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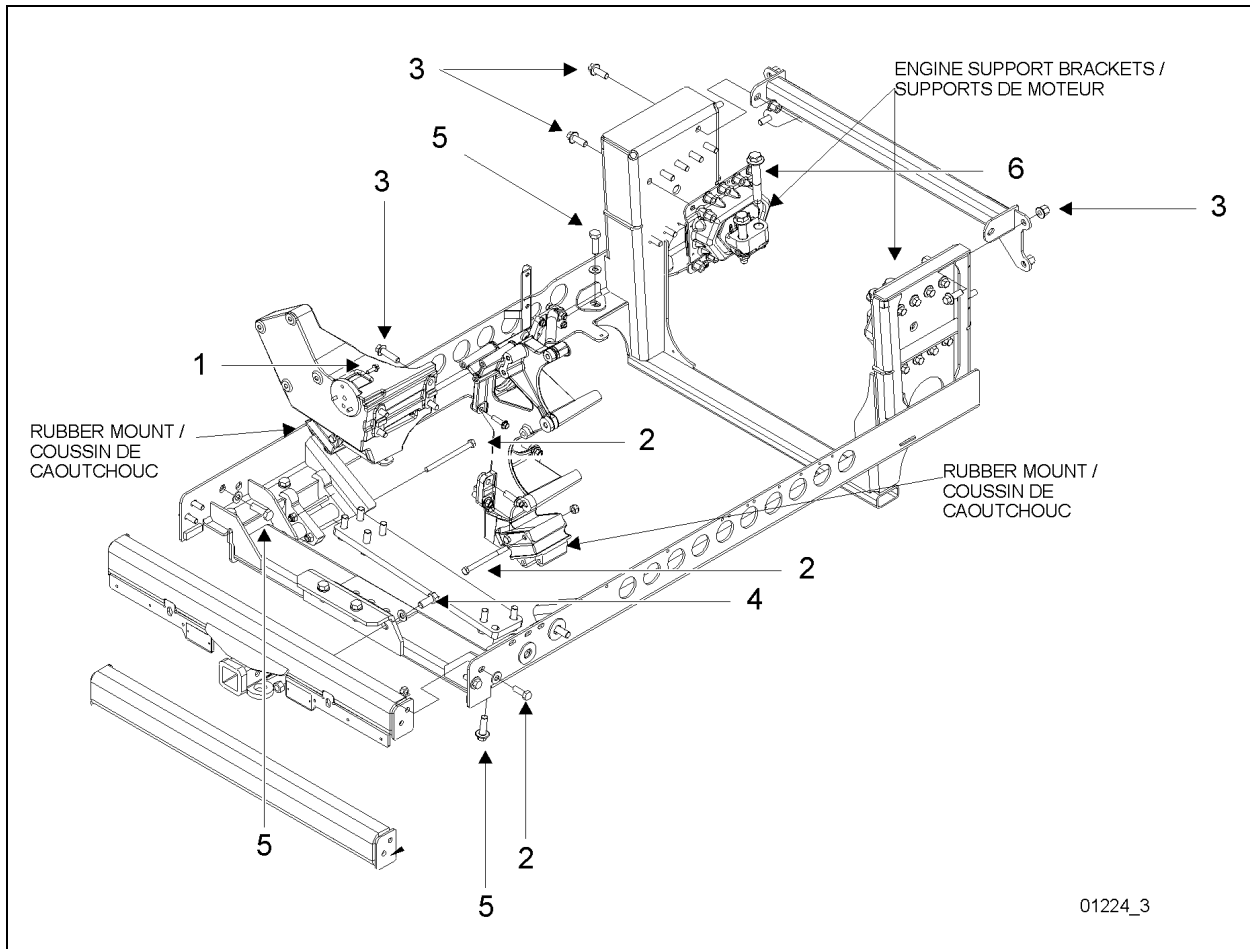
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1. TORQUE TABLES

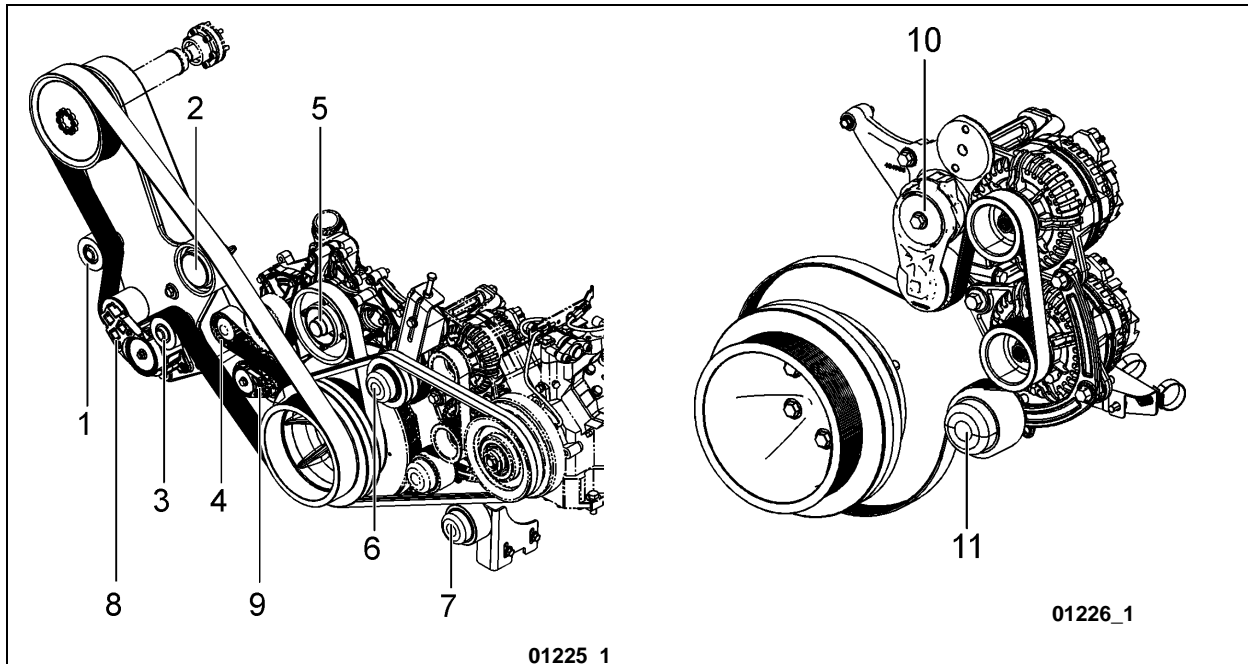
1.1 POWER PLANT CRADLE INSTALLATION



VOLVO ENGINE POWER PLANT CRADLE INSTALLATION

No	DESCRIPTION	TORQUE
1	Screw, cap hexagonal head m8 – 1.25 g8.8	14 lb-ft (19 Nm)
2	Screw, cap hexagonal head m12 – 1.75 g8.8	60 lb-ft (81 Nm)
3	Screw, cap hexagonal head m14 – 2.0 g8.8	90 lb-ft (122 Nm)
4	Screw, cap hexagonal head m16 – 2.0 g8.8	140 lb-ft (190 Nm)
5	Screw, cap hexagonal head m16 – 2.0 g10.9	190 lb-ft (258 Nm)
6	Screw, cap hexagonal head m20 – 2.5 g10.9	450 lb-ft (610 Nm)

1.2 BELT TENSIONERS AND IDLERS

**VOLVO ENGINE – DRIVE BELT IDLERS & TENSIONERS**

No	DESCRIPTION	TORQUE
1	Idler, cooling fan drive	50 lb-ft (68 Nm)
2	Idler, cooling fan drive	35 lb-ft (47 Nm)
3	Idler, cooling fan drive	45-55 lb-ft (61-75 Nm)
4	Idler, water pump drive	43 lb-ft (58 Nm)
5	Idler, water pump drive	pulley 16 lb-ft (22 Nm) shaft 32 lb-ft (43 Nm)
6	Central A/C tensioner idler shaft bolt (M12 shoulder bolt)	31.5-38.5 lb-ft (43-52 Nm)
	Central A/C tensioner idler shaft bolt (M12 x 1.75 std bolt)	59 lb-ft (80 Nm)
7	Idler, A/C compressor drive	82 lb-ft (111 Nm)
8	Tensioner, cooling fan drive	32 lb-ft (43 Nm)
9	Tensioner, water pump drive	48 lb-ft (65 Nm)
10	Tensioner, alternator drive	48 lb-ft (65 Nm)
11	Idler, alternator drive	82 lb-ft (111 Nm)

2. VOLVO D13 ENGINE

2.1 SYSTEM OVERVIEW

NOTE

The "Premium Tech Tool" (PTT) is the preferred tool for performing diagnostic work. Contact your local dealer for more information.

The Engine Management System (EMS) controls many engine functions such as: fuel timing and delivery, engine protection functions, engine brake operation, EGR valve function and the turbocharger nozzle function. The Engine Electronic Control Unit (EECU) along with other supporting control units and sensors are responsible for monitoring and controlling these functions. These control units communicate through the J1939 high speed serial data line to share data.

In addition to their control functions, the modules have on-board diagnostic capabilities. The on-board diagnostics are designed to detect faults or abnormal conditions that are not within their operating parameters. When the system detects a fault or abnormal condition, the fault will be logged in one or both of the modules' memory. The vehicle operator will be advised that a fault has occurred by the illumination of a malfunction indicator lamp and a message in the driver information display, if equipped. The module may initiate the engine shutdown procedure if the system determines that the abnormal condition could damage the engine. In some situations, the system will enter the "limp home" mode. Limp home mode allows continued vehicle operation but, the system may substitute a sensor or signal value that may result in reduced engine performance.

Fault codes logged in the system memory, can later be read to aid in diagnosing the fault. These faults can be read via a diagnostic computer or through the instrument cluster display, if equipped. The "Premium Tech Tool" (PTT) is the preferred tool for performing diagnostic work. Using a diagnostic computer (or PTT) connected to the Serial Communication Port, expands the technician's diagnostic capabilities with additional data and tests.

For diagnostic software, contact your local dealer.

The following is a list of engine sensors that provide input to the EMS:

- Ambient Air Temperature Sensor
- Ambient Pressure sensor
- Boost Air Pressure (BAP) Sensor
- Camshaft Position (Engine Position) Sensor
- Crankshaft Position (Engine Speed) Sensor
- Differential Pressure DPF Sensor
- EGR Differential Pressure Sensor
- EGR Temperature Sensor
- Engine Coolant Level (ECL) Sensor
- Engine Coolant Temperature (ECT) Sensor
- Engine Oil Pressure (EOP) Sensor
- Engine Oil Level (EOL) Sensor
- Engine Oil Temperature (EOT) Sensor
- Exhaust Temperature Sensor (DPF Sensors)
- Fuel Pressure Sensor
- Intake Air Temperature And Humidity (IATH) Sensor
- Intake Manifold (Boost) Temperature Sensor
- Throttle Position (TP) Sensor
- Turbo Speed Sensor
- Variable Geometry Turbocharger (VGT) Position Sensor

Sensors

Ambient Air Temperature Sensor

The Ambient Air Temperature Sensor is used to detect the outside air temperature. The sensor modifies a voltage signal from the ECM. The modified signal returns to the ECM as the ambient air temperature. The sensor uses a thermistor that is sensitive to the change in temperature. The electrical resistance of the thermistor decreases as temperature increases.

The Ambient Air Temperature Sensor is located in the front of the vehicle.

Ambient (Atmospheric) Pressure Sensor

The Ambient (Atmospheric) Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Ambient (Atmospheric) Pressure Sensor is built into the Engine Management System (EMS) Module.

Camshaft Position Sensor

The Camshaft Position (Engine Position) Sensor is located in the rear face of the timing gear cover at the rear of the engine, near the bottom of the valve cover. It uses magnetic induction to generate a pulsed electrical signal. It senses the passage of seven (7) timing bumps on the edge of the camshaft dampener. Six of the holes correspond to the phasing of the electronic unit injectors, while the seventh hole indicates the top dead center position.

Crankshaft Position (Engine Speed) Sensor

The Crankshaft Position (Engine Speed) Sensor uses magnetic induction to generate a pulsed electrical signal. Notches are machined into the edge of the flywheel. When one of the notches passes close to the sensor, electric pulses result.

The Crankshaft Position (Engine Speed) Sensor also indicates when the crankshaft is at the top dead center position.

Differential Pressure DP Sensor

The differential pressure sensor is used for flow measurement of the Diesel Particulate Filter (DPF). This sensor has two pressure ports and senses the difference in pressure between the two ports. Measurement of the pressure before and after the DPF is used to calculate diesel filter regeneration.

The Differential Pressure DPF Sensor is located on the side of the Diesel Particulate Filter (DPF).

EGR Differential Pressure Sensor

The EGR differential pressure sensor is used for flow measurement of the Exhaust Gas Recirculation (EGR) valve. This sensor has two pressure ports and senses the difference in

pressure between the two ports. Measurement of the pressure before and after the EGR valve is used to calculate EGR flow.

The EGR Differential Pressure Sensor is located on the left or right side of the engine.

EGR Temperature Sensor

The EGR temperature sensor detects exhaust gas temperature for EGR system. The sensor modifies a voltage signal from the control unit. The modified signal returns to the control unit as the exhaust temperature of the EGR system to confirm EGR operation. The sensor uses a thermistor that is sensitive to the change in temperature.

The EGR Temperature Sensor is located near the EGR valve.

Engine Coolant Level (ECL) Sensor

The Engine Coolant Level (ECL) Sensor is a switch. If engine coolant level falls below a calibrated point the contacts open and the driver will be notified of the low coolant level.

The Engine Coolant Level (ECL) Sensor is located in the cooling system reservoir tank.

Engine Coolant Temperature (ECT) Sensor

The Engine Coolant Temperature Sensor is located at the front of the engine. The sensor will indicate a high coolant temperature caused by problems like radiator blockage, thermostat failure, heavy load, or high ambient temperatures. This sensor is also used for cold start enhancement and for fan clutch engagement.

Engine Oil Pressure (EOP) Sensor

The Engine Oil Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Engine Oil Pressure Sensor is located on the oil filter assembly. The sensor monitors engine oil pressure to warn of lubrication system failure.

Engine Oil Level (EOL) Sensor

The Engine Oil Level Sensor is located in the oil pan.

Engine Oil Temperature (EOT) Sensor

The Engine Oil Temperature Sensor is a thermistor whose resistance varies inversely to temperature. The sensor has a negative temperature coefficient, which means the sensor resistance will decrease as the engine oil temperature increases.

The Engine Oil Temperature Sensor is located in the oil pan.

Exhaust Temperature Sensor (DPF Sensors)

The exhaust gas temperature sensor detects exhaust gas temperature for DPF protection as well as DPF regeneration control. The sensor modifies a voltage signal from the control unit. The modified signal returns to the control unit as the exhaust temperature at that specific location of the exhaust. The sensor uses a thermistor that is sensitive to the change in temperature.

The Exhaust Temperature Sensors are located in the DPF assembly.

Fuel Pressure Sensor

The fuel pressure sensor contains a diaphragm that senses fuel pressure. A pressure change causes the diaphragm to flex, inducing a stress or strain in the diaphragm. The resistor values in the sensor change in proportion to the stress applied to the diaphragm and produce an electrical output.

The Fuel Pressure Sensor is located on top of the fuel filter housing.

Intake Air Temperature and Humidity (IATH) Sensor

The Intake Air Temperature and Humidity (IATH) Sensor contains a thermistor and a capacitive sensor. The resistance of the thermistor varies inversely to temperature. The output of the capacitive sensor increases as the humidity of the surrounding air increases. By monitoring the signals from both portions of the sensor, the Engine Management System (EMS) Module calculates the temperature and humidity of the air passing through the air filter housing.

The Intake Air Temperature and Humidity (IATH) Sensor is located in the air intake tube just downstream from the air filter canister.

Intake Manifold (Boost) Temperature Sensor

The Intake Manifold (Boost) Temperature Sensor is a thermistor whose resistance varies inversely to temperature. The sensor has a negative temperature coefficient, which means the sensor resistance will decrease as the inlet air temperature increases.

The Intake Manifold (Boost) Temperature Sensor is located in the intake manifold.

Intake Manifold Pressure Sensor

The Intake Manifold Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Intake Manifold Pressure Sensor is located on the air inlet pipe before the intake manifold.

Throttle Position (TP) Sensor

The Throttle Position Sensor is a potentiometer that is mechanically linked to the accelerator pedal. A potentiometer is a variable resistor whose resistance will change as the pedal is pressed. As the resistance changes, the signal voltage of the sensor changes indicating the accelerator pedal position.

The Throttle Position Sensor is located above the accelerator pedal. The sensor is designed to improve the driver's control by reducing sensitivity to chassis motion. This sensor provides the driver's fuel request input to the VECU.

Turbo Speed Sensor

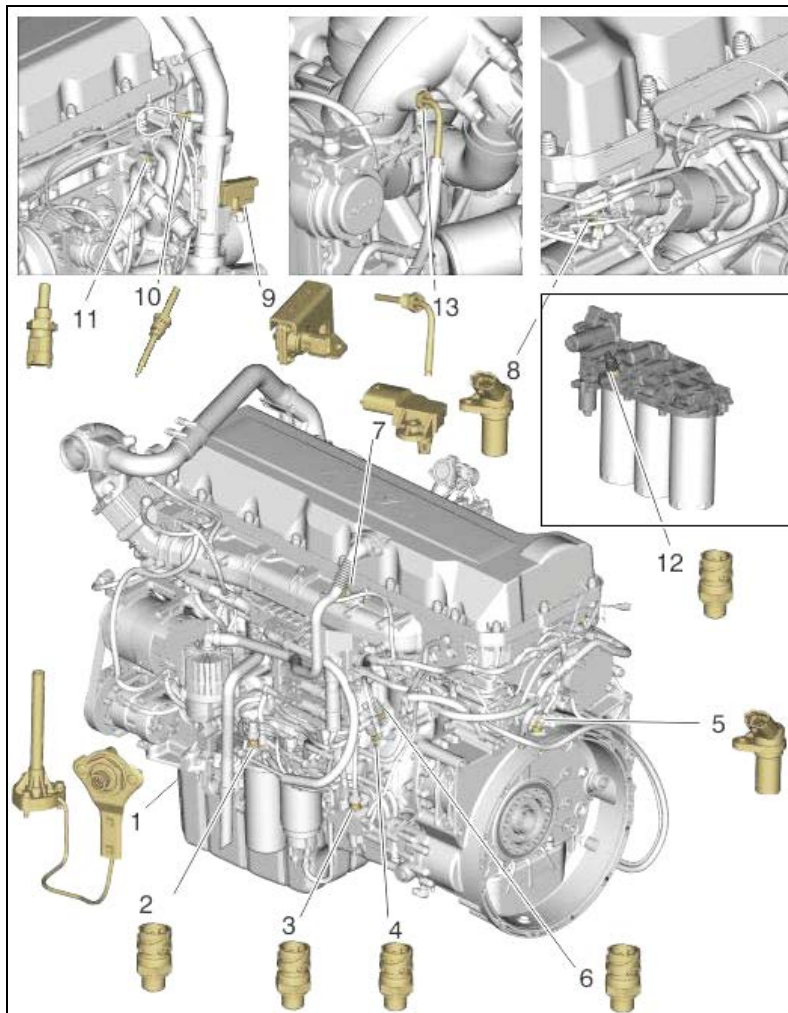
The Turbo Speed Sensor informs the EMS of the turbo shaft speed. The sensor does not read from the vanes, but reads from the shaft. The Engine Management System (EMS) Module uses this signal in conjunction with the VGT position sensor signal to control the speed of the turbocharger and therefore optimize the intake manifold pressure.

The Turbo Speed Sensor is mounted in the center of the turbocharger.

Variable Geometry Turbocharger Smart Remote Actuator (VGT SRA)

The Variable Geometry Turbocharger Smart Remote Actuator (VGT SRA) takes the position commands from the EMS, moves the nozzle of the turbocharger to the desired position, and performs all of the diagnostics and self-checks on the actuator.

2.2 OVERVIEW



1	Engine Oil Level/Temperature	8	Camshaft Position
2	Fuel Pressure	9	Exhaust Gas Recirculation (EGR) Diff. Pressure
3	Aftertreatment Fuel Pressure	10	EGR Temperature
4	Engine Oil Pressure (EOP)	11	Engine Coolant Temperature (ECT)
5	Crankshaft Position/Speed	12	Piston Cooling Jet Oil Pressure Sensor
6	Crankcase Pressure (CCP)	13	Compressor Discharge Temperature sensor
7	Intake Air Temperature/Pressure		

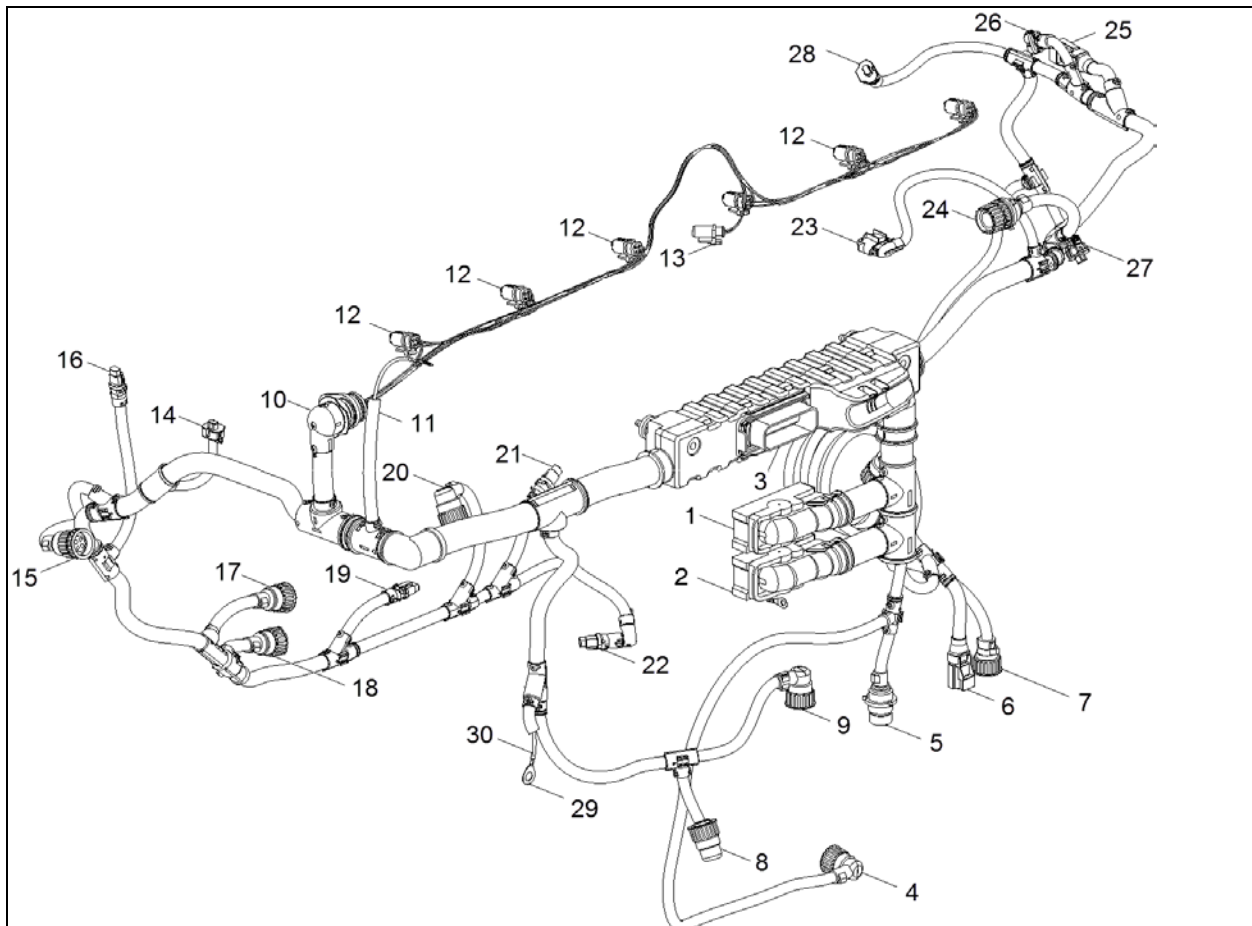


FIGURE 1: D13H ENGINE HARNESS

1 Vehicle harness connector	11 Preheater, engine	21 Oil thermostat
2 Engine control module (ECM) connector	12 Unit injectors	22 Oil piston cooling jet
3 Engine control module (ECM) connector	13 Solenoid valve, VEB	23 Sensor, boost temp
4 Sensor, oil level & temperature	14 Sensor, coolant temp	24 CAN3
5 Aftertreatment sensor	15 Sensor, EGR	25 7 th injector
6 Sensor, pressure crankcase	16 Sensor, temp EGR	26 Solenoid valve, EGR
7 Sensor, oil pressure	17 Sensor, turbo speed	27 Sensor, engine position camshaft
8 Solenoid valve, DRV	18 VGT	28 Sensor, engine position/speed crankshaft
9 Sensor, fuel pressure	19 Sensor, comp discharge temp	29 Ring terminal
10 Pass-through	20 Sensor, oil cooling	30 Electrical cable

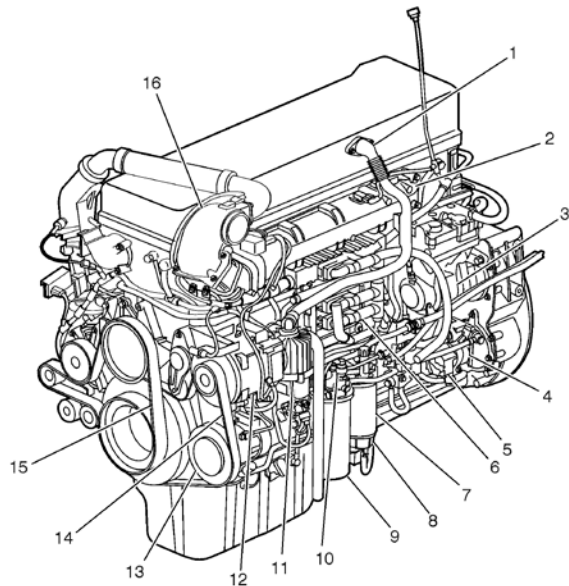


FIGURE 2: D13H ENGINE OVERVIEW, ALTERNATOR SIDE (TYPICAL)

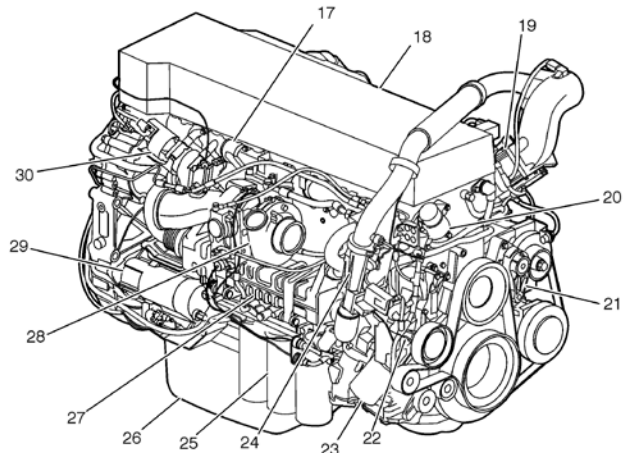


FIGURE 3: D13H ENGINE OVERVIEW, TURBO SIDE (TYPICAL)

- | | |
|--------------------------------|----------------------------------|
| 1. Breather tube | 16. EGR mixing chamber |
| 2. Intake Manifold | 17. Exhaust Manifold |
| 3. Air compressor | 18. Valve Cover |
| 4. Power steering pump | 19. Intake Air Heater (IAH) Opt. |
| 5. Fuel pump | 20. Thermostat |
| 6. Engine Control module (ECM) | 21. Belt tensioner |
| 7. Fuel filter | 22. Coolant Pump |
| 8. Fuel/Water Separator | 23. Coolant Filter |
| 9. Fuel Filter | 24. Venturi Pipe |
| 10. Hand-priming Pump | 25. Oil Filters |
| 11. Crankcase Ventilator | 26. Oil Pan |
| 12. Alternator | 27. EGR Cooler |
| 13. Alternator | 28. Turbocharger |
| 14. Alternator Belt | 29. Starter Motor |
| 15. Coolant Pump Belt | 30. EGR Valve |

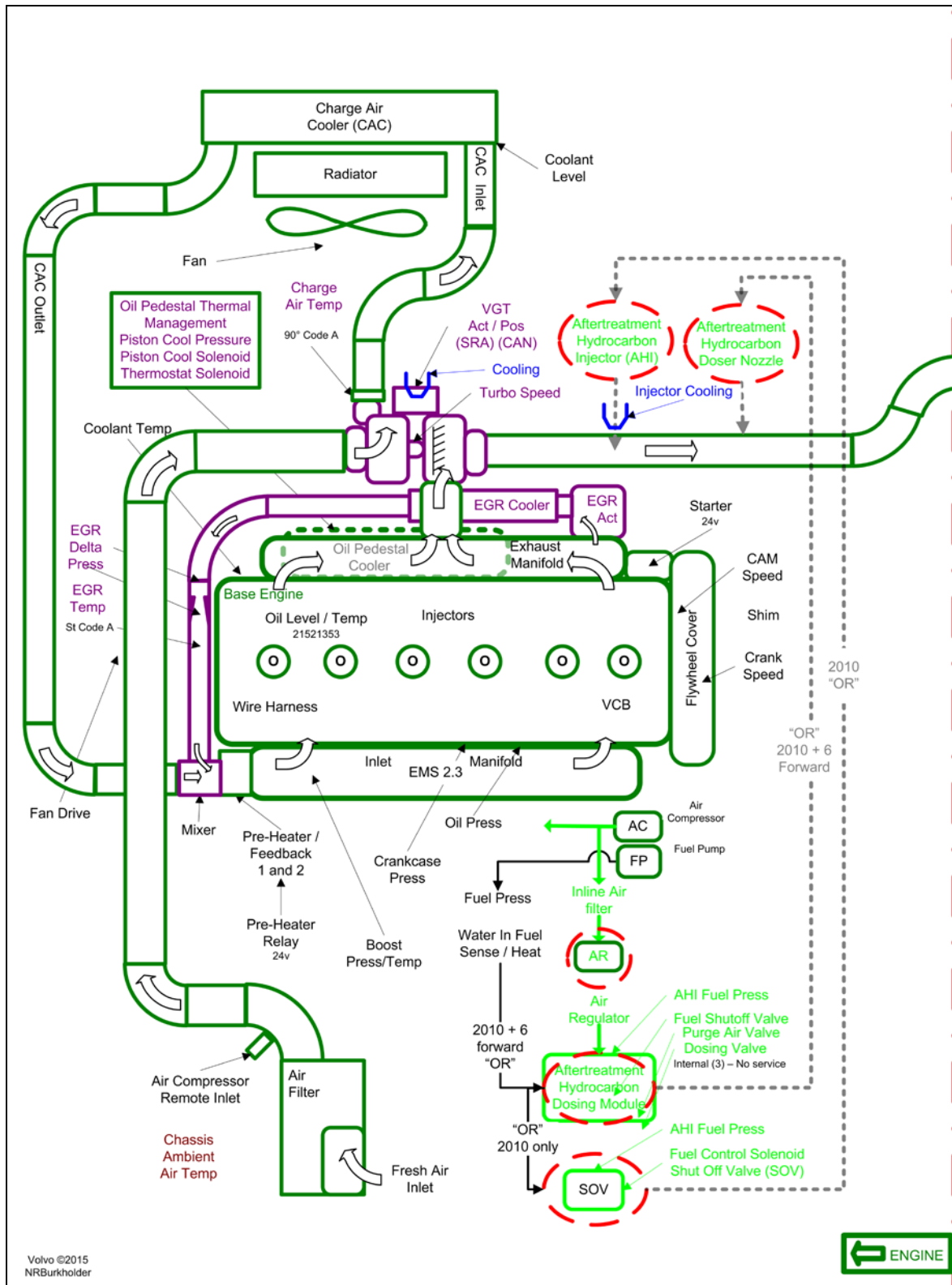


FIGURE 4: 2010-2015 ENGINE & EXHAUST AFTERTREATMENT SYSTEM DIAGRAM (1 OF 2)

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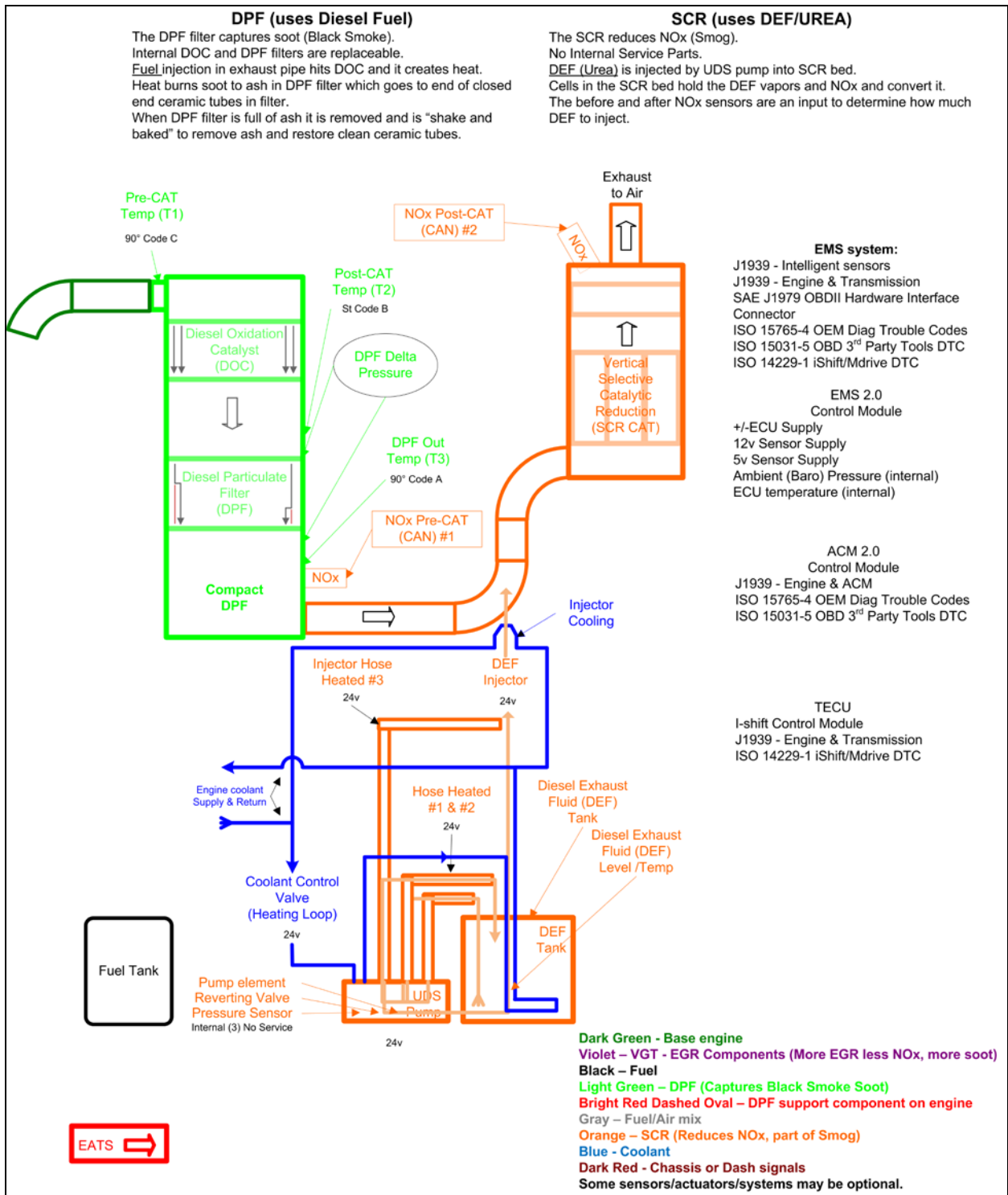


FIGURE 5: 2010-2015 ENGINE & EXHAUST AFTERTREATMENT SYSTEM DIAGRAM (2 OF 2)

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NOTE

For maintenance or repair of engine components or engine-related components, please refer to Volvo Trucks North America Web Site under: Parts & Service, purchase engine literature, D13H engine.

2.3 ENGINE OIL

Keep the engine oil at the proper level and change it at the recommended intervals. Always replace the oil filters at the same time as when the oil is changed.

2.3.1 Oil Quality

Volvo North America recognizes engine oils that meet or exceed the standards given by American Petroleum Institute (API) for the oil classifications listed in this manual. Only oils licensed to carry the API symbol should be used. Lubricants meeting API standards have provided maximum engine life when used together with the recommended oil and oil filter change intervals.

VDS-4 diesel engine oil is mandatory for use in all 2010 emission compliant Volvo engines. These engines, which can be identified by the presence of a DEF tank and an exhaust aftertreatment system using Selective Catalytic Reduction (SCR), also require the use of Ultra Low Sulfur Diesel (ULSD) fuel. VDS-4 oils exceed the new API service category CJ-4.

**CAUTION**

DO NOT add extra oil additives. Additives such as break-in oils, top oils, graphitizers, and friction-reducing liquids are not necessary and can harm the engine.

2.3.2 Oil Change Intervals

The length of time an engine can operate before an oil change depends on the quality oil used, the type of fuel used, fuel consumption, engine oil consumption, vehicle application, level of dust in the air, and fuel consumption. The change intervals given in the Lubrication And Servicing Schedule are maximum intervals. If the vehicle is operating in heavy-duty operation, dusty or off-road conditions, etc., reduce the intervals for more frequent oil changes.

**MAINTENANCE****Engine oil and filters change**

Change engine oil and filters at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

NOTE

Use the information in the table below to determine the operating condition and usage applicable to your vehicle.

engine operating condition	normal	heavy	severe
Total Fuel Consumption (mpg)	More than 6	Between 5 and 6	Less than 5
Total Fuel Consumption (L/100 KM)	Less than 39	Between 39 and 50	More than 60

NOTE: If idle time is greater than 25%, use the next lower drain interval (refer to Section 24 Lubrication and Servicing).

NOTE

Oil filters should always be changed when changing the oil.

2.3.3 Oil Filters

There are three filters on the engine, one of which is a bypass filter. This should be changed at the same time as the full-flow filter(s).

**CAUTION**

Volvo branded oil filters are designed to provide the proper level of filtration and protection for Volvo engines. Filters that do not meet the same stringent requirements may void engine warranty.

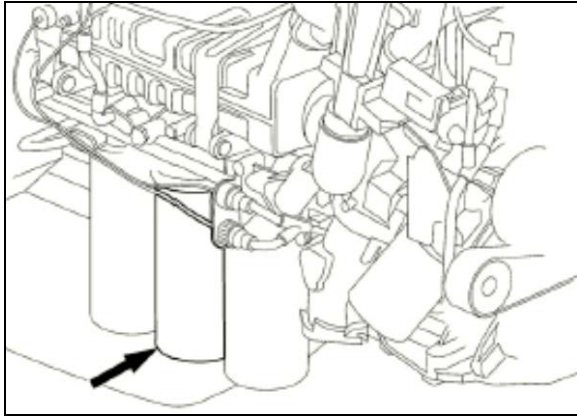


FIGURE 6: D13F OIL FILTERS

2.3.4 Synthetic Lubrication

Synthetic oils are offered by some oil suppliers as an alternative to the traditional, petroleum based oils for engines. These oils may be used in Volvo engines, provided they meet the quality levels the traditional, petroleum based oils for engines. These oils may be used in Volvo engines, provided they meet the quality level VDS-4.

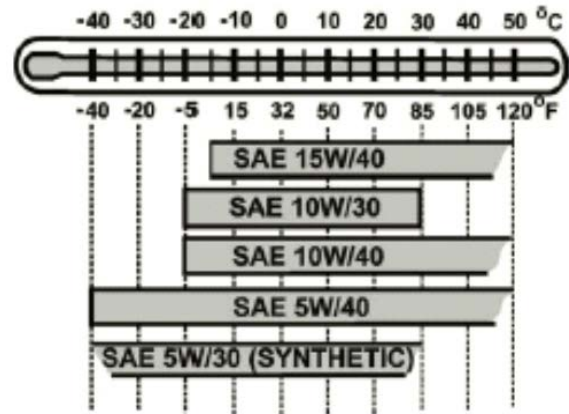
The use of synthetic oils does not permit the extension of the recommended oil change intervals.

2.3.5 Oil Viscosity

The viscosity grade defines the thickness of the oil. The oil must be thin enough at low temperatures for easy cold starts and thick enough to protect at high temperatures. Oil is not fully defined until both the API quality classification and the viscosity grade are specified.

Choose the viscosity grade for the typical ambient temperature for the application. Multigrade oils have a broad range that suit operation in changing temperature.

Volvo North America recommends the viscosities shown in the viscosity/temperature table for Volvo engines.



2.3.6 Oil Additives



CAUTION

Extra oil additives must never be added to any engine oil used. Additives such as break-in oils, top oils, graphitizers, and friction reducing liquids are not necessary and may even harm the engine.

Using oils to the quality standards recommended in this manual makes the use of extra oil additives unnecessary, as these oils already contain a balanced treatment of additives.

2.3.7 Oil Consumption

Once the engine is stopped, check the oil level daily. If the engine has just been stopped and it is warm, wait approximately five minutes to allow the oil to drain back to the oil pan before checking. Add oil as necessary.



CAUTION

DO NOT overfill engine with oil.

All diesel engines are designed to consume some oil, so it is normal to add oil periodically. An engine used in heavy-duty operation will consume more oil than one in normal operation.

2.3.8 Oil Change

**WARNING**

A hot engine or engine oil can be dangerous. Serious burns can result from contact with a hot engine or oil. Take precautions when draining the oil. Wear gloves or let the engine cool down before draining.

**WARNING**

When draining the oil, use the proper tools and keep away as far as possible. Raise the elbow so the forearm is parallel to the ground to prevent oil running down the arm, causing burns.

**CAUTION**

Always dispose of all lubricants (motor oil, coolant, gear box oils, etc) and filters according to Federal or local regulations. Used oil disposed of in nature or waterways contaminates our drinking water and kills wildlife.

**WARNING**

Prolonged contact with used engine oil may be harmful. Use rubber gloves when handling used oil. Wash skin thoroughly if it comes in contact with used oil.

It is important to drain as much oil as possible. Try to change oil immediately after driving, when the oil is warm. Always replace the oil filters when changing the oil.

component	capacity (l)
Oil pan	24 (min) – 32 (max)
Refill volume oil pan + filters	38

NOTE

Since about 1 liter of oil remains in the engine after draining, approximately 38 liters will be needed for a complete oil change.

2.3.9 Oil Filters Change

**WARNING**

Hot oil can cause severe burns. DO NOT allow hot oil to contact the skin. When changing oil, wear protective gloves.

**CAUTION**

Volvo-branded oil filters are designed to provide the proper level of filtration and protection for Volvo engines. Filters that do not meet the same stringent requirements may cause unsatisfactory results.

- Clean around the oil filter housing and remove the filters using the oil filter wrench or the oil filter socket.

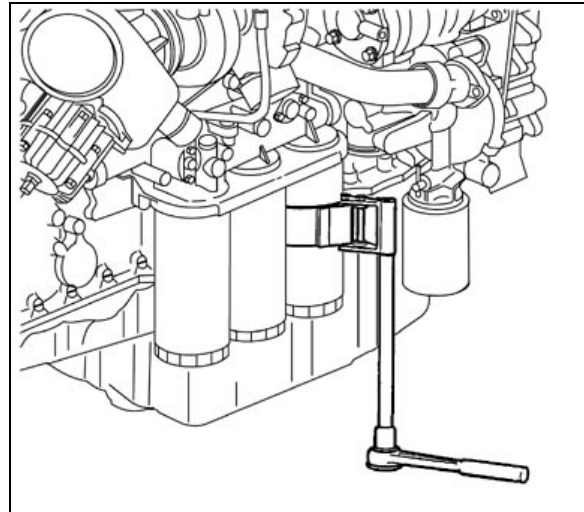


FIGURE 7: OIL FILTER WRENCH

- Prefill the new oil filters with approved engine oil. Also, lubricate the filter gaskets with engine oil (1). Hand tighten the oil filters until they contact the sealing surface of the oil filter housing (2). Manually tighten the oil filters an additional $\frac{3}{4}$ to 1 full turn (3).

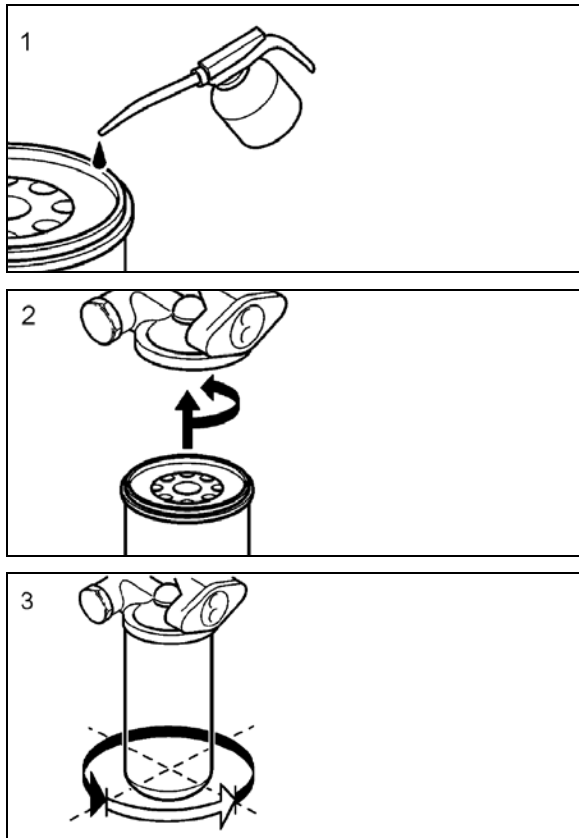


FIGURE 8: OIL FILTER REPLACEMENT

- Start the engine and check for leaks around the oil filter housing and filters.
- Check the oil level. Add approved engine oil to the recommended level, if necessary. Do not overfill.

2.3.10 Checking the Oil Level

Ensure that the vehicle is parked on level ground before checking the oil level. Wait five minutes after shutting off the engine and then proceed with checking the oil.



CAUTION

DO NOT let the oil level fall below the marking on the dipstick. **DO NOT** overfill so the level is above the upper marking on the dipstick. This could lead to excessive oil temperature and/or poor crankcase breather performance. Add oil through the oil filler pipe as required in order to maintain level within the safe range.

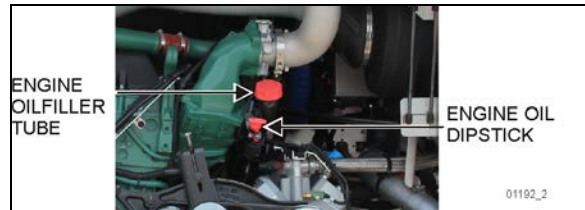


FIGURE 9: ENGINE OIL FILLING TUBE 01192_2

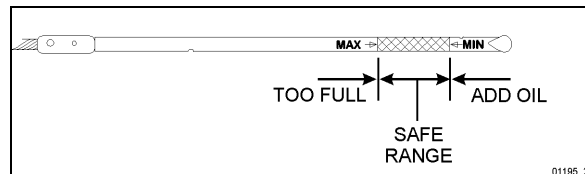


FIGURE 10: ENGINE OIL LEVEL DIPSTICK

2.4 POWER PLANT ASSEMBLY REMOVAL

To access the engine or engine-related components, the vehicle power plant assembly must be removed as a whole unit by means of a slide-out cradle. The power plant assembly includes the engine, transmission (including retarder if so equipped), air compressor, alternator and transmission oil cooler.

Remove the power plant assembly as follows:



CAUTION

Tag hoses and cables for identification before disconnecting in order to facilitate reinstallation. Plug all openings to prevent dirt from entering the system.

NOTE

No parts within the EECU are serviceable. If found defective, replace the EECU as a unit.

• First

1. Close the heater line shut-off valves.
2. Disconnect the battery or batteries from the starting system by removing one or both of the battery cables from each battery system. With the electrical circuit disrupted, accidental contact with the starter button will not produce an engine start.



WARNING

Due to the heavy load of the rear bumper assembly, it must be adequately supported

before attempting to remove it.

3. Remove the rear bumper assembly complete with hitch if applicable from the vehicle. Refer to Section 18, BODY, under "REAR BUMPER REMOVAL".
4. Using the quick-connect drain hose, drain the engine cooling system. Refer to Section 05, COOLING under "DRAINING COOLING SYSTEM".
5. If applicable, disconnect the block heater connector located near the EGR mixing chamber.

- **With Vehicle Raised**

1. Using a vehicle lift or jack, raise vehicle to access transmission fasteners and wire harness.
2. From under the vehicle, disconnect the propeller shaft as detailed in Section 09, under heading "Propeller Shaft Removal".
3. Partially remove L.H. side transmission protective panel to access connectors.
4. Disconnect transmission harness from transmission housing.
5. On vehicles equipped with an automatic transmission provided with a hydraulic output retarder, disconnect steel-braided airline from pressure regulator output. The pressure regulator is mounted in the upper section of engine compartment backwall and is accessible through the engine compartment R.H. side door.
6. Remove the retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe.
7. Disconnect the engine coolant hose near the starter.
8. Disconnect air compressor suction and discharge hoses.

- **With Vehicle Lowered**

Lower the vehicle enough to access all components.

- Engine Compartment R.H. side

1. If applicable, remove auxiliary sump tank to ease access.
2. Purge the A/C system and disconnect the A/C compressor hoses. Refer to Section 22, HEATING AND AIR CONDITIONING under "CENTRAL AIR CONDITIONING".
3. On X series vehicles, disconnect cables from two chassis grounds located on diagonal member. On H series vehicles, the ground cables are fixed to the rear subframe ground stud located close to the starter motor.
4. Inside engine compartment, disconnect starter, alternators and heater cables. Also disconnect AFSS cable if applicable.

Disconnect from engine, connector C397 and vehicle interface harness connector located above EECU connectors. Also disconnect DPF cable.

5. Disconnect power steering pump hoses.
6. Close engine fuel supply shut-off valve on primary fuel filter or Fuel Pro. Disconnect the fuel line located above fuel filters and connected to inlet port. On vehicles equipped with the optional water-separator-fuel-filter, disconnect the connector and remove cable ties from cradle.
7. Disconnect fuel return line from bulkhead fixed on engine cylinder head end.
8. Locate the A/C compressor belt tensioner pressure releasing valve (if so equipped). Turn pressure releasing valve handle counterclockwise in order to release pressure in belt-tensioner air bellows and loosen belts (Figure 11). Remove the belts.

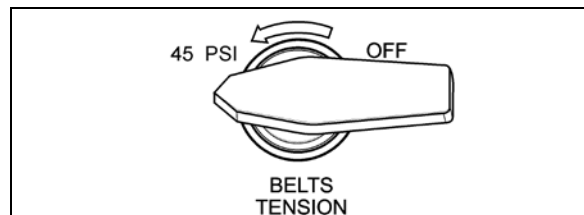


FIGURE 11: BELT TENSIONER VALVE ON REAR CONTROL PANEL

9. At the back of the air cleaner, disconnect the engine-air intake duct mounted between air cleaner housing and turbocharger inlet.

**CAUTION**

To avoid damage to turbocharger, cover the turbocharger inlet opening to prevent foreign material from entering.

10. Disconnect and remove the exhaust pipe mounted between the flexible coupling and the pipe going to the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) assembly. If necessary, refer to Section 4: EXHAUST SYSTEM under "EXHAUST AFTERTREATMENT SYSTEM OVERVIEW".
11. Disconnect and remove the air intake duct mounted between the charge air cooler outlet and the engine intake.

➤ Engine Compartment L.H. side

1. Disconnect the electric fan-clutch connector located near the cooling fan right angle gearbox
2. Disconnect fan driving shaft from radiator fan drive mechanism support.

**CAUTION**

To avoid damage to cooling fan right angle gearbox, make sure the power plant cradle clears the gearbox when pulling the engine out.

3. At the turbocharger inlet, disconnect and remove the engine-air intake duct mounted between air cleaner housing and turbocharger inlet.
4. Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.

5. Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet.
6. Disconnect and remove surge tank hose connected to pump inlet pipe and hose connected to engine.
7. Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet.
8. Unfasten and put aside engine compartment lighting fixture and turbocharger fire suppression nozzle if applicable.
9. Disconnect Exhaust Aftertreatment System control cable.

• **Last**

1. Inspect the power plant assembly to ensure that nothing will interfere when sliding out the cradle. Check for connections or hoses not mentioned in this list as some vehicles are equipped with special or aftermarket components.
2. Make sure the ten retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe are removed.

NOTE

Check if any spacer(s) have been installed between power plant cradle and vehicle rear subframe, and if so, note position of each washer for reinstallation purposes.

3. Using a suitable equipment with a minimum capacity of 4,000 lbs (1 800 kg), slightly raise the power plant cradle.
4. Pull engine out slowly from the engine compartment. Make sure all lines, wiring and accessories are disconnected and are not tangled.

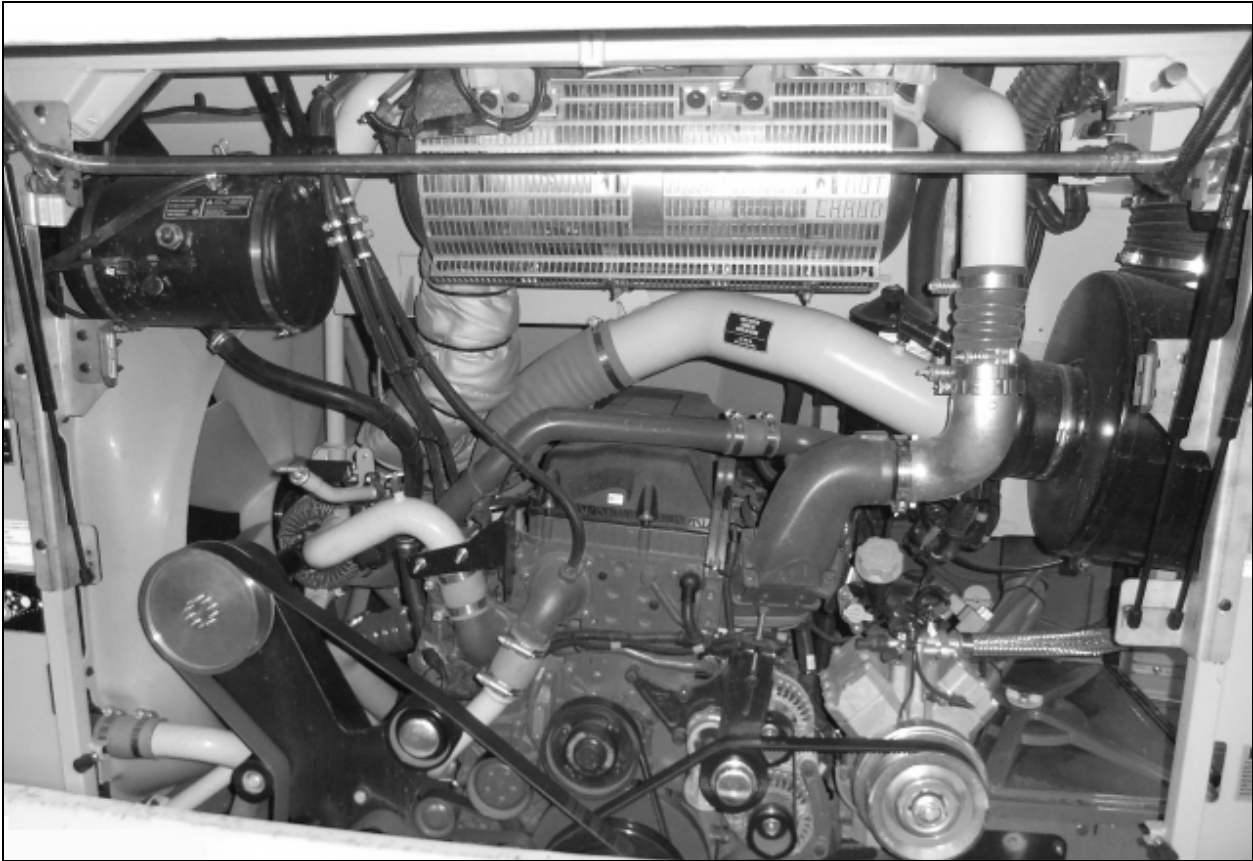


FIGURE 12: TYPICAL ENGINE COMPARTMENT(X3 COACHES SHOWN)

01184_B

2.5 POWER PLANT ASSY. INSTALLATION

To install a power plant assembly, follow the same procedure as in "Power Plant Assembly Removal" except in reverse order, then proceed with the following:

1. Torque the power plant cradle mounting bolts.

TORQUE: 190 lb-ft (258 Nm)

2. Refill cooling system with saved fluid (refer to Section 05 COOLANT SYSTEM).
3. Once engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil (refer to Section 03 FUEL SYSTEM).
4. Start engine for a visual check. Check fuel, oil, cooling, pneumatic and hydraulic system connections for leakage. Test operation of engine controls and accessories.

2.6 ENGINE MOUNTS

The power plant assembly is mounted to the cradle by means of rubber mounts and supports.

Two engine support brackets are used at the front of the engine while two rubber mounts are mounted underneath the engine & radiator fan drive mechanism support and the engine & alternator support.

It is recommended that new rubber mounts be installed at each major overhaul.

NOTE

Refer to the table on the following page for engine cradle tightening torques.

3. ELECTRONIC FOOT PEDAL ASSEMBLY (EFPA) & THROTTLE POSITION SENSOR

The Electronic Foot Pedal Assembly (EFPA) connects the accelerator pedal to a Throttle Position Sensor (TPS). The (TPS) is a device, which sends an electrical signal to the Motor Control Module (MCM). The TPS varies in voltage depending on how far the pedal is depressed. The system is installed in the space normally occupied by a mechanical foot pedal. The (EFPA) has maximum and minimum stops that are built into the unit during manufacturing (Figure 13). The (TPS) converts the operator's foot pedal input into a signal for the MCM.

When installed by the equipment manufacturer, the TPS should not require adjustment. If the TPS is suspected of being misadjusted, confirm that the sensor is installed in accordance with the manufacturer's specifications. It is recommended that the idle count be at 50 or higher with a full throttle count of up to 200.

The TPS is self-calibrating and therefore has no optimum closed throttle or wide open throttle count value. If the counts are within the 50 to 200 range, the sensor is properly set.

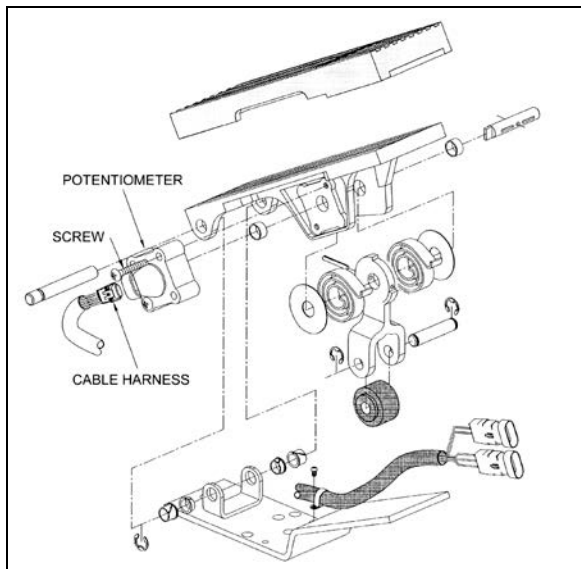


FIGURE 13: ELECTRONIC FOOT PEDAL ASSEMBLY 3035

Monitor the (TPS) at the controls as you move it through its full stroke. Be sure there is no misalignment or obstruction preventing the smooth movement of the TPS through the full stroke. Using a diagnostic data reader, check that the idle and full throttle position counts do not fall within the error zones. The error zones

occur when the idle position is less than 14 counts, or when the full throttle position is more than 233 counts. Should these conditions occur, the CPC will signal diagnostic codes of 21-12 for idle error and 21-23 for wide-open throttle error.

4. AUTOMATIC BELT TENSIONERS AND IDLER PULLEYS INSPECTION

With the engine running, if noise is coming from the tensioners or drive system, an inspection with the engine off is necessary.



MAINTENANCE

Remove belts and inspect automatic belt tensioners, idler pulley bearings at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

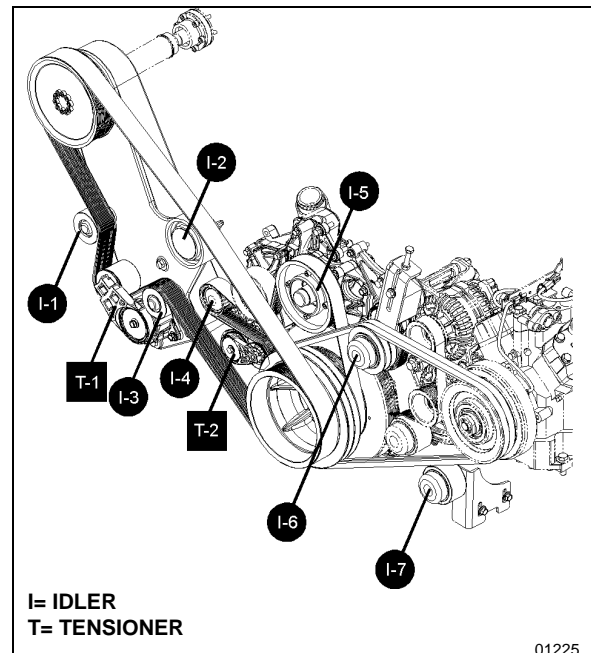


FIGURE 14: IDLER PULLEYS AND AUTOMATIC BELT TENSIONERS ON COOLING FAN DRIVE, WATER PUMP DRIVE AND A/C COMPRESSOR DRIVE

4.1 BEARING INSPECTION

1. First, set parking brake, turn the ignition OFF and set the rear start selector switch to the OFF position.
2. Remove all belts on cooling fan drive, water pump drive, A/C compressor drive and alternator drive.

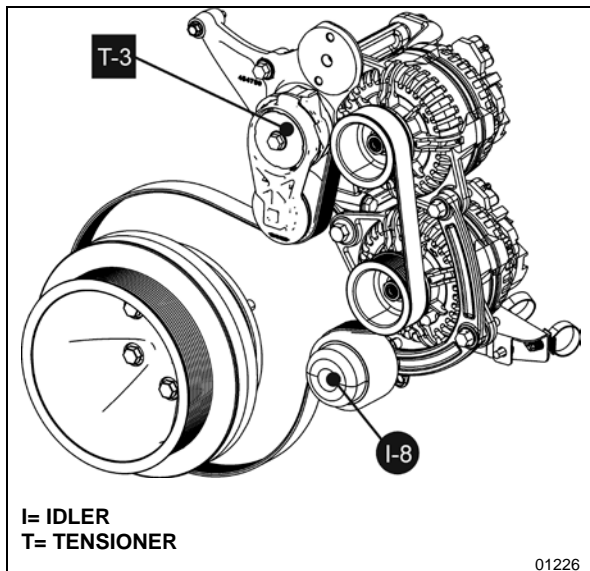


FIGURE 15: IDLER AND AUTOMATIC BELT TENSIONER ON ALTERNATOR DRIVE

3. Spin all idler pulleys, I-1 thru I-8, plus the idlers that are part of the automatic belt tensioners T-1 thru T-3.
4. Listen if some idlers are noisy and check for play in the bearings by hand.
5. Replace noisy idlers or if a play is found. Replace the automatic belt tensioner as a complete unit.
6. Record the results of the inspection.

4.2 AUTOMATIC BELT TENSIONER BUSHING WEAR

Automatic belt tensioner bushing wear may result in belt misalignment.

1. Check the automatic belt tensioner T-1 thru T-3.
2. Pry the automatic belt tensioner arm and check for a play between the arm and the spring case (see image below).

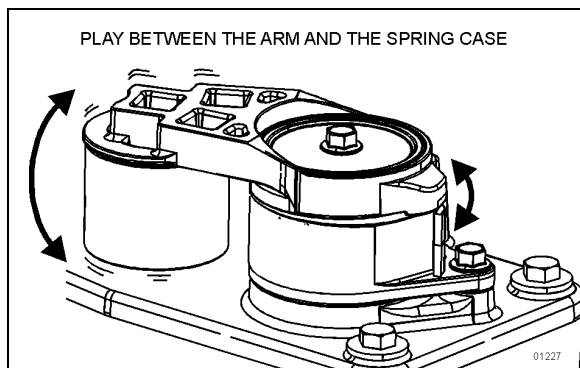


FIGURE 16: CHECKING BUSHING WEAR

3. If bushing wear is suspected, remove the tensioner. Inspect the tensioner for any signs of wear. Check for bearing noise as well as metal to metal contact between the arm and spring case which is a sign of bushing wear. Check for cracks in the tensioner body.
4. Replace the automatic belt tensioner if found defective.
5. Record the results of the inspection.

4.3 BELTS AND IDLERS VISUAL INSPECTION

1. Inspect drive belts for cracks, frayed material, missing chunks in the belt, abrasion and peeling. Replace belts if damaged.
2. Visually inspect all idlers for signs of deterioration, loose fasteners, etc.
3. Record the results of the inspection.



MAINTENANCE

Visually inspect belts and idlers for signs of deterioration, cracks, frayed material at the intervals specified by the Lubrication And Servicing Schedule in Section 24: LUBRICATION & SERVICING.

5. ENGINE PROTECTION STRATEGY

The engine protection system will automatically derate or derate and stop the engine when certain engine conditions reach a critical stage.

In the event of a serious fault, the red STOP telltale light comes on and an audible alarm will sound if the engine is running.



Prior to an actual automatic shutdown, the engine will automatically derate, go to idle, and then stop in 30 seconds.

ENGINE PROTECTION LOGIC (with yellow CHECK or red STOP telltale light)

High engine coolant temperature	Shutdown
High engine oil temperature	Shutdown
Low engine oil pressure	Shutdown
High crankcase pressure (rate of change)	Shutdown
Low coolant level	Derate only

SECTION 01 : ENGINE

High intake manifold air temperature	Derate only
High transmission oil temperature	Derate only
High temperature of cooled exhaust gas (EGR) - after EGR cooler	Derate only
EGR valve and position error	Derate only
Variable Geometry Turbo (VGT) valve and position error	Derate only
High VGT actuator temperature	Derate only
High pre-Diesel Oxidation Catalyst (DOC) temperature	Derate only
High Compressor Discharge Temperature (CDT – measured)	Derate only
High soot load	Derate only
High Diesel Particulate Filter (DPF) pressure differential (DP)	Derate only

OUTSIDE ENGINE PROTECTION LOGIC (no yellow CHECK or red STOP telltale light)

High altitude (ensures that high compressor discharge temp. is never reached)	Derate only
Turbo over-speed	Derate only
Low coolant temperature	Derate only
Crank sensor failure	Derate only
High crankcase pressure - Absolute Pressure	Shutdown

6. SPECIFICATIONS

Volvo D13 Engine

Make	Volvo
Type	Diesel four cycle/in-line direct injection engine
Description	Turbo/Air to air charge cooled
No. of cylinders.....	12.8 L in-line 6.
Operating range	1400-1800 RPM
X3-45 and H345 Coaches Peak Power Rating	435 HP (324 kW)
X3-45 and H345 Coaches Peak Torque Rating.....	1650 Ft-lb (2237 Nm)
X3-45 Bus Shells, X3-45 VIP and H345 VIP Peak Power Rating	500 HP (373 kW)
X3-45 Bus Shells, X3-45 VIP and H345 VIP Peak Torque Rating.....	1750 Ft-lb (2374 Nm)
Low Idle	600 rpm
Fast Idle.....	2150 rpm
Maximum full load revolutions	1900 rpm

Engine oil level quantity

Oil Pan Capacity, Low Limit.....	25 quarts/24 liters
Oil Pan Capacity, High Limit.....	34 quarts/32 liters
Refill volume including filter change	40 quarts/38 liters

Lubricating oil filter elements

Type	By-pass
Prevost number	510938
Type	Full Flow
Prevost number	488736

Torque specification

Engine oil filter	Tighten $\frac{3}{4}$ of a turn to 1 full turn after gasket contact
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Filters

Engine Air Cleaner Filter

Prevost number	530197
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Engine Coolant Filter/Conditioner

Prevost number.....	20458771
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**MAINTENANCE
INFORMATION**









MI16-16

DATE :	FEBRUARY 2016	SECTION :	01 - Engine
SUBJECT :	VOLVO D13 ENGINE – STARTER REMOVAL AND INSTALLATION		

DESCRIPTION

This procedure applies to current Melco 105P70 starter part number #21212425.

REQUIRED TOOLS

<p>RATCHET EXTENSION BAR</p> 	<p>RATCHET AND SOCKET SET – METRIC</p> 
<p>CORDLESS DRILL</p> 	<p>BRASS WIRE CUP BRUSH</p> 
<p>TORQUE WRENCH</p> 	<p>CUTTING PLIERS</p> 
<p>VOLTMETER / MULTIMETER</p> 	<p>METRIC OPEN END WRENCH SET</p> 

PROCEDURE – STARTER REMOVAL AND INSTALLATION



DANGER

Park vehicle safely, apply parking brake, stop engine. Prior to working on the vehicle, **set the ignition switch to the OFF position**, the battery master switch to the OFF position and trip the main circuit breakers equipped with a trip button.

RISK OF ELECTRICAL SHOCK

1. The starter is connected to the batteries through master relay R1. If the ignition switch is in the OFF position and the battery master switch (master cut-out) is set to the OFF position, there should not be electrical power to the starter **B** (batt) terminal. However, a faulty master relay R1 could eventually leave the battery power circuit closed, thus electrical power would be present at the starter **B** terminal.
2. Using a voltmeter or multimeter, probe the starter **B** terminal and the **ground** terminal. Make sure that the voltage reading is 0 volt prior disconnecting the starter cables (FIGURE 2).

STARTER REMOVAL

3. While proceeding from under the vehicle, gain access to the starter (item 29 on FIGURE 1) on the turbocharger side (street side).

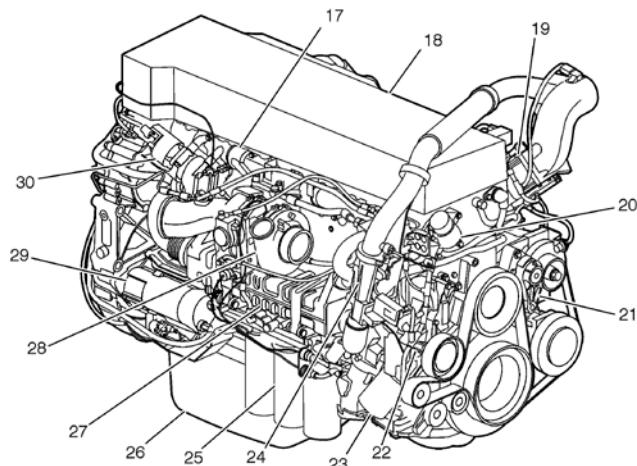


FIGURE 1: D13H ENGINE OVERVIEW, TURBO SIDE

4. On the starter, disconnect circuits **0C**, **101** and **101B** (see FIGURE 2). Properly clean cable lugs as applicable using a brass wire cup brush, a Scotch-Brite pad or an emery cloth. Remove old Color Guard Rubber Coating as much as possible.

IMPORTANT: keep hardware for later use

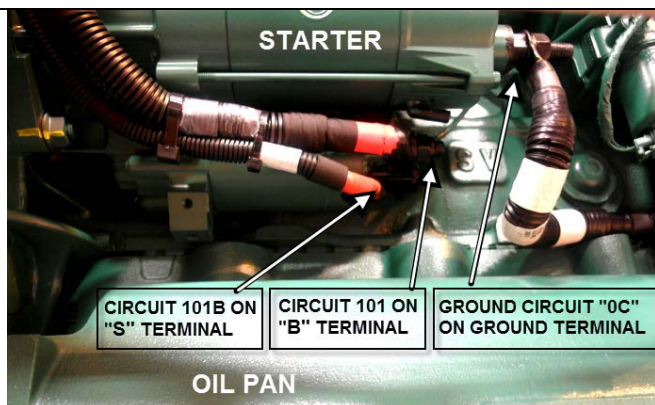


FIGURE 2

5. Using a 18mm socket, unscrew three bolts fastening the starter to the flywheel housing (FIGURE 3).
6. Detach the starter from the flywheel housing.

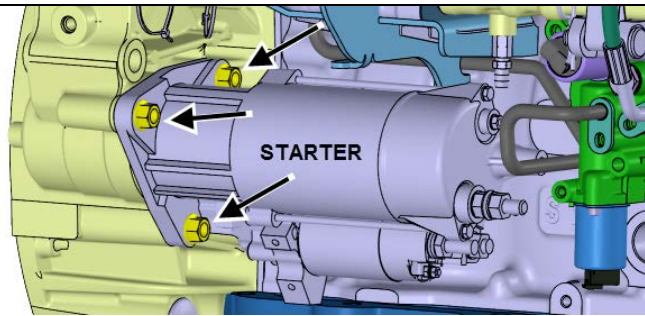


FIGURE 3

STARTER INSTALLATION

1. If the starter is replaced with a brand new starter, prepare the new starter as follows (refer to FIGURE 5).
 - a) Remove the second nut on the ground terminal (FIGURE 5). Keep for later use.
 - b) Remove the jumper cable connected to the ground terminal (FIGURE 5).
 - c) Make sure that the three nuts identified on FIGURE 5 are tightened to a torque of **22 lbf-ft**.
 - d) Reinstall the jumper cable to the ground terminal.
 - e) Install a nylon tie mount p/n 504013 on the starter. Refer to FIGURE 6 for proper location. Secure the nylon tie mount with one screw p/n 502817 (FIGURE 7).

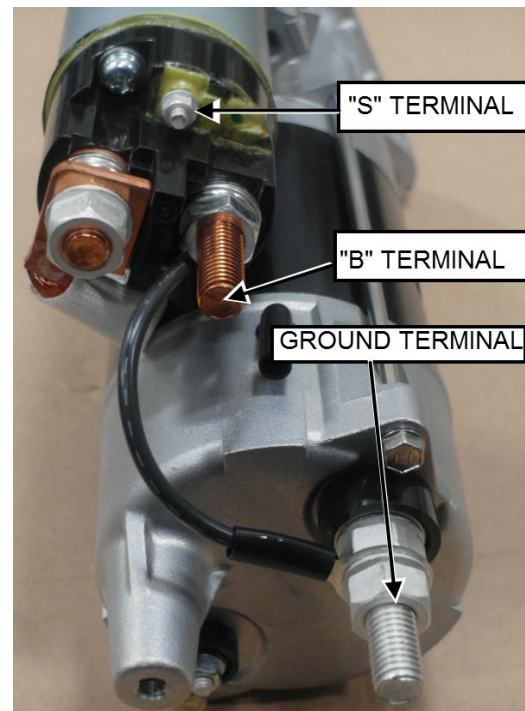


FIGURE 4 : TERMINAL IDENTIFICATION

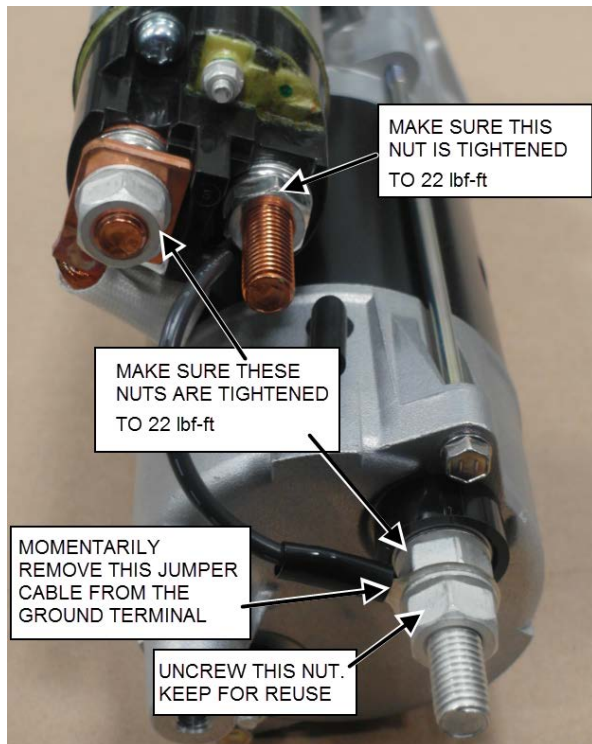


FIGURE 5

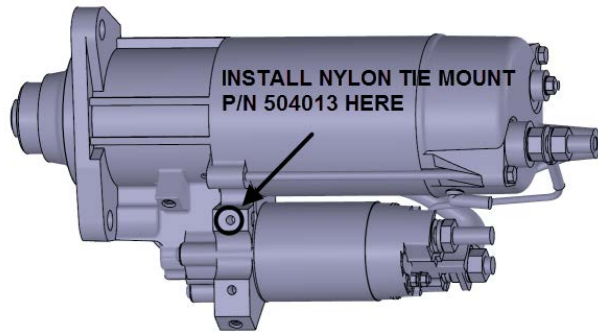


FIGURE 6

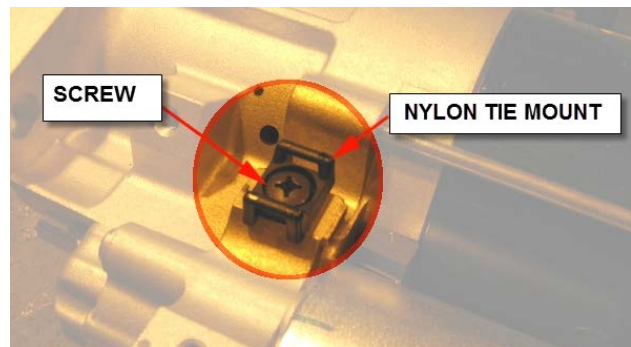


FIGURE 7

2. Install the replacement starter with the solenoid located on the underside of the starter motor as shown on **FIGURE 8**.
3. Hand tighten the three mounting nut.
Flange nut M12 p/n 990942 qty: 3
4. Once the starter is properly seated on the flywheel housing, torque the three mounting nuts to a torque of **44 lbf-ft**.

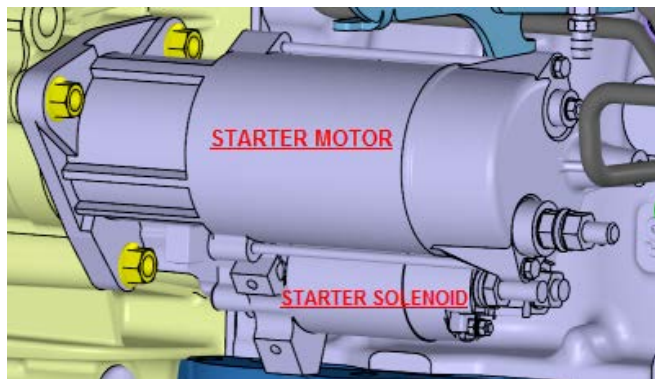


FIGURE 8

INSTALLATION OF CIRCUIT 0C

5. Connect the ground cable (circuit 0C) to the ground terminal first. Make sure the ground cable extends vertically downward from the terminal as shown on **FIGURE 9**.
6. Secure the ground cable lug with the nut previously removed at step 1-a. Tighten to a torque of **22 lbf-ft**.

M12 hex nut p/n 983717

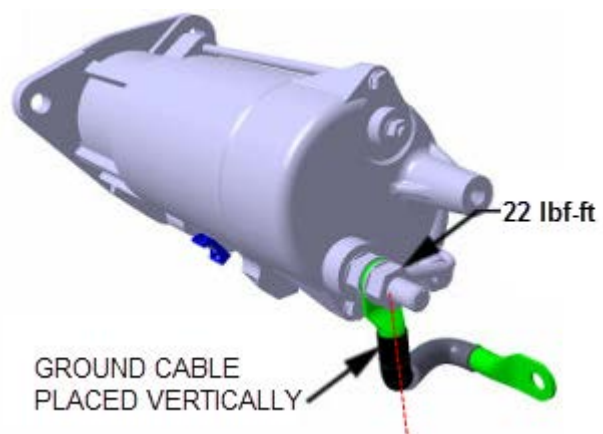


FIGURE 9

INSTALLATION OF CIRCUIT 101

7. Connect circuit **101** to **B** terminal (FIGURE 4 & FIGURE 5). Position circuit **101** cable to be in line with the nylon tie mount on the starter.
8. Place the washer against circuit **101** cable lug and secure cable lug and washer with the nut. Tighten the nut to a torque of **22 lbf-ft**.

washer p/n 500958 qty:1

nut p/n 5001761 qty:1

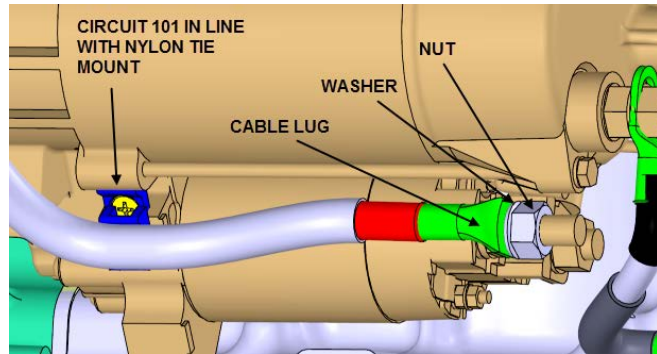


FIGURE 10

INSTALLATION OF CIRCUIT 101B

9. If not already done, remove the nut and washer provided with the brand new alternator on **S** terminal (FIGURE 4).
10. Connect circuit **101B** to **S** terminal. Position circuit **101B** cable to be in line with the nylon tie mount on the starter.
11. Place the provided washer against circuit **101** cable lug and then secure cable lug and washer with the nut provided. Tighten the nut to **35 lbf-in**.

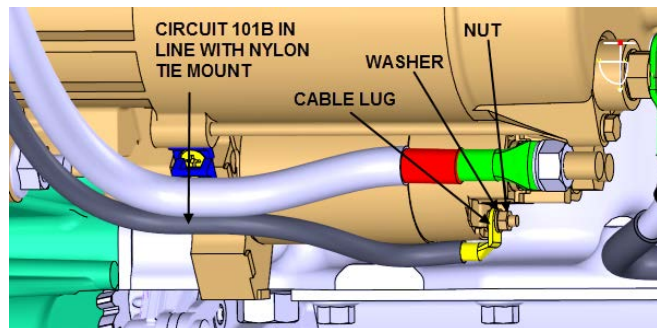


FIGURE 11

12. Secure circuit **101** and **101B** to the tie mount using one nylon tie *p/n 504016*.
13. Tie circuit **101** and **101B** together using one nylon tie *p/n 504637* as shown on FIGURE 12.



FIGURE 12

14. Apply anti-corrosion compound or **Color Guard Rubber Coating** (Prevost *p/n 684013*) on starter terminals, cable lugs and nuts (see FIGURE 13 to FIGURE 15).



FIGURE 13

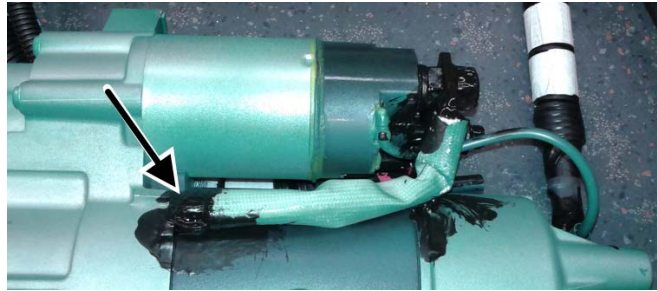


FIGURE 14



FIGURE 15

FUNCTIONAL TEST

1. Reset main circuit breakers if applicable. Set the battery master switch (master cut-out) to the ON position and start the engine.

PARTS / WASTE DISPOSAL

Discard according to applicable environmental regulations (Municipal/State[Prov.]/ Federal)



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