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## 1. DESCRIPTION

A radiator and thermo-modulated fan are used to effectively dissipate the heat generated by the engine. A centrifugal-type water pump is used to circulate the engine coolant.

One full blocking-type thermostat is used in the water outlet passage to control the flow of coolant, providing fast engine warm-up and regulating 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 air streams created by the revolving fan 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 cooling system is filled through a filler cap on the surge tank (Figure 1). A Pressure cap is also used to maintain pressure within the system. When system exceeds normal pressure rating (13 psi – 89.63 kPa), the cap releases air and if necessary, coolant through the overflow tube (Figure 1). A pressure relief valve is also provided to depressurize the system before servicing. The thermostat is located in the housing bolted to the engine on the L.H. side.

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

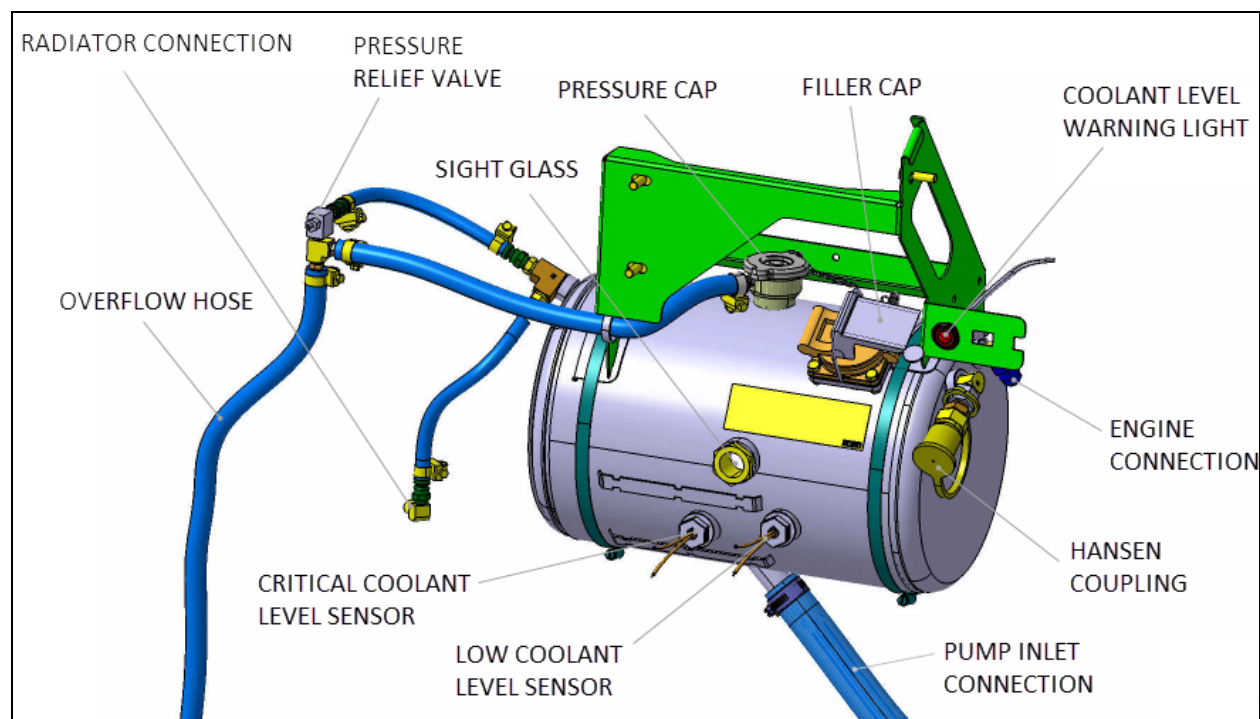


FIGURE 1: COOLANT SURGE TANK

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## 2. MAINTENANCE

### 2.1 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 tank daily and correct if required. Test antifreeze strength.
- Check belts for proper tension; adjust as necessary and replace any frayed or badly worn belts.
- 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.
- Pressurize system periodically using Hansen Quick Coupling (Figure 2).

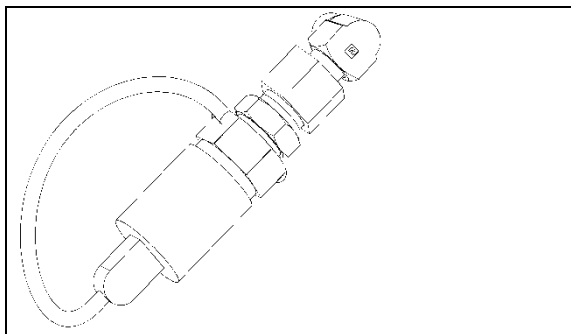


FIGURE 2: HANSEN QUICK COUPLING

#### 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 10-15 psi using Hansen Quick Coupling. Do not exceed 15 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.*

Leaks at the thermostat housing hose connections may be caused by deformation of

connections or by rough surfaces on the castings of the hose mounting surfaces. It is recommended that "Dow Corning RTV-102 Compound" or any equivalent product be applied on cast surfaces prior to hose installation.



#### CAUTION

Castings should be clean and free of oil and grease before applying compound. No other sealer should be used with RTV-102 compound.

### 2.2 MTA VEHICLES EQUIPPED WITH VOLVO D13 ENGINE

#### NOTE

*For additional information concerning Volvo D13 engine components or engine-related components, consult 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.*



#### MAINTENANCE

Drain, flush, thoroughly clean and refill the system with Fleet Charge 50/50 Fully Formulated Coolant every two years or every 100,000, whichever comes first. Change the coolant filter every 12,000 miles. When using Fleet Charge 50/50, use a filter that contains Supplemental Coolant Additives (SCA).

## 3. 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.

When installing a new hose, clean pipe connections and apply a thin layer of a non-hardening sealing compound. Replace worn out clamps or clamps that pinch hoses.

### 3.1 HOSE CLAMPS ON COOLANT LINES

All hose clamps used on the heating and cooling systems have a spring function (spring in the

housing) to compensate for the normal expansion/contraction of a hose and metal connection that occurs during vehicle operation and shutdown. These clamps are worm-driven, made of stainless steel.

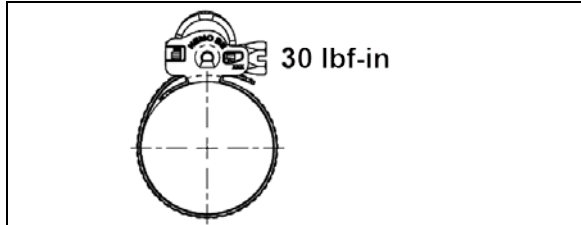


FIGURE 3: CLAMP TYPE USED ON HEATING & COOLING SYSTEMS

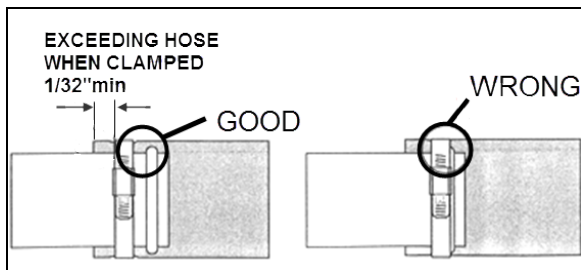


FIGURE 4: PROPER HOSE CLAMP INSTALLATION

All connections equal or greater than of 2-in 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. The recommended torque for these clamps is **30 lbf-in at room temperature**.

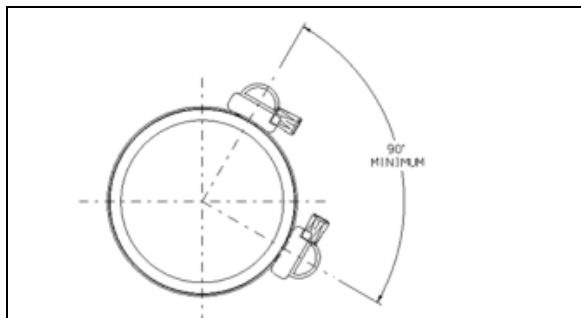


FIGURE 5: DOUBLED CLAMP POSITIONING

**CAUTION**

Do not over-tighten, especially during cold weather when hose has contracted.

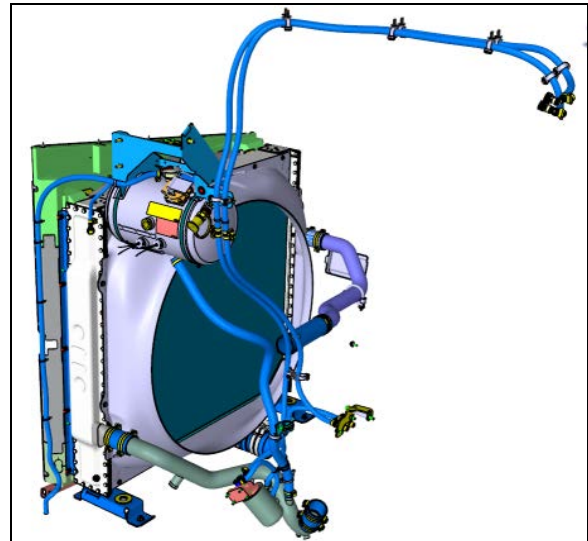


FIGURE 6: COOLANT FLOW TO RADIATOR (VOLVO D13)

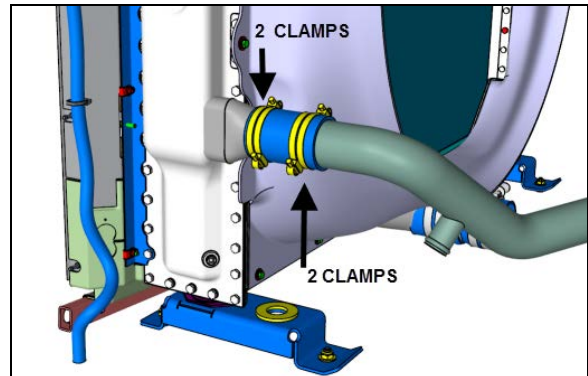


FIGURE 7: COOLANT LINE TO THE RADIATOR

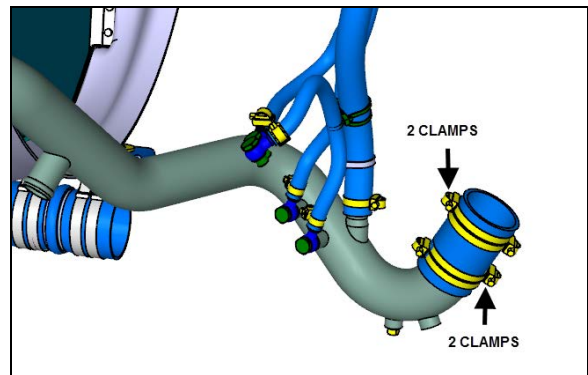


FIGURE 8: COOLANT LINE CONNECTED TO PUMP OUTLET

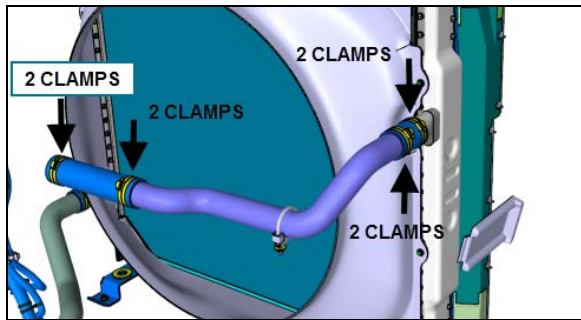


FIGURE 9: COOLANT LINE AT THE RADIATOR OUTLET

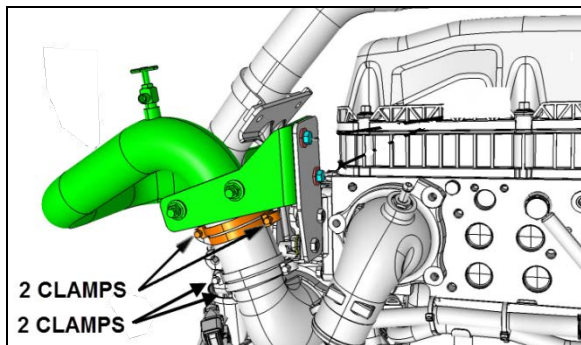


FIGURE 10: COOLANT LINE AT PUMP INLET

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

If for any reason such as an accident, hose clamps need to be changed; install and tighten hose clamps to **60 lbf-in** (dry) (Figure 11).



#### CAUTION

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

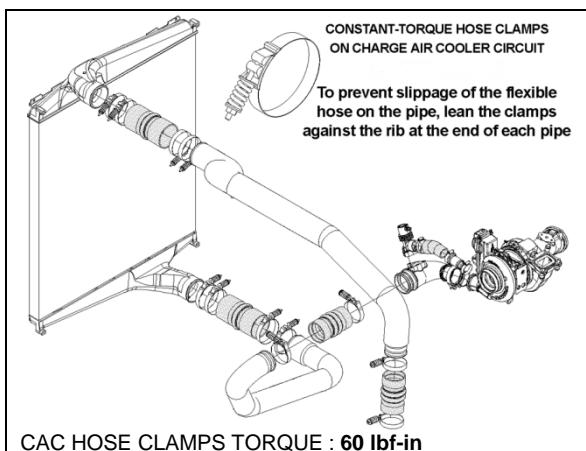


FIGURE 11: CHARGE AIR COOLER HOSE CLAMPS -

### 3.2.1 Maintenance

Since the constant-torque clamp automatically adjusts to keep a consistent sealing pressure, there is no need to torque again 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.**

## 4. THERMOSTAT OPERATION

1. Drain the cooling system.
2. Remove the bolts, the thermostat housing and the thermostat. Carefully clean the thermostat seat and all cylinder head-to-thermostat housing mating surfaces.

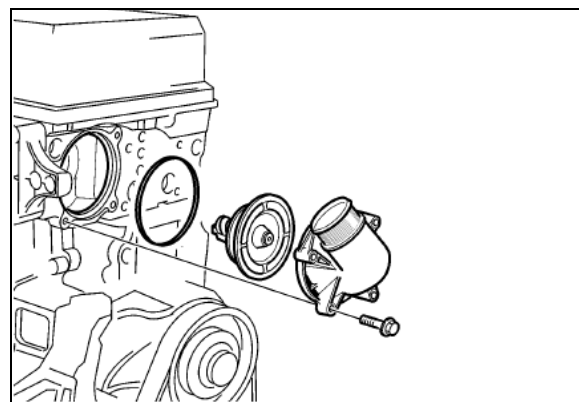


FIGURE 12: VOLVO D13 THERMOSTAT HOUSING

3. Install the new thermostat. Make sure that the rubber seal remains properly seated.
4. Position the thermostat housing to the cylinder head, install the bolts and torque-tighten to  $24 \pm 4$  Nm ( $18 \pm 3$  ft-lb).
5. Install the rubber radiator hose to the thermostat housing. Position the clamp and tighten to secure.
6. Fill the system with the recommended coolant.
7. Start the engine, check for leaks and proper operation. After shutdown, replenish fluids as necessary.

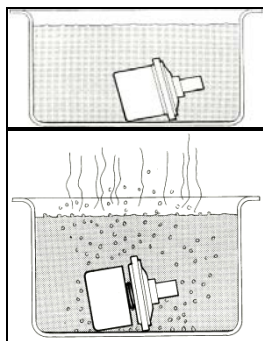
### 4.1 CHECKING THERMOSTAT

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

**NOTE**

Check to be sure that the 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 (9/32"). 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).

## 5. COOLANT

### 5.1 COOLANT LEVEL VERIFICATION

Check the coolant level when the engine is cold (room or ambient temperature).

If the coolant level has reached the bottom of the sight glass, add coolant up to the middle of the sight glass.

Fill the tank as required with the same 50/50 water-antifreeze mixture already in the cooling system. **Do not** mix two different types of coolant. Refer to the Maintenance Manual for proper coolant type specifications or see the label affixed near the coolant surge tank on the vehicle.

When the coolant level reaches the low coolant sensor, the red warning light located next to the tank in the engine compartment will illuminate to indicate the need to add coolant to the system.

If the coolant level reaches the coolant surge tank critically low level sensor, the STOP telltale light illuminates, a beeping tone is heard and "ENGINE COOLANT LEVEL CRITICALLY LOW" message appears in the DID. Stop the vehicle in a safe location and add coolant to the cooling system surge tank as soon as possible.

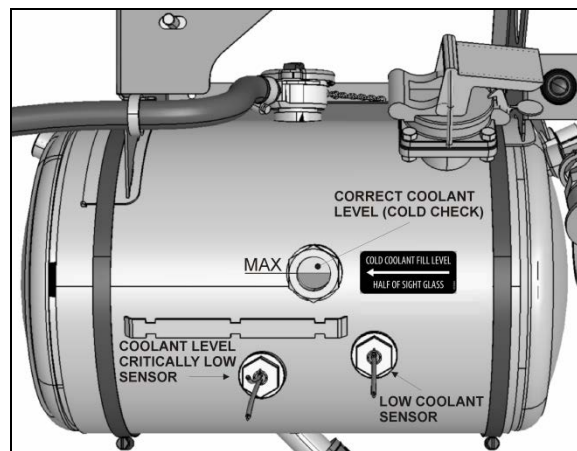


FIGURE 13: COOLANT LEVEL SIGHT GLASS

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### WARNING

Hot engine coolant is under high pressure. Allow engine to cool down before adding coolant.

### 5.2 COOLANT LEVEL SENSORS

This warning device consists of two fluid level probes mounted on the surge tank. The first probe (upper) is a low coolant level warning and will send a signal to the indicator light located near the tank in the engine compartment (Figure 1).

The second probe (lower) is a critically low coolant level warning and will send 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.

Both level probes are mounted on the front of the surge tank (Figure 13).

### 5.3 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 thawed, check engine, radiator and related components for damage caused by expansion of frozen coolant fluid.

### 5.4 COOLING SYSTEM RECOMMENDATIONS

Always maintain cooling system at the proper coolant level. Check daily.

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.

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. Coolant must therefore be carefully selected and properly maintained.

Select and maintain coolant in order to meet the following basic requirements:

- Provide for adequate heat transfer.
- Provide protection from cavitation damage.
- Provide a corrosion and erosion resistant environment within the cooling system.
- Prevent formation of scale or sludge deposits in the cooling system.
- Be compatible with the cooling system hose and seal materials.
- Provide adequate freeze protection during cold weather operation.

When freeze protection is required, a mixture of suitable water and antifreeze containing adequate inhibitors will provide a satisfactory coolant fluid.

Freeze protection down to:	Boiling up protection to:	% of antifreeze in mixture
-10°F (-25°C)	259°F (126°C)	40%
-34°F (-38°C)	265°F (129°C)	50%
-62°F (-46°C)	270°F (132°C)	60%

### 5.5 COOLANT RECOMMENDATIONS FOR MTA COACHES EQUIPPED WITH VOLVO D13 ENGINE

Fleet Charge Fully formulated Coolant mixture consisting of 50/50 antifreeze solution 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.

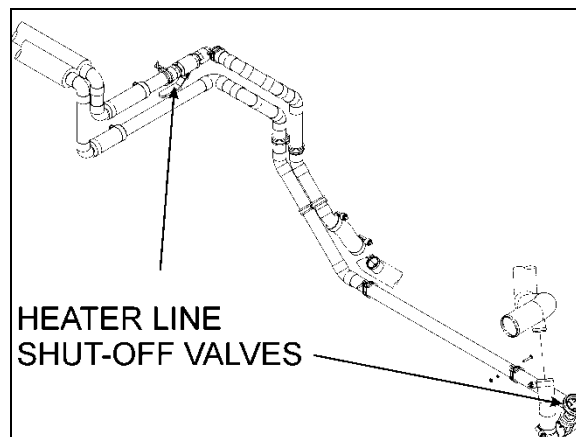


FIGURE 14: LOCATION OF HEATER LINE SHUT-OFF VALVES IN ENGINE COMPARTMENT 05105



## 5.6 COOLANT SAMPLING

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

**NOTE**

*The following procedure is provided for reference only.*

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

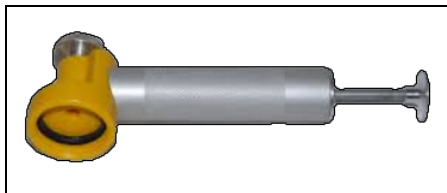
**WARNING**

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*.

Typical material required:

- Hand Vacuum Pump w/ bottle provision



- Sample bottle
- Plastic tube (1/4 "refrigerator" tube)
- Nitrile gloves
- Security 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 1 for location of cap.
2. Thread the sample bottle to the pump. Hand tighten.
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.

## 6. 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- 45 coaches, the valves are located in the engine compartment. One is located under the radiator fan drive mechanism support; another valve is on the L.H. side of the engine compartment in front of the radiator (Figure 14).

### NOTE

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



### 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.
4. Unscrew the surge tank pressure cap counterclockwise, ¼ turn to let air enter the system and permit the coolant to drain completely from system.
5. Connect coolant extractor (Figure 15). 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.

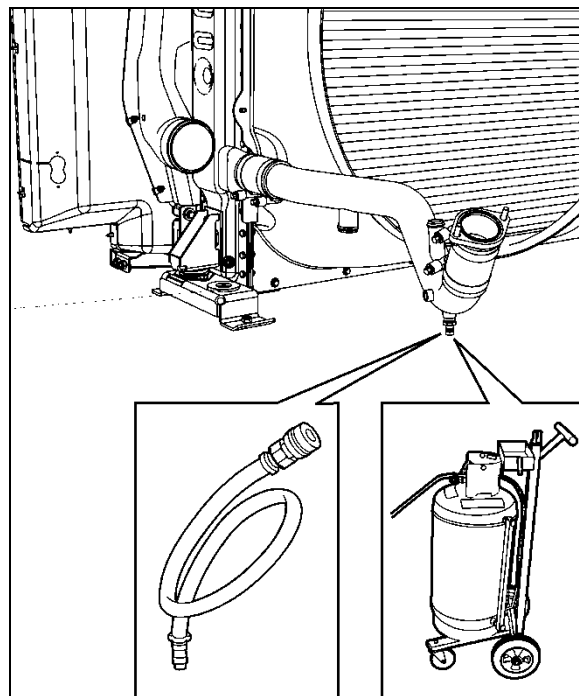


FIGURE 15: EXTRACTING COOLANT

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



### CAUTION

Drain water pump completely before extended storage to avoid possible water pump damage.

If freezing weather is anticipated and the engine is not protected with antifreeze, drain the cooling system completely when 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 shut-off valves in the open position; then follow the procedure under "Draining Heating System" in Section 22.

**7. 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:


1. Close radiator drain cock.
2. Open the shut-off valve on the coolant filter mounting head.
3. **Refill cooling system from the surge tank filler cap** inlet with Fleet Charge Fully Formulated universal formula antifreeze 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.*

4. Add coolant up to the top of the sight glass.
5. Close the filler and 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 critically low level probe, the Check Engine warning light will illuminate.*

6. Stop engine and allow cooling.
7. Open the two heater line shutoff valves, check the coolant level in the surge tank, and then 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".

**8. 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 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.

**COOLING SYSTEM CAPACITY (approximation)**  
 Includes heating system: 24 US gal (91 liters)

**8.1 COOLING SYSTEM DESCALERS**

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

Remove scale formation by using a reputable and safe de-scaling solvent. Immediately after using the de-scaling solvent, neutralize with a neutralizing agent. It is important that product directions be thoroughly read and followed.

After using the solvent and neutralizer, fully drain the system, and then reverse flush the engine and radiator (see "Reverse Flushing" in this section) before filling the system with coolant solution.

**8.2 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 15 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 or 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.

**9. SPIN-ON COOLANT FILTER**

The engine cooling system filter is used to filter out impurities such as scale or sand from the coolant and it also eliminates the process of adding inhibitors to the antifreeze/water solution. The filter is mounted onto the cooling fan drive mechanism aluminum casting (Figure 16)

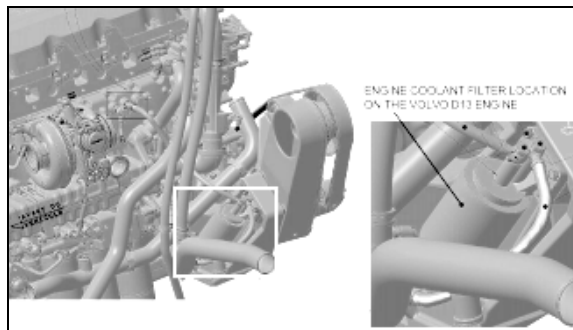


FIGURE 16: COOLANT FILTER (VOLVO D13)

05145

To replace a filter:

**WARNING**

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

1. Close the filter shutoff valve on the filter mounting head. The shutoff valve can be reached behind the fan pulley (Figure 17)

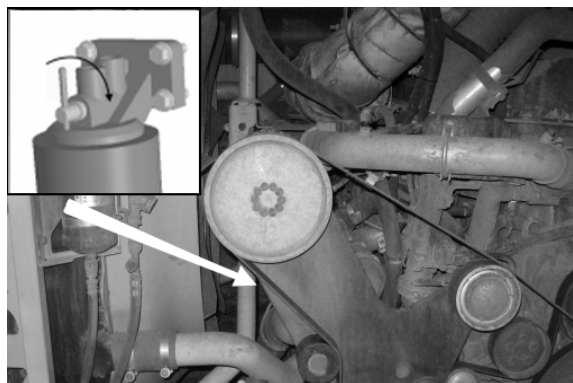



FIGURE 17: ACCESS TO FILTER SHUT OFF VALVE

2. From under the vehicle, unscrew the filter using a suitable filter wrench and discard the filter. Recover the coolant remaining in the filter in a suitable container.
3. Clean mounting base making sure the "O" ring from the old filter is not stuck to the filter mount.
4. Coat surface of gasket with a light coat of clean antifreeze.


5. Screw new filter on until gasket reaches base contact. Then tighten according to instructions on filter (usually around 2/3 turn).
6. Open the filter shutoff valve.
7. Start engine and check for leaks.



### MAINTENANCE

#### VOLVO D13 ENGINE

Replace the coolant filter cartridge after 12,000 miles to prevent external rust damage to the filter walls. Use a coolant filter containing Supplemental Coolant Additives (SCA).



### CAUTION

Do not exceed recommended service intervals.

## 10. RADIATOR

The radiator is mounted on the L.H. side of engine compartment. It is designed to reduce the temperature of the coolant under all operating conditions. It is essential that the radiator core be kept clean and free from corrosion and scale at all times.

### 10.1 MAINTENANCE

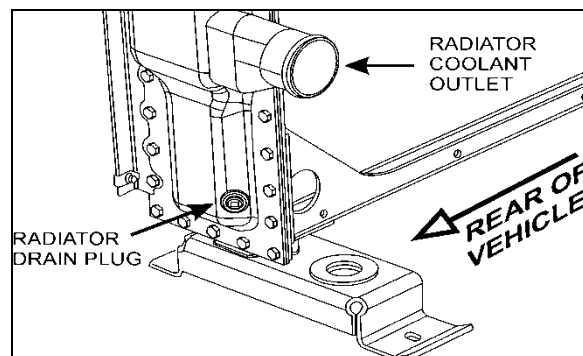



FIGURE 18: RADIATOR DRAIN PLUG

05139




### MAINTENANCE

Inspect the exterior of the radiator core every 50,000 miles. Clean with a quality grease solvent, such as a mineral spirits and dry with compressed air. Do not use fuel oil, kerosene, gasoline, or any caustic material. It may be necessary to clean the radiator more

frequently if the vehicle is operated in extremely dusty or dirty areas. Refer to coolant system flushing and reverse flushing in this section for maintenance of radiator interior.

### 10.2 RADIATOR REMOVAL & INSTALLATION

1. Apply the parking brake and shift the transmission to neutral. Shut off all electrical loads. Turn the ignition switch to the OFF position.
2. Open engine compartment doors.
3. Set starter selector switch to the OFF position.
4. Connect coolant extractor (Figure 15). 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.
5. Raise L.H. side hinged rear fender.
6. Remove tag axle L.H. side wheel.



### 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.

7. Unfasten 4 cap screws and remove access panel located behind tag axle L.H. side wheel (refer to figure 14).

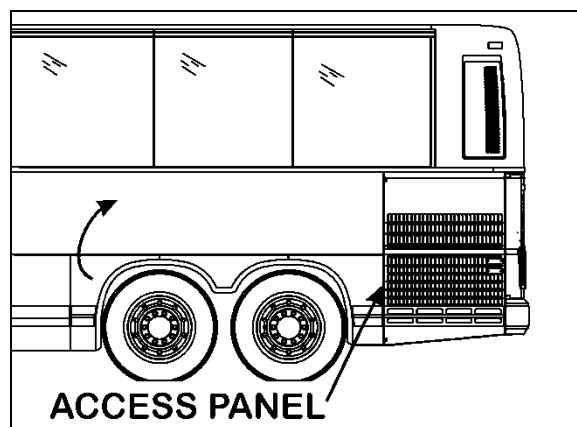


FIGURE 19: ACCESS PANEL (TYPICAL)

8. Open radiator door to access radiator assembly. Unfasten upper arm assembly.
9. Remove radiator sealing frame.

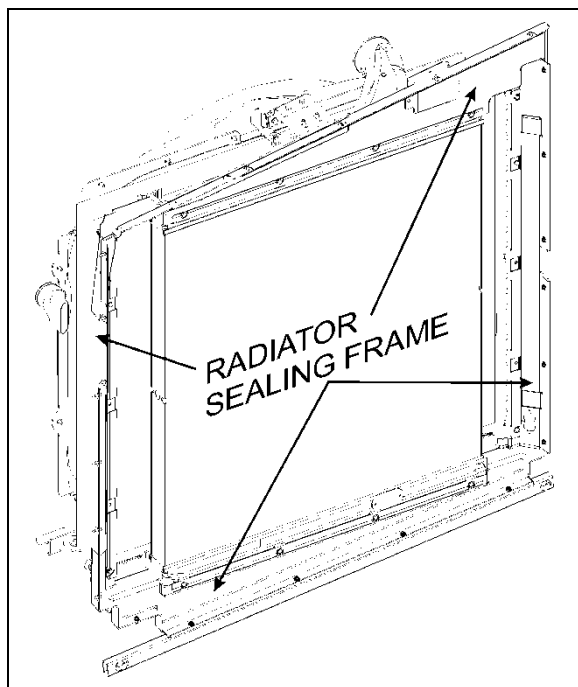


FIGURE 20: RADIATOR SEALING FRAME

10. Remove clamps and then break hoses from the front coolant and charge air pipes (Figure 21).

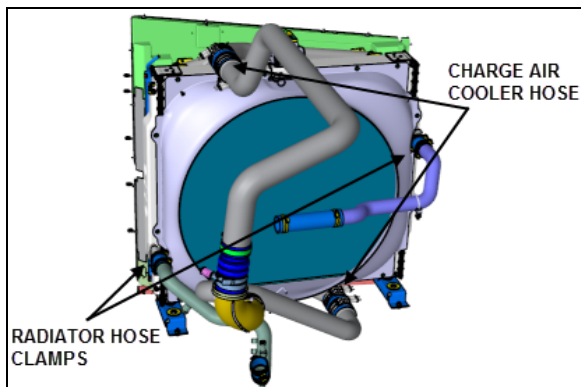


FIGURE 21: RADIATOR & CHARGE AIR COOLER HOSE CLAMPS

11. Remove rear coolant and charge air hose clamps then break hoses loose.
12. Remove the upper radiator assembly support bracket (Figure 22).

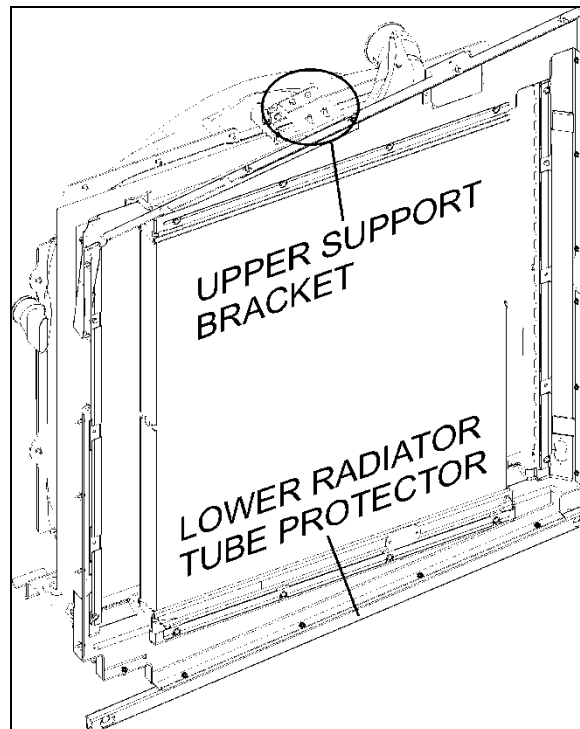


FIGURE 22: UPPER SUPPORT BRACKET & TUBE PROTECTOR

13. Remove the lower radiator assembly tube protector from the lower section (Figure 22).
14. Remove all lower radiator assembly mounting fasteners.

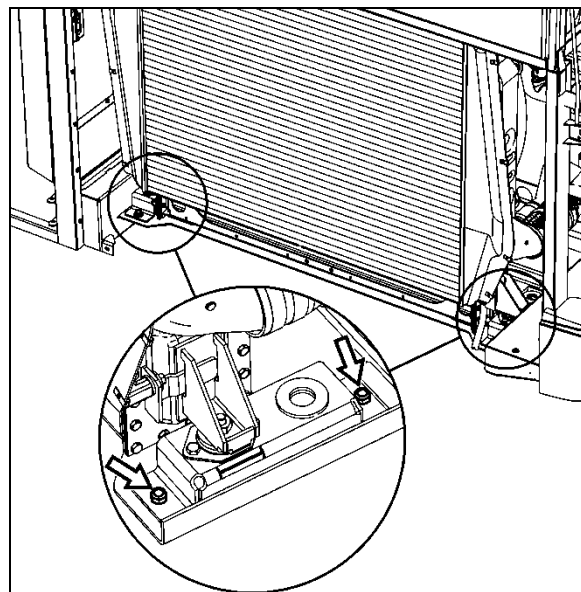


FIGURE 23: RADIATOR ASSEMBLY LOWER MOUNTING FASTENERS

15. Cut cable tie and disconnect electrical connector from fan clutch. Remove fan drive shaft fasteners at the gear box.

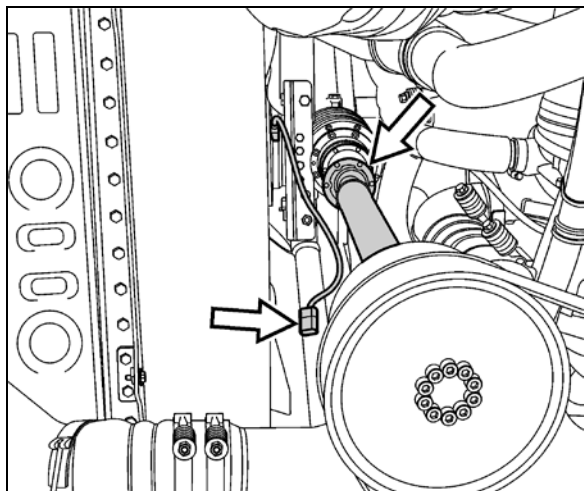


FIGURE 24: DISCONNECTING FAN DRIVE SHAFT

16. Position a forklift under the radiator assembly that is capable of safely lifting the radiator.

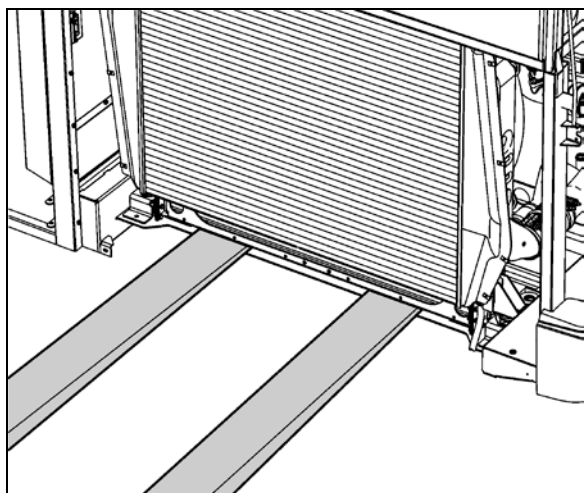


FIGURE 25: POSITIONING FORKLIFT

17. With assistance, slide radiator assembly out and onto the forklift. Transfer radiator assembly to a secure location.
18. Separate charge air cooler from radiator.
19. Lay radiator face down. Remove the fasteners that connect lower radiator mounts to radiator.

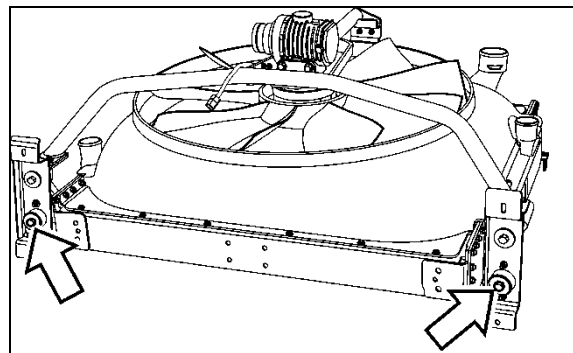


FIGURE 26: REMOVING FASTENERS

20. Remove upper fan drive support bracket from the upper section of the radiator.

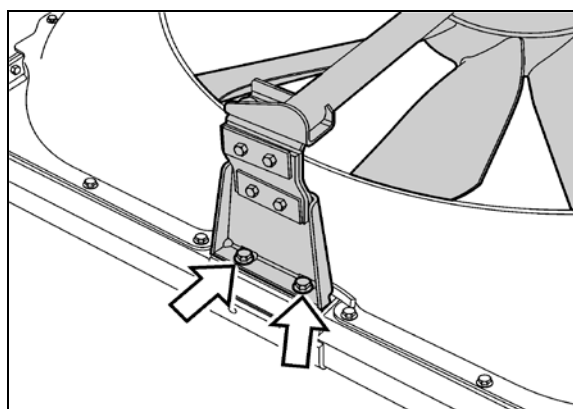


FIGURE 27: REMOVING UPPER FAN DRIVE SUPPORT BRACKET

21. With assistance, remove fan drive and drive frame from radiator.
22. Remove fan shroud from radiator.

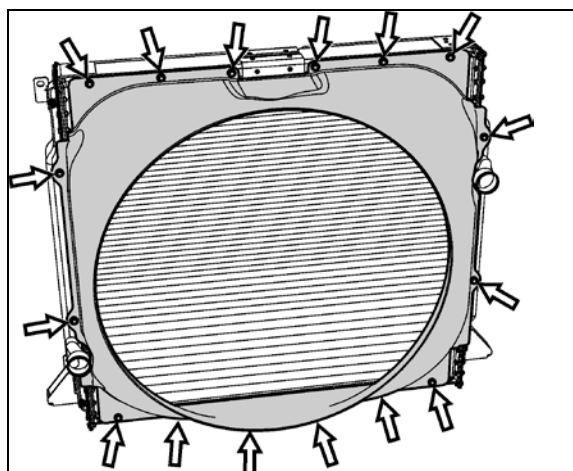


FIGURE 28: REMOVING FAN SHROUD FROM RADIATOR

23. Reverse removal procedure to reinstall radiator assembly.

**11. CHARGE AIR COOLER LEAKAGE**

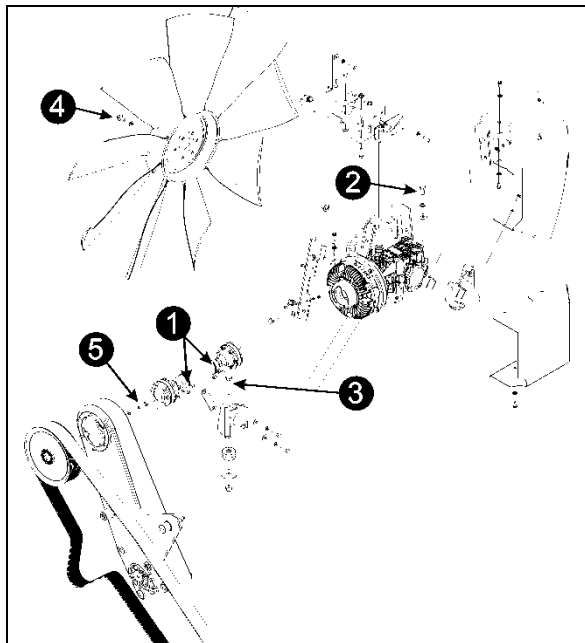
Spec for CAC acceptable leakage:

“The CAC is considered acceptable if it can hold 30 psi (206 kPa) gauge pressure with less than 5 psi (34.5 kPa) loss in 15 seconds after turning off the hand valve.”

**NOTE**

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

**12. COOLING FAN DRIVE MECHANISM**



COOLING FAN DRIVE INSTALLATION

Ref	Note	Torque lbs-ft
1	Use Loctite 243	16 (12x)
2		60 (4x)
3		35 (2x)
4		32 (6x)
5	Use Loctite 243	16 (6x)

FIGURE 29: COOLING FAN DRIVE MECHANISM 05123B

**12.1 MOUNTING THE DRIVE BELT**

To install the cooling fan drive belt, proceed as follow:



**WARNING**

Turn the ignition switch and set rear start selector switch to the OFF position to prevent accidental starting of the engine.



**WARNING**

Potential Accident Risk. Always use extreme caution when working in the vicinity of hot, rotating or moving parts.

1. Wrap the new drive belt around the fan drive mechanism pulley, the idlers and the automatic tensioner idler as shown on figure 26.

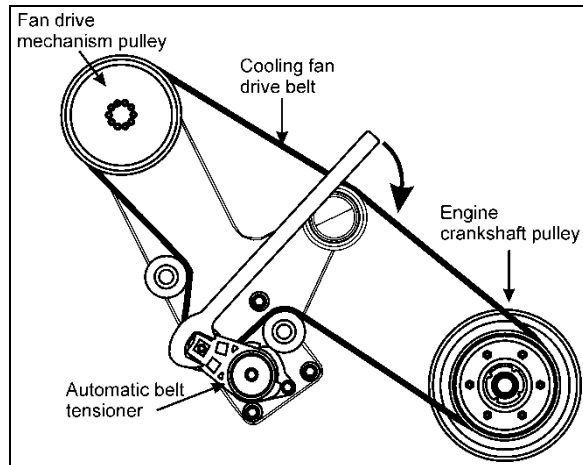


FIGURE 30: DRIVE BELT ROUTING (VOLVO D13 ENGINE)

2. Rotate the automatic tensioner in clockwise direction to relieve tension on the belt and hold the tensioner in that position (Figure 30).
3. Finally, place the drive belt around the engine crankshaft pulley.
4. Release the tensioner slowly and let it return to its natural position.

**12.2 DRIVE PULLEY AND UNIVERSAL JOINT SHAFT**

To disconnect the universal shaft, proceed as follow:



**WARNING**

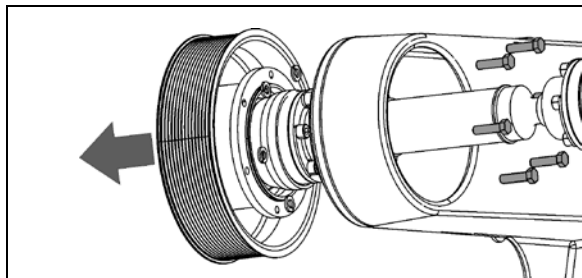
Turn the ignition switch to the OFF position and set rear start selector switch to the OFF position to prevent accidental starting of the engine.

1. Unwrap the drive belt from around the pulley (see paragraph MOUNTING THE DRIVE BELT).
2. Dismount the fan drive pulley. Gain access to the 6 mounting bolts from behind the pulley, through the opening in the cast aluminum support (Figure 31).



3. Unscrew and remove the universal joint shaft mounting bolts (6 bolts) at the fan clutch.
4. Pull the shaft toward the rear of the vehicle.
5. Finally, dismount the universal joint shaft from the fan drive pulley (6 bolts).

Installation of the universal joint shaft is the same as removal, but in reverse order.



**FIGURE 31: DISMOUNTING FAN DRIVE PULLEY** 05123C

### 12.3 IDLER REPLACEMENT

If an idler is defective, replace as follow:

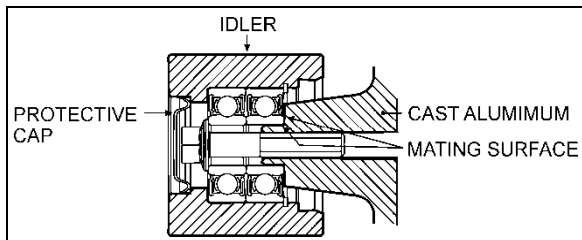
**⚠ WARNING**

Turn the ignition switch to the OFF position and set starter selector switch to the OFF position to prevent accidental starting of the engine.

1. Remove the protective cap (replace with a new one).
2. Unscrew the idler mounting bolt.
3. Replace idler with a new one.

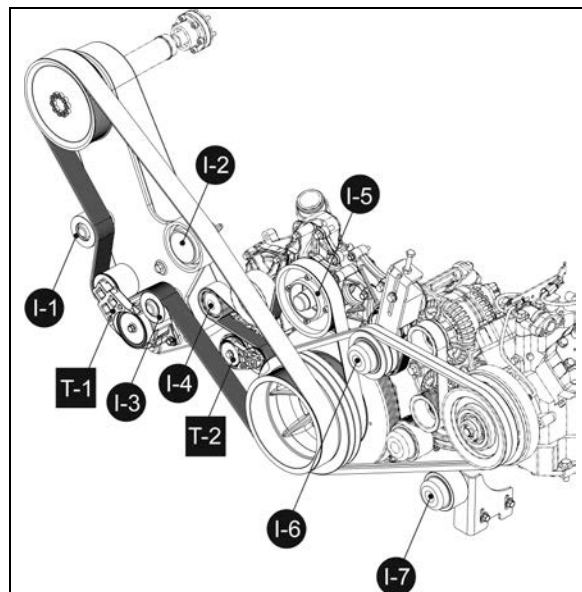
**⚠ CAUTION**

When installing the idler, make sure it rests perfectly against the bearing surface on the cast aluminum support. If not, the drive belt may slip of the idler. See following figure.



**FIGURE 32: IDLER MOUNTED ON THE CAST ALUMINUM SUPPORT**

4. Bolt the new idler on the cast aluminum support. Tighten as prescribed.
5. Place a new protective cap.





IDLERS		
Ref	System	Torque lbs-ft
I-1	cooling fan drive	50
I-2	cooling fan drive	32
I-3	cooling fan drive	50
I-4	water pump drive	43
I-5	water pump drive	16 (pulley) 32 (shaft)
I-6	A/C compressor drive	60
I-7	A/C compressor drive	74
AUTOMATIC BELT TENSIONERS		
Ref	System	Torque lbs-ft
T-1	cooling fan drive	32 (2x)
T-2	water pump drive	43


**FIGURE 33: TIGHTENING SPECIFICATION (VOLVO D13 ENGINE)**

### 13. VARIABLE SPEED FAN CLUTCH

The cooling fan clutch has two thermostatically controlled speeds, plus a neutral (clutch disengaged). The engine ECU controls the speed by comparing data from engine coolant temperature, charge air temperature, Allison transmission oil temperature (if applicable) and small A/C High side pressure to a set of calibration data. The fan drive clutch is electromagnetic; the engine control module sends an electric current to regulate speed by activating one magnetic coil for the first speed and two magnetic coils for the second speed.

The settings are:

	Engine coolant temp.	Air intake temp.	Allison trans. oil temp.
temperature rising 	208°F: fan engages in HIGH SPEED	194°F: fan engages in HIGH SPEED	230°F: fan engages in HIGH SPEED
	203°F: fan engages in LOW SPEED	176°F: fan engages in LOW SPEED	216°F: fan engages in LOW SPEED
temperature dropping 	203°F: fan HIGH SPEED disengages	189°F: fan HIGH SPEED disengages	225°F: fan HIGH SPEED disengages
	198°F: fan LOW SPEED disengages	170°F: fan LOW SPEED disengages	210°F: fan LOW SPEED disengages

 **WARNING**


DO NOT work near the fan with the engine running or the ignition switch in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.

### 13.1 LOCKING FAN CLUTCH FOR EMERGENCY OPERATION

#### 13.1.1 Electrical Locking

If the cooling fan clutch does not function due to an electrical control system malfunction and the engine is overheating, active the fan clutch execute the following procedure:

1. Turn the ignition switch to the ON position.
2. Activate the dashboard Telltale Light Test switch 3 times within 4 seconds.
3. In the engine compartment, set the starter selector switch to REAR START and then start the engine from the rear.

 **WARNING**

Potential Accident Risk. Always use extreme caution when working in the vicinity of hot, rotating or moving parts.

While in this mode, the rear start push-button can be used to manually engage the fan clutch. The multiplex system knows when the engine is

already running, and it will not activate the starter.

4. Press the push-button one time to engage the clutch to 1<sup>st</sup> speed, press a second time to engage to 2<sup>nd</sup> speed, press a third time to stop the fan, press once again to return to 1<sup>st</sup> speed.

You can activate the fan clutch through a Driver Information Display menu also. For more detail, refer to “Forced Activation of the Radiator Fan Clutch” paragraph in Section 06: ELECTRICAL.

**NOTE**

*If the fan clutch does not engage using this procedure then the clutch is faulty or the wiring between the multiplex module and the clutch is faulty. Mechanically lock the fan as described hereafter in section 13.1.2.*

#### 13.1.2 Mechanical Locking

Once mechanically locked, the fan is rigidly connected to the drive mechanism and will rotate continuously, with no considerations for the cooling needs. This is an emergency situation and the vehicle shall not be operated in that situation for an extended period.

In case of a magnetic clutch malfunction:

1. Turn the ignition switch to the OFF position and set starter selector switch to the OFF position to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Unscrew and remove the 4 spare M6x12 hex bolts screwed to the angle on the fan gearbox mounting support (see figure 30).
4. Screw in 4 hex bolts through the clutch anchor plate into the rotor. Using the automatic belt tensioner, release tension on the drive belt in order to be able to rotate the fan clutch drive mechanism by hand. Tightening torque: 7.5 lbf-ft.

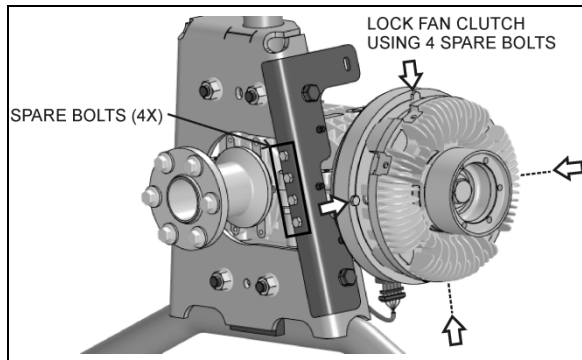


FIGURE 34: MECHANICAL LOCKING 05124

## 14. RIGHT ANGLE GEARBOX

The radiator fan is belt driven from the engine crankshaft pulley through a drive belt, a universal joint shaft, a clutch and right angle gearbox assembly.



### MAINTENANCE

Change the right angle gearbox oil every 100,000 miles. Replace seals at every oil change.

Use **Shell transmission oil MA 75W90**.

### 14.1 OIL CHANGE

1. Stop engine and make sure that all engine safety precautions have been observed.
2. Set the ignition switch and set rear start selector switch to the OFF position to prevent accidental starting of the engine.
3. Clean gear case carefully.
4. Remove the drain plug located underneath the right angle gearbox case and allow the oil to drain into a suitable container.
5. Replace the seal and screw the drain plug back in. Torque as prescribed.
6. Unscrew and remove the oil level plug and the top filler plug/vent.
7. Add gear lubricant until oil level reaches the bottom of the side oil level check point.

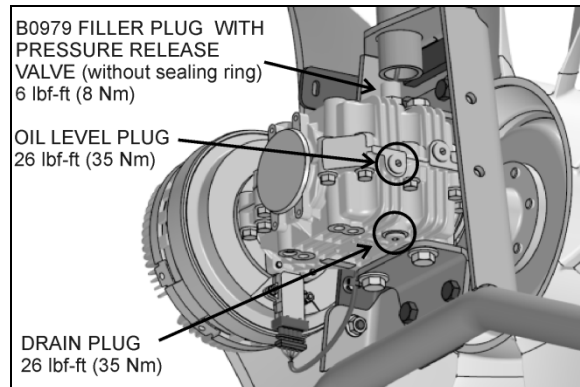


FIGURE 35: RIGHT ANGLE GEARBOX

8. Replace the seals and screw plugs back in. Torque as prescribed.
9. Clean gear case carefully.
10. Start the engine and allow running a few minutes. Stop the engine and check for leaks.



### WARNING

Note that warranty may be voided if proper maintenance at oil change intervals is not respected.

### 14.2 REMOVAL / INSTALLATION

To remove the right angle gearbox, proceed as follow:

1. Turn the ignition switch to the OFF position and set rear start selector switch to the OFF position to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Dismount the fan and lean it against the radiator.
4. Disconnect the universal joint shaft.
5. Remove the bracket shown on figure 30.

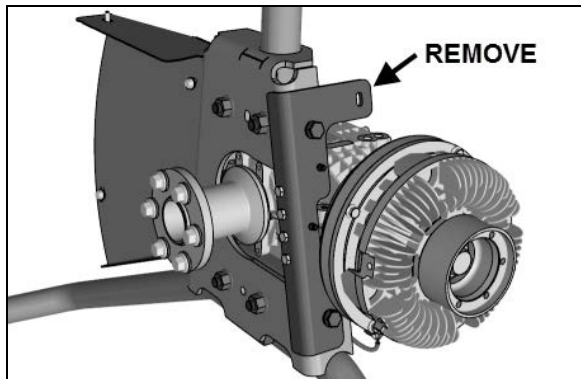


FIGURE 36: DISMOUNT THIS BRACKET

6. Loosen the gearbox support bracket top bolts (Figure 37).
7. Unscrew and remove 4 gearbox mounting bolts.
8. Slide the gearbox out of the support assembly.

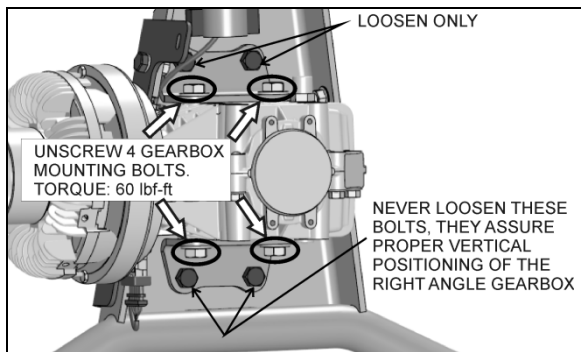


FIGURE 37: RIGHT ANGLE GEARBOX 05126

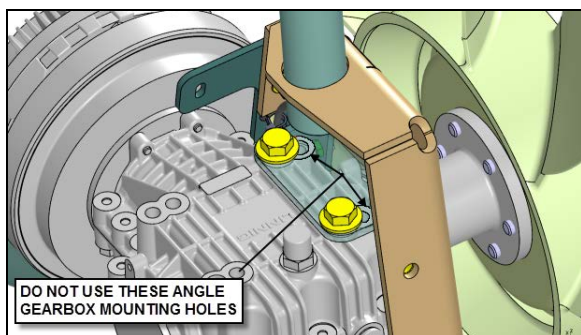


FIGURE 38: RIGHT ANGLE GEARBOX

## 15. FAN REMOVAL AND INSTALLATION

The fan is bolted to the right angle gearbox shaft flange. To remove the fan:

- Unscrew and remove the mounting bolts and washers.

To reinstall the fan:

- If the fan is still in the radiator fan shroud, place 2 of the mounting bolts on the opposite side of the flange, in reverse

direction, in order to use them as guide pins to position the fan.

- Once properly positioned, screw the 4 remaining bolts back in (finger tight).
- Finally, take the 2 bolts that were used as guide pins and screw them back in on the proper side of the fan. Tighten in a star pattern to 32 lbf-ft.

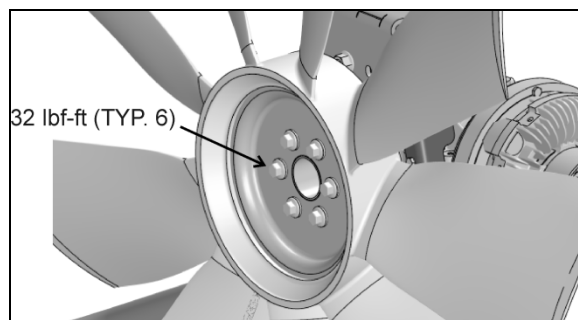


FIGURE 39: RADIATOR FAN MOUNTING BOLTS 05125

## 15.1 MAINTENANCE

1. Clean the fan and related parts with clean fuel oil and dry them with compressed air. Do not clean with steam or high-pressure jet.
2. Check the fan blades for cracks or other damage. Replace the fan if the blades are cracked or deformed.
3. Remove any rust or rough spots in the grooves of the fan pulley. If the grooves are damaged or severely worn, replace the pulley.
4. Do not restrict fan rotation during engine operation for any reason.
5. Do not operate fan-driving mechanism with a damaged fan assembly. Replace a damaged fan as soon as the fault is noted.
6. Immediately investigate and correct any operator complaint involving driving mechanism or cooling system performance.
7. When questions arise, obtain answers before proceeding. Assistance is available through the Prevost After-Sales Service Support serving your area.

## 15.2 INSPECTION



## DANGER

Set the starter selector switch in engine compartment to the "Off" position to prevent accidental starting of the engine.

- Check security of fasteners securing fan blade assembly to right angle gearbox.
- Visually inspect fan driving mechanism, fan blade assembly, shroud, radiator, and surrounding area for evidence of contact between rotating and non-rotating parts.
- Check drive belt for fraying, cracking, and proper tension.
- Turn fan through at least 360° of rotation. It should turn smoothly with no resistance.

**16. SPECIFICATIONS**

**Cooling System Capacity (Approximation)**

Includes heating system ..... 24 US gal (91 liters)

**Thermostat - Volvo D13 Engine**

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

**Cooling Fan Drive Belt – Volvo D13 Engine**

Type ..... Poly-Rib 14PK2526  
 Qty ..... 1

**Coolant - Volvo D13 Engine**

Type ..... Fleet Charge 50/50 Fully Formulated Antifreeze

**Coolant Filter Cartridge – Volvo D13 Engine**

Number used ..... 1  
 Type ..... Spin-on filter containing Supplemental Coolant Additives (SCA)

**17. SECTION CHANGE LOG**

<b>DESCRIPTION</b>		<b>DATE</b>
1	Added 5.6 coolant sampling.	April 8, 2016
2		
3		
4		
5		
6		