Engine, General Information
VN, VHD, VAH
Section 2

General Information

This information provides details concerning engines available for Volvo vehicles.

Note: We have attempted to cover as much information as possible. However, this information does not cover all the unique variations that a vehicle may present. Note that illustrations are typical but may not reflect all the variations of assembly.

All data provided is based on information that was current at time of release. However, **this information is subject to change without notice**.

Contents:

DANGER

Risk of serious personal injury
Do not use ether or other combustible starting aids in any Volvo engine. Introduction of ether or similar starting aids could cause a fire or explosion resulting in severe property damage, serious personal injury or death.

CAUTION

Risk of component damage
DO NOT crank the engine for more than 30 seconds at a time. Wait two minutes after each try to allow the starter to cool. Failure to follow these instructions could cause damage to the starter.

Note: Some starters are equipped with starter protection. If the engine is running, the starter temperature is too high, the transmission is not in neutral or the clutch pedal is not pressed, starter engagement is inhibited.

Allow the engine to slow down and idle for three to five minutes before shutting it off. This allows the turbocharger to cool down and the cooling system to dissipate the engine heat. Switch the engine off by turning the ignition key to the OFF position.

CAUTION

Risk of component damage
Shutting off an engine immediately after high speed or full load operation can damage the turbocharger and cause heat stress in the engine. Always let the engine idle for three to five minutes before shutting it off.

Volvo Trucks North America does not recommend the use of winterfronts, shutters or any other shield in front of the grille or radiator package under normal circumstances. Today's electronically controlled engines are designed to operate in cold temperatures without a winterfront. These devices, if not used properly, can cause higher exhaust gas temperatures, power loss, excessive fan usage, failure of the Charge Air Cooler (CAC) and a reduction in fuel economy. Winterfronts can be used in the wintertime during very cold weather if used properly. In these cases, engine coolant and intake air temperatures must also be carefully monitored and controlled. Contact your authorized Volvo truck dealer for recommended winterfronts.

CAUTION

Risk of component damage
Volvo is now using the Ambient Air Temperature (AAT) sensor for On-Board Diagnostic (OBD) monitoring. If a customer installs a winterfront or blocks the radiator opening and blocks airflow to the sensor, they will likely set an OBD Diagnostic Trouble Code (DTC) for inaccurate sensor data due to restricted airflow across the sensor.

DANGER

Failure to take the necessary precautions when the stop tell-tale is ON can result in automatic engine shutdown and the loss of power steering. Vehicle crash can occur.

The engine shutdown system will automatically derate or stop the engine when one or more of the conditions listed below reaches a critical stage:

- High engine coolant temperature (ECT)
- Low engine oil pressure (EOP)
- Low engine coolant level (ECL)
- High crankcase pressure (CCP).

When the shutdown is activated, the tell-tales come on along with display symbols and the buzzer is also activated. After a brief time, the engine shuts down. Find a safe place to pull off the road as soon as possible.

After the engine is shut down by the system, turn the ignition key to the OFF position. If necessary, the engine can be re-started for a brief time so that the vehicle may be pulled off the road.

The alarm will remain activated until repairs are made to correct the problem that caused the shutdown.

CAUTION

Risk of engine damage
Continuously restarting the engine once the shutdown system is active may result in severe engine damage.

Refer to the Driver Information Display manual for information about the display symbols.

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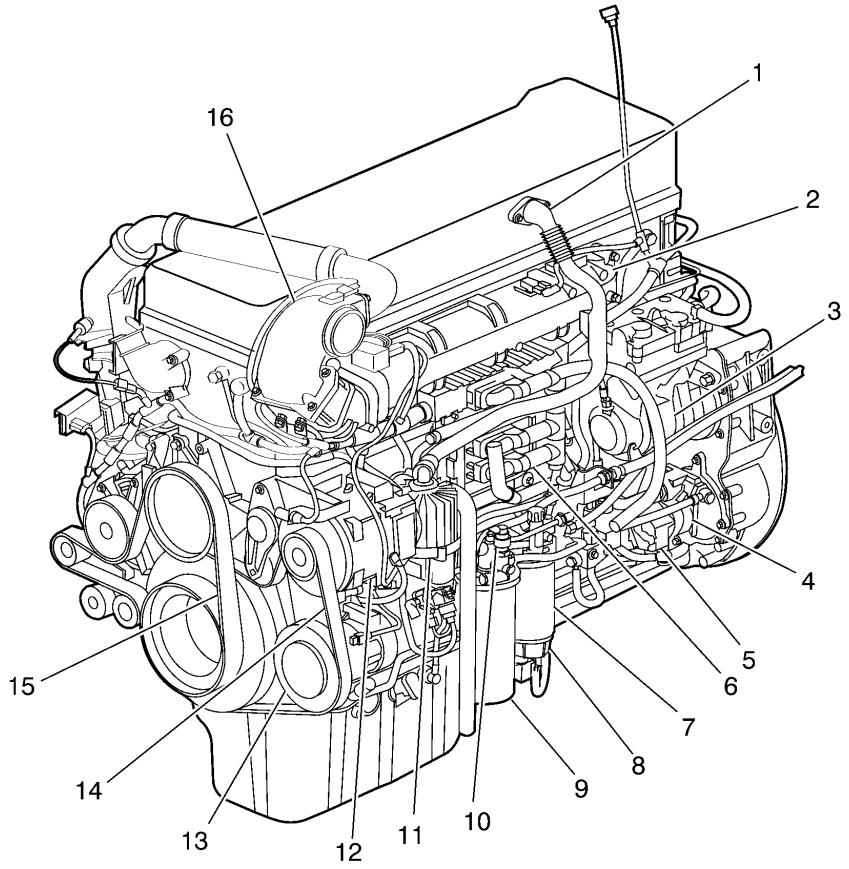
Notes

Engine Overview, D11 and D13

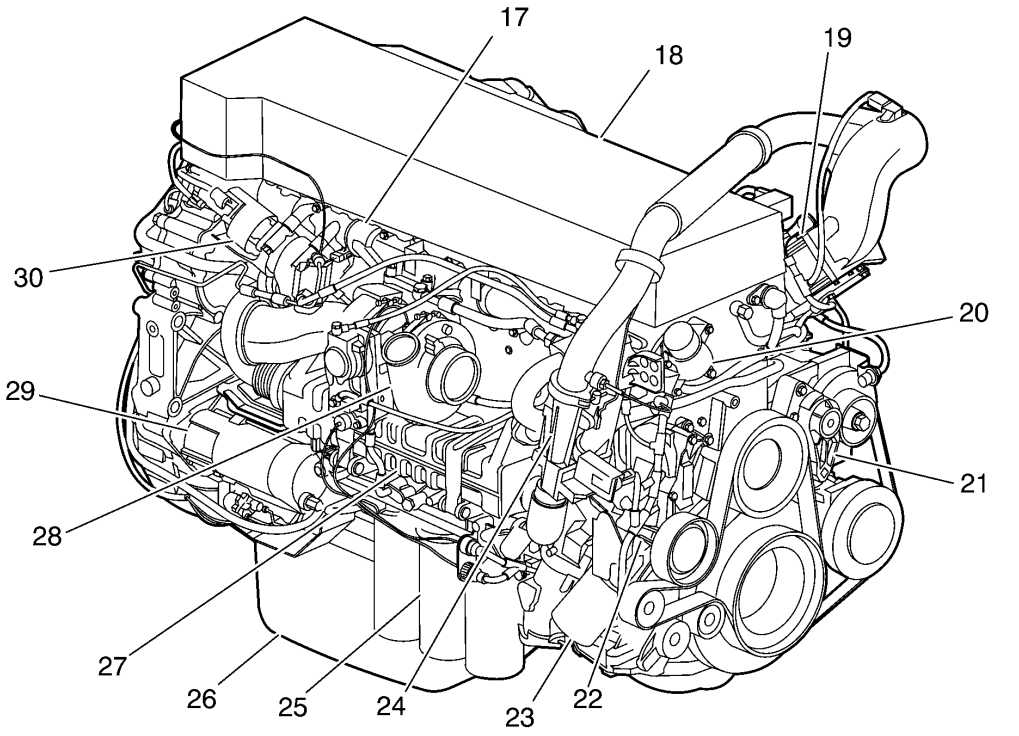
Left Side View



D13 Engine Shown, D11 Engine Similar

1. Breather tube	9. Fuel filter
2. Intake manifold	10. Hand-priming pump
3. Air compressor	11. Crankcase ventilator
4. Power steering pump	12. Alternator
5. Fuel pump	13. AC compressor
6. Engine Control Module (ECM)	14. Alternator/AC compressor belt
7. Fuel filter	15. Fan/Coolant pump belt
8. Fuel/Water separator	16. EGR mixing chamber

D11 and D13 Right Side View



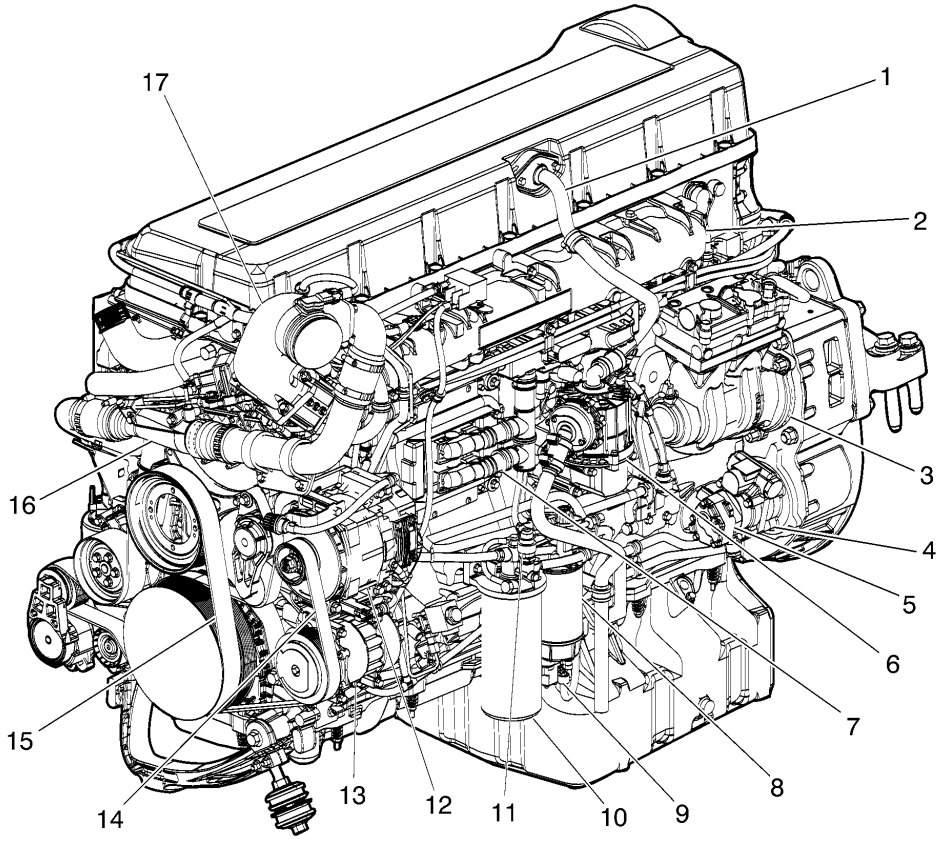
D13 Engine Shown, D11 Engine Similar

17. Exhaust manifold	24. Venturi pipe
18. Valve cover	25. Oil filter housing
19. Intake Air Heater (IAH) optional	26. Oil pan
20. Thermostat	27. EGR cooler
21. Belt tensioner	28. Turbocharger
22. Coolant pump	29. Starter motor
23. Coolant filter	30. EGR valve

Note: The oil filter housing (25) consists of two full flow filters and a bypass filter. From the model year 2020 D13 engines with VGT (Variable Geometry Turbocharger) and from the model year 2021 D13 engines with turbocompound, will not have the bypass oil filter.

Engine Overview, D16

Left Side View



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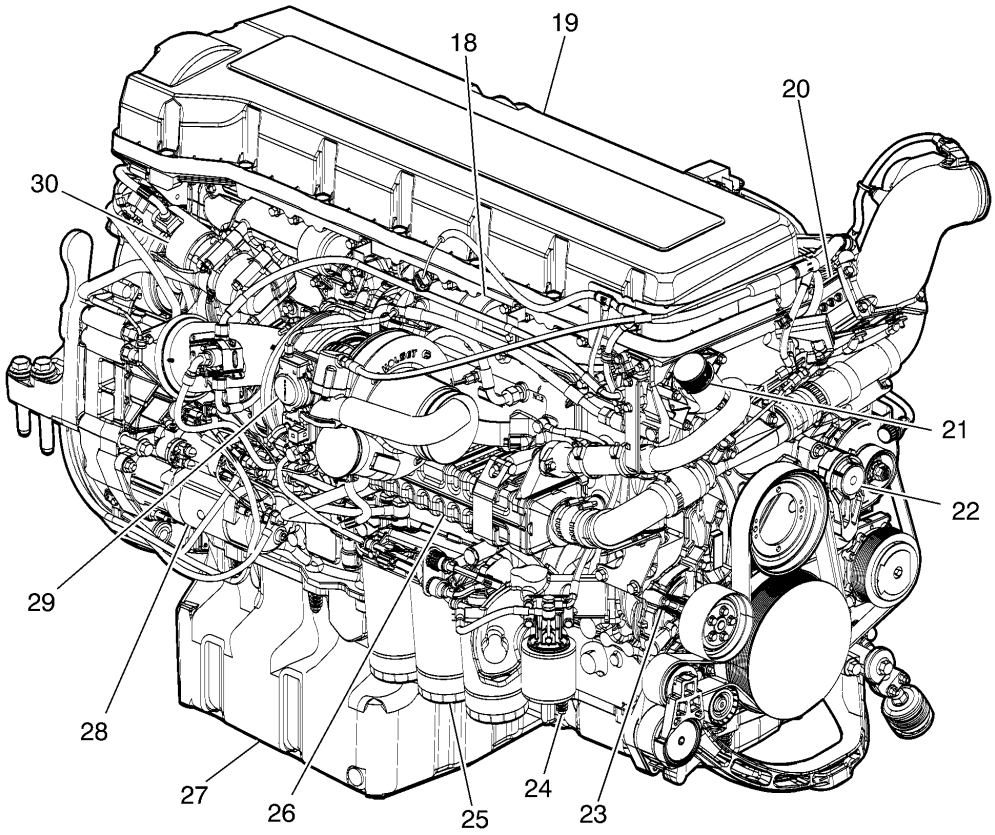
1. Breather tube	10. Fuel filter
2. Intake Mmanifold	11. Hand-priming pump
3. Air compressor	12. Alternator
4. Power steering pump	13. AC compressor
5. Fuel pump	14. Alternator/AC compressor belt
6. Crankcase ventilator	15. Fan/Coolant pump belt
7. Engine Control Module (ECM)	16. Venturi pipe
8. Fuel filter	17. EGR mixing Cchamber
9. Fuel/Water separator	

D16 Right Side View



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18. Exhaust manifold	25. Oil filters
19. Valve cover	26. EGR cooler
20. Intake Air Heater (IAH)	27. Oil pan
21. Thermostat	28. Starter motor
22. Belt tensioner	29. Turbocharger
23. Coolant pump	30. EGR valve
24. Coolant filter	

Exhaust Emissions and Aftertreatment Diesel Particulate Filters (DPF)

General

USA

Emissions Control Compliance: The Federal Clean Air Act, Section 203 (a) (3), states the following concerning the removal of air pollution control devices or modification of a certified engine to a non-certified configuration:

The following acts and the causing thereof are prohibited:

For any person to remove or render inoperative any device or element of design installed on or in a motor vehicle or motor vehicle engine in compliance with regulations under this part prior to its sale and delivery to the ultimate purchaser, or for any manufacturer or dealer knowingly to remove or render inoperative any such design after sale and delivery to the ultimate purchaser.

Specifically, please note that no person may make such changes prior to the sale and delivery of the vehicle to the ultimate purchaser, and, in addition, no manufacturer or dealer may make take such action after sale and delivery of the vehicle to the ultimate purchaser. The law provides a penalty of up to $10,000 for each violation.

Modifications, such as reprogramming of the fuel system so the engine will exceed the certified horsepower or torque, or removing the mufflers are examples of illegal changes.

Changes must not be made to a certified engine that would result in an engine that does not match the configuration of an engine model that is currently certified to meet Federal Standards.

Mexico

The same conditions that apply in the USA apply to Mexico. Refer to the Mexican Federal Law for Emission Control which adheres to EPA regulations. No changes must be made that render any or all of the emissions control devices inoperative. If the owner/operator wishes to make changes to the emission control devices, check with the state authority before changes are made.

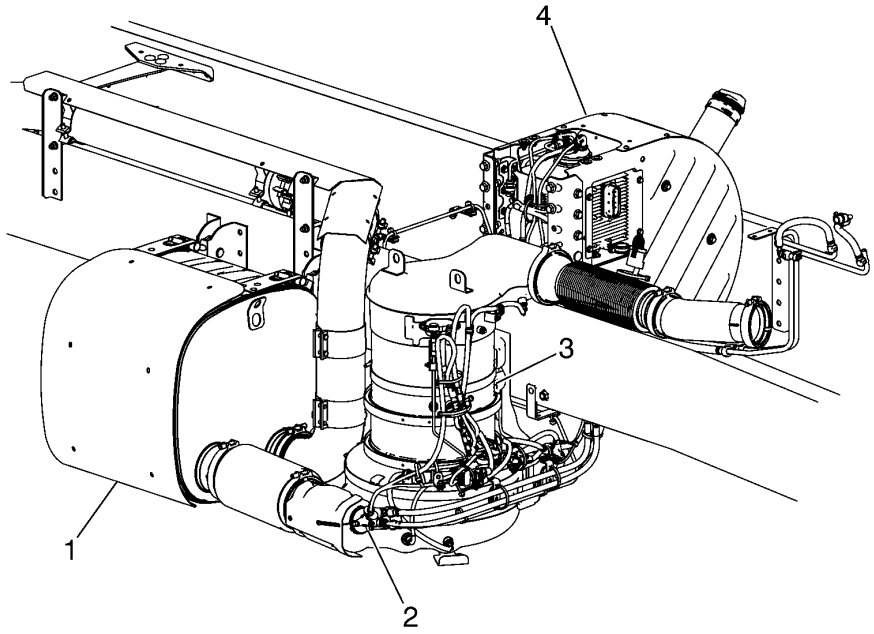
Canada

The same conditions that apply in the USA apply to Canada, with one exception. After the vehicle is sold to a retail customer, that is, the end user, the jurisdiction controlling the emission control devices becomes the province in which the vehicle is licensed. No changes must be made that render any or all of the devices inoperative.

If the owner/operator wish to make any changes to the emission control devices, they must check with the provincial authority before making any such changes.

Notes

Exhaust Emissions and Aftertreatment DPF with Horizontal SCR Catalyst



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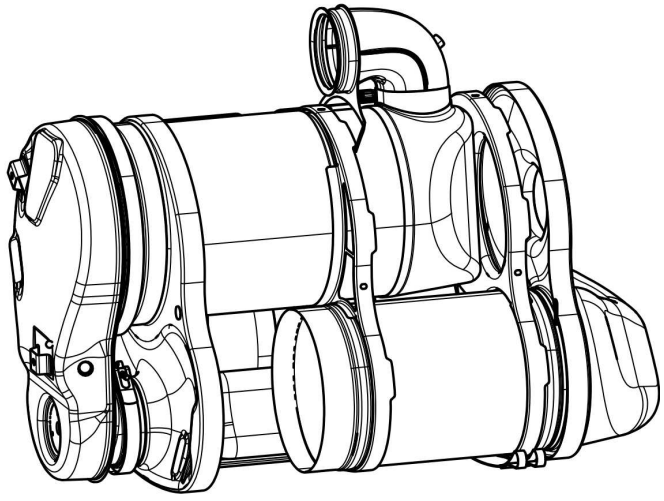
1. Aftertreatment SCR Catalyst
2. Aftertreatment Diesel Exhaust Fluid (DEF) Dosing Valve
3. Aftertreatment DPF
4. Aftertreatment DEF Tank

Integrated Aftertreatment DPF



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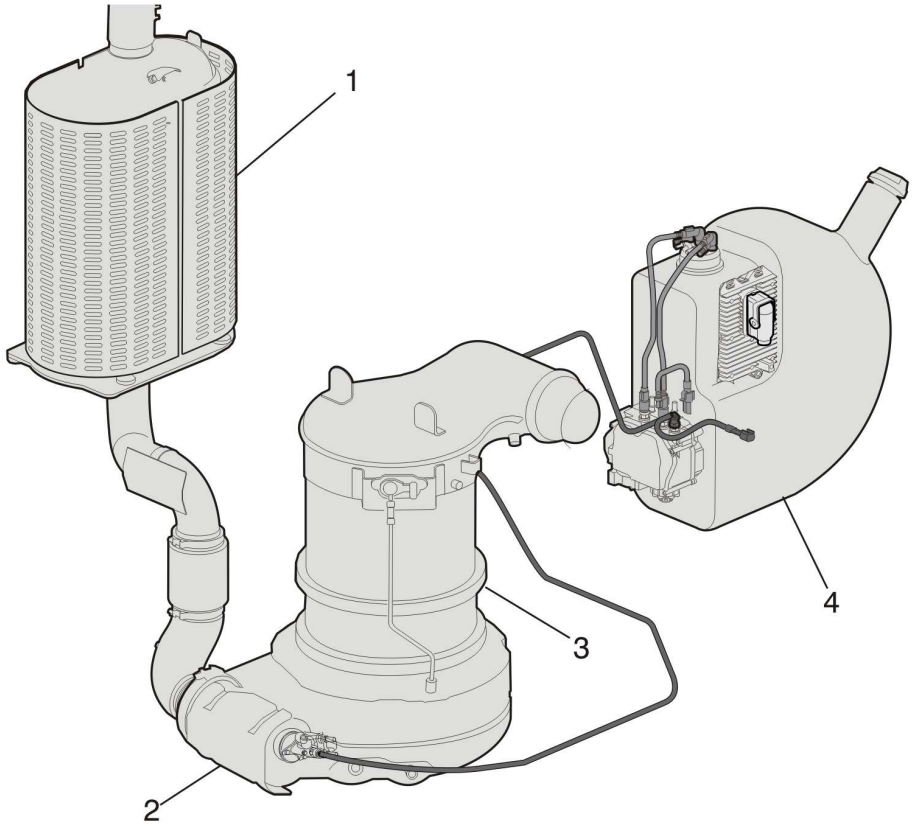

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1. Aftertreatment SCR Catalyst
2. Aftertreatment DEF Dosing Valve
3. Aftertreatment DPF
4. Aftertreatment DEF Tank

Notes

Exhaust Aftertreatment System

⚠ DANGER

The DPF/SCR shield must not be removed while the vehicle is in use. Also, only remove the shield, once the vehicle is out of use and the SCR/DPF is sufficiently cooled. Failure to follow these instructions can result in fire, which can cause component damage, personal injury or death.

⚠ CAUTION

Risk of component damage
The Diesel Particulate Filters (DPF), Selective Catalytic Reduction unit (SCR) and their components, **cannot** be moved or altered from the OEM installation in any fashion. Any alterations may cause component damage and is prohibited by the law.

The DPF, SCR and their components are the part of the overall vehicle emissions control system. In normal operation, these components can experience surface temperatures as high as 350° C (662° F). It is important to verify the temperature at which the material or substance in, or associated with, the body can ignite. If it is possible for the material or substance to fall or leak from the body, take steps to prevent them from contacting or collecting on the DPF or SCR. Failure to do so may result in fire.

It is important to note that additional shielding may, depending upon conditions and the material or substance, trap flammable substances between the additional shield and the DPF/SCR. If this condition can develop, advise the user of the vehicle to periodically check to ensure there are no trapped substances.

Note: The DPF/SCR and associated components are part of a U.S. EPA and California Air Resources Board (CARB) certified engine emissions system. These components must not be moved, altered or modified in any way. Tampering with these systems render the emissions warranty void and may result in possible tampering charges by the EPA or CARB.

New stringent standards for exhaust emission control begin with the US 2010 engine model year. The Diesel Particulate Filter (DPF) system has been developed to act in combination with ultra low sulfur diesel (ULSD) fuel to reduce particulate emissions to meet the requirement. The Exhaust After-Treatment System (EATS) includes all the engine and exhaust emissions control components that are required to meet the stringent US 2010/GHG 2017 standard.

Particulate matter consists of soot and ash in the exhaust that engines with an EGR system alone, are not equipped to handle. The particulate matter is considered a contaminant that contains undesirable elements. The DPF system reduces the unwanted elements to a more acceptable level defined in the regulations. There are multiple methods of reducing these emissions. Volvo has selected to use a Diesel Oxidation Catalyst (DOC) with a catalyzed diesel particulate filter. The other uses a diesel particulate filter of a different kind without a DOC and in its place uses a combustion chamber to heat the exhaust mixture thus causing active regeneration.

The particulate matter removed from the exhaust collects on the filter surfaces. To avoid eventual blockage, which would increase exhaust back pressure and affect power and fuel economy, the filter must be cleaned. The DPF is cleaned automatically. The soot breaks down to safer substances before being released to the atmosphere. Some of the ash remains, but takes a long time to reach the point where ash clogs the filter.

Cleaning a filter so it can continue to function is called “regeneration.” Depending on vehicle usage, the engine utilizes a passive or parked regeneration system. Either system uses high heat to break down the chemical properties.

In “passive regeneration,” the exhaust produces enough heat continuously to convert the soot, with approximately 260 °C (500 °F) being required. The process is slow and continues indefinitely. Passive regeneration is possible only in vehicle applications where the temperature is likely to remain at or above the required temperature level, making active regeneration unnecessary.

Parked regeneration is initiated manually by the driver when alerted by the dash. The vehicle must be stationary to begin the regeneration, and remain stationary to complete.

The aftertreatment DPF regeneration system is self-monitoring. Under certain duty cycles driver action is needed to perform a parked regeneration. When driver action is needed to perform a parked regeneration the aftertreatment DPF regeneration needed icon on the instrument cluster flashes and the message “Parked REGEN Needed” is displayed. Initiate a parked aftertreatment DPF regeneration at the next stop.

WARNING

Risk of personal injury
Before working on the exhaust, allow time for the entire exhaust system to cool. Failure to do so may result in personal injury. Severe burns can occur.

DPF Systems and Temperatures

The Volvo systems chemically alters soot by high heat into a harmless gas which passes out through the stack pipe. At these high temperatures, the process is relatively rapid (10–12 minutes). Eventually, the filter must be removed with special equipment to clean the ash.

Volvo offers a compact DPF unit with muffler. The compact unit is attached to the right frame rail, under the cab.

The DPF-muffler has an integrated heat insulation that covers most areas of the muffler. The DPF mufflers are not insulated at the V-clamp body connections, inlet and outlet pipes.

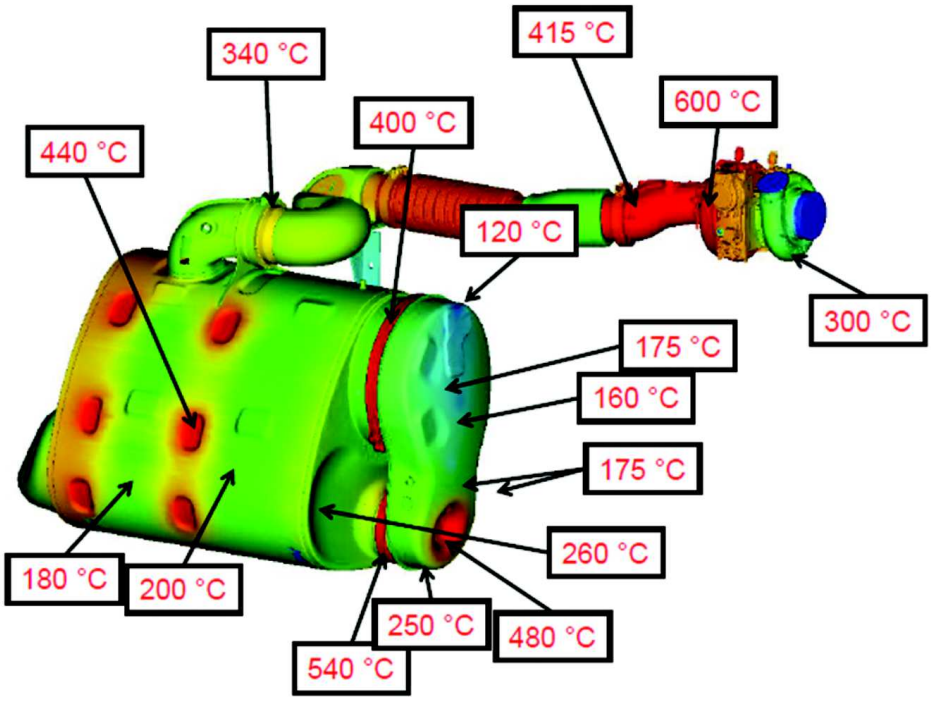
The following surface temperatures are measured with the muffler which is freely positioned in a room temperature environment with no forced cooling or wind (only self convection).

Note: The below values are **not** maximum temperatures. The surface temperature in a certain vehicle installations is dependent on the degree of encapsulation and the airflow around the muffler.

Compact DPF Temperatures

Position	Thickness of Heat Insulation	at exhaust temperature of 350 °C (662 °F) at the DPF-muffler inlet (no regeneration)	at exhaust temperature 450 ° C (842 °F) at the DPF-muffler inlet (no regeneration)
Inlet section — top	10 mm (0.4 in.)	170 °C (338 °F)	190 °C (374 °F)
Inlet section — side	No insulation	260 °C (550 °F)	320 °C (608 °F)
DOC section	9 mm (0.35 in.)	175 °C (347 °F)	215 °C (419 °F)
DPF section	10.5 mm (0.41 in.)	145 °C (293 °F)	190 °C (374 °F)
Outlet section — side	4.5 mm (0.18 in.)	100 °C (212 °F)	150 °C (302 °F)
Outlet section — bottom	4.5 mm (0.18 in.)	120 °C (248 °F)	170 °C (338 °F)
Clamping area — side	No insulation	230 °C (446 °F)	300 °C (572 °F)

These 2017 GHG Integrated DPF/SCR surface temperatures were measured from a test vehicle in a controlled environment and are meant to be used as guidelines for mounting additional Customer equipment. These temperatures could vary based on the application and operating environment of your specific vehicle.



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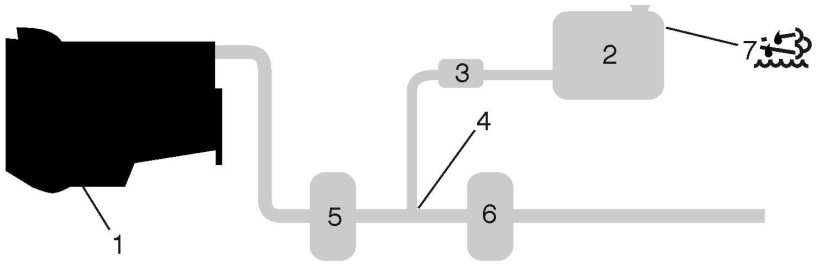
GHG Integrated DPF/SCR Surface Temperatures Conversion

Degrees Celsius	Degrees Fahrenheit
120	248
160	320
175	347
180	356
200	392
250	482
260	500
300	572
340	644
400	752
415	779
440	824
480	896
540	1004
600	1112

Selective Catalytic Reduction (SCR)

Selective Catalytic Reduction (SCR) is an emissions-reduction technology with the ability to deliver near-zero emissions of nitrogen oxides (NOx), a smog-causing pollutant and greenhouse gas. SCR's performance is proved in millions of miles of real-world truck operations in other countries, as well as in long-term field tests in the U.S. The SCR reduces NOx emissions to very low levels, at the same time delivering excellent fuel economy and reliability. The system does not change the design or operation of the basic engine. Rather, The SCR is an aftertreatment system which converts NOx in the exhaust stream into harmless gases. Modern diesels already use exhaust aftertreatment systems, called diesel particulate filters, to control emissions of another pollutant, soot (also known as particulate matter or PM). The SCR works by injecting Diesel Exhaust Fluid (DEF) into the exhaust steam, after the DPF. The DEF is a safe, simple solution of water and urea. The DEF works with the heat of the exhaust and a catalyst to convert NOx into nitrogen and water vapor - two harmless and natural components of the air we breathe. The end result is cleaner air, excellent fuel efficiency and a reliable emissions control system for today's modern diesel engine.



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System operation

1. Diesel engine optimized for high performance, low particle emissions and low fuel consumption.
2. Aftertreatment DEF Tank.
3. The aftertreatment control module continuously monitors and adjusts the DEF dosing rate.
4. DEF is injected into the exhaust gases in between the aftertreatment DPF (5) and the SCR catalyst (6).
5. Aftertreatment Diesel Particulate Filter (DPF).
6. In the SCR catalyst, nitrogen oxides are transformed into harmless nitrogen gas and water.
7. Aftertreatment DEF Tank Gauge.

SCR Surface Temperatures

Position	Thickness of Heat Insulation	at exhaust temperature of 350 °C (662 °F) at the SCR-muffler inlet	at exhaust temperature 450 ° C (842 °F) at the SCR-muffler inlet
Casing – all round	Muffler filled with insulation	75 °C (167 °F)	125 °C (257 °F)
End wall – in/outlet side	20 mm (0.78 in.)	100 °C (212 °F)	150 °C (302 °F)
End wall – other side	20 mm (0.78 in.)	125 °C (257 °F)	200 °C (392 °F)
Mounting strap area	No insulation	225 °C (437 °F)	300 °C (572 °F)

CAUTION

Risk of personal injury
Do not put diesel fuel in the Aftertreatment DEF tank. Diesel fuel, if sprayed into the hot exhaust along with the DEF, could ignite explosively causing a fire resulting in personal injury or damage to the exhaust system.

There are two different configurations for the SCR catalysts, they are vertical and horizontal. The horizontal SCR catalyst comes in two different sizes, one for the D11/D13 engines and larger size for the D16 engine. The vertical SCR catalyst also comes in two different sizes, one for the D11/D13 engines and larger size for the D16 engine.

The Volvo SCR system is simple and effective, with few components. It consists of a aftertreatment DEF tank which is positioned near the standard diesel tank, aftertreatment DEF pump, aftertreatment DEF dosing unit and SCR catalyst. The advantage of using DEF is that it enables the engine to use less EGR and higher oxygen levels for better combustion, while meeting the EPA near-zero NOx emissions requirement of 0.2 g/hp-hr NOx. By using DEF, we avoid the disadvantages of increasing EGR to massive levels. This results in better fuel economy from your Volvo engine.

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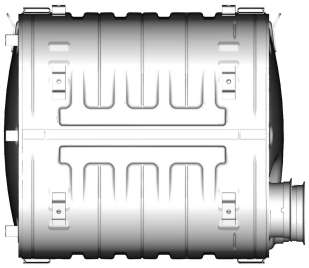
Vertical SCR, vertical inlet



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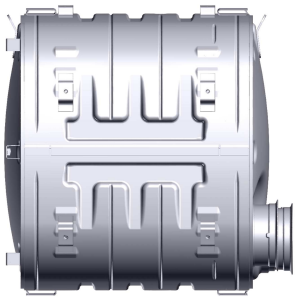
Horizontal SCR, full size



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Horizontal SCR, compact size

Notes

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Diesel Exhaust Fluid (DEF)

DEF is a key reactant to the SCR process. It's a non-toxic, ultra-pure solution of urea and ultra-pure water. Urea is a compound of nitrogen that turns to ammonia when heated. The fluid is non-flammable and is not dangerous when handled as recommended. However, it is highly corrosive to certain metals, especially copper and brass. Read the separate section concerning the handling of DEF solution. Use only DEF that is clearly labeled as meeting ISO-22241 standards, and certified by the American Petroleum Institute (API). The container must display the API certification seal. Never use agricultural or industrial grade urea. Use of fluids other than API certified DEF will compromise aftertreatment system performance, increase emissions and may impact your product warranties. Never dilute DEF with water or any other fluid. It is recommended not to stored DEF in extreme hot or cold conditions or for prolonged periods. Follow the instructions for proper storage and handling as indicated on the container or provided with the purchase.

Note: Agriculture mixtures are not pure enough for use in the SCR system and impurities in the solution will compromise the SCR system.

Diesel Exhaust Fluid (DEF) Handling

When handling DEF solution, it is important that electrical connectors to be connected or well encapsulated. Otherwise there is a risk that the DEF will cause oxidation that cannot be removed. Water or compressed air does not help, since DEF quickly oxidizes metal. If a connector comes into contact with the DEF solution, it must be replaced immediately to prevent the DEF solution from creeping further into the copper wiring, which takes place at a speed of about 60 cm (2.4 in) per hour.

⚠ **CAUTION**
Risk of component damage When detaching hoses and components, do not spill DEF on disconnected connectors. If DEF is spilled on a connector, the connector must be replaced immediately.

Things to know about spilled Diesel Exhaust Fluid (DEF)

If DEF solution comes into contact with the skin, rinse with plenty of water and remove contaminated clothing.
If DEF solution comes into contact with the eyes rinse for several minutes and call for medical help if necessary.
If inhaled breathe fresh air and call for medical help if necessary.
Do not allow the DEF solution to come into contact with other chemicals.
The DEF solution is not flammable. If the DEF solution is exposed to high temperatures for long periods of time, it breaks down into ammonia and carbon dioxide.

The DEF solution is corrosive to certain metals, including copper and aluminium. This is similar to the corrosion caused by salt water.
If the DEF solution is spilled onto the vehicle, wipe off the excess and rinse with water. Spilled DEF solution can form concentrated white crystals on the vehicle. Rinse off these crystals with water.

Note: Do not flush DEF spills into the normal drain system.

WARNING
Risk of personal injury DEF split onto hot components will quickly vaporize. Turn your face away!

Diesel Exhaust Fluid (DEF) Consumption

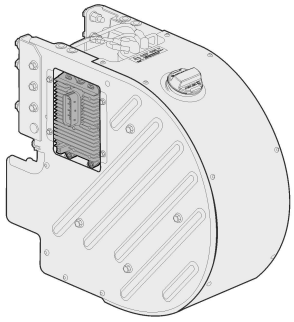
DEF consumption is related to fuel consumption. A highway truck may travel 225-300 miles or more on one gallon of DEF. A gauge much like a fuel gauge will indicate the level of DEF in the tank. A DEF low-level warning activates when DEF is low. If a driver runs out of DEF completely, vehicle power will be reduced to derate mode. When the DEF tank is refilled, the engine will resume normal power.

Note: DEF tanks are sized for a two to one fuel to DEF ratio in order to meet US 2010 requirements.

Diesel Exhaust Fluid (DEF) Availability

DEF is available in 2.5 gallon containers, 55 gallon drums, 275 gallon IBC and in bulk storage for fleet locations, truck stops and dealerships. All major truck stops, dealers and distributors carry DEF. For more information on DEF and availability visit the website www.Volvoscr.com.

Aftertreatment Control Module (ACM)



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The ACM controls the following components in the exhaust aftertreatment system:

- Aftertreatment DEF Dosing Unit
- Aftertreatment DEF Pump
- Aftertreatment DEF Tank Heater Valve
- Aftertreatment DEF Return Valve
- Aftertreatment DEF Line Heaters
- Aftertreatment DEF Tank Level Sensor

The ACM also monitors the following values in the exhaust aftertreatment system:

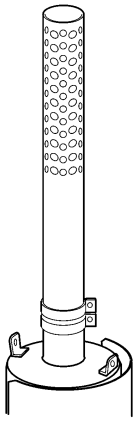
- Aftertreatment DEF Dosing Absolute Pressure
- Aftertreatment DEF Tank Temperature
- Aftertreatment DEF Tank Level
- Aftertreatment DPF Inlet/Outlet Temperature
- Aftertreatment DPF Differential Pressure
- NOx Sensors

The ACM is a standalone module. Depending on your configuration, it may be mounted as part of the DEF tank (as shown above) or on a bracket near the DEF tank.

Exhaust Diffusers (Optional)

Due to higher exhaust temperatures created during regeneration and for a short period after regeneration, devices are designed to help dissipate the exhaust gases more effectively, which reduces the impact of the heat. These exhaust diffusers reduce the temperature of the exhaust gas by diffusing the heat outlets. Diffusers also reduce the risk of extremely high temperature areas at the point of exhaust. Three different diffusers are available to cover different exhaust applications.

Note: Exhaust diffusers must not be modified in any way. If an exhaust diffuser must be removed for truck body installation purposes, the diffuser must be installed exactly as the OEM installation.



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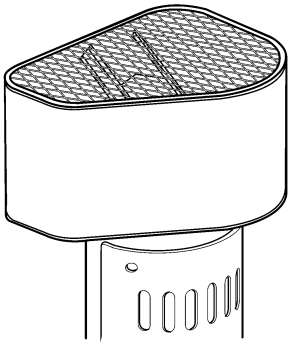
Straight exhaust stack, diffuser end vertical; 5-inch perforated pipe



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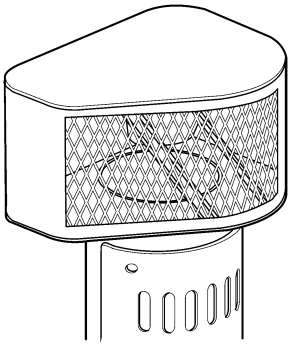
Straight stack, top outlet diffuser box; with vertical pipe



W2006300

Straight stack, side outlet diffuser box; with vertical pipe

CAUTION

Risk of component damage
Due to the higher exhaust temperatures created during the regeneration process of Diesel Particulate Filter equipped vehicles, it is strongly recommended to consult your heated dump body supplier to verify that these temperatures will not adversely affect their product. Failure to do so may result in component damage.

The exhaust aftertreatment system virtually eliminates exhaust smoke. Exhaust vapor (water condensation) may be visible during a cold start. If exhaust smoke is visible during engine operation, this indicates a problem with the exhaust aftertreatment system. Take the vehicle to an authorized Volvo Truck dealer immediately.

Vehicles equipped with a US 2010/GHG 2017 emission compliant engine have an exhaust aftertreatment system which includes a Selective Catalytic Reduction (SCR) system and a Catalyzed Aftertreatment Diesel Particulate Filter (DPF). The Aftertreatment DPF takes the place of the standard muffler, and it reduces soot and particulate emissions into the atmosphere. Soot and other particulate matter are collected by a filter where it is eventually oxidized using a regeneration process. Vehicles equipped with a Aftertreatment DPF require the use of EO-O Premium Plus (or VDS-4) specification high performance diesel engine oil and ultra low sulfur diesel (ULSD) fuel.

Note: Refer to section 1 of the Body Builder Manual for oil recommendations for model year.

The following are important items to consider when installing a heated dump body;

- Due to the presence of the aftertreatment system, exhaust gas temperatures can reach up to 650 °C (1202 °F) on GHG 2017 and newer vehicles and US 2010 vehicles can reach 500 °C (932 °F) at the DPF outlet during a normal regeneration cycle. These temperatures must be taken into consideration while installing equipment, in the vicinity of the exhaust system. It may be necessary or prudent to affix warning labels on the equipment to warn people about these temperatures.
- In the case of a heated dump installation; only use materials that can withstand the high temperatures as mentioned above, for body and other related parts.
- The use of a diverter valve to divert the exhaust to the atmosphere and away from the body during a regeneration.
- The lack of soot coating may mean increased corrosion for the body, diverter valve, pipes and other related parts. Always use suitable corrosion resistant materials for these parts.
- Heater lines to urea pump.

DPF Requirements

Back Pressure

If modifications are made to the exhaust system after the SCR muffler, the back pressure must be measured to ensure the changes. Do not exceed the back pressure limits.

Note: If the pressure in the exhaust is too high, engine can be damaged.

Requirement: Allowed pressure in the exhaust piping after the SCR muffler: on D11, D13, and D16 engines 3 - 5 kPa (0.43 - 0.73 psi).

Note: To view back pressure accurately, use tech tool procedure 2545-08-03-02 and exhaust aftertreatment diagnostics.

Note: The maximum allowed added back pressure from exhaust piping is 4 kPa (0.6 PSI).

Measuring Back Pressure:

1 Remove the post NOx sensor and add a pressure gauge (Thread size - M20 x 1.5).

Note: For Smart NOx sensor locations refer to “Smart NOx Sensor”, page 26 .

Note: The test must be conducted with the vehicle between 60–70 °F (16–21 °C).

2 With the gauge attached to the exhaust pipe, run the engine at High Idle (2000 rpm with no engine load) for 3–5 minutes.

3 Record the exhaust pressure at the end of the 3–5 minutes.

Vibration

To reduce the level of engine-related vibration on the aftertreatment assembly, flexible tubing must be installed between the engine and the assembly. The DPF must not be exposed to excessive shock and vibration levels. The vibration levels on the assembly must not exceed 5 grams under normal operating conditions and 10 grams under rare conditions not to exceed 10% of the equipment's duty cycle.

Exhaust Materials

Any corrosion particles from the exhaust pipes will be trapped in the DPF catalyst and will cause wear and/or plugging of the catalyst. Therefore, ensure the exhaust pipes and the flexible hose upstream the DPF muffler is made from stainless steel.

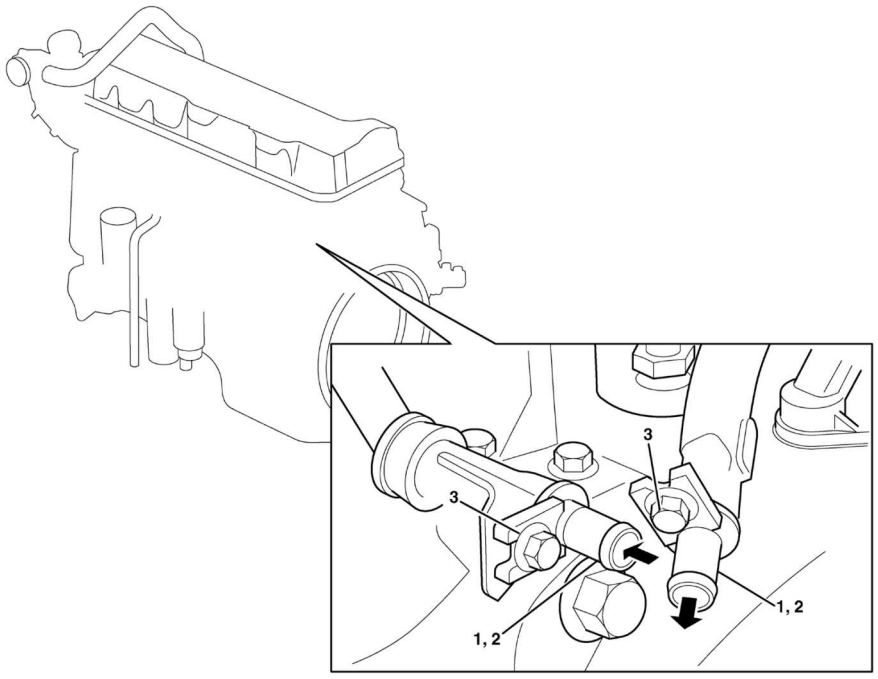
Heat Protection

Factory installed heat protection must not be removed for US 2010/GHG 2017 Volvo vehicles.

Notes

In-Transit Heat Cooling System

For chassis used in operations where the cargo must be kept warm by heat from the engine coolant, connections are available at the back of the engine to connect 5/8 heater hose and provide the necessary coolant flow to the truck body or trailer. The following illustrations and part number charts show the locations of the coolant supply and return connections, along with the part numbers for the stub pipes, sealing rings and necessary hardware.



W0113624

Figure 1 — Cooling System Supply and Return Connections — D13 Engines

Key	Qty.	Part No.	Description
1	2	21087921	Pipe, stub assembly, coolant supply and return (arrows in illustration above indicate direction of coolant flow)
2	2	20566808	Ring, sealing
3	2	946173	Flange screw, M8 x 1.25 - 20 mm long

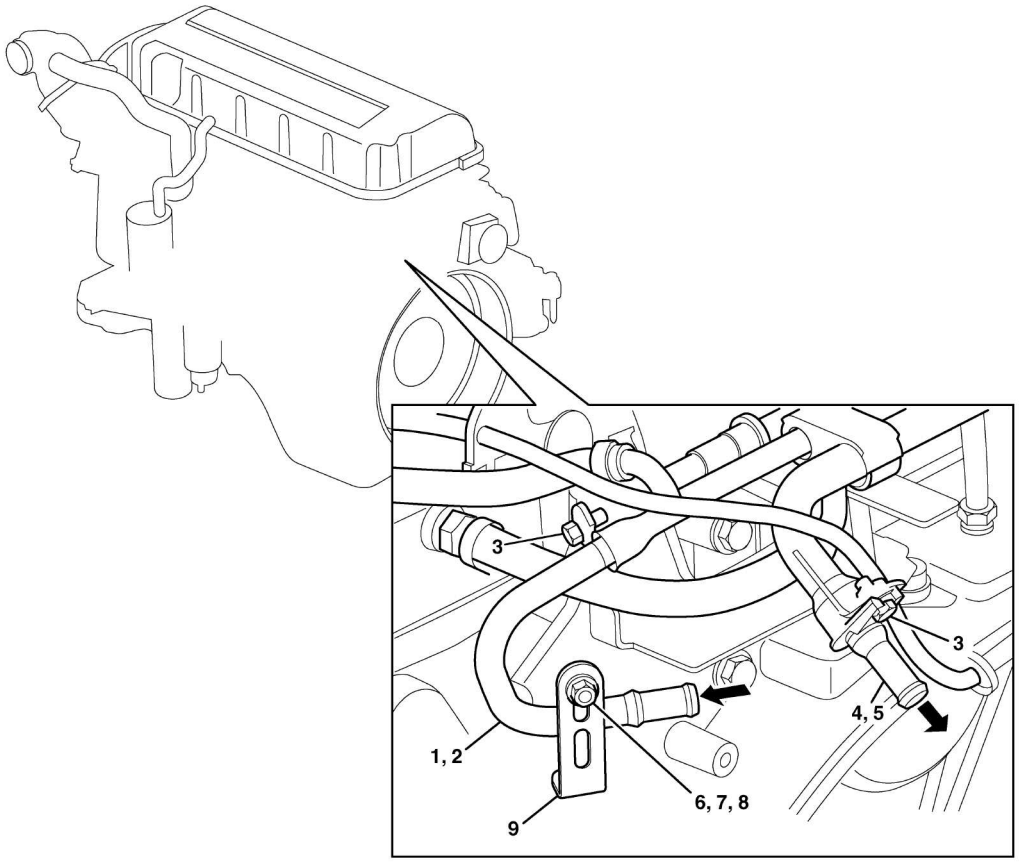


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Figure 2 — Cooling System Supply and Return Connection — D11 Engines

Key	Qty.	Part No.	Description
1	1	21038748	Pipe, stub assembly, coolant return
2	1	20566808	Ring, sealing
3	2	946173	Flange screw, M8 x 1.25 - 20 mm long
4	1	21092290	Pipe, stub assembly, coolant supply
5	1	1547252	Ring, sealing
6	2	946440	Flange screw, M8 x 1.25 - 16 mm long
7	1	948645	Flange locknut, M8 x 1.25 mm long
8	1	977976	Clamp
9	1	965558	Bracket, coolant return support

Note: GU models equipped with a fuel heater and engine coolant are used to heat the fuel. These connections provide the flow of coolant to the fuel heater and cannot be used for in-transit heat.

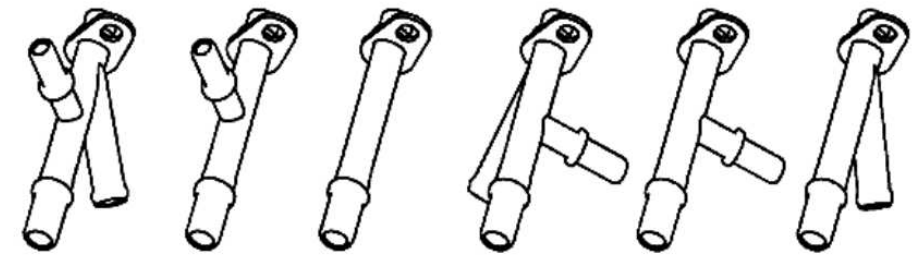
The total available cooling capacity of the system is 11.1 Gallons Per Minute (GPM). Refer the below chart for the available coolant flow dependent on your vehicle configuration. In-transit coolant draw and vehicle component draw MUST NOT EXCEED 11.1 GPM.

Exceeding the cooling system capacity will result in engine component failures.

I-Shift Cooler	Artic Fox Heater	In Transit Heater	OK/ NOK	Available Flow for Extra Components (GPM)
X	X	X	Not OK	N/A
X	X		OK	None
X		X	OK	Depends on how much the transit heater demands. The transit heater may demand no more than 5 GPM.
X			OK	5 GPM
	X	X	OK	Depends on how much the transit heater demands. The transit heater may demand no more than 6.1 GPM.
	X		OK	6.1 GPM
		X	OK	Depends on how much the transit heater demands. The transit heater may demand no more than 11.1 GPM.
			OK	11.1 GPM

Available Fittings for Specific Applications

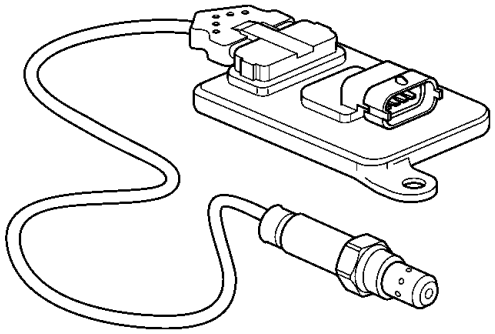
Note: Contact your local Volvo dealer to order these fittings.



22304908 **22305504** **22305507** **22394595** **22394596** **22421119**

W2123680

Smart NOx Sensor



W9000948

The smart NOx- sensor is used to monitor the emission reduction system. Two NOx sensors are needed for US 2010/GHG 2017 vehicles. One sensor is positioned on the DPF-muffler outlet, the other one is on the exhaust pipe after the SCR-muffler outlet (horizontal or vertical version).

Note: The smart NOx sensors must not be moved or modified in anyway. To do so would inhibit the proper operation of the aftertreatment system.

Notes

Engine Operation

Engine Overspeed

This vehicle is equipped with a diesel engine and must not be operated in an area with a concentration of hydrocarbon vapors (for example, gasoline or diesel fuel fumes). Be cautious of low-lying or closed-in areas. The vapors may be drawn into the engine through the air intake and cause the engine to overspeed. Hot carbon and other sparks may come from the exhaust system, and cause an explosion and fire.

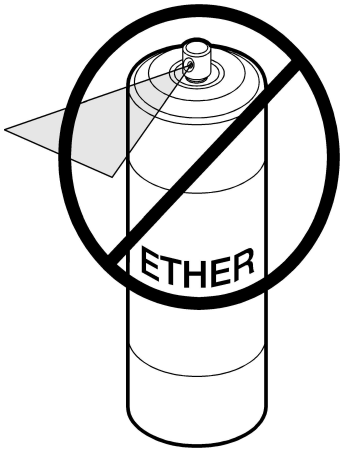
If the vehicle is in an area where hydrocarbon vapors may be present, shut the engine off immediately if any abnormalities are experienced. DO NOT leave it unattended.

⚠ DANGER

The diesel engine will operate on any fuel which enters the cylinder, whether it is from the injectors or from the air intake system. Therefore, if any solvent is used to flush out the air cleaner element, the engine may overspeed during start-up. Engine damage and serious personal injury or death from burns or explosion can occur.

⚠ DANGER

DO NOT use ether or similar starting aids in a Volvo or any other engine with a preheater. The Volvo engine is equipped with a preheater. Introduction of ether or other combustible material in the intake manifold could cause a fire or explosion, serious personal injury or death.



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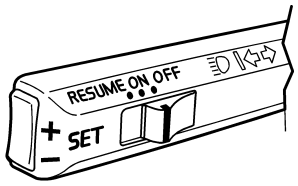
Engine Idling

All VN and VHD model engines are electronically governed engines. The idle speed is pre-programmed from the manufacturer. Low idle speed is adjustable within certain limits (for most engines between 550 to 700 rpm).

The common belief that idling a diesel engine causes no engine damage is wrong. Idling produces sulfuric acid, which breaks down the oil and eats into bearings, rings, valve stems and engine surfaces.

Note: Avoid excessive idling. If the vehicle is parked for more than five minutes, stop the engine. An engine can burn from 0.5 to 1.5 gallons (2 to 5.5 liters) of fuel per hour while idling. During long engine idling periods, the engine coolant temperature may fall below the normal operating range*. Incomplete combustion of fuel during the warm-up period can cause dilution of the oil in the crankcase, formation of lacquer or gummy deposits on the valves, pistons and rings, and rapid accumulation of sludge in the engine.

Low Idle Adjustment



W3002499

⚠ DANGER

Before setting the idle, apply the parking brakes and place the transmission in neutral. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

If the engine coolant temperature is above 122° F (50° C), the vehicle is stationary (engine running; accelerator released; parking brake on) and the PTO not engaged, the engine low idle speed can be adjusted with the use of the cruise control function.

1 Set the cruise control switch to the ON position.
2 Depress the foot brake pedal. Hold it down during the entire procedure.
3 Move the cruise control switch to the RESUME position and hold it there for four seconds. Release the switch. The engine speed will drop to the default low idle.
4 The idle speed is adjusted up with the SET+ switch. Each time the SET+ switch is pressed momentarily, idle speed will increase approx. 10 rpm (the speed cannot be increased above the maximum allowed by the engine manufacturer).
5 The idle speed is adjusted down with the SET- switch. Each time the SET- switch is pressed momentarily, the idle speed will decrease approx. 10 rpm. (the speed cannot be adjusted below the low idle set by the engine manufacturer). By continuously pressing the switch, engine speed will ramp up (SET+) or down (SET-).
6 When the desired engine idle speed is reached, push and hold the SET and move the cruise control switch to the RESUME position at the same time and hold them in position for four seconds. Release the switches.
7 Release the brake pedal to set the new idle speed. If an error was made during the adjustment procedure, the default idle speed will be maintained.

If the engine coolant temperature is above 122° F (50° C), the vehicle is stationary (engine running; accelerator released; parking brake on) and the PTO not engaged, the engine low idle speed can be adjusted with the use of the cruise control function.

Idle Shutdown Timer

The idle shutdown timer can be programmed to shut the engine down after a specific engine idling time. This programming cannot be changed by the operator and can only be done using special tools. Contact your authorized Volvo Truck dealer for details.

The permitted idle time can be set to the following time intervals:

Volvo – 1 to 40 minutes

Cummins – 1 to 100 minutes

When the idle shutdown feature is enabled the engine will shut down at the set time under the following conditions:

- Vehicle speed is 0.
- Engine is running at idle speed.
- Coolant temperature is above 113° F (45° C).
- Parking brake is applied (Volvo engines only).

These are standard choices when the vehicle is delivered. For more information about other customer adaptation choices, contact your authorized Volvo Truck dealer.

High Altitude Operation

Engines lose power when operated at high altitude because the air is too thin to allow burning as much fuel as at sea level. For naturally aspirated engines, this loss is about 3% per 1000 feet (300 m) increase in altitude above sea level. Most turbo-charged engines are rated for higher altitudes and will not lose as much power as a naturally aspirated engine.

Closely monitor the gauges during high altitude operation. The thinner ambient air reduces the efficiency of the engine cooling system. Engine overheating or cylinder damage could occur if the engine is operated at full load for extended periods at high altitudes in hot weather. Downshift and reduce vehicle speed to reduce engine load when driving on long grades in these conditions. This will help keep engine air intake manifold and coolant temperatures within safe limits.

Note: If exhaust smoke is visible during engine operation, this indicates a problem with the exhaust aftertreatment system. Take the vehicle to an authorized Volvo Truck dealer immediately.

Notes

Enhanced Cruise with the Volvo Enhanced Stability System

Note: For further information on the Volvo Enhanced Cruise system, including operation and dangers, warnings and cautions associated with using this system, refer to Volvo Enhanced Cruise operator's manual.

Volvo Enhanced Cruise is integrated with the vehicle's normal cruise control. Once the driver turns "on" and "sets" normal cruise control, Volvo Enhanced Cruise is automatically engaged.

The Volvo Enhanced Cruise is an additional integrated feature of your cruise control. When using cruise control, your vehicle will now not only maintain the "set" speed, but the system will also intervene, as needed, to help maintain a set following distance behind the vehicle in front of your vehicle.

Using a radar sensor (with a range of approximately 500 ft [152 m]) mounted to the front of your vehicle, the Volvo Enhanced Cruise system reacts to moving vehicles ahead of you.

As a brief introduction, once cruise control is engaged and you are maintaining a set following distance between you and the vehicle in front:

If the vehicle in front of you slows down below your cruise control's set speed, the system will intervene and, as necessary, in this order:

1 de-throttle the engine,
2 apply the engine retarder, and
3 apply the foundation brakes,

in an attempt to maintain the set following distance behind the vehicle ahead.

Note: If during the intervention, it is necessary to apply the foundation brakes, the vehicle will not automatically resume to the set speed.

If the vehicle ahead slows, below your cruise control's set speed, but then accelerates away, and the Volvo Enhanced Cruise system did not need to use the foundation brakes as it managed the intervention, your vehicle will automatically accelerate back to the original cruise control set speed, and again maintain a set following distance behind any vehicles that are ahead of you.

Other system features include a two-stage audible and visual warning system, part of which is always on, whether or not you are using cruise control.

Since the VEC operates along with normal cruise control, all the typical features built into cruise control work as usual. For example, limits imposed by factory-set road speed governors, etc. are fully supported by the VEC system.

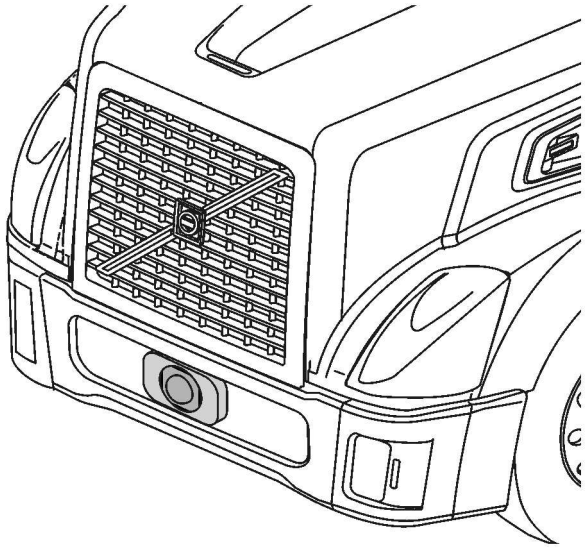
All vehicles equipped with Volvo Enhanced Cruise are also equipped with the Volvo Enhanced Stability System (VEST). VEST is a constantly on, full-stability system which monitors vehicle performance and, when necessary, automatically intervenes to reduce the throttle and/or applies the foundation brakes to help you maintain stability during potential loss-of-control and/or rollover events. Volvo Enhanced Cruise uses the VEST to help maintain vehicle stability during automatic brake applications on slick surfaces. Keep in mind that Volvo Enhanced Cruise must never be used on roads where you cannot drive safely at a steady speed, including city roads, winding roads, or when road conditions are poor, such as on gravel, dirt, ice or wet surfaces (wet surfaces may increase the risk of hydroplaning), or in fog, heavy rain or snowy conditions. Always switch off Volvo Enhanced Cruise when entering turning lanes, entering or exiting highways, driving through construction zones, or similar situations.

Note: The VEST is always operational when the vehicle is running; the active interventions and select warnings of the Volvo Enhanced Cruise are only operational when the cruise control is engaged.

Volvo Enhanced Cruise Components

The radar unit that provides Volvo Enhanced Cruise with its ability to locate and track moving vehicles, is located at the front of the vehicle — the antenna is located on the center-line of the vehicle just behind the bumper and is visible from the front of the vehicle.

The Volvo Enhanced Cruise radar sensor is pre-aligned at the factory and no adjustment needed. If the sensor becomes misaligned, (or any other system problem is detected) a message, or light on the dash lets the driver know that service is needed.



W3030662

Volvo Enhanced Cruise radar sensor

Integrated Dashboard

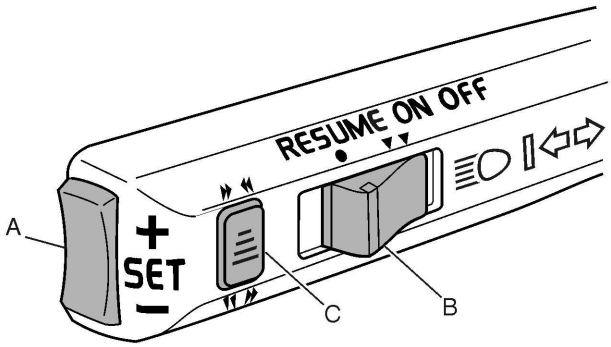
The VEC system is fully integrated into the vehicle dashboard so that a separate status/display box is not required. All visual, text and audible indications and warnings come directly from the vehicle's instrument cluster and Driver Information Display (DID). The volume level of the alerts is not adjustable, nor can they be switched off.

Automatic Foundation Brake Applications

The vehicle automatically manages foundation braking priorities among the various vehicle systems that use the foundation brakes, such as Volvo Enhanced Cruise (VEC), Volvo Enhanced Stability Technology (VEST), Automatic Traction Control (ATC), and the Anti-lock Braking System (ABS).

After an event where the foundation brakes are applied, normal cruise will automatically be cancelled. The driver must activate "resume" or "set" in order for the vehicle to throttle up.

Operating the Volvo Enhanced Cruise



W3031243

Note: Whenever the cruise control is engaged, the Volvo Enhanced Cruise system is also engaged. You cannot engage cruise control without also using the VEC system.

Switching on the Volvo Enhanced Cruise (VEC) system is similar to using an ordinary cruise control.

1 B.) Switch "on" the cruise control switch.
2 Accelerate your vehicle to the cruise speed you wish to maintain,
3 A.) Then press the cruise control "set" switch.

Once the cruise control speed is "set," a green "cruise" icon will illuminate on the instrument panel. Please refer to your Vehicle Owner's Manual to double-check the location of the icon and for further troubleshooting information.

The “set” speed displays on the illuminated LED (Light Emitting Diode), above the speedometer, at the set speed mark. Please refer to your Vehicle Owner's Manual for further information.

The driver can switch the VEC system off manually by either stepping on the brake, turning the vehicle ignition off (if parked), or switching "OFF" the cruise control.

Note: As mentioned, the cruise control will automatically cancel whenever the VEC applies the foundation brakes. You can verify the system is disengaged by observing the green "cruise" or "set" icon is no longer illuminated. You must "resume" or "set" cruise control in order to regain normal cruise functionality and to reengage the system.

Cruise Control

Pre - 2018

⚠ DANGER

DO NOT use the cruise control in heavy traffic, with ice/snow on the road or during other unfavorable conditions. This may lead to a loss of vehicle control, causing a vehicle crash, serious personal injury or death.

Note: For more detailed information about the cruise control system, refer to the Operator's Manual.

Note: This section covers Pre-2018 trucks.

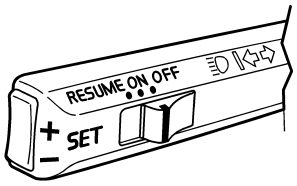
Engaging

Cruise Control: The cruise control switches are located on the turn signal lever.

To engage and set desired speed:

1 Set the cruise control switch to ON.
2 When the desired vehicle speed has been reached, momentarily press in the SET+ or SET- switch on the end of the lever.
3 If the speed needs to be increased, press the SET+ switch. The vehicle speed will increase as long as the SET+ switch is pressed (speed will not increase above the maximum programmed speed). Release when the desired speed has been reached.
4 If the speed needs to be decreased, press the SET- switch. The vehicle speed will decrease as long as the SET- switch is pressed (speed will not decrease below the minimum programmed speed). Release when the desired speed has been reached.

Note: The cruise control cannot be engaged at speeds below approximately 45 km/h (30 mph) and engine speed below approximately 1000 rpm.



W3002499

Disengaging

The cruise control is disengaged if the brake or clutch pedal is pressed, or if the cruise control switch is set to OFF. If the ignition key is turned back to the accessories position (I), the cruise control system will automatically be disengaged.

Resuming Vehicle Speed

The previously selected cruise speed is retained in the memory. When the cruise control switch is pushed to the RESUME position, the vehicle resumes the previously set speed (provided vehicle speed exceeds approximately 15 km/h (10 mph) when the switch is pressed).

Acceleration

Momentary acceleration (such as for passing another vehicle) does not interrupt cruise control operation. After passing, release accelerator and let the vehicle slow to cruise control speed. The previously set speed will then be maintained without having to set the switch to RESUME.

Note: On vehicles equipped with Eaton VORAD SmartCruise, cruise control is disengaged in the event the SmartCruise system fails to operate. You must stop the truck, turn the ignition off and on, and activate the control twice in order for the cruise control to operate.

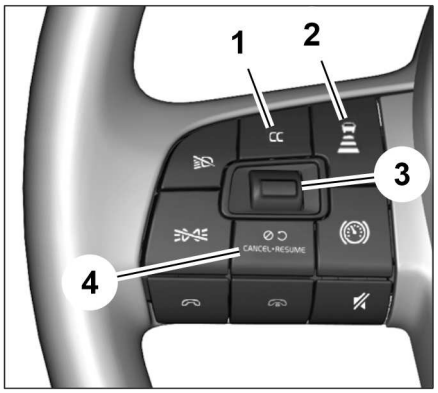
Note: Read the Eaton VORAD Collision Warning System Driver Reference Manual before taking a vehicle equipped with VORAD out on the road.

Cruise Control

2018 - current

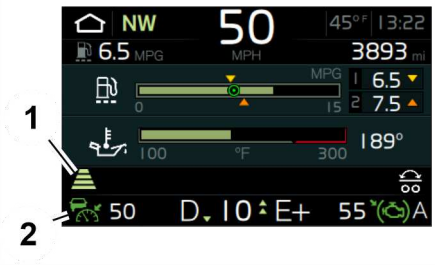
Cruise control switches are on the steering wheel and operate in the same manner as listed above for the pre-2018 truck. (See Illustrations below).

Note: For more detailed information about the cruise control system, refer to the Operator's Manual.



T2189660

1. Cruise control ON/OFF
2. Volvo active driver assist (VADA) cruise following distance
3. Toggle/up/down/enter
4. Cruise control resume/cancel.



T2189661

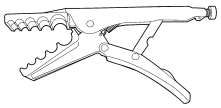
1. Cruise control following distance icon when equiped with VADA
2. Cruise control icon

Fittings, Fuel Line, Replacement

This information covers the proper procedure for replacing the Voss fuel line fittings.

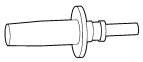
Note: Information is subject to change without notice. Illustrations are used for reference only, and may differ slightly from the actual engine version. However, key components addressed in this information are represented as accurately as possible.

Special Tools



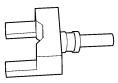
W2006113

85111500
Voss Pliers



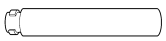
W2006115

85111501
Voss Straight Drift



W2006116

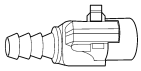
85111502
Voss Elbow Drift



W2006114

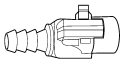
85111503
Voss Handle

Fittings



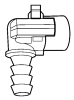
W2006109

20395030
Straight 16 mm Fitting



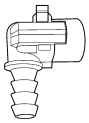
W2006110

20395028
Straight 12.5 mm Fitting



W2006111

20395034
90 degree 12.5 mm Fitting



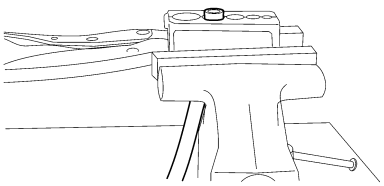
W2006112

20395036
90 degree 16 mm Fitting

Replacement

1. After determining which molded Nylon end needs to be replaced, cut the nylon tubing off just behind the barb.

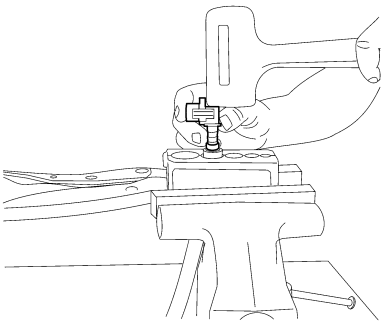
   Note: Make a nice clean, square cut.



W2006149

2. Clamp the tubing in the jaws, special tool number 85111500, and carefully insert the Nylon end in by using a soft tipped hammer or a small arbor or drill press.

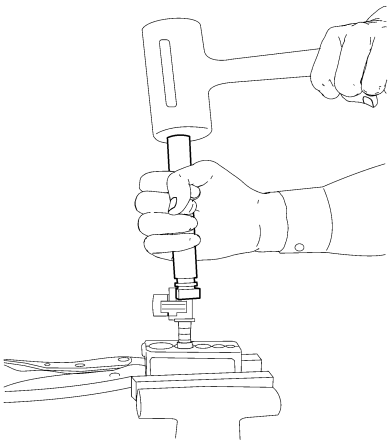
   Note: To press in the new end, the Nylon tubing must be held in the special serrated jaws.



W2006150

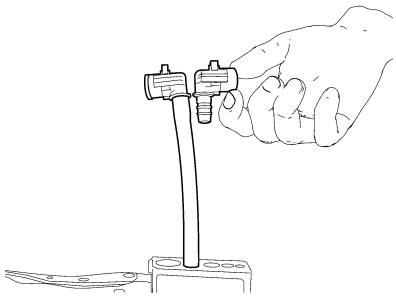
3. The Nylon end can be pressed in with a small arbor press or a small hammer if used carefully. The Nylon tubing must stick out of the pliers about 1/4 inch.

   Note: For ease of assembly, small hand tools as shown are available.



W2006151

4. The Nylon must be pressed down into the Nylon tubing so that all barbs are fully inserted. Care must be taken to keep all parts clean.
5. The Nylon tube need not be heated for assembly.
6. The tube end must be free of grease or lubricants.



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7. Care must be taken to not damage the tubing by excessive clamp force.
8. Make sure the proper sized end is used for the selected Nylon tubing.

Notes

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