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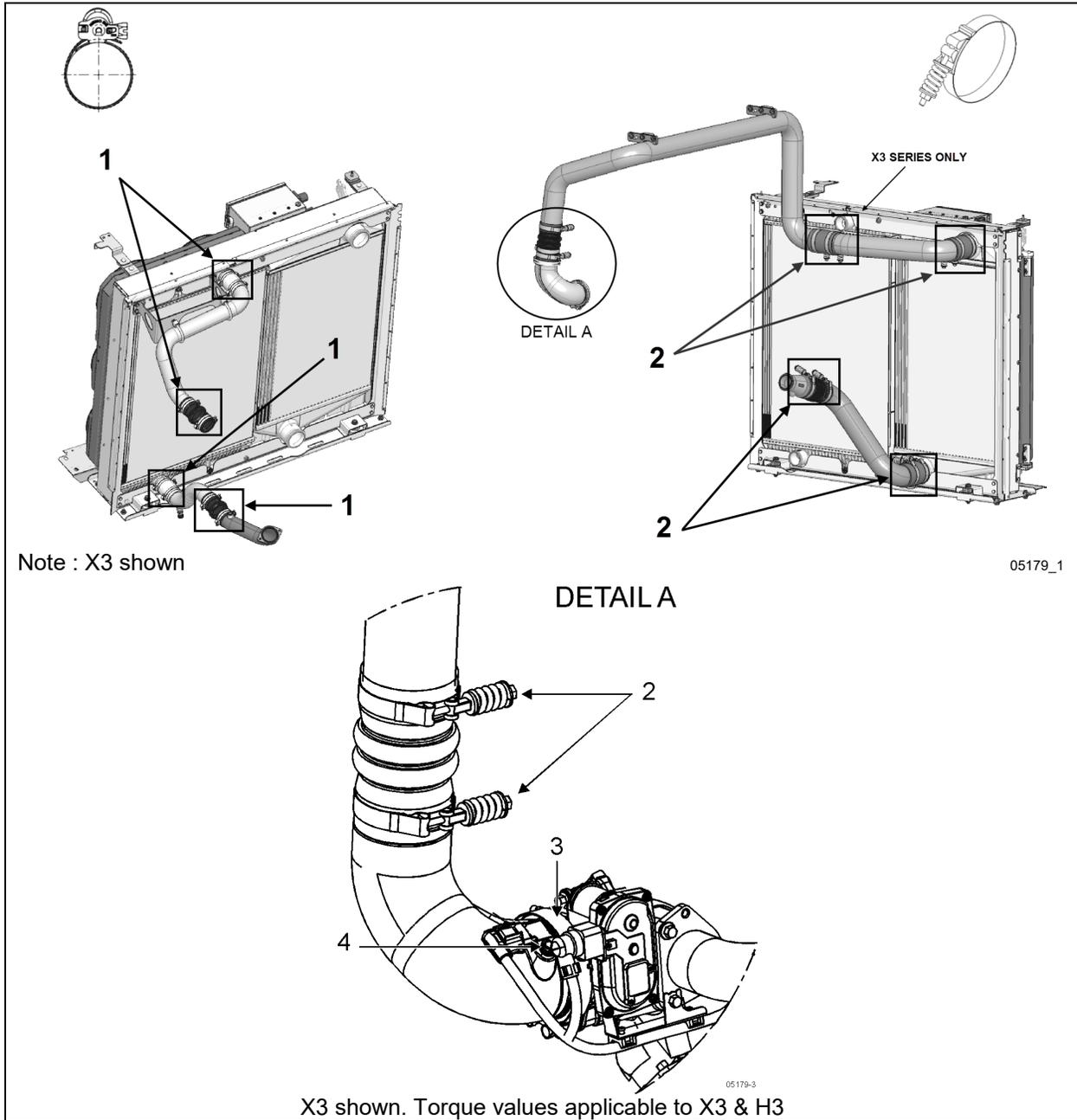
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**SECTION CHANGE LOG**

DESCRIPTION		DATE
1	Section 05A & 05B merged - intro H3 Series NEA & Electric Fans	Jan 2018
2	Addition of paragraph 3.2: coolant filter housing shut-off valve – spindle servicing	Apr 2018
3	New X3 Series recovery tank and CAC clamps torque values	June 2018
4	New component torque value added – CAC air temp sensor	Feb 2019
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6		

1. TORQUE TABLES

1.1 HOSE CLAMPS

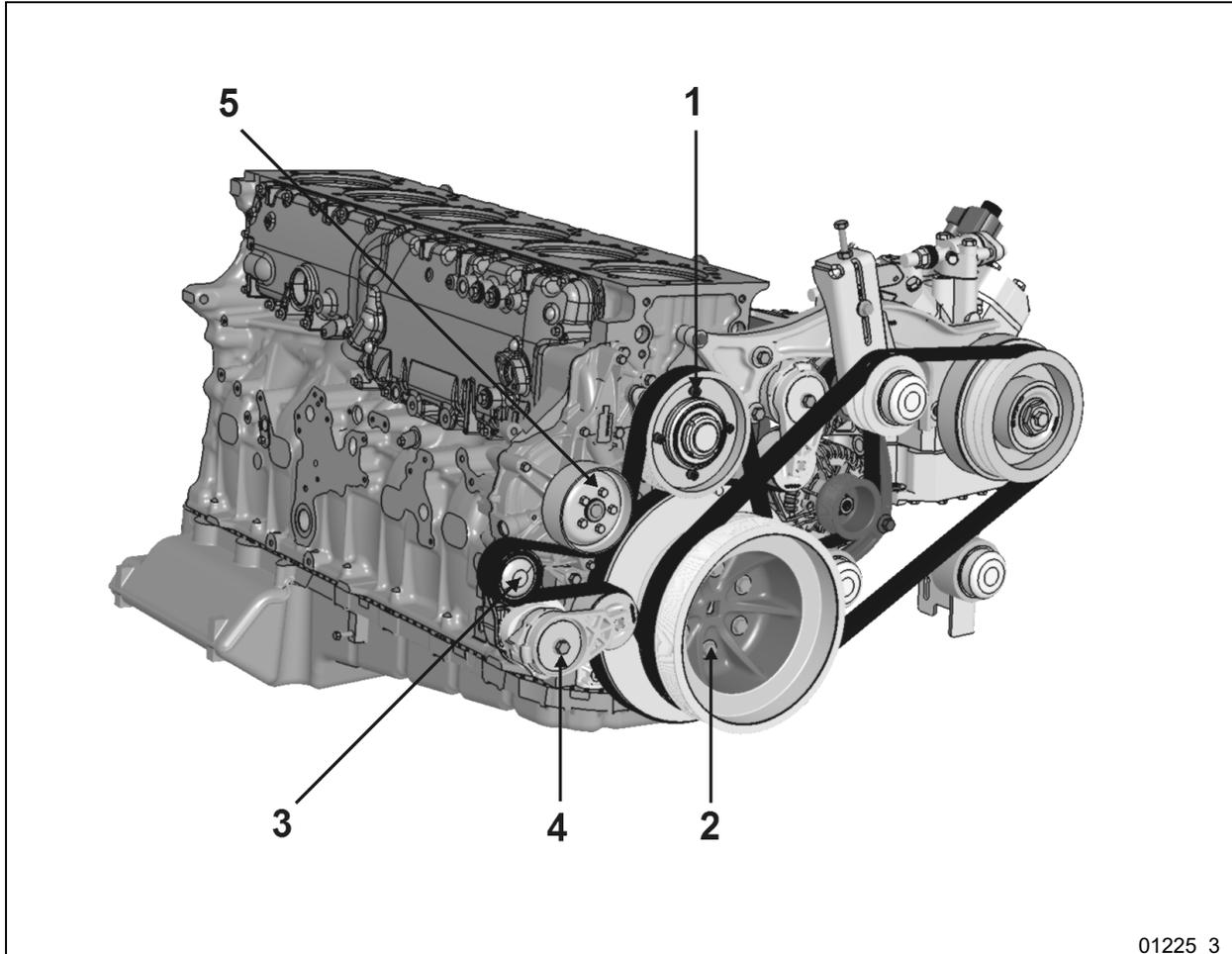


HOSE CLAMPS		
No	DESCRIPTION	TORQUE
1	Hose clamps - coolant lines (2.5 in O.D)	30 lb-in (3.39 Nm)
2	Constant-torque hose clamps - charge air cooler (CAC)	4.5-5.5 lb-ft (6.1-7.46 Nm)

## SECTION 05: COOLING SYSTEM

3	Intake elbow - V-clamps (both)	4.5-6 lb-ft (6.1-8.13 Nm)
4	Screw, CAC air temperature sensor	5.3-6.5 lb-ft (7-9 Nm)

### 1.2 PULLEYS, IDLERS & TENSIONERS

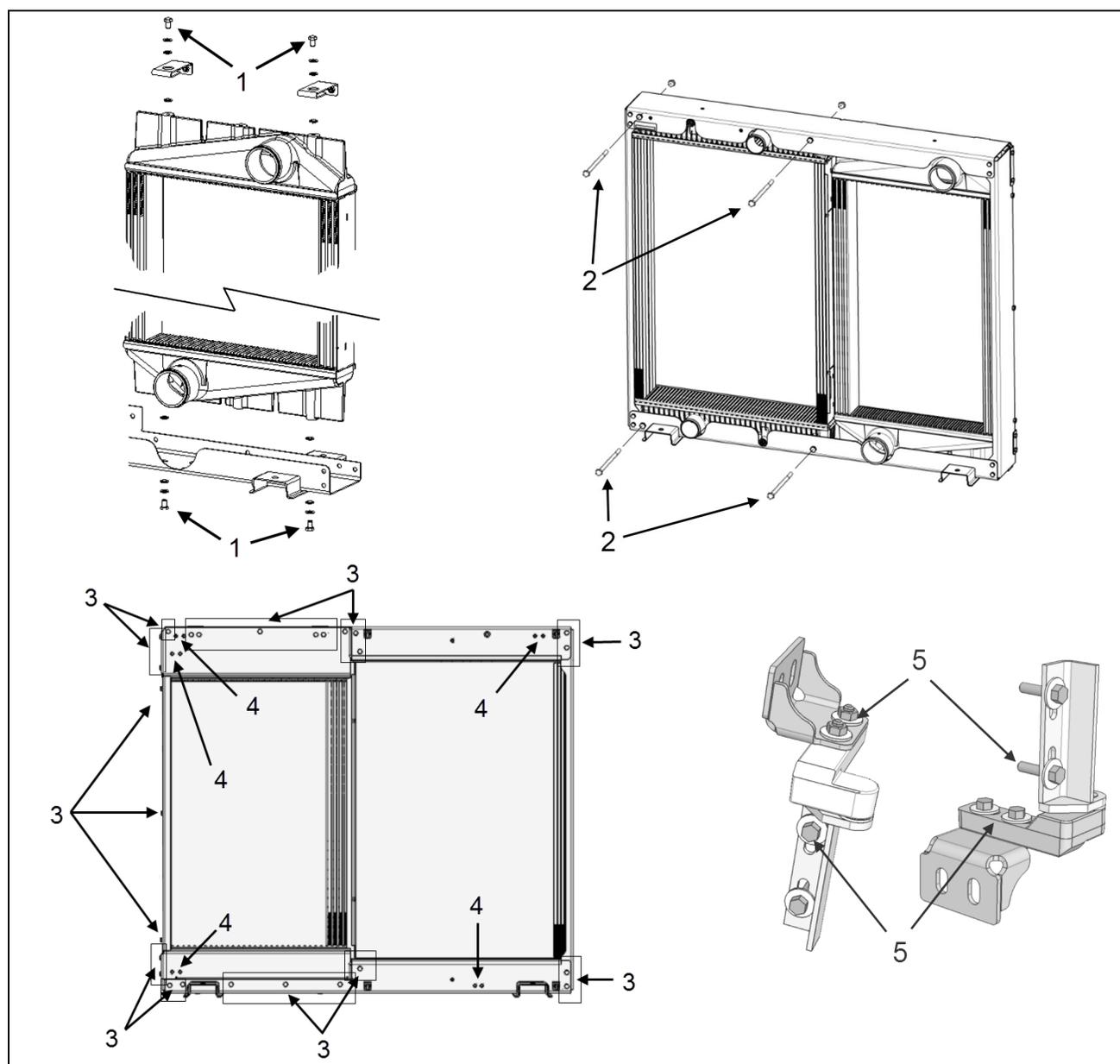


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#### PULLEYS, IDLERS & TENSIONERS

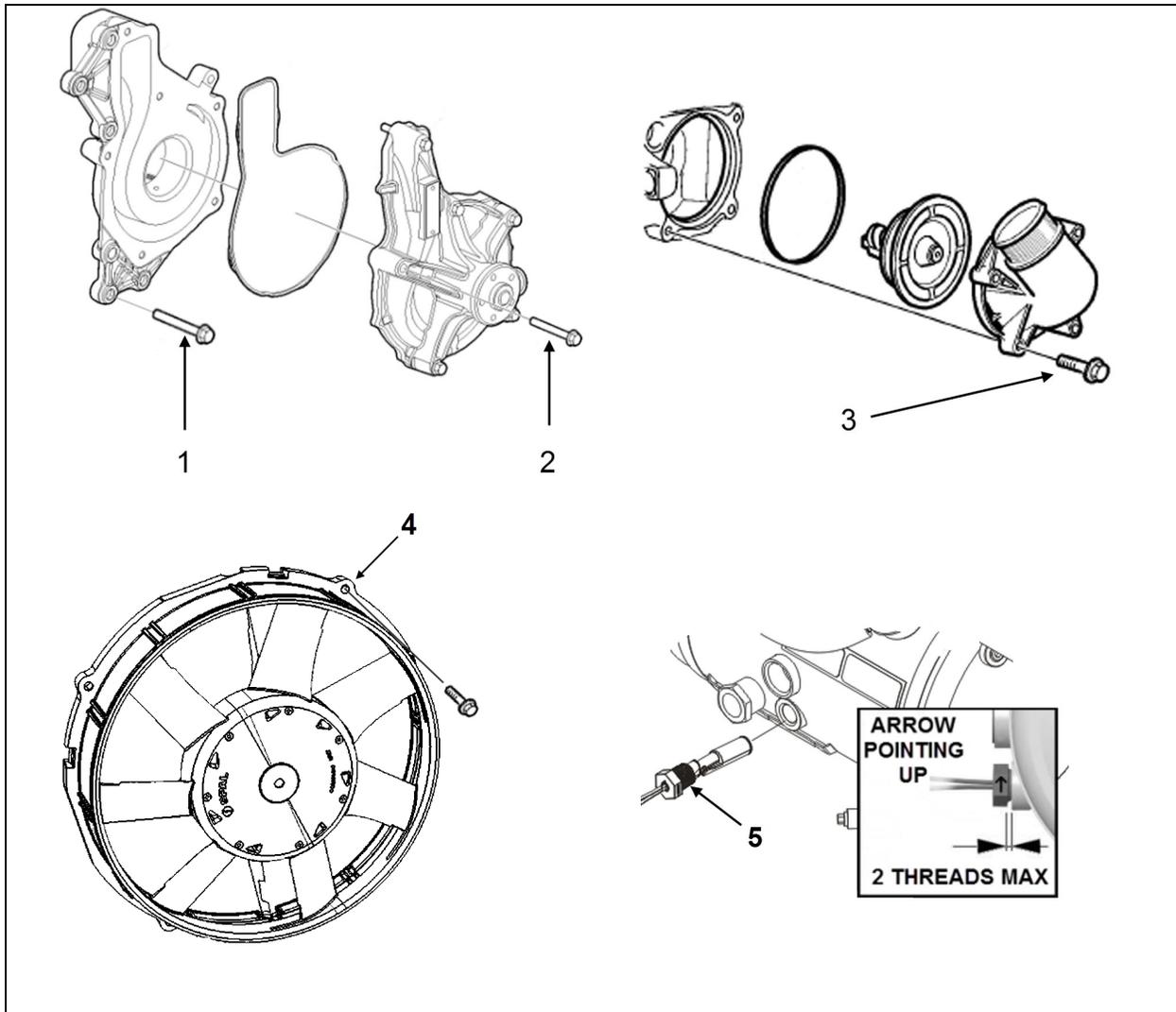
No	DESCRIPTION	TORQUE
1	Water pump idler pulley bolts	16 lb-ft (22 Nm)
2	Crank pulley bolts	22 lb-ft (30 Nm)
3	Idler bolt – water pump	43 lb-ft (58 Nm)
4	Automatic belt tensioner bolt – water pump	48 lb-ft (65 Nm)
5	Water pump pulley	18 lb-ft (24 Nm)

## 1.3 COOLING ASSEMBLY

**COOLING ASSEMBLY**

No	DESCRIPTION	TORQUE
1	CAC upper & lower mounting bolts (with plastic bushings)	9 lb-ft (12 Nm)
2	Radiator to cooling pack frame mounting bolts (pass through)	9 lb-ft (12 Nm)
3	Cooling pack frame bolts (all 8mm bolts – both sides)	9 lb-ft (12 Nm)
4	Brackets, fan shroud hinge, shroud support & upper support	9 lb-ft (12 Nm)
5	Fan shroud hinge bolts (upper & lower)	68 lb-in (8 Nm)

1.4 MISCELLANEOUS



MISCELLANEOUS		
No	DESCRIPTION	TORQUE
1	Water pump - Back cover to engine	29-41 lb-ft (39-56 Nm)
2	Water pump - body to back cover	15-21 lb-ft (20-28 Nm)
3	Thermostat housing bolts	15-21 lb-ft (20-28 Nm)
4	Electric cooling fan mounting bolts	30 lb-in (3 Nm)
5	Coolant level sensor (arrow on side must point up)	2 Threads out MAX*

\* Add Teflon – PTFE sealant to threads

## 2. DESCRIPTION

A radiator and variable speed electric cooling fans are used to effectively dissipate the heat generated by the engine. A charge air cooler (CAC) mounted next to the radiator is also used to cool the compressed air flow coming from the turbocharger before it reaches the engine intake. All components, along with the fans' circuit breaker box, are grouped together and mounted on the L.H. side of the engine compartment to form an easy to access and service "cooling assembly".



### WARNING

#### WHEN THE ENGINE IS RUNNING

Cooling fans may activate at any moment.  
Keep hands away from cooling fans or keep the radiator door closed.



### WARNING

**Cooling fans may be running when the engine is shut down in the following conditions:**

- If a High Exhaust Temperature condition exists (e.g. following regeneration).
- During "Motor Test" sequence.

An engine mounted centrifugal water pump is used to circulate the engine coolant in the cooling circuit. The pump works in conjunction with a full blocking-type thermostat positioned in the water outlet passage, controlling the coolant flow and providing fast engine warm-up and regulated coolant temperature.

The engine coolant is drawn from the lower portion of the radiator by the water pump and is forced through the transmission cooler before going through the oil cooler and into the cylinder block.

From the cylinder block, the coolant passes up through the cylinder head and, when the engine is at normal operating temperature, it goes through the thermostat housing and into the upper portion of the radiator. The coolant then passes through a series of tubes where its heat is dissipated by airstreams created by the revolving fans and the motion of the vehicle.

Upon starting a cold engine or when the coolant is below normal operating temperature, the closed thermostat directs coolant flow from the thermostat housing through the by-pass tube to the water pump. Coolant is recirculated through the engine to aid engine warm up.

When the thermostat opening temperature is reached, coolant flow is divided between the radiator inlet and the by-pass tube. When the thermostat is completely open, all of the coolant flow is to the radiator inlet.

The H3 Series cooling system is filled with a funnel through a pressure & filler cap on the surge tank, the cap is also used to maintain pressure within the system. When system exceeds normal pressure rating (14 psi - 96.53 kPa), the cap releases air and if necessary, coolant through the overflow tube (Figure 3). On the X3 Series, the cap is also present on the surge tank to act as a pressure cap, but the fill cap is on the top of a plastic recovery tank located next to the surge tank (Figure 2). The thermostat is located in the housing bolted to the engine on the L.H. side.



### WARNING

On X3-Series vehicles ***do not open the surge tank pressure cap unless a large amount of liquid must be added.*** Always use the recovery tank fill cap to add coolant to the vehicle during normal operation (level check).



### WARNING

On X3 Series vehicles, the system pressure must be relieved using the pressure relief valve.

**Never open the surge tank pressure cap without making sure first that the system is completely depressurized.** Coolant under pressure (hot or not) may cause serious injuries and eyes damages.

### NOTE

*Close the valve after releasing the pressure.*

The engine cooling system also provides hot coolant for the vehicle heating system. Refer to section 22, "HEATING AND AIR CONDITIONING" in this manual for information relating to heating system water circulation.

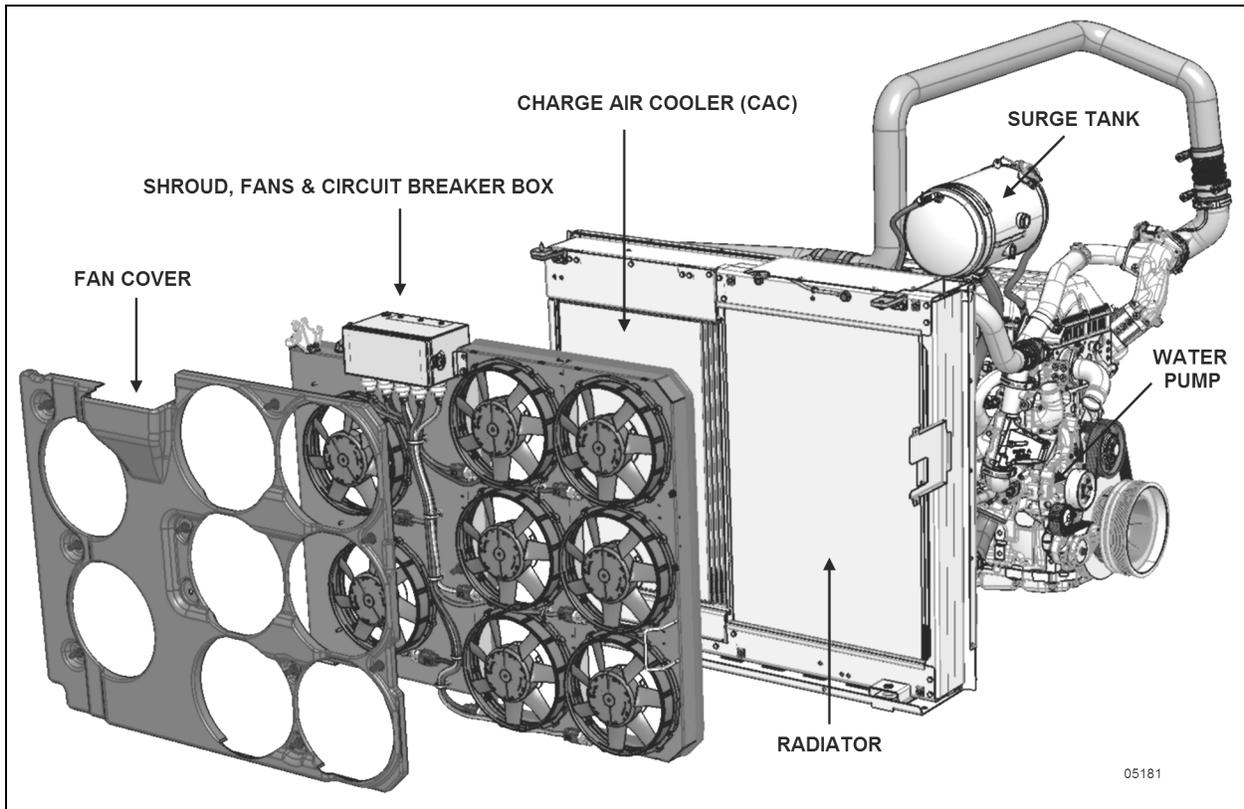


FIGURE 1: COOLING ASSEMBLY & RELATED COMPONENTS (X3 SERIES SHOWN)

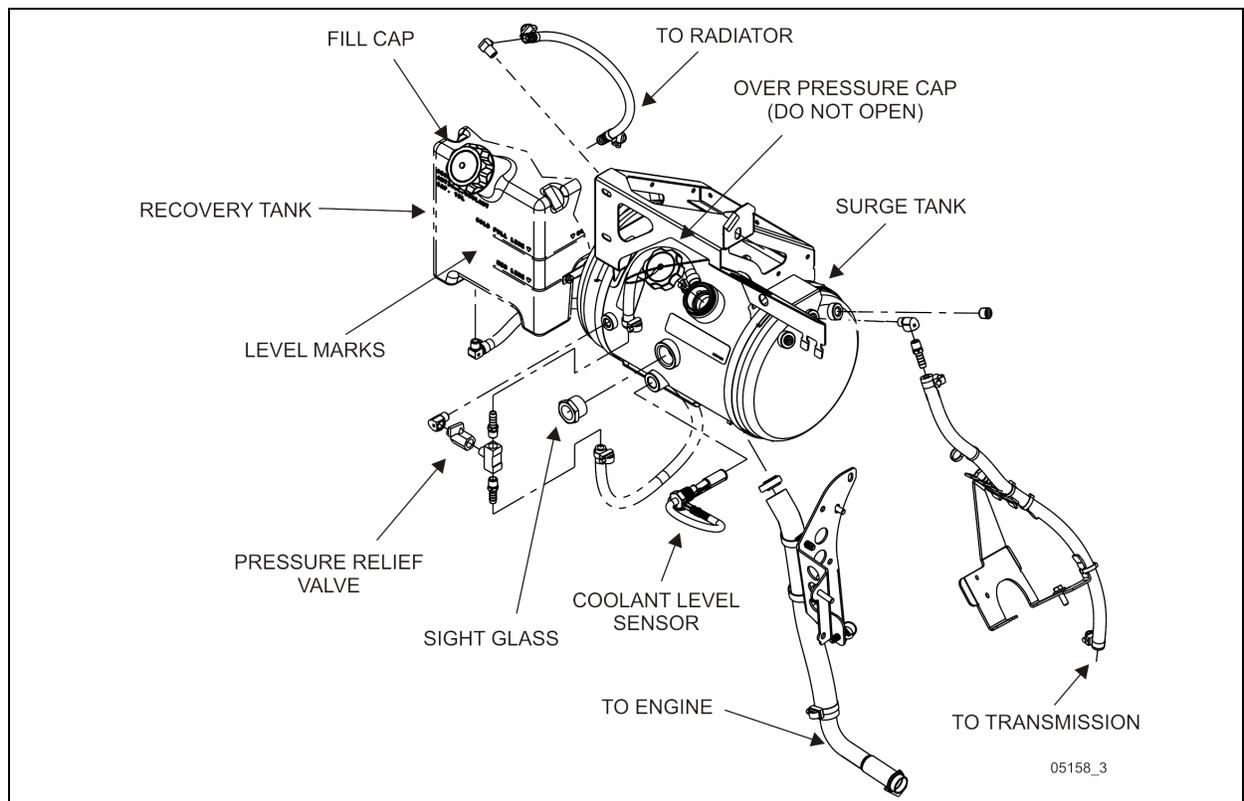


FIGURE 2: COOLANT SURGE TANK AND RECOVERY TANK ON X3 SERIES VEHICLES

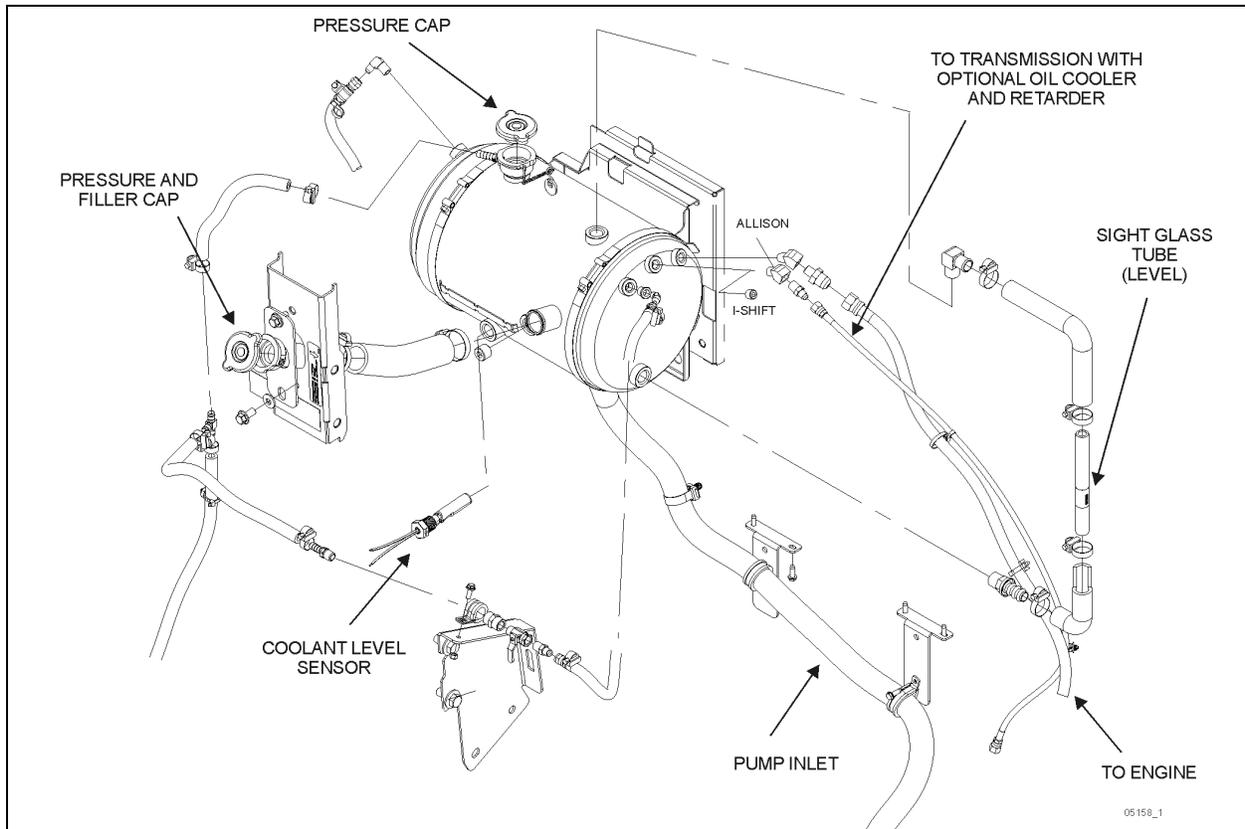


FIGURE 3: COOLANT SURGE TANK ON H3 SERIES VEHICLES

### 3. MAINTENANCE

#### 3.1 GENERAL RECOMMENDATIONS

A systematic routine inspection of cooling system components is essential to ensure maximum engine and heating system efficiency.

- Check coolant level in the surge/recovery tank daily, and correct if required. Test antifreeze strength.
- Check water pump belt and replace if frayed or badly worn.
- Check radiator cores for leaks and make sure the cores are not clogged with dirt or insects. To avoid damaging the fins, clean cores with a low-pressure air hose. Steam clean if required.
- Inspect the water pump operation. A leaky pump sucks in air, increasing corrosion.
- Repair all leaks promptly. Unrepaired leaks can lead to trouble. Inspect and tighten

radiator mounts periodically. Test and replace thermostat regularly.

#### NOTE

*In order to ensure the integrity of the system, it is recommended that a periodic cooling system pressure check be made. Pressurize the cooling system to 103-138 kPa (15-20 psi) using Radiator and Cooling System Tester, J24460-1. Do not exceed 138 kPa (20 psi).*

*Any measurable drop in pressure may indicate a leak. Whenever the oil pan is removed, the cooling system should be pressure checked as a means of identifying any incipient coolant leaks. Make sure the cause of the internal leak has been corrected before flushing the contaminated system.*



#### CAUTION

Hoses and hose connections should be clean and free of oil and grease before hose clamp installation. **Do not use** soap, lubricant or sealing compound on hose connections.

**NOTE**

For additional information concerning Volvo D13 engine components or engine-related components, consult Volvo Trucks Canada or Volvo Trucks North America Web site under: *Parts & Service*. On Volvo web site, you will find detailed service procedures for parts replacement, repair and maintenance.

### 3.2 COOLANT FILTER HOUSING SHUT-OFF VALVE – SPINDLE SERVICING

Seizing of the spindle in the coolant filter housing (Figure 4) could prevent proper operation of the valve. With proper cleaning, the application of a silicone-based lubricant to the groove in the spindle, and cycling the valve at regular intervals will prevent the buildup of corrosion in the coolant filter housing. Follow this spindle servicing and repair procedure.

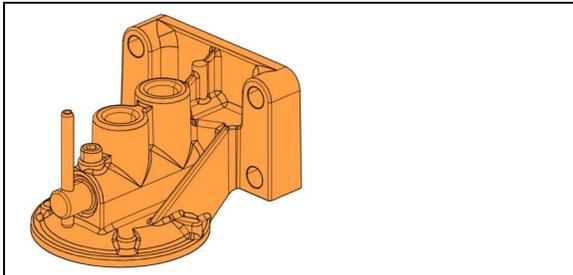


FIGURE 4: COOLANT FILTER HOUSING

1. Park the vehicle on a level surface. Apply the parking brake and place the transmission in neutral.
2. Turn the ignition switch to the OFF position.
3. On the engine compartment rear start panel (Figure 5), push the **engine stop/ignition interlock** button to prevent the engine from being started.

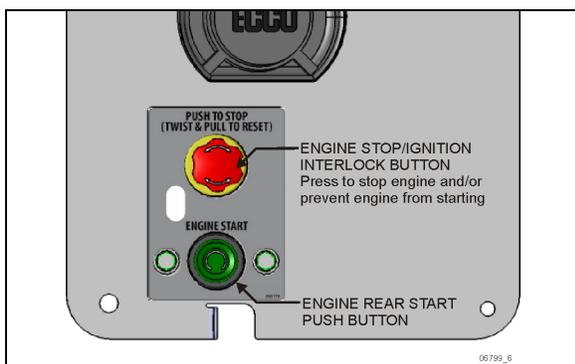


FIGURE 5: REAR START PANEL

4. Drain the coolant from the engine. Refer to **DRAINING COOLING SYSTEM** in this section.

#### Shut-off valve corrosion repair procedure

5. Place a spill container under the engine coolant filter housing.
6. Loosen the M5 hex socket screw (1) in the coolant filter housing (3) until it clears the groove in the spindle (2) (Figure 6).

*Note: This is the groove the M5 hex socket screw sets in when the coolant filter housing is fully assembled.*

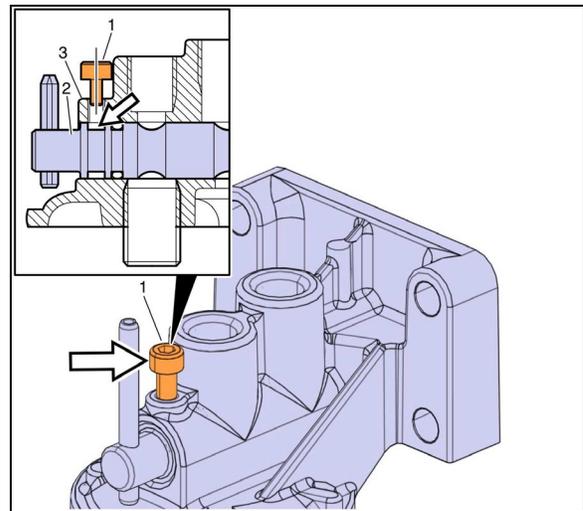


FIGURE 6: M5 HEX SOCKET SCREW

7. Extract the spindle (2) from the coolant filter housing (3).

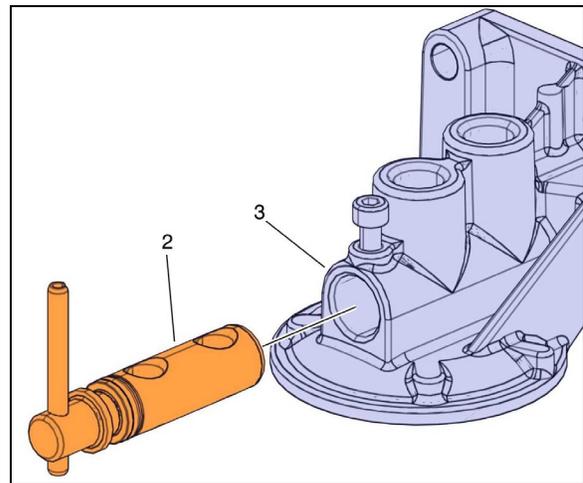


FIGURE 7: SPINDLE

8. Gently scrape by hand and remove any loose debris or corrosion from the spindle and coolant filter housing using an abrasive cleaning pad (Figure 8).

**Note:** Do not allow any corrosion or solid contaminants to fall into the filter housing.

**Note:** When cleaning is required **DO NOT** use power tools or grinders to clean the areas covered with corrosion. This could damage the parts beyond repair.

**Note:** Inspect the O-ring (4) in the spindle (2) for damaged due to corrosion or during removal. Replace the O-ring using part number 968725 if needed. Replace the spindle using part number 3979940 if needed.

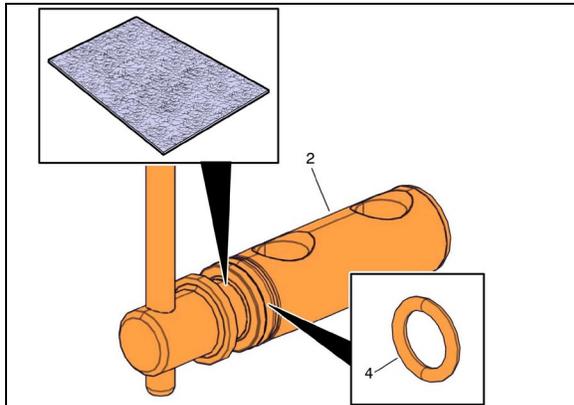


FIGURE 8: INSPECT THE O-RING (4) IN THE SPINDLE (2)

9. If the area containing corrosion cannot be reliably cleaned or there is damage to the sealing surface for the O-ring, the coolant filter housing must be replaced.
10. Apply grade NLGI No.2 silicone-based grease to the grooved area of the spindle. Ensure the grooved area of the spindle is filled as completely as possible.

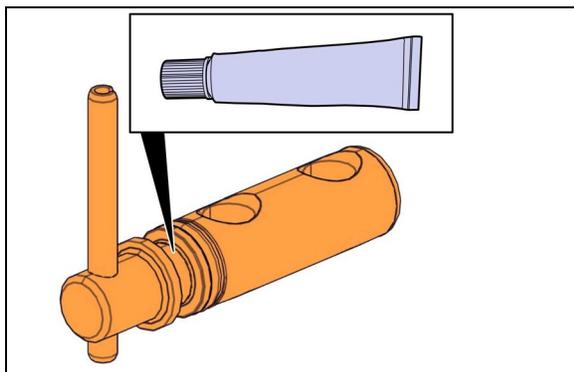


FIGURE 9: APPLY GRADE NLGI NO.2 SILICONE-BASED GREASE TO THE GROOVED AREA

11. Reinsert the spindle (2) into the coolant filter housing (3) and tighten the M5 hex socket screw (1).
12. To prevent reoccurrences, at a minimum, the grease should be repacked in this area when the coolant is changed, and the valve should be rotated periodically.

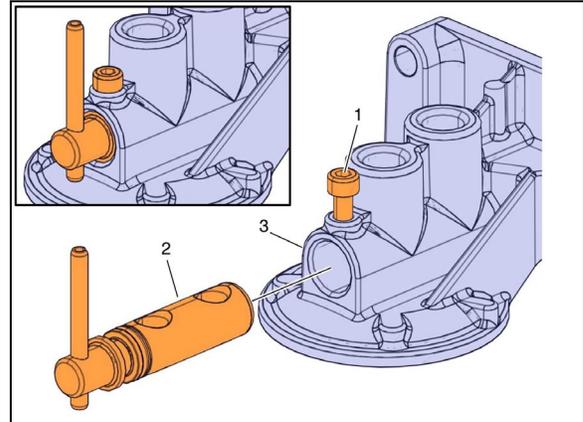


FIGURE 10: INSERTING THE SPINDLE

13. Fill the cooling system with the recommended coolant.
14. Set the engine stop/ignition interlock back to the normal position.
15. Start the engine, check for leaks and proper operation.
16. After shutdown, replenish coolant as necessary.

#### 4. HOSES

Rotten, swollen, and worn out hoses or loose connections are frequent causes of cooling system problems.

Serious overheating is often caused by an old hose collapsing or from rotten rubber shedding from hoses and clogging the coolant passages.

Connections should be inspected periodically and hose clamps tightened. Replace any hose found to be cracked or swollen.

##### 4.1 HOSE CLAMPS ON COOLANT LINES

All hose clamps used for the heating and cooling systems have a spring function (spring in the housing) to compensate for the normal expansion/contraction of hose and metal

## SECTION 05: COOLING SYSTEM

connection that occurs during vehicle operation and shutdown. These clamps are worm-driven and made of stainless steel.

All connections equal or greater than 2 inches OD have doubled clamps (two clamps, side by side) with screw housing separated from at least 90°. A torque wrench should be used for proper installation.

**TORQUE: 30 lb-in (3,39 Nm)**

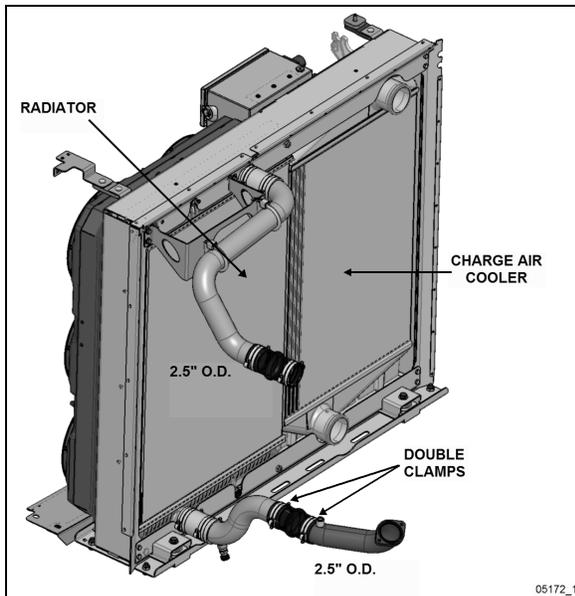
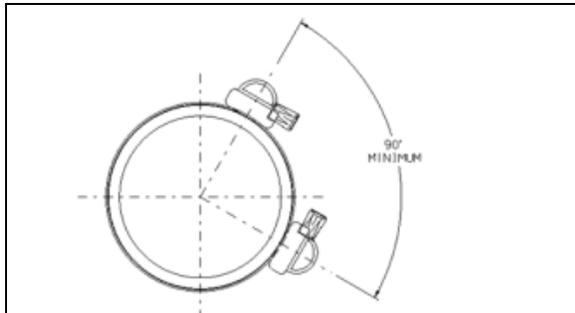


FIGURE 11: COOLANT FLOW (X3 SERIES SHOWN)



### CAUTION

The hose clamps will break if over-torqued. Do not over-tighten, especially during cold weather when hose has contracted.

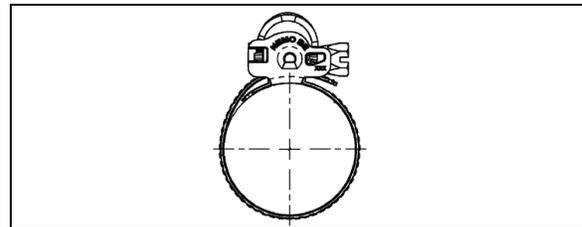


FIGURE 12: CLAMP TYPE USED ON HEATING & COOLING SYSTEMS

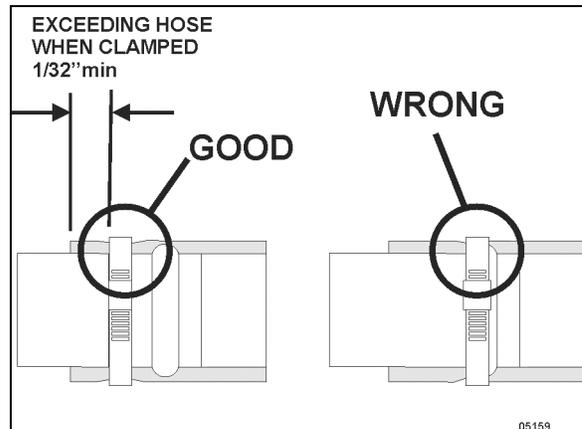


FIGURE 13: PROPER HOSE CLAMP INSTALLATION

### 4.2 CONSTANT-TORQUE HOSE CLAMPS ON CHARGE AIR COOLER (CAC)

If for any reason hose clamps need to be replaced; install and tighten hose clamps to specified torque (dry) (Figure 14).

**TORQUE: 4.5-5.5 lb-ft (6.1-7.46 Nm)**

**IMPORTANT:** The two constant torque clamps used *at the CAC to intake manifold elbow* must be torqued differently on the X3 Series (see torque table for proper identification).

**TORQUE: 12-15 lb-ft (16-20 Nm)**

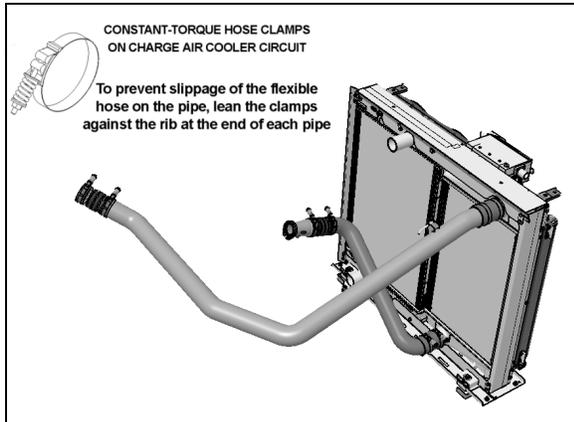
Elbow V-clamps must also be torqued to specification.

**TORQUE: 4.5-6 lb-ft (6.1-8.13 Nm)**



### CAUTION

The hose clamps will break if over-tighten. Do not over-tighten, especially during cold weather when hose has contracted.



**FIGURE 14: CHARGE AIR COOLER HOSE CLAMPS (H3 SERIES SHOWN)**

#### 4.2.1 Maintenance

Since the constant-torque clamp automatically adjusts to keep a consistent sealing pressure, there is no need to torque hose clamps on a regular basis. During vehicle operation and shutdown, the screw tip will adjust according to the temperature and pressure changes.

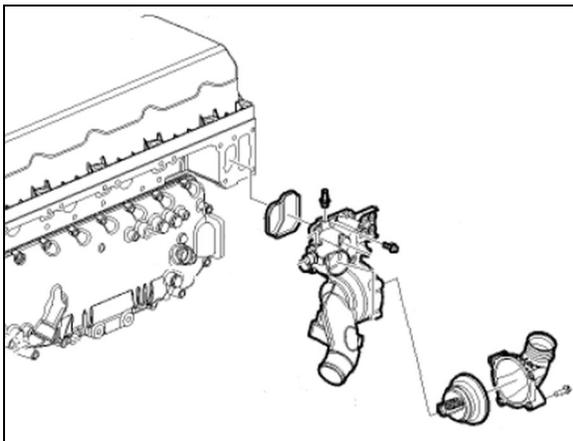
**Checking for proper torque should be done at room temperature.**

## 5. THERMOSTAT OPERATION

### 5.1 THERMOSTAT REPLACEMENT

17. Drain the cooling system.

18. Remove the bolts, the thermostat housing and the thermostat. Carefully clean the thermostat seat and all cylinder head-to-thermostat housing mating surfaces.



**FIGURE 15: VOLVO D13 THERMOSTAT HOUSING**

19. Install the new thermostat. Make sure that the rubber seal remains properly seated.

20. Position the thermostat housing to the cylinder head, install the bolts and tighten.

**TORQUE: 15-21 lb-ft (20-28 Nm)**

21. Install the rubber radiator hose to the thermostat housing. Position the clamp and tighten to secure.

22. Fill the system with the recommended coolant.

23. Start the engine, check for leaks and proper operation. After shutdown, replenish fluids as necessary.

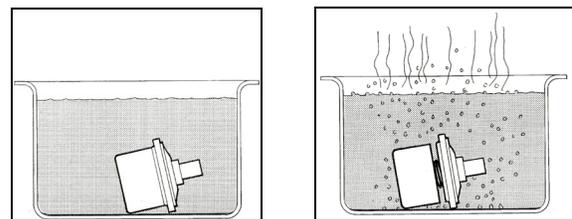
### 5.2 CHECKING NEW THERMOSTAT

A function check must be carried out before installing a new thermostat.

#### **NOTE**

*Check to be sure that the new thermostat closes fully. This can be done by holding it up to the light to check that there is no visible gap at the opening point. If the thermostat does not close properly, replace it.*

1. Warm up water in a receptacle to 75°C (167°F) and immerse the thermostat in the water. Use a piece of wire attached to the thermostat.



2. After at least 30 seconds, check that the thermostat is still closed.

3. Now warm the water to 100°C (212°F). After at least 30 seconds at the boiling point, check that the thermostat has opened at least 7mm (9/32in). If the thermostat has not opened, it must be replaced. A good thermostat starts to close at 95°C (203°F) and is fully closed at approximately 85°C (185°F).

## 6. COOLANT

### 6.1 COOLANT LEVEL VERIFICATION

*Cold engine* coolant level is correct when coolant is visible halfway up through the surge tank lateral sight tube on the H3 series or when the coolant level is visible between the two level marks in the X3 Series recovery tank (Figure 2 & Figure 3). If coolant level is low, fill cooling system.

### 6.2 COOLANT LEVEL SENSOR

This warning device consists of a fluid level probe mounted on the surge tank. The probe sends a signal to the engine control module to indicate coolant level. If the coolant level drops below the probe, the "Check Engine" light flashes and a diagnostic code is registered (see section 01 "ENGINE").



#### CAUTION

Do not run engine with the "Check Engine" light flashing.

The level probe is mounted on the front of the surge tank.

### 6.3 THAWING COOLING SYSTEM

If the cooling system becomes frozen solid, place the coach in a warm area until the ice is completely thawed.



#### CAUTION

Under no circumstances should the engine be operated when the cooling system is frozen, as it will result in engine overheating due to insufficient coolant.

Once it is thawed, check engine, radiator and related components for damage caused by expansion of frozen coolant fluid.

### 6.4 COOLANT RECOMMENDATIONS FOR VOLVO D13 ENGINE

The coolant provides a medium for heat transfer and controls the internal temperature of the engine during operation. In an engine having proper coolant flow, some of the combustion heat is conveyed through the cylinder walls and the cylinder head into the coolant. Without adequate coolant, normal heat transfer cannot take place within the engine, and engine temperature rapidly rises.

To function properly, the cooling system must be pressurized to prevent localized boiling of coolant. The system must be kept clean and leak-free. The filler and pressure caps must be checked periodically for proper operation.

Always maintain cooling system at the proper coolant level. Check daily, use recommended *extended life coolant* (ELC) with *50/50 antifreeze and deionized water mixture ratio*. This ratio should be used year-round to provide freeze and boil-over protection as well as providing a stable environment for seals and hoses.

When topping up coolant, use the same coolant mixture type as the mixture already in the cooling system. Do not mix two different types of coolant.

Do not use antifreeze formulated for automobile gasoline engines, these have a very high silicate content that will clog the radiator and leave unwanted deposits in the engine.

A decal located on the surge tank provides information on recommended coolants.



#### CAUTION

On Volvo D13 engine, use **only Extended Life Coolant** (ELC). **Do not** add supplemental coolant additives (SCA) to extended life coolant. **Do not** use a coolant filter containing Supplemental Coolant Additives (SCA).

ANTIGEL LONGUE DURÉE  
EXTENDED LIFE COOLANT  
ANTICONGELANTE DE  
LARGA DURACION



AVERTISSEMENT  
CAUTION  
ADVERTENCIA

NE PAS OUVRIR À CHAUD  
NEVER OPEN WHEN HOT  
NO ABRIR EN CALIENTE

RECOMMANDÉ/RECOMMENDED/RECOMENDADO:  
VOLVO #20358716 50/50  
CHEVRON #CPS 227811 50/50  
TEXACO #CPS 227998 50/50

05-1587

**Recommended coolants for Volvo D13 engine:**

- Texaco CPS#227998 (pre-diluted 50/50 mixture);
- Chevron CPS#227811 (pre-diluted 50/50 mixture);
- Volvo 20358716 (pre-diluted 50/50 mixture);

The ELC coolant slow depleting additive chemistry does not require regular testing, but the coolant can be tested with a *FleetFix® Maintenance Test Strip* (to measure nitrite and carboxylate levels) and the *FleetFix® Dilution Test Kit* (to determine contamination and protection levels of the ELC coolant).

The freeze protection level should be checked at least twice a year using a coolant refractometer.

**CAUTION**

Extended Life Coolant (ELC) will test as out of additives (SCA), but SCA should not be added. Shortened engine life may be the result of adding SCA.

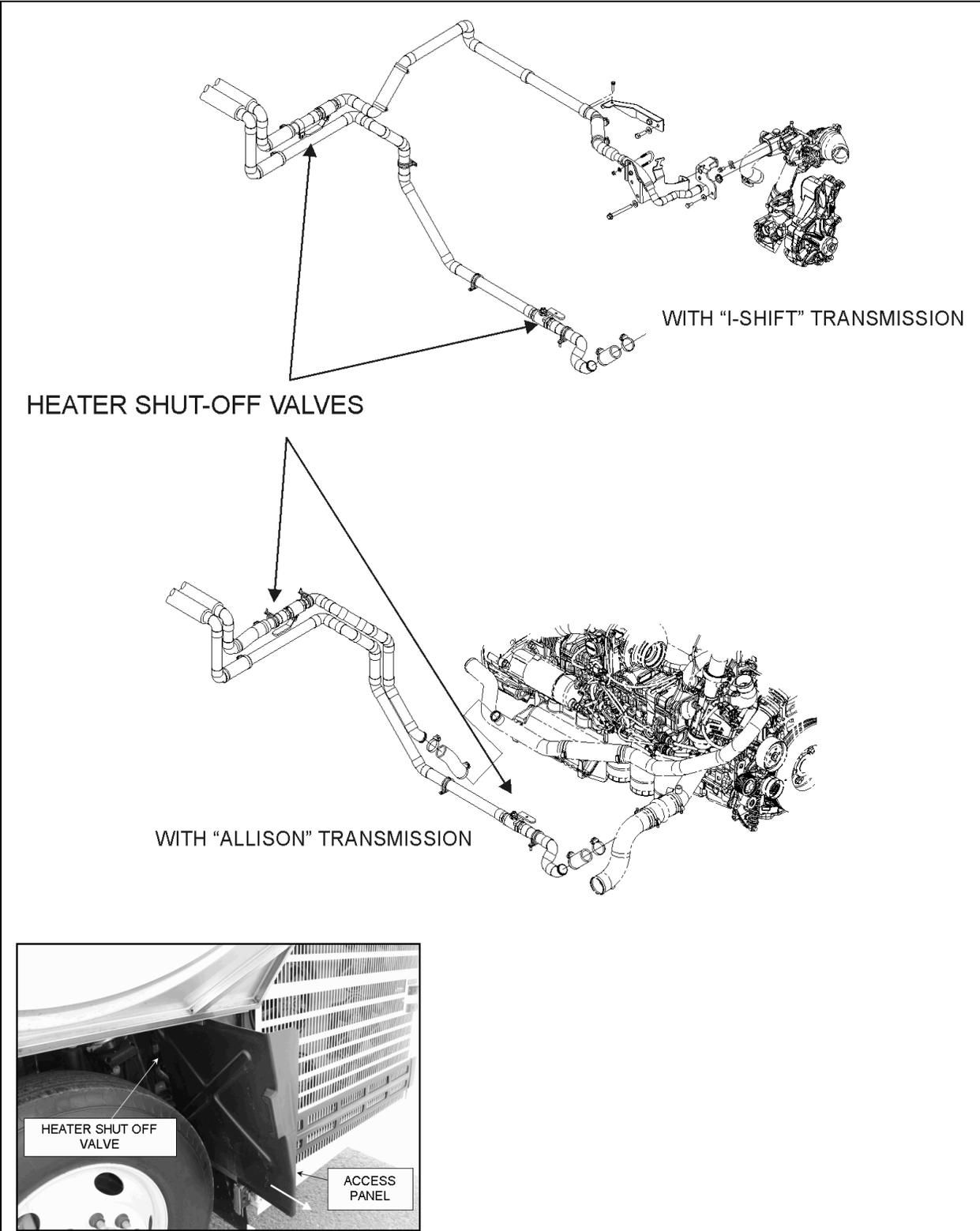


FIGURE 16: LOCATION OF HEATER LINE SHUT-OFF VALVES IN ENGINE COMPARTMENT (X3 SERIES)

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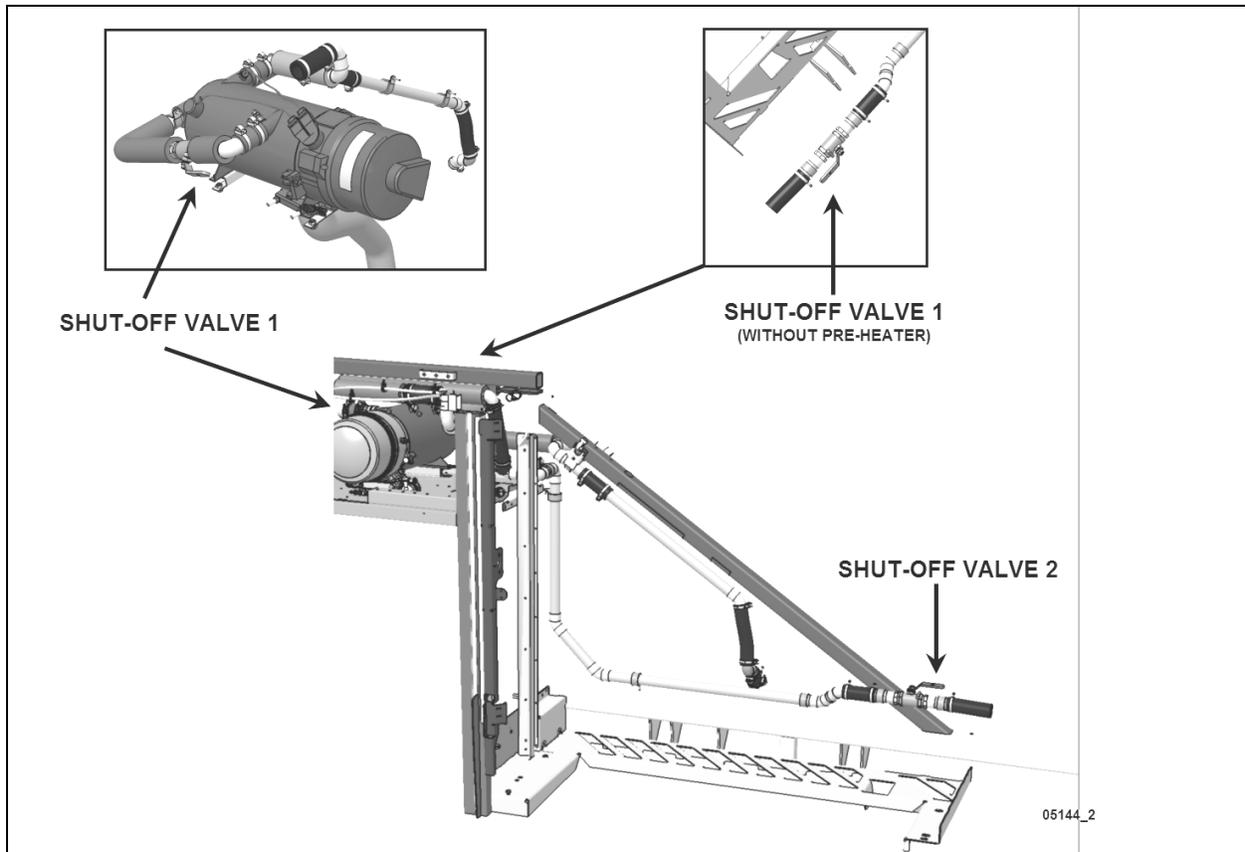


FIGURE 17: LOCATION OF HEATER LINE SHUT-OFF VALVES IN ENGINE COMPARTMENT (H3 SERIES)

## 6.5 COOLANT SAMPLING

### **NOTE**

The following procedure is provided for reference only.

Instructions coming with the laboratory test kit take precedence over this procedure.



### **WARNING**

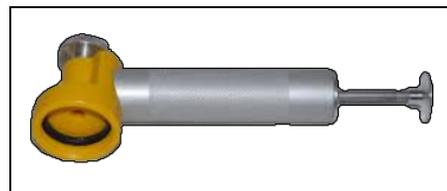
Before proceeding with the following steps, make sure the coolant has cooled down. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

Sampling should be performed on a *cold* engine.

Providing a sample of coolant for lab analysis may be required at some point in the life of the vehicle.

Typical material required:

- Hand Vacuum Pump w/ bottle provision



- Sample bottle
- Plastic tube (1/4 "refrigerator" tube)
- Nitrile gloves
- Safety glasses
- Shop Towels

**NOTE**

*Watch out for accidental contamination!*

*Hand vacuum pump should be used for coolant sampling only to prevent cross-contamination.*

*Also, ensure cleanliness throughout this procedure to make sure the coolant sample is not contaminated accidentally.*

Sampling should be performed on the surge tank, on a cold engine.

If the vehicle has been standing still for a significant period, drive it around 30 min up to normal operating temperature. Then let it cool down.

1. Pull the pressure cap off the surge tank. Refer to Figure 2 for location of cap.
2. Thread the sample bottle to the pump. Hand tightens.
3. Slide the plastic tubing in the fitting on the pump until it exceeds about 1/2 inch into pump cavity.
4. Insert tube in the surge tank about half way to the bottom. (Do not draw sample in the bottom of the surge tank.)
5. Pump until sample bottle is about 2/3 full. Do not overfill.
6. Loosen pump fitting to remove tube from pump. Allow any coolant in the tube to flow in the bottle.
7. Remove sample bottle and install cap.
8. Throw plastic tube away. (Not to be re-used)
9. Complete any forms required by the laboratory.

## 7. DRAINING COOLING SYSTEM

Use the following procedures to drain the cooling system partially or completely.

To drain engine and related components:

1. Stop engine and allow engine to cool. Close both heater line shutoff valves.

On X3 Series vehicles, the valves are located in the engine compartment. One is located under the turbocharger inlet pipe in the lower L.H side of the engine compartment; another valve is located behind the L.H. tag axle wheel and is accessible by lifting the hinged rear wheel fender and removing the access panel behind it (Figure 16).

On the H3 Series vehicles, one valve is located in the engine compartment near the water pump (Figure 17). Another valve is located behind rear fender, above the L.H. rear wheel housing near the optional coolant heater.

**NOTE**

*Refer to section 22 under "Preheating System" for information about preheater access and heater line shutoff valve.*



## MAINTENANCE

### Cooling system

Drain, flush, thoroughly clean and refill the system at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

When using ELC, **do not** use a filter that contains Supplemental Coolant Additives (SCA).



## WARNING

Before proceeding with the following steps, make sure the coolant has cooled down. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

2. Close the shut-off valve on the coolant filter mounting head and remove filter (perform only if filter as to be replaced).
3. Open the shut-off valve on the coolant filter mounting head and drain the coolant into a suitable container. Close the shut-off valve.

- Unscrew the surge tank pressure cap of the H3 Series vehicles counterclockwise,  $\frac{1}{4}$  turn to let air enter the system and permit the coolant to drain completely from system. *On X3 Series, release the pressure using the pressure release valve before removing the pressure cap.*

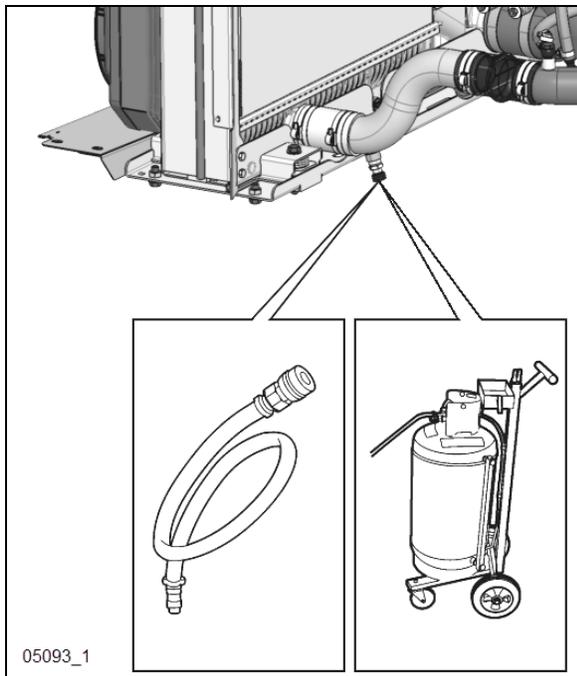
**CAUTION**

***On X3 Series vehicles, never open the surge tank pressure cap without making sure first that the system is completely depressurized. Coolant under pressure (hot or not) may cause serious injuries and eyes damages.***

- Connect coolant extractor (Figure 18). Use coolant extractor to drain the coolant from the engine. An alternate method is to drain the coolant into a suitable container using the drain hose.

**DANGER**

Coolant is toxic; risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals. Failure to follow these precautions can cause serious illness or death.



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**FIGURE 18: EXTRACTING COOLANT**

- Open the radiator drain cock.
- Remove the transmission oil cooler. Drain, flush and inspect. Refer to Section 7, "TRANSMISSION" for oil cooler maintenance or preventive replacement.

**CAUTION**

If freezing weather is anticipated and the engine is not protected with antifreeze, drain the cooling system completely when the vehicle is not in use. Trapped water in the cylinder block, radiator or other components may freeze and expand resulting in damages. Leave the drain plugs open until the cooling system can be filled with coolant fluid. Do not run engine with cooling system empty.

To drain the entire system, do the previous steps while maintaining the shutoff valves in the open position; follow procedure under "Draining Heating System" in Section 22.

**8. FILLING COOLING SYSTEM**

If only the engine and related components were drained, maintain the two heater line shutoff valves in their closed position, then proceed as follows:

- Close radiator drain cock.
- Open the shut-off valve on the coolant filter mounting head.
- Refill cooling system from the surge tank filler cap inlet with the recommended ethylene glycol-based antifreeze and water solution of the required concentration using the coolant extractor.

**NOTE**

*Make sure the purge lines are properly connected and not obstructed. The purge lines (thermostat housing dome, radiator top tank, transmission oil cooler or delivery line) are required to ensure complete engine fill and proper purging of air in the system.*

**NOTE**

*The coolant level should remain within two inches of the tank filler neck.*

4. Install the pressure cap, then start the engine and run it at fast idle until reaching normal operating temperature. Check for leaks.

**NOTE**

*If for any reason, the coolant level drops below the surge tank level probe, the Check Engine warning light will illuminate.*

5. Stop engine and allow cooling.
6. Open the two heater line shutoff valves, check the coolant level and add as required.

**CAUTION**

Never pour cold coolant into a hot engine. The sudden change in temperature may crack the cylinder head or block.

If the entire system has been drained, redo the previous steps while maintaining the two heater line shutoff valves in the "Open" position. With engine running, activate the driver's and central heating systems to permit coolant circulation. Complete the procedure by bleeding the heater cores as explained in Section 22, under "Bleeding Heating System".

**9. FLUSHING**

If the cooling system is contaminated, flush the cooling system as follows:

1. Drain the coolant from the engine.
2. Refill with clean water.

**CAUTION**

If the engine is hot, fill slowly to prevent rapid cooling and distortion of the engine castings.

3. To thoroughly circulate the water, start and run the engine for 15 minutes after the thermostats have opened.
4. Fully drain system.
5. Refill with clean water and operate for 15 minutes after the thermostats have opened.
6. Stop engine and allow cooling.
7. Fully drain system.

Vehicles without coolant filters:

Fill with a 50/50-antifreeze/water solution and add required inhibitors.

Vehicles with coolant filters:

Fill with a 50/50-antifreeze/water solution. Replace coolant filter as per the Lubrication and Servicing Schedule in section 24 if required.

Dispose of spent fluids in an environmentally responsible manner according to regulations in effect in your area.

**MAINTENANCE****COOLING SYSTEM CAPACITY Including heating system (approximation):**

H3 Series 26 US gal (99 liters)

X3 Series 22.5 US gal (85 liters)

**9.1 COOLING SYSTEM DESCALERS**

If the engine overheats and the water pump, coolant level and thermostat operation have been found to be satisfactory, it may be necessary to flush and de-scale the cooling system.

1. Drain the coolant from the engine.
2. Fill system with clean water.
3. Add the required amount of a reputable commercially available de-scaling product (aluminum & copper compatible). It is important that product directions be thoroughly read and followed regarding duration of the treatment, temperature and product mix ratio).

**CAUTION**

**CAUTION**

Only use de-scaling products sold by a reputable manufacturer, product must be aluminum and copper compatible and must be safe for rubber hoses and gaskets.

*Some de-scaling products will require the use of a neutralizing agent before coolant system refill*

Carefully follow manufacturer's directions to avoid cooling system damage when using descaling products.

Never use "home-brewed" descaling solution containing caustic or acid products not intended for cooling system descaling or having unknown active product concentration.

4. Drain descaling solution from the cooling system.
5. Refill with clean water and carefully rinse the cooling system to completely evacuate all remaining descaling solution.
6. On heavily contaminated system, reverse flush the cooling system to prevent remaining dirt and scale deposits from clogging the radiator tubes or being forced through the water pump (refer to paragraph 9.2 *Reverse Flushing* below).
7. Flush the system.
8. Refill system with appropriate coolant.

## 9.2 REVERSE FLUSHING

After the engine and radiator have been thoroughly de-scaled, they should be reverse-flushed. The water pump should be removed and the radiator and engine reverse-flushed separately to prevent dirt and scale deposits from clogging the radiator tubes or being forced through the pump. Reverse flushing is accomplished by hot water, under pressure, being forced through the cooling system in a direction opposite to the normal flow of coolant, loosening and forcing deposits out.

The radiator is reverse flushed as follows:

1. Remove the radiator inlet and outlet hoses and replace existing radiator cap with a new one.

2. Attach a hose to the top of the radiator to lead water away from the engine.
3. Attach a hose at the bottom of the radiator and insert a flushing gun in the hose.
4. Connect the water hose of the gun to the water outlet and the air hose to the compressed air outlet.
5. Turn on the water and when the radiator is full, turn on the air in short blasts, allowing the radiator to fill between blasts.

**NOTE**

*Apply air gradually. Do not exert more than 138 kPa (20 psi) air pressure. Too great a pressure may rupture a radiator tube.*

6. Continue flushing until only clean water is expelled from the radiator.

The cylinder block and cylinder head water passages are reverse flushed as follows:

1. Remove the thermostats and the water pump.
2. Attach a hose to the water inlet of oil cooler housing to drain water away from engine.
3. Attach a hose to the water outlet at the top of the cylinder head (thermostat housing) and insert the flushing gun in the hose.
4. Turn on the water until the jackets are filled, and then turn on the air in short blasts. Allow jackets to fill with water between air blasts.
5. Continue flushing until the water from the engine runs clean.

If scale deposits in the radiator cannot be removed by chemical cleaners and reverse flushing as outlined above, it may be necessary to remove the upper tank and rod out the individual radiator tubes with flat steel rods. Circulate the water through the radiator core from the bottom to the top during this operation.

## 10. SPIN-ON COOLANT FILTER

The optional engine cooling system filter is used to filter out impurities such as scale or sand from the coolant. The filter is mounted on the frame below the turbocharger inlet tube (Figure 19).

### To replace a filter:

1. Close the filter shutoff cock on the filter mounting head and unscrew the old filter from mounting.

**WARNING**

Failure to relieve cooling system pressure may result in personal injury.

2. Remove and discard the filter. Recover the coolant remaining in the filter with a suitable container.
3. Clean the filter adapter with a clean, lint-free cloth.
4. Coat surface of gasket with clean antifreeze, tighten 2/3 to 1 turn after gasket makes contact with head.
5. Open the filter shutoff cock.
6. Start engine and check for leaks.

**CAUTION**

Do not exceed recommended service intervals.

**MAINTENANCE****Coolant filter**

Replace the coolant filter cartridge at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

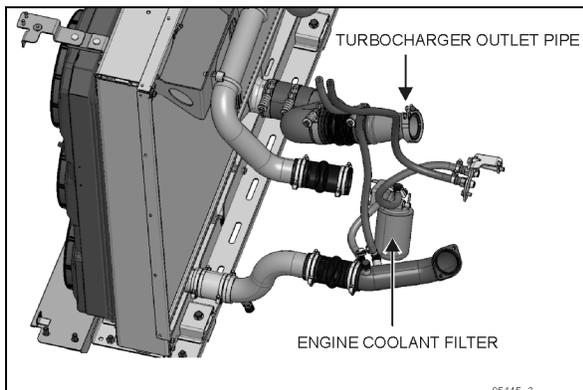


FIGURE 19: COOLANT FILTER (X3 SERIES SHOWN)

**11. COOLING ASSEMBLY**

The cooling assembly uses a total of 8 identical 12 inches (305mm) brushless (24V) electric cooling fans to dissipate the heat generated by the engine. The two first fans are used by the charge air cooler (CAC) to cool the hot compressed air coming from the turbocharger; the remaining 6 fans are used by the radiator.

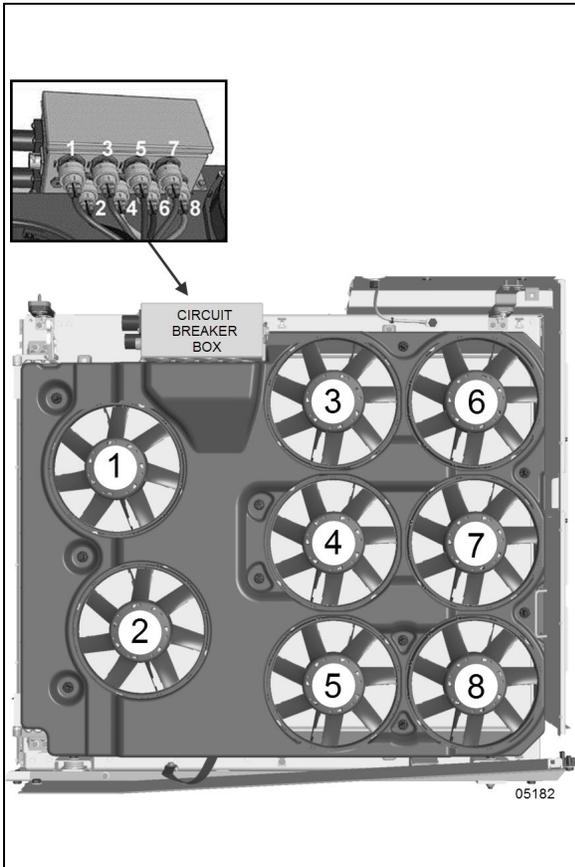
Each fan is fixed to a shroud by 4 hex screws and is individually connected to the circuit breaker box through a main wiring harness (*refer to section 06 ELECTRICAL for more information regarding breaker box components and harness*).

The shroud assists in directing the air flow generated by the fans through the radiator/CAC assembly with maximum efficiency and is sealed to the radiator/CAC assembly (cooling pack) with rubber seals. The shroud is hinged and can be "pivoted" out of the way to inspect or clean the radiator/CAC fins and tanks.

A cover is installed over the shroud to protect the fan harness and connectors from the elements.

**CAUTION**

The fan shroud is an essential component used to achieve maximum air flow capacity through the cooling assembly. To prevent overheating, inspect rubber seal regularly to ensure proper sealing.



**FIGURE 20: FAN ORDER AND CONNECTOR NUMBER AT CIRCUIT BREAKER BOX**

11.1 MAINTENANCE

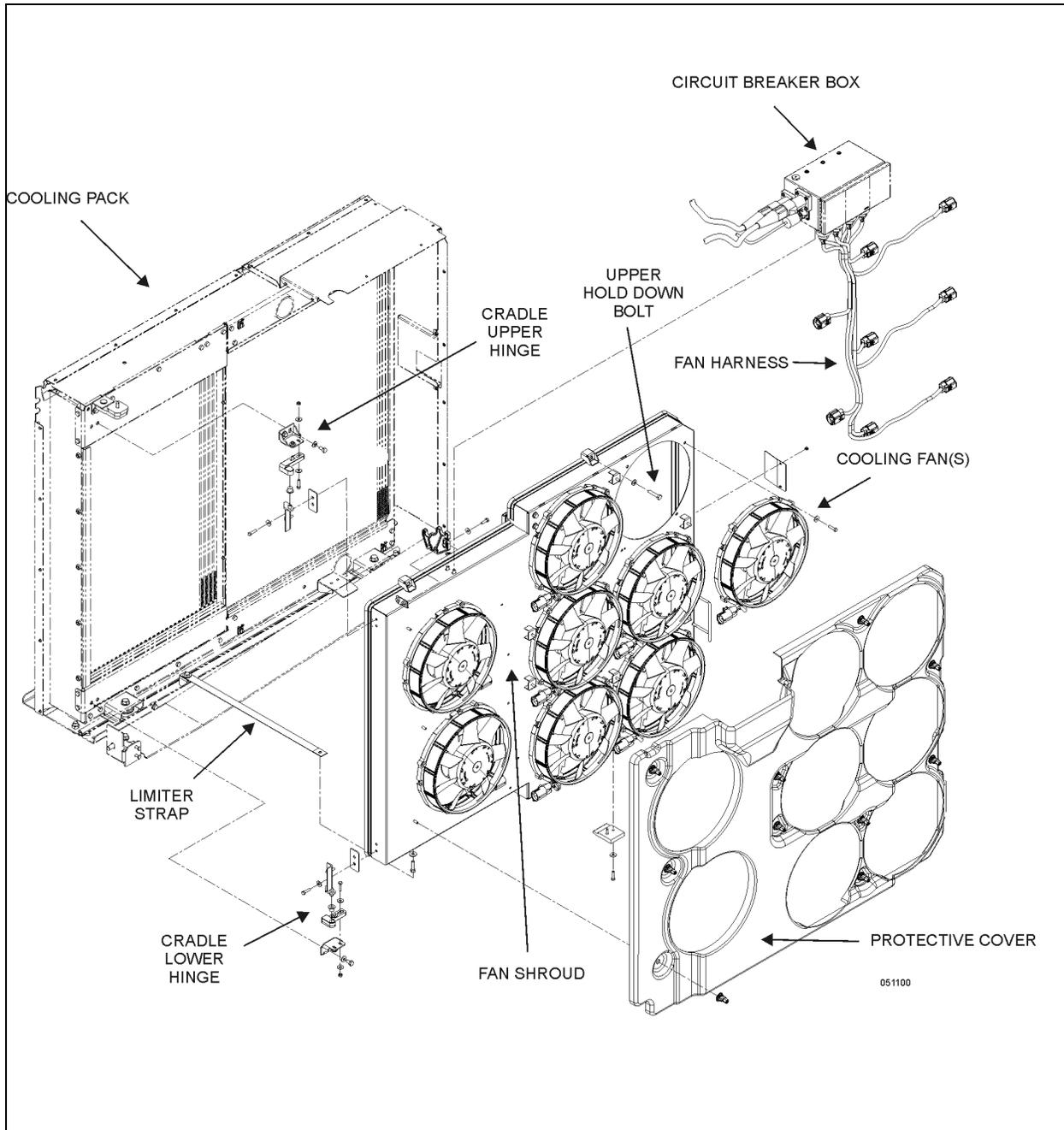


FIGURE 21: COOLING ASSEMBLY MAIN COMPONENTS

**WARNING**

Cooling fans may start when the engine is shut down in the following conditions:

- If a High Exhaust Temperature condition exists (e.g. following regeneration).
- During "Motor Test" sequence.

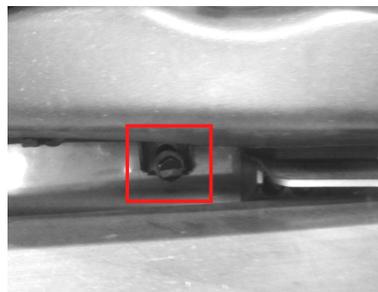
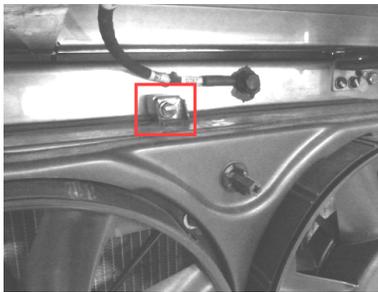
**MAINTENANCE**

Inspect fan blades regularly, check for dirt or grime accumulations on the blade that could cause vibrations, clean as necessary using water and regular strength degreaser.

Check for cracks and signs of abrasion on the blades that could indicate contact with debris or obstruction during operation.

Check the bottom of the shroud cover and remove debris that could have accumulated. In sub-zero winter area, also check for snow and ice accumulation that could block the fan blades rotation.

Open the fan shroud as necessary (remove top and bottom hex screws shown below) to facilitate cleaning and debris removal.

**NOTE**

Electric cooling fan motors are sealed and certified IP6K9K and IP68. They can therefore be safely power/pressure washed.

**NOTE**

To prevent a situation where debris would stick to the radiator door (due to fans suction force) and prevent full cooling performance, all fans are forced to stop for a period of 25 sec. every 30 minutes.

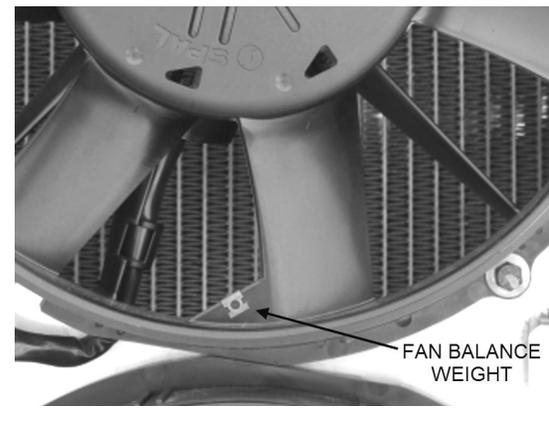
**NOTE**

To keep area between fans and shroud cover clean and, in winter, prevent snow and ice accumulation, a cleaning sequence, where the fans will run at full reverse speed for 30 sec. will take place the first time the vehicle reaches 30 km/h (19 mph) after start-up.

A winter cleaning mode will also take place if exterior temperature drops below 0°C (32°F) and will activate the fans at full reverse speed for 30 sec every 30 min.

**CAUTION**

Fans are factory balanced by the use of small metal weight clipped to the fan blades, to avoid damaging vibrations during fan operation, do not remove, shift or interchange balancing weights.



## 11.2 COOLING FAN REPLACEMENT

Proceed as follow to remove one (or more) individual fan from the shroud.

1. Remove the cooling fan shroud cover by unscrewing the 10 plastic fasteners holding it to the fan shroud.

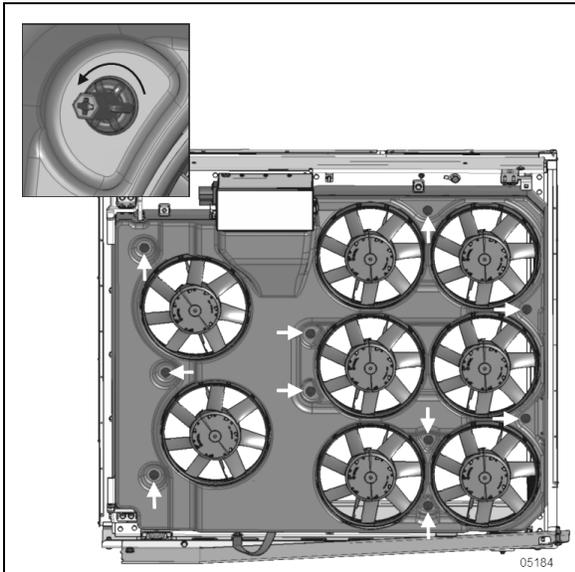


FIGURE 22: SHROUD COVER FASTENER LOCATION

2. Unplug the fan from the main fan harness (blue connector).
3. Remove the 4 hex screws holding the fan body to the shroud.
4. Remove the fan.
5. Reverse removal procedure to reinstall the fan and apply specified torque to the fan frame mounting screws.

**TORQUE: 30 lb-in (3 Nm)**

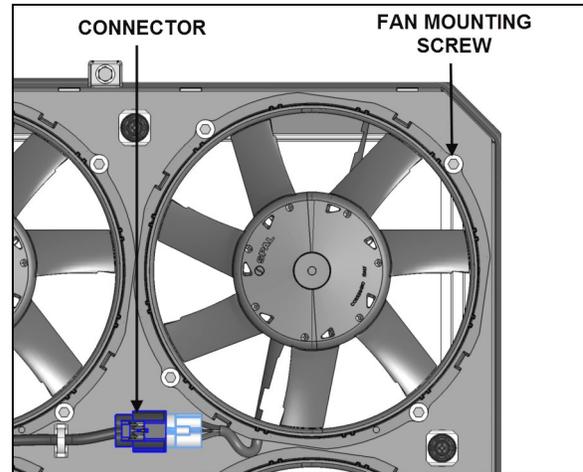


FIGURE 23: CONNECTOR & MOUNTING SCREW LOCATION

## 11.3 COOLING FAN SHROUD REMOVAL &amp; INSTALLATION

1. Open rear engine door and set engine stop button to the OFF position (push).
2. Open the radiator door and disconnect the door support arm to allow full door opening (optional).

**NOTE**

*X3 Series vehicles; If fan shroud is removed in preparation for the removal of the complete cooling assembly (see 11.4 in this section); the radiator door must be removed from the vehicle.*

- *Open and support door.*
- *Disconnect side marker lights.*
- *Remove light harness from door.*
- *Unscrew lower hinge from vehicle.*
- *Lift and remove door.*

*See section 18b BODY X-Series for more information.*

3. Disconnect the cooling fans circuit breaker box.
  - Turn the two main harness (black and red) connectors half a turn counterclockwise and pull.
  - Turn the smaller wiring connector 1/3 turn counterclockwise.

- Remove the wires from the wire separator and move them out of the way.

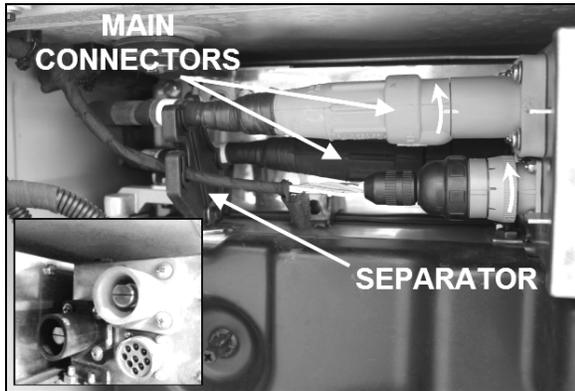


FIGURE 24: CIRCUIT BREAKER BOX CONNECTIONS

- Remove the shroud upper and lower hold down screws and open the shroud assembly (yellow handle).

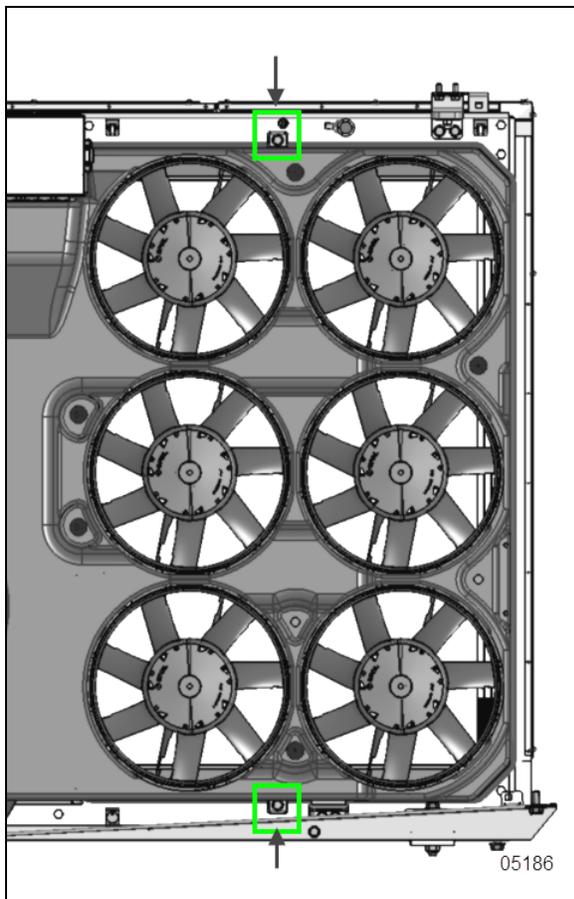
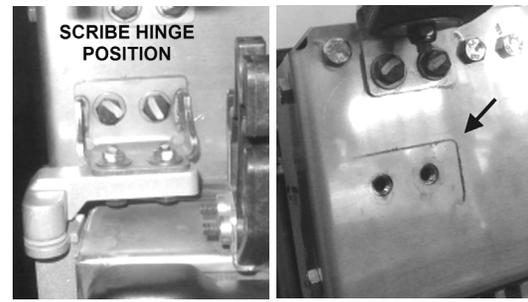


FIGURE 25: SHROUD HOLD DOWN SCREWS

- Unfasten the limiter strap at the bottom of the shroud assembly.
- Support the bottom of the shroud assembly with a lift table or other suitable equipment.
- Unscrew the shroud upper hinge at the vehicle structure and remove the hinge.

**NOTE**

*It is good practice to scribe the hinge position on the vehicle structure to use as a reference point upon reinstallation. This will minimize the need for hinge adjustment.*



- Slightly lift the door with the lift table to disengage the lower hinge pin and allow shroud removal from the vehicle.

**NOTE**

*Do not lose the plastic bushings installed at the pivot point of both lower and upper hinges.*

- Reverse removal procedure to reinstall the fan shroud assembly making sure that;
  - The bushings are installed at the hinges pivot point.
  - There is no gap at both hinges between the bushing and the hinge pivot.
  - Main connectors are fully engaged (paint mark are aligned).

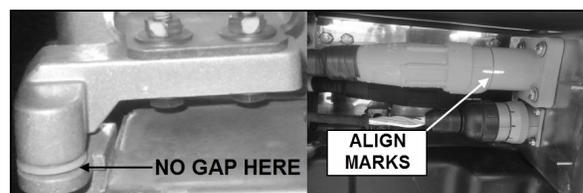


FIGURE 26: INSTALLED HINGE &amp; MAIN CONNECTOR

### 11.4 H3 SERIES VEHICLES - COOLING PACK (RADIATOR & CAC) REMOVAL & INSTALLATION

#### NOTE

For CAC only replacement, removal of the entire cooling pack is not necessary. Refer to paragraph 11.6 in this section for "in vehicle" CAC replacement instructions.



#### WARNING

##### GALVANIC CORROSION PREVENTION

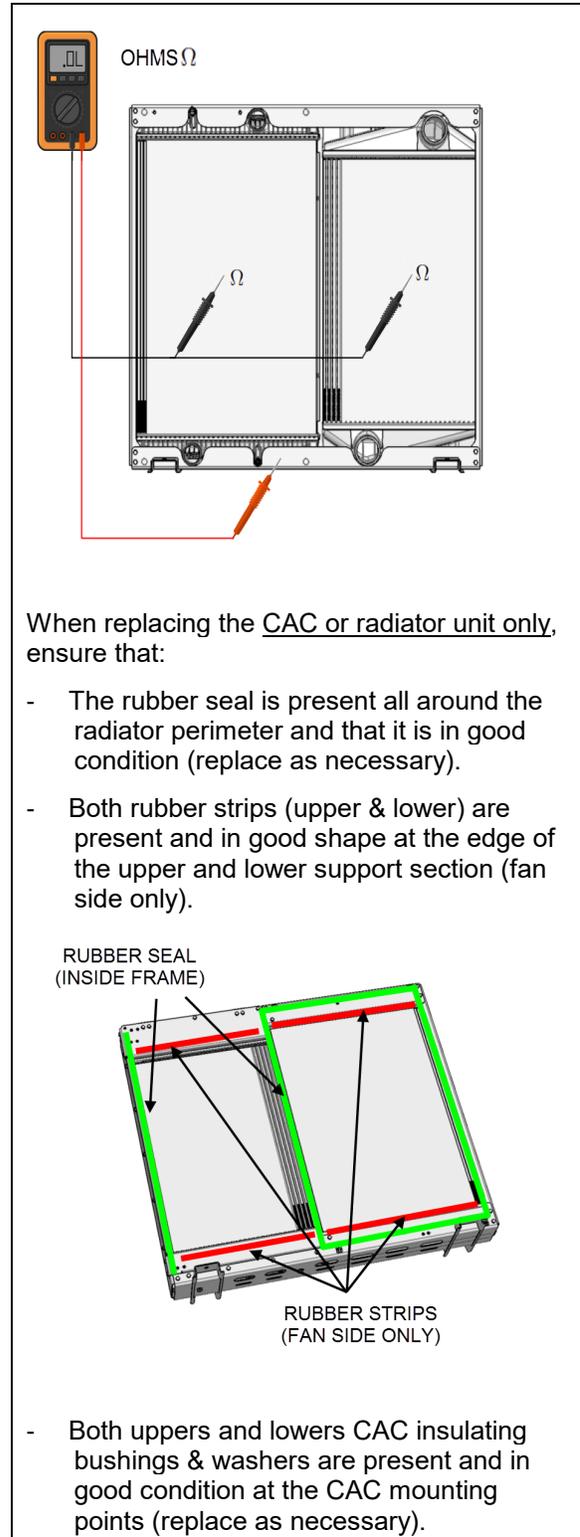
*Galvanic corrosion (also called bimetallic corrosion or contact corrosion) is an electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact.*

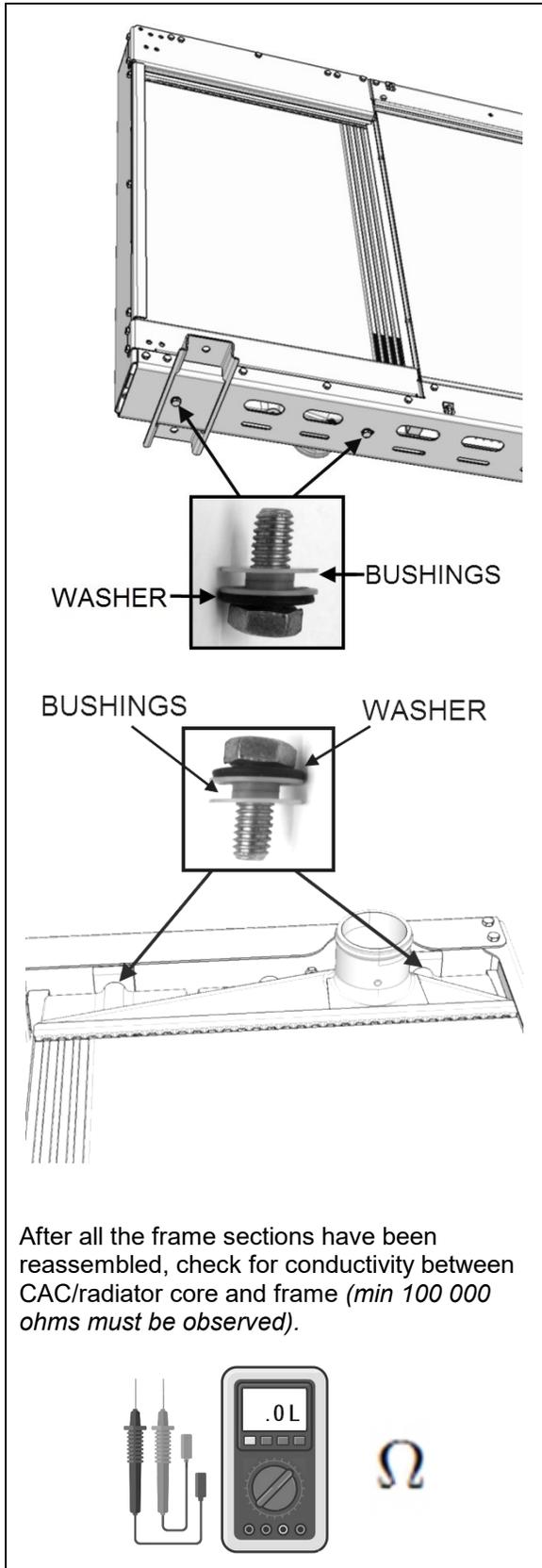
To avoid galvanic corrosion problems, the aluminum CAC and radiator have been electrically isolated from the cooling pack stainless frame.

When replacing the entire cooling pack with a new unit, make sure before installation that :

- There is no conductivity between the frame and both CAC and radiator core using a suitable ohmmeter or continuity (buzzer) tester.

*Note: If using ohmmeter, a minimum of 100 000 (100K) ohms must be observed to be considered acceptable for installation.*





1. Open rear engine compartment door.
2. Open rear engine door and set engine stop button to the OFF position (push).
3. Remove L.H. side hinged rear fender.

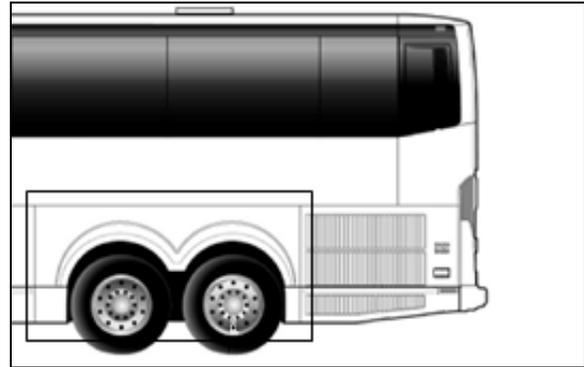


FIGURE 27: REMOVE REAR FENDER

4. If the vehicle is equipped with a coolant preheater, loosen the preheater exhaust clamp and remove the exhaust pipe.
5. Unscrew and remove access panel located behind L.H tag axle wheel (remove tag wheel).
6. Access the heater shut-off valve located behind the access panel and set it to the closed position.
7. Set the second heater shut-off valve, located over the tag axle wheel (next to the preheater if so equipped), at the closed position.

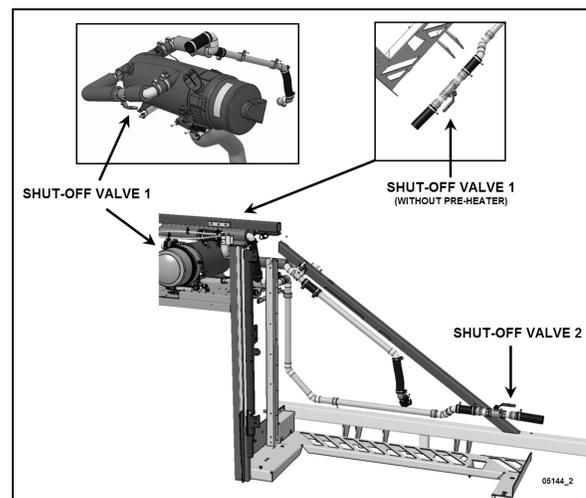


FIGURE 28: HEATER SHUT-OFF VALVES POSITION

- Connect coolant extractor to the radiator drain cock and drain the coolant system as per *Draining cooling system in paragraph 7 of this section*.

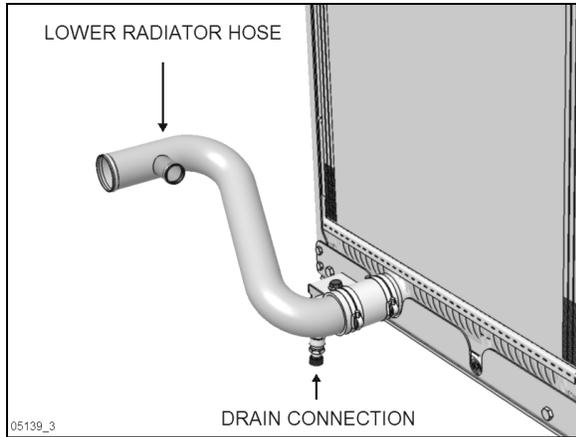


FIGURE 29: COOLANT DRAIN EXTRACTOR CONNECTION

**DANGER**

Risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals.

- Disconnect the upper radiator pipe at the radiator bracket junction (loosen U-Bolt and hose clamps).
- Also disconnect the upper CAC pipe.

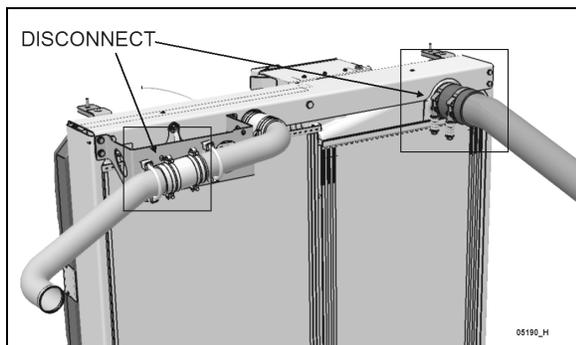


FIGURE 30: RADIATOR & CAC UPPER CONNECTION

- Disconnect the radiator lower pipe at the radiator outlet.
- Disconnect the lower CAC pipe (turbo outlet).

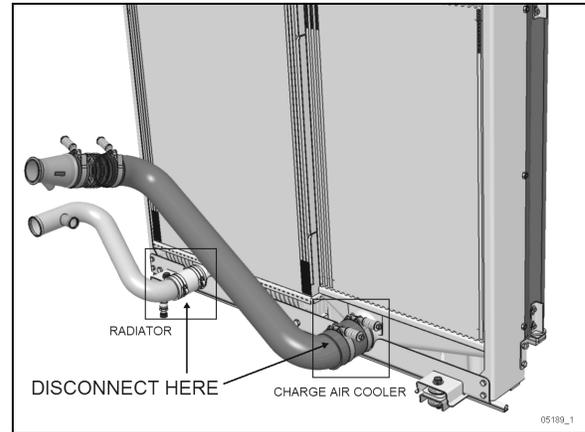


FIGURE 31: RADIATOR & CAC LOWER CONNECTION

- Proceed to the cooling fan shroud removal following *paragraph 11.3 of this section*.
- Disconnect the ground connection at the upper right corner of the cooling assembly.



FIGURE 32: COOLING ASSEMBLY GROUND

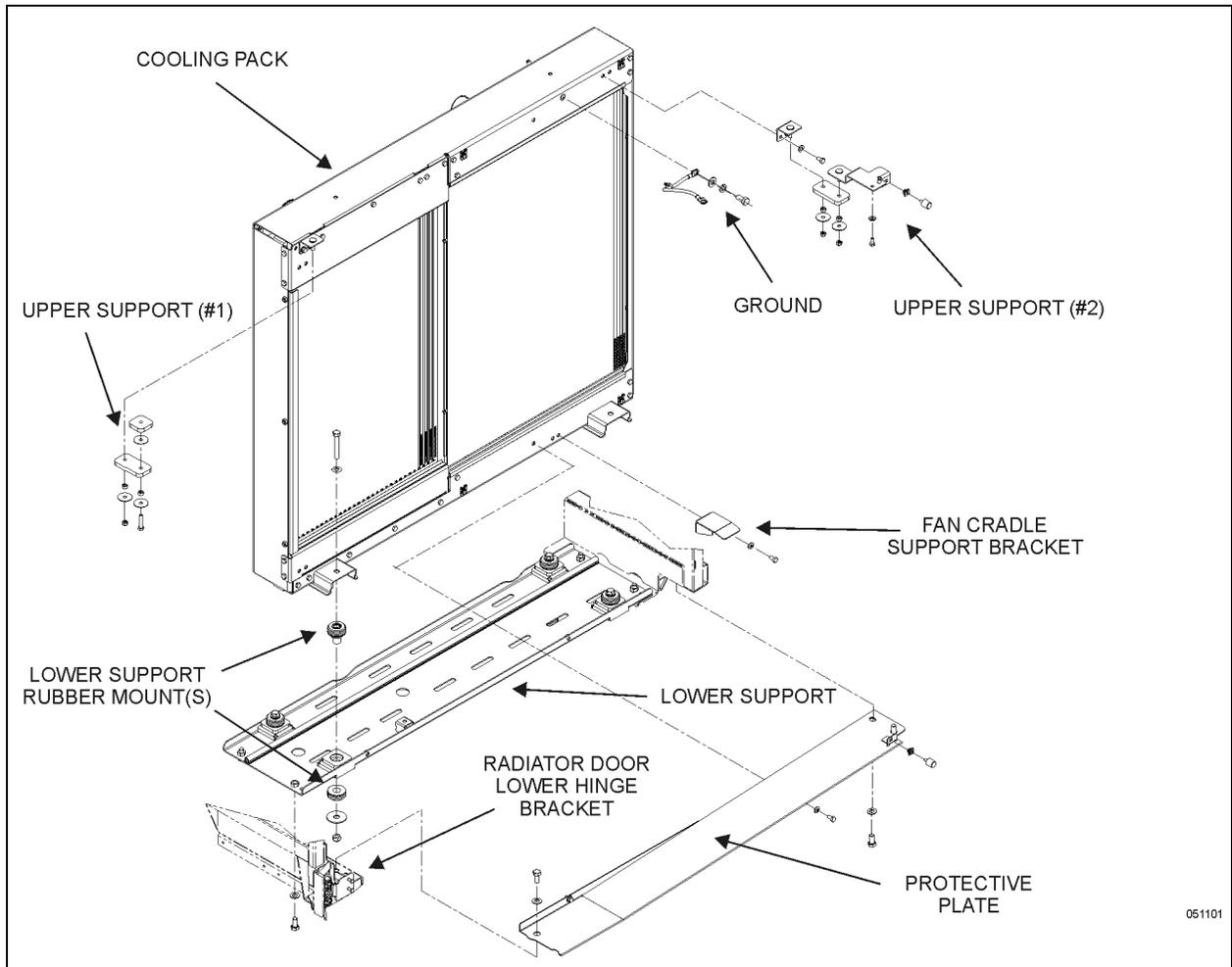


FIGURE 33: COOLING PACK SUPPORTS AND COMPONENTS

15. Remove the protective (splash) plate fixed to the cooling pack lower support.

16. Support the cooling assembly with a lift table positioned under the lower support.

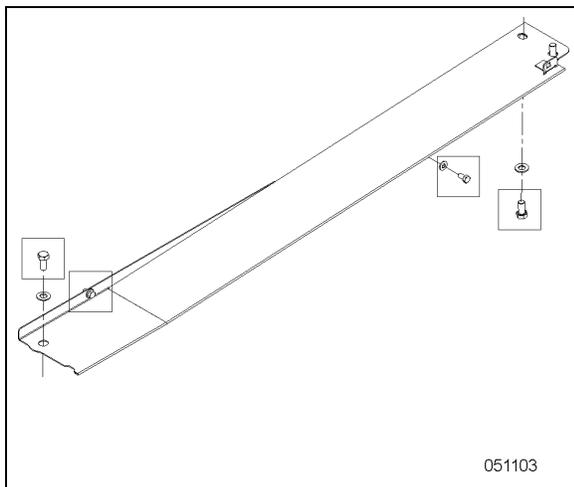


FIGURE 34: PROTECTIVE PLATE MOUNTING BOLTS

17. Unscrew the lower support from the vehicle (two hex bolts at each end of the support).

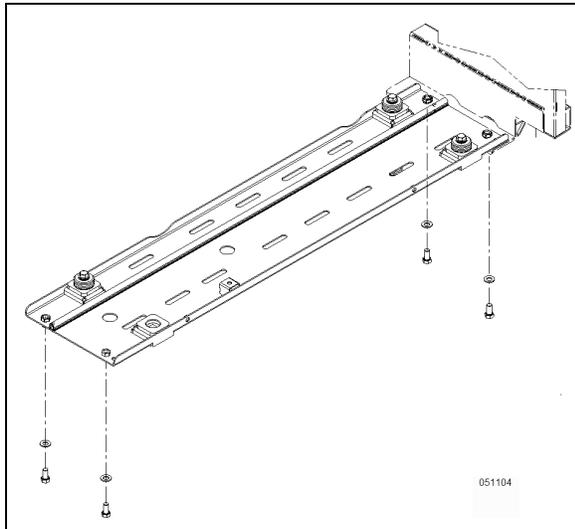


FIGURE 35: LOWER SUPPORT MOUNTING BOLTS

18. Unscrew the two upper supports from the vehicle structure so they will be removed with the cooling assembly.

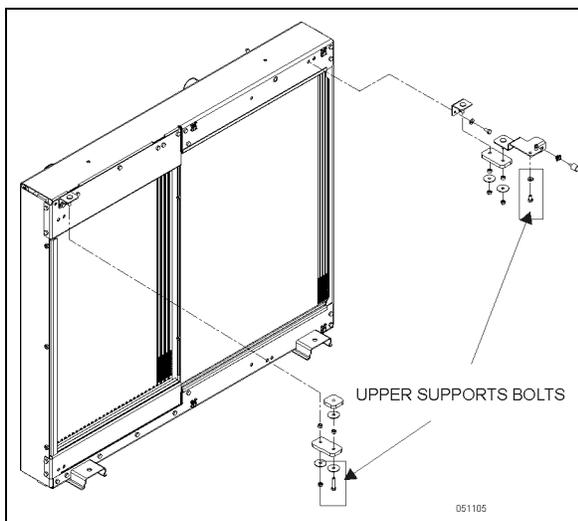


FIGURE 36: UPPER SUPPORTS MOUNTING BOLTS

19. Slightly lift the assembly and slide it out of the vehicles.

- Check interference at the back of the assembly with the pipe section still attached to the assembly and the vehicle structure.

20. To proceed to the *radiator replacement*, remove radiator upper pipe section, bracket and hardware, unbolt the four support bolts passing through the radiator and holding it to the frame (upper & lower) also unbolt the

cooling pack frame upper and lateral sections and slide the old radiator out.

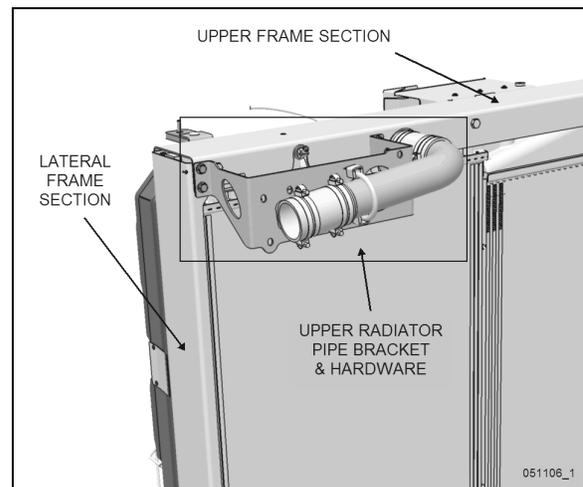


FIGURE 37: COOLING PACK PARTS TO BE REMOVED FOR RADIATOR REPLACEMENT

21. Insert a new radiator in the lower support making sure that insulating foam is installed all around the radiator body.
22. Reinstall the four support bolts and the upper and lateral frame sections only (*go to step 59 below*) Torque all support bolts and frame bolts to specified torque below.

**TORQUE: 9 lb-ft (12 Nm)**

23. To proceed to the *complete cooling pack replacement*, ignore steps 55 to 57 above and remove and transfer to the new assembly:

- Both upper supports & brackets
- Lower support & rubber mounts
- Shroud support bracket
- Lower hinge & hinge bracket

Torque all brackets to specified torque.

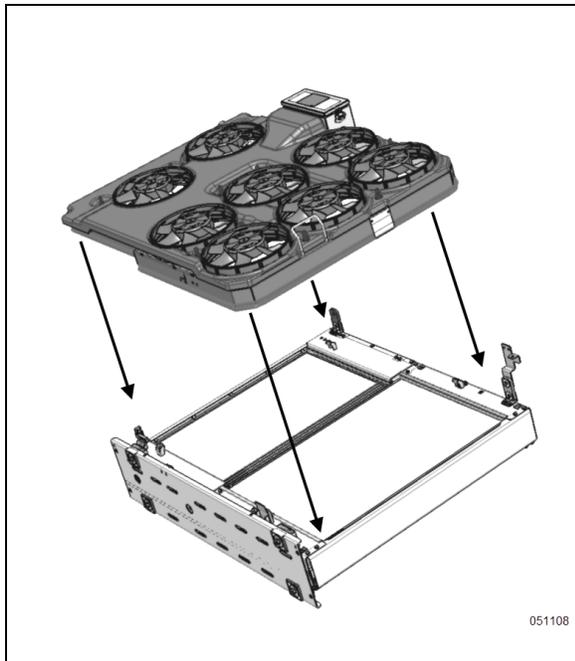
**TORQUE: 9 lb-ft (12 Nm)**

**NOTE**

Reinstallation of the cooling components as a complete assembly is recommended.

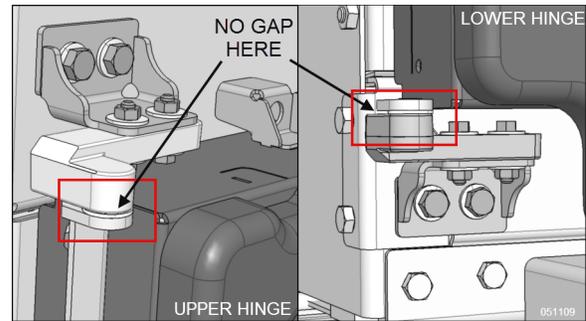
- Install fan shroud on the cooling pack frame then install complete assembly to vehicle structure.

24. Lay the cooling pack horizontally at working height (use large workbench or sawhorses) exterior face pointing up.
25. Install fan shroud in position over the cooling pack (make sure the lower hinge is correctly assembled with plastic bushing in place).



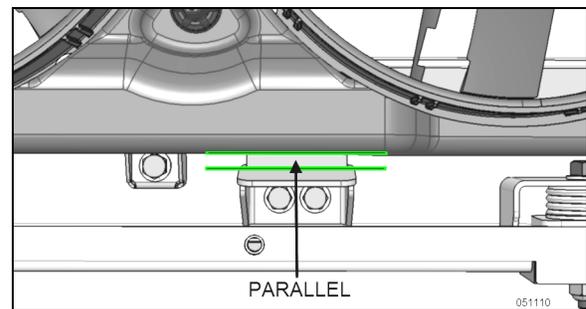
**FIGURE 38: FAN SHROUD POSITIONING**

26. Partially screw down the both upper and lower shroud hold down screws to position the shroud
27. Loosely install the hinges.
28. Adjust the shroud in its final position.
  - There should be no gaps between the hinge pivot point and the plastic bushing (upper & lower hinges).



**FIGURE 39: SHROUD HINGES INSTALLATION**

- The bottom of the shroud should fit flat (parallel) against the shroud lower support.

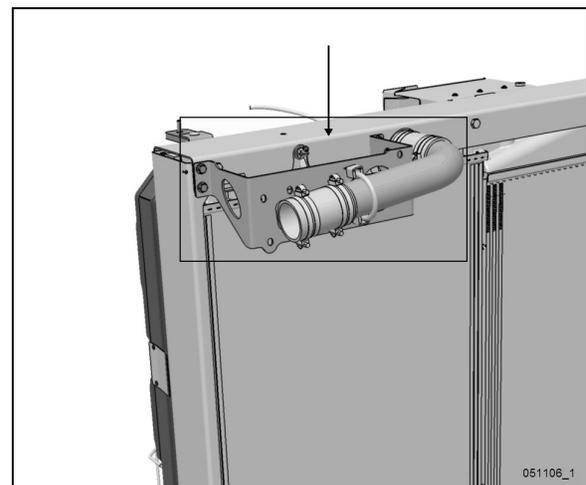


**FIGURE 40: FAN SHROUD PARALLEL TO SUPPORT**

29. Tighten hinges and hold down bolts.

**TORQUE: 68 lb-in (8 Nm)**

30. Put back the cooling assembly in its vertical position on a small lift table.
31. Reinstall the upper radiator pipe section (including bracket and hardware).



**FIGURE 41: INSTALLED RADIATOR UPPER PIPE & BRACKET**

32. Slide back the cooling assembly into position and reverse removal procedure to reinstall in vehicle.
33. Make sure that there is no conductivity between the CAC/radiator units and the cooling pack frame (see note at the beginning of paragraph 11.4).
34. Fill the vehicle cooling system.
35. Set engine stop button to the ON position (depressed), start the engine and check for coolant leaks.

### 11.5 X3 SERIES VEHICLES - COOLING PACK (RADIATOR & CAC) REMOVAL & INSTALLATION

**NOTE**

For CAC only replacement, removal of the entire cooling pack is not necessary. Refer to paragraph 11.6 in this section for "in vehicle" CAC replacement instructions.



**WARNING**

**GALVANIC CORROSION PREVENTION**

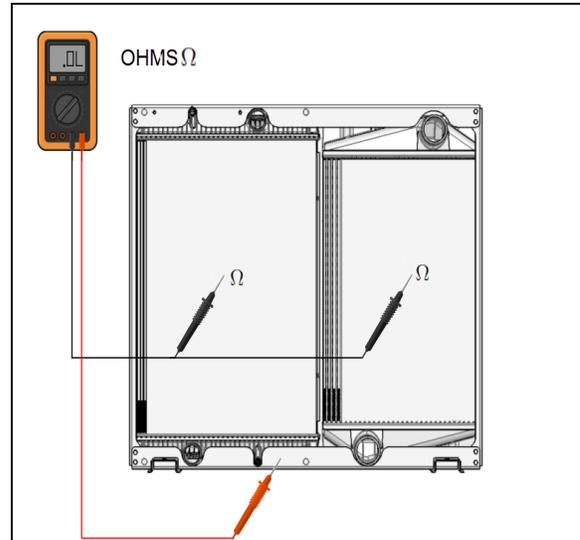
*Galvanic corrosion (also called bimetallic corrosion or contact corrosion) is an electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact.*

To avoid galvanic corrosion problems, the aluminum CAC and radiator have been electrically isolated from the cooling pack stainless frame.

When replacing the entire cooling pack with a new unit, make sure before installation that :

- There is no conductivity between the frame and both CAC and radiator core using a suitable ohmmeter or continuity (buzzer) tester.

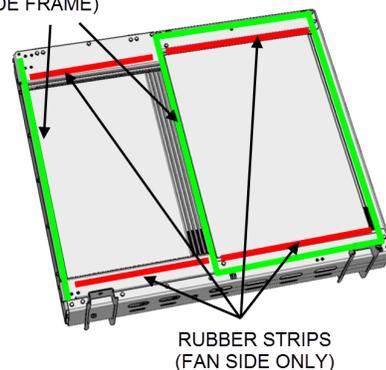
*Note: If using ohmmeter, a minimum of 100 000 (100K) ohms must be observed to be considered acceptable for installation.*



When replacing the CAC or radiator unit only, ensure that:

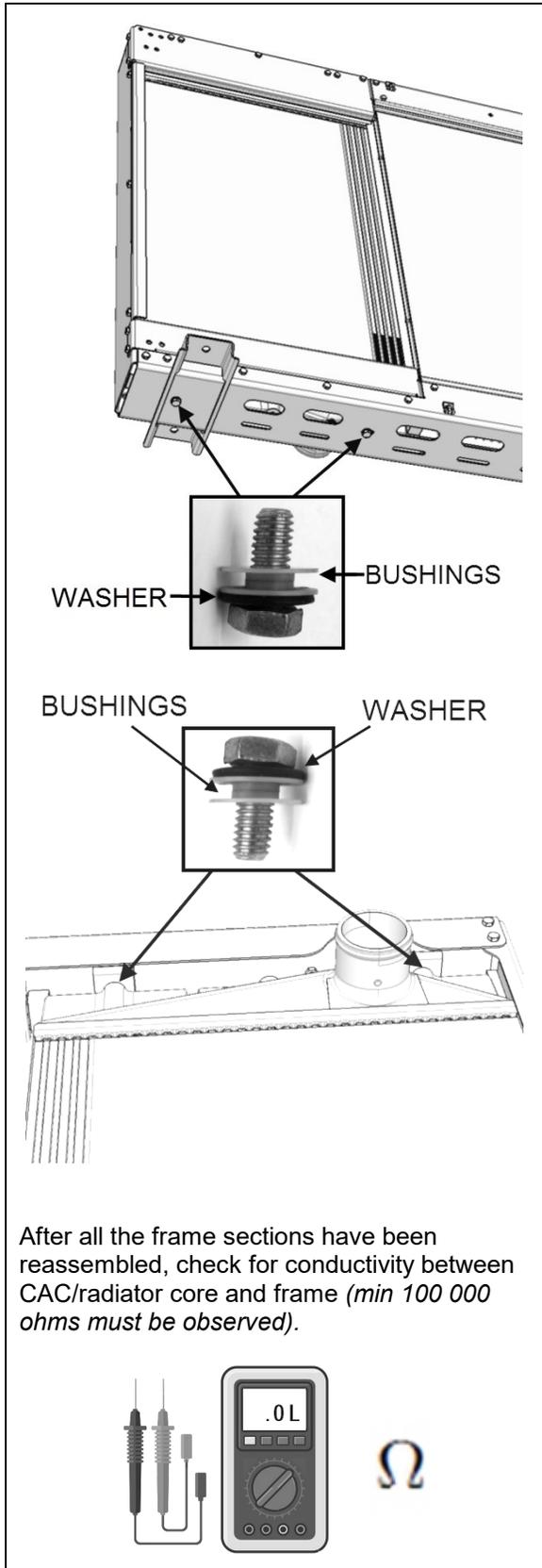
- The rubber seal is present all around the radiator perimeter and that it is in good condition (replace as necessary).
- Both rubber strips (upper & lower) are present and in good shape at the edge of the upper and lower support section (fan side only).

RUBBER SEAL (INSIDE FRAME)



RUBBER STRIPS (FAN SIDE ONLY)

- Both uppers and lowers CAC insulating bushings & washers are present and in good condition at the CAC mounting points (replace as necessary).



36. Open rear engine compartment door.
37. Open rear engine door and set engine stop button to the OFF position (push).
38. Raise L.H. side hinged rear fender.

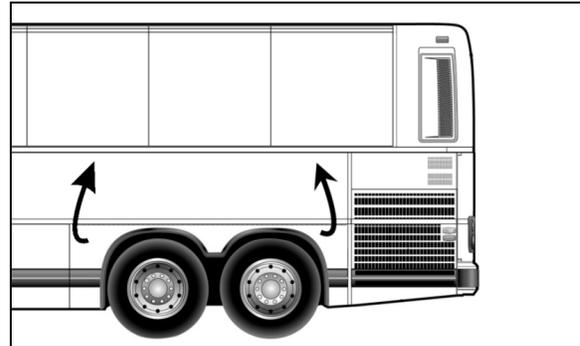


FIGURE 42: RAISING REAR FENDER

39. Remove access panel located behind L.H tag axle wheel.
40. Access the heater shut-off valve located behind the access panel and set it to the closed position.
41. Set the second heater shut-off valve, located in the engine compartment below the turbocharger outlet to CAC pipe, at the closed position.

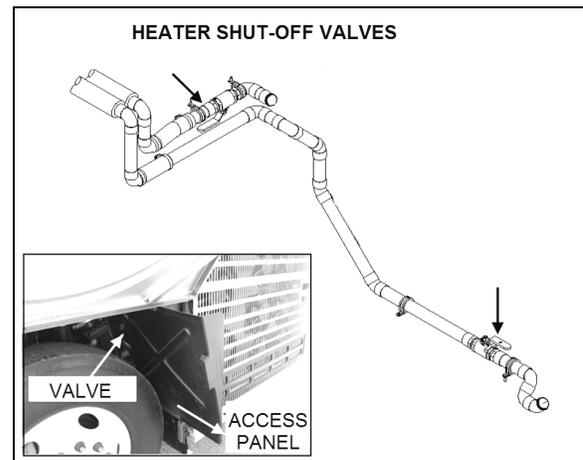


FIGURE 43: HEATER SHUT-OFF VALVES POSITION

42. Connect coolant extractor to the radiator drain cock and drain the coolant system as per *Draining cooling system* in paragraph 7 of this section.

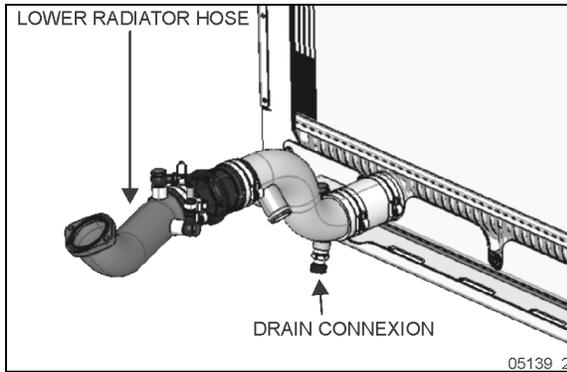


FIGURE 44: COOLANT DRAIN EXTRACTOR CONNECTION

 **DANGER**

Risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals.

43. Disconnect the upper radiator pipe *at the pipe junction* between the radiator and the engine.
44. Also disconnect the upper CAC pipe at the *mid pipe junction*.

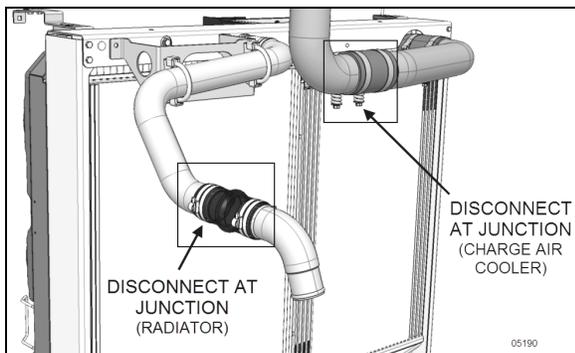


FIGURE 45: RADIATOR & CAC UPPER CONNECTION

45. Disconnect the radiator lower pipe directly at the radiator outlet.
46. Disconnect the lower CAC pipe (turbo outlet).

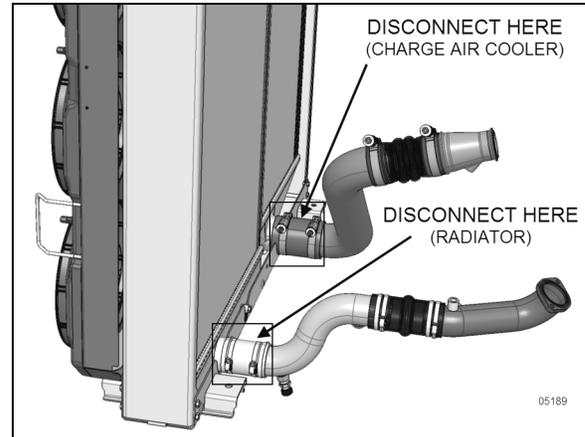


FIGURE 46: RADIATOR & CAC LOWER CONNECTION

47. Proceed to the cooling fan shroud removal following *paragraph 11.3* of this section (radiator door must be removed).
48. Disconnect the ground connection at the upper right corner of the cooling assembly.

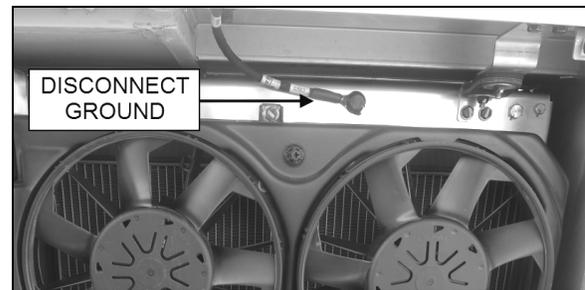


FIGURE 47: COOLING ASSEMBLY GROUND

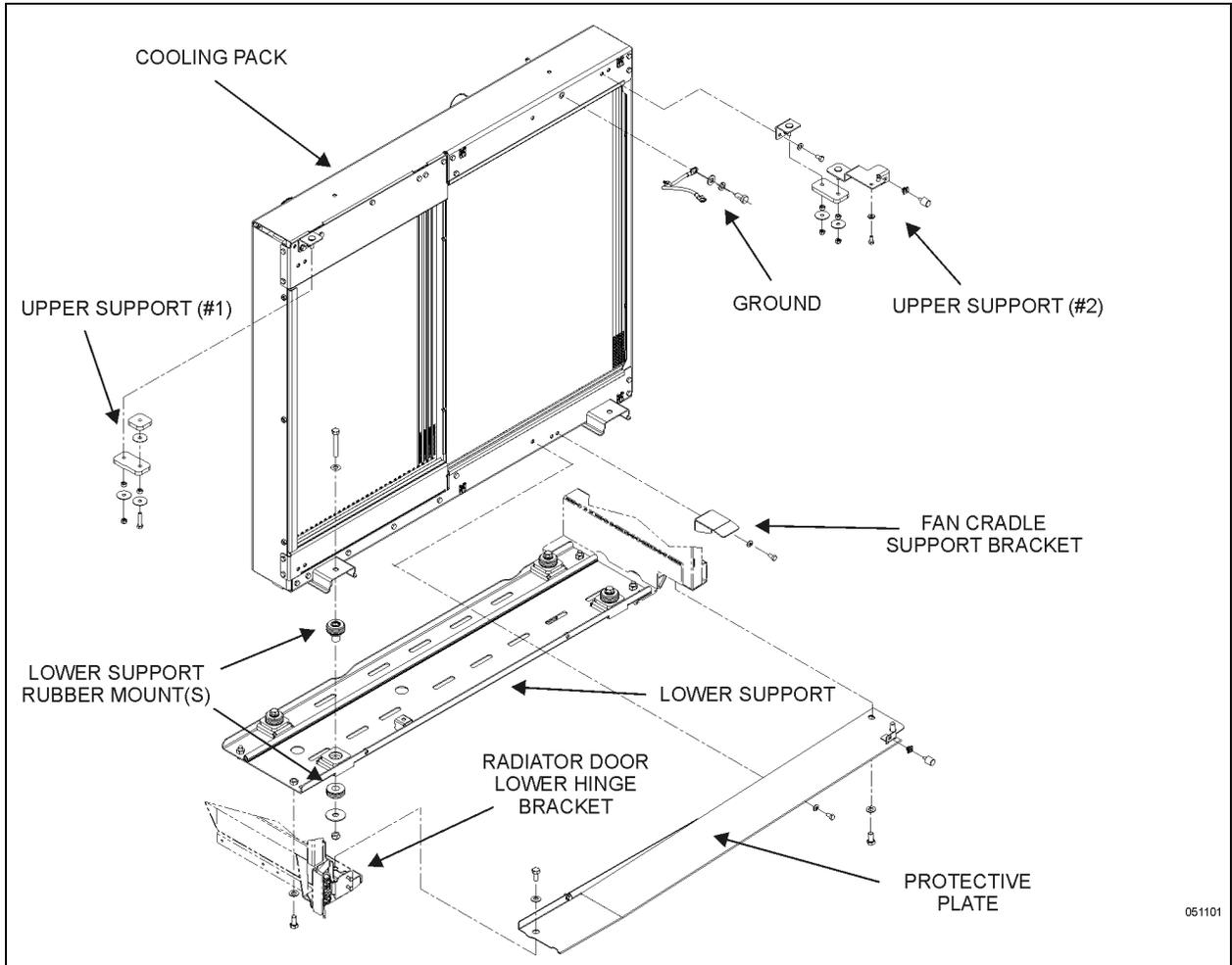


FIGURE 48: COOLING PACK SUPPORTS AND COMPONENTS

49. Remove the radiator door lower hinge bracket.

50. Remove the protective (splash) plate fixed to the cooling pack lower support.



FIGURE 49: RADIATOR DOOR LOWER HINGE BRACKET

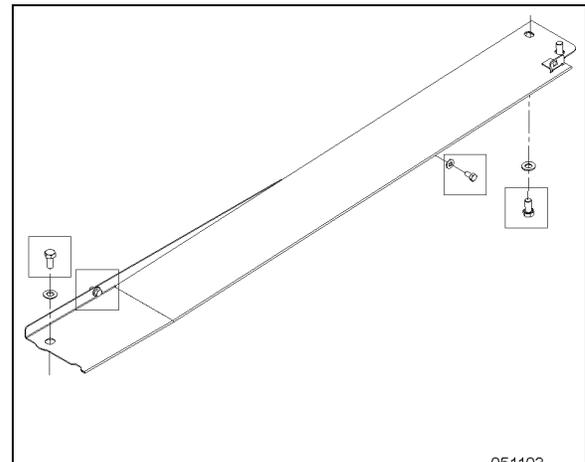


FIGURE 50: PROTECTIVE PLATE MOUNTING BOLTS

51. Support the cooling assembly with a lift table positioned under the lower support.
52. Unscrew the lower support from the vehicle (two hex bolts at each end of the support).

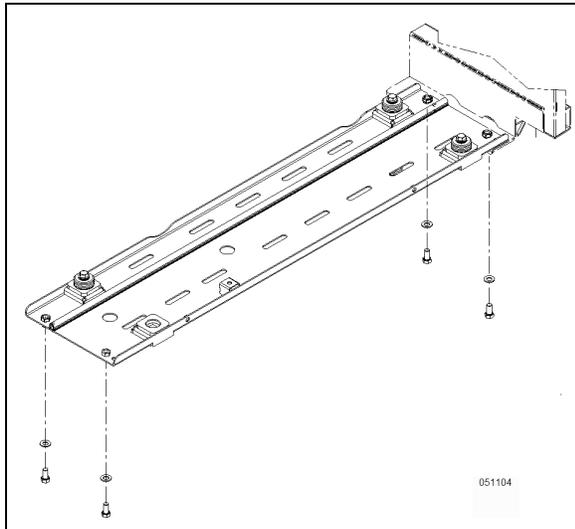


FIGURE 51: LOWER SUPPORT MOUNTING BOLTS

53. Unscrew the two upper supports from the vehicle structure so they will be removed with the cooling assembly.

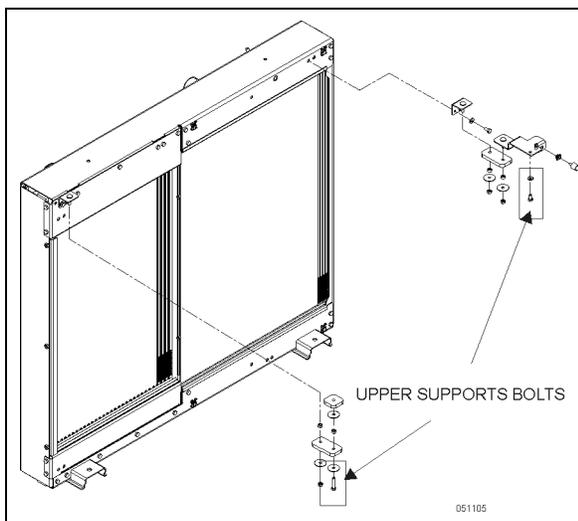


FIGURE 52: UPPER SUPPORTS MOUNTING BOLTS

54. Slightly lift the assembly and slide it out of the vehicles.
  - Check interference at the back of the assembly with the pipe sections still attached to the assembly and the vehicle structure (slack hose clamps and turn down tubes as necessary).

55. To proceed to the radiator replacement, remove radiator upper pipe section, bracket and hardware, unbolt the four support bolts passing through the radiator and holding it to the frame (upper & lower) also unbolt the cooling pack frame upper and lateral sections and slide the old radiator out.

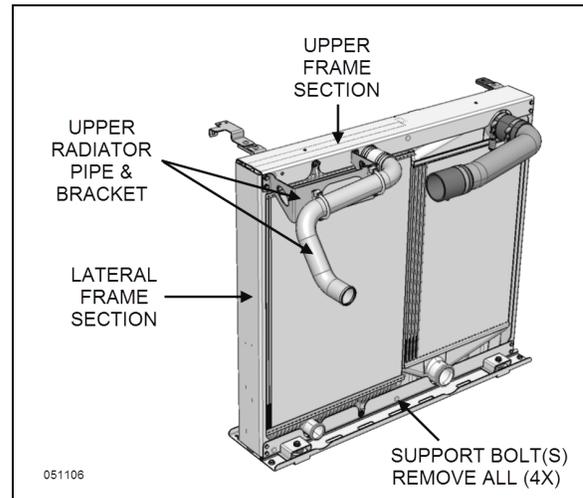


FIGURE 53: COOLING PACK PARTS TO BE REMOVED FOR RADIATOR REPLACEMENT

56. Insert a new radiator in the lower support making sure that insulating foam is installed all around the radiator body.
57. Reinstall the four support bolts and the upper and lateral frame sections only (*go to step 59 below*) Torque all support bolts and frame bolts to specified torque below.

**TORQUE: 9 lb-ft (12 Nm)**

58. To proceed to the complete cooling pack replacement, ignore steps 55 to 57 above and remove and transfer to the new assembly:

- Both upper supports & brackets
- Lower support & rubber mounts
- Shroud support bracket
- Lower hinge & hinge bracket

Torque all brackets to specified torque.

**TORQUE: 9 lb-ft (12 Nm)**

**NOTE**

Reinstallation of the cooling components as a complete assembly is recommended.

- Install fan shroud on the cooling pack frame then install complete assembly to vehicle structure.

59. Lay the cooling pack horizontally at working height (use large workbench or sawhorses) exterior face pointing up.

60. Install fan shroud in position over the cooling pack (make sure the lower hinge is correctly assembled with plastic bushing in place).

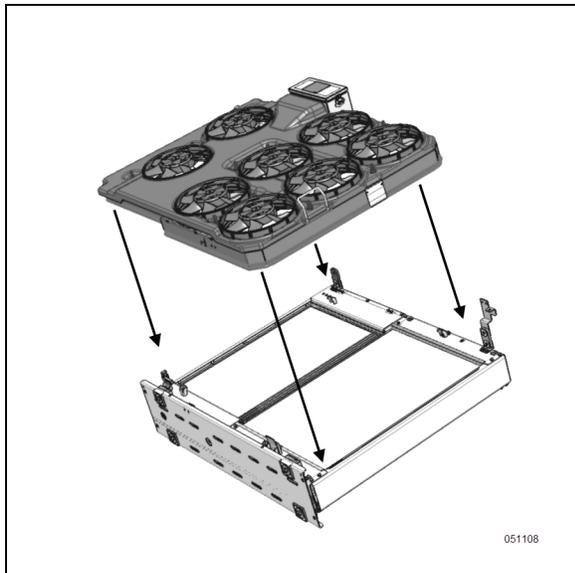


FIGURE 54: FAN SHROUD POSITIONING

61. Partially screw down the both upper and lower shroud hold down screws to position the shroud

62. Loosely install the hinges.

63. Adjust the shroud in its final position.

- There should be no gaps between the hinge pivot point and the plastic bushing (upper & lower hinges).

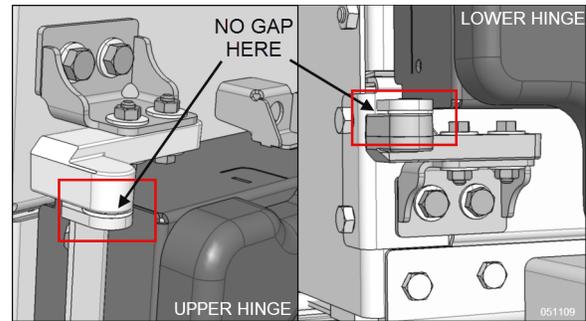


FIGURE 55: SHROUD HINGES INSTALLATION

- The bottom of the shroud should fit flat (parallel) against the shroud lower support.

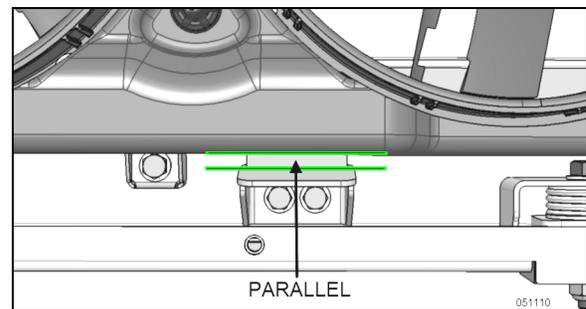


FIGURE 56: FAN SHROUD PARALLEL TO SUPPORT

64. Tighten hinges and hold down bolts.

**TORQUE: 68 lb-in (8 Nm)**

65. Put back the cooling assembly in its vertical position on a small lift table.

66. Reinstall the upper CAC and radiator pipe sections (including bracket and hardware).

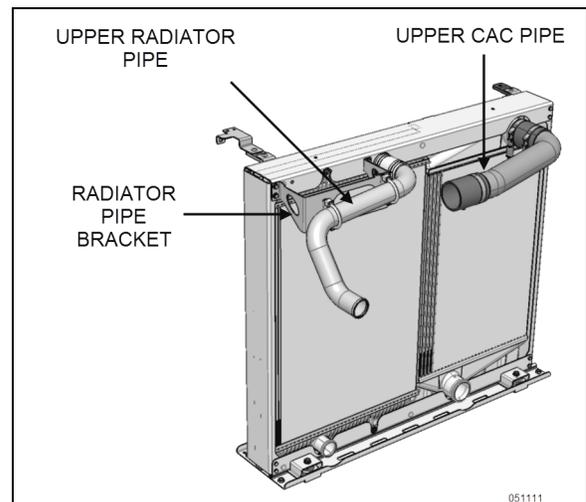


FIGURE 57: INSTALLED RADIATOR & CAC UPPER PIPES

67. Slide back the cooling assembly into position and reverse removal procedure to reinstall in vehicle.
68. Make sure that there is no conductivity between the CAC/radiator units and the cooling pack frame (see note at the beginning of paragraph 11.4).
69. Fill the vehicle cooling system.
70. Set engine stop button to the ON position (depressed), start the engine and check for coolant leaks.

### 11.6 CHARGE AIR COOLER (CAC) IN VEHICLE REMOVAL

In the event that the charge air cooler (CAC) would require replacement or in cases where access to the engine hot side and/or turbocharger would be required. It is possible to remove the CAC from the vehicle without removing the complete cooling pack thereby eliminating the need to drain and refill the vehicle cooling system.

#### **NOTE**

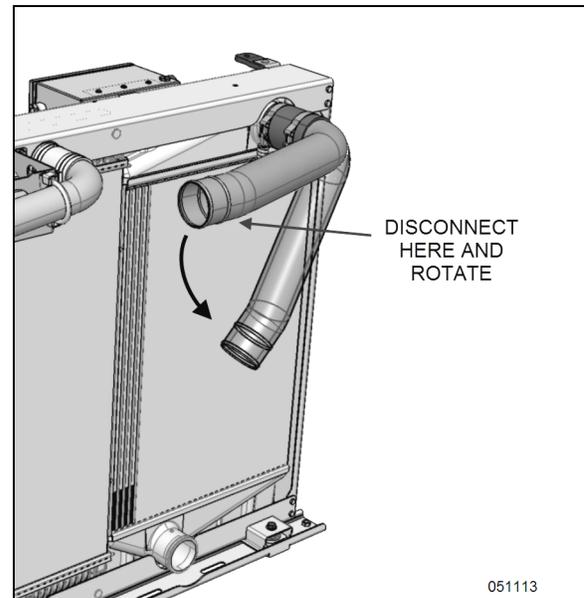
*Spec for CAC acceptable leakage:*

*The CAC is considered acceptable if it can hold 30 psi (206 kPa) gauge pressure with less than 1 psi (6.9 kPa) loss in 60 seconds.*

*This spec does not apply if there is any evidence that the leak was caused by a foreign object impact.*

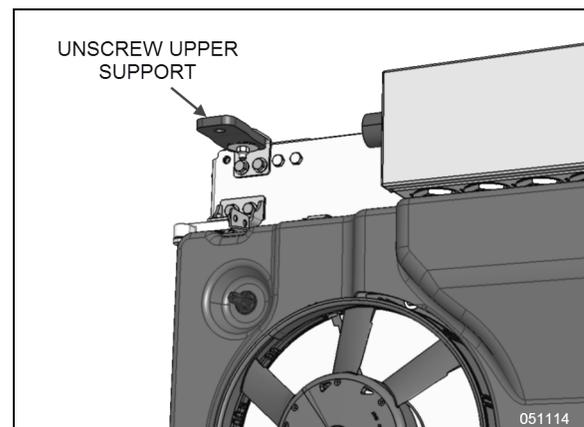
1. Open rear engine compartment door.
2. Set engine stop button to the OFF position (push).
3. Proceed to the cooling fan shroud removal following paragraph 11.3 of this section.
4. Disconnect the lower CAC pipe (directly at the CAC connection or at the turbo connection).

5. Disconnect the upper CAC pipe: On the X3 Series, it is possible to disconnect the pipe middle section junction and loosen the hose clamps at the CAC connection to pivot down the pipe (to clear radiator). The H3 Series upper CAC pipe is a one piece unit and must be disconnected directly at the CAC connection.



**FIGURE 58: ROTATE CAC UPPER PIPE (X3 SERIES ONLY)**

6. Unscrew the upper cooling pack support from the vehicle structure (CAC side support only).



**FIGURE 59: UPPER SUPPORT (CAC SIDE)**

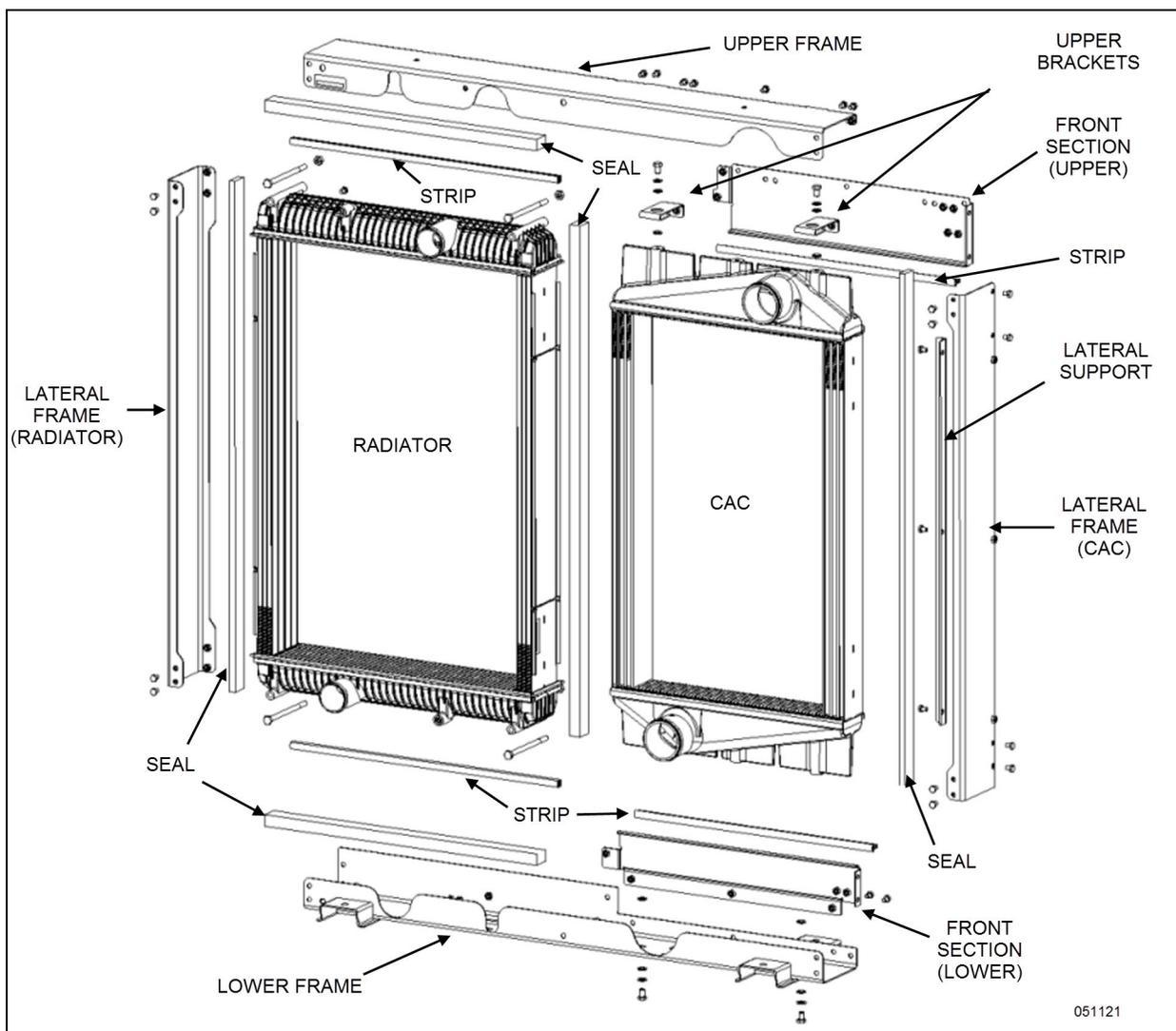


FIGURE 60: COOLING PACK EXPLODED VIEW

7. Remove CAC upper front frame structure by unscrewing the 11 hex bolts holding it.

8. Remove the CAC lower front frame structure by unscrewing the 8 hex bolts holding it.

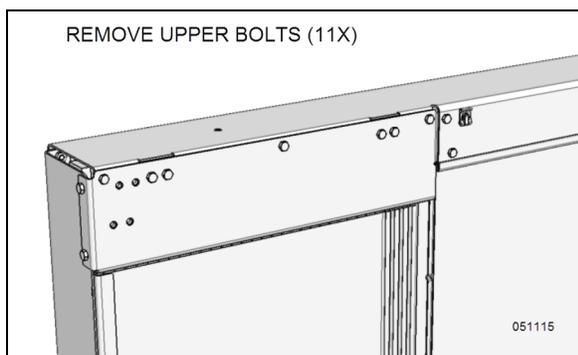


FIGURE 61: UPPER FRAME BOLTS

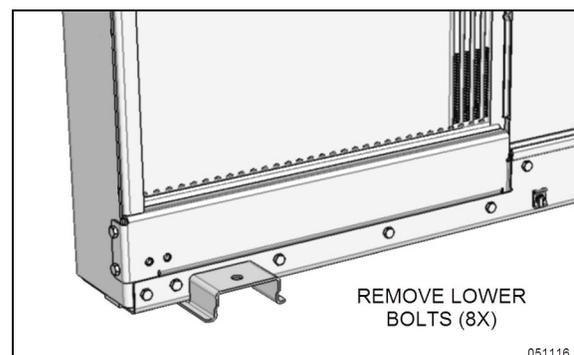


FIGURE 62: LOWER FRAME BOLTS

- Also remove the CAC lateral support (3 hex bolts).

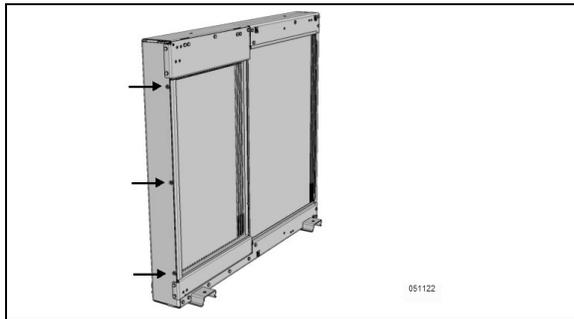


FIGURE 63: CAC LATERAL SUPPORT BOLTS

- From under the vehicle, unscrew the CAC from the lower support (two hex bolts with plastic insulating bushings).

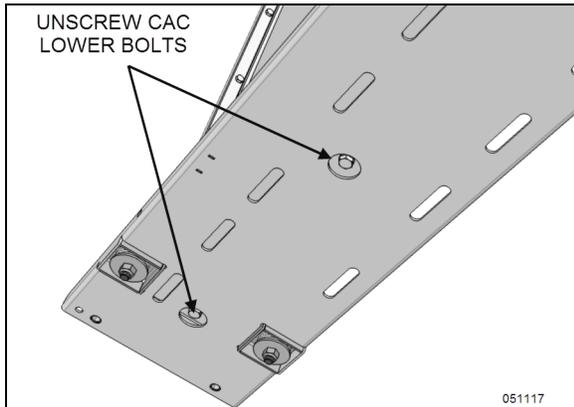


FIGURE 64: LOWER CAC INSULATED BOLTS

- Remove CAC (and two upper brackets) from the vehicle.
- If a new CAC is to be installed, transfer the upper CAC pipe (X3 Series only) and upper brackets to the new unit. Torque upper brackets with plastic bushings & washers to specified torque. Also reinstall the lower CAC pipe if it was previously removed with the CAC unit.

**TORQUE: 9 lb-ft (12 Nm)**

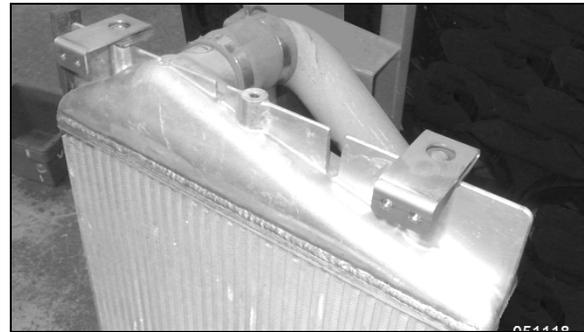


FIGURE 65: CAC UPPER BRACKETS & PIPE



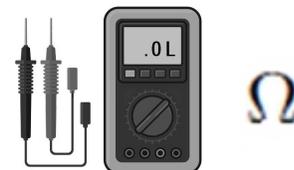
**WARNING**

To prevent galvanic corrosion, the CAC upper brackets need to be electrically insulated from the CAC body.

When reinstalling brackets, make sure the plastic insulating bushings (two per bracket) & washers (one per bracket) are present and in good condition (replace as necessary).



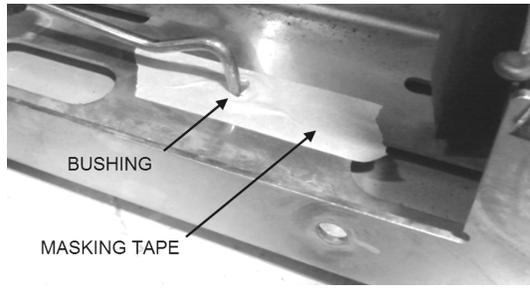
After installation, check for proper insulation (lack of conductivity) between brackets and CAC body with a suitable ohmmeter or continuity tester (buzzer).



- In preparation for reinstallation of the CAC, install the inner insulating bushings in their location (lower support).

**NOTE**

To ease installation and ensure that the bushings will not move during reinstallation, use masking tape to hold the inner bushings to the lower support.



14. Install CAC on the vehicle and secure to the lower support using both lower hex bolts, washers and remaining plastic insulating bushings.

**TORQUE: 9 lb-ft (12 Nm)**

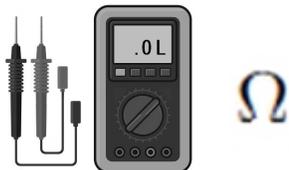
**WARNING**

To prevent galvanic corrosion, the CAC is electrically insulated from the support by the use of plastic insulating bushings.

When reinstalling brackets, make sure the plastic insulating bushings (two per bracket) & washers (one per bracket) are present and in good condition (replace as necessary).



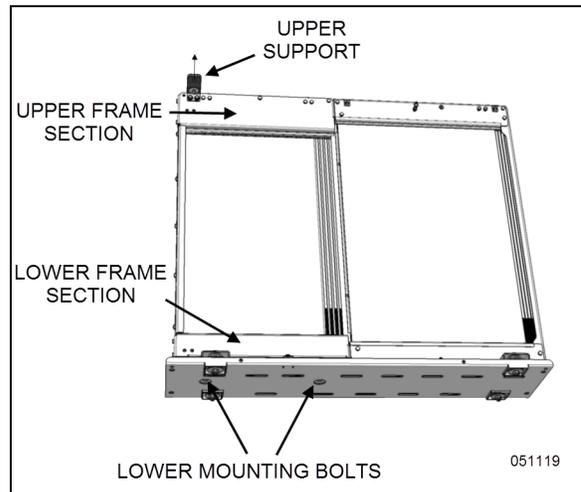
After installation, check for proper insulation (lack of conductivity) between support and CAC body with a suitable ohmmeter or continuity tester (buzzer).



15. Reinstall both (upper and lower) front frame sections.

**TORQUE: 9 lb-ft (12 Nm)**

16. Secure upper support to the vehicle structure.



**FIGURE 66: CAC IN VEHICLE**

17. Double check for lack of continuity between CAC body and vehicle structure (see note at the beginning of paragraph 11.4 for reference).
18. Reconnect upper CAC pipe and tighten hose clamps at both ends.
19. Reconnect lower CAC pipe.
20. Proceed to the fan shroud reinstallation (refer to paragraph 11.3 earlier in this section).
21. Set engine stop button to the ON position (depressed) and start the vehicle.
22. Check for CAC leakage at the pipe connections.

**12. SPECIFICATIONS****Cooling System Capacity (Approximation)**

H3 Series (incl. heating system).....	26 US gal (99 liters)
X3 Series (incl. heating system).....	22.5 US gal (85 liters)

**Cooling System Fans**

Number used .....	8
Diameter .....	12 in (30.5 cm)
Power .....	850W
Voltage (nominal) .....	24 Volts
Voltage (operating range).....	16-32 Volts
Maximum speed .....	4760 rpm
Sealing .....	SAE J1455 IP67 / IP69K
Operating temperature range .....	-40 to 138°F (-40 to 59°C)

**Thermostat - Volvo D13 Engine**

Number used .....	1
Start to close .....	203°F (95°C)
Fully closed .....	185°F (85°C)

**Coolant (ELC) - Volvo D13 Engine**

Volvo Number .....	20358716
Texaco CPS .....	227998
Chevron CPS .....	227811

**Coolant Filter Cartridge – Volvo D13 Engine**

Number used .....	1
Type .....	Spin-on
Prevost number .....	20458771