

SECTION 05: COOLING SYSTEM

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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 (Fig. 1).

Two full blocking-type thermostats are 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.

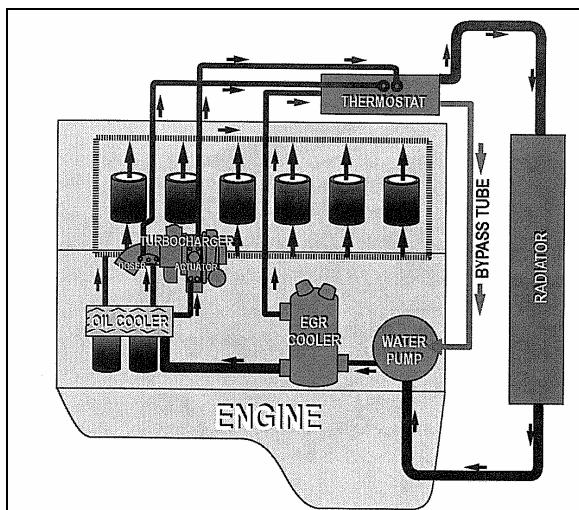


FIGURE 1: COOLANT FLOW SCHEMATIC (IMAGE DDC)

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 thermostats direct 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 thermostats are completely open, all of the coolant flow is to the radiator inlet.

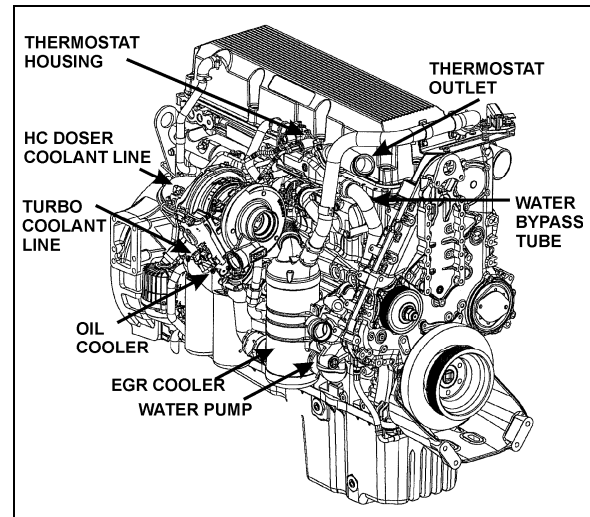


FIGURE 2: COOLING SYSTEM COMPONENTS (DDC S60 ENGINE) 05116

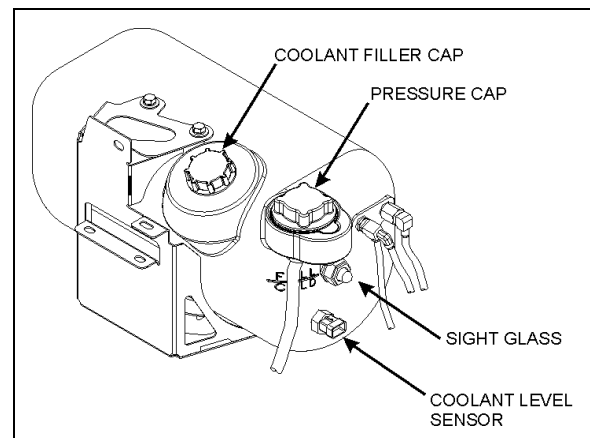


FIGURE 3: COOLANT SURGE TANK 05132

The cooling system is filled through a filler cap on the surge tank (Fig. 3). A pressure cap on top of the surge tank is 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 (Fig. 4). Two thermostats are located in the housing attached to the right side of the cylinder head (Fig. 2). Furthermore, a water temperature sensor mounted on the cylinder head (radiator side) is also supplied for engine protection purposes (DDC S60).

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.

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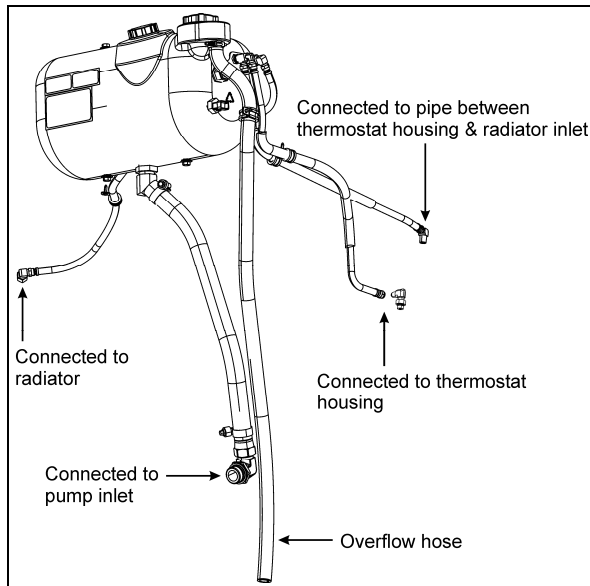


FIGURE 4: SURGE TANK (WITH DDC S60) 05115

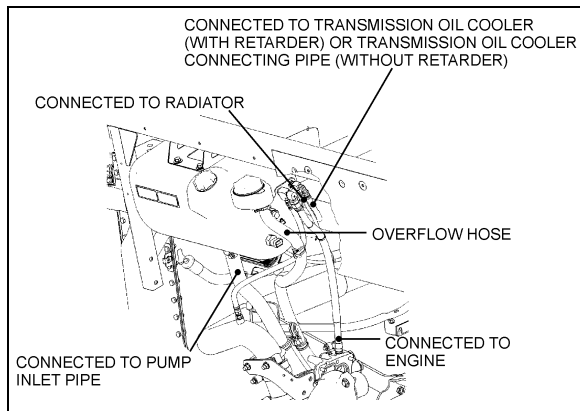


FIGURE 5: SURGE TANK (WITH VOLVO D13) 05143

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 thermostats 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.

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 VEHICLES EQUIPPED WITH DDC SERIES 60 ENGINE



MAINTENANCE

Maintain the prescribed inhibitor strength levels as required. Coolant and inhibitor concentration must be checked at each engine oil change, every 12,500 miles (20 000 km) or once a year, whichever comes first to ensure inhibitor strength. For vehicles equipped with coolant filters replace precharge element filter with a maintenance element filter as per "SPIN-ON COOLANT FILTER" in this section. If the vehicle is not equipped with a filter, add the recommended inhibitor concentration to the antifreeze/water solution.



MAINTENANCE

Drain, flush, thoroughly clean and refill the system every two years or every 200,000 miles (320 000 km), whichever comes first. For vehicle equipped with coolant filters, change the precharge element filter or the existing maintenance element filter for a new precharge element filter. If the vehicle is not equipped with filters add the recommended inhibitor concentration to the antifreeze/water solution.

NOTE

Do not add inhibitors to the antifreeze / water solution if vehicle is equipped with a coolant filter containing Supplemental Coolant Additives (SCA).

Coolant must be discarded in an environmentally safe manner.

2.2.1 Vehicles without coolant filters

Refer to Nalcool 3000 with Stabil-Aid bulletin annexed to the end of this section for preventive maintenance (at each oil change) and initial treatment instructions (each time the cooling system is drained and flushed).

2.2.2 Vehicles with coolant filters

Change the coolant precharge element filter for a maintenance element filter at initial oil change (see "*Specifications*" at the end of this section) and replace existing maintenance element filter with a new one as per "*SPIN-ON COOLANT FILTER*" in this section. A precharge element filter must be installed each time the cooling system is drained and flushed prior to installing a maintenance element filter.

NOTE

The precharge coolant filter contains inhibitors.

2.3 VEHICLES EQUIPPED WITH VOLVO D13 ENGINE

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.



MAINTENANCE

Drain, flush, thoroughly clean and refill the system with Extended Life Coolant (ELC) every four years or every 600,000 miles (1 000 000 km), whichever comes first. Change the coolant filter once a year or every 150,000 miles (240 000 km), whichever comes first. When using ELC, **do not** 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 CONSTANT-TORQUE HOSE CLAMPS ON COOLANT LINES – DDC S60 & VOLVO D13

All hose clamps of 1 3/8" ID and over, used on the heating and cooling systems, are of the "*Constant-torque*" type. These clamps are worm-driven, made of stainless steel, and supplied with a series of Belleville spring washers. They also feature an extended integral liner that covers the band slots to protect soft/silicone hoses from damage, and help maintain consistent sealing pressure.

This type of clamp is designed to automatically adjust its diameter to compensate for the normal expansion/contraction of a hose and metal connection that occurs during vehicle operation and shutdown. The constant-torque clamp virtually eliminates coolant losses due to "*Cold flow*" leakage and greatly minimizes clamp maintenance.

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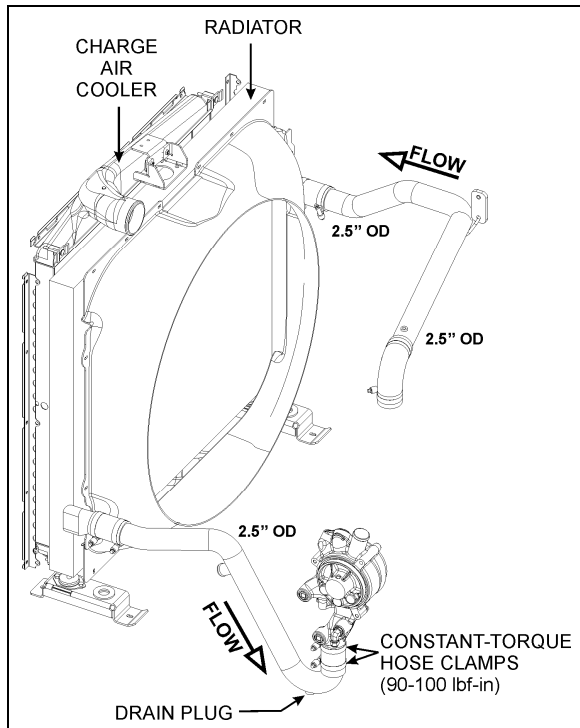


FIGURE 6: COOLANT FLOW TO RADIATOR (DDC S60)
05133

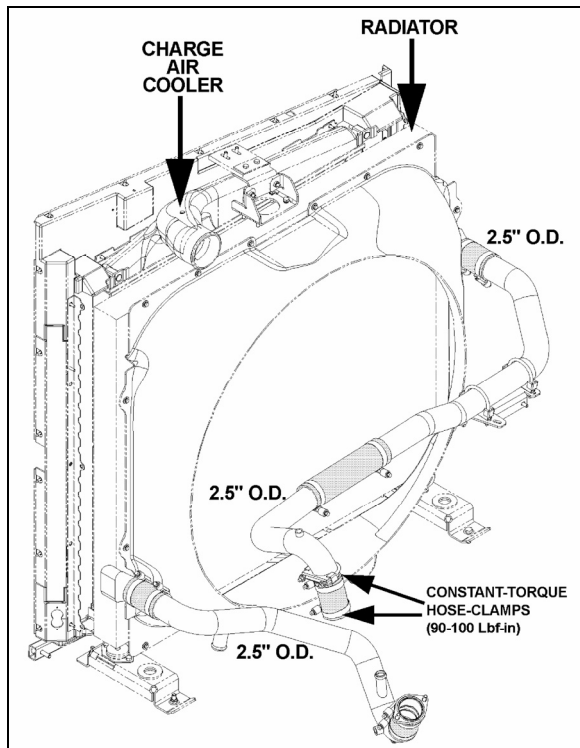


FIGURE 7: COOLANT FLOW TO RADIATOR (VOLVO D13)

3.1.1 Installation

A torque wrench should be used for proper installation. The recommended torque is 90 to

100 lbf-in. (10 to 11 Nm). The Belleville spring washer stacks should be nearly collapsed flat and the screw tip should extend 1/4" (6 mm) beyond the housing (Fig. 8).

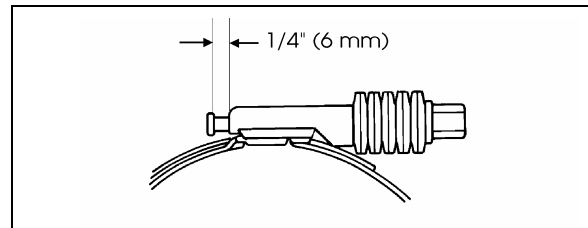


FIGURE 8: CONSTANT-TORQUE CLAMP

05037



CAUTION

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

3.1.2 Maintenance

The constant-torque clamps contain a "Visual torque check" feature. When the tip of the screw is extending 1/4" (6 mm) out of the housing, the clamp is properly installed and maintains a leak-proof connection. Since the constant-torque clamp automatically adjusts to keep a consistent sealing pressure, there is no need to re-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.**

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 10±1 lbf-ft (dry) (Fig. 9 & 10).



CAUTION

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

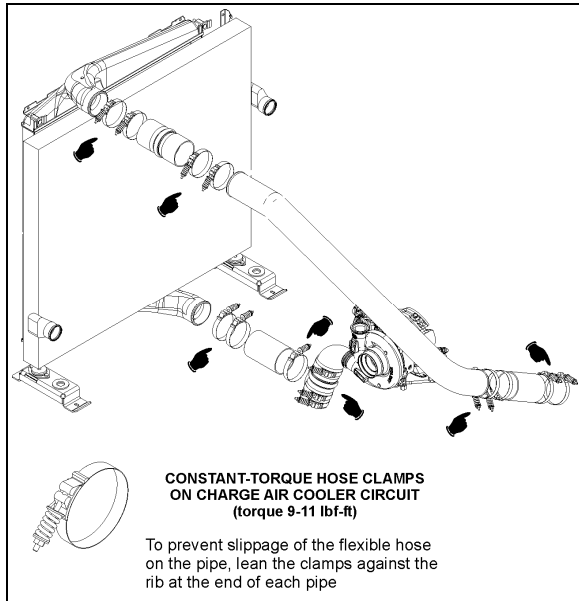


FIGURE 9: CHARGE AIR COOLER HOSE CLAMPS (DDC S60) 05134

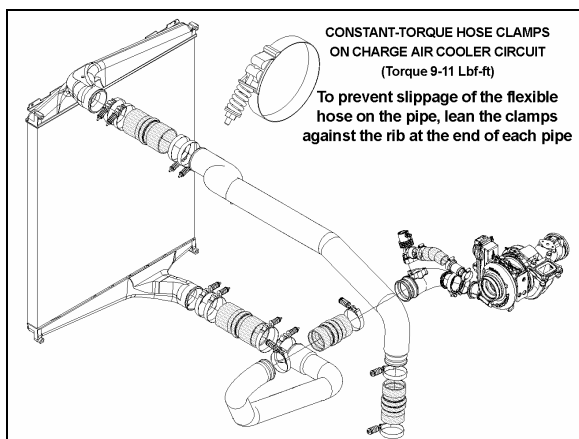


FIGURE 10: CHARGE AIR COOLER HOSE CLAMPS (VOLVO D13)

NOTE

Detroit Diesel Series 60 and Volvo D13 engines have similar CAC piping designs and they use the same constant-torque hose clamps. Tighten hose clamps as specified above.

3.2.1 Maintenance

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

4.1 DETROIT DIESEL SERIES 60 ENGINE

Coolant temperature is controlled by two blocking-type thermostats located in a housing attached to the cylinder head, on the turbo side of the engine (Fig. 11).

At coolant temperature below approximately 182°F-188°F (83°C-86°C), the thermostat valves remain closed and block the flow of coolant from the engine to the radiator. During this period, all of the coolant in the system is recirculated through the engine and directed back to the suction side of the water pump via a bypass tube. As the coolant temperature rises above 182°F -188°F (83°C-86°C) the thermostat valves start to open, restricting the bypass system, and allowing a portion of the coolant to recirculate through the radiator. When the coolant temperature reaches approximately 202°F (95°C) thermostat valves are fully open, the bypass system is blocked off and the coolant is directed through the radiator.

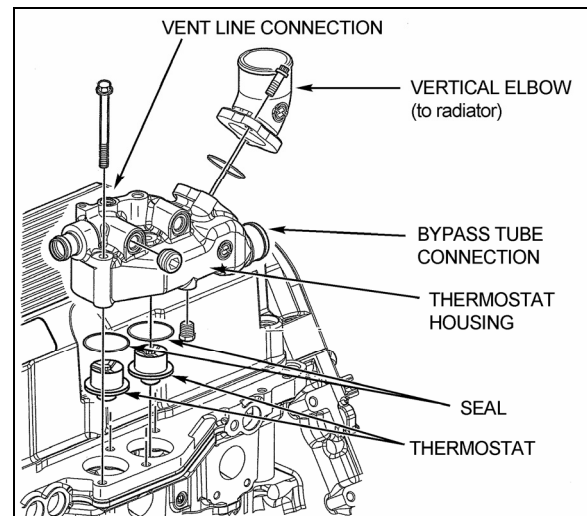


FIGURE 11: THERMOSTAT HOUSING (DDC S60 ENGINE) 05117

4.2 VOLVO D13 ENGINE

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.

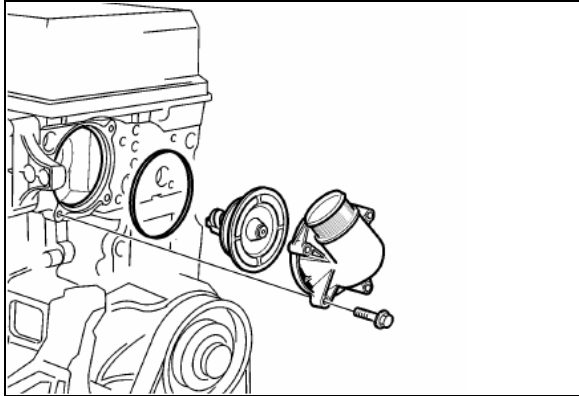


FIGURE 12: THERMOSTAT HOUSING (VOLVO D13 ENGINE)

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 ± 4 Nm (18 ± 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.

4.2.1 Thermostat Checking

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 ($9/32$ in). 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

Coolant level is correct when cold coolant is visible through the surge tank sight glass (Fig. 13). If coolant level is low, fill cooling system.

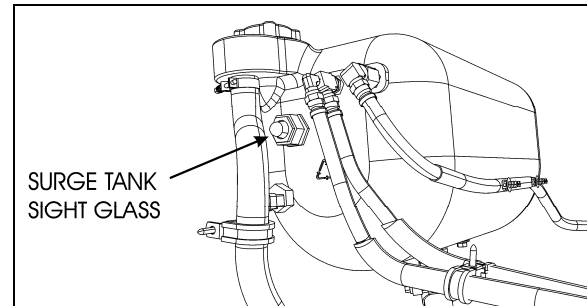


FIGURE 13: SURGE TANK SIGHT GLASS 05114

5.2 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 R.H. side of the surge tank.

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. 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:	percentage of antifreeze in mixture
-13°F (-25°C)	40%
-22°F (-30°C)	46%
-36°F (-38.5°C)	54%
-51°F (-46°C)	60%

5.5 COOLANT RECOMMENDATIONS FOR DETROIT DIESEL SERIES 60 ENGINE

A decal (052635) located on the surge tank provides information on recommended coolants.



Recommended phosphate free coolants for Detroit Diesel Series 60 engine:

- Prevost #685125;

- Detroit Diesel “DDC Power Cool” (P/N 23512138);
- Prestone AF977 (bulk), 72702 (3.78 L), 70119 (205L), 70102 (4L).

Combining suitable water with reliable inhibitors satisfies the first five requirements. When freeze protection is required, a solution of suitable water and antifreeze containing adequate inhibitors will provide a satisfactory coolant fluid. Ethylene glycol-based antifreeze is recommended for use in Series 60 engines. The cooling system capacity is 24 US gal (91 liters).

NOTE
In general, antifreeze does not contain adequate inhibitors. For this reason, supplemental coolant additives are required.

For a complete overview of engine coolants used with Detroit Diesel Engines, refer to “Coolant Selections” For Engine Cooling Systems Guide at the end of this section (#7se298).

1. Always use recommended antifreeze, inhibitor and water at proper concentration levels. A 50% coolant/water solution is normally used as factory fill. Antifreeze concentration over 70% is not recommended because of poor heat transfer capability, adverse freeze protection and silicate dropout. Antifreeze concentration below 30% offers little freeze, boilover or corrosion protection.
2. Use only ethylene glycol antifreeze meeting the Detroit Diesel #7se298 or TMC RP-329 “Type A” formulation.
3. Use an antifreeze solution year-round for freeze and boil-over protection. Seasonal changing of coolant from an antifreeze solution to an inhibitor/water solution is recommended.
4. Pre-mix coolant makeup solutions at proper concentrations before adding to the cooling system.
5. Maintain the prescribed inhibitor strength levels as required.
6. Do not mix different base inhibitor packages.
7. Always maintain proper coolant level.

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CAUTION

Always test the solution before adding water or antifreeze.

8. If cooling system is not at the proper protection level. Mix coolant/water solution to the proper concentration before adding to the cooling system
9. Use only non-chromate inhibitors.
10. Distilled water is recommended.

5.5.1 Coolant Not Recommended

- All antifreeze and coolant containing phosphorous;
- Automotive type coolants;
- Methoxy propanol-base antifreeze;
- Methyl alcohol-base antifreeze;
- Sealer additives or antifreezes containing sealer additives.

5.5.2 Inhibitors

A coolant solution, which has insufficient inhibitors or no inhibitors at all, invites the formation of rust, scale, sludge and mineral deposits within the cooling system. These deposits can cause water pump seal wear and coat the interior of coolant system passages. Heat transfer is reduced as deposits build up, leading to an overheating condition. Continued operation with this condition can lead to serious engine damage: liner scuffing, scoring, piston seizure and cylinder head cracking. These damages can occur quickly or over a longer period of time, depending of location and amount of deposits. Improperly inhibited coolants can become corrosive enough to "eat away" coolant passages and seal ring grooves and cause leaks to develop. Hydrostatic lock can occur if leak is internal and accumulates on top of a piston. The result may be a bent connecting rod. Cavitation erosion may occur in improperly inhibited coolants. Cavitation erosion is caused by the implosion of tiny bubbles against localized surfaces of the system. Such implosion causes pinpoint pressures high enough to erode pump impellers, cylinder liners and cylinder blocks. In extreme cases, their surfaces are so deeply pitted that they appear to

be spongy, and holes can develop completely through them.

5.5.3 Inhibitor Test Procedures

Test Kits are commercially available to check engine coolant for nitrite concentration. Nitrite concentration is an indication of Supplemental Coolant Additive (SCA) level. Nitrite must be maintained within recommended levels. Coolant must be tested at each oil change to insure that inhibitor levels are maintained within the ranges shown hereafter:

DDC Fully Formulated Glycol Coolant Limits	
-30 — 50(°F)	Freeze Point (°F)
125 — 500 ppm	Boron (ppm)
800 — 3200 ppm	Nitrite (ppm)
200 — 750 ppm	Nitrate (ppm)
50 — 250 ppm	Silicon (ppm)
0 ppm MAX	Phosphorus (ppm)
8.0 — 11.0	pH
40 ppm MAX	Chlorides (ppm)
100 ppm MAX	Sulfates (ppm)

NOTE

Above SCA values with Detroit Diesel #7se298 or TMC RP-329 "Type A". Use Nalco Chemical Company nitrite test kits (CO-318). A factory coolant analysis program is available through Detroit Diesel distributors under part number 23508774.

5.5.4 Additives Not Recommended

- Soluble Oils;
- Chromates.



WARNING

Never remove filler cap while coolant is hot. When coolant is at ambient temperature, release pressure from system by turning the pressure cap counterclockwise 1/4 turn; then remove filler cap slowly. A sudden release of pressure from the heated cooling system can result in severe burns from the expulsion of hot coolant fluid.

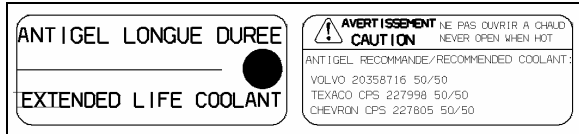
5.6 COOLANT RECOMMENDATIONS FOR VOLVO D13 ENGINE

Coolant mixture consisting of 50/50 antifreeze and deionized water 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.

A decal (053487) located on the surge tank provides information on recommended coolants.



Recommended coolants for Volvo D13 engine:

- Prevost #685241 (pre-diluted 50/50 mixture);
- Texaco CPS#227998 (pre-diluted 50/50 mixture);
- Chevron CPS#227805 (pre-diluted 50/50 mixture);
- Volvo 20358716 (pre-diluted 50/50 mixture);

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).

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.

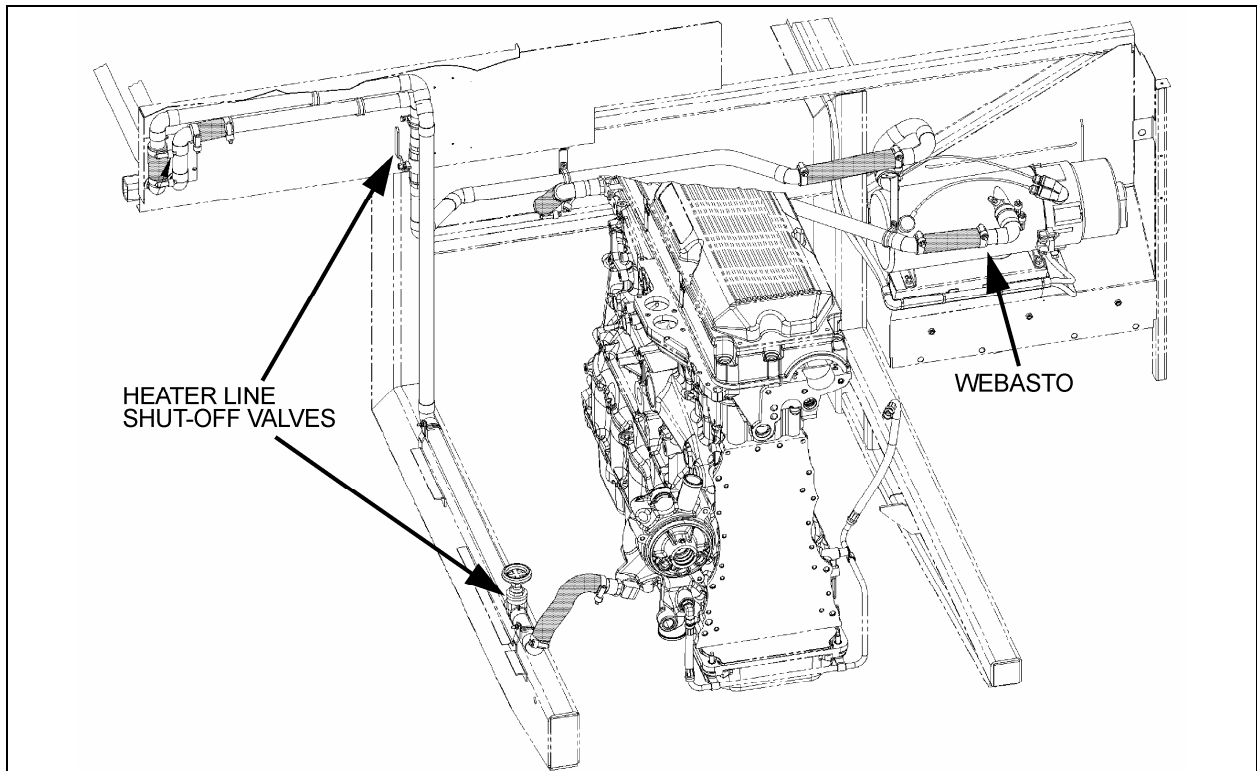


FIGURE 14: LOCATION OF HEATER LINE SHUT-OFF VALVES IN ENGINE COMPARTMENT

05105

Section 05: COOLING SYSTEM

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 cooling fan right angle gearbox; another valve is on the L.H. side of the engine compartment in front of the radiator (Fig. 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 valves on the coolant filter mounting head (if applicable) and remove filter (perform only if filter as to be replaced).
3. Open the shut-off valves on the coolant filter mounting head (if applicable) and drain the coolant into a suitable container. Close the shut-off valves.
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. Unscrew the water pump housing inlet line drain plug (Fig. 15) plus the transmission oil cooler delivery line drain plug. Drain the coolant into an approved container.

NOTE

On Volvo D13 engine, the regular drain plugs are replaced by quick connect fittings to ease draining and filling of coolant system.

6. Open drain cock at bottom of thermostat housing to drain the coolant trapped above the thermostats (Fig. 11).
7. Open the radiator drain cock.

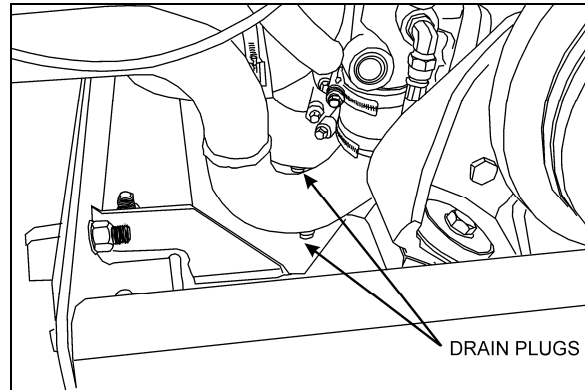


FIGURE 15: WATER PUMP DRAIN PLUG

05093

8. 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 shutoff 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 all drain cocks. Reinstall the drain plugs with new seals. Refer to draining procedure for the location of draining points.
2. Open the shut-off valves on the coolant filter mounting head (if applicable).
3. Refill cooling system from the surge tank filler cap inlet with the recommended ethylene glycol-based antifreeze and water solution of the required concentration.

NOTE

On Volvo D13 engine, the regular drain plugs are replaced by quick connect fittings to ease draining and filling of coolant system. Coolant system may be refilled by the use of the quick connect fittings.

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 surge tank filler neck.

4. Install the filler and pressure caps, 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 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 without coolant filters:

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

Vehicles with coolant filters (DDC Series 60 engine):

Replace the coolant filter with a precharge element filter; in this case do not mix inhibitors with antifreeze/water solution.

Vehicles with coolant filters (Volvo D13 engine):

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.

Section 05: COOLING SYSTEM

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 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 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 optional 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 (Fig. 16 & 17).

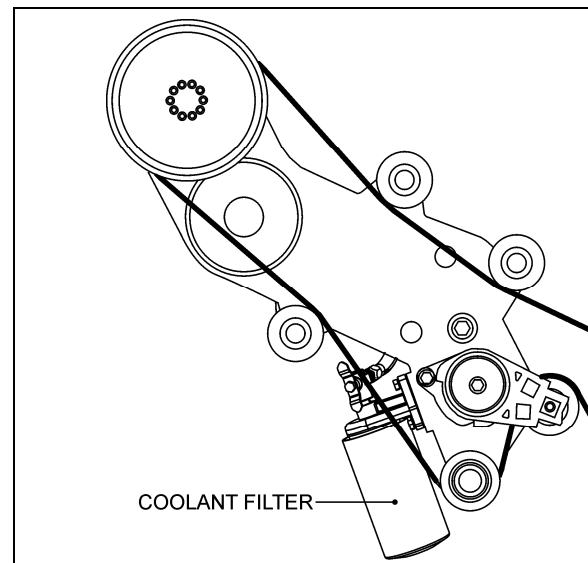


FIGURE 16: COOLANT FILTER (DDC S60 ENGINE) 05138

To replace a filter:

1. Close the two filter shutoff cocks (two on DDC S60, one on Volvo D13) 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 two filter shutoff cocks.
6. Start engine and check for leaks.



CAUTION

Do not exceed recommended service intervals.



MAINTENANCE

DETROIT DIESEL S60 ENGINE

The precharge element filter lasts for 12,500 miles (20 000 km) or one year, whichever comes first. Replace the precharge element filter with a maintenance element filter, which lasts for 200,000 miles (320 000 km) or two years, whichever comes first. Each time the coolant is renewed, a precharge element filter must be installed before installing a maintenance element filter.

PRECHARGE ELEMENT FILTER

Prevost number: 550629

MAINTENANCE ELEMENT FILTER

Prevost number: 550630

CORROSION INHIBITOR & COOLANT STABILIZER

Make: Detroit Diesel Number: 23507857

Make: Nalco Number: DD3000-15

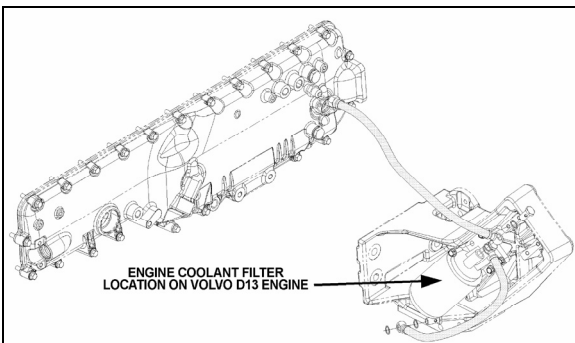


FIGURE 17: COOLANT FILTER (VOLVO D13) 05145



MAINTENANCE

VOLVO D13 ENGINE

Replace the coolant filter cartridge after 150,000 miles (240 000 km) or one year to prevent external rust damage to the filter walls. **Do not** use a coolant filter containing Supplemental Coolant Additives (SCA).

Coolant filter cartridge (Volvo D13): #20458771

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



MAINTENANCE

Inspect the exterior of the radiator core every 25,000 miles (40 000 km) or once a year, whichever comes first. 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.

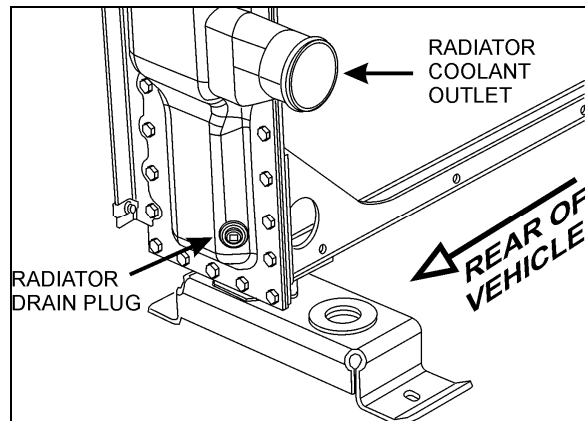


FIGURE 18: RADIATOR DRAIN PLUG 05139

Section 05: COOLING SYSTEM

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

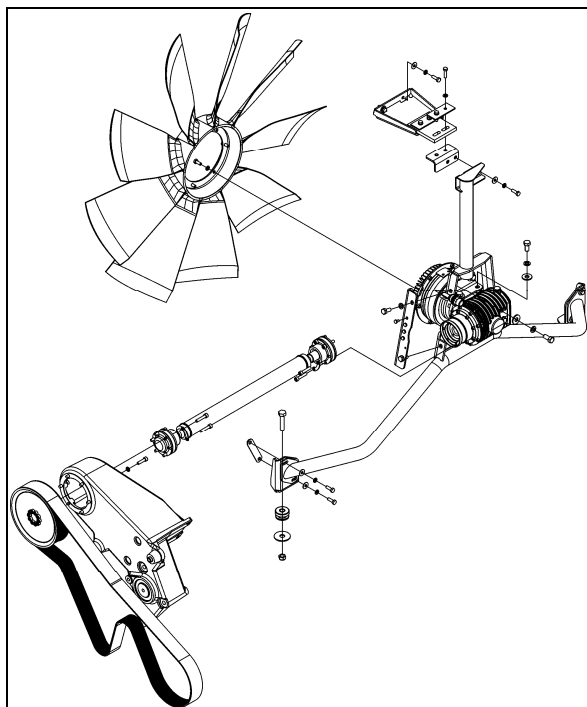


FIGURE 19: COOLING FAN DRIVE MECHANISM

12.1 DRIVE PULLEY AND UNIVERSAL JOINT SHAFT

To disconnect the universal shaft, proceed as follow:



WARNING

Set the ignition to the OFF position and remove the key from the contact switch 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 drive pulley. Gain access to the 6 mounting bolts from behind the pulley, through the opening in the cast aluminum support (Fig. 15).
3. Unscrew and remove the universal joint shaft mounting bolts (6) at the right angle gearbox.
4. Slowly, move the shaft toward the rear of the vehicle.
5. Finally, dismount the universal joint shaft from the drive pulley (6 bolts).

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

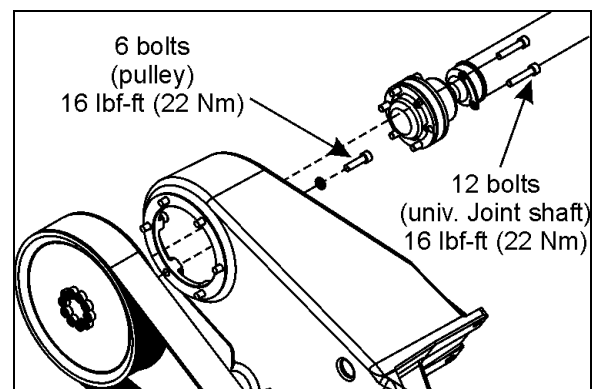


FIGURE 20: TIGHTENING SPECIFICATION

05123A

12.2 IDLER REPLACEMENT

If an idler is defective, replace as follow:



WARNING

Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.

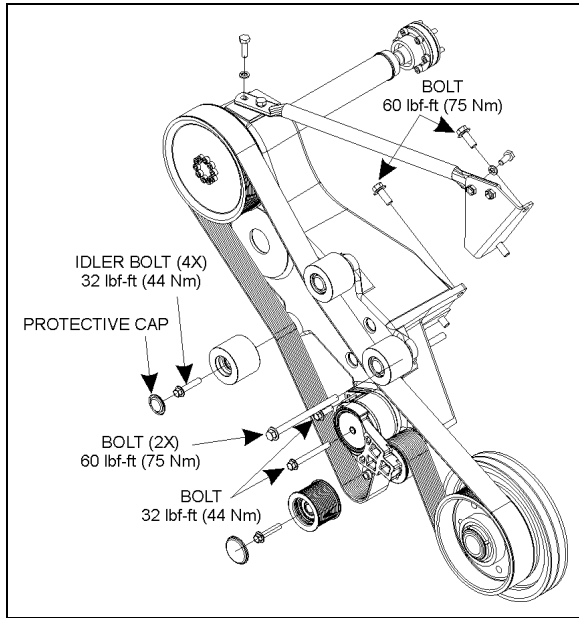


FIGURE 21: TIGHTENING SPECIFICATION (DDC S60 ENGINE) 05140

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

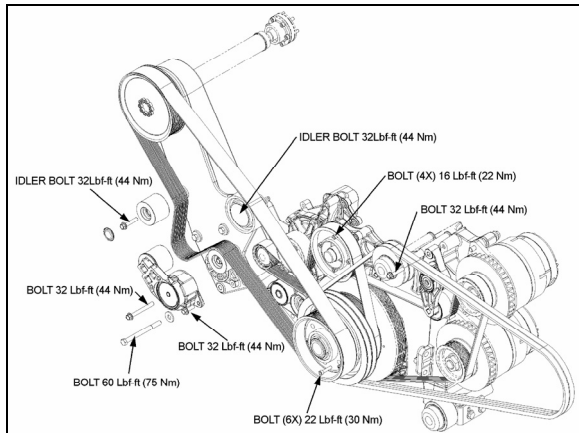


FIGURE 22: TIGHTENING SPECIFICATION (VOLVO D13 ENGINE)



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 figure below.

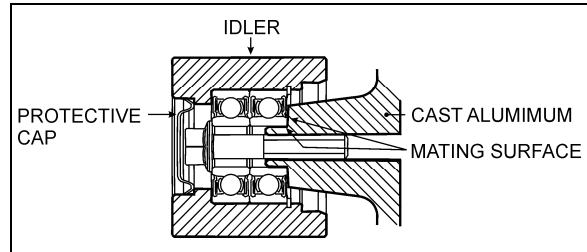


FIGURE 23: IDLER MOUNTED ON THE CAST ALUMINUM SUPPORT

4. Bolt the new idler on the cast aluminum support. Tighten to 32 lbf-ft (44 Nm).
5. Place a new protective cap.

13. VARIABLE SPEED COOLING FAN


The cooling fan clutch has two thermostatically controlled speeds, plus a neutral (clutch disengaged). The engine control module controls the speed by comparing data from engine coolant temperature, charge air temperature, Allison transmission oil temperature 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

	Small A/C high side pressure
pressure rising ↑	170 psi: fan engages in HIGH SPEED
	120 psi: fan engages in LOW SPEED

Section 05: COOLING SYSTEM

pressure dropping 	130 psi: fan HIGH SPEED disengages
	90 psi: fan LOW SPEED disengages



WARNING

DO NOT work near the fan with the engine running or the ignition 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 RADIATOR FAN 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, execute the following procedure:

1. Set the ignition key 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 1st speed, press a second time to engage to 2nd speed, press a third time to stop the fan, press once again to return to 1st speed.

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 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. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Unscrew and remove the 4 spare bolts screwed to the angle on the fan gearbox mounting support.
4. Turn the fan blades in order to position the locking plate bores over the rotor's threaded sockets.
5. Screw in and tighten the spare bolts (Fig. 24).
6. 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.
7. Rotate the shaft to get access to the second locking plate and rotor threaded sockets.
8. Screw in and tighten the spare bolts.

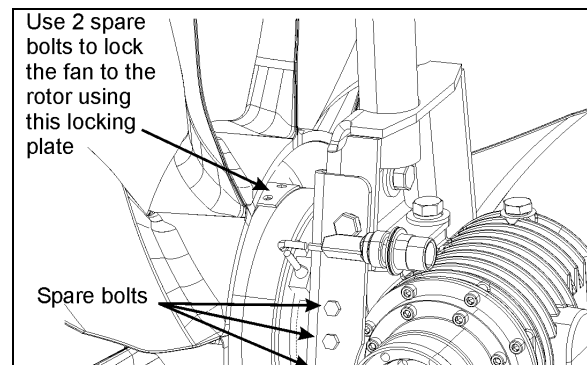


FIGURE 24: MECHANICAL LOCKING


05124

13.2 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 Prevest After-Sales Service Support serving your area.

13.3 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 fan clutch.
- 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.

13.4 FAN REMOVAL / INSTALLATION

The fan is bolted to the magnetic clutch. 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 clutch, 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 and tighten properly (16 lbf-ft; 22 Nm).
- Finally, take the 2 bolts that were used as guide pins and screw them back in on the proper side of the clutch and tighten properly.

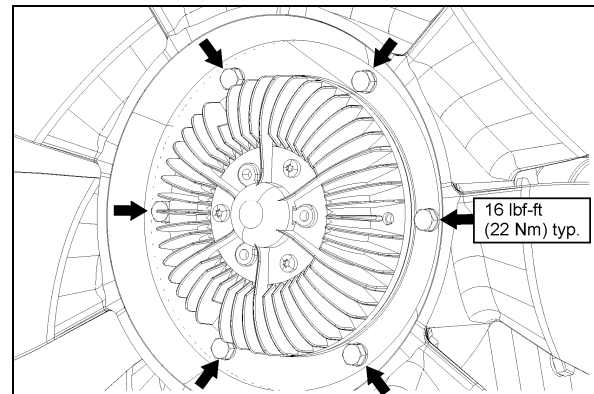


FIGURE 25: RADIATOR FAN MOUNTING BOLTS 05125

14. FAN RIGHT ANGLE GEARBOX

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

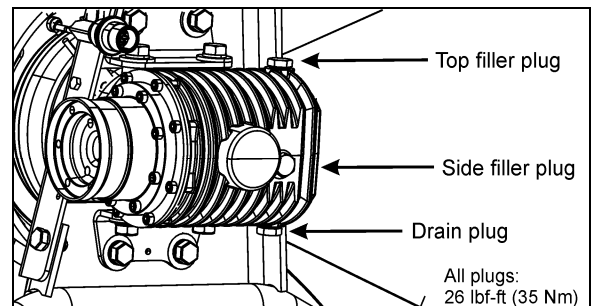



FIGURE 26: RIGHT ANGLE GEARBOX 05118

14.1 MAINTENANCE



MAINTENANCE

Change the right angle gearbox oil every 50,000 miles (80,000-km) or once a year, whichever comes first.

Use **Synthetic Gear Lubricant SAE 75W-90**.

14.2 OIL CHANGE

1. Stop engine and make sure that all engine safety precautions have been observed.

Section 05: COOLING SYSTEM

2. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine or set the rear start panel selector switch to the OFF position.
3. Remove the drain plug located underneath the right angle gearbox case and allow the oil to drain into a suitable container.
4. Replace the seal and screw the drain plug back in (torque: 26 lbf-ft).
5. Unscrew and remove the side filler plug.
6. Unscrew and remove the top filler plug.
7. Add gear lubricant. The oil level is correct once the top of the oil has reached the bottom of the side filling point.
8. Replace the seals and screw side and top filler plug back in (torque: 26 lbf-ft).
9. Clean gear case carefully.
10. Start the engine and allow running a few minutes. Stop the engine and check for leaks.

14.3 REMOVAL / INSTALLATION

To remove the right angle gearbox, proceed as follow:

1. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Dismount the fan and lean it against the radiator (refer to previous paragraph).
4. Disconnect the universal joint shaft.

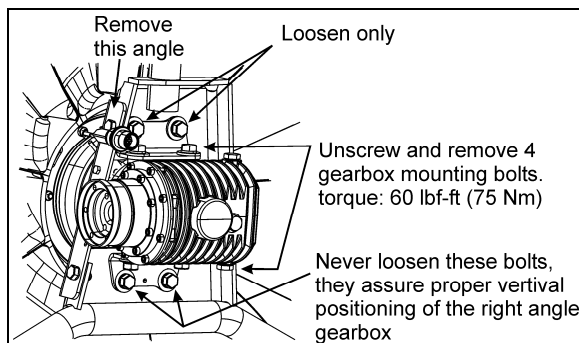


FIGURE 27: RIGHT ANGLE GEARBOX MOUNTING 05126

5. Dismount the angle (see fig. 27).

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

Installation procedure is the same as removal but in reverse order. Tighten the 4 mounting bolts as specified.

15. COOLING FAN DRIVE BELT

15.1 MOUNTING THE DRIVE BELT

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



WARNING

Set the ignition to the OFF position and remove the key from the contact switch 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.

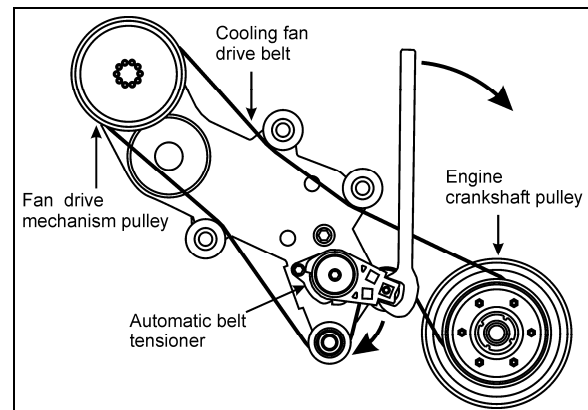


FIGURE 28: DRIVE BELT ROUTING (DDC S60 ENGINE) 05137

1. Wrap the new drive belt around the fan drive mechanism pulley, the idlers and the automatic tensioner idler as shown on figure 28 & 29.
2. Using the special tool included with your vehicle (see inside the Warning Reflectors box located in the first curb-side baggage bay), rotate the automatic tensioner in

clockwise direction to relieve tension on the belt and hold the tensioner in that position (Fig. 28 & 29).

3. Finally, place the drive belt around the engine crankshaft pulley.

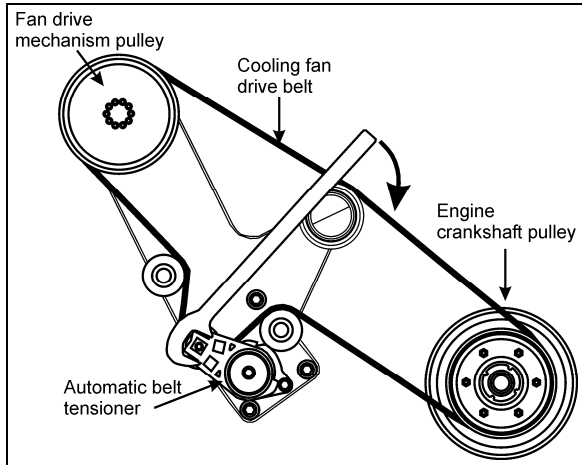


FIGURE 29: DRIVE BELT ROUTING (VOLVO D13 ENGINE)

4. Release the tensioner slowly and let it return to its natural position.

COOLING FAN DRIVE BELT

With Detroit Diesel Series 60 engine

Type: 14PK2605

Prevost number: 550926

With Volvo D13 engine

Type: 14PK2526

Prevost number: 5060097

16. SPECIFICATIONS

Cooling System Capacity (Approximation)

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

Thermostat - Detroit Diesel Series 60 Engine

Number used 2

Start to open 182-188°F (83-86°C)

Fully open 202°F (95°C)

Section 05: COOLING SYSTEM

Thermostat - Volvo D13 Engine

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

Cooling Fan Drive Belt - Detroit Diesel Series 60 Engine

Type Poly-Rib 14PK2605
Qty 1
Prevost number 550926

Cooling Fan Drive Belt – Volvo D13 Engine

Type Poly-Rib 14PK2526
Qty 1
Prevost number 5060097

Coolant - Detroit Diesel Series 60 Engine

Prevost Number685125
DDC (Power Cool)23512138
Prestone (Heavy Duty)..... AF977 (bulk), 72702 (3.78 L), 70119 (205L), 70102 (4L)

Coolant - Volvo D13 Engine

Prevost Number 685241
Texaco CPS 227998
Chevron CPS 2227805

Corrosion Inhibitor and Coolant Stabilizer - Detroit Diesel Series 60 Engine

Supplier number.....Detroit Diesel23507857
Supplier number.....Nalco..... DD3000-15

Coolant Filter - Detroit Diesel Series 60 Engine

Number used 1
Make Nalco
Type Spin-on

MAINTENANCE ELEMENT FILTER

Supplier number.Detroit Diesel23507545
Supplier number.....Nalco..... DDF3000
Prevost number550630

PRECHARGE ELEMENT FILTER

Supplier number.....Detroit Diesel23507189
Supplier number.....Nalco..... DDF60
Prevost number550629

Coolant Filter Cartridge – Volvo D13 Engine

Number used 1
Type Spin-on
Prevost number 20458771