

Cooling Fan Description and Operation

Cooling Fan Control

The engine cooling fan system is composed of 2 electric cooling fans, fan motors, and a control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motors in relation to the pulse width modulated signal, which allows the cooling fans to operate at variable speeds.

The cooling fan speed is effected by many different conditions and the ECM will adjust the duty cycle from 0–100 percent based on cooling system requirements. The scan tool output control is only capable of operating the cooling fan increments, between 10–90 percent. 90 percent is considered high speed fan. When multiple cooling fan speed requests are received, the ECM operates the fan at the highest of speed requests. The ECM commands the fans ON under the following conditions:

- The engine coolant temperature is warmer than a predetermined temperature.
- The engine oil temperature is warmer than a predetermined temperature.
- The A/C pressure reaches a predetermined pressure.
- If the engine coolant temperature at key-off is warmer than a predetermined value, or the A/C pressure is greater than a predetermined value, the cooling fan will operate at a low speed. The fan will shut OFF if the temperature or pressure drops below the predetermined value, but will only operate for 2 minutes, regardless of the coolant temperature or A/C pressure.

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Cooling System Description and Operation (LSA)

Cooling System

The cooling system's function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the system cools slowly or not at all. This allows the engine to warm quickly.

Cooling Cycle

The thermostat is located between the radiator outlet and the water pump inlet. At normal operating temperature, coolant is drawn from the radiator outlet and into the water pump inlet by the water pump. In cold conditions, the thermostat will bypass the radiator, and the pump will draw coolant directly from the engine outlet.

Coolant is then pumped through the water pump outlet and into the engine block. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where it absorbs heat.

The coolant is then forced through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where it absorbs additional heat.

From the cylinder heads, the coolant is then forced to the engine outlet. Coolant leaves the engine through three different routes:

1. Through the engine outlet fitting to the radiator inlet, where the coolant is cooled. This path is blocked at cold conditions by the thermostat at the engine inlet fitting.
2. To the heater core for passenger compartment heat and defrost.
3. Through the coolant air bleed hose to the top radiator tank, providing continuous de-aeration of the engine.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the overflow reservoir. As the coolant circulates, air is allowed to exit. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the components identified below.

Coolant

The engine coolant is a solution made up of a 50-50 mixture of DEX-COOL and clean drinkable water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger. It consists of a core and two tanks. The aluminum core is a downflow tube and fin design. This is a brazed tube with convoluted louvered fin design. Separate tubes and fins are stacked together with a manifold (header) at top and bottom. The entire assembly is then brazed forming a homogeneous unified structure. The fins allow for efficient heat transfer from the coolant to the atmosphere. The inlet (top) and outlet (bottom) tanks are molded with a high temperature, glass reinforced nylon plastic. 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 also has a drain plug which is located in the bottom right of the lower tank.

Heat is removed from the coolant as the coolant passes through the radiator. The fins on the core transfer heat from the coolant passing through the tubes. Air passing between the fins absorbs the heat and cools the coolant.

Pressure Cap

The pressure cap seals the cooling system. It contains a blow off or pressure relief valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring, which protects the radiator from excessive cooling system pressure. The vacuum valve relies on system pressure to hold it closed.

The pressure cap allows cooling system pressure to build up as the temperature increases. As the pressure builds, the boiling point of the coolant increases. Engine coolant can be safely run at a temperature much higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the faster the heat transfers from the radiator to the passing air.

When the cooling system pressure exceeds the rating of the pressure cap (140kPa), it raises the pressure valve, venting the excess pressure and releasing coolant to the overflow reservoir, which is at atmospheric pressure.

As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing coolant from the overflow reservoir to draw back into the main part of the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, preventing the radiator and coolant hoses from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow hose. The overflow reservoir is also called a recovery tank or expansion tank. It is partially filled with coolant and is connected to the coolant fill neck with the overflow hose. Coolant can flow back and forth between the main cooling system and the reservoir as pressure increases and decreases.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure in the cooling system gets too high, it will open the pressure valve in the pressure cap. This allows the coolant, which has expanded due to being heated, to flow through the overflow hose and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be drawn back into the main cooling system. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full. An advantage to using a coolant recovery reservoir is that it eliminates almost all air bubbles from the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

The overflow reservoir also provides a way to check the coolant level via the cap and dipstick without opening the main system, which is under pressure when the vehicle is hot.

Charge Air Cooling System

The charge air cooling systems function is to reduce the temperature of the air charge that is heated during the supercharging process which improves the efficiency and performance of the Powertrain. The charge air cooling system is an air-to-water system that uses a separate charge air cooling radiator located in front of the condenser and the radiator to cool the air charge. An electric pump is used to flow coolant from the charge air cooler, through the supercharger and charge air cooler reservoir, then back to the charge air cooler where the cycle repeats.

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase system cooling. Air baffles are also used to direct airflow into the radiator and increase cooling. Air seals prevent air from bypassing the radiator and A/C condenser. Air seals also prevent recirculation of the air for better hot weather cooling and A/C condenser performance.

Water Pump

The water pump is a centrifugal vane impeller type pump. The pump consists of a housing with coolant inlet and outlet passages and an impeller. The impeller is a flat plate mounted on the pump shaft with a series of flat or curved blades or vanes. When the impeller rotates, the coolant between the vanes is thrown outward by centrifugal force. The impeller shaft is supported by one or more sealed bearings, which never need to be lubricated. With a sealed bearing, grease cannot leak out, and dirt and water cannot get in.

The water pump circulates coolant throughout the cooling system. The pump is driven by the crankshaft from the drive belt.

Thermostat

The thermostat is a coolant flow control component, whose purpose is to regulate the operating temperature of the engine. The thermostat utilizes a temperature sensitive wax-pellet element, which connects to a valve through a piston. Heating causes the element to expand and exert pressure against a rubber diaphragm. This pressure forces the valve to open. Cooling causes the element to contract. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 86°C (186°F) the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 86°C (186°F) the thermostat valve will begin to open. The switch point will differ a little depending on engine. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after opening. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger. It is located inside the lower tank of the radiator. The transmission fluid temperature is regulated by the temperature of the engine coolant that surrounds the oil cooler as the transmission fluid passes through the cooler.

The transmission oil pump, pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid then flows through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then pumped through the transmission oil cooler return line, to the transmission.

The transmission oil cooling system includes an integrated rear differential cooler. There are two transmission oil coolers in a series in the LSA transmission oil cooler system. The initial transmission oil cooler is a heat exchanger located in the lower tank of the radiator. The transmission oil temperature is partially regulated by the temperature of the coolant leaving the radiator and passing over the heat exchanger.

Pipes/hoses from the transmission bring oil pumped at a high pressure through the rear differential, back to the radiator end tank cooler. The oil out of the radiator end tank cooler is plumbed to an air-to-oil cooler in front of the A/C condenser and radiator. This cooler helps provided additional cooling for performance driving conditions for the LSA transmission and rear differential. The transmission oil is then directed back to the transmission.

Cooling System Description and Operation (LS3, L77)

Cooling System

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Cooling Cycle

The thermostat is located between the radiator outlet and the water pump inlet. At normal operating temperature, coolant is drawn from the radiator outlet and into the water pump inlet by the water pump. In cold conditions, the thermostat will bypass the radiator, and the pump will draw coolant directly from the engine outlet.

Coolant is then pumped through the water pump outlet and into the engine block. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where it absorbs heat.

The coolant is then forced through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where it absorbs additional heat.

From the cylinder heads, the coolant is then forced to the engine outlet. Coolant leaves the engine through three different routes:

1. Through the engine outlet fitting to the radiator inlet, where the coolant is cooled. This path is blocked at cold conditions by the thermostat at the engine inlet fitting.
2. To the heater core for passenger compartment heat and defrost.
3. Through the coolant air bleed hose to the top radiator tank, providing continuous de-aeration of the engine.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the overflow reservoir. As the coolant circulates, air is allowed to exit. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the components identified below.

Coolant

The engine coolant is a solution made up of a 50-50 mixture of DEX-COOL and clean drinkable water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger. It consists of a core and two tanks. The aluminum core is a downflow tube and fin design. This is a brazed tube with convoluted louvered fin design. Separate tubes and fins are stacked together with a manifold (header) at top and bottom. The entire assembly is then brazed forming a homogeneous unified structure. The fins allow for efficient heat transfer from the coolant to the atmosphere. The inlet (top) and outlet (bottom) tanks are molded with a high temperature, glass reinforced nylon plastic. 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 also has a drain plug which is located in the bottom right of the lower tank.

Heat is removed from the coolant as the coolant passes through the radiator. The fins on the core transfer heat from the coolant passing through the tubes. Air passing between the fins absorbs the heat and cools the coolant.

Pressure Cap

The pressure cap seals the cooling system. It contains a blow off or pressure relief valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring, which protects the radiator from excessive cooling system pressure. The vacuum valve relies on system pressure to hold it closed.

The pressure cap allows cooling system pressure to build up as the temperature increases. As the pressure builds, the boiling point of the coolant increases. Engine coolant can be safely run at a temperature much higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the faster the heat transfers from the radiator to the passing air.

When the cooling system pressure exceeds the rating of the pressure cap (140kPa), it raises the pressure valve, venting the excess pressure and releasing coolant to the overflow reservoir, which is at atmospheric pressure.

As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing coolant from the overflow reservoir to draw back into the main part of the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, preventing the radiator and coolant hoses from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow hose. The overflow reservoir is also called a recovery tank or expansion tank. It is partially filled with coolant and is connected to the coolant fill neck with the overflow hose. Coolant can flow back and forth between the main cooling system and the reservoir as pressure increases and decreases.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure in the cooling system gets too high, it will open the pressure valve in the pressure cap. This allows the coolant, which has expanded due to being heated, to flow through the overflow hose and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be drawn back into the main cooling system. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full. An advantage to using a coolant recovery reservoir is that it eliminates almost all air bubbles from the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

The overflow reservoir also provides a way to check the coolant level via the cap and dipstick without opening the main system, which is under pressure when the vehicle is hot.

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase system cooling. Air baffles are also used to direct airflow into the radiator and increase cooling. Air seals prevent air from bypassing the radiator and A/C condenser. Air seals also prevent recirculation of the air for better hot weather cooling and A/C condenser performance.

Water Pump

The water pump is a centrifugal vane impeller type pump. The pump consists of a housing with coolant inlet and outlet passages and an impeller. The impeller is a flat plate mounted on the pump shaft with a series of flat or curved blades or vanes. When the impeller rotates, the coolant between the vanes is thrown outward by centrifugal force. The impeller shaft is supported by one or more sealed bearings, which never need to be lubricated. With a sealed bearing, grease cannot leak out, and dirt and water cannot get in.

The water pump circulates coolant throughout the cooling system. The pump is driven by the crankshaft from the drive belt.

Thermostat

The thermostat is a coolant flow control component, whose purpose is to regulate the operating temperature of the engine. The thermostat utilizes a temperature sensitive wax-pellet element, which connects to a valve through a piston. Heating causes the element to expand and exert pressure against a rubber diaphragm. This pressure forces the valve to open. Cooling causes the element to contract. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 86°C (186°F) the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 86°C (186°F) the thermostat valve will begin to open. The switch point will differ a little depending on engine. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after opening. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger. It is located inside the lower tank of the radiator. The transmission fluid temperature is regulated by the temperature of the engine coolant that surrounds the oil cooler as the transmission fluid passes through the cooler.

The transmission oil pump, pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid then flows through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then pumped through the transmission oil cooler return line, to the transmission.

Auxiliary Transmission Oil Cooler

On high performance variants, there are two transmission oil coolers in a series. As above, initially the transmission oil goes through the cooler located in the lower tank of the radiator. On high performance variants, the transmission oil then flows to an oil bypass thermostat, where hot (> 84°C) oil flows through it to an auxiliary air-to-oil cooler located in front of the A/C condenser where additional cooling is provided, before the oil is directed back to the transmission. When additional cooling is not required (i.e. the transmission oil is below 84°C), the transmission oil thermostat remains closed and oil flows through the bypass portion of the thermostat and the oil is then directed back to the transmission.

Cooling System Description and Operation (LFW, LFX, LWR)

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Thermostat

The thermostat is a coolant flow control component, whose purpose is to regulate the operating temperature of the engine. The thermostat utilizes a temperature sensitive wax-pellet element, which connects to a valve through a piston. Heating causes the element to expand and exert pressure against a rubber diaphragm. This pressure forces the valve to open. Cooling causes the element to contract. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 82°C (180°F) the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 82°C (180°F) the thermostat valve will begin to open. The switch point will differ a little depending on engine. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after opening. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Transmission Oil Cooler

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Auxiliary Transmission Oil Cooler

On high performance variants, there are two transmission oil coolers in a series. As above, initially the transmission oil goes through the cooler located in the lower tank of the radiator. On high performance variants, the transmission oil then flows to an oil bypass thermostat, where hot (> 84°C) oil flows through it to an auxiliary air-to-oil cooler located in front of the A/C condenser where additional cooling is provided, before the oil is directed back to the transmission. When additional cooling is not required (i.e. the transmission oil is below 84°C), the transmission oil thermostat remains closed and oil flows through the bypass portion of the thermostat and the oil is then directed back to the transmission.

DTC P0480, P0691, or P0692

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480

Cooling Fan Speed Output Circuit

DTC P0691

Cooling Fan Speed Output Circuit Low Voltage

DTC P0692

Cooling Fan Speed Output Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cooling Fan Control Module Ignition Voltage	P0480*	P0480	—	—
Cooling Fan Control Module Ground	—	P0480	—	—
Cooling Fan Control Module Control	P0480 or P0691	P0480	P0480 or P0692	—
*Opens cooling fan fuse.				

Circuit/System Description

The engine control module (ECM) commands the speed of the cooling fans based on cooling requirements. The ECM controls the cooling fan speed by commanding the cooling control module. The cooling fan control module supplies separate power and ground circuits for each cooling fan. The ECM sends a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module interprets the signal and operates the cooling fans at the commanded speeds.

Conditions for Running the DTC

L77, LS3, or LSA

- The ignition voltage is between 11- 32 volts.
- The engine speed is 400 RPM or greater.
- The ECM driver transitions from ON to OFF or from OFF to ON.
- DTC P0480 runs continuously once the above conditions are met.

LFW, LFX, or LWR

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- The ignition voltage is between 11 volts or greater.
- The ECM has commanded the output driver ON and OFF at least once during the ignition cycle.
- DTCs P0480, P0691, P0692 run continuously when the conditions above are 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 5 seconds.

Action Taken When the DTC Sets

- DTCs P0480, P0691, and P0692 are Type C DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0480, P0691, and P0692 are Type C DTCs.

Diagnostic Aids

- A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.
- When operating the cooling fans with a scan tool, the Commanded States should be exercised in order, from OFF to High or High to OFF. The cooling fan control module may disable the cooling fans if a Commanded State is skipped.

Reference Information

Schematic Reference

[Engine Heating/Cooling Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Cooling Fan Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[K20 Engine Control Module: Scan Tool Information](#) for scan tool information

Circuit/System Verification

Note: There is a slight delay before the cooling fans activate.

1. Engine operating, command the Cooling Fans from 0 % to 90 % with a scan tool.
2. Verify the G10 Cooling Fan Motors activates in each available speed.

⇒ **The cooling fan does not activate or increase in speed as commanded**

Refer to Circuit/System Testing

⇓ **The cooling fan activates and increases in speed as commanded**

3. 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.
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 harness connector X1 at the K22 Cooling Fan Control Module, ignition ON.
2. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
 - 2.1. Ignition OFF, remove the test lamp and turn all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
 - 2.2. Test for less than 2 Ω in the 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, remove the test lamp and turn 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 terminals listed below and ground.
 - K22 Cooling Fan Control Module harness connector X1-1
 - G10L Cooling Fan Motor-Left harness connector X2-1
 - G10R Cooling Fan Motor-Right harness connector X3-1
 - ⇒ If less than infinite resistance, repair the short to ground in the circuit.
 - ⇒ If infinite resistance, replace the appropriate G10 Cooling Fan Motor.
- ⇓ **If the test lamp illuminates**
3. Verify that a test lamp illuminates between the ground circuit terminal 2 and B+.
- ⇒ **If the test lamp does not illuminate**
 - 3.1. Ignition OFF, remove the test lamp and turn all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
 - 3.2. 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 ground circuit.
 - ⇒ If less than 2 Ω , repair the open/high resistance in the ground connection.
- ⇓ **If the test lamp illuminates**

Note: The cooling fan speed output circuit is pulled-up to a voltage within the ECM, 2-3 volts on the output circuit is normal.
4. Connect a DMM, set on the diode setting, between the control circuit terminal X1-4 and ground.
5. Verify the DMM reading is greater than 2.5 V or displays O.L. with the cooling fan commanded OFF.
 - ⇒ **If 2.5 V or less**
 - 5.1. Ignition OFF, all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
 - 5.2. Disconnect the K20 Engine Control Module harness connector X1.
 - 5.3. Test for infinite resistance between the K22 Cooling Fan Control Module control circuit terminal X1-4 and ground.

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

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

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

6. Command the Cooling Fan ON to 90 % with a scan tool.

7. Verify the DMM reading is less than 1 V.

⇒ **If 1 V or greater**

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

7.2. Test for less than 1 V between the K22 Cooling Fan Control Module circuit terminal X1-4 and ground.

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

↓ If less than 1 V.

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

7.4. Test for less than 2 Ω in the control circuit terminal X1-4, end to end.

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

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

↓ **If less than 1 V**

8. Replace the K22 Cooling Fan Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Fan Control Module Replacement](#)
- [Control Module References](#) for ECM replacement, setup, and programming

DTC P1258

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P1258

Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

The engine control module (ECM) uses the engine coolant temperature sensor to monitor the engine for an over-temperature condition. This condition occurs when the coolant temperature is above a calibrated value. The ECM will alternately disable 2 groups of cylinders by turning OFF the fuel injectors. By switching between the 2 groups of cylinders, the ECM is able to reduce the temperature of the coolant.

Conditions for Running the DTC

- The engine is operating for greater than 30 seconds.
- DTC P1258 runs continuously once the conditions above have been met.

Conditions for Setting the DTC

The ECM detects that engine coolant temperature is warmer than 132°C (270°F) for 2 seconds or greater.

Action Taken When the DTC Sets

- DTC P1258 is a Type A DTC.
- The engine will operate in the Overheated Engine Protection Operating Mode.
- The IP will illuminate the coolant temperature indicator lamp and the driver information center (DIC), if equipped, may display a message.
- If the protection mode is active and an ECT sensor DTC sets, the protection mode will remain active at the start of the next drive cycle until the ECT sensor DTC runs and passes.

Conditions for Clearing the MIL/DTC

DTC P1258 is a Type A DTC.

Reference Information

Schematic Reference

[Engine Controls Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

- [Cooling Fan Description and Operation](#)
- [Instrument Cluster Description and Operation](#)

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- [Indicator/Warning Message Description and Operation](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[K20 Engine Control Module: Scan Tool Information](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0480, P0691, or P0692 is not set.
 - ⇒ **If a DTC is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
 - ↓ **If no DTCs is set**
Note: A short delay occurs before the ECM changes the cooling fan speed.
3. Verify the cooling fan operates at each available speed as commanded with a scan tool.
 - ⇒ **Cooling fan does not operate**
Refer to [Cooling Fan Inoperative](#).
 - ↓ **Cooling fan operates**
4. Verify that the engine does not overheat.
 - ⇒ **Engine overheats**
Refer to [Engine Overheating](#).
 - ↓ **Engine does not overheat**
5. Operate the vehicle within the conditions that the customer experienced and verify the DTC does not set.
 - ⇒ **If the DTC sets**
Refer to [Symptoms - Engine Cooling](#).
 - ↓ **If the DTC does not set**
6. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

Symptoms - Engine Cooling

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform [Diagnostic System Check - Vehicle](#) 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](#) and [Cooling System Description and Operation](#).

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 coolant recovery 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 chafed 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 fault is detected, refer to [Testing for Intermittent Conditions and Poor Connections](#) 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](#)
- [Cooling Fan Inoperative](#)
- [Engine Overheating](#)
- [Loss of Coolant](#)
- [Thermostat Diagnosis](#)
- [Engine Fails To Reach Normal Operating Temperature](#)

Cooling Fan Always On

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) commands the speed of the cooling fans based on cooling requirements. The ECM controls the cooling fan speed by commanding the cooling control module. The cooling fan control module supplies separate power and ground circuits for each cooling fan. The ECM sends a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module interprets the signal and operates the cooling fans at the commanded speeds.

Diagnostic Aids

- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fan 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.
- When operating the cooling fans with a scan tool, the Commanded States should be exercised in order, from OFF to High or High to OFF. The cooling fan control module may disable the cooling fans if a Commanded State is skipped.

Reference Information

Schematic Reference

[Engine Heating/Cooling Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Cooling Fan Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that there are no cooling system DTC's set.

⇒ If a DTC is set

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).

↓ **If no DTC is set.**

3. Verify the scan tool Cooling Fan Motor Command parameter is at 0 %.

⇒ **If greater than 0 %**

Refer to Diagnostic Aids and [Symptoms - Engine Cooling](#) for further diagnosis.

↓ **If at 0 %**

4. Verify that the G10 Cooling Fan Motors are not operating.

⇒ **If a G10 Cooling Fan Motor is operating**

Refer to Circuit/System Testing.

↓ **If the G10 Cooling Fan Motors are not operating**

5. All OK.

Circuit/System Testing

1. Ignition OFF.

2. Disconnect the appropriate harness connector at the K22 Cooling Fan Control Module, ignition ON.

3. Verify that the G10 Cooling Fan Motor is not operating.

⇒ **If a G10 Cooling Fan Motor is operating**

3.1. Ignition ON.

3.2. Test for less than 1 V between the appropriate G10 Cooling Fan Motor harness connector terminal 1 and ground.

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

↓ **If the G10 Cooling Fan Motor is not operating**

4. Replace the K22 Cooling Fan Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- [Fan Control Module Replacement](#)
- [Control Module References](#)

Cooling Fan Inoperative

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) commands the speed of the cooling fans based on cooling requirements. The ECM controls the cooling fan speed by commanding the cooling control module. The cooling fan control module supplies separate power and ground circuits for each cooling fan. The ECM sends a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module interprets the signal and operates the cooling fans at the commanded speeds.

Diagnostic Aids

- A delay or ramp up of approximately 12 seconds may occur before the cooling fan activates or changes speed when being commanded with a scan tool.
- When operating the cooling fans with a scan tool, the Commanded States should be exercised in order, from OFF to High or High to OFF. The cooling fan control module may disable the cooling fans if a Commanded State is skipped.

Reference Information

Schematic Reference

[Engine Heating/Cooling Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Cooling Fan Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Special Tools

EL 36169-HD Heavy Duty Fused Jumper

Circuit/System Verification

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

⇒ **If a DTC is set**

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Refer to [DTC P0480, P0691, or P0692](#).

↓ **If no DTC is set.**

Note: A slight delay may occur before the cooling fan activates.

3. Verify both G10 Cooling Fan Motors activate and increase in speed as command with a scan tool.

⇒ **A cooling fan does not activate or increase in speed**

Refer to Circuit/System Testing

↓ **Both cooling fans activate and increase in speed**

4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the appropriate G10 Cooling Fan Motor harness connector from the K22 Cooling Fan Control Module.

- G10L Cooling Fan Motor – Left harness connector X2
- G10R Cooling Fan Motor – Right harness connector X3

2. Connect the *EL 36169-HD* between B+ and the G10 Cooling Fan Motor control circuit terminal 1. Connect a jumper wire between the cooling fan motor ground circuit terminal 2 and ground. Verify the cooling fan operate at high speed.

⇒ **If the fan does not operate**

Replace the G10 Cooling Fan Motor.

↓ **If both of the fans operate**

3. Test or replace the K22 Cooling Fan Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- [Cooling Fan and Shroud Replacement](#)
- [Fan Control Module Replacement](#)
- [Control Module References](#)

Engine Overheating

Engine Overheating

Step	Action	Yes	No
DEFINITION: Either of the following conditions indicate a probable engine overheat condition. - The engine temperature gauge is in the red (overheat) zone and/or the engine temperature indicator is ON. - Hot engine coolant overflows from the coolant recovery reservoir and/or coolant pressure cap onto the ground while the engine is running.			
1	- Inspect and fill the cooling system, as necessary. Refer to Cooling System Draining and Filling. - Inspect the cooling system for leaks, as necessary. - Repair the cooling system leaks, as necessary. Has the inspection/repair been performed?	Go to Step 2	—
2	- Start the engine and allow the engine to run at approximately 1,200 RPM. - Use the Scan Tool in order to verify the overheat condition. Does the Scan Tool verify the engine overheat condition?	Go to Step 3	Go to Diagnostic System Check - Vehicle
3	- Verify that the cooling fans are operating correctly. - Repair the cooling fan system, as necessary. Does the engine still overheat?	Go to Step 4	System OK
4	Perform the following inspections: - Inspect the radiator and the A/C condenser cooling fins for debris or any other obstruction. - Inspect the drive belt system and the drive belt tensioner for correct operation in order to ensure that the water pump is rotating correctly. Refer to Drive Belt Tensioner Diagnosis for 3.6L engine, or Drive Belt Tensioner Diagnosis for 6.0L engine. - Inspect for loose, damaged and/or missing air deflector(s).	Go to Step 5	System OK

Step	Action	Yes	No
	- Check for a pinched or kinked cooling system hose. - Repair the systems as necessary. Does the engine still overheat?		
5	Inspect the thermostat for correct operation. Refer to Thermostat Diagnosis. Is the thermostat operating correctly?	Go to Step 7	Go to Step 6
6	Replace the thermostat. Refer to Engine Coolant Thermostat Housing Replacement. Does the engine still overheat?	Go to Step 7	System OK
7	Important: Excessive coolant freeze point protection MAY cause the coolant to boil at low temperatures. - Inspect for the correct coolant concentration (mixture). Correct the coolant concentration as necessary. - Remove the coolant pressure cap. - Start the engine and inspect for a constant flow of air bubbles in the engine coolant. Is there a constant flow of air bubbles in the engine coolant?	Go to Step 8	Go to Step 9
8	The probable cause of the engine overheat is combustion chamber gasses leaking into the cooling system. This condition is usually caused by the following: - A worn or damaged cylinder head gasket. - A worn or damaged cylinder head. - A worn and/or damaged engine block. Verify this condition by inspecting the spark plug electrodes and porcelain surrounding the spark plug electrode for signs of coolant. Replace and/or repair the engine internal component(s), as necessary, in order to repair the engine internal coolant leak. Does the engine still overheat?	Go to Step 1	System OK
9	The engine overheat may be caused by a cooling system blockage. Flush the cooling system. Refer to Flushing. Does the engine still overheat?	Go to Step 10	System OK
10	Important: It is unlikely that the water pump is the cause of the overheat condition. If NONE of the cooling system passages are restricted, replace the water pump. Refer to Water Pump Replacement.	Go to Step 1	System OK

Step	Action	Yes	No
	Does the engine still overheat?		

Loss of Coolant

Loss of Coolant

Step	Action	Yes	No
DEFINITION: The cooling system is losing coolant either internally or externally.			
1	Inspect the coolant level. Is the coolant at the correct level?	Go to Step 6	Go to Step 4
2	Fill the cooling system to the correct level. Refer to Cooling System Draining and Filling . Is the action complete?	Go to Step 5	—
3	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to Step 6	Repair the engine no crank condition. Refer to Engine Will Not Crank - Crankshaft Will Not Rotate for the V6 engine, or Engine Will Not Crank - Crankshaft Will Not Rotate for the V8 engine
4	Engine overheating can cause a loss of coolant. Is the engine overheating?	Repair the engine overheating condition. Refer to Engine Overheating	Go to Step 7
5	Extended operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Repair the engine knock. Refer to Lower Engine Noise, Regardless of Engine Speed for the V6 engine, or Lower Engine Noise, Regardless of Engine Speed for the V8 engine	Go to Step 8
6	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust system.	Go to Step 9	Go to Step 10

Step	Action	Yes	No
	Is a heavy white smoke present from the exhaust pipe?		
7	Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Repair the engine internal coolant leak. Refer to: • Coolant in Combustion Chamber for the V6 engine • Coolant in Combustion Chamber for the V8 engine • Coolant in Engine Oil for the V6 engine • Coolant in Engine Oil for the V8 engine	Go to Step 10
8	With the engine idling, inspect the coolant recovery reservoir. Does the coolant recovery system discharge coolant while the engine is idling?	Repair the engine internal coolant leak. Refer to: • Coolant in Combustion Chamber for the V6 engine • Coolant in Combustion Chamber for the V8 engine • Coolant in Engine Oil for the V6 engine • Coolant in Engine Oil for the V8 engine	Go to Step 11
9	Visually inspect the hoses and hose retaining clamps at the following locations: • Coolant bypass • Coolant reservoir • Heater core	Repair or replace the leaking component. Refer to the appropriate repair.	Go to Step 12

Step	Action	Yes	No
	- Coolant bypass valve - Radiator Are any of the hoses leaking?		
10	Visually inspect the following components: - Coolant pressure cap - Core plugs - Cylinder head gaskets - Engine block - Intake manifold - Radiator - Thermostat housing - Water pump Are any of the listed components leaking?	Repair or replace the leaking component. Refer to the appropriate repair.	Go to Step 13
11	1. Pressure test the cooling system. Refer to Cooling System Leak Testing . 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. Are any leaks present?	Repair or replace the leaking component. Refer to the appropriate repair.	Go to Step 14
12	Pressure test the coolant pressure cap. Refer to Pressure Cap Testing . Does the coolant pressure cap hold pressure?	Go to Step 13	Replace the coolant pressure cap
13	Inspect for the following conditions: - A coolant smell inside of the vehicle. - Coolant in the HVAC module drain tube. - Coolant on the vehicle floor covering near the HVAC module. Is coolant present?	Replace the heater core. Refer to Heater Core Replacement .	Go to Step 15
14	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is there a milky substance on under the oil fill cap?	Repair the engine internal coolant leak. Refer to: Coolant in Combustion Chamber for the V6 engine Coolant in Combustion Chamber for the V8 engine	Replace the coolant pressure cap.

Step	Action	Yes	No
		• Coolant in Engine Oil for the V6 engine • Coolant in Engine Oil for the V8 engine	
15	Inspect the engine oil level indicator for a gray/white milky substance. Is there a milky substance on the engine oil level indicator?	Repair the engine internal coolant leak. Refer to: • Coolant in Combustion Chamber for the V6 engine • Coolant in Combustion Chamber for the V8 engine • Coolant in Engine Oil for the V6 engine • Coolant in Engine Oil for the V8 engine	Replace the coolant pressure cap.

Thermostat Diagnosis

Tools Required

J-24731-206 Tempil Stick

The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil-like device which has a wax material containing certain chemicals that melt at a given temperature. Temperature sticks can be used to determine a thermostat's operating range by rubbing 87°C (188°F) and 97°C (206°F) sticks on the outlet coolant hose.

1. Use a tempil stick in order to find the opening and the closing temperatures of the thermostat.
J-24731-206 Tempil Stick melts at 87°C (188°F). The thermostat should begin to open at 82°C (181°F) for V6 and 86°C (186°F) for V8.
2. Replace the thermostat if it does not operate correctly between this temperature range.

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Engine Fails To Reach Normal Operating Temperature

Engine Fails To Reach Normal Operating Temperature

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s). Is the electric cooling fan on?	Go to Step 2	Go to Step 3
2	1. Diagnose and repair the cooling fan system. Refer to Cooling Fan Always On . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 3	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to Step 5	Go to Step 4
4	1. Diagnose and repair the coolant temperature gauge system. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 5	System OK
5	Inspect the thermostat for correct operation. Refer to Thermostat Diagnosis . Is the thermostat operating correctly?	System OK	Go to Step 6
6	1. Replace the thermostat and housing. Refer to Engine Coolant Thermostat Housing Replacement . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 1	System OK

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Pressure Cap Testing

Special Tools

J-24460-A Cooling System Pressure Tester

Testing Procedure

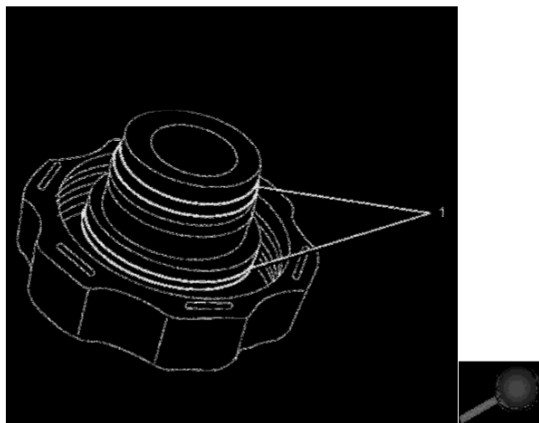
Warning: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, 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.

Warning: Refer to [Radiator Cap Removal Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

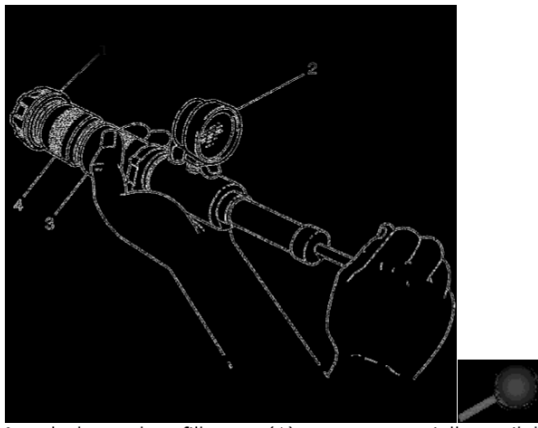
1. Ensure engine is below 50 °C before removing the coolant pressure cap.



Note: Only use water to wet the cloth.

2. Inspect and clean the sealing O-rings (1) with a wet cloth.

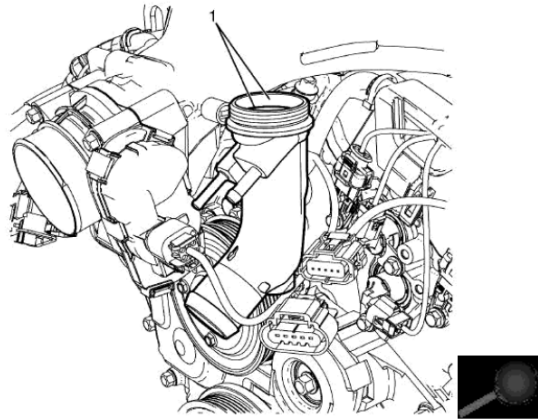
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3. Attach the coolant filler cap (1) to a commercially available cooling system pressure tester (2), using the pressure cap adapter (4) and the pressure tester adapter (3).

Note: Should the coolant pressure cap fail to reach or hold the specified pressure, replace the cap.

4. Slowly pressurize cap to 120–150 kPa (17–22 psi).



Note: The V6 coolant filler neck is shown in the illustration above, for the V8 variant the coolant filler neck is located on the radiator assembly.

5. Prior to installing the coolant pressure cap ensure that the coolant filler neck cap seating surface (1) is clean and free from obstruction.

Caution: Refer to [Fastener Caution](#).

6. Install the coolant pressure cap.

Tighten

Tighten the cap to 3.0 N•m (27 lb in).

Cooling System Leak Testing

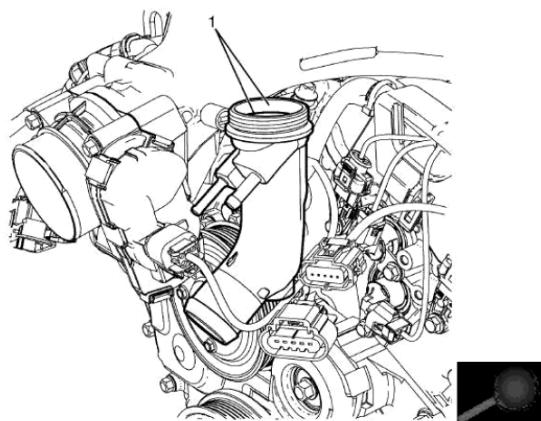
Special Tools

- J-24460-A Cooling System Pressure Tester
- KM-471 Pressure Tester Adapter
- KM-6327-A Cooling System Test Adapter

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 coolant pressure cap.
2. Test the operation of the coolant pressure cap. Refer to [Pressure Cap Testing](#).
3. Ensure that the coolant level is correct.



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Note: The V6 coolant filler neck is shown in the illustration, for the V8 variant the coolant filler neck is located on the radiator assembly.

4. Install the coolant filler neck adapter to commercially available cooling system pressure tester.
5. Install the assembly to the engine coolant filler neck.
6. Using compressed air, blow dry any spilled coolant around coolant filler neck.

Note: Make sure not to exceed the stated pressure.

7. Using the cooling system pressure tester pump, pressurize the cooling system to 150 kPa (22 psi) absolute maximum and check for leaks at the following points:
 - All hose and hose connections.
 - Overflow hose connection at coolant outlet housing connection.
 - Radiator seams and core.
 - Corroded or damaged engine core plugs.
 - Water pump and gasket.
 - Thermostat housing and inlet pipe connection.

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- Radiator drain cock.
 - Vehicle heating system (e.g. heater core and water valve).
 - Check engine oil dipstick for evidence of engine oil contamination with the coolant.
8. Repair any leaks as required.
- Note:** If a visible loss of coolant is not evident from pressure testing, the use of dye and black light testing will aid in locating the leak.
9. If pressure will not hold, there is a leak in the cooling system. Repair as necessary.

Black Light and Dye Leak Diagnosis Method

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.

Note: Adding dye to the cooling system, may change the color of the coolant to a dark, muddy green. As the use of extended life anti-freeze coolant (conforming to GM6277M) to this cooling system is mandatory and should not be mixed with other composition coolants, the green color could be misleading for future top-up operations. Therefore , should the coolant change color when the leak detection dye is added, then the cooling system must be drained and new extended life anti-freeze coolant (conforming to GM6277M) coolant added. Refer to [Cooling System Draining and Filling](#).

1. Remove the pressure cap.
2. Pour a specified amount of dye into the cooling system.
3. Road test the vehicle under normal operating conditions.
4. Direct the black light towards the suspect area. Any fluid leak will appear as a bright colored path leading to the source.
5. Repair the fluid leak and carry out a second road test to ensure the leak has been rectified.
6. Refer to the manufacture's direction when performing this method.

Charge Air Cooling System Leak Testing (LSA)

Special Tools

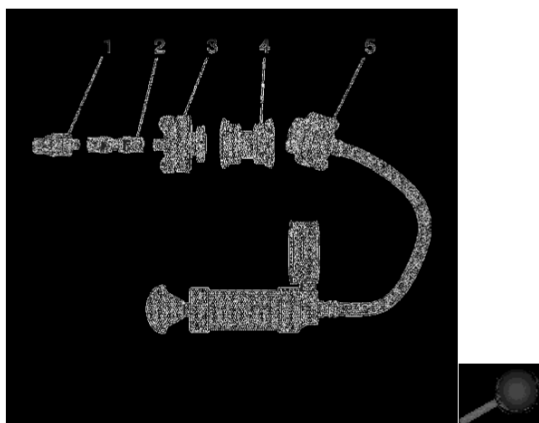
- EN-24460-A Cooling System Pressure Tester
- GE-47716 Vac-N-Fill Coolant Refill Tool
- GE-47716-20 Cooling System Fill Adapter
- GE-50389 Coolant Pressure Test Quick Connector
- For equivalent regional tools. Refer to [Special Tools](#).

Cooling System Leak Testing

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 CAC quick connect cap (1) and ensure there is adequate coolant within the CAC system.



2. Install Cooling System Pressure Tester Cap Adapter (4) to EN-24460-A Cooling System Pressure Tester (5).
3. Install the Vac-N-Fill Cap (3) to the Cooling System Pressure Tester Cap Adapter (4).
4. Install the GE-50389 Coolant Pressure Test Quick Connector (2) to the Vac-N-Fill Cap (3).
5. Install the GE-47716-20 Cooling System Fill Adapter (1) to the GE-50389 Coolant Pressure Test Quick Connector (2).
6. Install the GE-47716-20 Cooling System Fill Adapter (1) in place the charge air cooling system cap. Ensure that the Cooling System Fill Adapter is firmly seated.
7. Apply 5 psi pressure to the charge air cooler system for at least 2 minutes.
8. Observe the gauge for any pressure loss and repair any leaks as required.

Cooling System Draining and Filling

Draining Procedure

Warning: Refer to [Battery Disconnect Warning](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

Warning: Refer to [Safety Glasses Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

Ensure engine is below 122° F (50 °C) before removing the coolant pressure cap.

2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



3. Place a drain pan under the drain plug (1).
4. Remove the drain plug (1) from the radiator.
5. Inspect the engine coolant for the following conditions:
 - Discolored appearance – follow the flush procedure. Refer to [Flushing](#).
 - Normal in appearance – follow the filling procedure. Refer to [Cooling System Draining and Filling](#).

Filling Procedure

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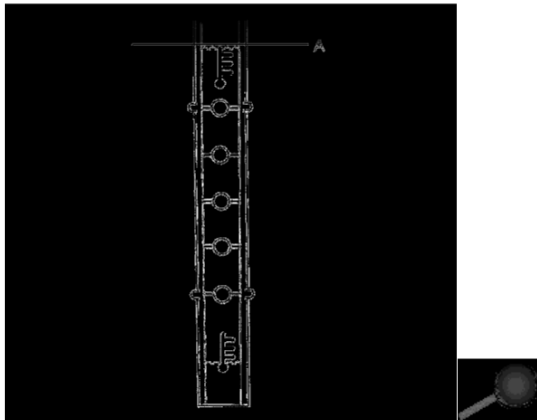


Caution: Refer to [Fastener Caution](#).

1. Install the drain cock plug (1) to the radiator and tighten to **1.5 N·m (13 lb in)**.
2. Lower the vehicle.
3. With the engine off, remove the coolant filler cap.
4. Remove the engine coolant air bleed hose by releasing retaining hose clamp and remove it from the radiator spigot.

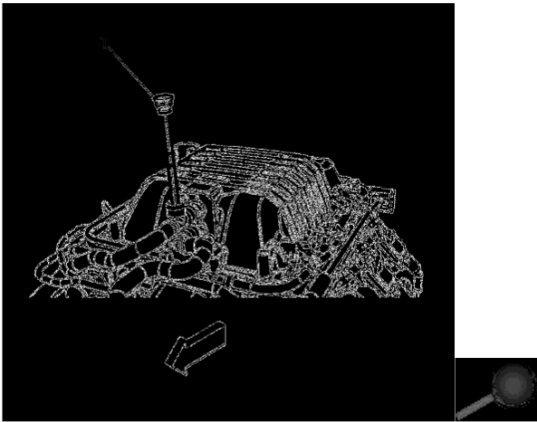
Note: When pouring coolant take care not to spill any coolant on to the accessory drive belts. If spills occurs, rinse belts immediately.

5. Slowly fill the cooling system through the coolant pressure cap point with a mixture of 50/50 Dex Cool and water until full, wait several seconds and "top up" if level drops.
6. Lift the radiator top hose underneath the air intake tube, to release air bubble in hose, top up if level drops.
7. Install the engine coolant air bleed hose to the radiator spigot.
8. Start engine.
9. With engine idling top up coolant until full, wait for several seconds and "top up" if level drops.
10. When full, fit coolant filler cap and switch off engine.



11. Check coolant level in coolant recovery reservoir. Adjust coolant level in the reservoir to the top of graphic mark (A) on the dipstick.

Charge Air Cooling System Coolant Level Inspection



Note: Make sure the intercooler system is cool and that the pump is not in the ON position.

1. Open the hood and remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
2. Orientate the charge air coolant (CAC) quick connect fitting to the vertical position.
3. Rotate and remove the charge air coolant cap (1).
4. Verify that coolant is visible near to top of the opening.

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

Pour the coolant in very small amounts to avoid coolant spillage from the charge air coolant cap port or from funnel.

5. If necessary, using a small funnel, slowly fill the charge air cooling system through the charge air coolant cap port with a 50/50 coolant mixture until the level is slightly below the charge air coolant cap port. Refer to [Approximate Fluid Capacities](#).
6. If the system is significantly low, refer to [Charge Air Cooling System Draining and Filling](#).
7. Install the charge air coolant cap (1).
8. Orientate the charge air coolant (CAC) quick connect fitting to the previously installed position to allow for the engine cover clearance.
9. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).

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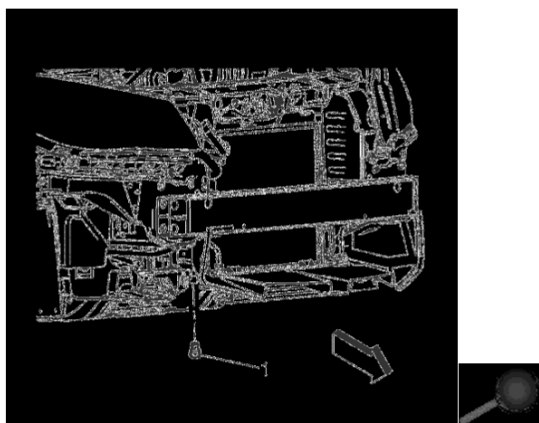
Charge Air Cooling System Draining and Filling (Static LSA)

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.

Note: Make sure the intercooler system is cool and that the pump is not in the ON position.

1. Open the hood and remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
2. Orientate the charge air coolant (CAC) quick connect fitting to the vertical position.
3. Rotate and remove the charge air coolant cap (1).
4. Raise and suitable support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove front bumper fascia. Refer to [Front Bumper Fascia Replacement](#).
6. Remove the radiator air inlet duct chute. Refer to [Radiator Air Inlet Duct Replacement](#).

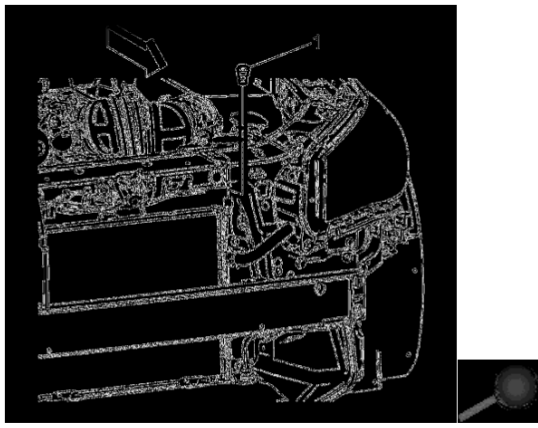


7. Remove the drain plug at the (CAC) radiator (1).
8. Allow the system to fully drain into a clean container.
9. Measure and record the amount of coolant drained.
- Caution:** Refer to [Fastener Caution](#).
10. Install and tighten the drain plug (1) to **9.6 N·m (85 lb in)**.
11. Lower the vehicle.

Filling Procedure

Note: It is critical that the system must be completely free of air to prevent CAC pump noise and loss of system performance.

1. Install absorbent rags under the (CAC) quick connect fitting to absorb any coolant loss.



Note: Do NOT remove the right hand upper (CAC) vent plug.

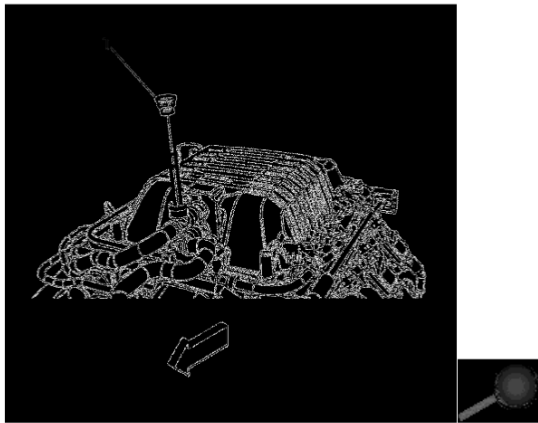
2. Loosen the vent plug (1) on the left hand upper (CAC) end tank.

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

3. Ensure the CAC quick connect fitting is in the vertical position.
4. Slowly fill coolant through the (CAC) quick connect until the coolant is visible at the vent port.

Caution: Refer to [Fastener Caution](#).

5. Tighten the vent plug (1) to **9.6 N·m (85 lb in)**.
6. Slowly fill coolant through the (CAC) quick connect until the coolant stabilizes within the fitting.



7. Install the charge air coolant cap (1).

Note: Use one of the following methods to cycle the coolant with the (CAC) pump.

8. Using the Tech 2, cycle the (CAC) pump ON for 60 seconds and then to the OFF position.

Or set the parking brake and ensure the transmission is in PARK or Neutral. Start the engine and allow the (CAC) pump to run for 60 seconds. Turn engine OFF.

9. Allow the system to stabilize for 60 seconds and remove the charge air coolant cap.

10. Continue to slowly fill the (CAC) cooling system with coolant until the level stabilizes within the fitting.

11. Install the charge air coolant cap.

12. Repeat steps 6-10 until additional coolant can not be added through the charge air coolant cap into the system. Refer to [Approximate Fluid Capacities](#)

13. Inspect the CAC cooling system for leaks.
14. Remove the absorbent rags.
15. Rinse away any excess coolant from the engine and the engine compartment.
16. Orientate the charge air coolant (CAC) quick connect fitting to the previously installed position to allow for the engine cover clearance.
17. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
18. Install the radiator air inlet duct chute. Refer to [Radiator Air Inlet Duct Replacement](#).
19. Install front bumper fascia. Refer to [Front Bumper Fascia Replacement](#).

Charge Air Cooling System Draining and Filling (Vacuum Fill LSA)

Special Tools

- GE-26568 Coolant and Battery Fluid tester
- GE-47716 Vac-N-Fill Coolant Refill Tool
- GE-47716-20 Cooling System Fill Adapter

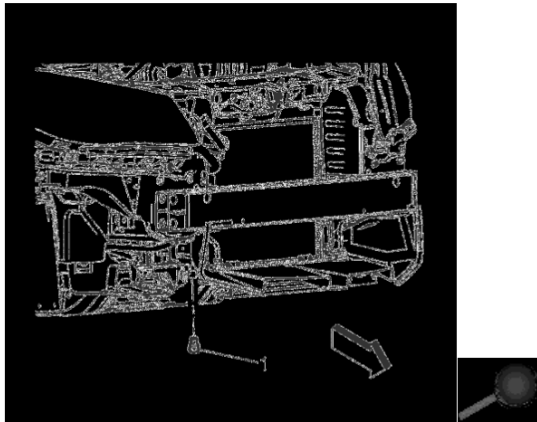
For equivalent regional tools, refer to [Special Tools](#).

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.

Note: Make sure the intercooler system is cool and that the pump is not in the ON position.

1. Open the hood and remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
2. Orientate the air charge air coolant (CAC) quick connect fitting to the vertical position.
3. Rotate and remove the CAC cap (1).
4. Raise and suitable support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the radiator air inlet duct chute. Refer to [Radiator Air Inlet Duct Replacement](#).



6. Remove the drain plug (1) from the CAC radiator.
7. Allow the system to fully drain into a clean container.
8. Measure and record the amount of coolant drained.
- Caution:** Refer to [Fastener Caution](#).
9. Install and tighten the drain plug (1) to **9.6 N·m (85 lb in)**.
10. Lower the vehicle.

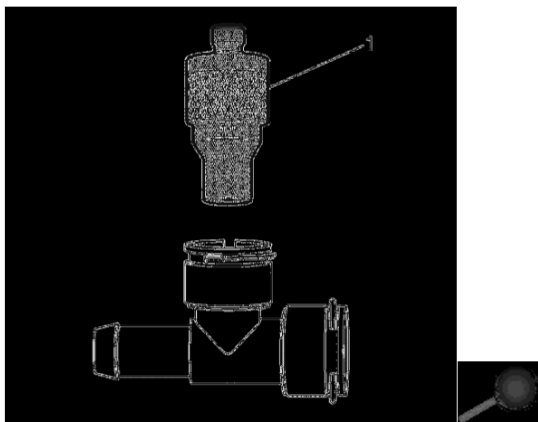
Vac-N-Fill Procedure

Note: It is critical that the system must be completely free of air to prevent CAC pump noise and loss of system performance.

1. Install absorbent rags under the CAC quick connect fitting to absorb any coolant loss.

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

2. Ensure the CAC quick connect fitting is in the vertical position.

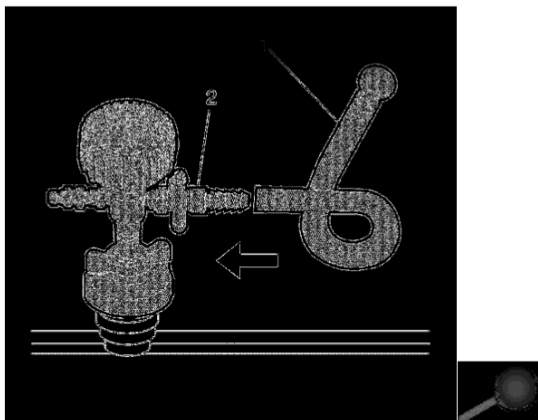


3. Install the GE-47716-20 Cooling System Fill Adapter (1) to the CAC quick connect fitting.

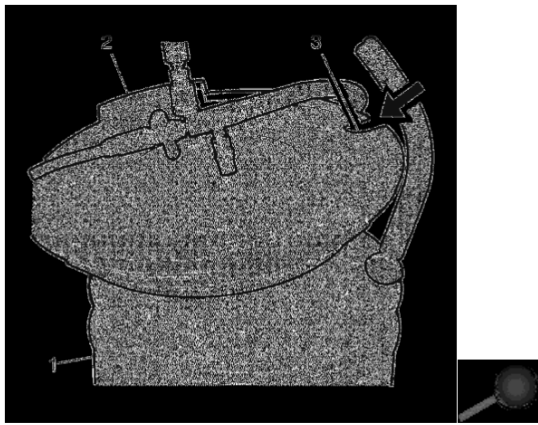
Warning: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

4. Attach the Vac-N-Fill gauge assembly to GE-47716-20 Cooling System Fill Adapter.

5. Attach the vacuum gauge assembly to the Vac-N-Fill cap.



6. Attach the fill hose (1) to the barb fitting on the vacuum gauge assembly (2). Ensure that the valve is closed.



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

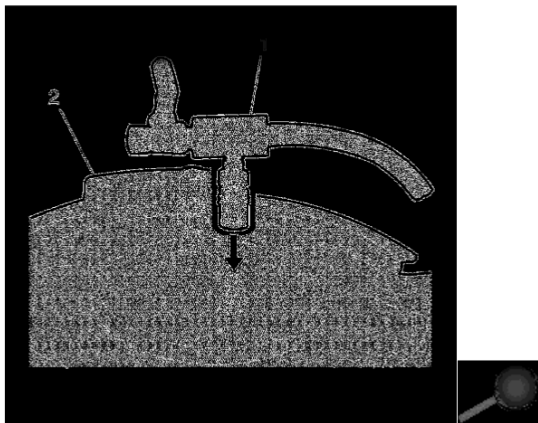
Always use more coolant than necessary. This will eliminate air from being drawn into the cooling system.

7. Pour the coolant mixture into the graduated reservoir (1).

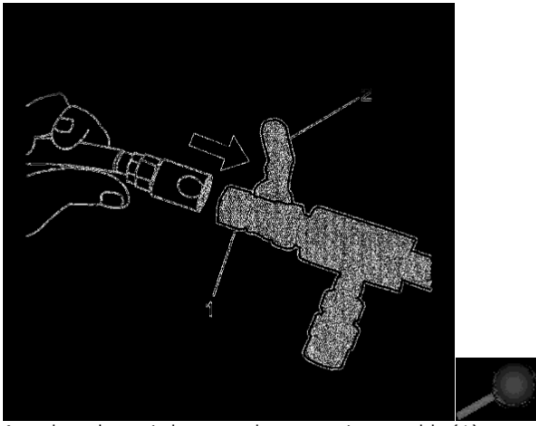
8. Place the fill hose in the graduated reservoir (1).

Note: Prior to installing the vacuum tank onto the graduated reservoir, ensure that the drain valve located on the bottom of the tank is closed.

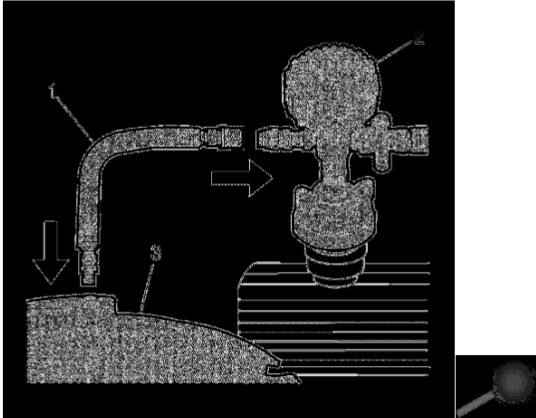
9. Install the vacuum tank (2) on the graduated reservoir with the fill hose routed through the cut-out area (3) in the vacuum tank.



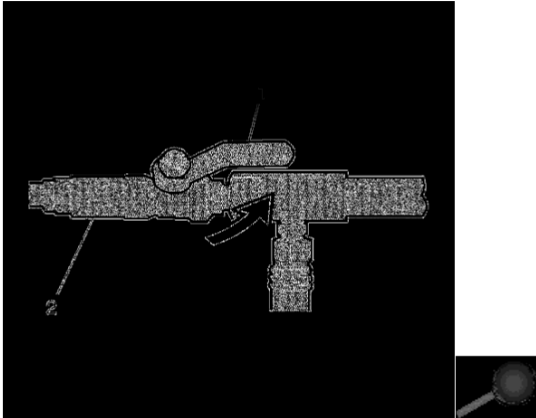
10. Attach the venturi (1) assembly to the vacuum tank (2).



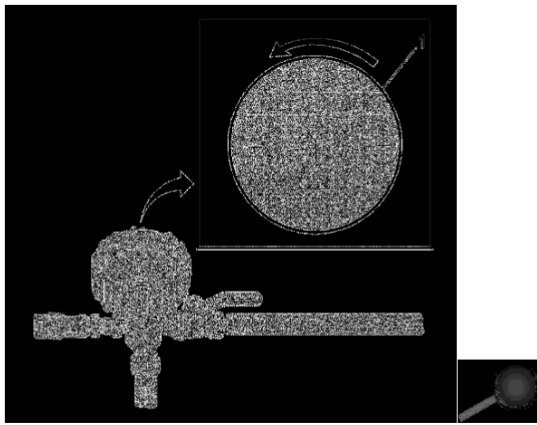
11. Attach a shop air hose to the venturi assembly (1).
Ensure the valve (2) on the venturi assembly is closed.



12. Attach the vacuum hose (1) to the vacuum gauge assembly (2) and the vacuum tank (3).



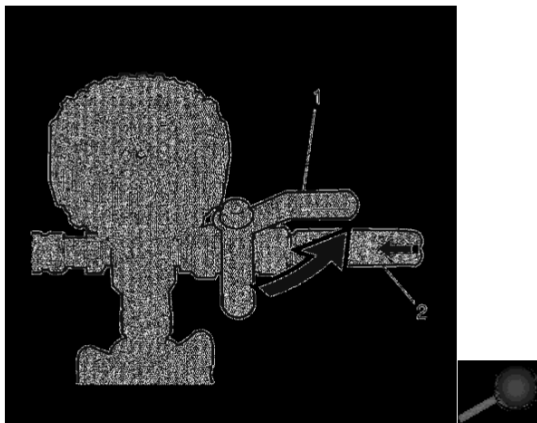
13. Open the valve (1) on the venturi assembly (2). The vacuum gauge will begin to rise and a hissing noise will be present.



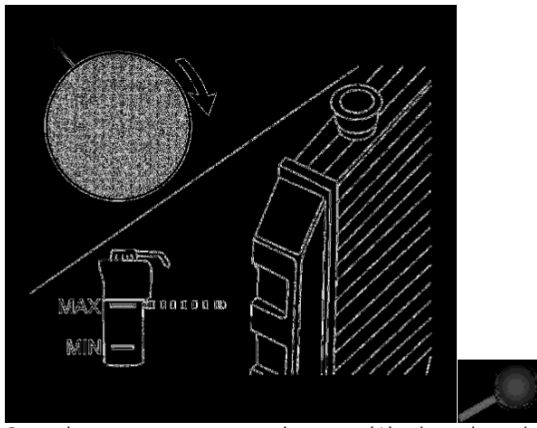
14. Continue to draw vacuum until the needle stops rising (1). This should be 610–660 mm Hg (24–26 in Hg).

Cooling hoses may start to collapse. This is normal due to vacuum draw.

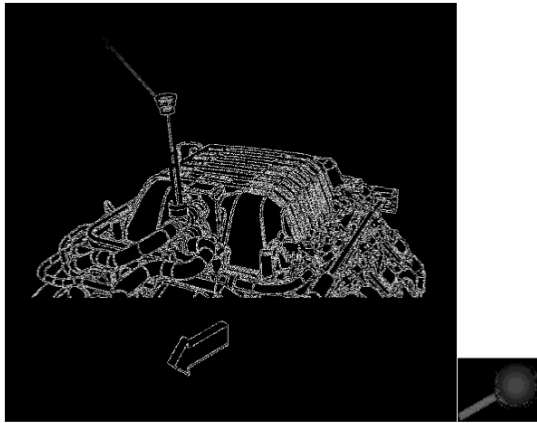
15. To aid in the fill process, position the graduated reservoir above the coolant fill port.



16. Slowly open the valve (1) on the vacuum gauge assembly (2). When the coolant reaches the top of the fill hose, close the valve. This will eliminate air from the fill hose.
17. Close the valve on the venturi assembly.
18. If there is a suspected leak in the cooling system, allow the system to stabilize under vacuum and monitor for vacuum loss.
If vacuum loss is observed, refer to [Loss of Coolant](#).
19. Open the valve on the vacuum gauge assembly. The vacuum gauge will drop as coolant is drawn into the system.



20. Once the vacuum gauge reaches zero (1), close the valve on the vacuum gauge assembly and repeat steps 12-18.
21. Detach the Vac-N-Fill gauge assembly from the GE-47716-20 Cooling System Fill Adapter.
22. Remove the GE-47716-20 Cooling System Fill Adapter from the CAC quick connect fitting.



23. Install the charge air coolant cap (1).
- Note:** Use one of the following methods to cycle the coolant with the CAC pump.
24. Using the Tech 2, cycle the CAC pump ON for 60 seconds and then to the OFF position.
25. Or set the parking brake and ensure the transmission is in PARK or NEUTRAL. Start the engine and allow the CAC pump to run 60 seconds. Turn the engine OFF.
26. Allow the system to stabilize for 60 seconds and remove the CAC cap.
27. Continue to slowly fill the CAC cooling system with coolant until the level stabilizes within the fitting.
28. Install the CAC cap.
29. Repeat steps 6-10 until additional coolant can not be added through the CAC cap into the system. Refer to [Approximate Fluid Capacities](#).
30. Inspect the concentration of the coolant mixture using GE-26568 Coolant and Battery Fluid tester.
31. Inspect the CAC cooling system for leaks.
32. Remove the absorbent rags.
33. Rinse away any excess coolant from the engine and the engine compartment.

34. Orientate the CAC quick connect fitting to the previously installed position to allow for engine cover clearance.
35. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
36. Remove the radiator air inlet duct chute. Refer to [Radiator Air Inlet Duct Replacement](#).

Flushing

Radiator Flush

Note: Do not use a chemical flush.

Store used coolant in the correct 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.

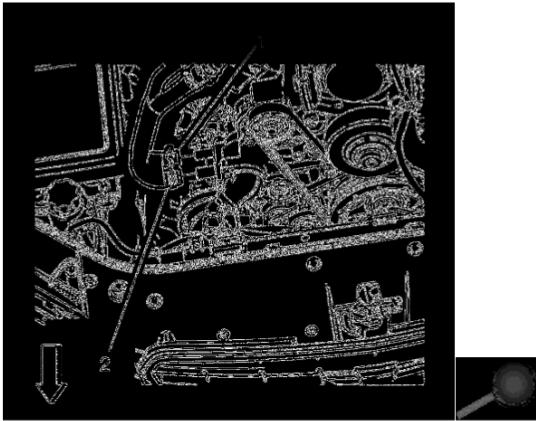
1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).

Warning: Refer to [Safety Glasses Warning](#).

2. Remove the lower radiator outlet hose at the coolant inlet pipe connection.
3. Remove the upper radiator inlet hose at the coolant outlet housing connection.
Note: When attaching the lead away hose, make sure not to block the air bleed hose.
4. Attach a lead away hose to the open end of the upper radiator hose.
5. Attach a suitable piece of hose or adaptor between the flushing gun and the open end of the lower radiator hose.
6. Connect and operate the flushing equipment as recommended by the manufacturer.
Note: Apply air pressure gradually and not in excess of 19 lb in (130 kPa) otherwise radiator damage will result.
7. Continue flushing until water from the lead away hose runs clean and clear.
8. Install all disconnected hoses, ensuring that they are correctly position and securely clamped.
9. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
10. Pressure test the cooling system. Refer to [Cooling System Leak Testing](#).

Heater Hoses and Core

1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).



Note: Make a note of how the inlet and outlet hoses were removed for correct installation.

2. Remove the heater hoses (1) and (2) from the water pump.
3. Direct the hose (1) that was connected to the water pump's rear-most connection into a suitable container.
4. Attach the hose (2) from the front connection to the flushing gun.

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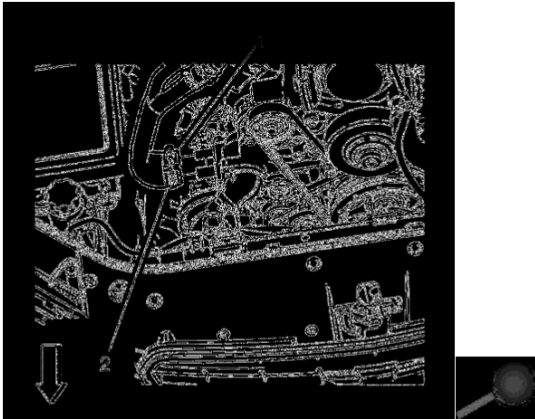
Note: Apply air pressure gradually and not in excess of 16 lb in (110 kPa) otherwise heater hoses and core damage will result.

Connect and operate the flushing gun.

5. Install the heater hoses (1) and (2), ensuring they are installed in the correct positions.
6. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
7. Pressure test the cooling system. Refer to [Cooling System Leak Testing](#).

Engine

1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
2. Detach the inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
3. Detach the outlet hose. Refer to [Radiator Outlet Hose Replacement](#).
4. Remove the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement](#).
5. Remove the thermostat. Refer to [Engine Coolant Thermostat Housing Replacement](#).
6. Install the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement](#).
7. Remove the engine coolant air bleed hose by releasing retaining hose clamp and remove it from the radiator spigot and temporarily plug the end of the hose.



Note: Make a note of how the inlet and outlet hoses were removed for correct installation.

8. Remove the heater hoses (1) and (2) from their connections at the water pump. Seal the pump connections by looping the water pump heater inlet connection to the outlet connection using a suitable piece of hose and two retaining clamps.
9. Install a lead-away hose to the thermostat housing and a length of suitable hose between the water pump outlet fitting and the flushing gun.
10. Connect and operate the flushing gun.
11. Unplug the air bleed hose and continue flushing until the water runs clear.
12. Install the heater hoses (1) and (2), ensuring they are installed in the correct positions.
13. Install the thermostat. Refer to [Engine Coolant Thermostat Housing Replacement](#).
14. Install the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement](#).
15. Attach the coolant air bleed hose to the radiator spigot.
16. Secure the coolant air bleed hose with the retaining hose clamp.
17. Attach the outlet hose. Refer to [Radiator Outlet Hose Replacement](#).
18. Attach the inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
19. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
20. Pressure test the cooling system. Refer to [Cooling System Leak Testing](#).

Charge Air Cooling System Flushing (LSA)

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 manufacturer's instruction.

When the charge air cooling (CAC) cooling system becomes contaminated, the CAC cooling system should be flushed thoroughly to remove the contaminants before the supercharger is seriously damaged.

1. Drain the CAC cooling system. Refer to [Charge Air Cooling System Draining and Filling](#)
2. Follow the drain and fill procedure using only clean, drinkable water. Refer to [Charge Air Cooling System Draining and Filling](#)
3. Command the CAC pump to the ON position using the Tech 2 or by starting the engine. Run the CAC pump for 5 minutes.
4. Drain the CAC cooling system. Refer to [Charge Air Cooling System Draining and Filling](#)
5. Repeat the procedure if necessary, until the fluid is colorless.
6. Fill the CAC cooling system. Refer to [Charge Air Cooling System Draining and Filling](#)

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Charge Air Cooling System Cleaning (LSA)

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: Remove bugs, leaves, dirt and other debris by blowing compressed air through the engine side of the charge air coolant radiator.

- Some conditions may require the use of warm water and a mild detergent.
- Clean the A/C condenser fins.
- Clean between the A/C condenser and charge air coolant radiator.
- Clean the charge air coolant radiator cooling fins.
- Straighten any damaged cooling fins.

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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.

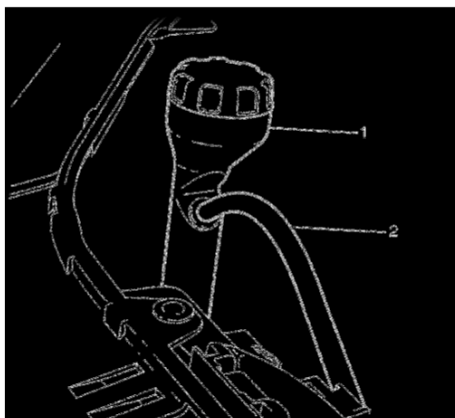
Note: Remove bugs, leaves, dirt, and other debris by blowing compressed air through the engine side of the radiator.

- Some conditions may require the use of warm water and a mild detergent.
- Clean the A/C condenser fins.
- Clean between the A/C condenser and radiator.
- Clean the radiator cooling fins.
- Clean between the transmission cooler and the radiator (if fitted)
- Straighten any damaged cooling fins.

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Coolant Recovery Reservoir Replacement (LFX, LFW, LSA, LS3, L77)

[Removal Procedure](#)



1. Disconnect the coolant recovery hose (2) from the coolant recovery reservoir filler neck (1).



2. Remove the coolant recovery reservoir filler neck (1) from the coolant recovery reservoir.

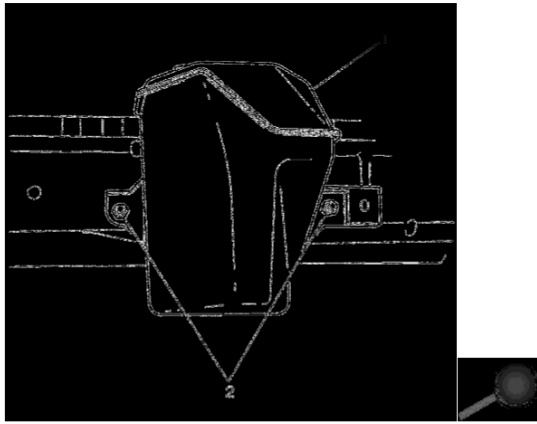
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the right front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
5. Remove the right wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).
6. Remove the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).

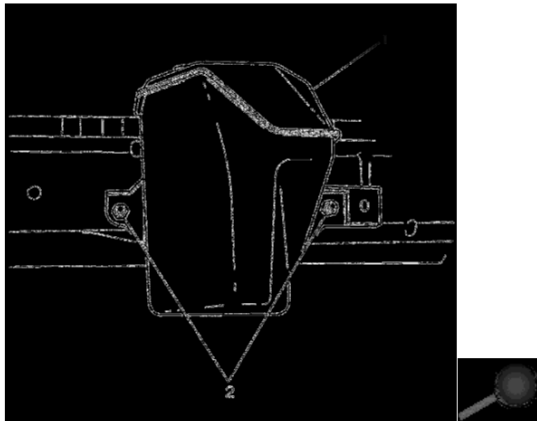
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- Without disconnecting the wiring harness unclip the wiring harness from the coolant recovery reservoir and reposition out of the way.

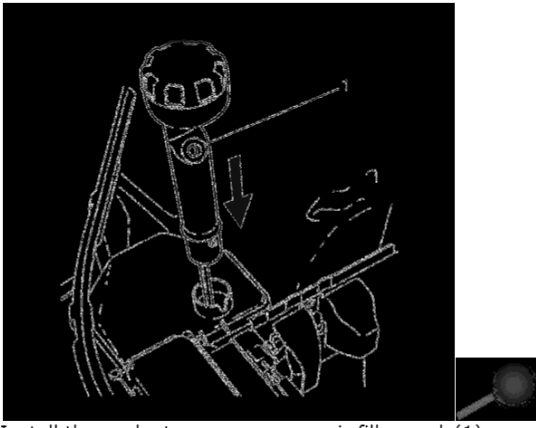


- Remove the coolant recovery reservoir retaining bolts (2).
- Remove the coolant recovery reservoir (1).

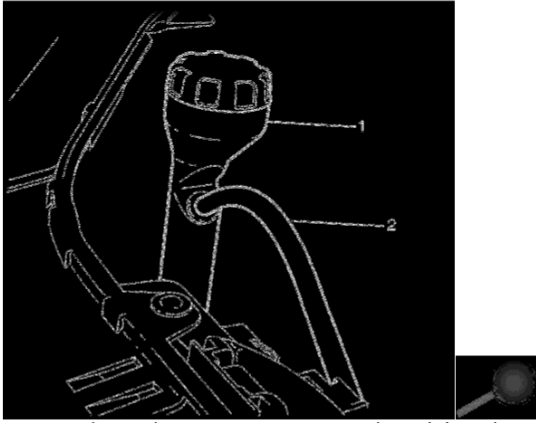
Installation Procedure



- Install the coolant recovery reservoir (1).
- Caution:** Refer to [Fastener Caution](#).
- Install the coolant recovery retaining nuts (2) and tighten to **17 N·m (13 lb ft)**.
- Install the wiring harness to the coolant recovery reservoir.
- Install the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).
- Install the right wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).
- Install the right front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
- Lower the vehicle.



8. Install the coolant recovery reservoir filler neck (1).

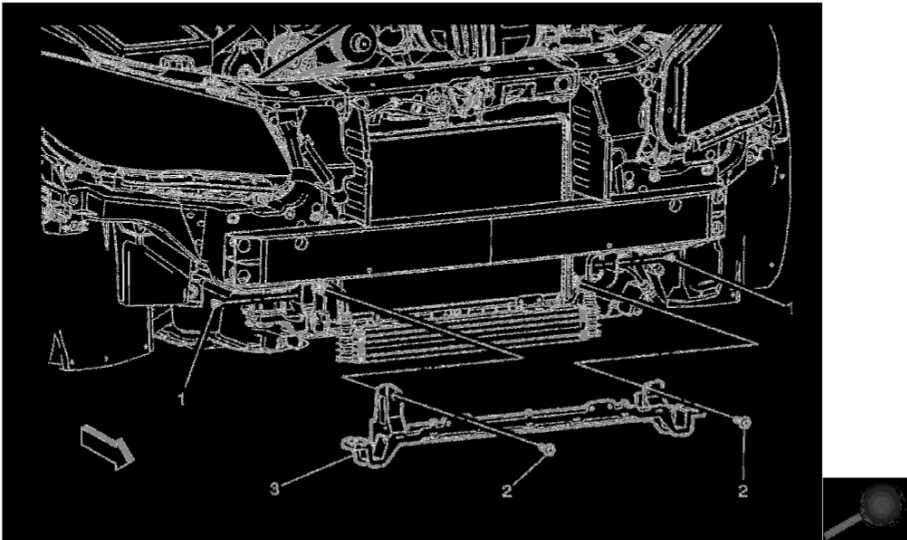


9. Connect the coolant recovery reservoir hose (2) to the coolant recovery reservoir filler neck (1).

10. Fill the coolant reservoir to the fill level. Refer to [Cooling System Draining and Filling](#).

11. Inspect cooling system for leaks.

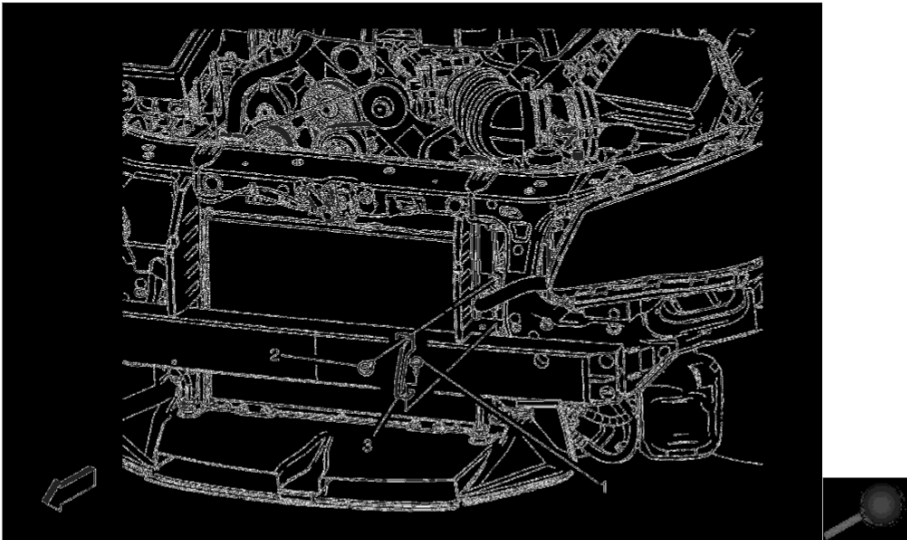
Charge Air Cooler Bracket Replacement (Lower)



Charge Air Cooler Bracket Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Remove the lower radiator air inlet duct. Refer to Radiator Air Inlet Duct Replacement . 3. Support the transmission fluid auxiliary cooler and remove the mounting fasteners. Refer to Transmission Fluid Auxiliary Cooler Replacement .	
1	Radiator Air Duct Retainer (Qty: 2)
2	Charge Air Cooler Bracket Bolt (Qty: 2) Caution: Refer to Fastener Caution . Tighten 9 N•m (80 lb in)
3	Charge Air Cooler Bracket-Lower

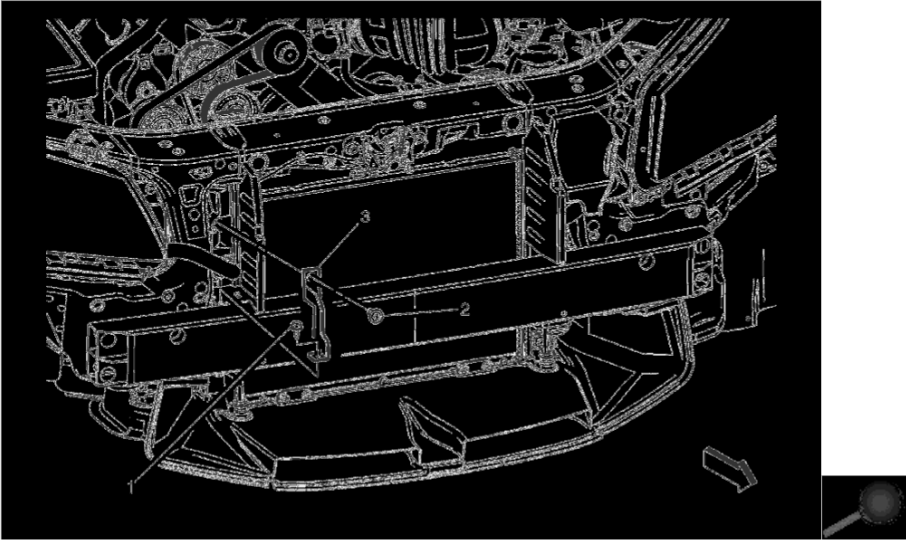
Charge Air Cooler Bracket Replacement (Upper Left)



Charge Air Cooler Bracket Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Remove the left side radiator air upper baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .	
1	Charge Air Cooler Bracket Bolt Caution: Refer to Fastener Caution .
2	Charge Air Cooler Bracket Bolt Tighten 9 N•m (80 lb in)
3	Charge Air Cooler Bracket-Upper Left

Charge Air Cooler Bracket Replacement (Upper Right)



Charge Air Cooler Bracket Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Remove the right side radiator air upper baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .	
1	Charge Air Cooler Bracket Bolt Caution: Refer to Fastener Caution .
2	Charge Air Cooler Bracket Bolt Tighten 9 N•m (80 lb in)
3	Charge Air Cooler Bracket-Upper Right

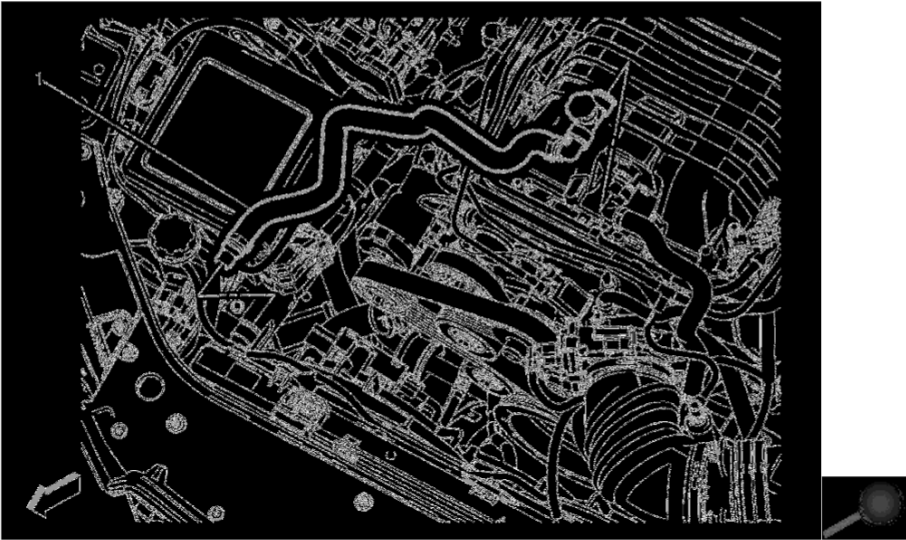
Charge Air Cooler Coolant Hose Replacement (Inlet to Charge Air Cooler Pump LSA)



Charge Air Cooler Coolant Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement - Front . 2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement . 3. Remove the mass air flow sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement . 4. Drain the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling . 5. Release the charge air cooler coolant inlet quick connect hose clamp retainer. Refer to Metal Collar Quick Connect Fitting Service .	
1	Charge Air Cooler Coolant Inlet Hose Clamp Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Charge Air Cooler Coolant Inlet Hose Procedure 1. Fill the cooling system. 2. Inspect cooling system for leaks.

Charge Air Cooler Coolant Hose Replacement (Outlet LSA)

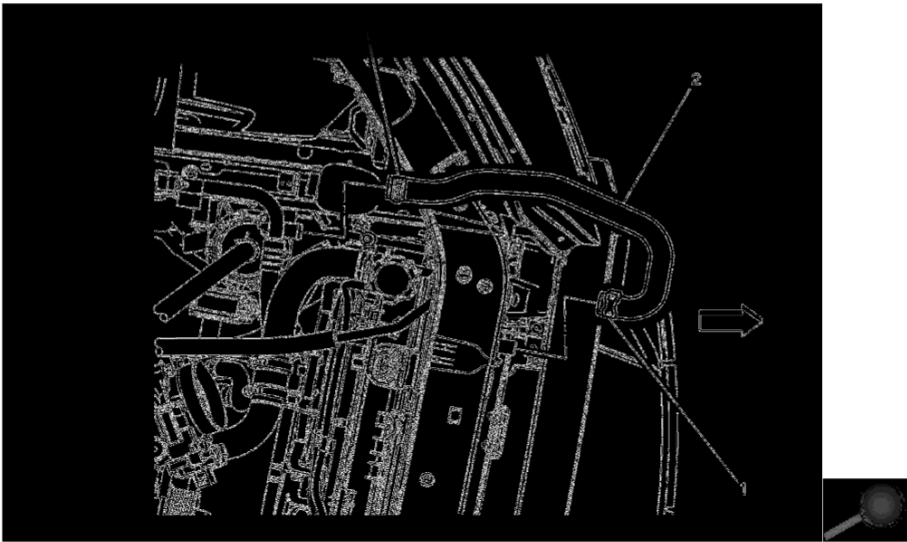


Charge Air Cooler Coolant Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement - Front . 2. Drain the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling . 3. Release the charge air cooler coolant outlet quick connect hose clamp retainers. Refer to Metal Collar Quick Connect Fitting Service .	
1	Charge Air Cooler Coolant Outlet Hose Procedure 1. Fill the cooling system. 2. Inspect cooling system for leaks.

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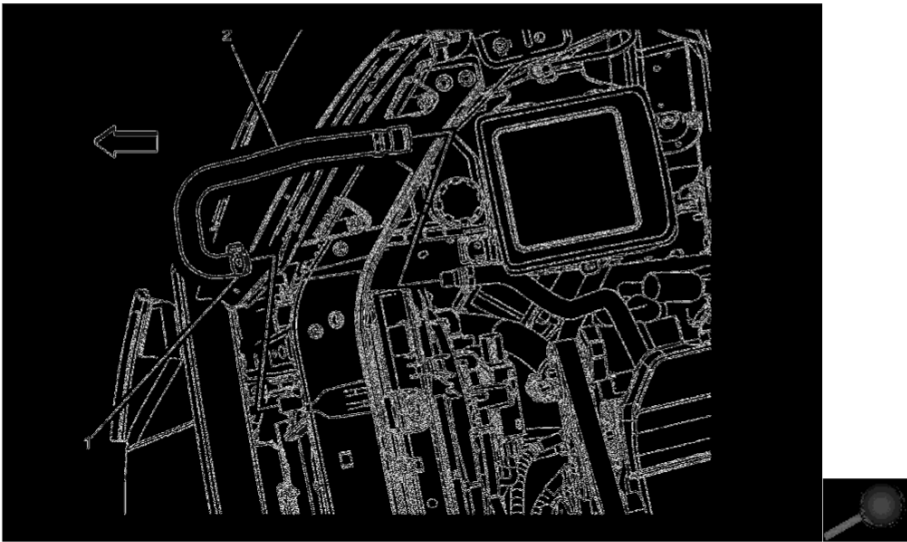
Charge Air Cooler Coolant Hose Replacement (Inlet to Charge Air Cooler Radiator LSA)



Charge Air Cooler Coolant Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement . 2. Remove the mass air flow sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement . 3. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement . 4. Radiator air upper baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement . 5. Drain the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling . 6. Remove left side radiator air side baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .	
1	Charge Air Cooler Coolant Inlet Hose to the Charge Air Cooler Radiator Hose Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Charge Air Cooler Coolant Inlet Hose to the Charge Air Cooler Radiator

Charge Air Cooler Coolant Hose Replacement (Outlet from Charge Air Cooler Radiator LSA)



Charge Air Cooler Coolant Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement - Front . 2. Drain the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling . 3. Release the charge air cooler coolant outlet quick connect hose clamp retainers. Refer to Metal Collar Quick Connect Fitting Service .	
1	Charge Air Cooler Coolant Outlet Hose-Outlet From Charge Air Cooler Radiator Clamp Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Charge Air Cooler Coolant Outlet Hose-Outlet From Charge Air Cooler Radiator Procedure 1. Fill the cooling system. 2. Inspect cooling system for leaks.

Radiator Inlet Hose Replacement (LSA, LS3, L77)

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

1. Ensure engine is below 50°C before removing the coolant pressure cap.
2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
3. Remove the engine cover. Refer to [Engine Cover Replacement](#).
4. Remove the mass air flow sensor. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
5. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

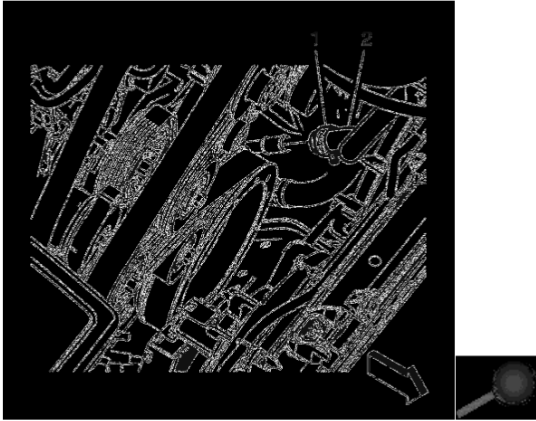


6. Reposition the radiator inlet hose clamp (1) on the radiator inlet hose (2) using BO-38185 hose clamp pliers.
7. Remove the radiator inlet hose (2) from the radiator.

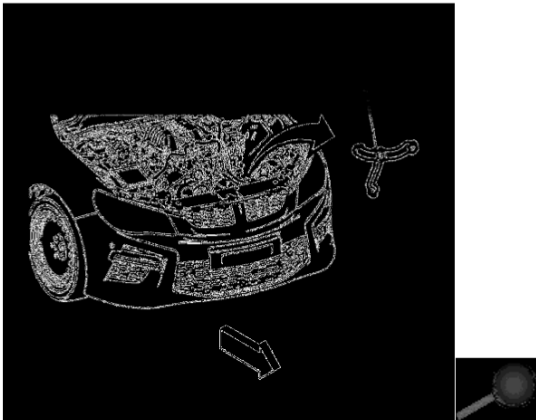
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8. Reposition the radiator inlet hose clamp (1) on the radiator inlet hose (2) using *BO-38185* hose clamp pliers.
9. Remove the radiator inlet hose (2) from the water pump.

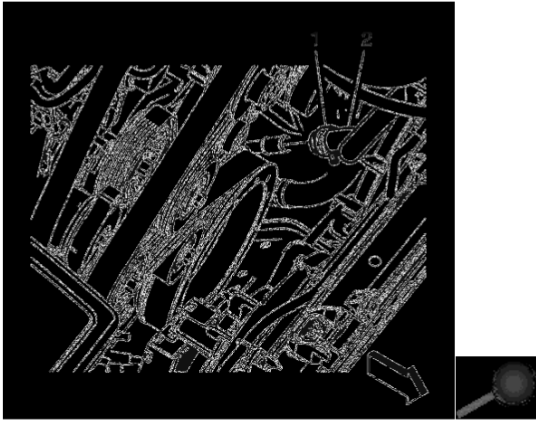


10. Reposition the radiator inlet hose clamp (1) on the radiator inlet hose (2) using *BO-38185* hose clamp pliers.
11. Remove the radiator inlet hose (2) from the engine oil cooler pipe.



12. Remove the radiator inlet hose (1) from the vehicle.

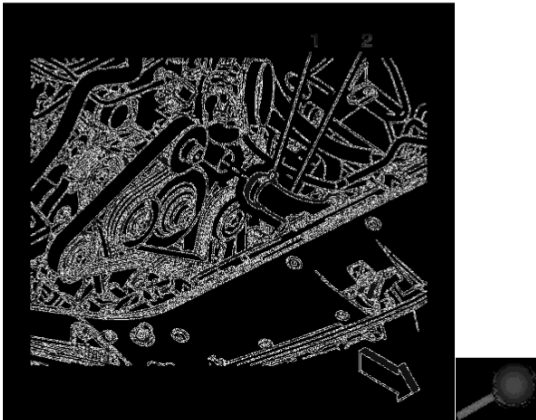
Installation Procedure



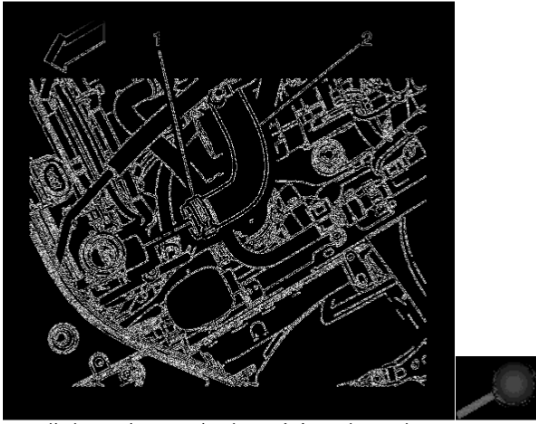
Warning: Refer to [Safety Glasses Warning](#).

Caution: Refer to [Installing Hoses without Twists or Bends Caution](#).

1. Install the radiator inlet hose (2) to the engine oil cooler pipe.
2. Reposition the radiator inlet hose clamp (1) on the radiator inlet hose (2) using *BO-38185* hose clamp pliers.



3. Install the radiator inlet hose (2) to the water pump.
4. Reposition the radiator inlet hose clamp (1) on the radiator inlet hose (2) using *BO-38185* hose clamp pliers.



5. Install the radiator inlet hose (2) to the radiator.
6. Reposition the radiator inlet hose clamp (1) on the radiator inlet hose (2) using *BO-38185* hose clamp pliers.
7. Install the mass air flow meter. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
8. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
9. Install the engine cover. Refer to [Engine Cover Replacement](#).
10. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
11. Inspect cooling system for leaks.

Radiator Inlet Hose Replacement (LFX, LFW, LWR)

Special Tools

BO-38185 Hose Clamp Pliers

Removal Procedure

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

1. Ensure engine is below 50°C (122°F) before removing the coolant pressure cap.
2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
3. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
4. Remove the mass airflow sensor. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
5. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).



6. Reposition the radiator inlet hose clamps (1) using BO-38185 hose clamp pliers.
7. Remove the radiator inlet hose (2) from the vehicle.

Installation Procedure



Warning: Refer to [Safety Glasses Warning](#).

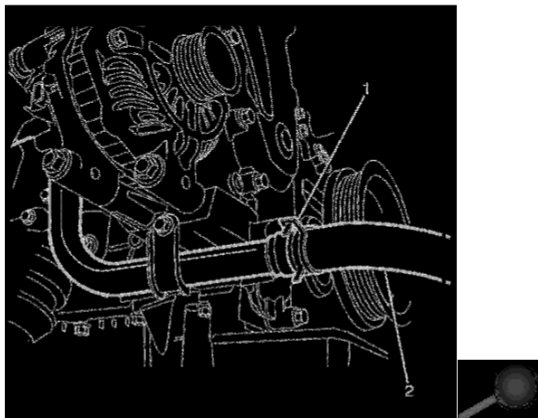
Caution: Refer to [Installing Hoses without Twists or Bends Caution](#).

1. Install the radiator inlet hose (2) to the vehicle.
2. Reposition the radiator inlet hose clamps (1) using *BO-38185* hose clamp pliers.
3. Install the mass airflow meter. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
6. Inspect cooling system for leaks.
7. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).

Radiator Outlet Hose Replacement (LFX, LFW, LWR)

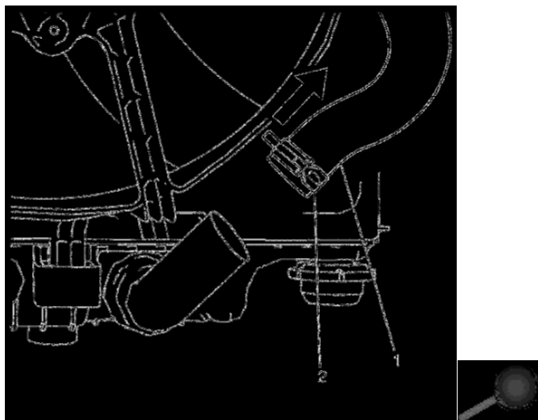
Removal Procedure

1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).



Warning: Refer to [Safety Glasses Warning](#).

2. Reposition the radiator outlet hose clamps (1) using *BO-38185* hose clamp pliers.
3. Remove the radiator outlet hose (2) from the coolant pipe.
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.
4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the front bumper fascia extension. Refer to [Front Bumper Fascia Extension Replacement](#).
6. Remove the engine coolant fan shroud. Refer to [Engine Coolant Fan Shroud Replacement](#).

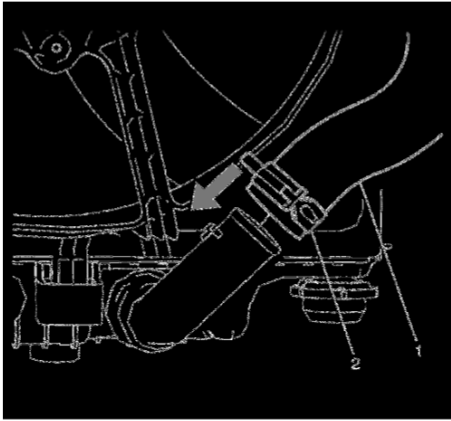


7. Reposition the radiator outlet hose clamps (2) using *BO-38185* hose clamp pliers.

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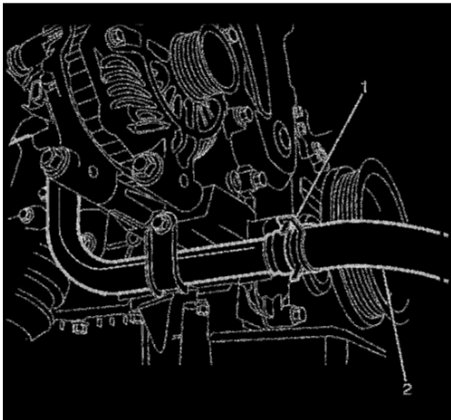
8. Remove the outlet hose (1).

Installation Procedure



Caution: Refer to [Installing Hoses without Twists or Bends Caution](#).

1. Install the outlet hose (1).
2. Reposition the radiator outlet hose clamps (2) using *BO-38185* hose clamp pliers.
3. Install the engine coolant fan shroud. Refer to [Engine Coolant Fan Shroud Replacement](#).
4. Install the front bumper fascia extension. Refer to [Front Bumper Fascia Extension Replacement](#).
5. Lower the vehicle.



Warning: Refer to [Safety Glasses Warning](#).

6. Install the radiator outlet hose (2) to the coolant pipe.
7. Reposition the radiator outlet hose clamps (1) using *BO-38185* hose clamp pliers.
8. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
9. Inspect cooling system for leaks.

Radiator Outlet Hose Replacement (LSA, LS3, L77)

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

Warning: Refer to [Safety Glasses Warning](#).

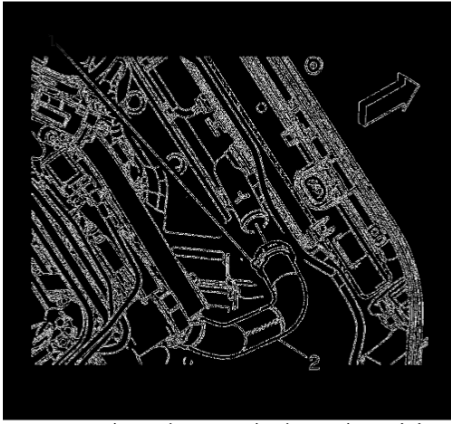
Warning: Refer to [Radiator Cap Removal Warning](#).

1. Ensure engine is below 50°C before removing the coolant pressure cap.

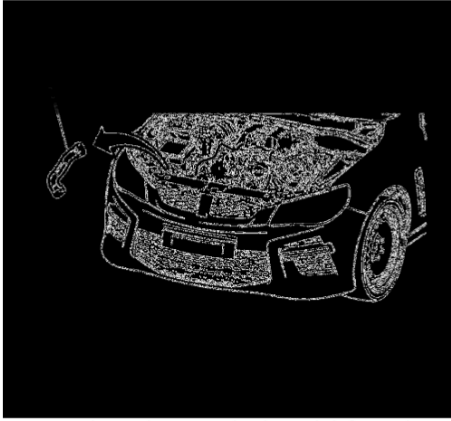


2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
3. Reposition the radiator outlet hose clamp (1) on the radiator outlet hose (2) using BO-38185 hose clamp pliers.
4. Remove the radiator outlet hose (2) from the thermostat housing.
5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
6. Remove the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).

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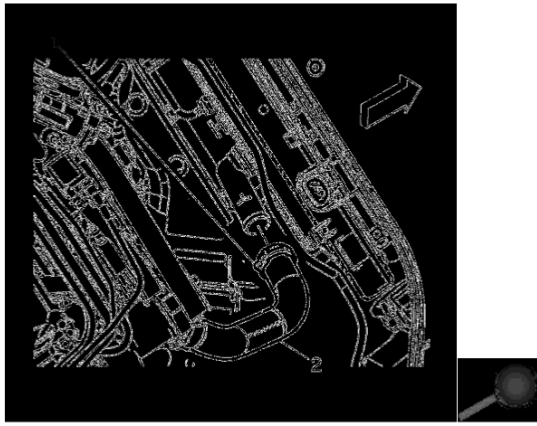


7. Reposition the radiator outlet hose clamp (1) on the radiator outlet hose (2) using *BO-38185* hose clamp pliers.
8. Remove the radiator outlet hose (2) from the radiator outlet pipe.



9. Remove the radiator outlet hose (1) from the vehicle.

[Installation Procedure](#)



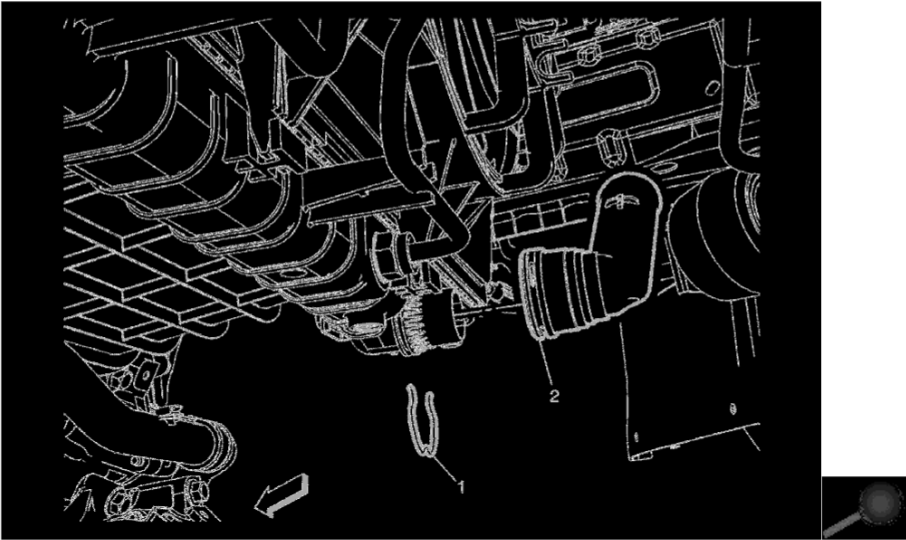
Caution: Refer to [Installing Hoses without Twists or Bends Caution](#).

1. Install the radiator outlet hose (2) to the radiator outlet pipe.
2. Reposition the radiator outlet hose clamp (1) on the radiator outlet hose (2) using *BO-38185* hose clamp pliers.
3. Install the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).
4. Lower the vehicle.



5. Install the radiator outlet hose (2) to the thermostat housing.
 6. Reposition the radiator outlet hose clamp (1) on the radiator outlet hose (2) using *BO-38185* hose clamp pliers.
- Warning:** Refer to [Safety Glasses Warning](#).
7. Fill the cooling system to the proper level. Refer to [Cooling System Draining and Filling](#).
 8. Inspect cooling system for leaks.

Radiator Outlet Pipe Replacement (LWR, LFX, LSA, LS3, LFW, L77)



Radiator Outlet Pipe Replacement

Callout	Component Name
Preliminary Procedures 1. Remove radiator upper mounting brackets to allow hand clearance between radiator outlet pipe and drivetrain and front suspension frame. Refer to Radiator Upper Mount Replacement . 2. Remove the underbody front air deflector. Refer to Underbody Front Air Deflector Replacement . 3. Drain the cooling system. Refer to Cooling System Draining and Filling . 4. Remove the radiator outlet hose from the radiator outlet pipe. Refer to Radiator Outlet Hose Replacement .	
1	Radiator Outlet Pipe Retaining Clip
2	Radiator Outlet Pipe Procedure 1. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling . 2. Inspect the cooling system for leaks.

Engine Coolant Inlet Pipe Replacement (LWR)

Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
3. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
4. Remove the front air deflector. Refer to [Front Air Deflector Replacement](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

5. Ensure the engine temperature is below 50°C before removing the radiator cap.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

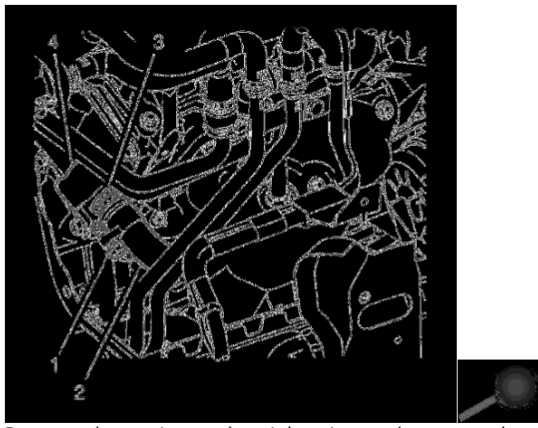
Note: Store used coolant in the correct manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

7. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
8. Remove the right side catalytic converter. Refer to [Catalytic Converter Replacement - Right Side](#).



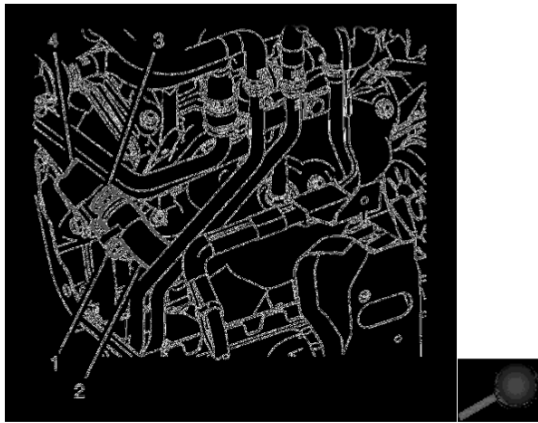
Note: Use an appropriate tool to release the radiator outlet hose to engine coolant inlet pipe retaining clamp (1).

9. Detach the radiator outlet hose from the engine coolant inlet pipe (3).
10. Remove the engine coolant inlet pipe to generator bracket retaining nut (2).
11. Detach the engine coolant inlet pipe (3) from the generator bracket.
12. Lower vehicle.



13. Remove the engine coolant inlet pipe to thermostat housing retaining bolt (1).
14. Remove the engine coolant inlet pipe (2) from the thermostat housing (4).
Note: The engine coolant inlet pipe O-ring (3) is a single use part and must be discarded after removal.
15. Remove the engine coolant inlet pipe O-ring (3) from the engine coolant inlet pipe (2).
Note: The engine coolant inlet pipe (2) is removed between the cross member and radiator from underneath the vehicle.
16. Remove the engine coolant inlet pipe (2) from the vehicle.

Installation Procedure



1. Ensure all mating surfaces are thoroughly cleaned, using only a fine abrasive material.
Note: A NEW engine coolant inlet pipe O-ring must be installed to the engine coolant inlet pipe (2).
2. Install the engine coolant inlet pipe O-ring (3) to the engine coolant inlet pipe (2).
3. Install the engine coolant inlet pipe (2) to the vehicle.
Note: Lubricate the engine coolant inlet pipe O-ring with clean coolant prior to installation.
4. Install the engine coolant inlet pipe (2) to the thermostat housing (4).
Note: Do not tighten at this stage.
5. Install the engine coolant inlet pipe to the thermostat housing retaining bolt (1).
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



7. Attach the engine coolant inlet pipe (3) to the generator bracket.
- Caution:** Refer to [Fastener Caution](#).
8. Install the engine coolant inlet pipe to generator bracket retaining nut (2) and tighten to **22 N•m (16 lb ft)**.
- Caution:** Refer to [Installing Hoses without Twists or Bends Caution](#).
9. Attach the radiator outlet hose to the engine coolant inlet pipe (3).
- Note:** Use an appropriate tool to release the radiator outlet hose to engine coolant inlet pipe retaining clamp (1).
10. Secure the radiator outlet hose to engine coolant inlet pipe retaining clamp (1).
11. Tighten the engine coolant inlet pipe to the thermostat housing retaining bolt to **22 N•m (16 lb ft)**.
12. Install the front air deflector. Refer to [Front Air Deflector Replacement](#).
13. Install the right side catalytic converter. Refer to [Catalytic Converter Replacement - Right Side](#).
14. Lower the vehicle.
15. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
16. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
17. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
18. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
19. Inspect the cooling system for coolant leaks and repair as necessary.

Engine Coolant Inlet Pipe Replacement (V6)

Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
3. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
4. Remove the oil pan shield (2). Refer to [Oil Pan Shield Replacement](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

5. Ensure the engine temperature is below 50°C before removing the radiator cap.

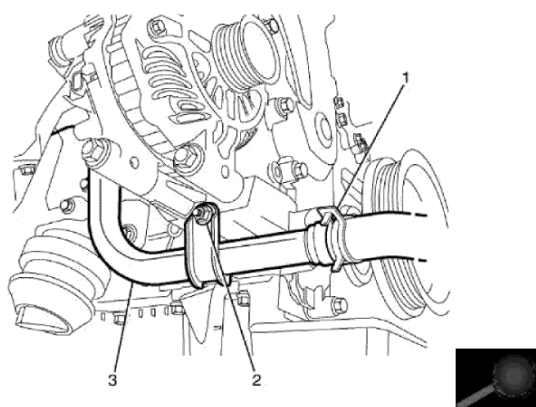
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

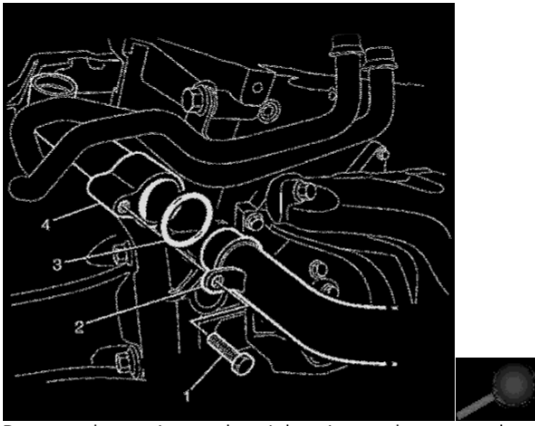
Note: Store used coolant in the correct manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

7. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
8. Remove the right side catalytic converter. Refer to [Catalytic Converter Replacement - Right Side](#).



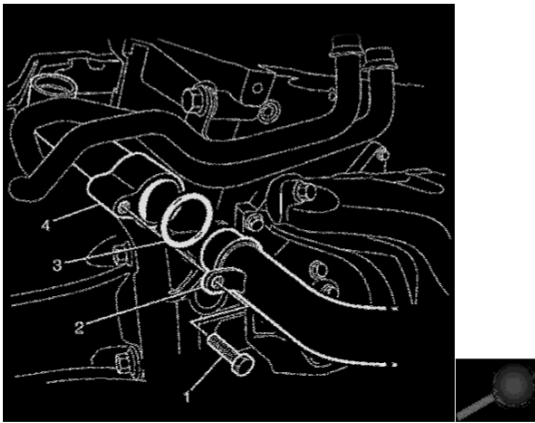
Note: Use an appropriate tool to release the radiator outlet hose to engine coolant inlet pipe retaining clamp (1).

9. Detach the radiator outlet hose from the engine coolant inlet pipe (3).
10. Remove the engine coolant inlet pipe to generator bracket retaining nut (2).
11. Detach the engine coolant inlet pipe (3) from the generator bracket.
12. Lower vehicle.

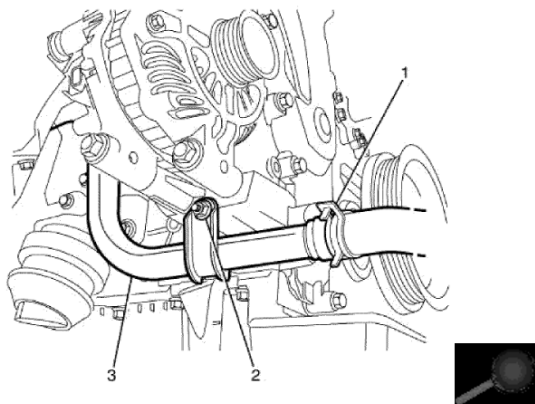


13. Remove the engine coolant inlet pipe to thermostat housing retaining bolt (1).
14. Remove the engine coolant inlet pipe (2) from the thermostat housing (4).
Note: The engine coolant inlet pipe O-ring (3) is a single use part and must be discarded after removal.
15. Remove the engine coolant inlet pipe O-ring (3) from the engine coolant inlet pipe (2).
Note: The engine coolant inlet pipe (2) is removed between the cross member and radiator from underneath the vehicle.
16. Remove the engine coolant inlet pipe (2) from the vehicle.

Installation Procedure



1. Ensure all mating surfaces are thoroughly cleaned, using only a fine abrasive material.
Note: A NEW engine coolant inlet pipe O-ring must be installed to the engine coolant inlet pipe (2).
2. Install the engine coolant inlet pipe O-ring (3) to the engine coolant inlet pipe (2).
3. Install the engine coolant inlet pipe (2) to the vehicle.
Note: Lubricate the engine coolant inlet pipe O-ring with clean coolant prior to installation.
4. Install the engine coolant inlet pipe (2) to the thermostat housing (4).
Note: Do not tighten at this stage.
5. Install the engine coolant inlet pipe to the thermostat housing retaining bolt (1).
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



7. Attach the engine coolant inlet pipe (3) to the generator bracket.

Caution: Refer to [Fastener Caution](#).

8. Install the engine coolant inlet pipe to generator bracket retaining nut (2) and tighten to **22 N•m (16 lb ft)**.

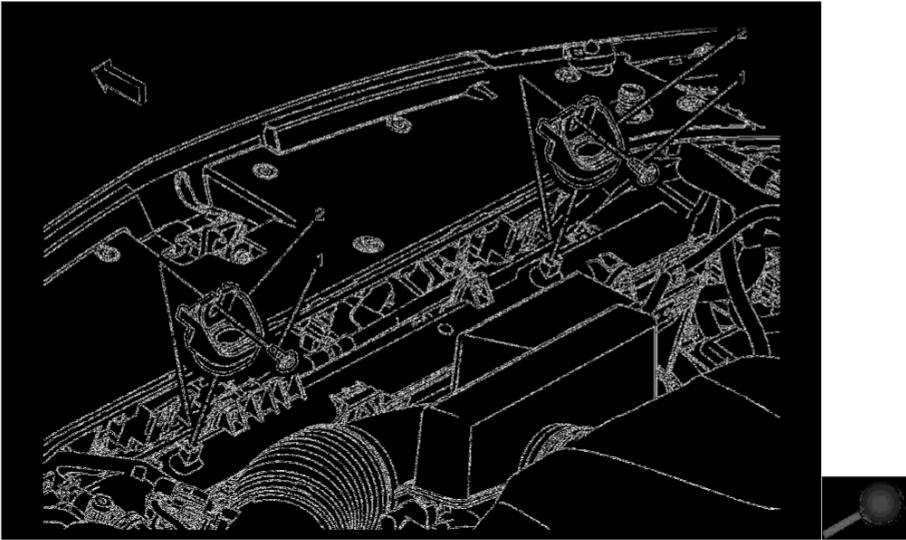
Caution: Refer to [Installing Hoses without Twists or Bends Caution](#).

9. Attach the radiator outlet hose to the engine coolant inlet pipe (3).

Note: Use an appropriate tool to release the radiator outlet hose to engine coolant inlet pipe retaining clamp (1).

10. Secure the radiator outlet hose to engine coolant inlet pipe retaining clamp (1).
11. Tighten the engine coolant inlet pipe to the thermostat housing retaining bolt to **22 N•m (16 lb ft)**.
12. Install the oil pan shield (2). Refer to [Oil Pan Shield Replacement](#).
13. Install the right side catalytic converter. Refer to [Catalytic Converter Replacement - Right Side](#).
14. Lower the vehicle.
15. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
16. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
17. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
18. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
19. Inspect the cooling system for coolant leaks and repair as necessary.

Radiator Upper Mount Replacement (LWR, LFW, LSA, LS3, LFX, L77)

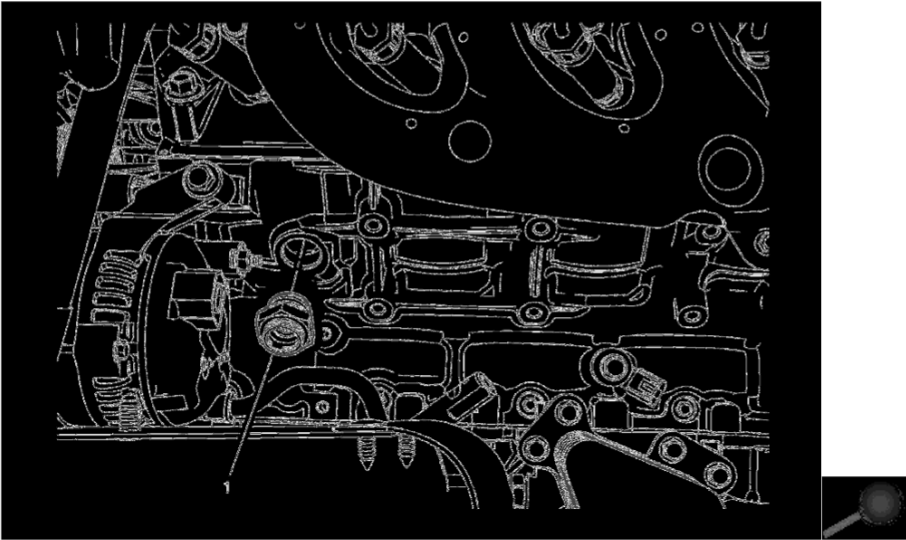


Radiator Upper Mount Replacement

Callout	Component Name
1	Radiator Upper Mount Bolt (Qty: 2) Caution: Refer to Fastener Caution . Tighten 9 N•m (80 lb in)
2	Radiator Upper Mount (Qty: 2) Procedure Move the radiator upper mount rearward to release the radiator upper mount retaining tab and to clear the radiator upper bracket. Note: Ensure the mounting bracket isolator is sitting firmly on top of radiator tank when the radiator upper mount bolt is installed, so there is no gap between the isolator and radiator tank.

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Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement

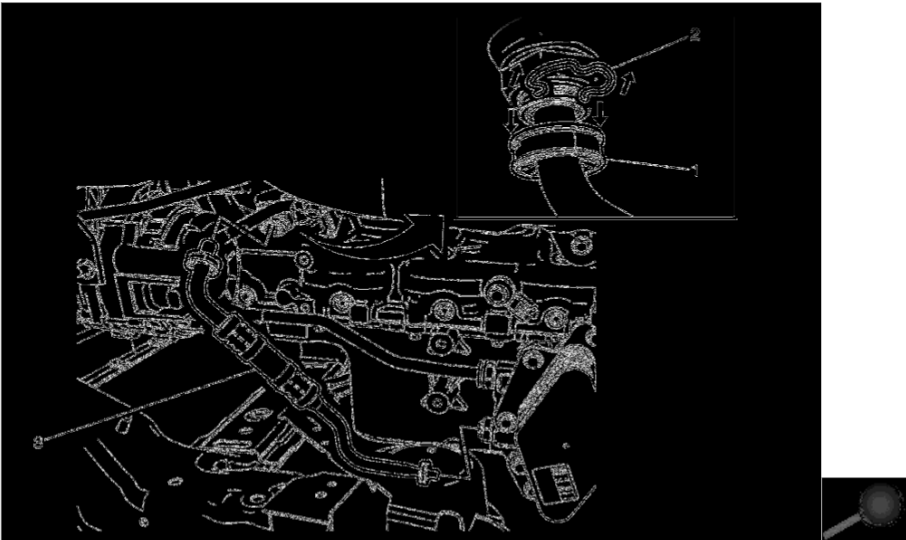


Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement

Callout	Component Name
Preliminary Procedure Remove the engine oil cooler coolant inlet hose. Refer to Engine Oil Cooler Coolant Inlet Hose Replacement .	
1	Engine Oil Cooler Inlet Hose Fitting Fastener Caution: Refer to Component Fastener Tightening Caution . Tighten 75 N•m (55 lb ft)

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Engine Oil Cooler Inlet Hose Replacement

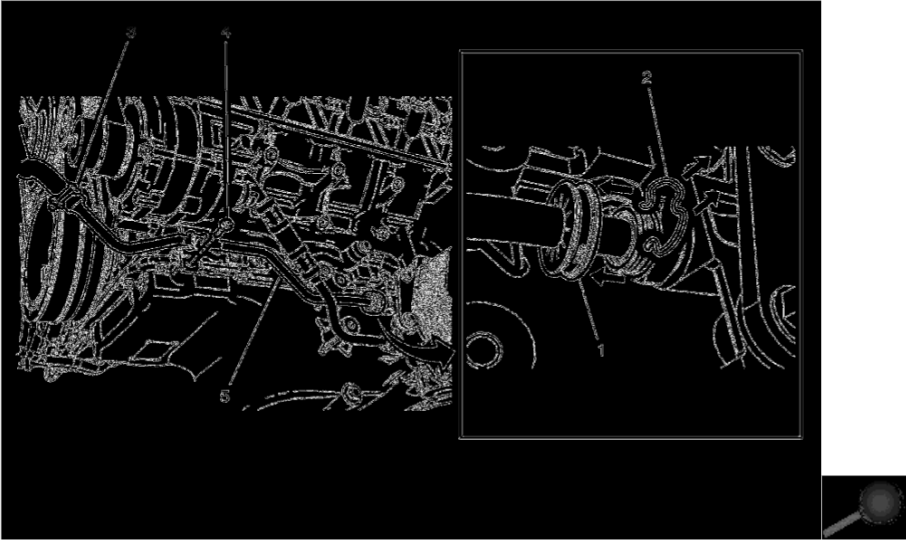


Engine Oil Cooler Inlet Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to Cooling System Draining and Filling . 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .	
1	Engine Oil Cooler Inlet Hose Quick Connect Fitting Caps (Qty: 2) Procedure Carefully pry the caps off the engine oil cooler inlet hose quick connect fitting to expose the retaining clip.
2	Engine Oil Cooler Inlet Hose Retaining Clip (Qty: 2)
5	Engine Oil Cooler Inlet Hose Procedure 1. Fill coolant to the proper level. Refer to Cooling System Draining and Filling . 2. Inspect cooling system for leaks. Refer to Cooling System Leak Testing .

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Engine Oil Cooler Outlet Pipe Replacement

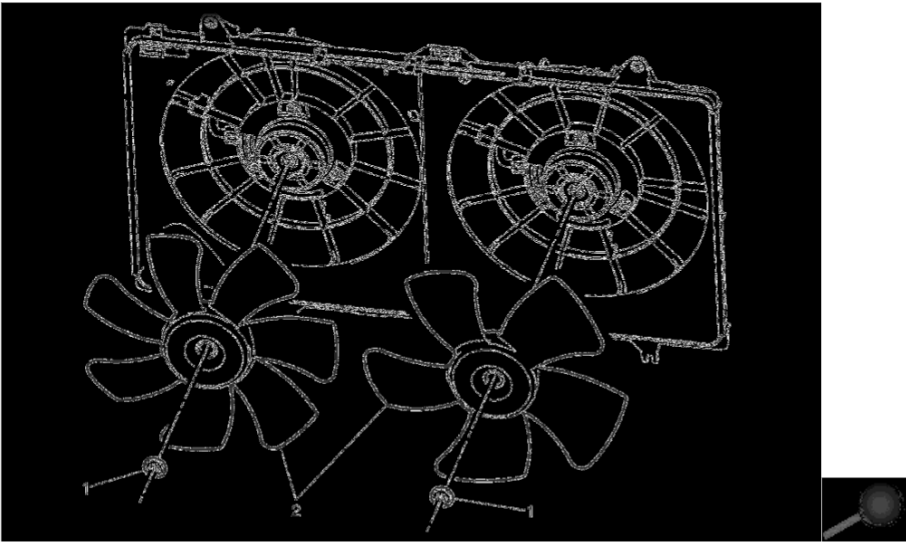


Engine Oil Cooler Outlet Pipe Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to Cooling System Draining and Filling . 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle	
1	Engine Oil Cooler Outlet Pipe Quick Connect Fitting Cap Procedure Carefully pry the cap off the engine oil cooler outlet pipe quick connect fitting to expose the retaining clip.
2	Engine Oil Cooler Outlet Pipe Retaining Clip
3	Engine Oil Cooler Outlet Pipe Hose Clamp
4	Engine Oil Cooler Outlet Pipe Fastener Caution: Refer to Fastener Caution . Tighten 9N·m (80 lb in)
5	Engine Oil Cooler Outlet Pipe Procedure 1. Fill coolant to the proper level. Refer to Cooling System Draining and Filling . 2. Inspect cooling system for leaks. Refer to Cooling System Leak Testing .

Callout	Component Name
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Fan Blade Replacement (LWR, LFX, LFW, LSA, LS3, L77)

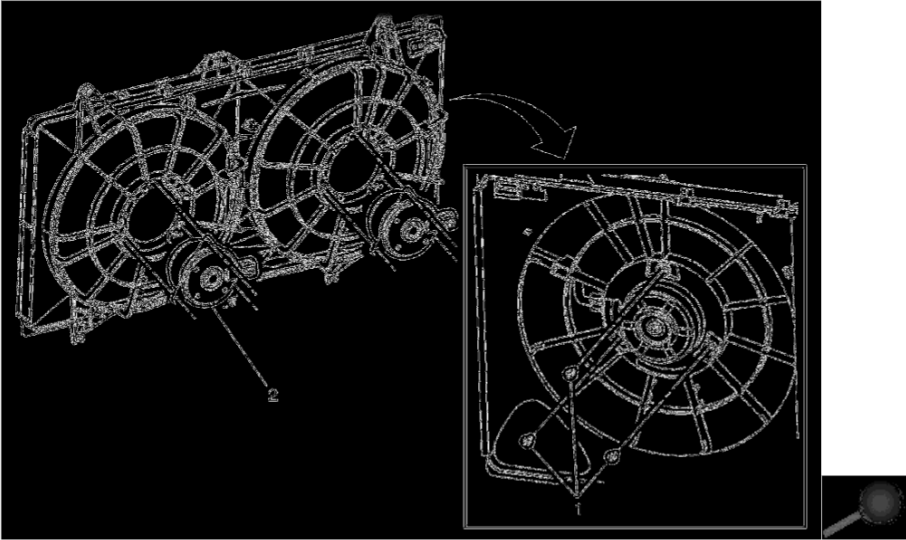


Fan Blade Replacement

Callout	Component Name
Preliminary Procedure Remove the engine coolant fan shroud. Refer to Engine Coolant Fan Shroud Replacement . Note: The left and right side engine coolant fans are different. Ensure you install the left or right side engine coolant fans on the proper side.	
1	Fan Blade Nuts (Qty: 2) One Per Motor Caution: Refer to Fastener Caution . Tighten 6 N•m (53 lb in)
2	Fan Blade (Qty: 2) Procedure The fans blades are serviced separately.

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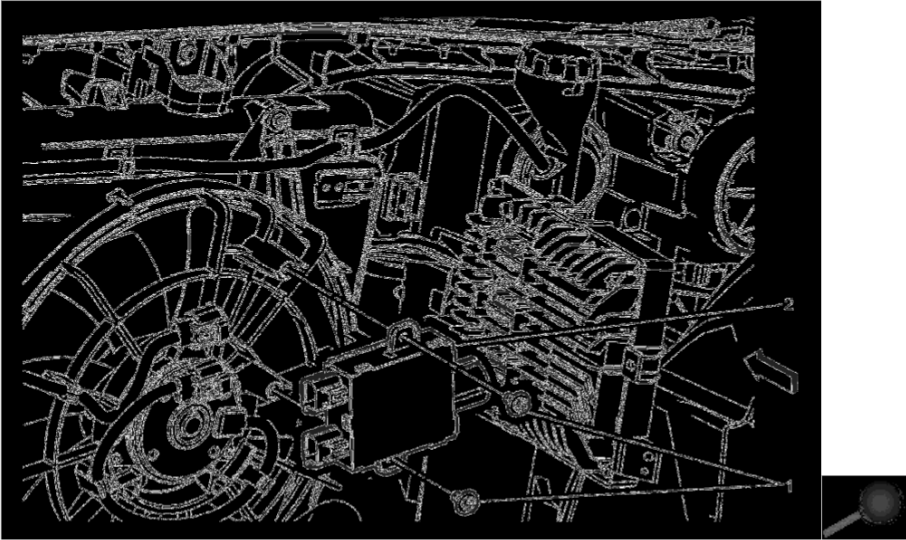
Engine Coolant Fan Motor Replacement



Engine Coolant Fan Motor Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the engine coolant fan shroud from the vehicle. Refer to Engine Coolant Fan Shroud Replacement . 2. Remove the fan blade. Refer to Fan Blade Replacement .	
1	Engine Coolant Fan Motor Bolt (Qty: 3) Three Per Motor Caution: Refer to Fastener Caution . Tighten: 4 N•m (35 lb in)
2	Engine Coolant Fan Motor (Qty: 2) Procedure Disconnect the engine coolant fan motor electrical harness from the engine coolant fan shroud. Note: The coolant fan motors are serviced separately.

Fan Control Module Replacement



Fan Control Module Replacement

Callout	Component Name
1	Fan Control Module Bolt (Qty: 2) Caution: Refer to Fastener Caution . Tighten 5 N•m (44 lb in)
2	Fan Control Module Procedure Disconnect the electrical connectors.

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Engine Coolant Thermostat Housing Replacement (V8)

Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

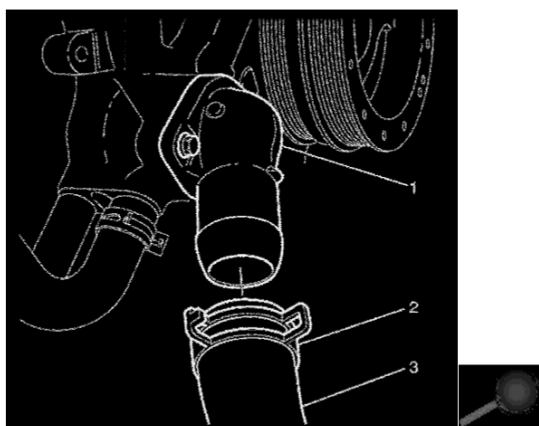
Warning: Refer to [Radiator Cap Removal Warning](#).

2. Ensure engine is below cool before removing the coolant pressure cap.
3. Remove the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Drain the coolant into a suitable container. Refer to [Cooling System Draining and Filling](#).
6. Lower the vehicle.



Warning: Refer to [Safety Glasses Warning](#).

7. Release the retaining hose clamp (2) and detach the hose (3) from the thermostat housing end (1).

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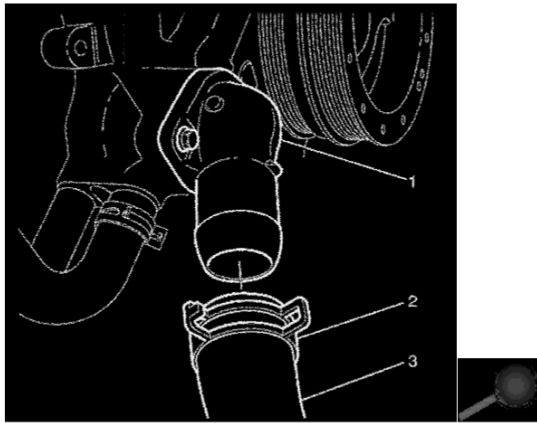
8. Remove the thermostat housing (2) to water pump retaining bolts (1), and remove thermostat housing.
9. If the housing is to be replaced, discard the O-ring.

Installation Procedure

1. Ensure all mating surfaces are thoroughly cleaned, using only a fine abrasive material.



- Note:** Ensure a new O-ring seal is used.
2. Install the thermostat housing (2).
 - Caution:** Refer to [Fastener Caution](#).
 3. Install the thermostat housing to water pump retaining bolts (1) and tighten to **14 N•m (124 lb in)**.



Warning: Refer to [Safety Glasses Warning](#).

Caution: Refer to [Installing Hoses without Twists or Bends Caution](#).

4. Install the hose (3) to the thermostat housing (1), by opening the retaining hose clamp (2) and securing it over the hose.
5. Install the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
6. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
7. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
8. Inspect cooling system for leaks.
9. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

Engine Coolant Thermostat Housing Replacement (V6)

Special Tools

EN-48536 Frame Support Tool (Engine Lower 65 mm Kit)

Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).
3. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
4. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
- Warning:** Refer to [Radiator Cap Removal Warning](#).
5. Ensure the engine temperature is below 50°C before removing the radiator cap.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

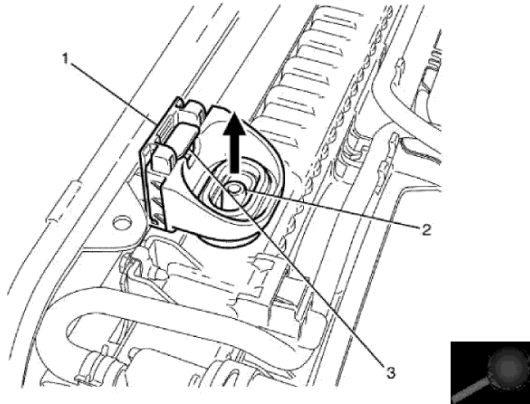
Warning: Refer to [Safety Glasses Warning](#).

6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

Note: Store used coolant in the correct 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.
7. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).

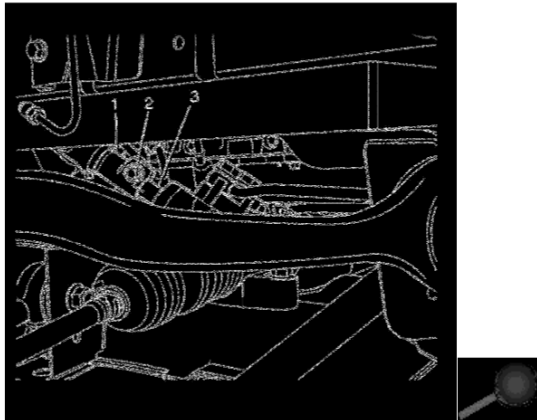
Note: Remove the lower intake manifold for LY7 equipped vehicles and Do Not separate the upper and lower intake manifolds.
8. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).

Note: Ensure material used to cover cylinder head inlet ports is lint free to prevent any foreign matter entering the ports.
9. Cover the exposed cylinder head inlet ports .



10. Raise the securing lock (3) from the radiator support bracket (2) by 10 mm on both sides.

11. Remove the radiator support bracket (2) from the radiator slide pin assembly (1) on both sides.
12. Remove the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).
13. Remove the oil pan shield if equipped. Refer to [Oil Pan Shield Replacement](#).
14. Remove the engine coolant inlet pipe. Refer to [Engine Coolant Inlet Pipe Replacement](#).
15. Remove the exhaust system. Refer to [Exhaust System Replacement](#).
16. Remove the propeller shaft. Refer to [Propeller Shaft Replacement](#).



Note: Right hand drive shown, left hand drive similar.

Note: The front wheels of the vehicle must be maintained in the straight ahead position and the steering column must be in the LOCK position before disconnecting the steering column or intermediate shaft. If these procedures are not followed, incorrect alignment of some components during installation will result and damage to the SIR coil assembly will occur.

Note: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimize the potential of incorrect steering column assembly alignment.

17. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).

Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

18. Remove the intermediate shaft to pinion shaft retaining bolt (2).
Discard the bolt.

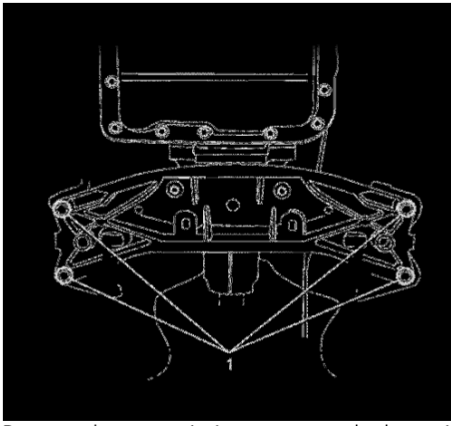
19. Disconnect the intermediate shaft (2) from the pinion shaft (3).

Note: Step 20 to 35 detail how to use the engine and transmission 65 mm drop tool. If this procedure is known, go to Step 36.

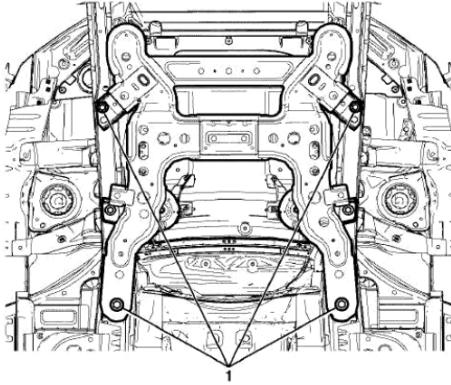
20. Using special tool *EN-48536* frame support tool, lower the engine and transmission assembly 65 mm.

Note: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

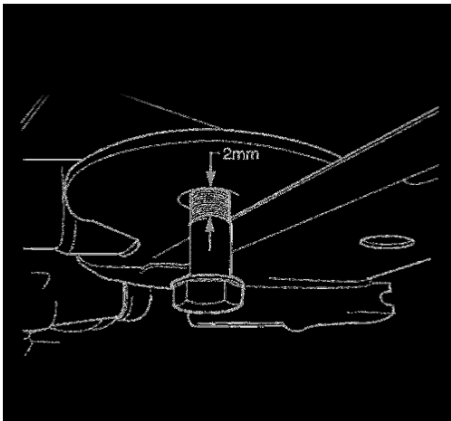
21. Support the power train with a suitable jack or table.



22. Remove the transmission support to body retaining bolts (1).



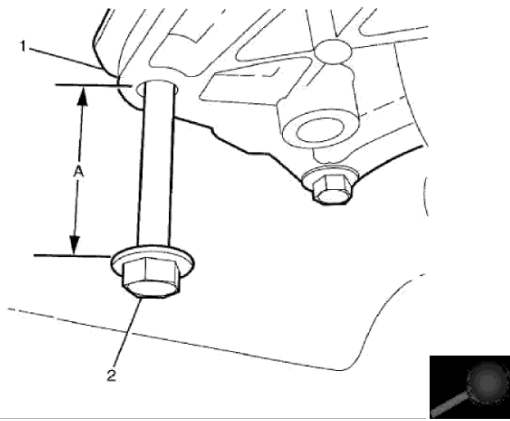
23. Remove the front and rear sub frame to front chassis rail retaining bolts (1).



Note: Do not tighten the bolts at this stage.

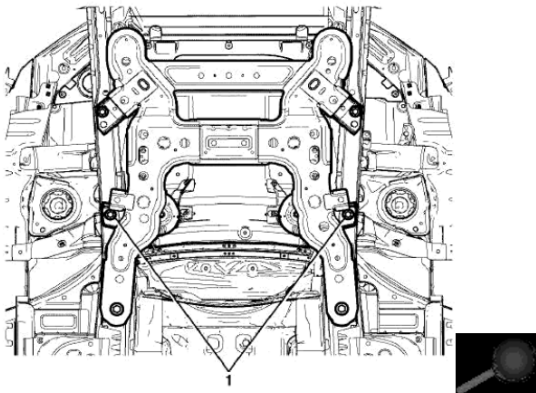
24. Replace the front and rear sub frame to body retaining bolts with four (M16 x 2.0) 160 mm bolts from special tool kit *EN-48536* frame support tool.

25. Install the bolts until 2 mm of the thread remains visible below the sub frame.

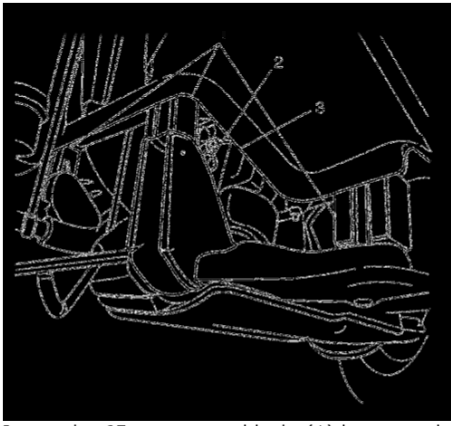


Note: Do not tighten the bolts at this stage.

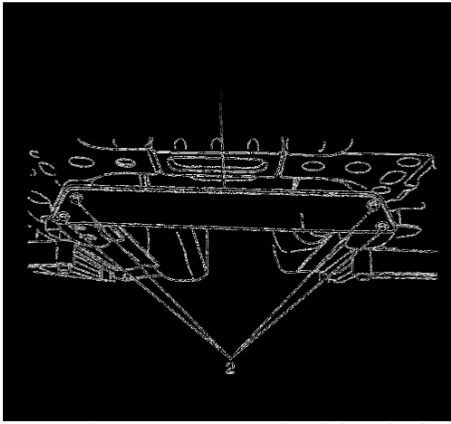
26. Replace the transmission support to body retaining bolts with the two (M10 x 1.5) 115 mm bolts (2) from special tool kit *EN-48536* frame support tool adjacent to each other. e.g. Left hand front and Right hand rear.
27. Install the bolts until 65 mm of bolt remains visible (A) between the bolt heads (2) and the transmission mount (1).



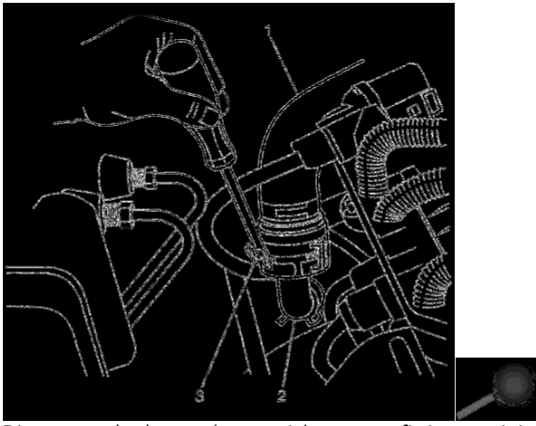
28. Remove the centre sub frame to body retaining bolts (1).
29. Lower the power train slowly until the sub frame and transmission assembly is resting on the bolt heads.



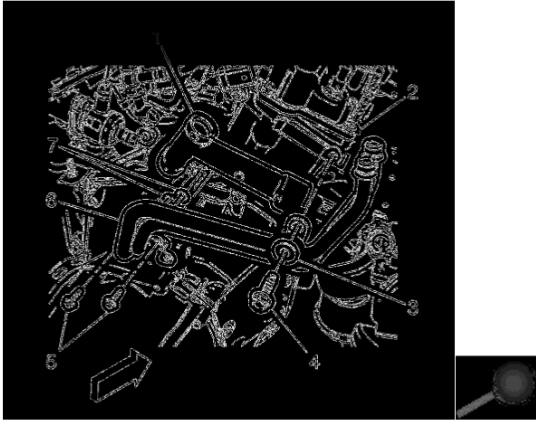
30. Insert the 65 mm spacer blocks (1) between the sub frame (2) and chassis rails (3).
31. Tighten the front and rear sub frame retaining bolts to **95 N·m (70 lb ft)**.
32. Install the remaining two (M16 x 2.0) 115 mm centre sub frame to body retaining bolts from special tool kit *EN-48536* frame support tool to the front sub frame and tighten to **95 N·m (70 lb ft)**.



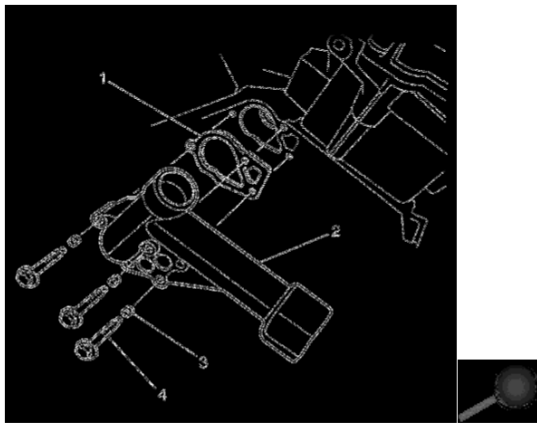
33. Position the engine support plate (1) to the front sub frame.
34. Install the four (M8 x 1.25) 28 mm engine support plate to front sub frame retaining bolts (2) from special tool kit *EN-48536* frame support tool and tighten to **10 N·m (89 lb in)**.
35. Support the transmission with a suitable jack or table.



36. Disengage the heater hose quick connect fitting retaining clip (3) with a suitable screwdriver.
37. Detach the heater hoses (1) from the heater pipes (2).



38. Remove the heater pipe assembly to cylinder head retaining bolt (4) and washer (3).
39. Remove the heater pipe assembly to engine coolant thermostat housing retaining bolts (5).
40. Remove the heater pipe assembly (6) from the cylinder head (2) and engine coolant thermostat housing (1).
41. Remove the heater pipe assembly to engine coolant thermostat housing O-ring seals (7).



Note: The engine coolant thermostat housing has one longer bolt which is located in the upper left of the housing.

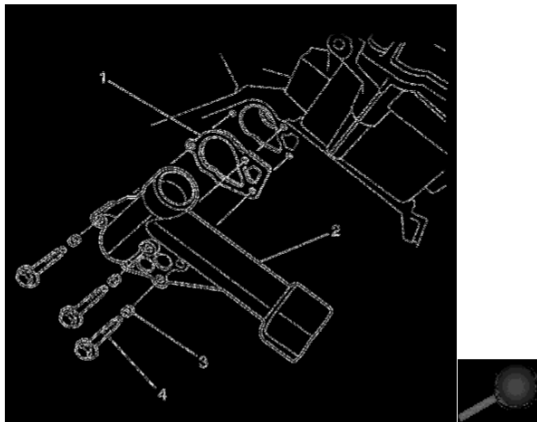
42. Remove engine coolant thermostat housing to cylinder head retaining bolts (4) and plastic retainers (3).

43. Remove engine coolant thermostat housing (2).

Note: Always replace the engine coolant thermostat housing to cylinder head gasket (1).

44. Remove engine coolant thermostat housing gasket (1).

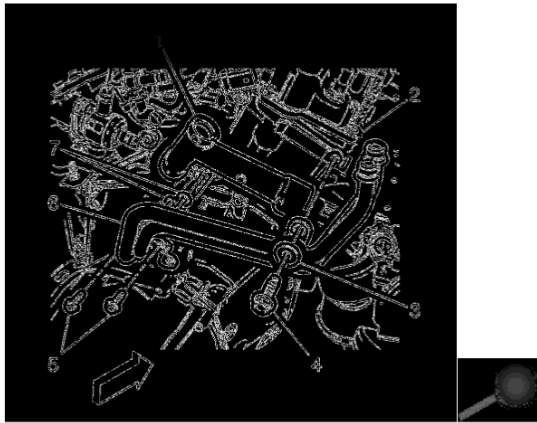
Installation Procedure



1. Assemble the engine coolant thermostat housing to cylinder head retaining bolts (4), plastic retainers (3) and engine coolant thermostat housing gasket (1) to the engine coolant thermostat housing (2).

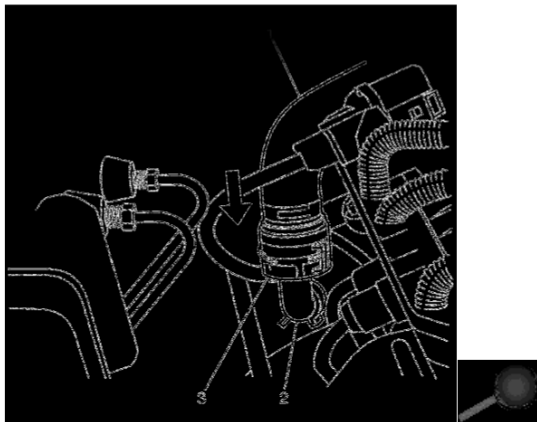
Caution: Refer to [Fastener Caution](#).

2. Install engine coolant thermostat housing (2) to the cylinder head and tighten the engine coolant thermostat housing to cylinder head retaining bolts (4) to **10 N•m (89 lb in)**.



Note: Ensure new O-ring seals (6) are fitted to the heater pipe assembly (4).

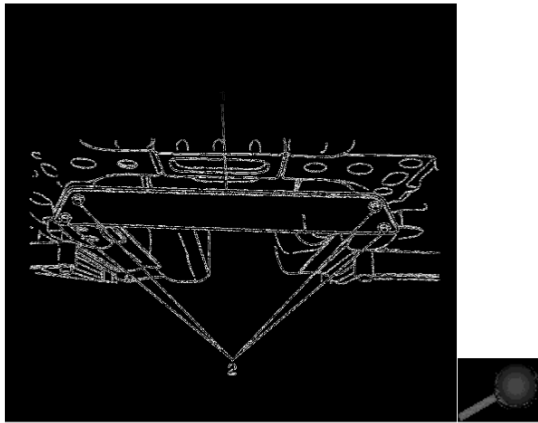
3. Install the heater pipe assembly to engine coolant thermostat housing O-ring seals (7) to the heater pipe assembly (6).
4. Install the heater pipe assembly (6) to the cylinder head (2) and engine coolant thermostat housing (1).
5. Install the heater pipe assembly to engine coolant thermostat housing retaining bolts (5) and tighten to **9 N·m (80 lb in)**.
6. Install the heater pipe assembly to cylinder head washer (3) and retaining bolt (4) and tighten to **35 N·m (26 lb ft)**.



Caution: Refer to [Installing Hoses without Twists or Bends Caution](#).

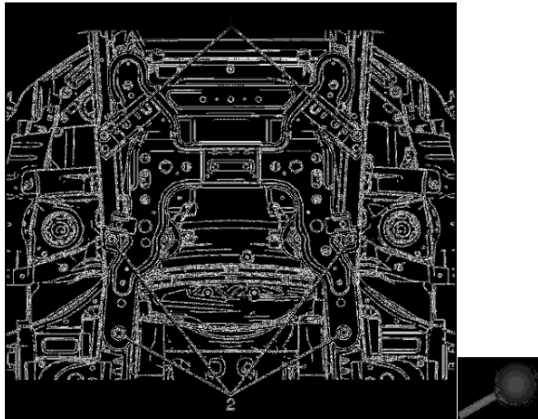
Note: Make sure the heater hose quick connect fitting retaining clip is securely engaged into the heater hose quick connect fitting (3).

7. Attach the heater hoses (1) to the heater pipes (2).
8. Install the engine coolant inlet pipe. Refer to [Engine Coolant Inlet Pipe Replacement](#).

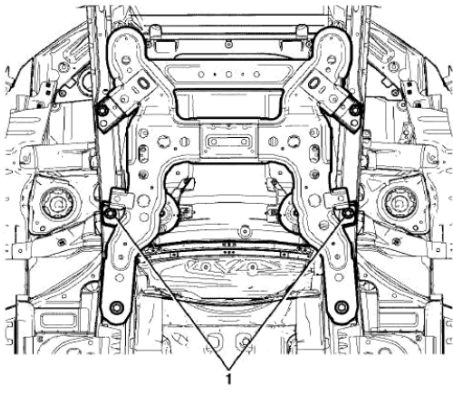


Note: Step 9 to 20 detail how to use the engine and transmission 65 mm drop tool. If this procedure is known, go to Step 21.

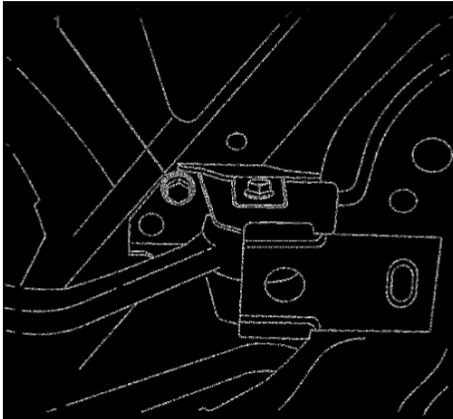
9. Remove the four (M8 x 1.25) 28 mm engine support plate to front sub frame retaining bolts (2).
10. Remove the engine support plate (1) from the front sub frame.



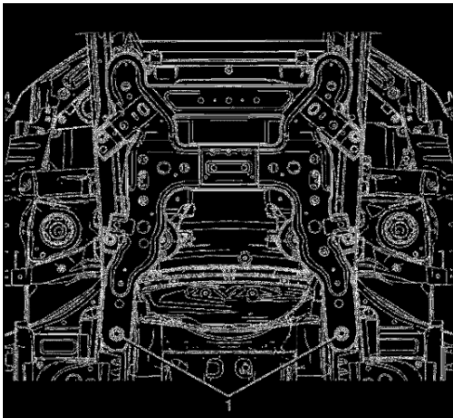
11. Loosen the six sub frame to front chassis rail retaining bolts (1 and 2) by one turn each.
12. Remove the 65 mm spacer blocks from between the sub frame and chassis rails.
13. Raise the power train slowly until the sub frame and transmission mount are lifted off the bolt heads and the power train is positioned back up into the engine bay.



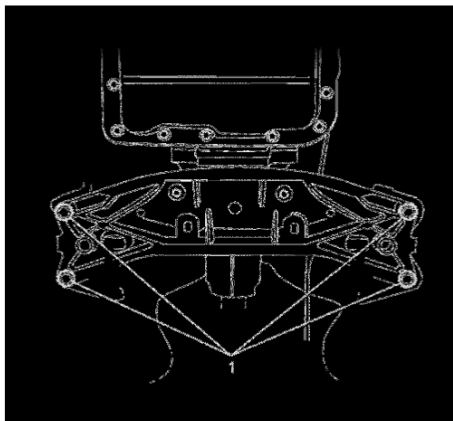
14. Remove the centre (M16 x 2.0) 115 mm sub frame to front chassis rail retaining bolts (1).
15. Install the original centre sub frame to front chassis rail retaining bolts (1) and tighten to **160N·m (118 lb ft)**.



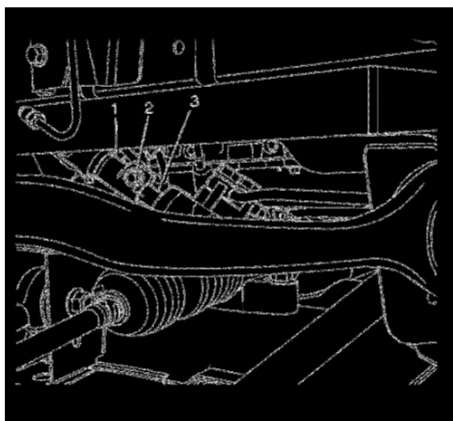
16. Tighten the front sub frame to front chassis rail retaining bolts to **160N·m (118 lb ft)**.



17. Tighten the rear sub frame to front chassis rail retaining bolts to **240N·m (178 lb ft)**.



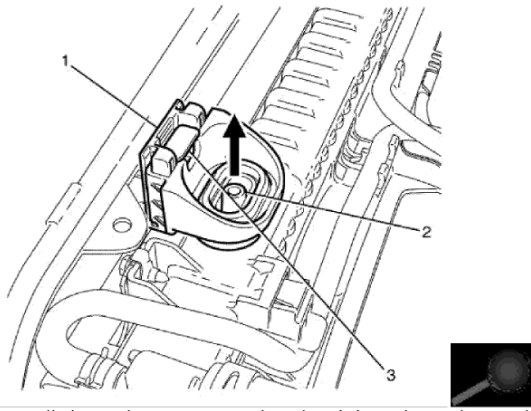
18. Remove the two (M10 x 1.5) 115 mm special tool kit *EN-48536* frame support tool transmission support to body retaining bolts (1).
19. Install the four original transmission support to lower sub frame retaining bolts (1) and tighten to **55 N·m (41 lb ft)**.
20. Remove the support from under the power train.



Note: Right hand drive shown, left hand drive similar.

Note: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

21. Connect the intermediate steering shaft (1) to the pinion shaft (3).
22. Install a NEW intermediate steering shaft to pinion shaft retaining bolt (2) and tighten to **25 N·m (18 lb ft)**.

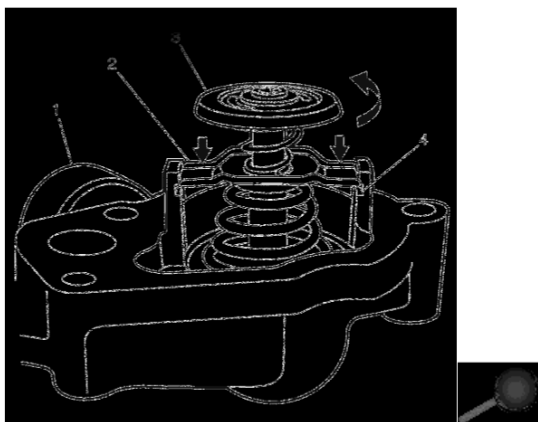


23. Install the radiator support bracket (2) to the radiator slide pin assembly (1) on both sides.
24. Push the securing lock (3) into the radiator support bracket (2) making sure it is correctly seated on both sides.
25. Install the propeller shaft. Refer to [Propeller Shaft Replacement](#).
26. Install the exhaust system. Refer to [Exhaust System Replacement](#).
27. Install the engine coolant inlet pipe. Refer to [Engine Coolant Inlet Pipe Replacement](#).
28. Install the oil pan shield if equipped. Refer to [Oil Pan Shield Replacement](#).
29. Install the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).
30. Remove the material used to cover the exposed cylinder head inlet ports.
31. Lower the vehicle.
32. Install the intake manifold. Refer to [Intake Manifold Replacement](#).
33. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
34. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
35. Install the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).
36. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
37. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
38. Inspect the cooling system for coolant leaks and repair as necessary.

Engine Coolant Thermostat Replacement (V6)

Removal Procedure

1. Remove the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement](#).



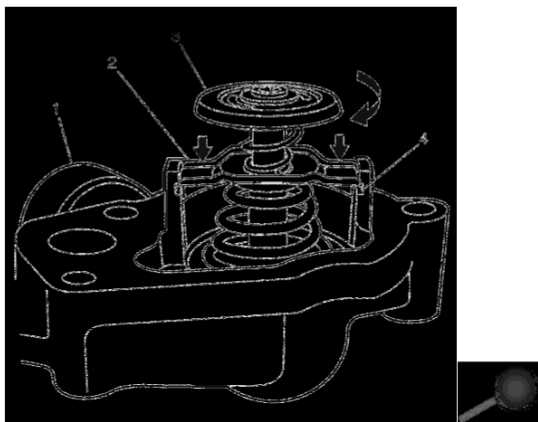
2. Place thermostat housing in a soft jaw vice.

Warning: Refer to [Safety Glasses Warning](#).

3. While depressing the thermostat (3) rotate the retaining bar (2) anti-clockwise in the housing (1) until it clears the retaining lugs (4).
4. Carefully release the thermostat spring force.
5. Remove the thermostat from it's housing.

Installation Procedure

1. Ensure that the thermostat housing is clean and free of damage.



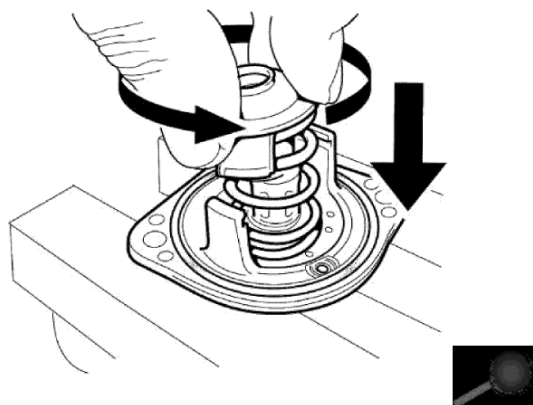
2. While pressing the thermostat (3) rotate the retaining bar (2) clockwise in the housing (1) until it locks into the retaining lugs (4).
3. Install the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement](#).

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Engine Coolant Thermostat Replacement (V8)

Removal Procedure

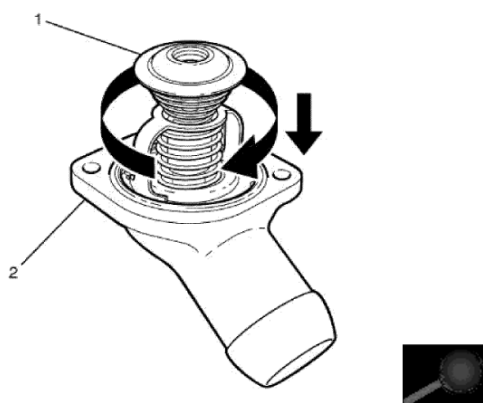
1. Remove the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement](#).
2. Place thermostat housing in a soft jaw vice.



Warning: Refer to [Safety Glasses Warning](#).

3. Press and rotate the springs of the thermostat anti-clock wise to release it from the thermostat housing.
4. Remove the thermostat from the thermostat housing.

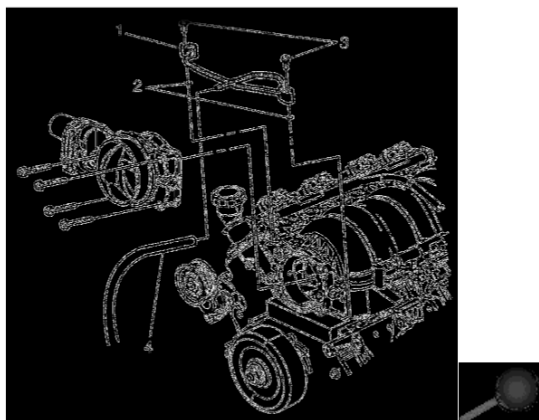
Installation Procedure



1. Make sure that the air bleed ball is not jammed by slightly shaking the assembly.
2. Place the thermostat (1) assembly into the thermostat housing (2).
3. Install the thermostat (1), by pressing and rotating clock wise until it locks into the thermostat housing (2).

Engine Coolant Air Bleed Pipe Replacement (V8)

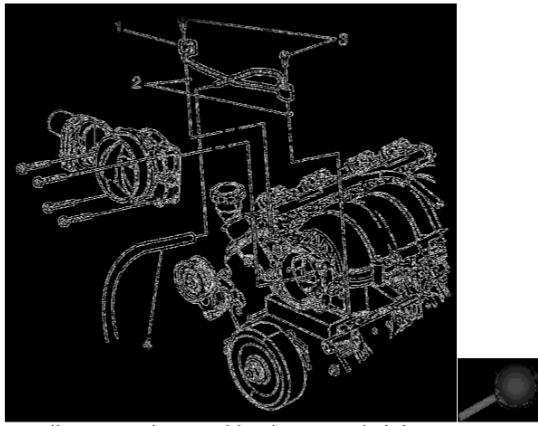
[Removal Procedure](#)



Warning: With a pressurized cooling system, the coolant temperature in the radiator can be considerably higher than the boiling point of the solution at atmospheric pressure. Removal of the surge tank cap, while the cooling system is hot and under high pressure, causes the solution to boil instantaneously with explosive force. This will cause the solution to spew out over the engine, the fenders, and the person removing the cap. Serious bodily injury may result.

1. Drain approximately one litre of coolant. Refer to [Cooling System Draining and Filling](#).
2. Remove the throttle body assembly. Refer to [Throttle Body Assembly Replacement](#).
3. Detach the coolant air bleed hose (4) from the coolant air bleed pipe (1).
4. Remove the coolant air bleed pipe mounting bolts (3).
5. Remove the coolant air bleed pipe (1) from the cylinder heads.
6. Discard the coolant air bleed pipe seals (2).

[Installation Procedure](#)

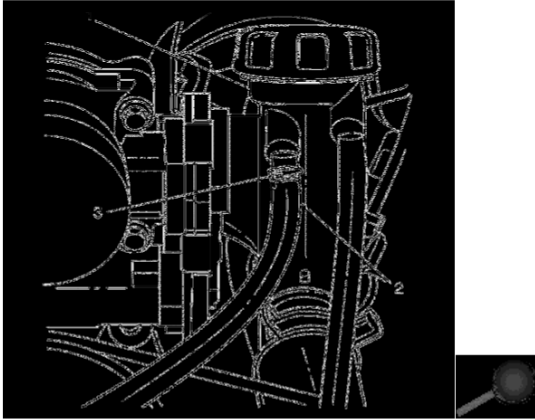


1. Install NEW coolant air bleed pipe seals (2).
2. Install the coolant air bleed pipe (1) to the cylinder heads.
- Caution:** Refer to [Fastener Caution](#).
3. Install the coolant air bleed pipe to cylinder head bolts (3) and tighten to **12N·m (106 lb in)**.
4. Install the coolant air bleed hose (4) to the coolant air bleed pipe (1).
5. Install the throttle body assembly. Refer to [Throttle Body Assembly Replacement](#).
6. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).

Engine Coolant Air Bleed Pipe Replacement (V6)

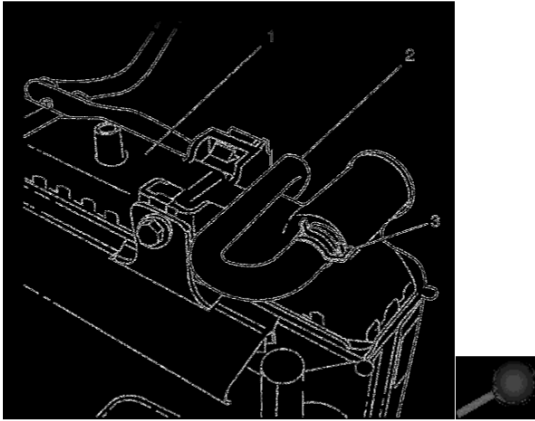
Removal Procedure

1. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).



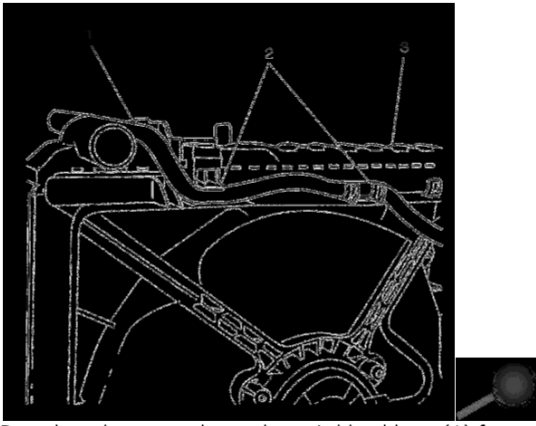
Warning: Refer to [Safety Glasses Warning](#).

3. Release the hose clamp (3) and remove the coolant air bleed hose (2) from the outlet housing (1).



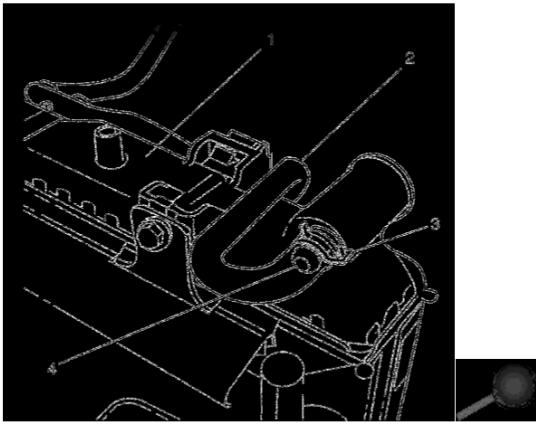
4. Release the hose clamp (3) and remove the coolant air bleed hose (2) from the radiator (1).

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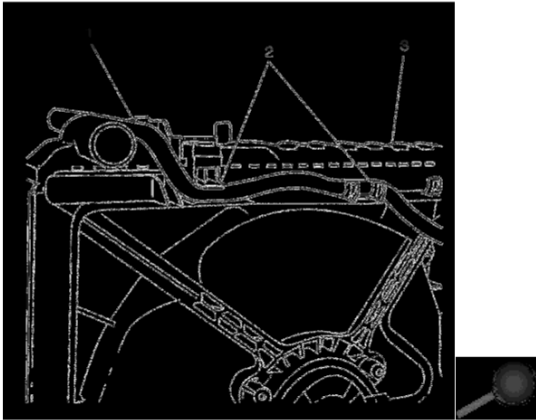


5. Detach and remove the coolant air bleed hose (1) from coolant air bleed hose retaining clips (2) located on the radiator (3).

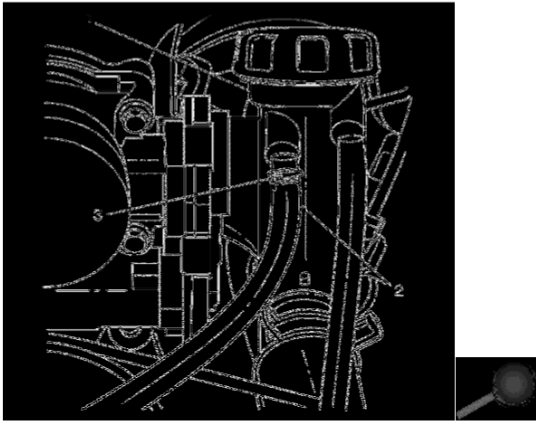
Installation Procedure



1. Install the air bleed hose (2) to the radiator (1) by fitting to the radiator spigot (4) and securing with the coolant air bleed hose clamp (3).



2. Attach the coolant air bleed hose (1) to the radiator (3) using the retaining clips (2).



3. Install the coolant air bleed hose (2) onto the outlet housing (1) and secure with hose clamp (3).
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
6. Check the coolant level. Refer to [Cooling System Draining and Filling](#).

Engine Coolant Air Bleed Hose Replacement (LWR, LFX, LFW)

Special Tools

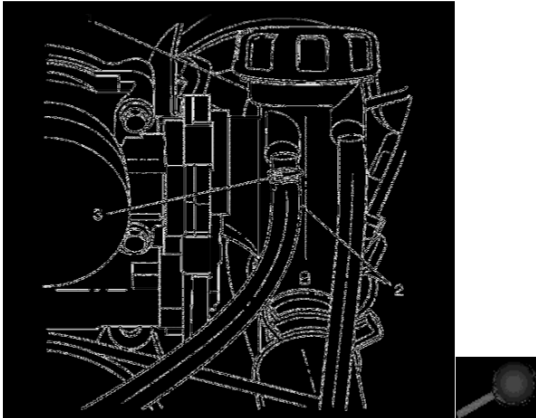
BO-38185 Hose Clamp Pliers

Removal Procedure

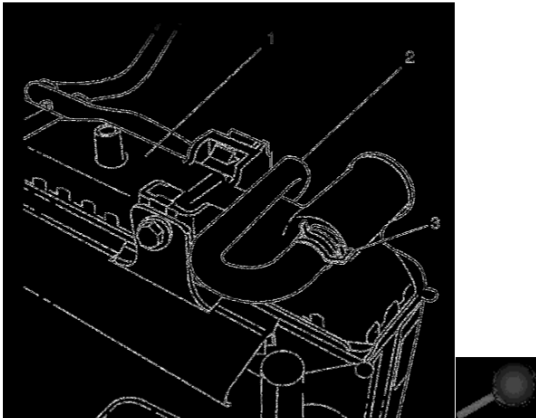
Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

1. Ensure engine is below 50°C before removing the coolant pressure cap.
2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
3. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

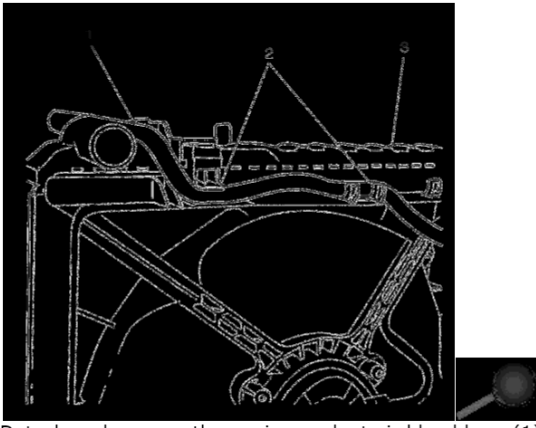


4. Reposition the engine coolant air bleed hose clamp (3) using BO-38185 hose clamp pliers.
5. Remove the coolant air bleed hose (2) from the water outlet housing (1).



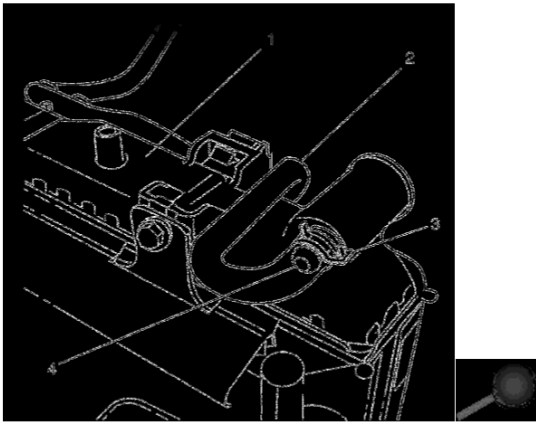
6. Reposition the engine coolant air bleed hose clamp (3) using BO-38185 hose clamp pliers.
7. Remove the coolant air bleed hose (2) from the radiator (1).

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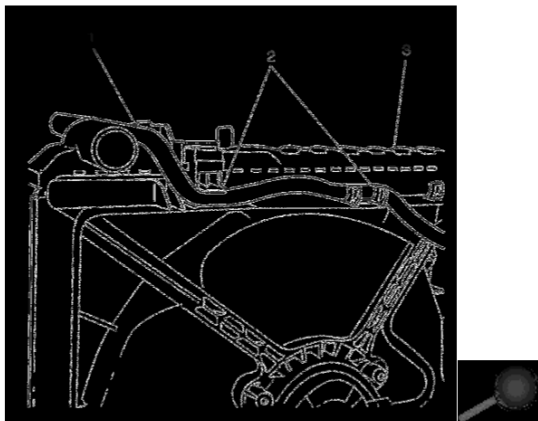


8. Detach and remove the engine coolant air bleed hose (1) from coolant air bleed hose retaining clips (2) on the engine coolant fan shroud.

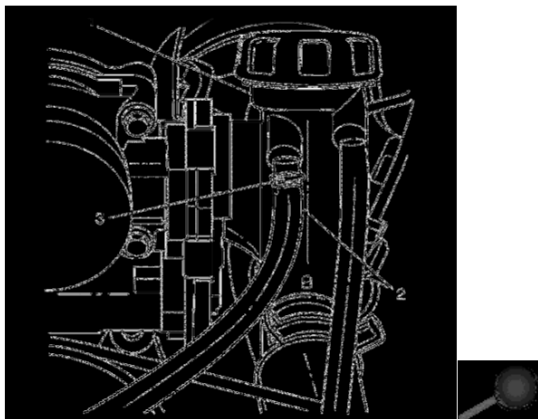
Installation Procedure



1. Install the air bleed hose (2) to the radiator spigot (4).
2. Reposition the engine coolant air bleed hose clamp (3) using *BO-38185* hose clamp pliers.

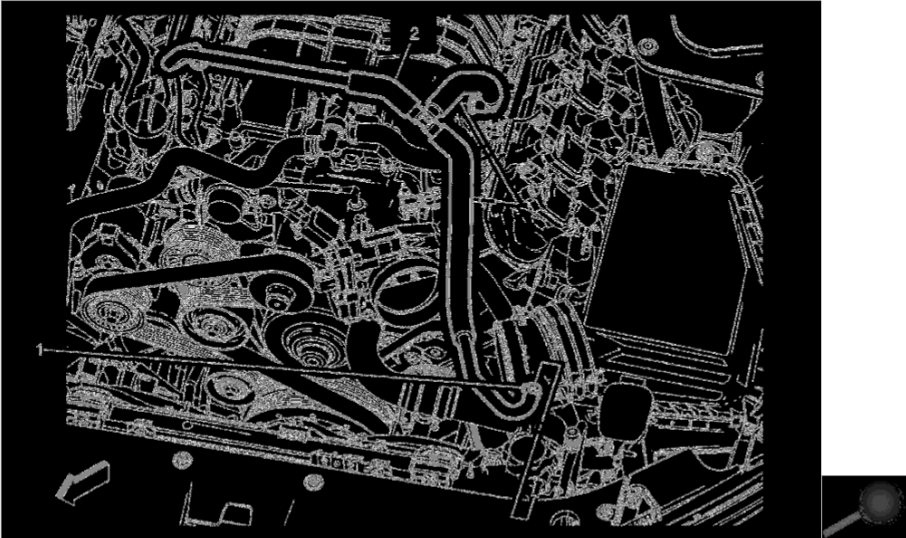


3. Attach the engine coolant air bleed hose (1) to the engine coolant fan shroud retaining clips (2).



4. Install the coolant air bleed hose (2) onto the outlet housing (1).
5. Reposition the engine coolant air bleed hose clamp (3) using *BO-38185* hose clamp pliers.
6. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
7. Check the coolant level. Refer to [Cooling System Draining and Filling](#).

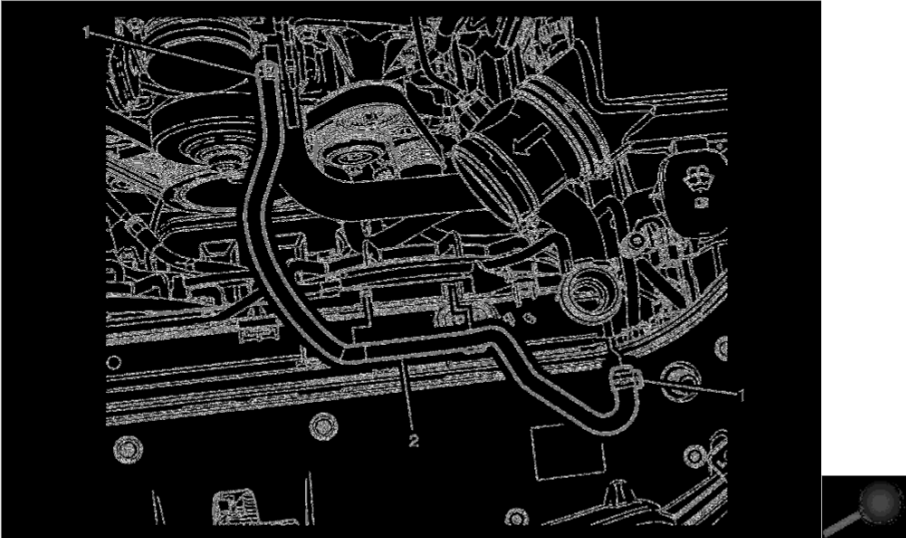
Engine Coolant Air Bleed Hose Replacement (LSA)



Engine Coolant Air Bleed Hose Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to Cooling System Draining and Filling . 2. Remove the front intake manifold cover. Refer to Intake Manifold Cover Replacement - Front . 3. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement . 4. Release the retainers from the quick disconnect. Refer to Plastic Collar Quick Connect Fitting Service .	
1	Engine Coolant Air Bleed Hose Clamp Procedure Reposition the engine coolant air bleed hose clamp using <i>BO-38185</i> hose clamp pliers. Special Tools <i>BO-38185</i> Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Engine Coolant Air Bleed Hose Procedure 1. Fill the cooling system. 2. Inspect cooling system for leaks.

Engine Coolant Air Bleed Hose Replacement (LS3, L77)



Engine Coolant Air Bleed Hose Replacement

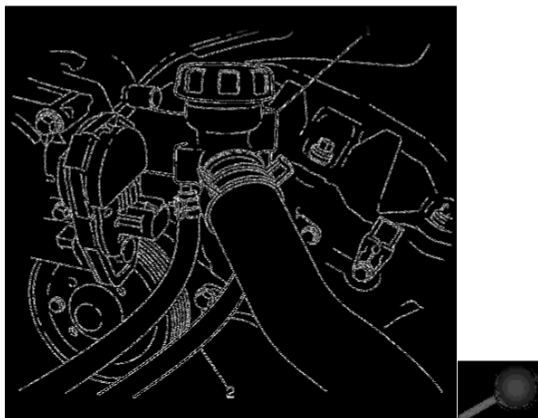
Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to Cooling System Draining and Filling . 2. Remove the intake manifold sight shield. Refer to Intake Manifold Sight Shield Replacement . 3. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Engine Coolant Air Bleed Hose Clamp (Qty: 2) Procedure Reposition the engine coolant air bleed hose clamp using <i>BO-38185</i> hose clamp pliers. Special Tools <i>BO-38185</i> Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Engine Coolant Air Bleed Hose Procedure 1. Fill the cooling system. 2. Inspect cooling system for leaks.

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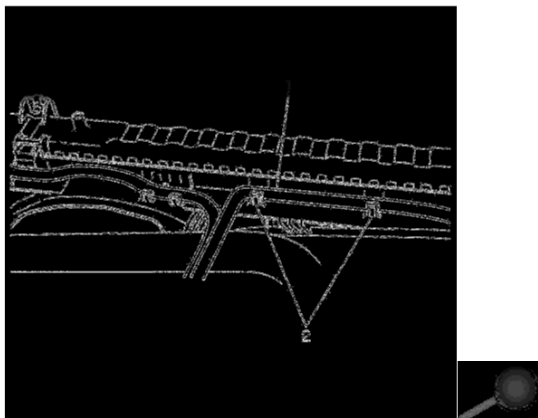
Coolant Recovery Reservoir Hose Replacement (LWR, LFX, LFW)

Removal Procedure

1. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
2. Remove the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

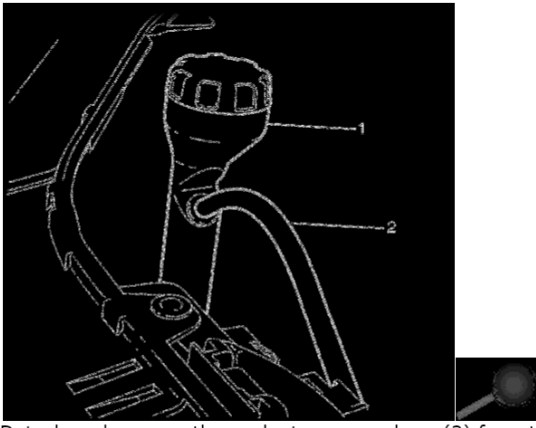


3. Detach the coolant recovery hose (2) from the outlet housing (1).



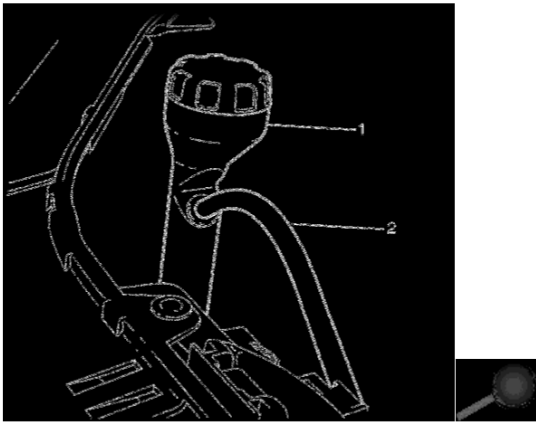
4. Detach the coolant recovery reservoir hose (1) from the engine coolant fan shroud retaining clips (2).

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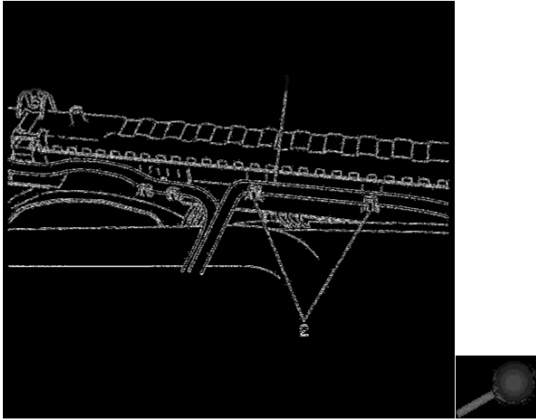


5. Detach and remove the coolant recovery hose (2) from the coolant recovery reservoir filler neck (1).

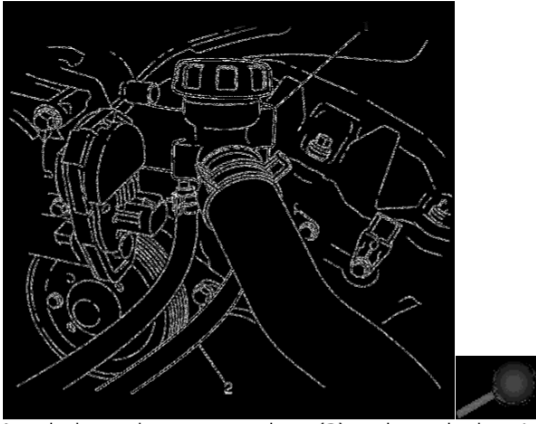
Installation Procedure



1. Attach the coolant recovery hose (2) to the coolant recovery reservoir filler neck (1).



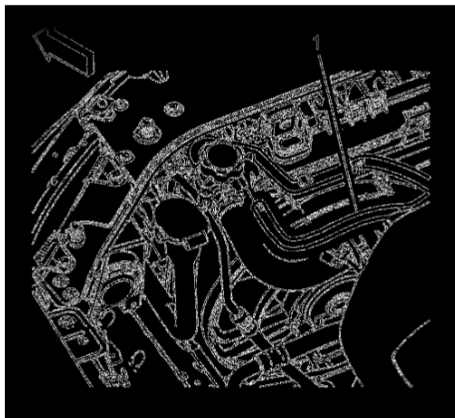
2. Attach the coolant recovery reservoir hose (1) into the engine coolant fan shroud retaining clips (2).



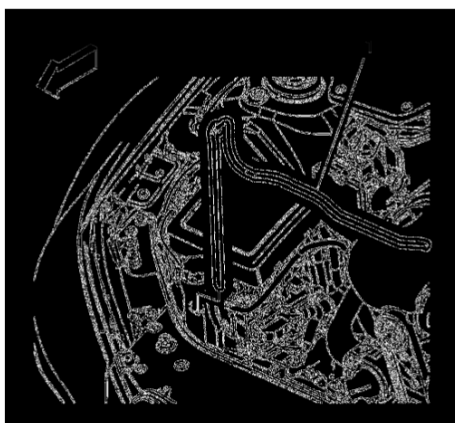
3. Attach the coolant recovery hose (2) to the outlet housing (1).
4. Check the coolant level and fill as required. Refer to [Cooling System Draining and Filling](#).
5. Inspect cooling system for leaks.
6. Install the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
7. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).

Coolant Recovery Reservoir Hose Replacement (L77, LSA, LS3)

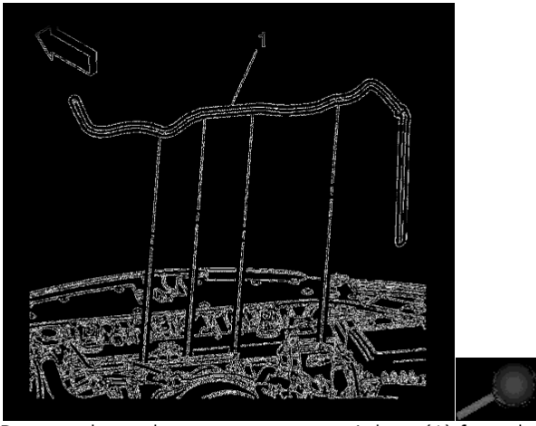
[Removal Procedure](#)



1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
2. Remove the coolant recovery hose (1) from the radiator.

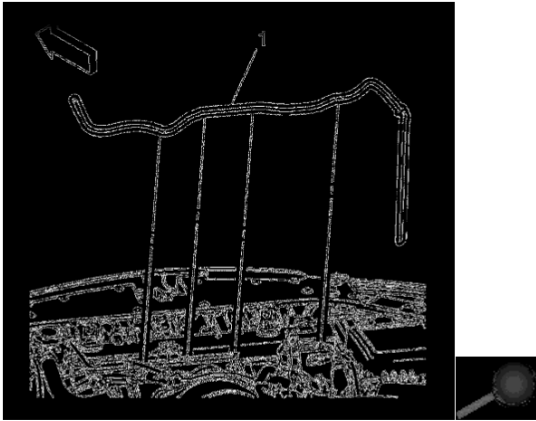


3. Remove the coolant recovery hose (1) from the coolant recovery reservoir filler neck.

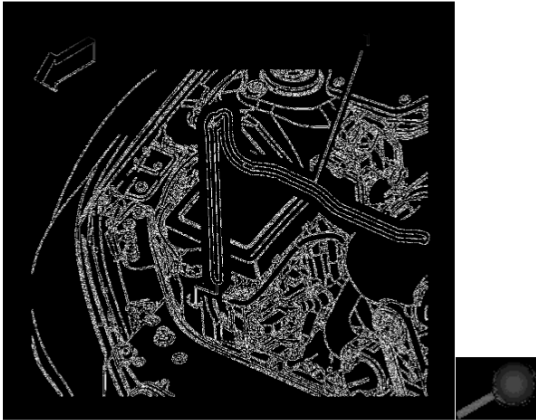


4. Remove the coolant recovery reservoir hose (1) from the engine coolant fan shroud retainers.
5. Remove the coolant recovery reservoir hose (1) from the vehicle.

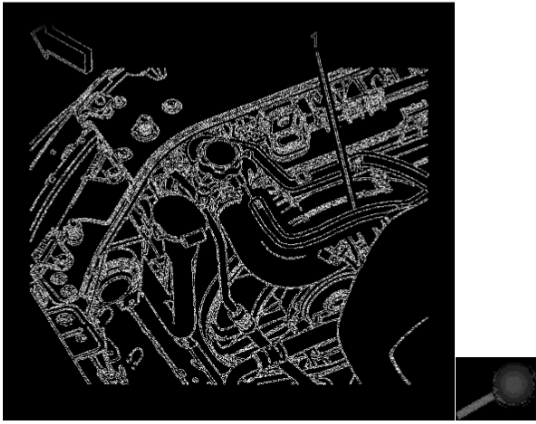
Installation Procedure



1. Install the coolant recovery reservoir hose (1) to the engine coolant fan shroud retainers.



2. Install the coolant recovery reservoir hose (1) to the coolant recovery reservoir filler neck.



3. Install the coolant recovery hose (1) to the radiator.
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Check the coolant level and fill the cooling system as required. Refer to [Cooling System Draining and Filling](#).
6. Inspect cooling system for leaks.

Water Outlet Replacement (V6)

Removal Procedure

Warning: Refer to [Safety Glasses Warning](#).

1. Ignition OFF.

Warning: Refer to [Battery Disconnect Warning](#).

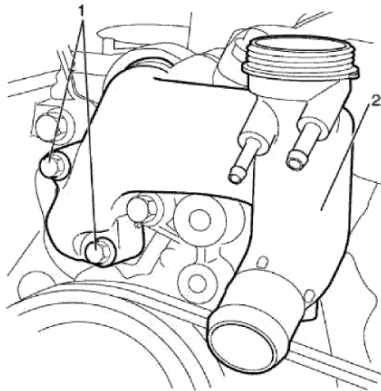
2. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

Warning: Under some conditions, the ethylene glycol engine coolant is combustible. In order to help avoid being burned, do not spill the antifreeze or the coolant on the exhaust system or the hot engine parts.

Warning: Dispose of the used engine coolant properly. Store the used coolant in a used coolant Holding Tank awaiting proper disposal or recycling. Do not pour used coolant down the drain. Ethylene glycol antifreeze is a very toxic chemical. Disposal into the sewer system or into the ground water is both environmentally irresponsible and illegal

Warning: Refer to [Radiator Cap Removal Warning](#).

3. Partly drain the cooling system. Refer to [Cooling System Draining and Filling](#).
4. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
5. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
6. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).
7. Detach the radiator inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
8. Detach the coolant recovery reservoir hose from the housing. Refer to [Coolant Recovery Reservoir Replacement](#).
9. Detach the coolant air bleed hose. Refer to [Engine Coolant Air Bleed Hose Replacement](#).

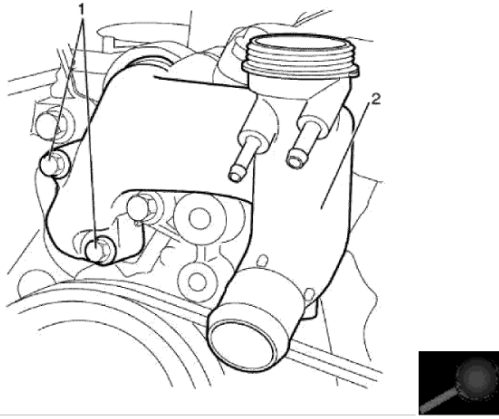


Note: Use of a soft pain hammer will aid in the removal of the water outlet housing.

10. Remove the water outlet housing (2) to cylinder head retaining bolts (1).
11. Remove the water outlet housing (2).
12. Discard the rubber O-ring and seal.

Installation Procedure

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Note: Ensure a new rubber O-ring and seal is used when installing the water outlet housing.

1. Install the water outlet housing (2) to the cylinder head.
- Caution:** Refer to [Fastener Caution](#).
2. Install the water outlet housing (2) to the cylinder heads using the water outlet housing retaining bolts (1).
- Tighten**
Tighten the bolts (1) to 10N·m (89 lb in).
3. Attach the coolant air bleed hose. Refer to [Engine Coolant Air Bleed Hose Replacement](#).
4. Attach the coolant recovery reservoir hose to the housing. Refer to [Coolant Recovery Reservoir Replacement](#).
5. Attach the radiator inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
6. Install the intake manifold. Refer to [Intake Manifold Replacement](#).
7. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
8. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
9. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
10. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
11. Inspect cooling system for leaks.

Water Pump Replacement (V6)

Removal Procedure

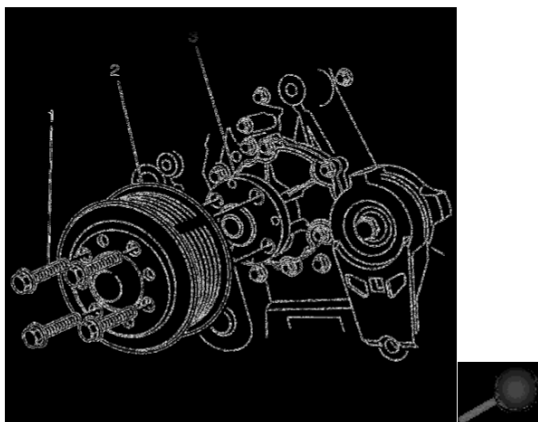
Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
3. Remove the engine cover. Refer to [Intake Manifold Sight Shield Replacement](#).
4. Remove the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Remove the engine drive belt. Refer to [Drive Belt Replacement](#).

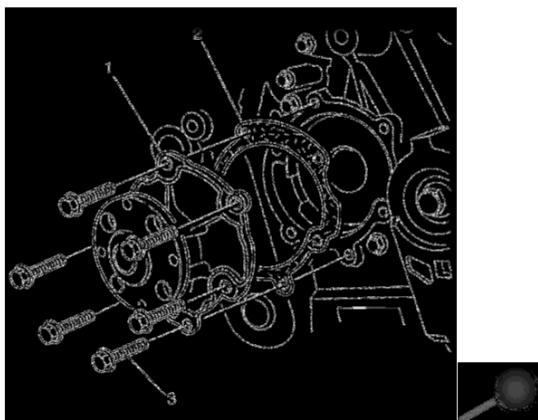
Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

6. Ensure engine is below 50°C before removing the coolant pressure cap.



7. Remove the water pump pulley to water pump retaining bolts (1).
8. Remove the water pump pulley (2) from the water pump (3).



Note: Use a soft hammer to separate the water pump from the engine cover.

9. Remove the water pump to engine front cover retaining bolts (3) and DISCARD the bolts.

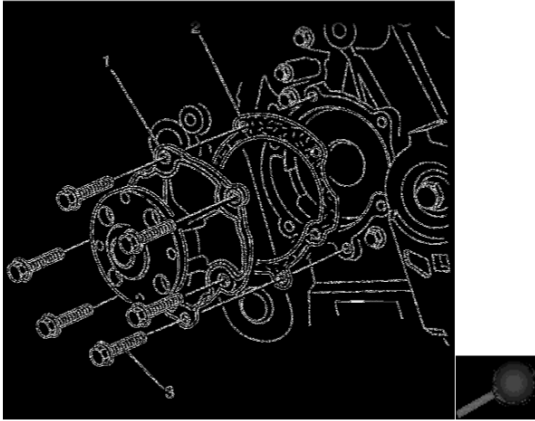
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10. Remove the water pump (1).
11. Remove the water pump gasket (2).
Discard the gasket.

Installation Procedure

Note: Make sure all mating surfaces are clean and free of grease.

1. Using a water sealant install the water pump and gasket to front engine cover.
2. Make sure all retaining bolts are clean and free of debris.

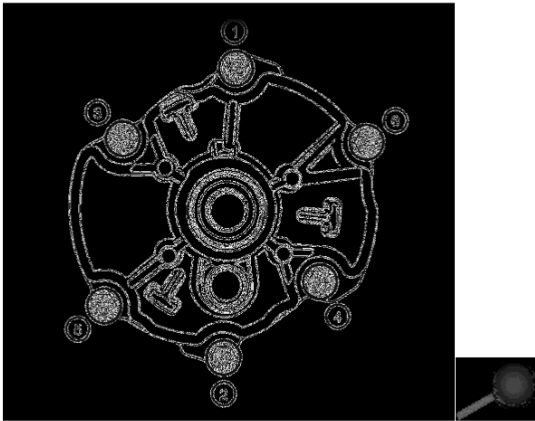


3. Install the water pump (1) and NEW gasket (2).

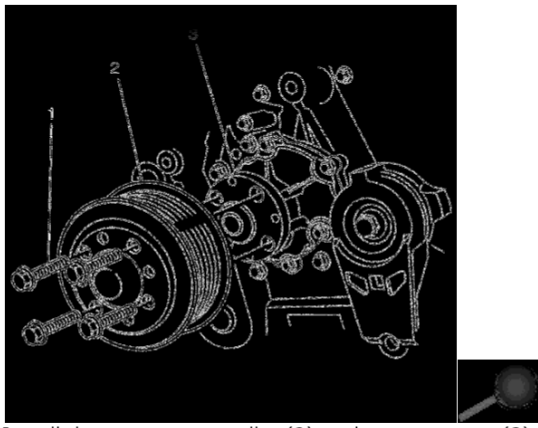
Caution: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

Caution: Refer to [Fastener Caution](#).

4. Install the NEW water pump bolts and hand tighten the water pump bolts.



5. Tighten the water pump bolts in sequence.
 - 5.1. On the initial pass, tighten the bolts in sequence to **10 N·m (89 lb in)**.
 - 5.2. On the second pass, tighten the bolts in sequence to **10 N·m (89 lb in)**.
 - 5.3. On the final pass, tighten the bolts in sequence shown an additional 45 degrees.



6. Install the water pump pulley (2) to the water pump (3)
7. Install the water pump pulley to water pump retaining bolts (1) and tighten to **10 N·m (89 lb in)**.
8. Install the drive belt. Refer to [Drive Belt Replacement](#).
9. Install the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
10. Install the engine cover. Refer to [Intake Manifold Sight Shield Replacement](#).
11. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
12. Fill cooling system. Refer to [Cooling System Draining and Filling](#).
13. Start engine and check for leaks.

Water Pump Replacement (V8)

Removal Procedure

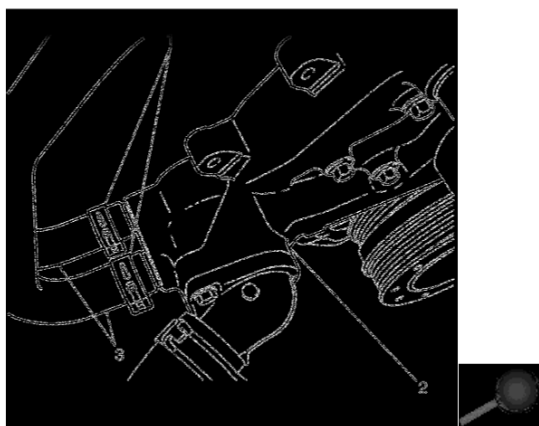
Note: The water pump is not a serviceable item and should be replaced as an assembly.

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
3. Remove the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
4. Remove the engine drive belt. Refer to [Drive Belt Replacement - Accessory](#).

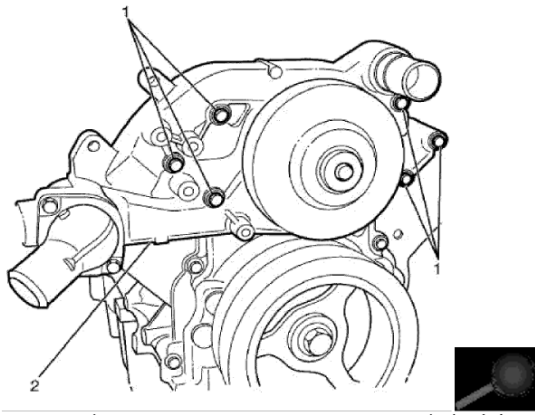
Warning: Refer to [Radiator Cap Removal Warning](#).

5. Remove the coolant pressure cap.
6. Detach the inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
7. Detach the outlet hose. Refer to [Radiator Outlet Hose Replacement](#).



8. Detach the heater hoses (1) from the water pump (2).
9. Remove drive belt tensioner. Refer to [Drive Belt Tensioner Replacement - Accessory](#).

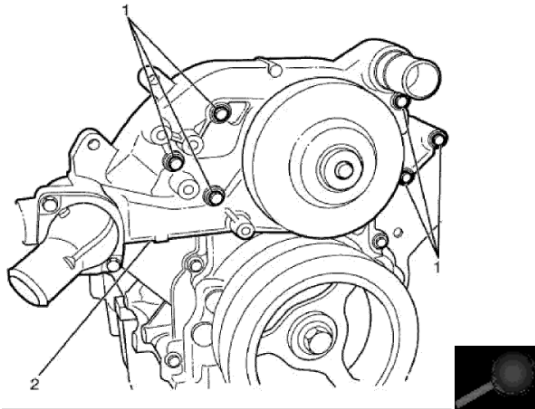
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10. Remove the water pump to engine retaining bolts (1).
- Note:** Use of a soft hammer will aid in the removal of the water pump (2).
11. Remove the water pump (2).
12. If replacing, remove the engine coolant thermostat housing and engine coolant thermostat. Refer to [Engine Coolant Thermostat Housing Replacement](#) and [Engine Coolant Thermostat Replacement](#).

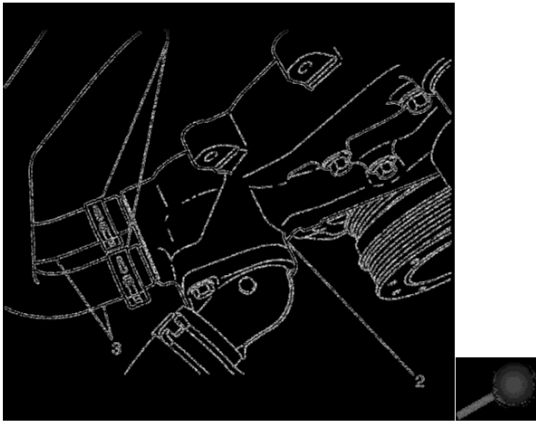
Installation Procedure

1. If required, install a NEW engine coolant thermostat and engine coolant thermostat housing. Refer to [Engine Coolant Thermostat Replacement](#) and [Engine Coolant Thermostat Housing Replacement](#).



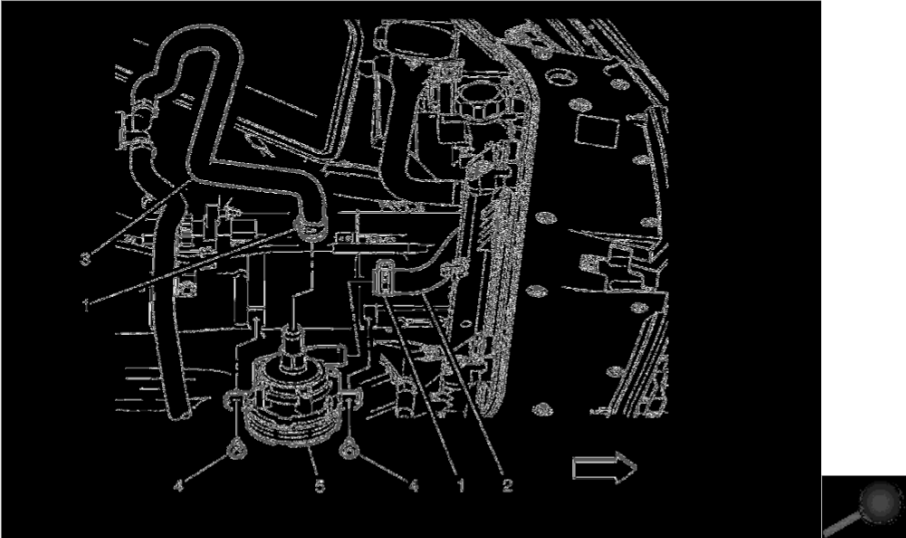
- Note:** Ensure all mating surfaces are clean and free of grease.
2. Insert two water pump to engine retaining bolts (1) at each end of the pump, place the new gasket of the bolts and use this as a guide to install the pump.
 3. Install the water pump (2).
 - Caution:** Refer to [Fastener Caution](#).
 4. Install and tighten the remaining water pump to engine retaining bolts (1) and tighten to **15N•m (11 lb ft)**.
Tighten the bolts at final pass to 30N•m (22 lb ft).
 5. Install drive belt tensioner. Refer to [Drive Belt Tensioner Replacement - Accessory](#).

6. Install the outlet hose to the water pump. Refer to [Radiator Outlet Hose Replacement](#).
7. Install the inlet hose to the water pump. Refer to [Radiator Inlet Hose Replacement](#).



8. Install the heater hoses (1) to the water pump (2).
9. Install the engine drive belt. Refer to [Drive Belt Replacement - Accessory](#).
10. Install the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
11. Install the ground battery lead to the vehicle. Refer to [Battery Negative Cable Disconnection and Connection](#).
12. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
13. Inspect cooling system for leaks.
14. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

Charge Air Cooler Coolant Pump Replacement (LSA)



Charge Air Cooler Coolant Pump Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement - Front . 2. Drain the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling . 3. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement . 4. Remove the mass air flow sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement . 5. To disconnect the charge air cooling (CAC) pump electrical connector, release the connector positive assurance clip (CPA) then using a needle nose pliers, depress the CPA while pulling down on the body of the connector until released from the CAC pump. Note: The connector positive assurance clip (CPA) must always be fully engaged to the charge air cooling (CAC) pump while the CAC pump is in operation. If the CPA will not engage, inspect the electrical connector and the CAC pump mating surface.	
1	Charge Air Cooler Coolant Hose Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Charge Air Cooler Coolant Inlet Hose to the Charge Air Cooler Radiator
3	Charge Air Cooler Coolant Inlet Pipe to Charge Air Cooler
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Callout	Component Name
4	Charge Air Cooler Coolant Pump Bracket Fastener (Qty: 2) Caution: Refer to Fastener Caution . Tighten 9 N•m (80 lb in)
5	Charge Air Cooler Coolant Pump and Bracket Procedure Install the charge air cooling pump electrical connector until an audible click is heard. Engage the CPA to secure the connection.

Radiator Drain Plug Replacement (LWR, LFX, LFW, LSA, LS3, L77)

[Replacement Procedure](#)

Warning: Refer to [Safety Glasses Warning](#).

Warning: Refer to [Radiator Cap Removal Warning](#).

1. Remove the filler cap.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

2. Raise and support the front of the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).



4. Remove the drain plug (1) from the radiator.

[Installation Procedure](#)

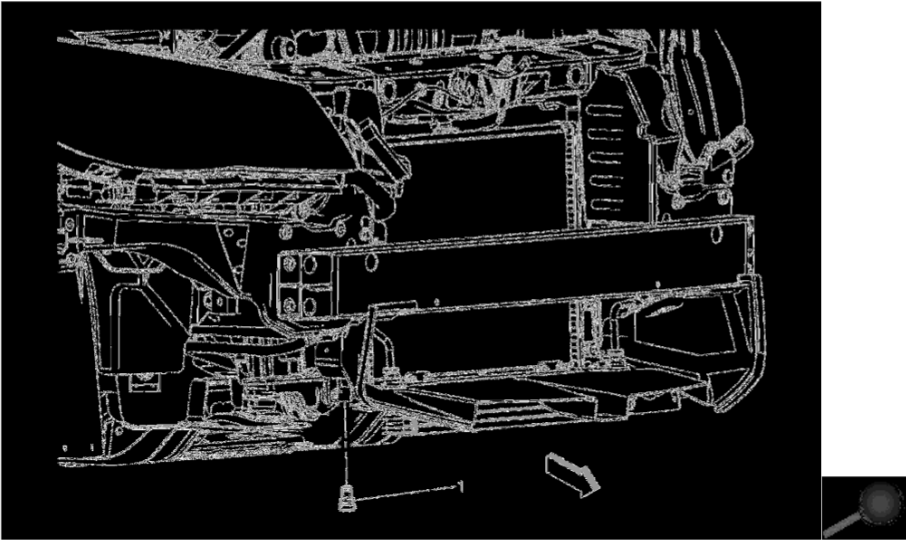


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Caution: Refer to [Fastener Caution](#).

1. Install the drain cock plug (1) to the radiator and tighten to **1.5 N·m (13 lb in)**.
2. Lower the vehicle.
3. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
4. Inspect the cooling system for leaks.

Charge Air Cooler Radiator Drain Plug Replacement (LSA)



Charge Air Cooler Radiator Drain Plug Replacement

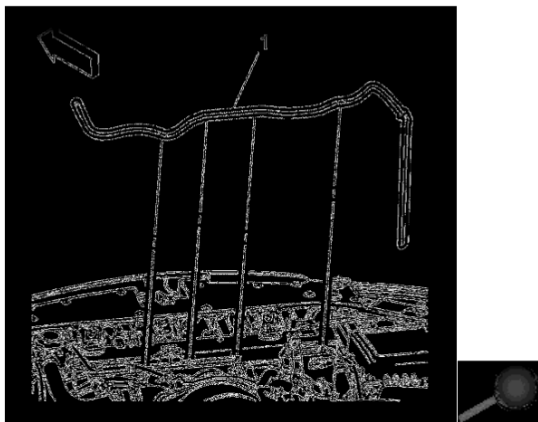
Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the radiator air inlet duct chute. Refer to Radiator Air Inlet Duct Replacement . 3. Place a drain pan under the charge air cooler radiator drain plug.	
1	Charge Air Cooler Radiator Drain Plug Caution: Refer to Fastener Caution . Procedure Fill the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling . Tighten 9.6N•m (89 lb in)

Engine Coolant Fan Shroud Replacement (LWR, LFX, LFW)

Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

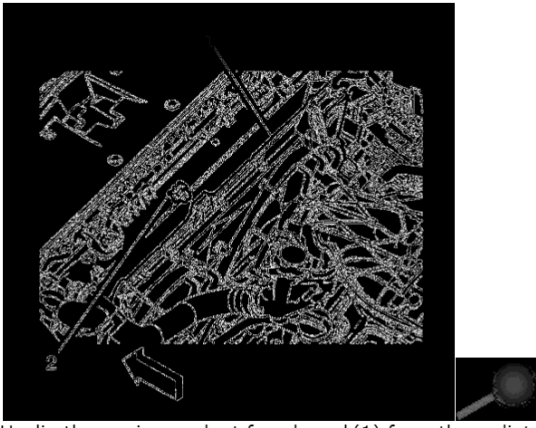
1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
3. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).



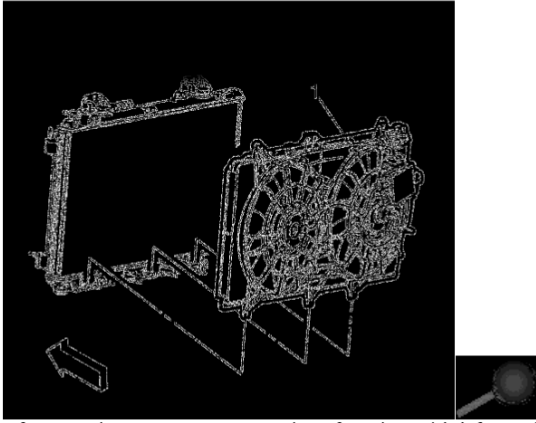
4. Remove the coolant recovery hose (1) from the engine coolant fan shroud retainers. Refer to [Coolant Recovery Reservoir Hose Replacement](#).
5. Remove the air bleed hose from the engine coolant fan shroud retainers. Refer to [Engine Coolant Air Bleed Hose Replacement](#).
6. Remove the radiator inlet hose from the radiator. Refer to [Radiator Inlet Hose Replacement](#).
7. Disconnect the electrical harness connector from the fan control module.



8. Remove the engine coolant fan shroud retaining bolts (1).

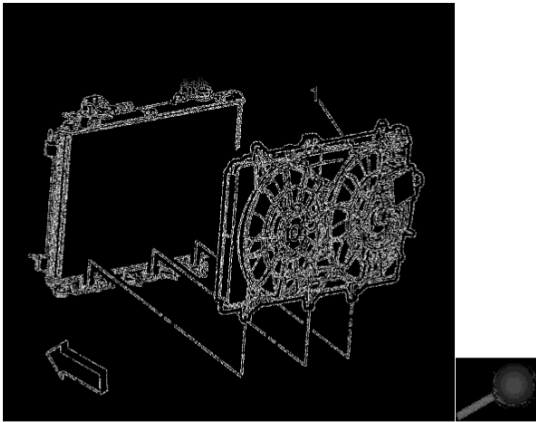


9. Unclip the engine coolant fan shroud (1) from the radiator retaining clip (2).

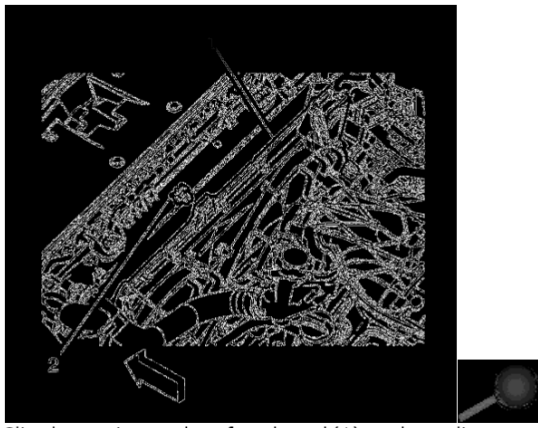


10. Lift up and remove engine coolant fan shroud (1) from the radiator.
11. Transfer components as necessary.

Installation Procedure



1. Install the engine coolant fan shroud (1) to the radiator.

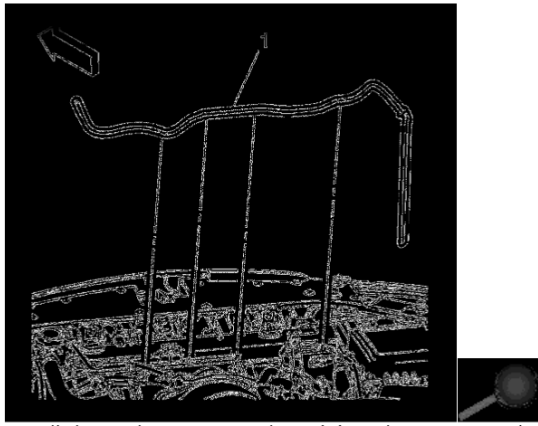


2. Clip the engine coolant fan shroud (1) to the radiator retaining clip (2).



Caution: Refer to [Fastener Caution](#).

3. Install the engine coolant fan shroud retaining bolts (1) and tighten to **5 N·m (44 lb in)**.
4. Connect the electrical harness connector to the fan control module.
5. Install the air bleed hose to the engine coolant fan shroud retainers. Refer to [Engine Coolant Air Bleed Hose Replacement](#).

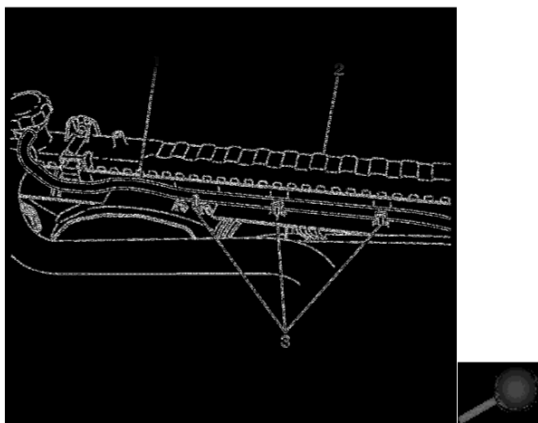


6. Install the coolant recovery hose (1) to the engine coolant fan shroud retainers. Refer to [Coolant Recovery Reservoir Hose Replacement](#).
7. Install the radiator inlet hose to the radiator. Refer to [Radiator Inlet Hose Replacement](#).
8. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
9. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
10. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
- Warning:** Refer to [Battery Disconnect Warning](#).
11. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
12. Start and run engine until the cooling fans are activated.
13. Inspect the cooling system for leaks.

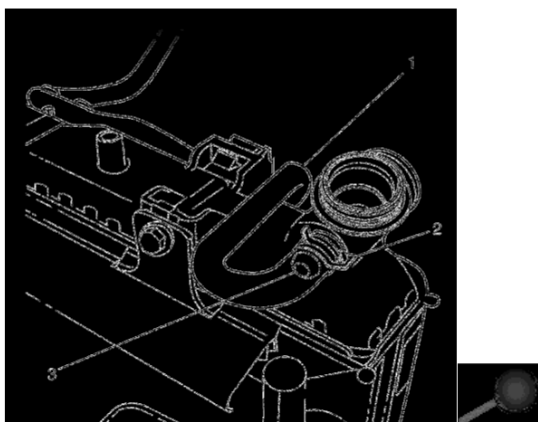
Engine Coolant Fan Shroud Replacement (LSA, LS3, L77)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
3. Remove the front intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).

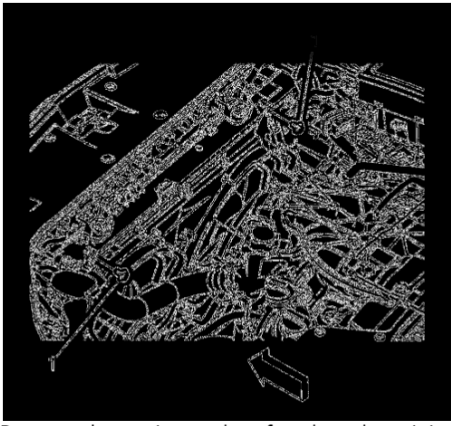


4. Remove the coolant recovery hose (1) from the engine coolant fan shroud retainers (3). Refer to [Coolant Recovery Reservoir Hose Replacement](#).

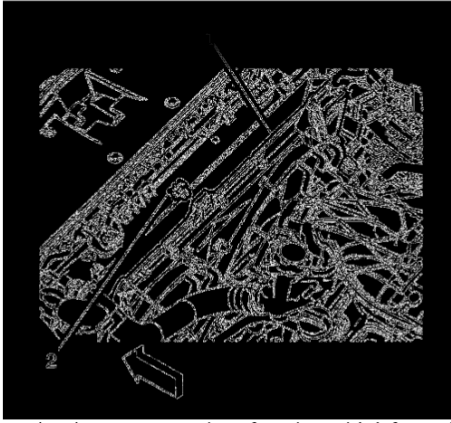


5. Remove the air bleed hose (1) from the radiator fill neck (3). Refer to [Engine Coolant Air Bleed Hose Replacement](#).
6. Remove the radiator inlet hose from the radiator. Refer to [Radiator Inlet Hose Replacement](#).
7. Disconnect the electrical harness connector from the fan control module.
8. Remove the transmission fluid cooler pipes from the engine coolant fan shroud if equipped.

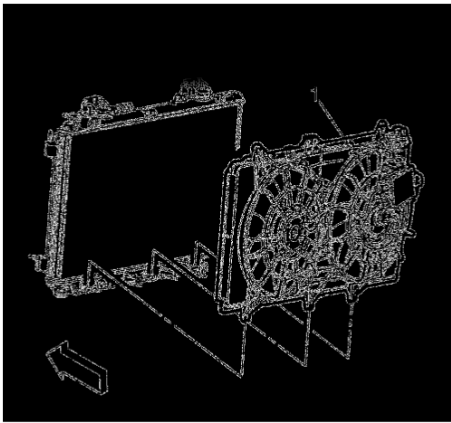
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9. Remove the engine coolant fan shroud retaining bolts (1).

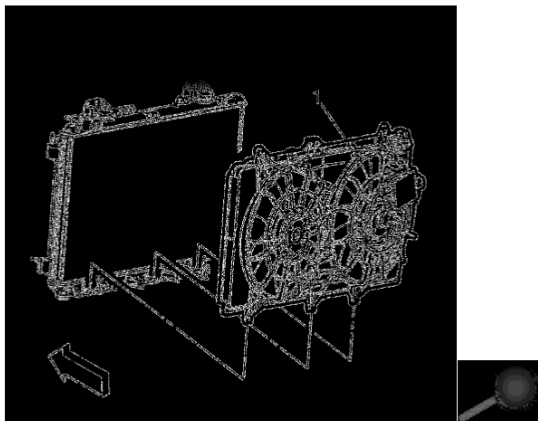


10. Unclip the engine coolant fan shroud (1) from the radiator retaining clip (2).

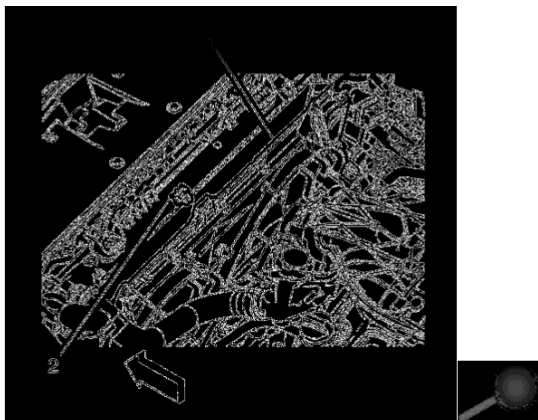


11. Lift up and remove engine coolant fan shroud (1) from the radiator.
12. Transfer components as necessary.

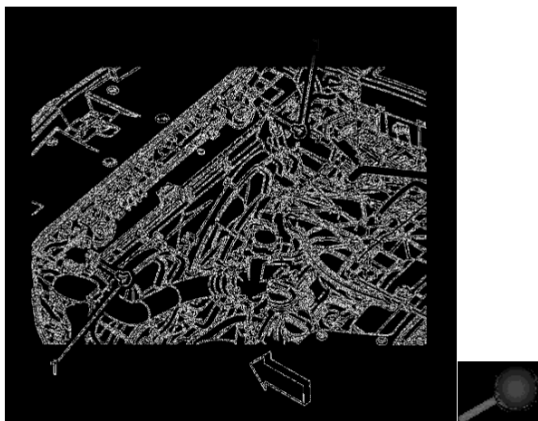
[Installation Procedure](#)



1. Install the engine coolant fan shroud (1) to the radiator.



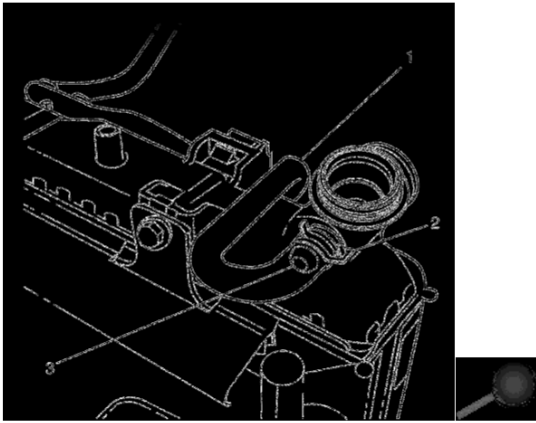
2. Clip the engine coolant fan shroud (1) to the radiator retaining clip (2).



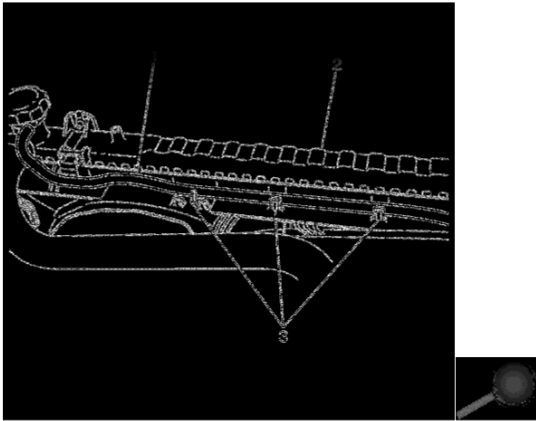
Caution: Refer to [Fastener Caution](#).

3. Install the engine coolant fan shroud retaining bolts (1) and tighten.
4. Install the transmission fluid cooler pipes to the engine coolant fan shroud if equipped.

5. Connect the electrical harness connector to the fan control module.
6. Install the radiator inlet hose to the radiator. Refer to [Radiator Inlet Hose Replacement](#).



7. Install the air bleed hose (1) to the radiator fill neck. Refer to [Engine Coolant Air Bleed Hose Replacement](#).



8. Install the coolant recovery hose (1) to the engine coolant fan shroud retainers (3). Refer to [Coolant Recovery Reservoir Hose Replacement](#).
9. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
10. Install the front intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
11. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
12. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
13. Start and run engine until the cooling fans are activated.
14. Inspect the cooling system for leaks.

Radiator Replacement (LWR, LFW, LFX, LSA, LS3, L77)

Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

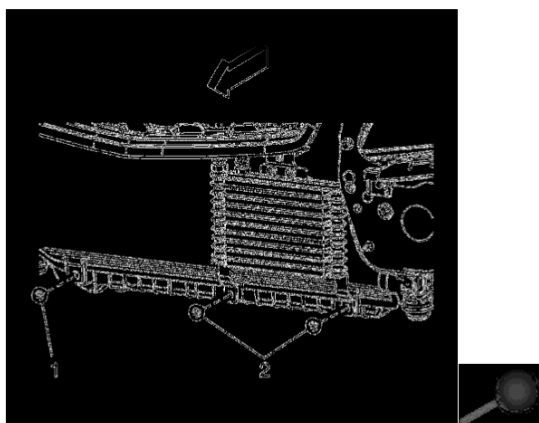
Warning: Refer to [Radiator Cap Removal Warning](#).

2. Ensure engine is below 50 C before removing the coolant pressure cap.
3. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).

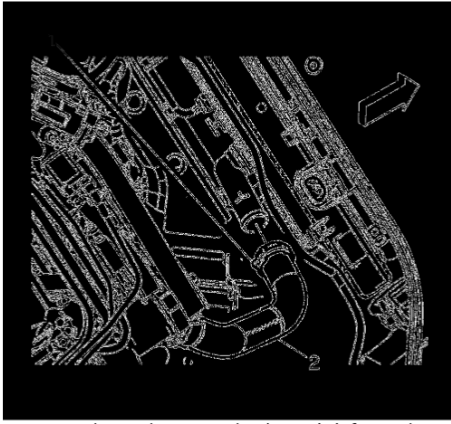
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

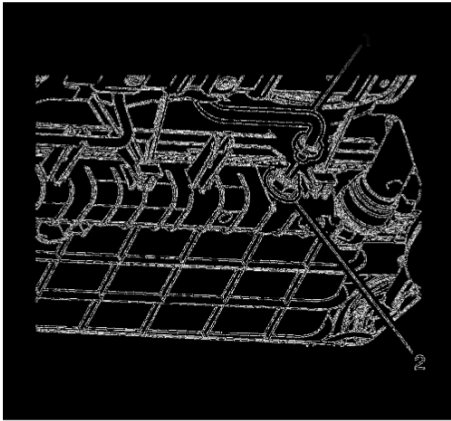
4. Raise and support vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).



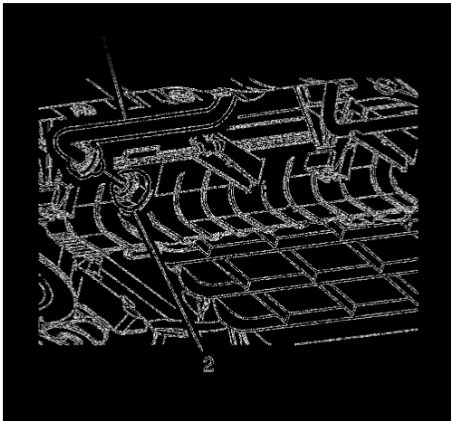
6. Remove the A/C condenser to radiator lower mounting fastener(s) (1). Refer to [Air Conditioning Condenser Replacement](#).
7. Remove the transmission fluid auxiliary cooler bracket to radiator lower mounting fasteners (2), if equipped. Refer to [Transmission Fluid Auxiliary Cooler Replacement](#).
8. Lower the vehicle.
9. Remove the radiator inlet hose from the radiator. Refer to [Radiator Inlet Hose Replacement](#).
10. Remove the engine coolant air bleed hose from the radiator. Refer to [Engine Coolant Air Bleed Hose Replacement](#).
11. Remove the engine coolant recovery reservoir hose from the radiator. Refer to [Coolant Recovery Reservoir Hose Replacement](#).
12. Remove the engine coolant fan shroud from the radiator. Refer to [Engine Coolant Fan Shroud Replacement](#).



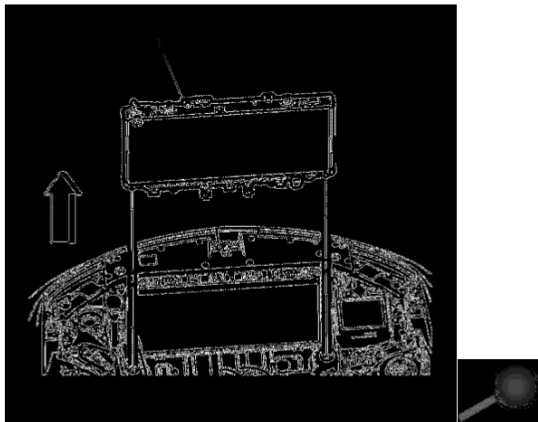
13. Remove the radiator outlet hose (2) from the radiator outlet pipe. Refer to [Radiator Outlet Hose Replacement](#).
14. Cap the fittings and plug the holes when removing the transmission fluid cooler pipes.



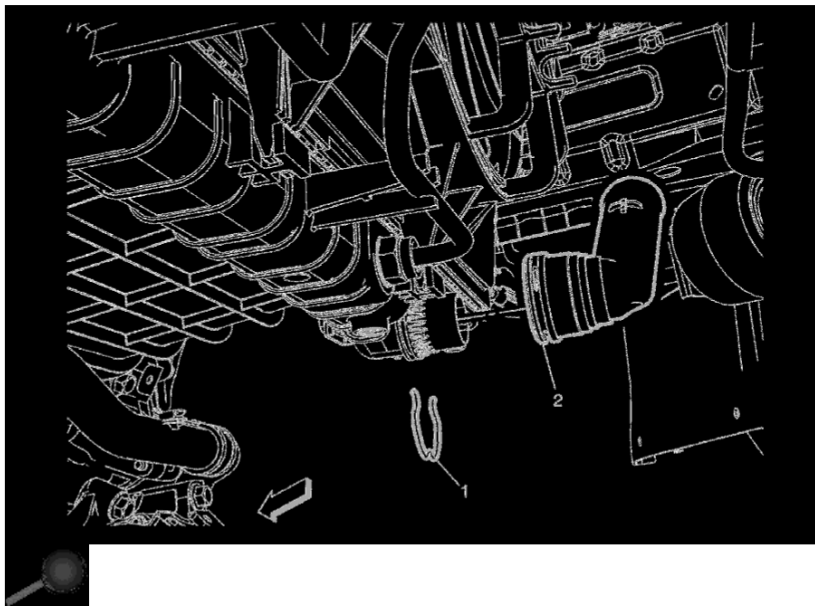
15. Remove the transmission fluid cooler inlet pipe (1) from the radiator. Refer to [Transmission Fluid Cooler Inlet Pipe Replacement](#).



16. Remove the transmission fluid cooler outlet pipe (1) from the radiator. Refer to [Transmission Fluid Cooler Outlet Pipe Replacement](#).
17. Remove the radiator upper mounts. Refer to [Radiator Upper Mount Replacement](#).
18. Support the A/C condenser and remove the two upper A/C condenser mounting bolts. Refer to [Air Conditioning Condenser Replacement](#).

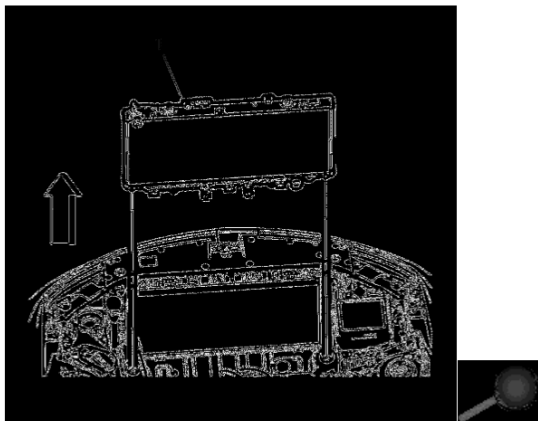


19. Tilt the radiator (1) rearward and lift up to remove the radiator out of the vehicle.

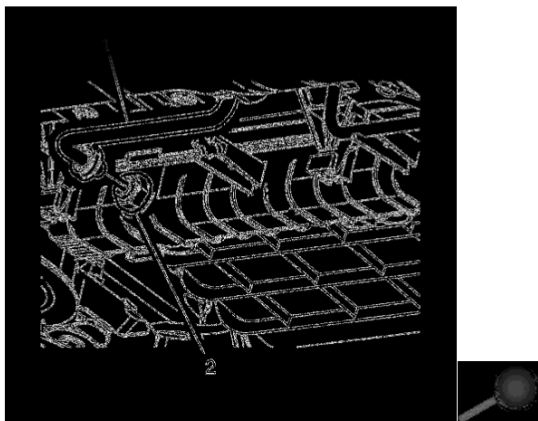


20. Transfer the radiator outlet pipe (2) to the new radiator. Refer to [Radiator Outlet Pipe Replacement](#).
21. Transfer all air guide seals to the new radiator.
22. Transfer the radiator lower insulators to the new radiator. Refer to [Radiator Lower Insulator Replacement](#).
23. Transfer components as necessary.

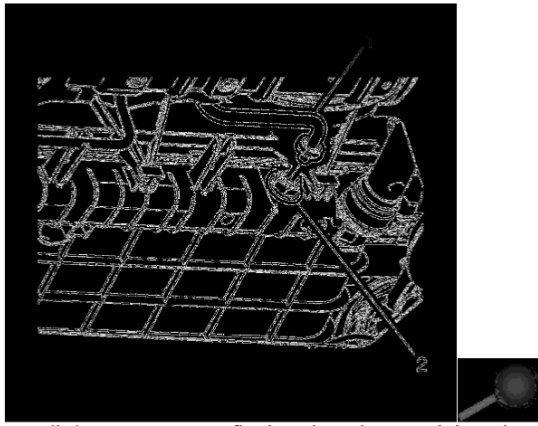
[Installation Procedure](#)



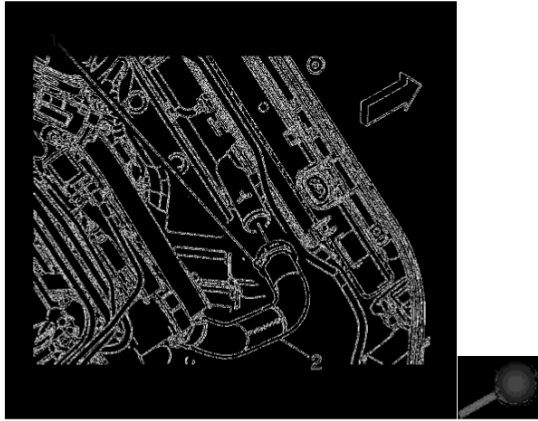
1. Install the radiator (1) into the lower radiator mounts.
2. Install the two upper A/C condenser mounting bolts. Refer to [Air Conditioning Condenser Replacement](#).
3. Install the radiator upper mounts. Refer to [Radiator Upper Mount Replacement](#).



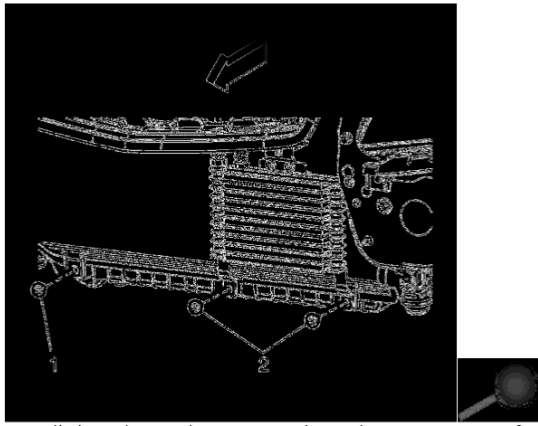
4. Install the transmission fluid cooler outlet pipe (1) to the radiator. Refer to [Transmission Fluid Cooler Outlet Pipe Replacement](#).



5. Install the transmission fluid cooler inlet pipe (1) to the radiator. Refer to [Transmission Fluid Cooler Inlet Pipe Replacement](#).

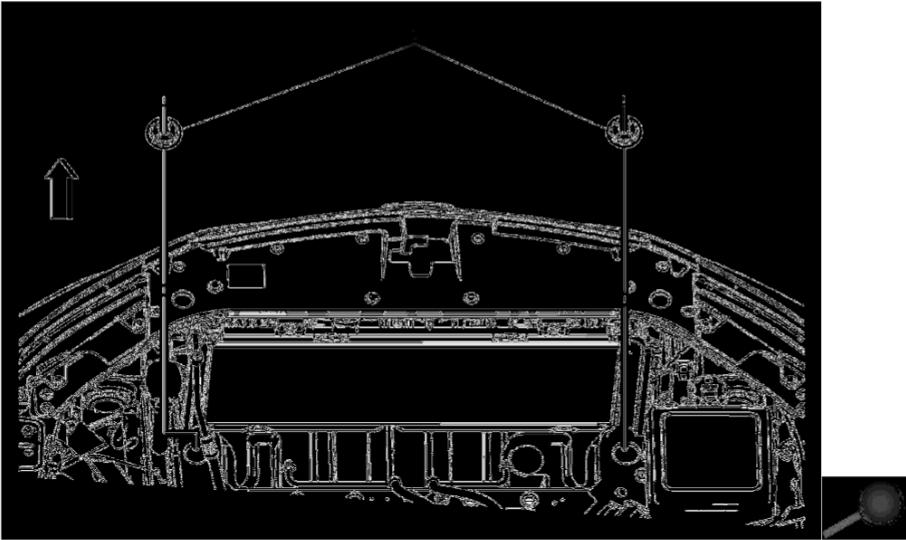


6. Install the radiator outlet hose (2) to the radiator outlet pipe. Refer to [Radiator Outlet Hose Replacement](#).
7. Install the engine coolant fan shroud to the radiator. Refer to [Engine Coolant Fan Shroud Replacement](#).
8. Install the radiator inlet hose to the radiator. Refer to [Radiator Inlet Hose Replacement](#).
9. Install the engine coolant recovery reservoir hose from the radiator. Refer to [Coolant Recovery Reservoir Hose Replacement](#).
10. Install the engine coolant air bleed hose to the radiator. Refer to [Engine Coolant Air Bleed Hose Replacement](#).
11. Raise and support vehicle. Refer to [Lifting and Jacking the Vehicle](#).



12. Install the A/C condenser to radiator lower mounting fastener(s) (1). Refer to [Air Conditioning Condenser Replacement](#).
13. Install the transmission fluid auxiliary cooler bracket to radiator lower mounting fasteners (2), if equipped. Refer to [Transmission Fluid Auxiliary Cooler Replacement](#).
14. Install the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).
15. Lower the vehicle.
16. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
17. Inspect cooling system for leaks.

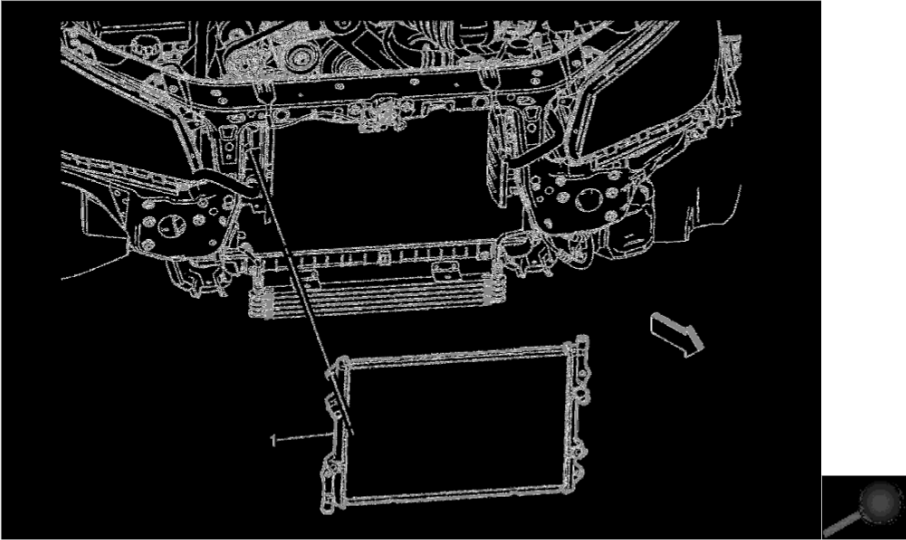
Radiator Lower Insulator Replacement (LWR, LFX, LFW, LSA, LS3, L77)



Radiator Lower Insulator Replacement

Callout	Component Name
Preliminary Procedure Remove radiator. Refer to Radiator Replacement .	
1	Radiator Lower Insulator (Qty: 2)

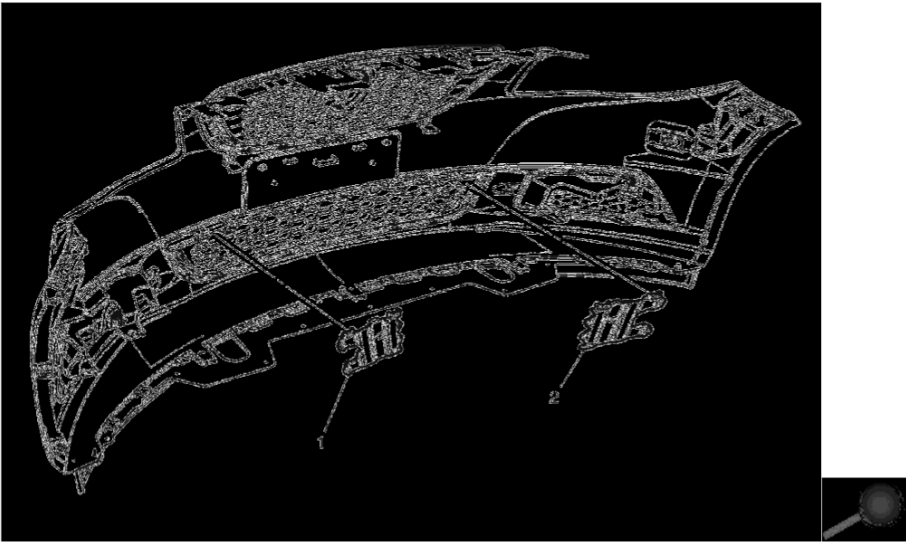
Charge Air Cooler Radiator Replacement (LSA)



Charge Air Cooler Radiator Replacement

Callout	Component Name
Preliminary Procedures 1. Drain the charge air cooling system. Refer to Charge Air Cooling System Draining and Filling . 2. Remove front bumper impact bar. Refer to Front Bumper Impact Bar Replacement . 3. Remove the lower radiator air inlet duct. Refer to Radiator Air Inlet Duct Replacement . 4. Remove the inlet and outlet charge air cooler coolant hoses from the charge air cooler radiator. Refer to Charge Air Cooler Coolant Hose Replacement . 5. Remove the lower charge air cooler bracket. Refer to Charge Air Cooler Bracket Replacement . 6. Remove the left and right upper charge air cooler brackets. Refer to Charge Air Cooler Bracket Replacement .	
1	Charge Air Cooler Radiator

Radiator Air Lower Baffle Replacement (Evoke)

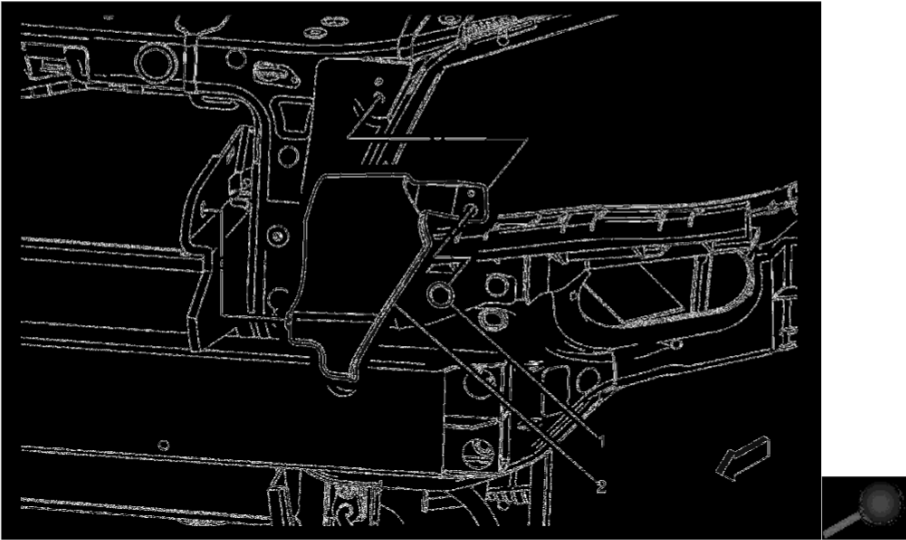


Radiator Air Lower Baffle Replacement

Callout	Component Name
Preliminary Procedure Remove front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Lower Baffle-Left Procedure Release the retaining tabs to remove.
2	Radiator Air Lower Baffle-Right Procedure Release the retaining tabs to remove.

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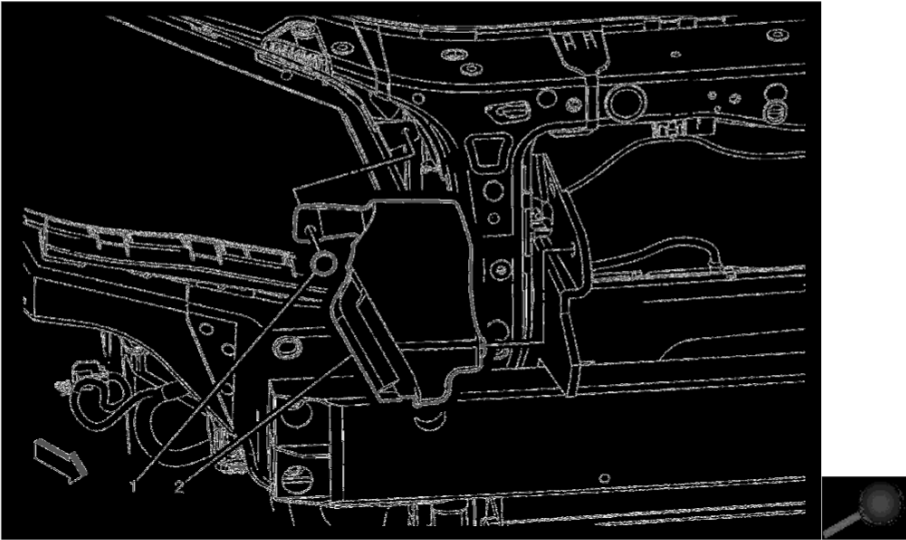
Radiator Air Upper Baffle and Deflector Replacement
(LWR, LFX, LFW, LSA, L77 Left Side)



Radiator Air Upper Baffle and Deflector Replacement

Callout	Component Name
Preliminary Procedure Remove front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Upper Baffle and Deflector Retainer
2	Radiator Air Upper Baffle and Deflector Procedure Detach the radiator air upper baffle and deflector from the radiator air inlet duct.

Radiator Air Upper Baffle and Deflector Replacement
(LWR, LFX, LFW, LSA, L77 Right Side)

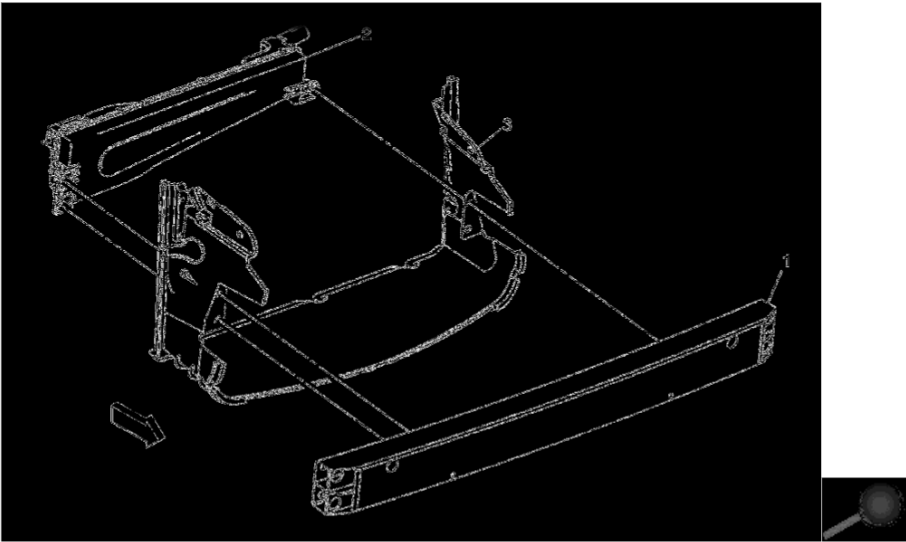


Radiator Air Upper Baffle and Deflector Replacement

Callout	Component Name
Preliminary Procedure Remove front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Upper Baffle and Deflector Retainer
2	Radiator Air Upper Baffle and Deflector Procedure Detach the radiator air upper baffle and deflector from the radiator air inlet duct.

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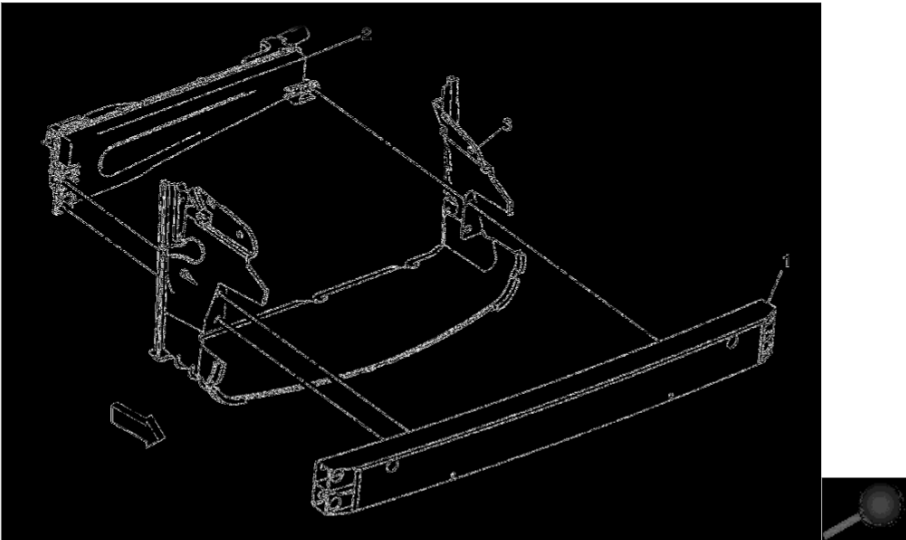
Radiator Air Inlet Duct Replacement (LWR, LFX, LFW)



Radiator Air Inlet Duct Replacement

Callout	Component Name
Preliminary Procedure 1. Remove front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Remove the radiator air upper baffle and deflectors. Refer to Radiator Air Upper Baffle and Deflector Replacement .	
1	Front Bumper Impact Bar Procedure Remove the front bumper impact bar. Refer to Front Bumper Impact Bar Replacement .
2	Windshield Washer Solvent Container Procedure Remove the windshield washer solvent container. Refer to Windshield Washer Solvent Container Replacement .
3	Radiator Air Inlet Duct

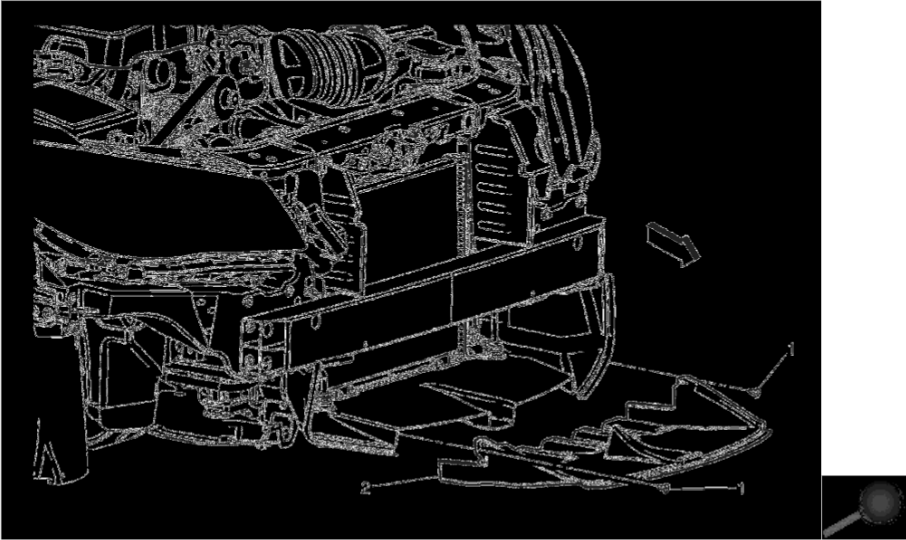
Radiator Air Inlet Duct Replacement (LS3, L77)



Radiator Air Inlet Duct Replacement

Callout	Component Name
Preliminary Procedure 1. Remove front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Remove the radiator air upper baffle and deflectors. Refer to Radiator Air Upper Baffle and Deflector Replacement . 3. Remove the ambient air temperature sensor. Refer to Ambient Air Temperature Sensor Replacement .	
1	Front Bumper Impact Bar Procedure Remove the front bumper impact bar. Refer to Front Bumper Impact Bar Replacement .
2	Windshield Washer Solvent Container Procedure Remove the windshield washer solvent container. Refer to Windshield Washer Solvent Container Replacement .
3	Radiator Air Inlet Duct

Radiator Air Inlet Duct Replacement (Chute LSA)

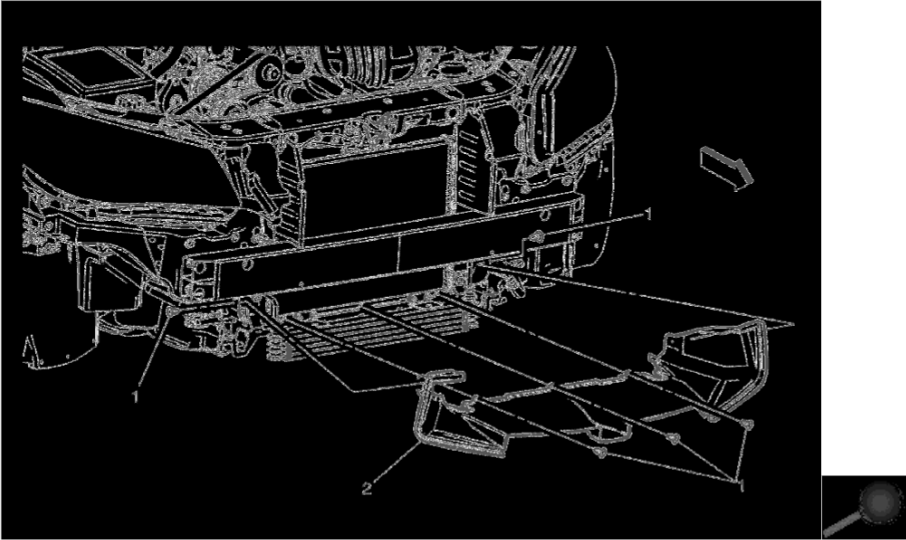


Radiator Air Inlet Duct Replacement

Callout	Component Name
Preliminary Procedure 1. Remove front bumper fascia. Refer to Front Bumper Fascia Replacement . 2. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle .	
1	Radiator Air Inlet Duct Chute Retainer (Qty: 2)
2	Radiator Air Inlet Duct Chute Procedure Clip the radiator air inlet duct chute to the lower air duct.

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Radiator Air Inlet Duct Replacement (Lower LSA)

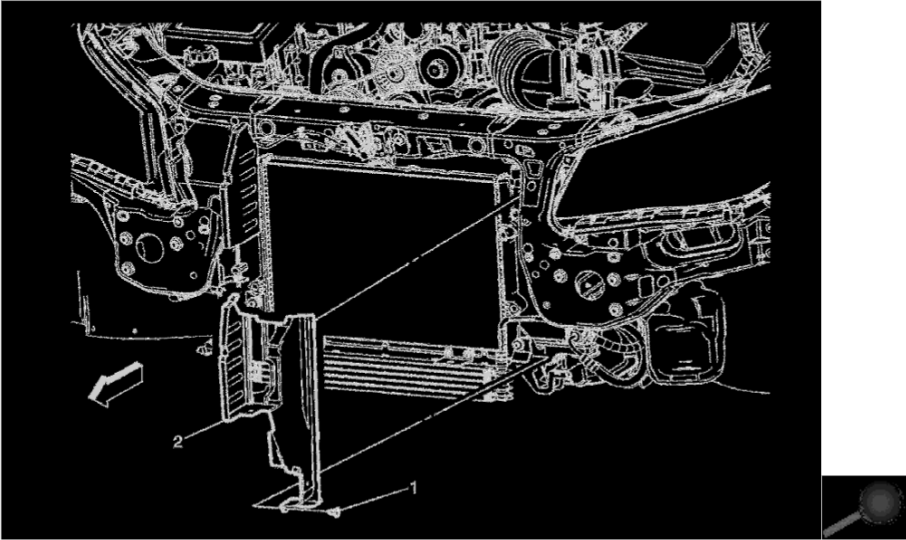


Radiator Air Inlet Duct Replacement

Callout	Component Name
Preliminary Procedure Remove the radiator air inlet duct chute. Refer to Radiator Air Inlet Duct Replacement .	
1	Radiator Air Inlet Duct Lower Retainer (Qty: 5)
2	Radiator Air Inlet Duct Lower

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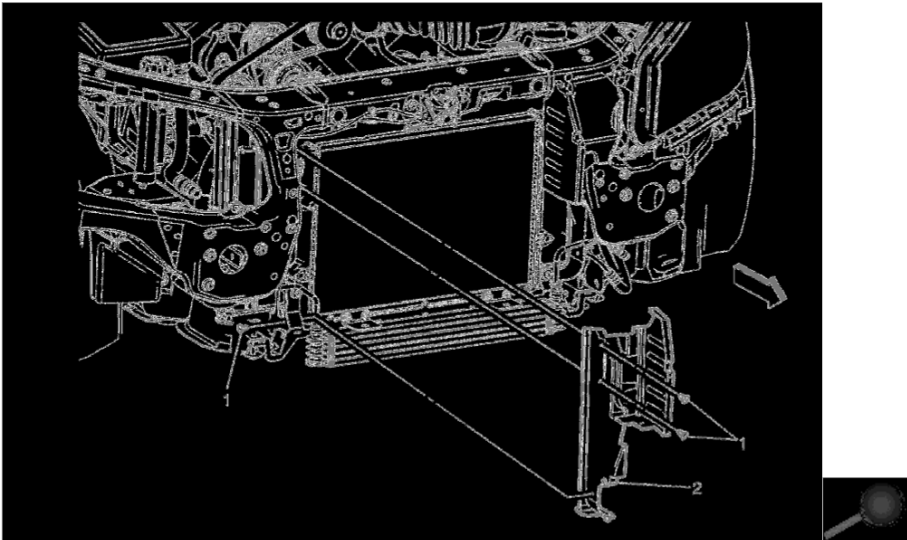
Radiator Air Inlet Duct Replacement (Left Hand LSA)



Radiator Air Inlet Duct Replacement

Callout	Component Name
Preliminary Procedure 1. Remove front bumper impact bar. Refer to Front Bumper Impact Bar Replacement . 2. Remove the left side radiator air upper baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement . 3. Remove the radiator air inlet duct lower. Refer to Radiator Air Inlet Duct Replacement . 4. Remove the left upper charge air cooler bracket. Refer to Charge Air Cooler Bracket Replacement . 5. Remove the inlet to charge air cooler radiator hose from the charge air cooler radiator. Refer to Charge Air Cooler Coolant Hose Replacement .	
1	Radiator Air Inlet Duct Retainer
2	Radiator Air Inlet Duct Left Hand

Radiator Air Inlet Duct Replacement (Right Hand LSA)



Radiator Air Inlet Duct Replacement

Callout	Component Name
Preliminary Procedure 1. Remove front bumper impact bar. Refer to Front Bumper Impact Bar Replacement . 2. Remove the right side radiator air upper baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement . 3. Remove the radiator air inlet duct lower. Refer to Radiator Air Inlet Duct Replacement . 4. Remove the right upper charge air cooler bracket. Refer to Charge Air Cooler Bracket Replacement . 5. Remove the outlet to charge air cooler radiator hose from the charge air cooler radiator. Refer to Charge Air Cooler Coolant Hose Replacement . 6. Remove the right headlight. Refer to Headlamp Replacement .	
1	Radiator Air Inlet Duct Retainer (Qty: 3)
2	Radiator Air Inlet Duct Right Hand

Fastener Tightening Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Auxiliary TOC Mounting Bolts	5 N•m	44 lb in
Charge Air Cooler Bracket Bolt	9 N•m	80 lb in
Condenser to Radiator Mounting Bolts	5 N•m	44 lb in
Coolant Recovery Reservoir Retaining Bolts	17 N•m	13 lb ft
Engine Coolant Air Bleed Pipe to Cylinder Head Retaining Bolts (V8)	12 N•m	106 lb in
Engine Coolant Fan Blade Retaining Nuts	6 N•m	53 lb in
Engine Coolant Fan Control Module Mounting Bolts	5 N•m	44 lb in
Engine Coolant Fan Motor Mounting Screws	4 N•m	35 lb in
Engine Coolant Inlet Pipe to Generator Bracket Retaining Nut	22 N•m	16 lb ft
Engine Coolant Inlet Pipe to Thermostat Housing Retaining Bolt	22 N•m	16 lb ft
Engine Coolant Thermostat Housing to Engine Block Retaining Bolts (V6)	10 N•m	89 lb in
Engine Coolant Thermostat Housing to Water Pump Retaining Bolt (V8)	14 N•m	10 lb ft
Engine Oil Cooler Pipe Fastener	9 N•m	80 lb in
Engine Oil Cooler Pipe/Hose Quick Connect Fitting	75 N•m	55 lb ft
Fan Shroud to Radiator Mounting Bolts	5 N•m	44 lb in
Heater Pipe Assembly to Cylinder Head Retaining Bolt (V6)	35 N•m	26 lb ft
Heater Pipe Assembly to Thermostat Housing Retaining Bolt (V6)	9 N•m	80 lb in
Radiator Drain Plug	1.5 N•m	13 lb in
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Application	Specification	
	Metric	English
Radiator Upper Mount Bolt	9 N•m	80 lb in
Water Outlet Housing Retaining Bolts (V6)	10 N•m	89 lb in
Water Pump Retaining Bolts (V8)		
• First Pass	15 N•m	11 lb ft
• Final Pass	30 N•m	22 lb ft
Water Pump Retaining Bolts (V6)		
• First Pass	10 N•m	89 lb in
• Second Pass	10 N•m	89 lb in
• Final Pass	45 Degrees	
Water Pump Pulley Retaining Bolts (V6)	10 N•m	89 lb in
1. Use NEW fastener.		

Adhesives, Fluids, Lubricants, and Sealers

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
Extended Life Coolant Leak Detection Dye	Dye	89022219	89022220
DEX-COOL	Coolant	12346290	10953464

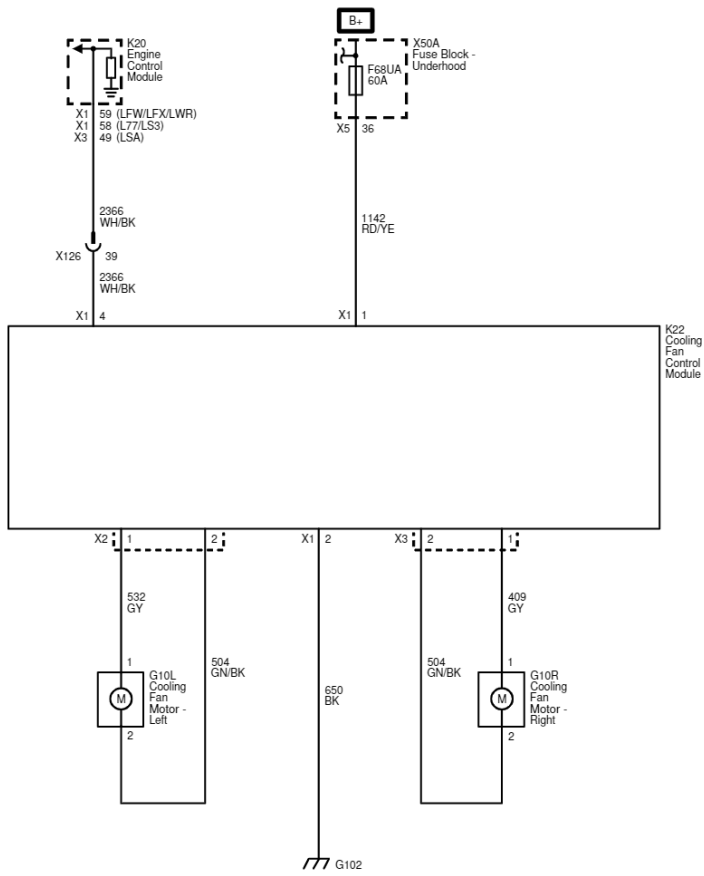
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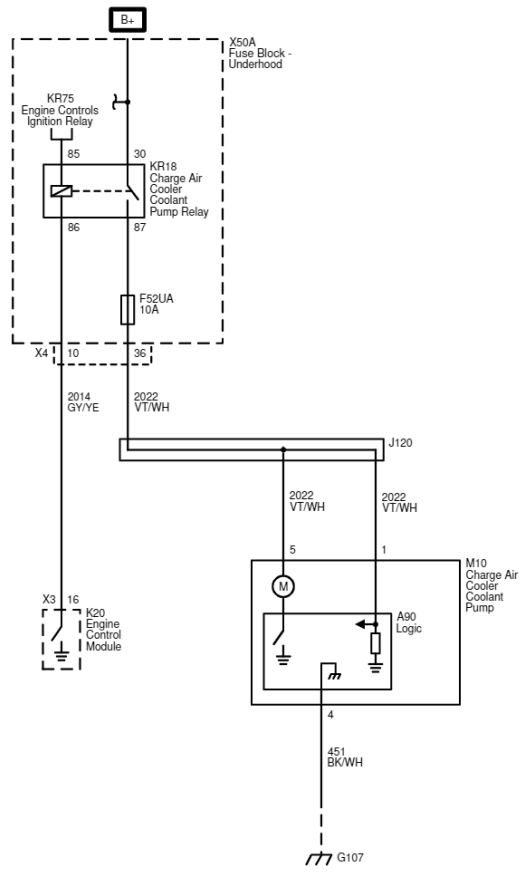
Engine Heating/Cooling Schematics

Figure 1: [Engine Cooling](#)

Figure 2: [Charge Air Cooling Coolant Pump \(LSA\)](#)

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Special Tools

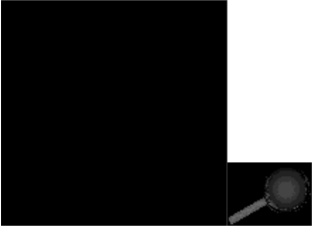
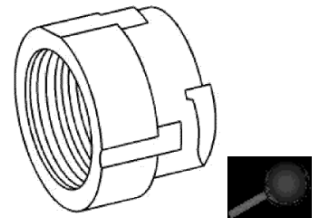
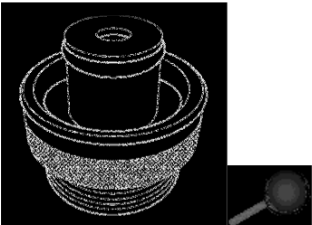
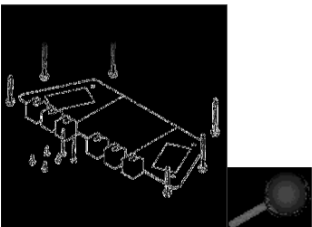
Illustration	Tool Number/ Description
	BO 38185 J 38185 Hose Clamp Pliers
	EL 35616-F Connector Test Adapter
	EN 471-A KM 471 Pressure Tester Adapter
	EN 6327-A KM 6327-A Cooling System Test Adapter
	EN 48536 Frame Support Tool (Engine Lower 65 mm Kit)

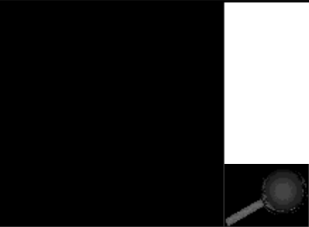
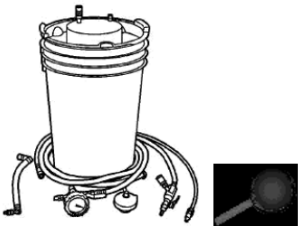
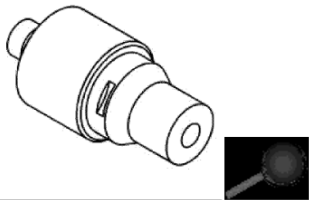
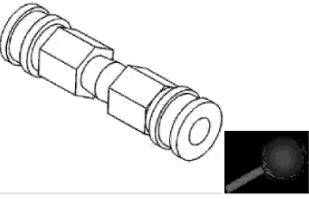
Illustration	Tool Number/ Description
	EN 24460-A J 24460-A Cooling System Pressure Tester
	GE 24731 J 24731 Tempil Stick
	GE 26568 J 26568 Coolant and Battery Fluid Tester
	GE 42401 J 42401 Radiator Cap and Surge Tank Test Adapter
	GE 47716 Vac N Fill Coolant Refill Tool
	GE 47716-20 Cooling System Refill Adapter

Illustration	Tool Number/ Description
	
	GE 50389 Coolant Pressure Test Quick Connector