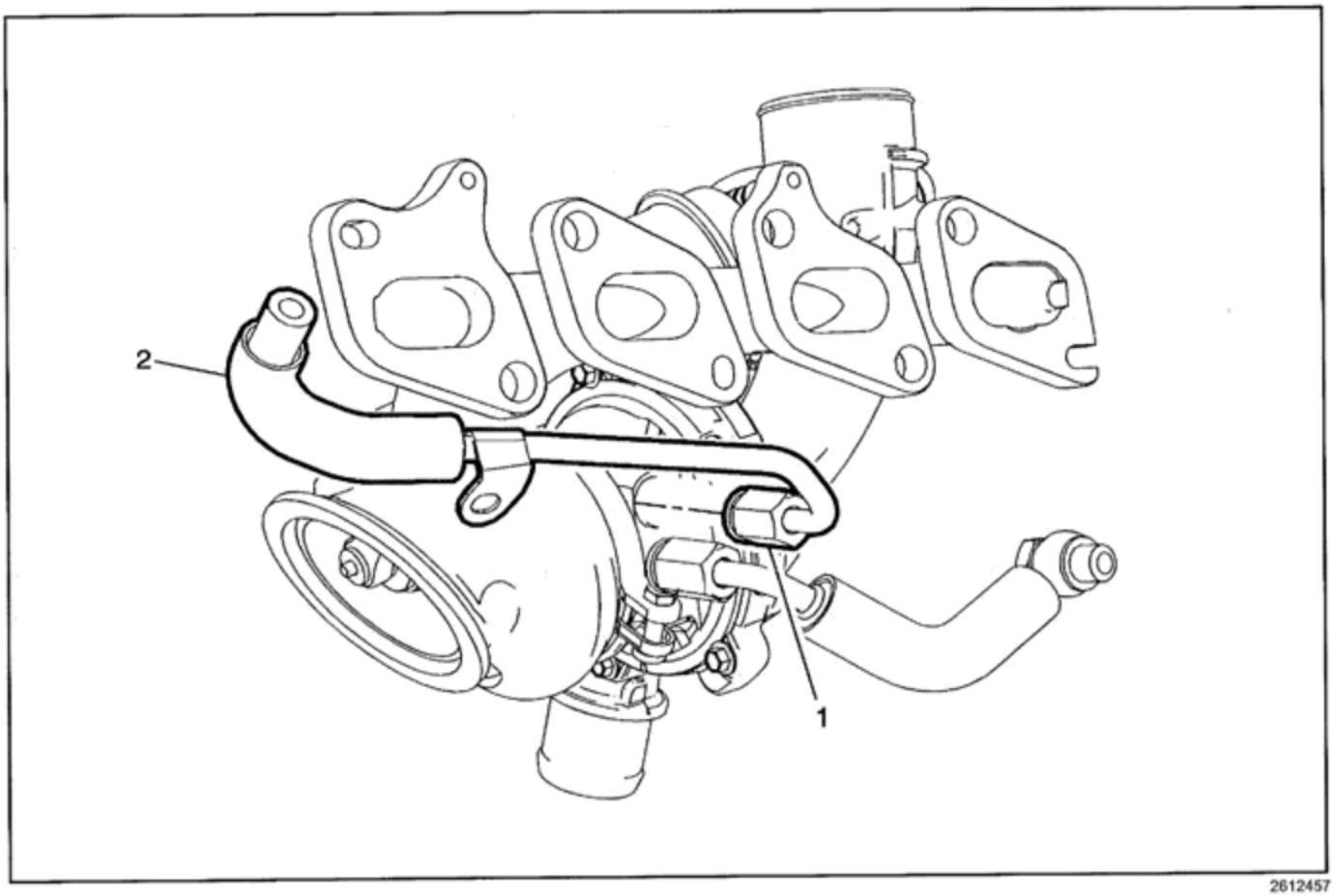


2612424

Turbocharger Coolant Feed Pipe Replacement (LUV)

Callout	Component Name
Preliminary Procedure Remove the turbocharger. Refer to *Turbocharger Replacement on page 9-843*.	
1	Turbocharger Fastener **Caution:** Refer to *Fastener Caution on page 0-8*. **Procedure** Replace seals with NEW seals. **Tighten** 8 N•m (71 lb in)
2	Turbocharger Coolant Feed Pipe

Turbocharger Coolant Return Pipe Replacement (LUV)



2612457

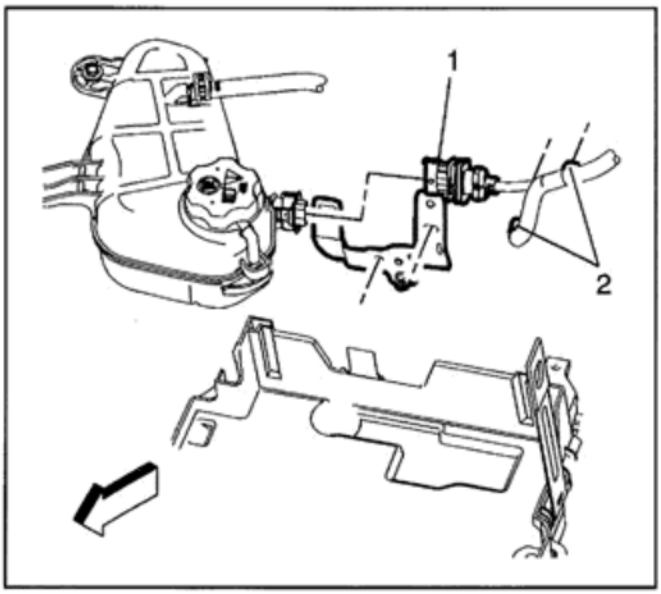
Turbocharger Coolant Return Pipe Replacement (LUV)

Callout	Component Name
Preliminary Procedure Remove the turbocharger. Refer to *Turbocharger Replacement on page 9-843*.	
1	Turbocharger Fastener **Caution:** Refer to *Fastener Caution on page 0-8*. **Procedure** Replace seals with NEW seals. **Tighten** 8 N•m (71 lb in)
2	Turbocharger Coolant Return Pipe

Engine Coolant Thermostat Housing Replacement (LUW)

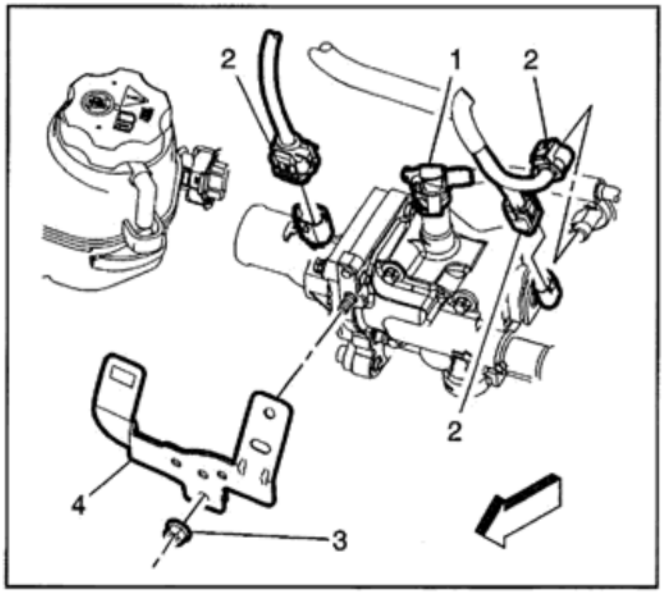
Removal Procedure

1. Remove the battery tray. Refer to *Battery Tray Replacement on page 9-721*.
2. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
3. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.



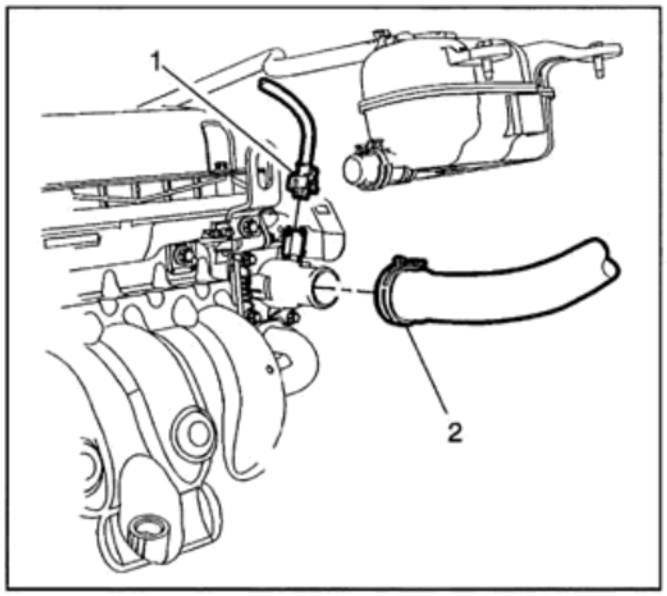
2494854

4. Disconnect the engine harness connector (1) and harness fasteners (2) from the engine harness bracket, attached to the thermostat housing.



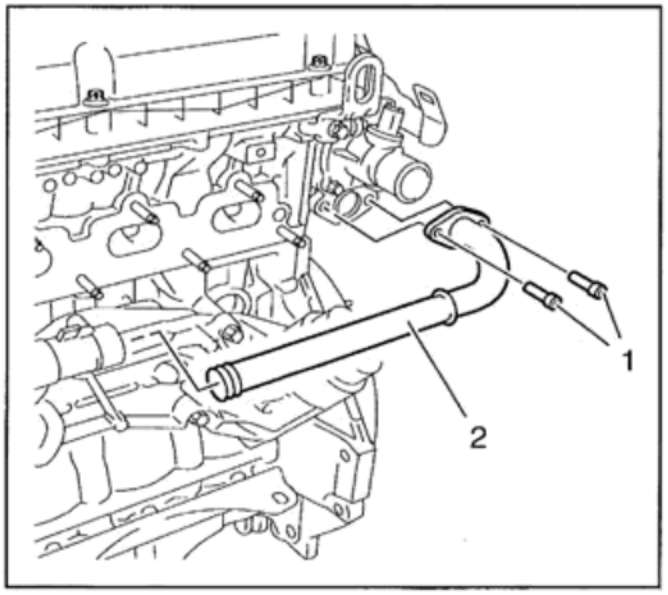
2494855

5. Disconnect the throttle body heater inlet hose (1) and the electrical connectors (2) from the thermostat housing.
6. Remove the engine harness bracket nut (3) and bracket (4) from the thermostat housing.



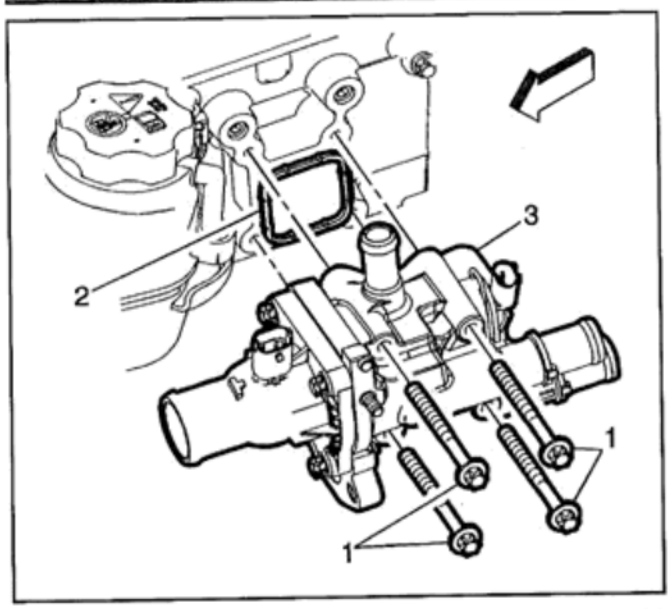
2494826

7. Remove the radiator inlet hose (2) from the engine coolant thermostat housing.
8. Remove the heater outlet hose from the engine coolant thermostat housing. Refer to *Heater Outlet Hose Replacement (LUV) on page 10-40* or *Heater Outlet Hose Replacement (LDE, LUW) on page 10-40*.
9. Remove the heater inlet hose from the engine coolant thermostat housing. Refer to *Heater Inlet Hose Replacement (LDE, LUW) on page 10-38* or *Heater Inlet Hose Replacement (LUV) on page 10-38*.



2026830

10. Remove the engine oil cooler outlet pipe bolts (1).
11. Remove the engine oil cooler outlet pipe (2) from the engine coolant thermostat housing.

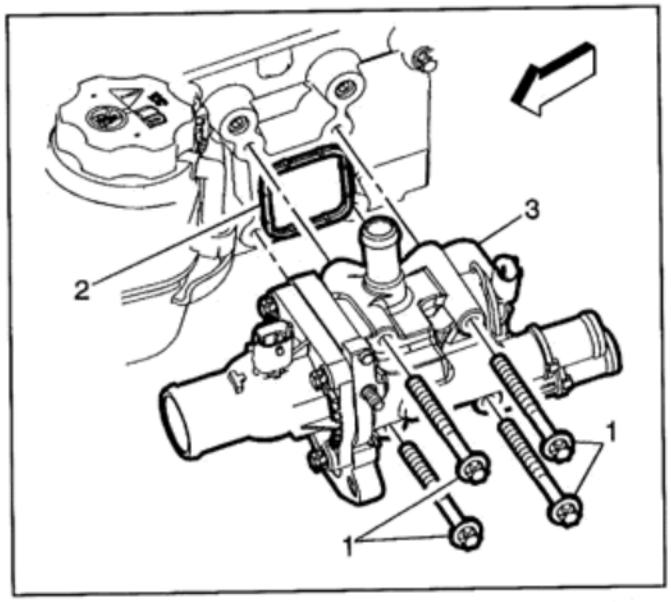


2494857

12. Remove the engine coolant thermostat housing mounting bolts (1) and discard the seal (2).
13. Remove the engine coolant thermostat housing (3) from the engine.

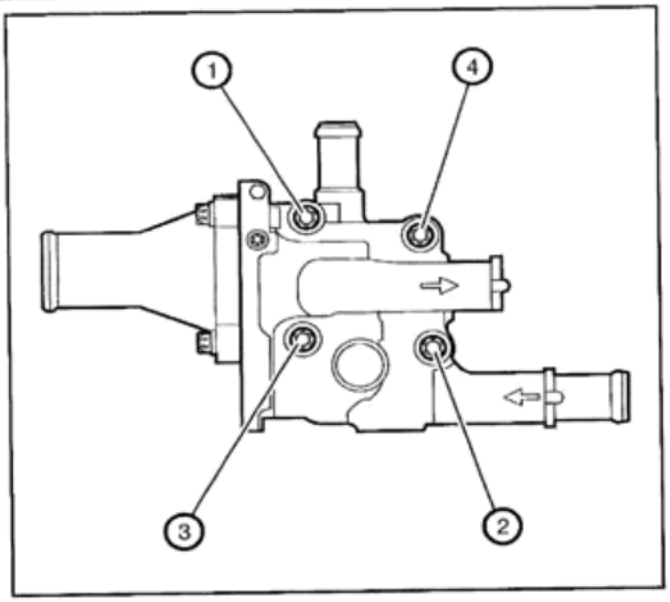
Installation Procedure

1. Clean the sealing surface.



2494857

2. Install a NEW engine coolant thermostat housing seal (2).
3. Loosely install the engine coolant thermostat housing mounting bolts (1).

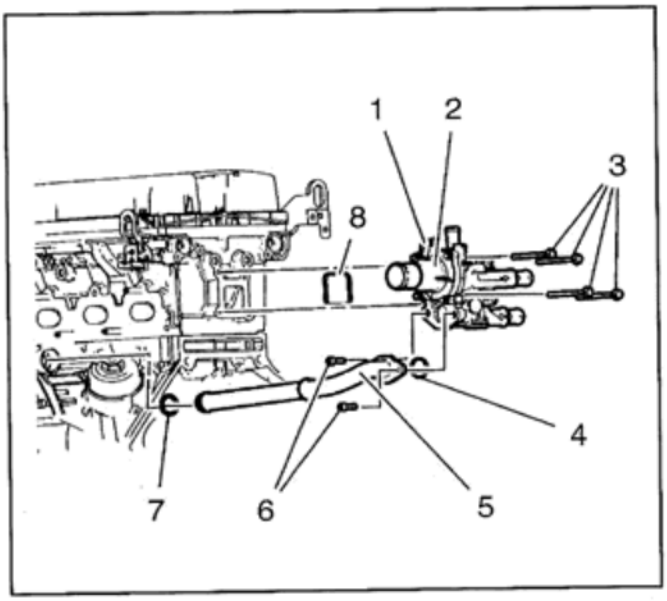


2028129

Caution: Following the proper fastener tightening sequence and torque is essential. Failure to do so may fracture the thermostat housing.

Caution: Refer to *Fastener Caution on page 0-8*.

4. Tighten the 4 engine coolant thermostat housing bolts to **8 N•m (71 lb in)** in sequence (1–2–3–4).



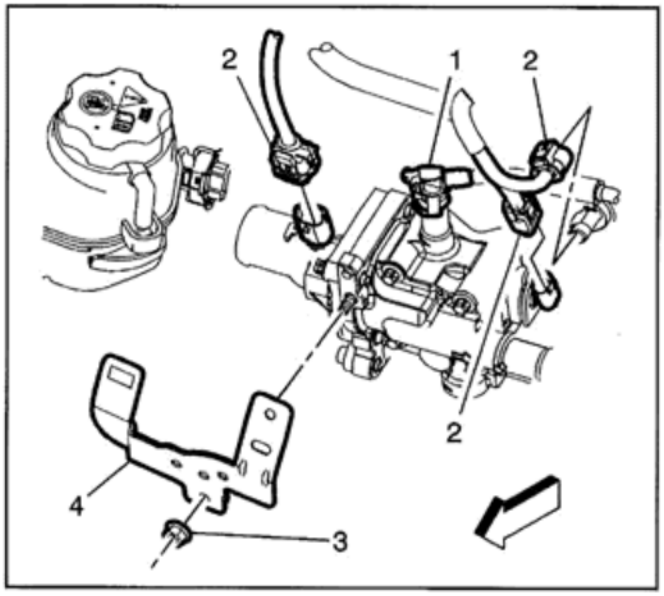
2028128

5. Install NEW engine oil cooler pipe seals (4, 7).

Note: Push the engine oil cooler pipe into the engine oil cooler.

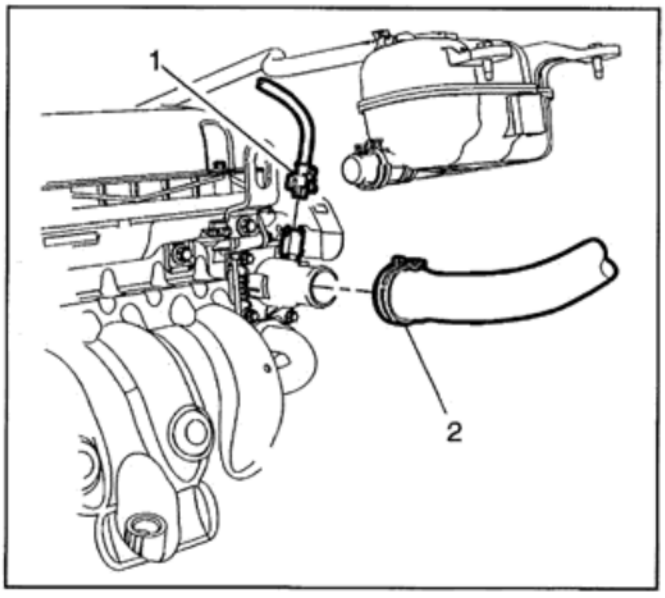
6. Install the engine oil cooler pipe (5).
7. Install the 2 engine oil cooler pipe bolts (6) and tighten to **8 N•m (71 lb in)**.
8. Install the heater inlet hose to the engine coolant thermostat housing. Refer to *Heater Inlet Hose Replacement (LDE, LUW) on page 10-38* or *Heater Inlet Hose Replacement (LUV) on page 10-38*.

9. Install the heater outlet hose to the engine coolant thermostat housing. Refer to *Heater Outlet Hose Replacement (LUV) on page 10-40* or *Heater Outlet Hose Replacement (LDE, LUW) on page 10-40*.



2494855

10. Connect the electrical connectors (2) to the engine coolant thermostat housing.
11. Install the throttle body heater inlet hose (1) to the engine coolant thermostat housing.
12. Install the engine coolant thermostat housing bracket (4) and nut (3) and tighten to **6 N•m (53 lb in)**.



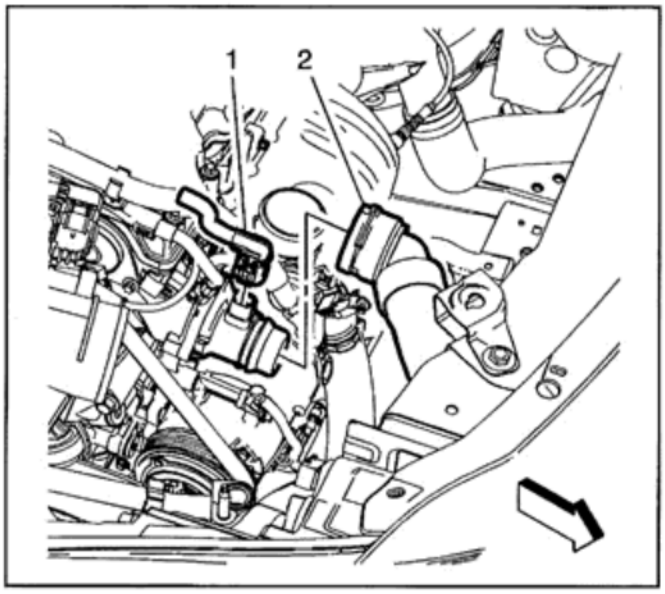
2494826

13. Install the radiator inlet hose (2) to the engine coolant thermostat housing.
14. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
15. Install the battery tray. Refer to *Battery Tray Replacement on page 9-721*.
16. Start the engine and check for coolant leaks.

Engine Coolant Thermostat Replacement (LUV)

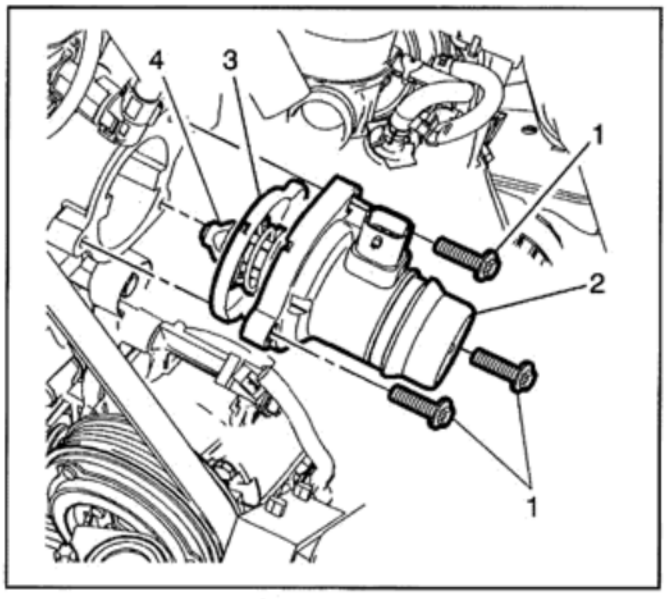
Removal Procedure

1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
2. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.



2612519

3. Remove the engine coolant temperature sensor connector (1) and the radiator outlet hose (2).

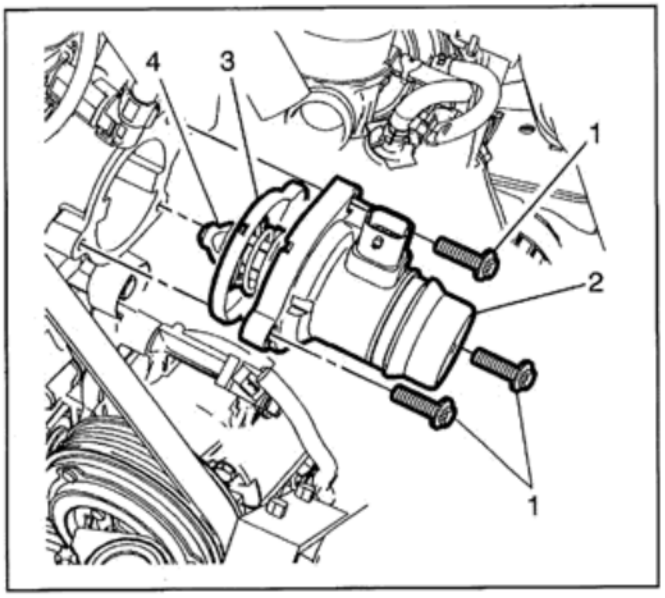


2612518

4. Remove the water inlet pipe mounting fasteners (1).
5. Remove the water inlet seal (3) and discard.
6. Remove the thermostat (4).

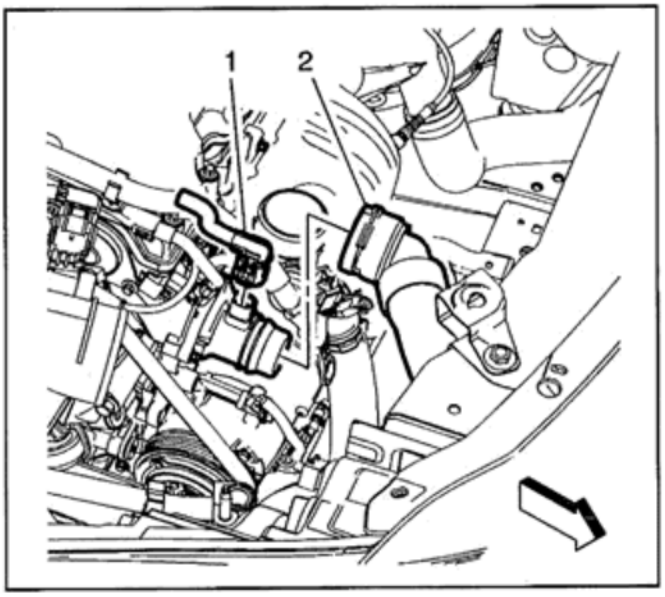
Installation Procedure

1. Clean the sealing surface.



2812518

2. Install the engine thermostat (4) into the water inlet pipe (2) with a NEW seal (3).
3. Tighten the water inlet pipe mounting fasteners (1) to **9 N•m (80 lb in)**.



2612519

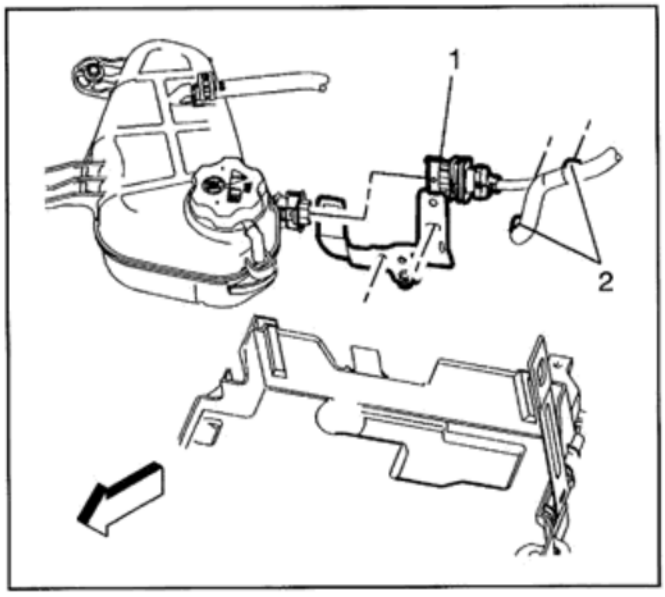
4. Install the radiator outlet hose (2) to the water inlet pipe.
5. Connect the engine coolant temperature sensor connector (1).
6. Install the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288.*
7. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628.*
8. After repairs, inspect cooling system for leaks.

Engine Coolant Thermostat Replacement (LUW)

Removal Procedure

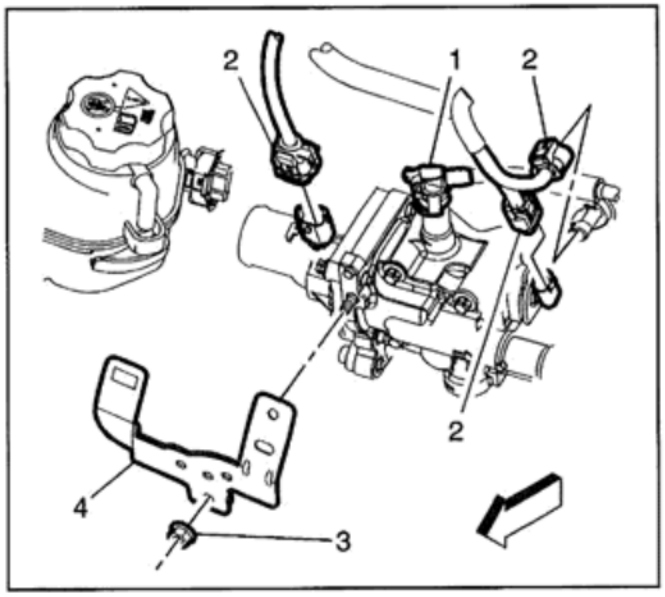
Warning: Refer to Battery Disconnect Warning on page 0-4.

1. Disconnect the battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713.*
2. Drain the coolant. Refer to *Cooling System Draining and Filling on page 9-628.*



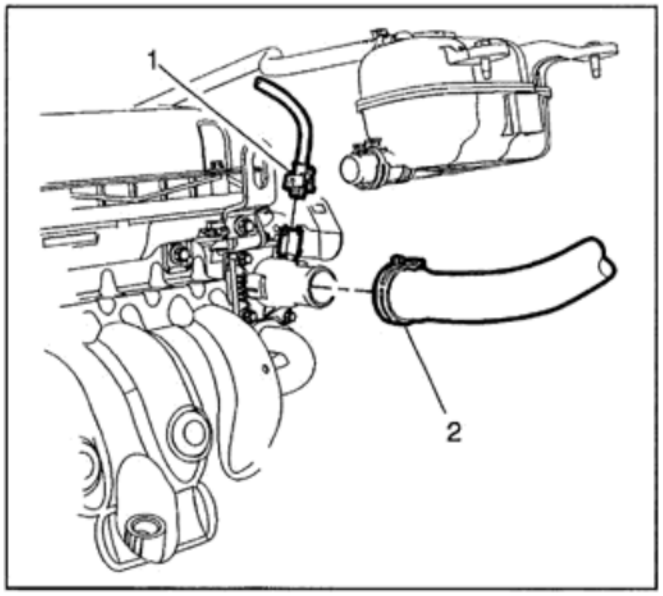
2494854

3. Disconnect the engine wiring harness connector (1) and retainers (2).



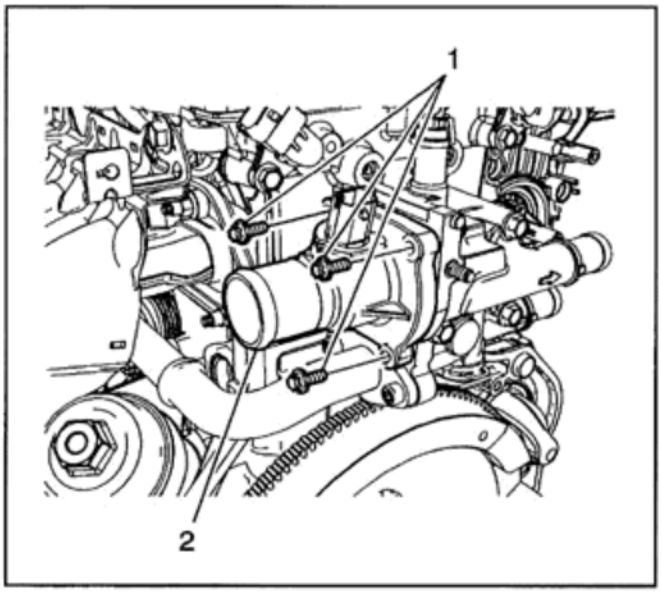
2494855

4. Remove the wiring harness bracket nut (3) and bracket (4).



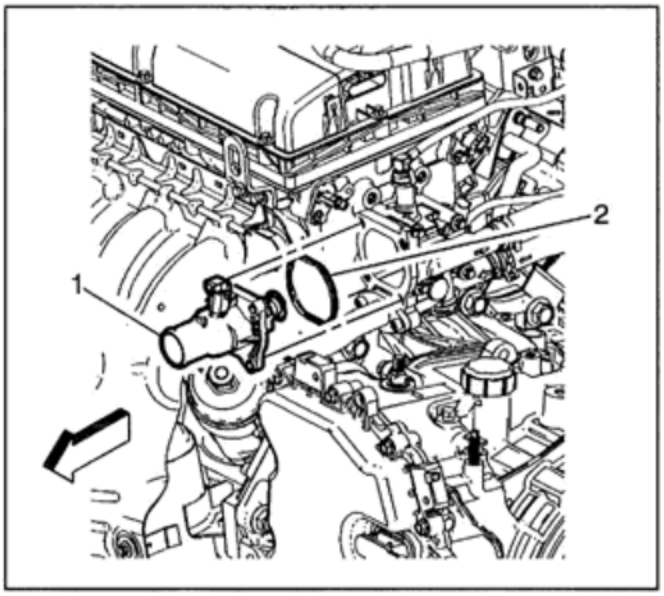
2494826

5. If equipped, disconnect the thermostat heating element sensor (1) and remove the radiator inlet hose (2).



2049072

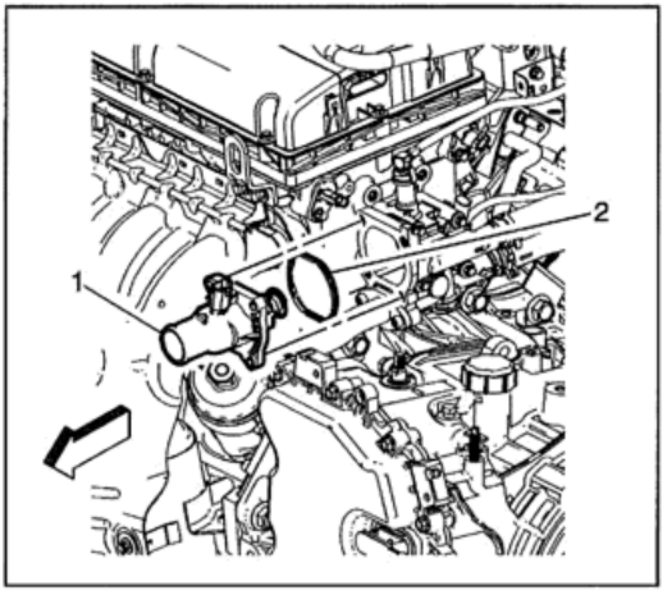
6. Remove the thermostat housing retaining bolts (1).



2889391

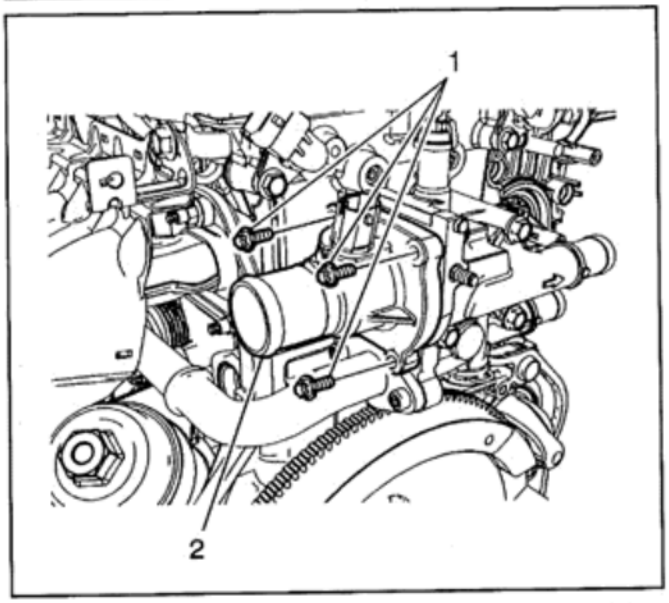
7. Remove the thermostat (1) and discard the seal (2).

Installation Procedure



2889391

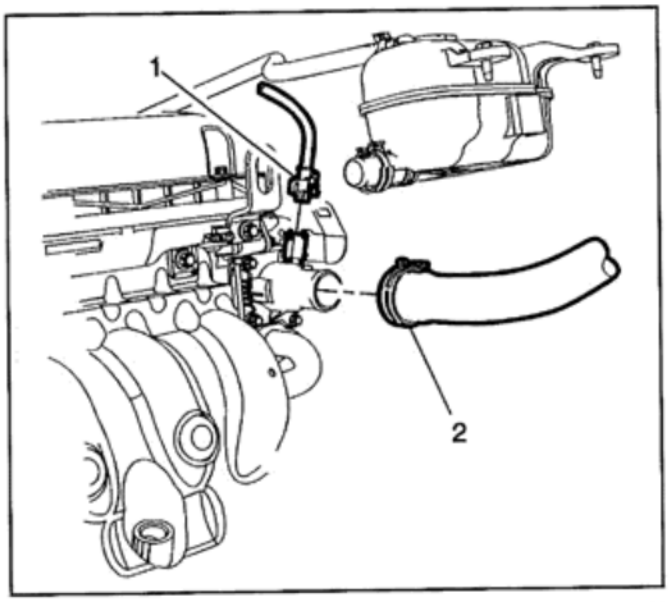
1. Fit the thermostat (1) to the thermostat housing using a NEW seal (2).



2049072

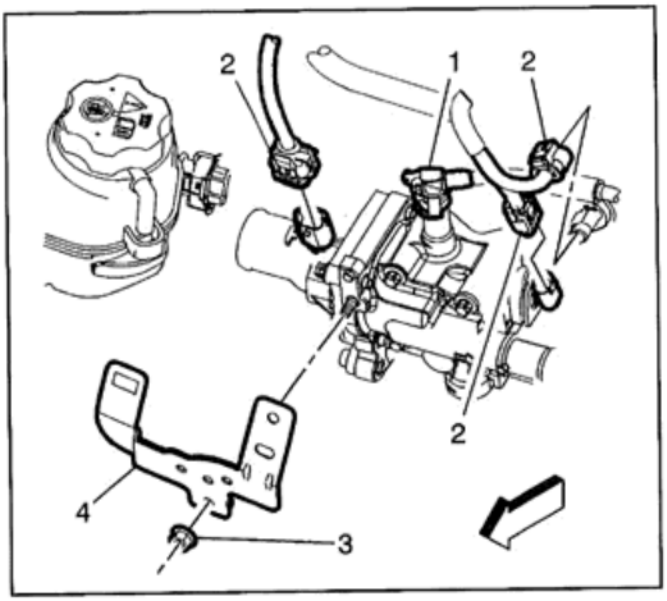
Caution: Refer to *Fastener Caution on page 0-8*.

2. Install the thermostat (2) and tighten the thermostat bolts (1) to **10** N•m **(89 lb in)**.



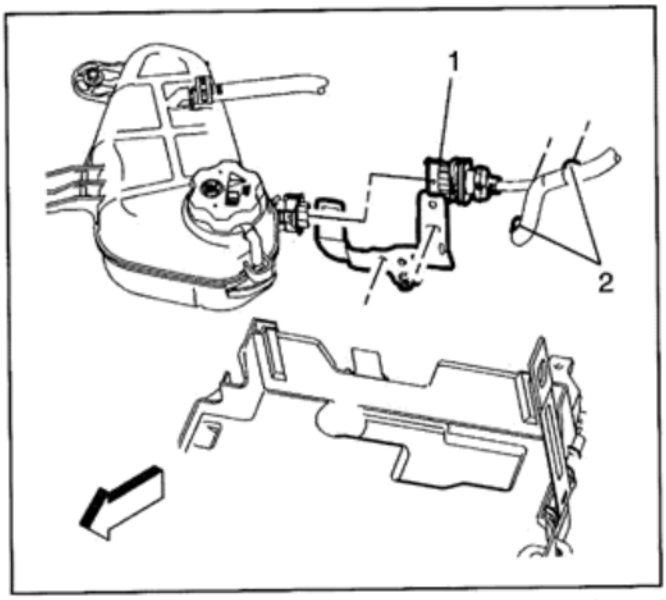
2494826

3. Install the radiator inlet hose (2) and connect the thermostat heating element sensor (1).



2494855

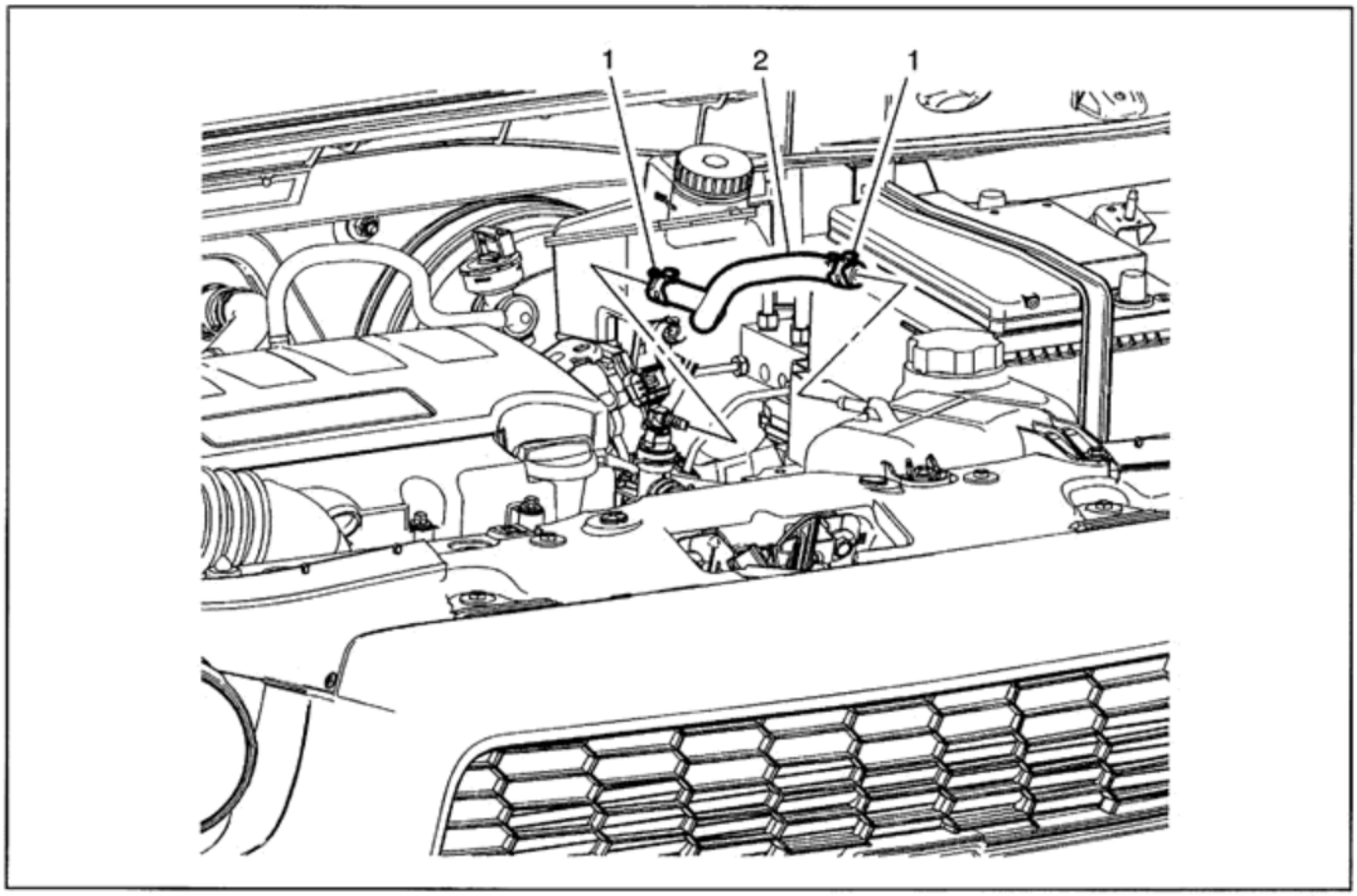
4. Install the wiring harness bracket (4) and tighten the nut (3) to **10** N•m **(89 lb in)**.



2494854

5. Connect the engine harness connector (1) and harness retainers (2) to the bracket.
6. Refill the engine cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
7. Connect the battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
8. Start the engine and check for coolant leaks.

Engine Coolant Air Bleed Hose Replacement (LUV)

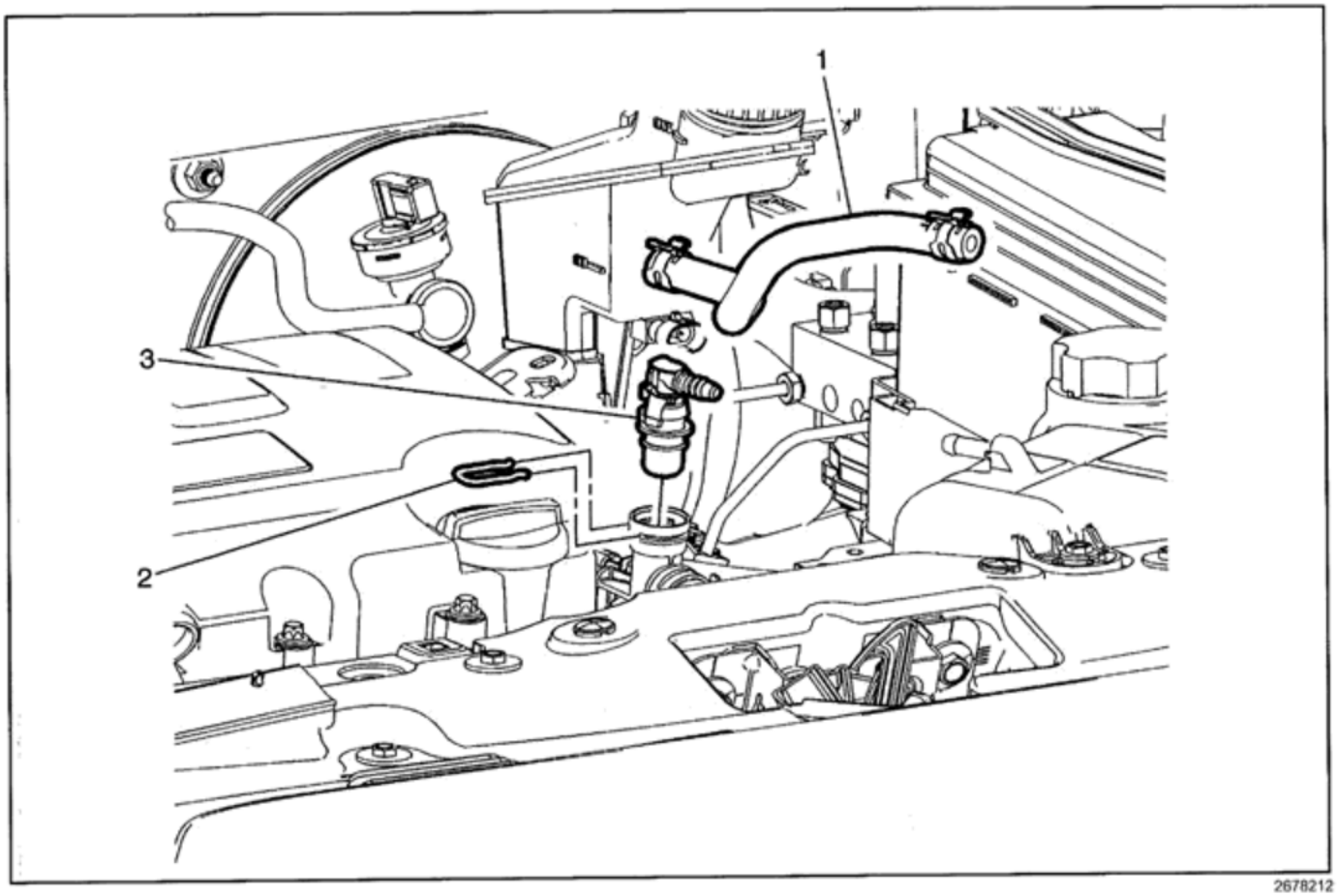


2678210

Engine Coolant Air Bleed Hose Replacement (LUV)

Callout	Component Name
1	Engine Coolant Air Bleed Hose Clamp (Qty: 2) **Special Tools** *BO-38185* Hose Clamp Pliers For equivalent regional tools, refer to *Special Tools on page 9-681*.
2	Engine Coolant Air Bleed Hose

Engine Coolant Air Bleed Hose Connector Replacement (LUV)



2678212

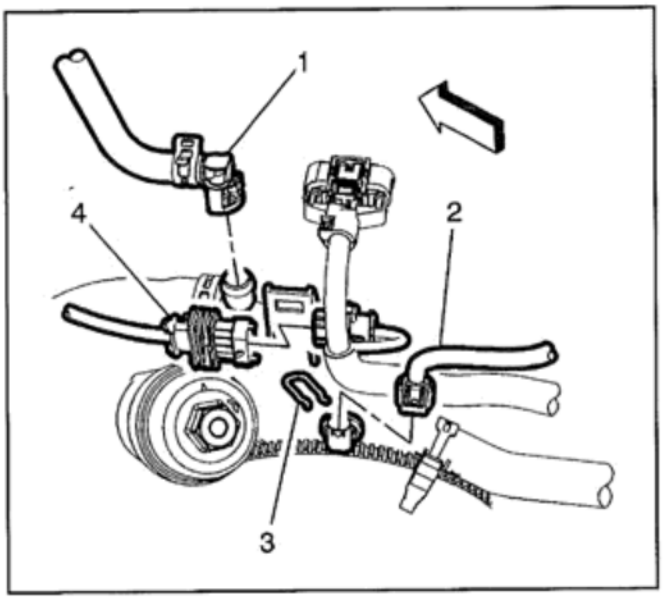
Engine Coolant Air Bleed Hose Connector Replacement (LUV)

Callout	Component Name
1	Engine Coolant Air Bleed Hose Refer to *Engine Coolant Air Bleed Hose Replacement (LUV) on page 9-665.*
2	Engine Coolant Air Bleed Hose Connector Retaining Clip
3	Engine Coolant Air Bleed Hose Connector

Water Outlet Replacement (LUV)

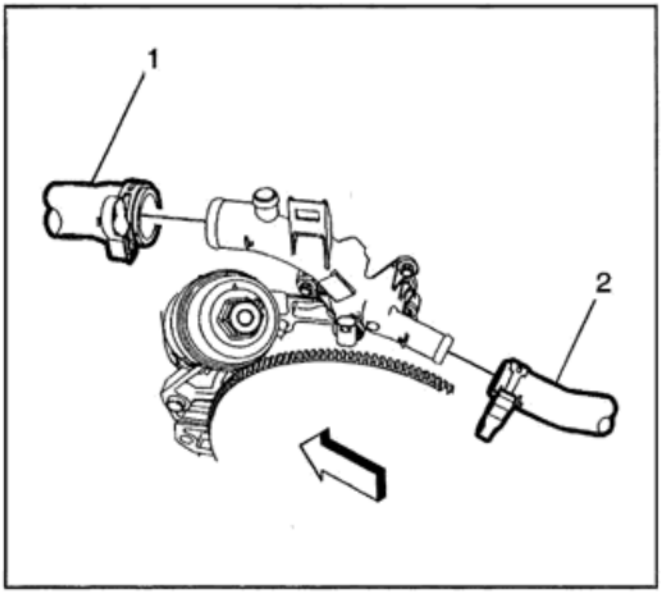
Removal Procedure

1. Drain the engine coolant system. Refer to *Cooling System Draining and Filling on page 9-628.*



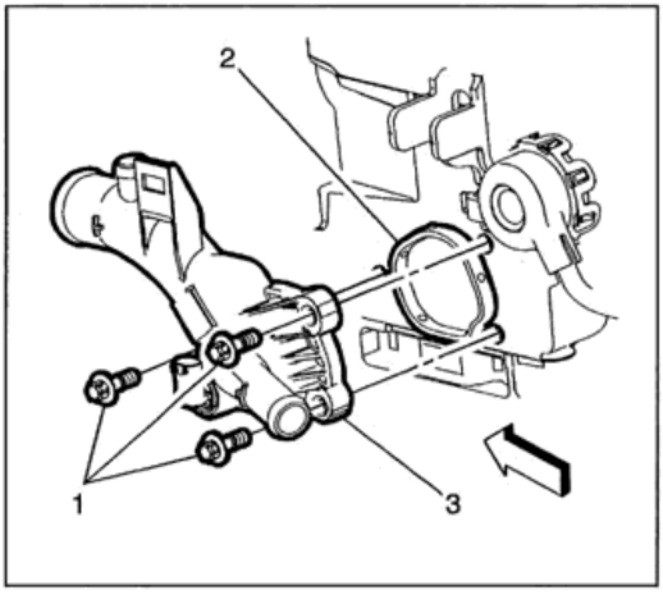
2511884

2. Remove the following:
   - Engine coolant air bleed hose (1)
   - Engine coolant temperature sensor (2) and connector clip (3)
   - Heated oxygen sensor connector (4)



2511834

3. Remove the heater outlet hose (1) and the heater inlet hose (2).

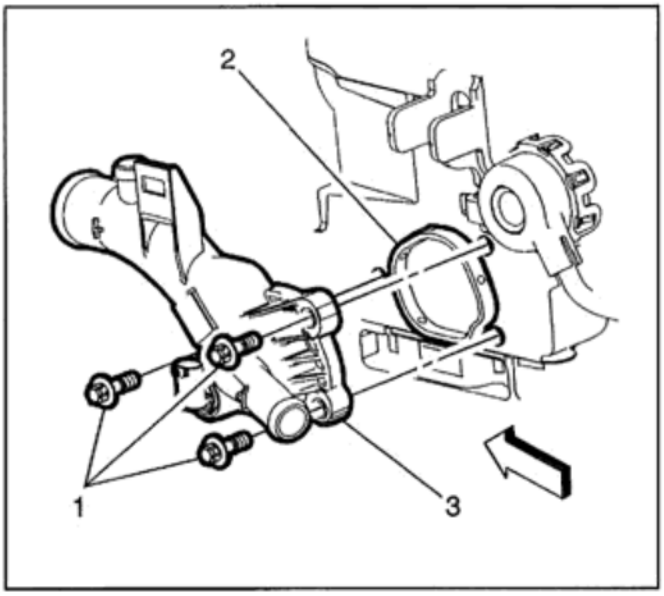


2511833

4. Remove the water outlet bolts (1) and discard the water outlet seal (2).
5. Remove the water outlet (3).

Installation Procedure

1. Clean the sealing surfaces.

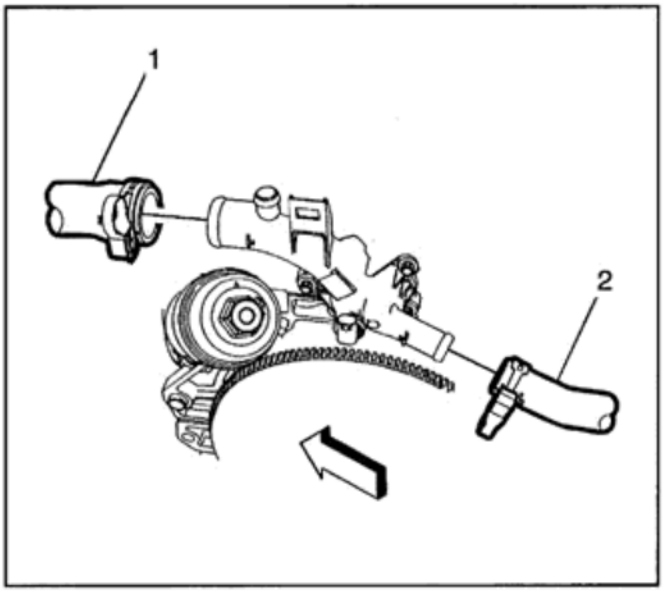


2511833

2. Install the water outlet (3) and a NEW water outlet seal (2).

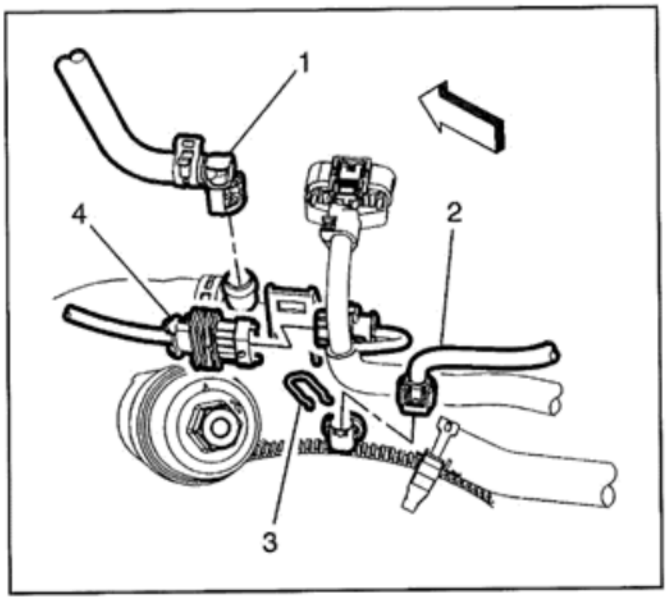
Caution: Refer to *Fastener Caution on page 0-8*.

3. Install the water outlet bolts (1) and tighten to **8 N•m (71 lb in)**.



2511834

4. Install the heater outlet hose (1) and the heater inlet hose (2).



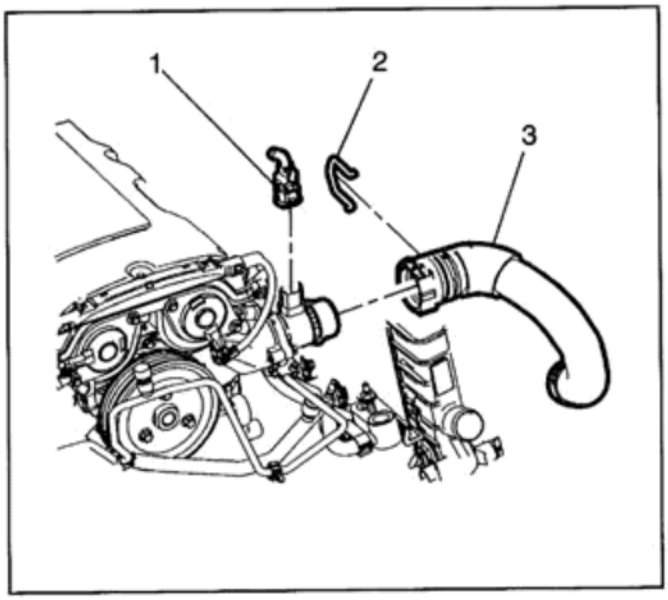
2511884

5. Connect the following:
   - Engine coolant temperature sensor (2) and connector clip (3)
   - Heated oxygen sensor connector (4)
   - Engine coolant air bleed hose connector (1)
6. Fill the engine coolant system. Refer to *Cooling System Draining and Filling on page 9-628.*
7. Start the engine and check for coolant leaks.

Water Inlet Replacement (LUW)

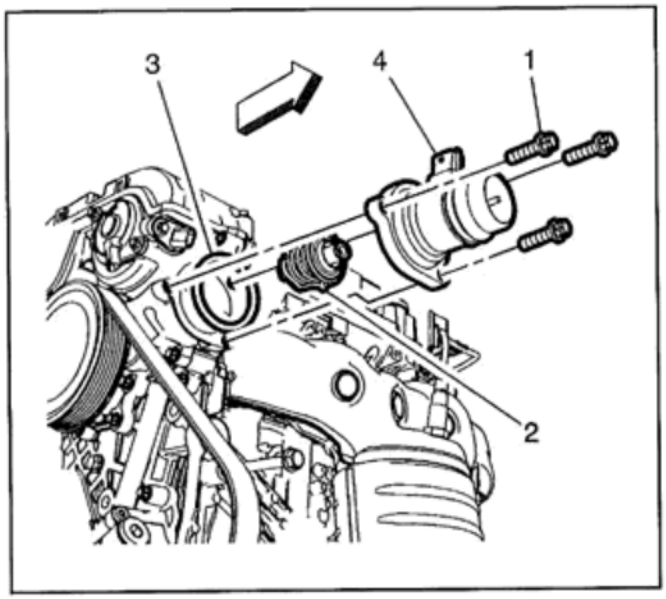
Removal Procedure

1. Drain the engine coolant system. Refer to *Cooling System Draining and Filling on page 9-628.*



2511831

2. Disconnect the engine coolant temperature sensor connector (1).
3. Remove the radiator outlet hose connector clip (2) and the radiator outlet hose (3).

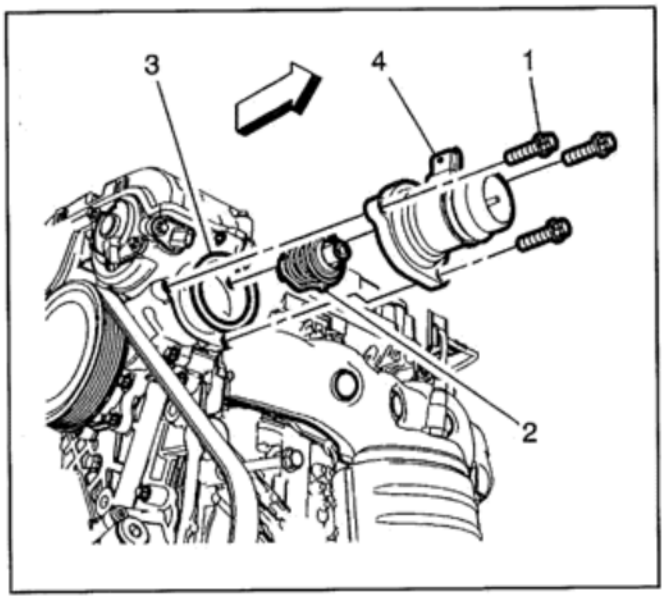


2511830

4. Remove the water inlet bolts (1) and discard the water inlet seal (3).
5. Remove the water inlet (4) and the engine coolant thermostat (2) from the engine.

Installation Procedure

1. Clean the sealing surfaces.

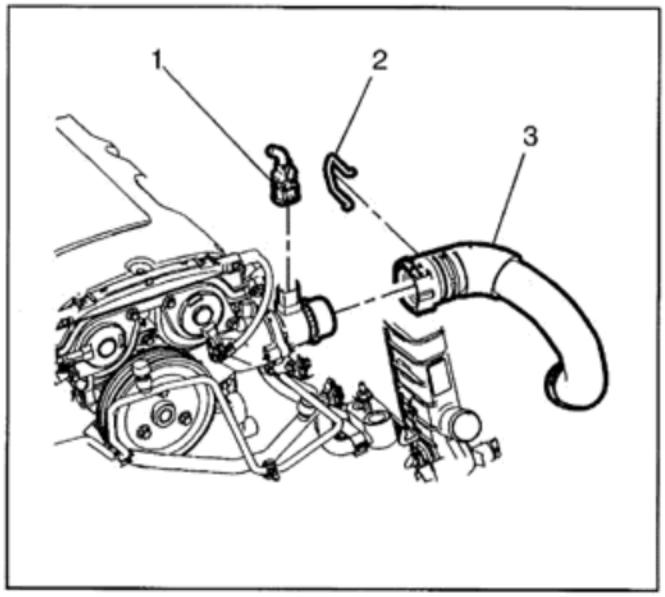


2511830

2. Install the water inlet (4) and a NEW water inlet seal (3).

Caution: Refer to *Fastener Caution on page 0-8.*

3. Install the water inlet bolts (1) and tighten to **8 N•m (71 lb in)**.



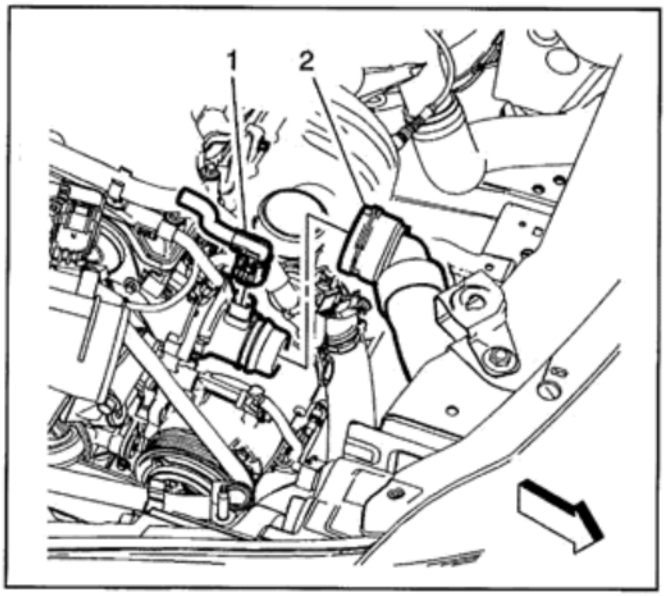
2511831

4. Install the radiator outlet hose (3) and retainer clip (2).
5. Connect the engine coolant temperature connector (1).
6. Fill the engine coolant system. Refer to *Cooling System Draining and Filling on page 9-628*.
7. Start the engine and check for coolant leaks.

Water Inlet Replacement (LUV)

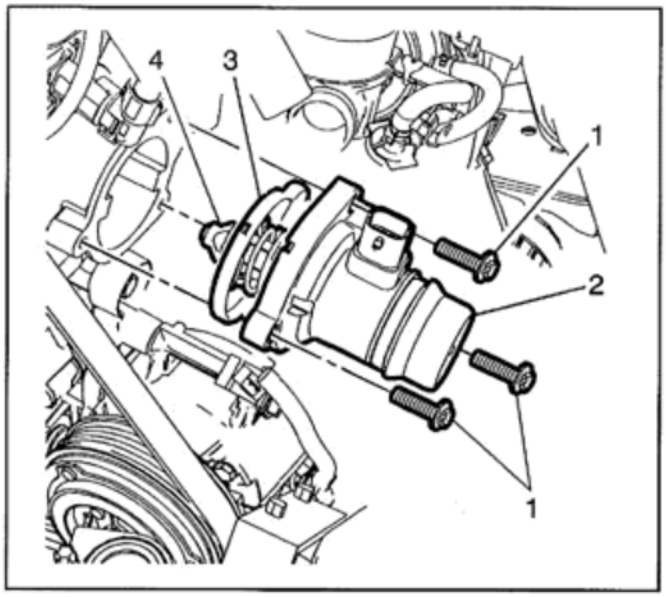
Removal Procedure

1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
2. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.



2612519

3. Remove the engine coolant temperature sensor connector (1) and the radiator outlet hose (2).

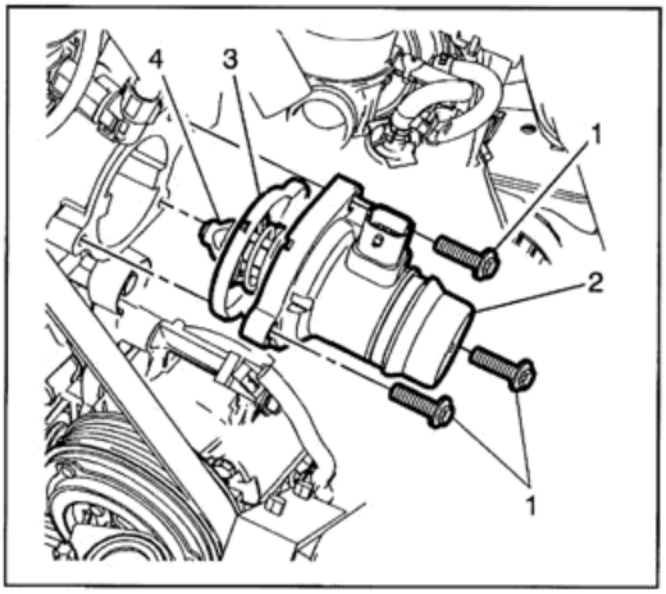


2612518

4. Remove the water inlet pipe mounting fasteners (1).
5. Remove the water inlet seal (3) and discard.
6. Remove the thermostat (4).

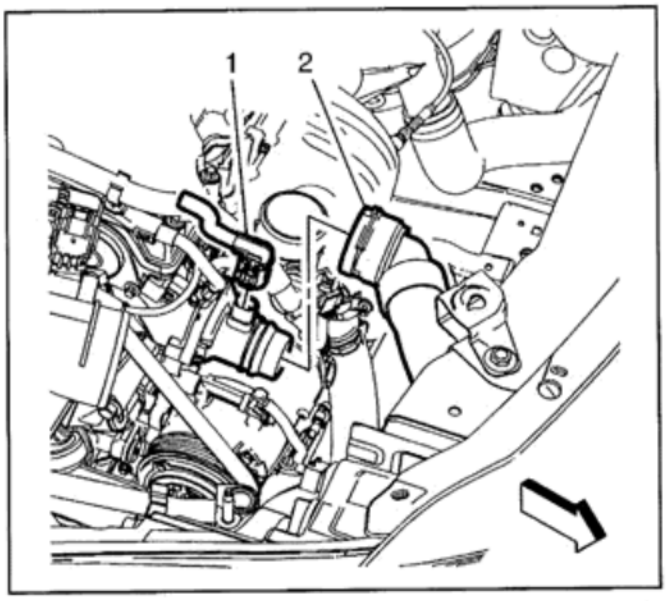
Installation Procedure

1. Clean the sealing surface.



2612518

2. Install the engine thermostat (4) into the water inlet pipe (2) with a NEW seal (3).
3. Tighten the water inlet pipe mounting fasteners (1) to **9 N•m (80 lb in)**.



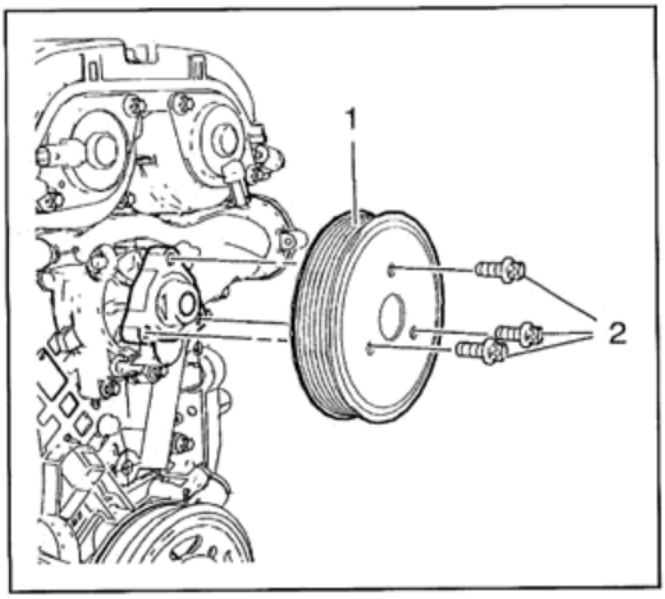
2612519

4. Install the radiator outlet hose (2) to the water inlet pipe.
5. Connect the engine coolant temperature sensor connector (1).
6. Install the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.
7. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
8. After repairs, inspect cooling system for leaks.

Water Pump Pulley Replacement (LUV)

Removal Procedure

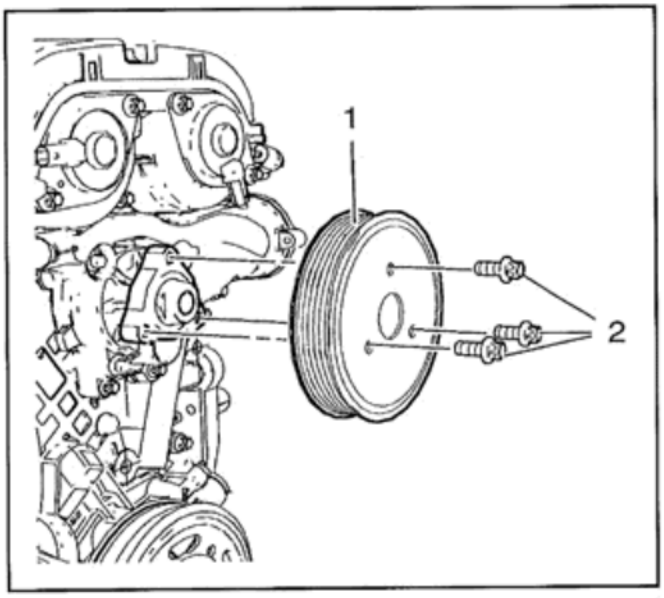
1. Remove the air cleaner assembly. Refer to *Air Cleaner Assembly Replacement on page 9-290*.
2. Remove the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
3. Remove the drive belt. Refer to *Drive Belt Replacement on page 9-784*.



2190373

4. Loosen the 3 water pump pulley bolts (2) while holding the water pump pulley hub with a wrench.
5. Remove the 3 water pump pulley bolts (2).
6. Remove the water pump pulley (1).

Installation Procedure



2190373

1. Install the water pump pulley (1).
2. Install the 3 water pump pulley bolts (2).

Caution: Refer to *Fastener Caution on page 0-8*.

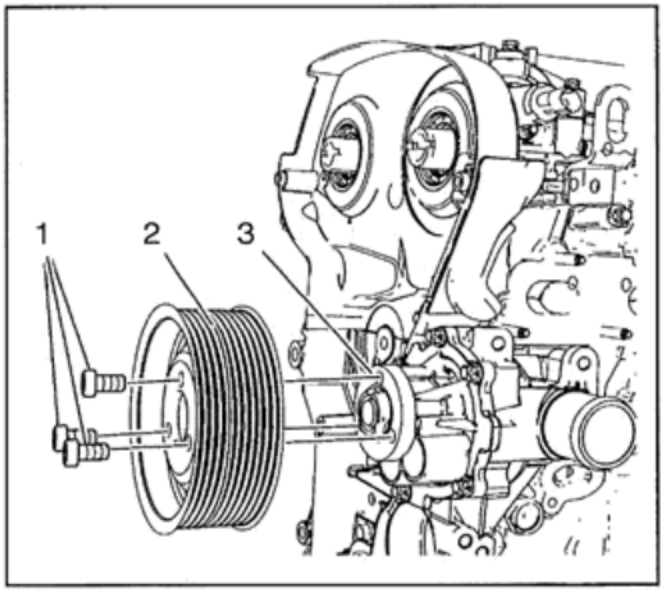
3. Tighten the 3 water pump pulley bolts to **22 N•m (16 lb ft)** while holding the water pump pulley hub with a wrench.

4. Install the drive belt. Refer to *Drive Belt Replacement on page 9-784*.
5. Install the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
6. Install the air cleaner assembly. Refer to *Air Cleaner Assembly Replacement on page 9-290*.

Water Pump Pulley Replacement (LUW)

Removal Procedure

1. Remove the air cleaner housing. Refer to *Air Cleaner Assembly Replacement on page 9-582*.
2. Support the engine with a suitable jack.
3. Remove the engine mount. Refer to *Engine Mount Replacement on page 9-976*.
4. Raise engine to access the bolts.



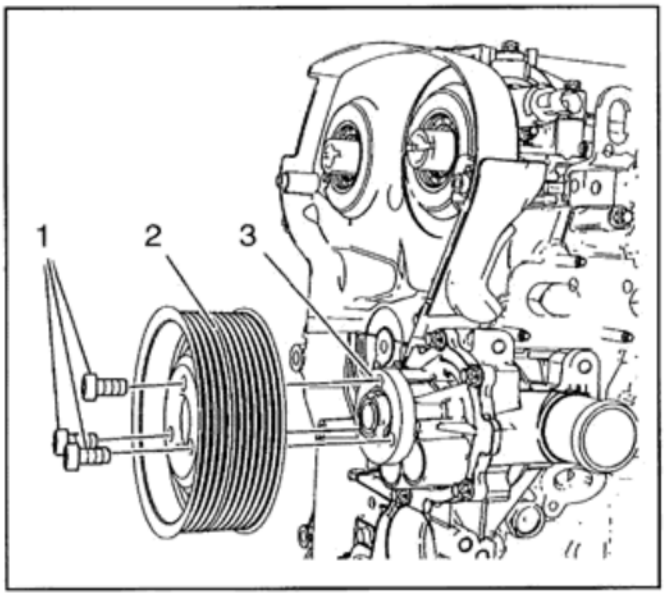
2026887

5. Loosen the 3 water pump pulley bolts (1).

Note: Counterhold against crankshaft balancer bolt.

6. Remove the drive belt. Refer to *Drive Belt Replacement on page 9-974*.
7. Remove the 3 water pump pulley bolts (1).
8. Remove the water pump pulley (2) from the water pump (3).

Installation Procedure



2026887

1. Install the water pump pulley (2) to the water pump (3).
2. Install the 3 water pump pulley bolts (1).
3. Install the drive belt. Refer to *Drive Belt Replacement on page 9-974*.

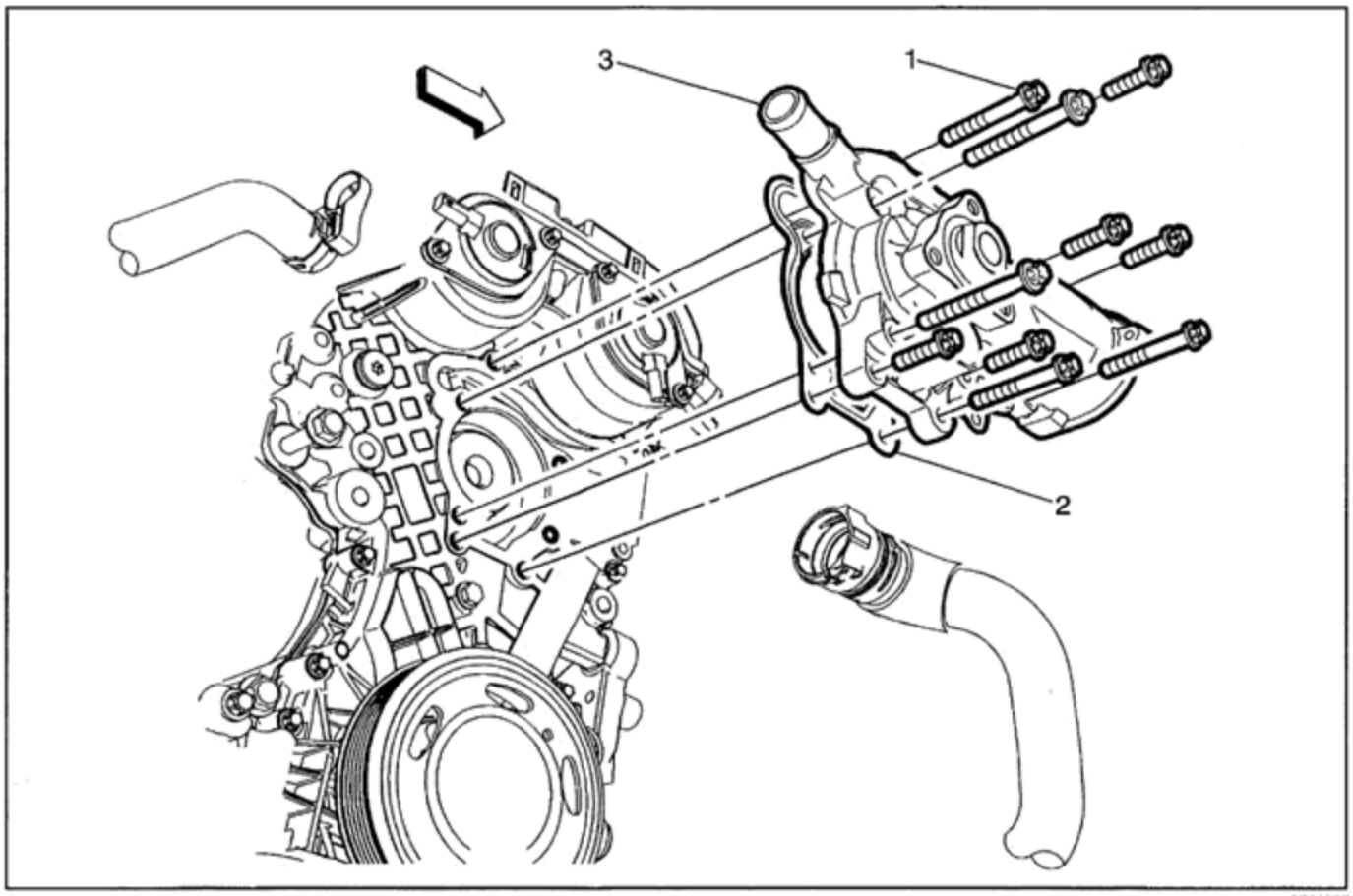
Caution: Refer to *Fastener Caution on page 0-8*.

4. Tighten the 3 water pump pulley bolts (1) to **20 N•m (15 lb ft)**.

Note: Counterhold against crankshaft balancer bolt.

5. Install the engine mount. Refer to *Engine Mount Replacement on page 9-976*.
6. Install the air cleaner housing. Refer to *Air Cleaner Assembly Replacement on page 9-582*.

Water Pump Replacement (LUV)



2511827

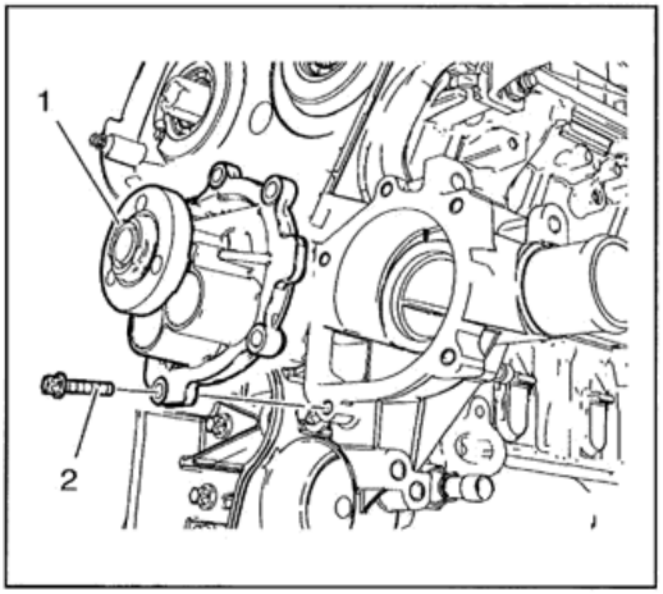
Water Pump Replacement (LUV)

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*. 2. Remove the water inlet. Refer to *Water Inlet Replacement (LUW) on page 9-668* or *Water Inlet Replacement (LUV) on page 9-669*. 3. Remove the water pump pulley. Refer to *Water Pump Pulley Replacement (LUV) on page 9-670* or *Water Pump Pulley Replacement (LUW) on page 9-671*. 4. Remove the heater outlet hose. Refer to *Heater Outlet Hose Replacement (LUV) on page 10-40* or *Heater Outlet Hose Replacement (LDE, LUW) on page 10-40*.	
1	Water Pump Bolt (Qty: 10) **Caution:** Refer to *Fastener Caution on page 0-8*. **Tighten** 8 N•m (71 lb in)
2	Water Pump Gasket
3	Water Pump **Procedure** 1. Clean the sealing surfaces. 2. Replace the water pump gasket with a NEW gasket. 3. Remember the location of the short and long bolts when removing.

Water Pump Replacement (LUW)

Removal Procedure

1. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
2. Remove the water pump pulley. Refer to *Water Pump Pulley Replacement (LUV) on page 9-670* or *Water Pump Pulley Replacement (LUW) on page 9-671*.

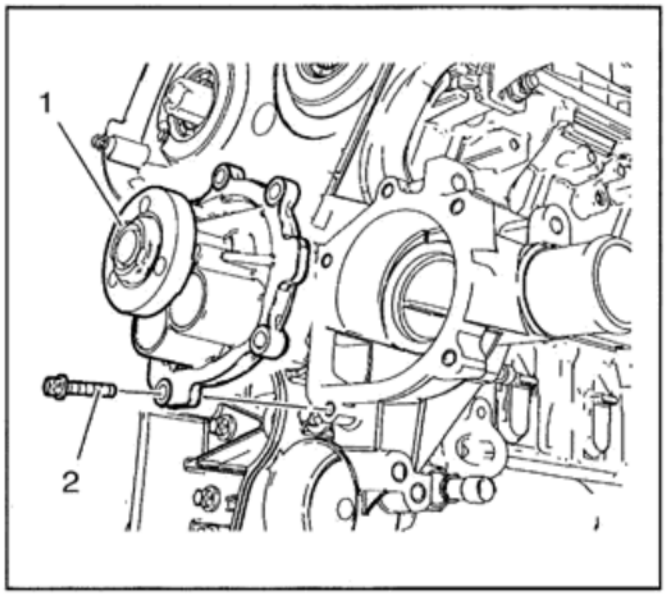


2026886

3. Remove the 5 water pump bolts (2).
4. Remove the water pump (1).

Installation Procedure

1. Clean the 5 water pump threads.
2. Insert a NEW water pump seal ring.



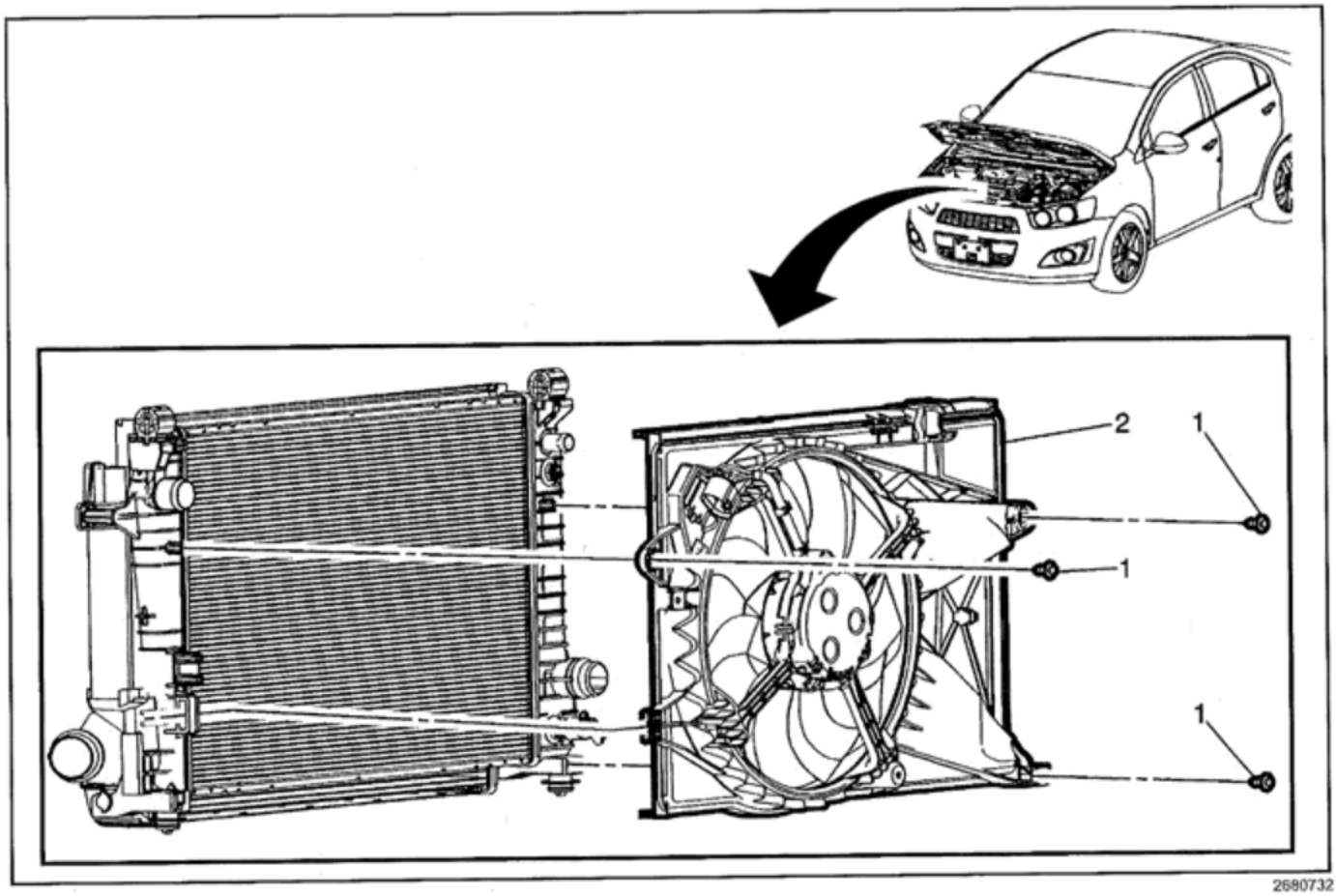
2026886

3. Install the water pump (1).

Caution: Refer to *Fastener Caution on page 0-8*.

4. Install the 5 water pump bolts (2) and tighten to **8 N•m (71 lb in)**.
5. Install the water pump pulley. Refer to *Water Pump Pulley Replacement (LUV) on page 9-670* or *Water Pump Pulley Replacement (LUW) on page 9-671*.
6. Refill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.

Engine Coolant Fan Shroud Replacement (LUV)

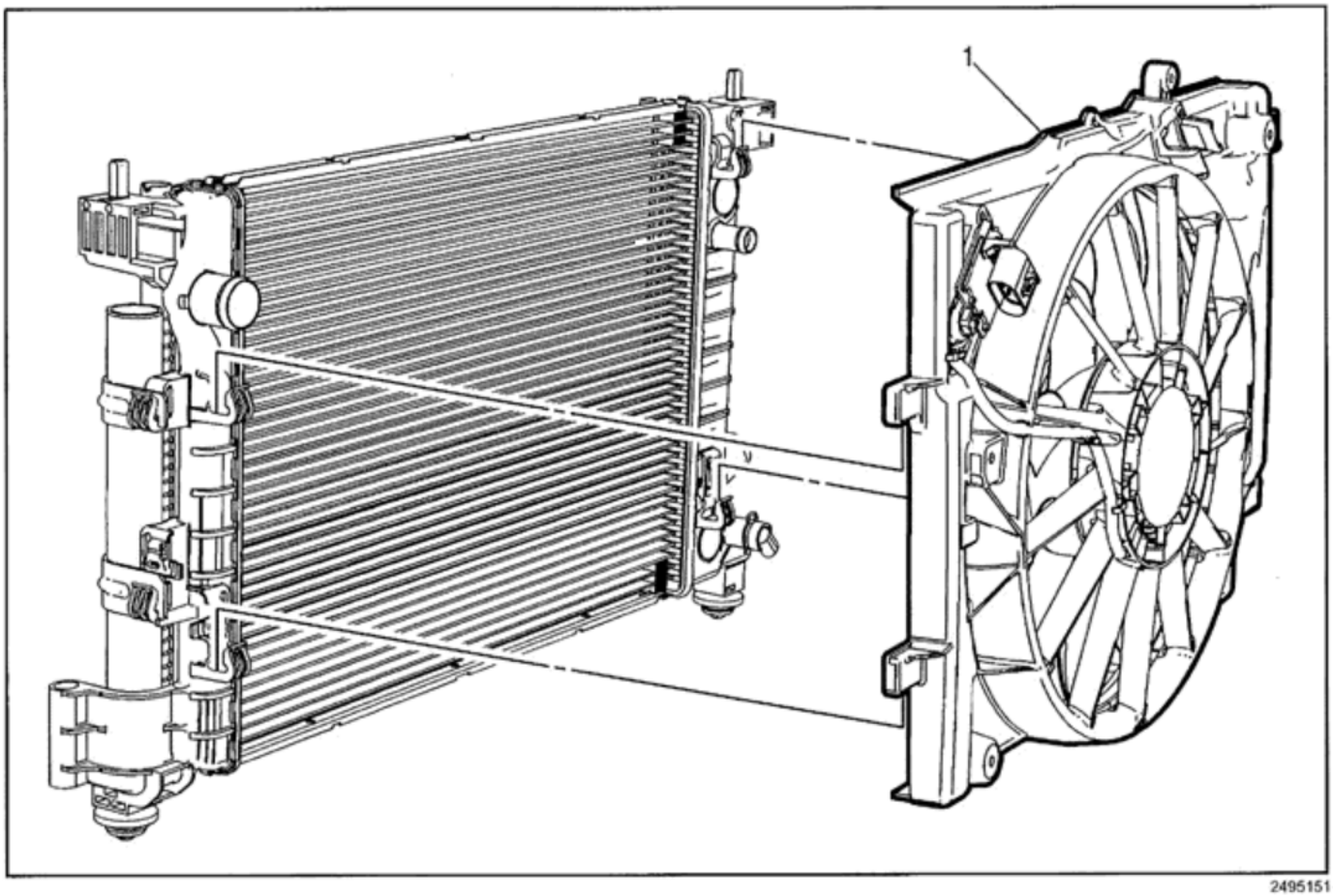


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Engine Coolant Fan Shroud Replacement (LUV)

Callout	Component Name
Preliminary Procedures 1. Drain the engine coolant. Refer to *Cooling System Draining and Filling on page 9-628.* 2. Remove the radiator surge tank. Refer to 3. Remove the radiator surge tank outlet hose from the engine coolant fan shroud and position it out of the way. 4. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288.* 5. Remove the front compartment front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157.*	
1	Engine Cooling Fan Shroud Fasteners (Qty: 3) **Caution:** Refer to *Fastener Caution on page 0-8.*
2	Engine Cooling Fan Shroud Assembly. **Procedure** 1. Disconnect the electrical connectors. 2. Transfer all necessary components.

Engine Coolant Fan Shroud Replacement (LDE LUW)



2495151

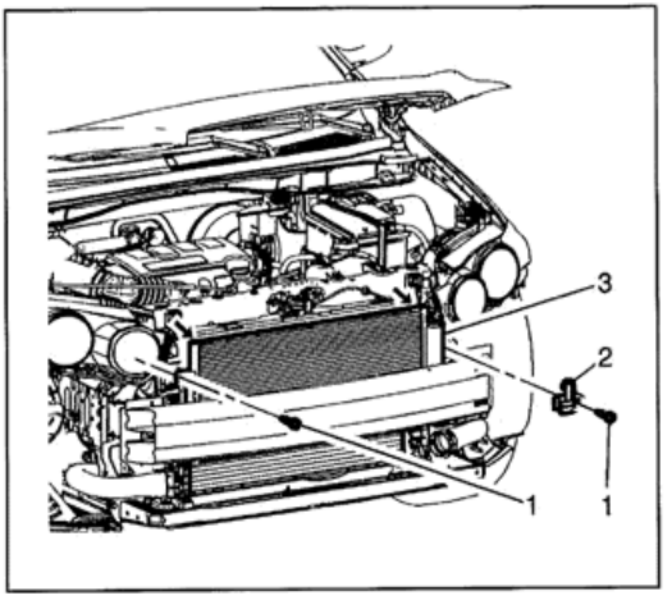
Engine Coolant Fan Shroud Replacement (LDE LUW)

Callout	Component Name
Preliminary Procedure 1. Remove the radiator surge tank. Refer to *Radiator Surge Tank Replacement on page 9-630*. 2. Unclip transmission cooler lines from shroud if equipped. 3. Unclip radiator surge tank outlet hose from fan shroud. 4. Disconnect any electrical connecters from the fan shroud.	
1	Engine Coolant Fan Shroud **Tip:** Unclip engine coolant fan shroud from radiator.

Radiator Replacement (LUV)

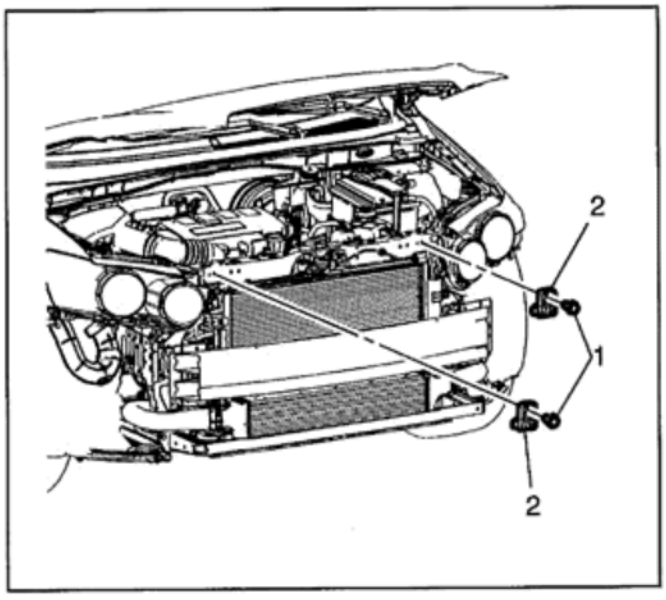
Removal Procedure

1. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.
2. Remove the front compartment front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157*.
3. Remove the engine coolant fan shroud. Refer to *Engine Coolant Fan Shroud Replacement (LDE LUW) on page 9-675* or *Engine Coolant Fan Shroud Replacement (LUV) on page 9-674*
4. If equipped with an automatic transmission remove the transmission cooler lines. Refer to *Fluid Cooler Inlet Hose Replacement on page 17-203* and *Fluid Cooler Outlet Hose Replacement on page 17-204*.
5. Drain the engine coolant. Refer to *Cooling System Draining and Filling on page 9-628*.
6. Remove the radiator inlet hose from the radiator. Refer to *Radiator Inlet Hose Replacement (LUV) on page 9-633* or *Radiator Inlet Hose Replacement (LDE LUW) on page 9-634*.
7. Remove the radiator outlet hose from the radiator. Refer to *Radiator Outlet Hose Replacement (LUV) on page 9-635* or *Radiator Outlet Hose Replacement (LDE LUW) on page 9-636*
8. Remove the front bumper fascia assembly. Refer to *Front Bumper Fascia Replacement on page 3-55*.
9. Remove the radiator upper air baffle. Refer to *Radiator Air Baffle Replacement (LUV, LUW) on page 9-679*



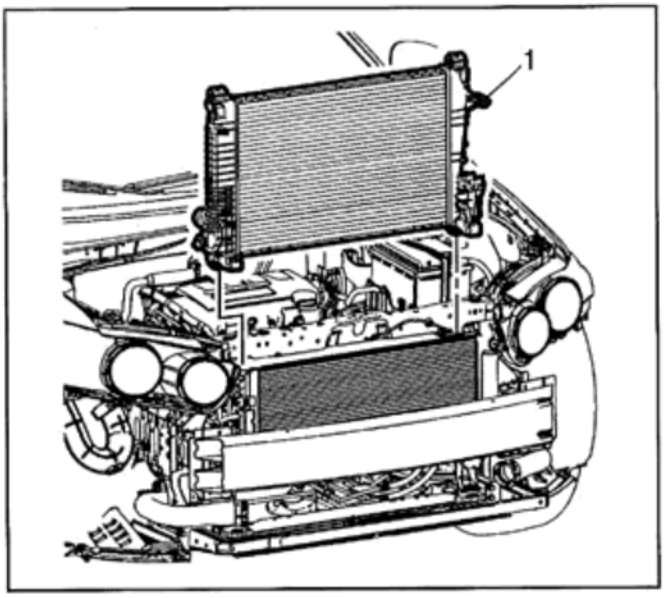
2680742

10. Remove the three air conditioning condenser bracket fasteners (1) and bracket. (2).
11. Release the clips securing the air conditioning condenser (1) to the radiator and pull the condenser (1) forward as far as possible.
12. Support the air conditioning condenser assembly.



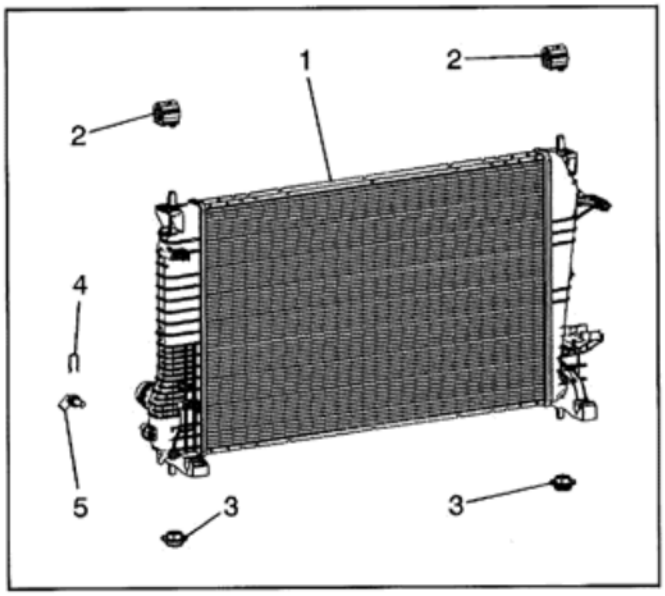
2680743

13. Remove the radiator upper bracket fasteners (1) and brackets (2).



2680744

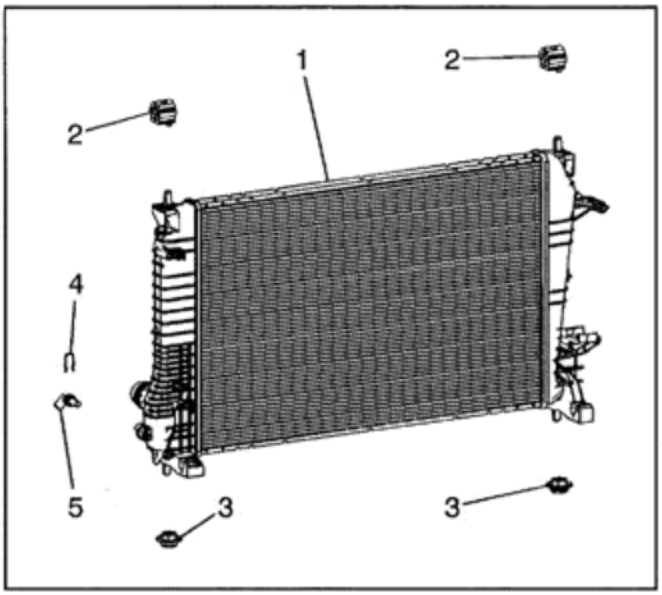
14. Remove the radiator assembly from the vehicle.



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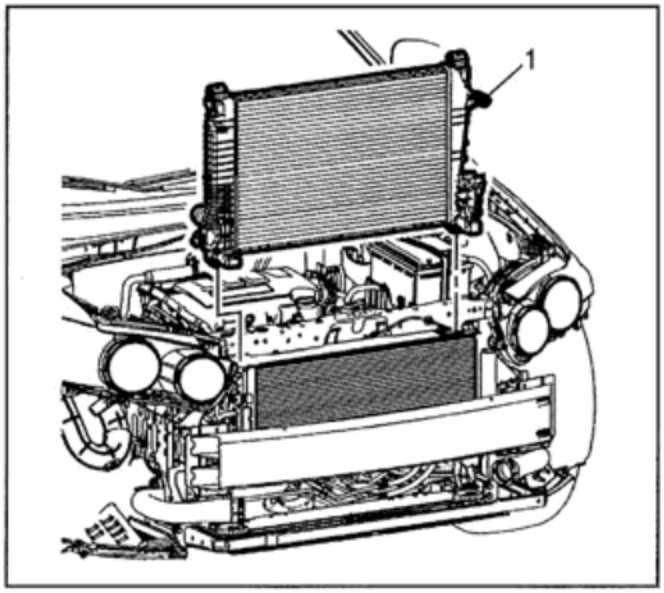
15. Remove the following components from the radiator assembly (1).
    - Radiator upper insulators (2) (Qty:2)
    - Radiator lower insulators (3) (Qty: 2)
    - Radiator temperature sensor (5) and retainer clip (4)

Installation Procedure



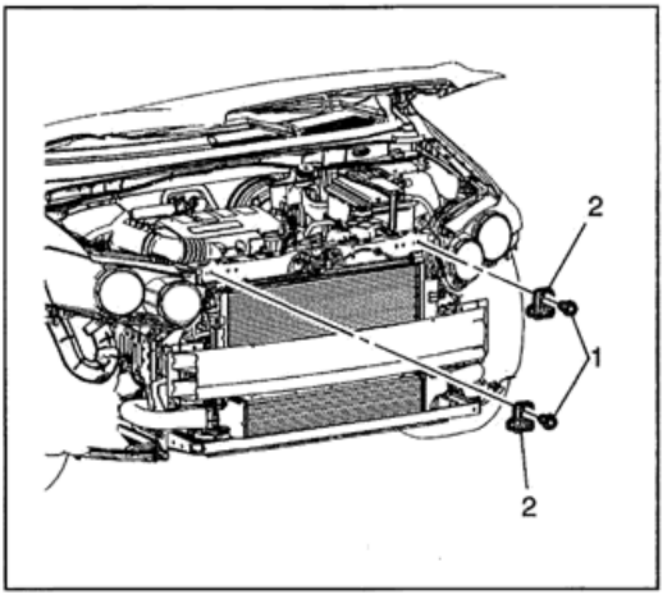
2680745

1. Install the following components to the radiator assembly (1).
   - Radiator upper insulators (2) (Qty:2)
   - Radiator lower insulators (3) (Qty: 2)
   - Radiator temperature sensor (5) and retainer clip (4)



2680744

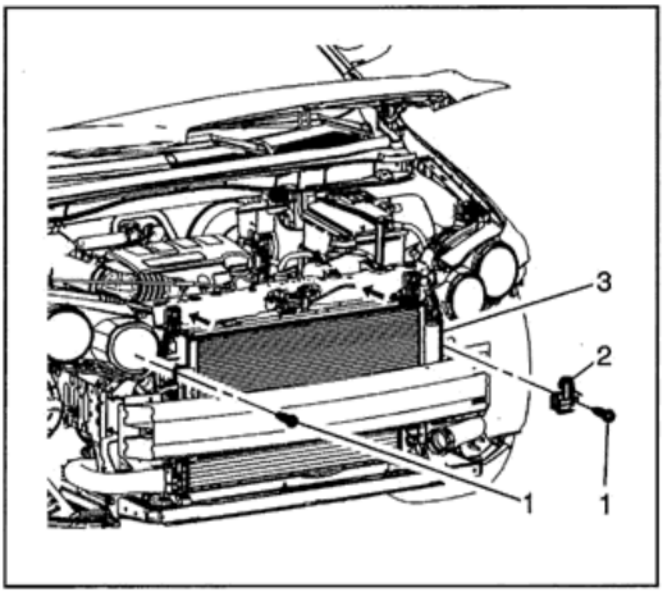
2. Install the radiator assembly into the vehicle.



2680743

Caution: Refer to *Fastener Caution on page 0-8.*

3. Install the radiator upper brackets (2) and bracket fasteners (1) tighten the bracket fasteners to **9N•m(80 lb in).**

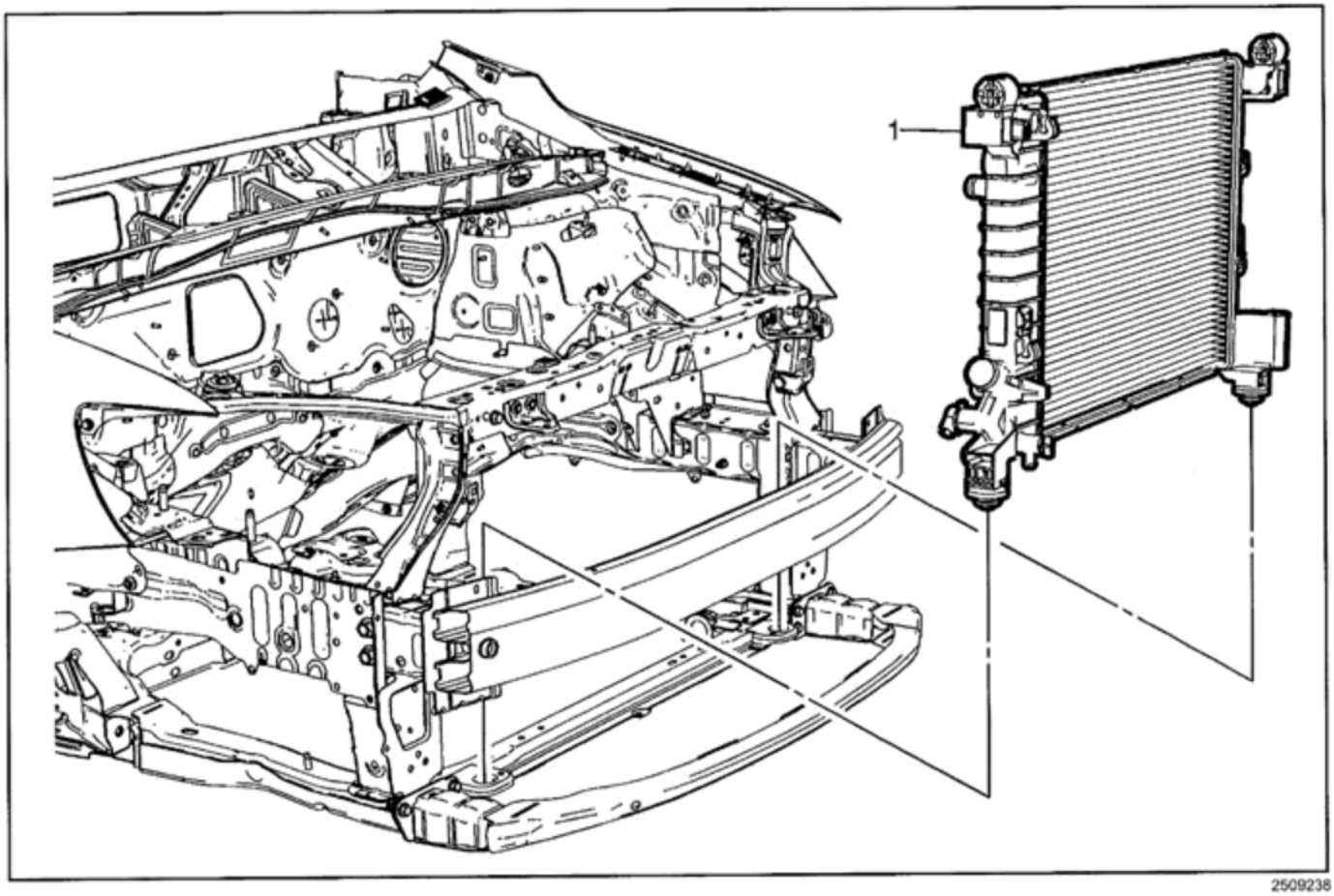


2680748

4. Position the air conditioning condenser (1) to the radiator, and push inward securing the air conditioning condenser to the radiator assembly.
5. Install the air conditioning condenser bracket (2) and the air conditioning condenser fasteners (1) .
6. Install the radiator upper air baffle. Refer to *Radiator Air Baffle Replacement (LUV, LUW) on page 9-679*
7. Install the front bumper fascia assembly. Refer to *Front Bumper Fascia Replacement on page 3-55.*
8. Install the radiator outlet hose from the radiator. Refer to *Radiator Outlet Hose Replacement (LUV) on page 9-635* or *Radiator Outlet Hose Replacement (LDE LUW) on page 9-636*

9. Install the radiator inlet hose from the radiator. Refer to *Radiator Inlet Hose Replacement (LUV) on page 9-633* or *Radiator Inlet Hose Replacement (LDE LUW) on page 9-634*.
10. If equipped with an automatic transmission install the transmission cooler lines. Refer to *Fluid Cooler Inlet Hose Replacement on page 17-203* and *Fluid Cooler Outlet Hose Replacement on page 17-204*.
11. Install the engine coolant fan shroud. Refer to *Engine Coolant Fan Shroud Replacement (LDE LUW) on page 9-675* or *Engine Coolant Fan Shroud Replacement (LUV) on page 9-674*
12. Install the front compartment front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157*.
13. Install the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.

Radiator Replacement (LDE LUW)

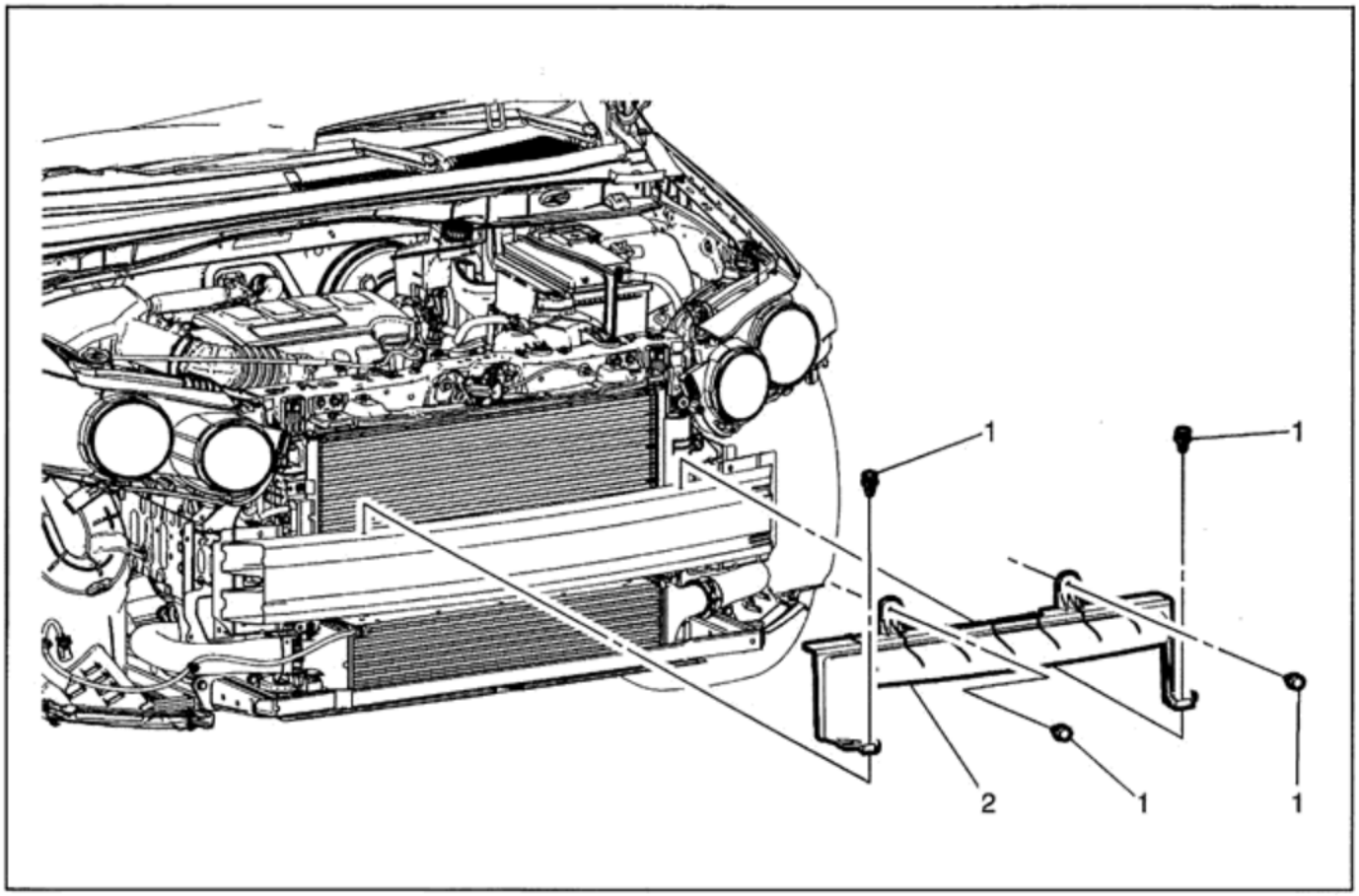


2509238

Radiator Replacement (LDE LUW)

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to *Cooling System Draining and Filling on page 9-628*. 2. Remove the engine coolant temperature sensor. 3. Remove the air conditioning condenser. Refer to *Air Conditioning Condenser Replacement (LDE,LUW) on page 10-33* or *Air Conditioning Condenser Replacement (LUV) on page 10-34*. 4. Remove the engine coolant fan shroud. Refer to *Engine Coolant Fan Shroud Replacement (LDE LUW) on page 9-675* or *Engine Coolant Fan Shroud Replacement (LUV) on page 9-674*. 5. Remove the radiator hoses. Refer to *Radiator Inlet Hose Replacement (LUV) on page 9-633* or *Radiator Inlet Hose Replacement (LDE LUW) on page 9-634* and *Radiator Outlet Hose Replacement (LUV) on page 9-635* or *Radiator Outlet Hose Replacement (LDE LUW) on page 9-636*. 6. Remove the radiator upper bracket. Refer to *Radiator Upper Bracket Replacement on page 9-640*.	
1	Radiator **Tip:** Tilt radiator forward to remove.

Radiator Air Baffle Replacement (LUV, LUW)



2680735

Radiator Air Baffle Replacement (LUV, LUW)

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia assembly. Refer to *Front Bumper Fascia Replacement on page 3-55.*	
1	Radiator Air Upper Baffle Push Pin Retainers (Qty: 4)
2	Radiator Air Upper Baffle Assembly

Description and Operation

Cooling Fan Description and Operation (LUV)

The engine cooling fan system is composed of one cooling fan, a series of 5 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes two resistors. This combination of components enables the ECM to operate the cooling fan at 3 speeds using two fan control circuits.

Low Speed Operation

The ECM applies ground at the FAN 1 control circuit for the coil side of the cooling fan relay. The energized cooling fan relay completes a ground, through the switch side of the relay, for the coils of the cooling fan low speed relay and the cooling fan speed control relay. The speed control relay activates and supplies B+ to the coil side of the cooling fan high speed relay. The high speed relay remains inactive because the ECM is not commanding the FAN 2 control circuit ON. The energized low speed relay switch closes to supply B+ through the internal low speed resistor of the engine cooling fan motor. The result is cooling fan operation at a reduced speed.

Medium Speed Operation

The ECM applies ground at the FAN 2 control circuit for the coil side of the cooling fan high speed, and medium speed relays. The high speed relay remains inactive because the ECM is not commanding the FAN 1 control circuit ON. The energized medium speed relay switch closes to supply B+ through the internal medium speed resistor of the engine cooling fan motor. The result is cooling fan operation at a medium speed.

High Speed Operation

The ECM applies ground at the FAN 1 control circuit for the coil side of the cooling fan relay. The energized cooling fan relay completes a ground, through the switch side of the relay, for the coil of the cooling fan

speed control relay. The energized speed control relay switch closes to supply B+ to the coil side of cooling fan high speed relay. Simultaneously, the ECM applies ground at the FAN 2 control circuit for the coil side of the cooling fan high speed relay. The energized high speed relay switch closes to supply B+ directly to the engine cooling fan motor, by-passing the fans internal resistors. The result is cooling fan operation at full speed.

Cooling Fan Description and Operation (LWE, LUW)

System Overview

The engine cooling fan system is composed of one cooling fan, 2 relays, the engine control module (ECM), and the associated wiring. The cooling fan assembly includes 1 resistor mounted in the cooling fan shroud. The cooling fan resistor may be a stand alone component, or a part of the cooling fan motor and harness assembly. This combination of components enables the ECM to operate the cooling fan at 2 speeds using two fan control circuits. The ECM will operate the cooling fan at either Low or High speed based on the cooling requirements.

Low Speed Operation

The ECM applies ground at the FAN 1 control circuit for the coil side of the low speed cooling fan relay. The energized low speed relay switch closes to supply B+ through the cooling fan resistor, to the engine cooling fan motor. The result is cooling fan operation at a reduced speed.

High Speed Operation

The ECM applies ground at the FAN 2 control circuit for the coil side of the cooling fan high speed relay. The energized high speed relay switch closes to supply B+ directly to the engine cooling fan motor, by-passing the cooling fan resistor. The result is cooling fan operation at full speed.

Cooling System Description and Operation

Cooling System

The cooling system maintains the engine operating temperature at the efficient level under any speed and operating condition. When the engine is cold, the cooling system cools the engine slowly or not at all. The slow cooling of the engine allows the engine to warm up quickly. The cooling system includes a radiator and recovery subsystem, cooling fans, a thermostat and housing, an oil cooler, a water pump and a water pump drive belt. The accessory belt drives the water pump. All components must function properly in order for the cooling system to operate. Before the coolant reaches operating temperature of the thermostat, the coolant circulates through water jackets in the engine block, the cylinder head, the heater core and the oil cooler. The coolant pump draws the coolant from the bypass pipe which the pipe receives returning floe form the engine and the heater core. When the coolant reaches the operating temperature of the thermostat, the thermostat opens. The coolant then goes to the radiator where it cools. This system directs some coolant through the hoses or pipes to the heater core and oil cooler. This provides for heating, defrosting and engine oil cooling. The surge tank is connected to the radiator to recover the coolant displaced by expansion from the high temperatures. The surge tank maintains the correct coolant level. The cooling system for this vehicle has no radiator cap or filler neck. The coolant is added to the cooling system through the surge tank.

Water Pump

The belt-driven centrifugal water pump consists of an impeller, a drive shaft, and a belt pulley. The water pump is mounted on the front of the transverse-mounted engine and is driven by the accessory belt.

The impeller is supported by a completely sealed bearing. The water pump is serviced as an assembly and cannot be disassembled.

Thermostat

A wax pellet-type thermostat controls the flow of the engine coolant through the engine cooling system. The thermostat is mounted in the thermostat housing to the rear of the cylinder head. The thermostat stops the flow of the engine coolant from the engine to the radiator to provide faster warm-up, and to regulate the coolant temperature. The thermostat remains closed while the engine coolant is cold, preventing circulation of the engine coolant through the radiator.

As the engine warms, the thermostat opens. This allows the engine coolant to flow through the radiator where the heat is dissipated through the radiator. This opening and closing of the thermostat permits enough engine coolant to enter the radiator to keep the engine within proper engine temperature operating limits.

The wax pellet in the thermostat is hermetically sealed in a metal case. The wax element of the thermostat expands when it is heated and contracts when it is cooled.

As the vehicle is driven and the engine warms, the engine coolant temperature increases. When the engine coolant reaches a specified temperature, the wax pellet element in the thermostat expands and exerts pressure against the metal case, forcing the valve open. This allows the engine coolant to flow through the engine cooling system and cool the engine. As the wax pellet cools, the contraction allows a spring to close the valve. To provide fuel economy and low emission benefit during part load driving condition, the electric controlled thermostat enables changing the thermostat opening temperature. Basically, the thermostat begins to open at 105° C (221° F) and is fully open at 120° C (248° F) when the electric energy not assisted.

If a certain driving environment encountered that requiring better cooling performance, the ECM orders to put electric energy to the thermostat. The energized electric heater in the wax pellet gives thermal energy to the wax for assisting the wax expansion. Then the thermostat valve opens earlier than the specified coolant temperature. For this vehicle, the programmed temperature set value by the ECM is 105° C (221° F) for cold and part load driving mode and 90° C (194° F) for hot and full load driving mode.

Radiator

The radiator is a heat exchanger. It consists of a core and 2 tanks. The aluminum core is a tube and fin cross-flow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere.

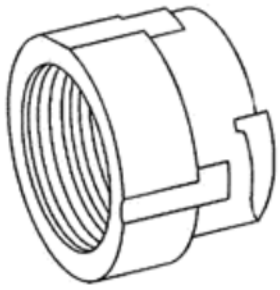
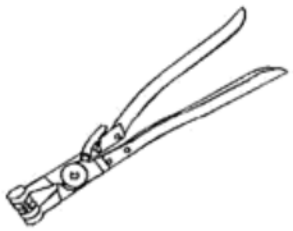
The inlet and outlet tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the tank flange edge to the aluminum core. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminum header at each end of the core.

The radiator removes heat from the coolant passing through it. The fins on the core transfer heat from the coolant passing through the tubes. As air passes between the fins, it absorbs heat and cools the coolant.

Surge Tank

The surge tank is a plastic tank with a threaded pressure cap. The tank is mounted at a point higher than all other coolant passages. The surge tank provides an air space in the cooling system that allows the coolant to expand and contract. The surge tank provides a coolant fill point and a central air bleed location. During vehicle use, the coolant heats and expands. The increased coolant volume flows into the surge tank. As the coolant circulates, any air is allowed to bubble out. Coolant without air bubbles absorbs heat much better than coolant with bubbles.

Special Tools and Equipment

Illustration	Tool Number/Description
 1282423	EN-471 KM-471 J-42070 J-36649 Adapter
 1985876	EN-6327-A KM-6327-A J-24460 J-42401 Cooling System Test Adapter
 14013	BO-38185 J-38185 Hose Clamp Pliers