

**Ford 6.8L Engine
Operation and Maintenance
Manual
WSG-1068/T/TA**



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Preface

This Operation and Maintenance Manual provides general instructions for operating the Ford 6.8L engine properly. It is essential that every person who works on or with the engine be completely familiar with the contents of this manual and that he/she carefully follows the instructions contained herein. Each operation and maintenance may require some modification of the suggested guidelines in this manual. They must be consistent with locally applicable standards and take into consideration safety guidelines and measures.

Carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. All instructions and diagrams have been checked for accuracy and simplicity of application, however, the skills of the operator are most important. MTU Onsite Energy does not guarantee the result of any operation contained in this manual nor can MTU Onsite Energy assume responsibility for any injury or damage to property. Persons engaging in operating do so entirely at their own risk.

Specifications

General Specifications	
Engine Type	V-10 4 stroke spark ignition 90 degree overhead valve (OHV) chain driven camshaft operating the valves via roller cam followers and hydraulic lash adjusters
Liter / CID	6.8 / 415
Bore: mm (in)	90.215 (3.55)
Stroke: mm (in)	105.8 (4.17)
Number of Cylinders	10
Compression Ratio	9:1

Fuel System	
LPG Type Fuel Specifications	Liquified Petroleum Gas Fumigation EN 589 (European) HD-5 (USA)
NG Type Fuel Specifications	Natural Gas Fumigation 38.7 MJ / m3 (UK) 39.0 MJ / m3 (USA)

Lubrication System	
Max. Oil Pressure	Hot @ 1800 RPM: 275.79 – 413.69 kPa (40-60 PSI)
Oil Type	Motorcraft SAE 5W30 Full Synthetic WSS M2C930-A
Service Oil Fill Capacity (Including Filter)	5.68 L (6 qt) = 5.5 qt pan + 0.5 qt filter

Oil Filter	MTU Onsite Energy Part Number: 120105
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Cooling System	
Thermostat	Type: Wax Element Commences Opening: 85 °C (185 °F) Fully open: 99 °C (210 °F)
Coolant	50% Motorcraft Premium Engine Coolant Plus 50% Distilled Water Ford Specification WSS M97B44-D or ESE-M97B44-A

Drive Belt	
Alternator Belt Length Tension: mm (in)	6 Groove: 1,618 (63.7)

Electrical System	
Polarity	Negative to Earth (ground)
Alternator Drive Belt Tension	Tension is within specification if the tensioner is within the indicator markings
Alternator Output	95 Amp @ 3,400 RPM

Ignition	
Spark Plug	Naturally Aspirated: Dedicated LPG & NG – Motorcraft AGSF-22F-M1 Gap: 1.12 mm (0.044 in.) Turbocharged: Dedicated LPG & NG – Motorcraft AGSF-22F-M1 Gap: 0.89 mm (0.035 in.)
Firing Order	1-6-5-10-2-7-3-8-4-9

Tightening Torques			
Item	Nm	ft lb	lb in
Oil Pan Drain Plug	20 – 34	15 – 25	98 – 143
Spark Plugs	8 – 12	7 – 15	71 – 106
Oil Filter	14 – 17	11 – 12	-
Coil Hold Down Bolts	5 – 7	-	44 – 62

Electrical System

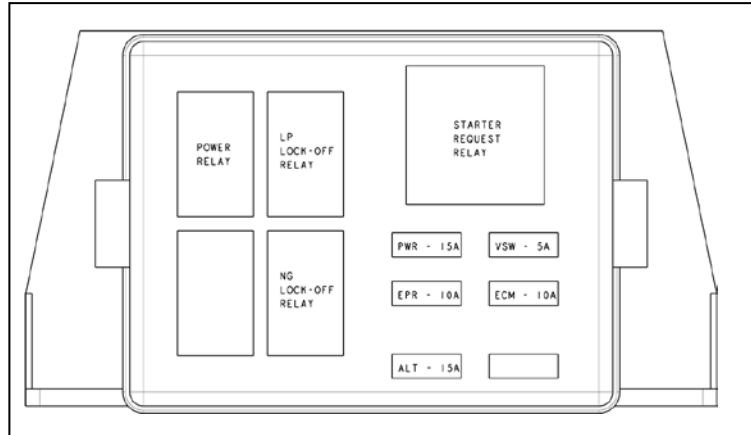


Figure 1: Fuse Box

Fuse	Amps	Circuits Protected
PWR	15A	Main Power
VSW	5A	Switched, Ignition Voltage
EPR	10A	Electronic Pressure Regulator
ECM	10A	Engine Control Module
ALT	15A	Alternator
Blank	-	Not Used

Ignition System

The Ford 6.8L engine is equipped with a coil-on-plug ignition system. Rather than a remotely-mounted coil with secondary ignition wires, this system has separate coils mounted on each spark plug. Operation of the coils is controlled by the engine control module (ECM), which computes ignition timing based on input from engine sensors.

Alternator

The alternator is mounted on a bracket at the front of the engine and is driven from the crankshaft by a serpentine belt.

The charging rate is adjusted automatically by the built-in regulator to provide sufficient electric current to keep the battery charged under normal operating conditions.

The alternator requires no lubrication or maintenance.

WARNING: It is essential that the wiring connections to the alternator are not removed while the engine is running, as this will result in damage to the regulator or personal injury.

Fluids and Lubricants Specifications

The importance of correct lubrication, periodic inspection and adjustment cannot be over emphasized. It will determine, to a very large extent, the service the engine will give. Detailed instructions regarding this maintenance are provided in the *Maintenance* section of this document.

Fuel Recommendation

This engine is designed to operate on dry fuel such as LPG Grade HD5 or NG (1,050 BTU/ft³).

CAUTION: Use of fuels lower than the grade specified above may cause persistent, heavy spark knock, which can lead to engine damage. If your engine knocks heavily or you hear continuous spark knock while maintaining constant operating speeds, consult your distributor or another qualified engine technician.

Recommended Lubricants

SAE 5W30 oil is recommended for all applications and temperatures.

CAUTION: Use Ford / Motorcraft formula "E" SAE 5W30 synthetic engine oil or equivalent that meets Ford specification WSS-M2C930-A (API Classification – SJ). If SJ oils are not available, SH oils are acceptable. Use only engine oil displaying the American Petroleum Institute Certification Mark on the front of the container or API specification SH or SJ.

CAUTION: Do not use supplemental oil additives or other engine treatments. They are unnecessary and could, under certain conditions, lead to engine damage which is not covered by warranty.

Lubricating oil cleanliness is vital for successful operation of your engine. The oil should be stored under the cleanest possible conditions. When changing or topping up engine oil, use only clean receptacles. Do not allow the oil to come in contact with rubber hoses on the engine.

NOTE: Ford engines are designed to perform with synthetic oils that are licensed by the American Petroleum Institute (API) and oils carrying the most current API classification should be used. API classifications are broken into two categories, gasoline and diesel engines. API's classification is designed by a two letter system. The first letter, the prefix, designates gasoline or diesel. An "S" designates gasoline and a "C" designates diesel. The second letter in the system designates the level of the classification. It should be noted that alternative fuel engines fall into the "gasoline" API category.

The Ford 6.8L engine must use oils labeled SH and / or SJ. Do not use oils that are specifically formulated for diesel engines only. CC or CD classification oils, even when labeled Heavy Duty or for Natural Gas Engines, are not acceptable.

Maintenance

The following Maintenance Schedule provides the maximum recommended service periods. Since operating conditions can vary, it may be advisable to carry out some operations, for example changing the engine oil, at an interim period. Your operating experience is the best guide for determining this time.

When carrying out any of the following maintenance operations, any fault or malfunction should be reported immediately to the supervisor or person responsible for engine overhaul or repair.

Please contact your authorized MTU Onsite Energy Distributor for regular maintenance assistance.

Maintenance Schedule Preface

Emission regulations prohibit alteration, removal or addition of any mechanical or electronic component or calibration that could affect the emissions characteristics of the engine. Maintenance, replacement, or repair of emission control devices and systems can only be performed using approved components or equivalents. Failure to adhere to these guidelines may be a violation of the Clean Air Act.

Maintenance Schedules ensure the reliability and performance of the engine and must be adhered to during the full life of the engine.

The maintenance system is based on a preventive maintenance concept. Preventive maintenance facilitates advance planning and ensures a high level of equipment availability.

Special operating conditions and technical requirements may require additional maintenance work and/or modification of the maintenance intervals. In order to be authorized to carry out the individual maintenance jobs, maintenance personnel must be appropriately trained to perform the task at hand.

The maintenance schedule matrix normally finishes with extended component maintenance. Following this, maintenance work is to be continued at the intervals indicated.

Notes on maintenance

Specifications for fluids and lubricants, guideline values for their maintenance and change intervals and lists of recommended fluids and lubricants are contained in the *Fluids and Lubricants Specifications*.

Amongst other items, the operator/customer must carry out the following additional maintenance work:

- Protect components made of rubber or synthetic material from oil. Never treat them with organic detergents. Wipe with a dry cloth only.
- Battery maintenance depends on the level of use and the ambient conditions. The battery manufacturer's instructions must be obeyed.

Out-of-service periods

If the engine-generator set is to remain out of service for more than one month, carry out engine preservation procedures in accordance with the *Preservation Guidelines* in this document.

Maintenance Tasks

Below is a table that outlines maintenance tasks that need to be performed in the first 3,000 operating hours.

Interval	Limit	Item	Maintenance tasks
[h]			
Engine operation			
Daily	1 m	Engine operation	Check engine oil level. Carry out visual inspection of engine for general condition and leaks.
-	2 a	Engine oil filter	Fit new engine oil filters each time the engine oil is changed or, at the latest, on expiry of the time limit (given in years).
First 50, then every 100	1 a	Engine oil	Change engine oil.
500	2 a	Fuel strainer	Clean or replace fuel strainer.
200	3 a	Belt drive	Check belt condition and tension. Fit new belts(s) if necessary.
400	5 a	Air filters	Fit new air filters.
400	5 a	Spark plugs	Clean, adjust and replace spark plugs.
800	5 a	PCV Valve	Replace PCV valve.
800	5 a	PCV hoses, tubes and fittings	Clean PCV hoses, tubes and fittings.
Cooling system			
500	6 m	Radiator	Check cooler elements externally for contamination and leaks.
Daily 100	3 m	Engine coolant	Check engine coolant level and top up if necessary with correct mixture.
-	1 a	Radiator cap	Clean radiator cap. Pressure test and replace if needed.
w = weeks m = months a = years			

Task Description

Cooling System

Inspect the exterior of the radiator. Remove all obstructions and foreign material.

Check all hoses and connections for leaks. If any of the hoses are cracked, frayed or feel spongy, they should be replaced.

CAUTION: Never use a cold coolant mixture to top up the radiator of a hot engine if the coolant level is very low, this could cause serious damage.

The radiator is equipped with a pressure cap. It is dangerous to remove this when the system is very hot.

WARNING: Never remove the pressure relief cap while the engine is operating or when the cooling system is hot. This may cause personal injury or damage to the cooling system or engine. To reduce the risk of having scalding hot coolant or steam blow out of the top radiator tank when removing the pressure relief cap, wait until the engine has cooled down to at least 40 °C (110 °F).

1. Wrap a thick cloth around the pressure relief cap and turn it slowly one half turn counter clockwise, stepping back while the pressure is released from the cooling system.
2. When you are sure all the pressure has been released, (still with the cloth) turn counter clockwise and remove the pressure relief cap.

The coolant should consist of a 50 / 50 mixture of plain water and approved antifreeze. This antifreeze contains additional corrosion inhibitors designed to provide lasting protection for the engine.

Only this antifreeze or proprietary antifreeze meeting Ford specifications WSS-M97B44-D or Ford specification ESE-M97B44-A should be used when topping up or refilling the cooling system.

NOTE: If a major component of the cooling system is replaced such as the radiator, water pump, etc., the system should be flushed and refilled with a 50 / 50 mixture of distilled water and approved antifreeze.

WARNING: Antifreeze contains monoethylene glycol and other constituents which are toxic if taken internally and can be absorbed in toxic amounts on repeated or prolonged skin contact persons using antifreeze are recommended to adhere to the following precautions:

- Antifreeze must never be taken internally. If antifreeze is swallowed accidentally, medical advice should be sought immediately.
- Precautions should be taken to avoid skin contact with antifreeze. In the event of accidental spillage onto the skin, antifreeze should be washed off as soon as possible. If clothing is splashed with antifreeze, it should be removed and washed before being worn again to avoid prolonged contact with the skin.
- For regular and frequent handling of antifreeze, protective clothing (plastic or rubber gloves, boots and impervious overalls or aprons) must be used to minimize skin contact.

Draining, Flushing and Filling the Cooling System

WARNING: Never remove the pressure relief cap while the engine is operating or the cooling system is hot. This may cause personal injury or damage to the cooling system or engine. To reduce the risk of having scalding hot coolant or steam blow out of the de-gas bottle, when removing the pressure relief cap, wait until the engine has cooled down to at least 40 °C (110 °F).

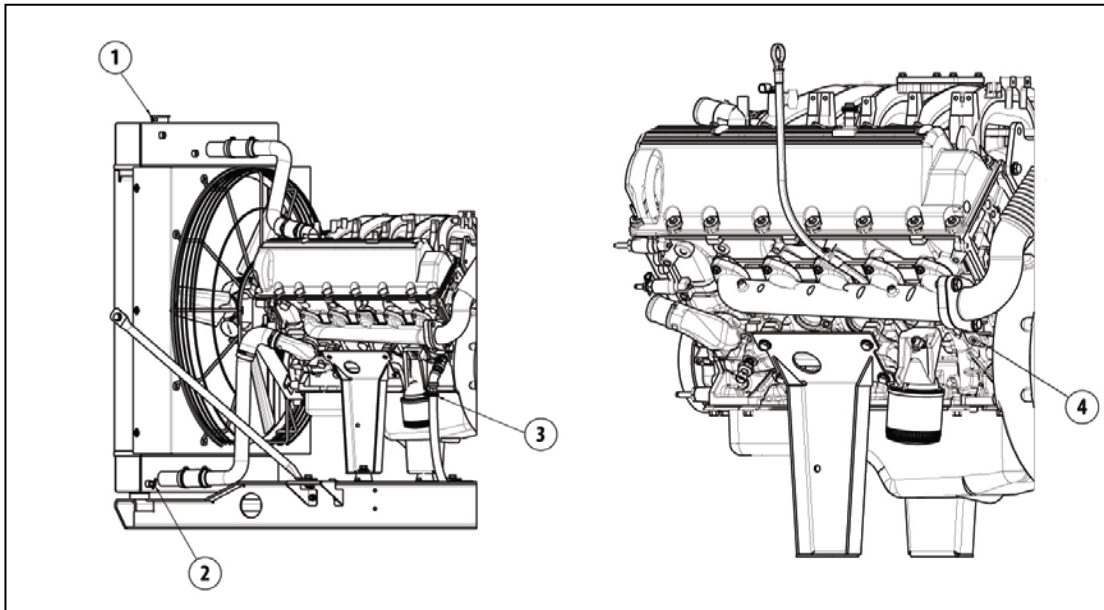


Figure 2: Cooling System

1. Wrap a thick cloth around the pressure relief cap (1) and turn it slowly one half turn counter clockwise. Stepping back while the pressure is released from the cooling system.
2. When the pressure has been completely released, (still with the cloth) turn counter clockwise and remove the pressure relief cap.
3. Remove the radiator filler cap and open the radiator drain cock (2) or detach the lower radiator hose. Remove water heater hose (3) or drain plug (4).
4. Flush the cooling system with water using a hose, until clean water emerges and allow all water to drain out. Close the drain cock (or replace the bottom of the radiator hose). Recover all old antifreeze and dispose of properly. Contact your local municipal government for proper disposal.
5. Fill the system with the correct coolant mixture via the radiator filler neck. Fill the system slowly to avoid air locks.
6. Run engine and check hose connections for leaks. Check and if necessary, top off the coolant in the radiator.

Check Engine Coolant Level

WARNING: To reduce the risk of injury when checking a hot engine, cover the radiator cap with a thick cloth and turn it slowly to the first stop. After the pressure has been completely released, press downward and finish removing the cap. Failure to follow these instructions could cause damage to the cooling system or engine and / or personal injury.

CAUTION: Do not add coolant to an engine that has become overheated until the engine cools. Adding coolant to an extremely hot engine could result in a cracked block or cylinder head.

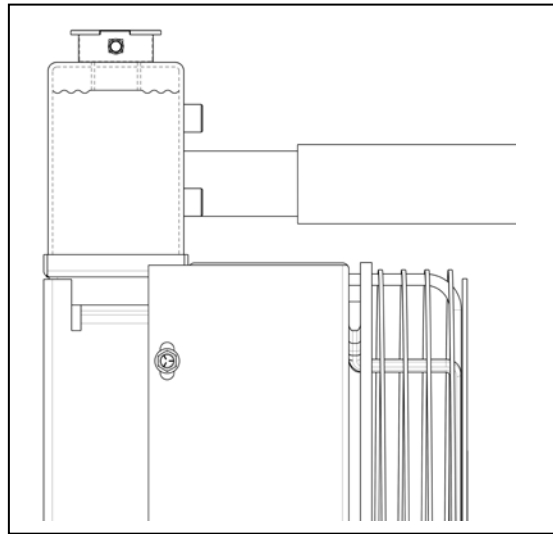


Figure 3: Coolant Level

NOTE: This cooling system does not require an external reservoir. An expansion chamber is designed into the top tank of the radiator.

1. Allow engine to cool down to 40 °C (110 °F).
2. Turn the radiator filler cap 90 degrees in a counter clockwise direction. Pause to allow any pressure to drop, then turn cap fully counter clockwise and remove it.
3. Top up as necessary with a 50 / 50 mixture of distilled water and antifreeze meeting spec WSS-M97B44-D or ESE-M97B44-A.

NOTE: It is imperative that only the correct type of antifreeze is used.

4. Replace the filler cap and turn down tightly.

Replace Engine Oil Filter

The Ford 6.8L engine is equipped with a Motorcraft oil filter. A filter of this quality should be used throughout the life of the engine. It is designed to protect your engine by filtering harmful, abrasive and sludgy particles without clogging up or blocking the flow of oil to vital engine parts. This filter is especially designed for use in engines built by Ford to give successful operation with the recommended oil filter change intervals. Contact your MTU Onsite Energy Distributor to obtain the correct filter. Before commencing, place a drain pan below the filter to catch any spilled oil.

1. Using a suitable strap wrench, unscrew the oil filter canister.
2. Thoroughly clean the oil filter housing face.
3. Partly fill the new filter with clean engine oil of the correct type and grade. Apply a thin film of clean engine oil to the oil filter sealing ring.
4. Screw on new filter canister until sealing ring contacts the filter head and tighten a further half turn. Do NOT use a strap wrench or similar tool to tighten the oil filter.
5. Run engine and check for any leaks from oil filter.
6. Stop engine and allow oil to settle and top off as necessary.

Replace Spark Plugs

WARNING: The ignition system commonly carries voltages in excess of 30,000 volts. Please use caution.

CAUTION: Do not pull directly on the lead as this could cause the wire connection inside the boot to become separated.

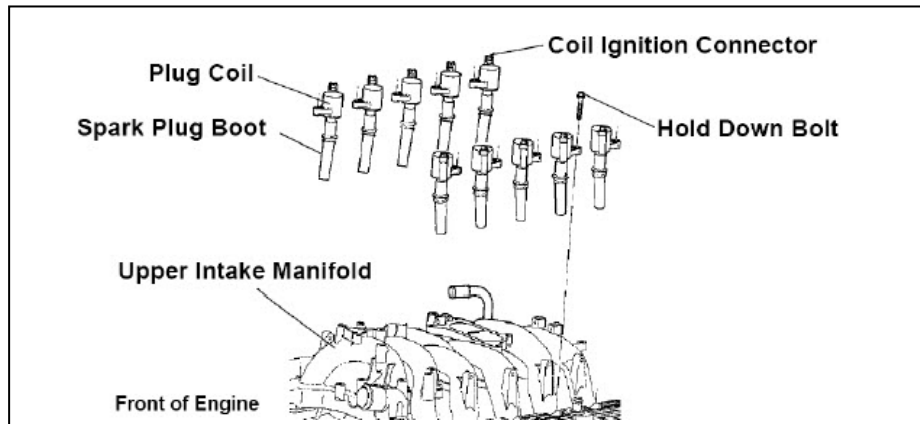


Figure 4: Ignition System

NOTE: To remove spark plugs, you must first remove coils.

1. Disconnect the ignition coil wire connectors.
2. Remove hold down screw, then the coil.
3. After loosening each spark plug one or two turns with a proper spark plug spanner, clean the area around each spark plug port with compressed air then remove the spark plugs.

WARNING: Protective goggles must be worn to protect the eyes when using compressed air.

4. Check the gaps of the new spark plugs with a feeler gauge and, where necessary, bend the outer ground extension to achieve the specified gap.
5. Use a proper spark plug spanner to avoid damaging the insulators. Screw the new spark plugs into the cylinder head and tighten them to the specified torque value listed under specification of this manual.

NOTE: Do not over tighten spark plugs as the gap may change considerably due to distortion of the plug's outer shell.

6. Coat the inside of each spark plug boot with silicone dielectric compound, using a small screwdriver blade.
7. Install the plug coils and tighten the hold down bolt to 5-7Nm (44-62 in-lb).

NOTE: Coils are interchangeable.

8. Reconnect ignition coil wire connectors.

Check Condition of Ancillary Drive Belt

WARNING: Engine should be stopped and any remote starter disabled before checking belts.

The serpentine ancillary belt used to drive the generator and water pump is tensioned automatically and does not require adjustment.

Ancillary Drive Belt Inspection

1. Remove belt guard, if necessary.
2. Visually inspect the condition of the ancillary drive belt for signs of wear or damage, such as:
 - a. Singular cracks
 - b. Cracks on entire surface
 - c. Chunking

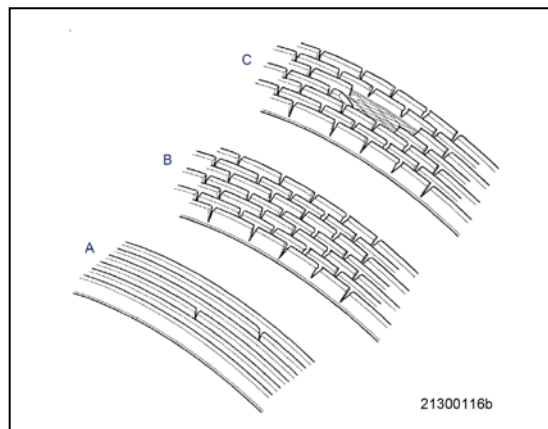


Figure 5: Ancillary Drive Belt Conditions

Ancillary Drive Belt Replacement

1. Remove belt guard (1), if necessary.
2. Relieve spring tension (2) on the belt tensioner using a ½ inch ratchet.
3. Remove ancillary drive belt (3).
4. Install new ancillary drive belt.
5. Reinstall belt guard, if necessary.

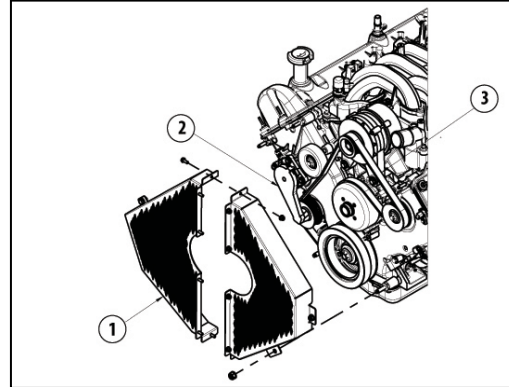


Figure 6: Ignition System

NOTE: May be purchased from your authorized MTU Onsite Energy Distributor.

PCV Replacement

NOTE: This maintenance is not necessary to keep the emissions warranty valid.

1. Detach hose (1) and oil separator (2) (if present) from the PCV valve (3) located at the top rear of the right valve cover and from the fuel mixer.
2. Detach hose (4) from the top of the left valve cover and from the fuel mixer.
3. Withdraw the PCV valve from the valve cover grommet (5) by rotating the PCV valve counter clockwise 90 degrees.
4. Discard the PCV valve and the O-ring (6).
5. Thoroughly clean the inside and outside of the hose and oil separator (if present).
6. Insert the new PCV valve, complete with a new O-ring.
7. Reconnect the hoses and oil separator (if present) to the PCV valve and to the fuel mixer.

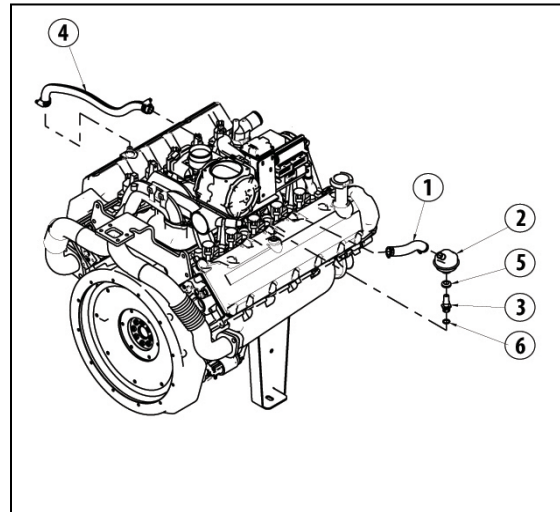


Figure 7: PCV System

NOTE: Graphic represents turbocharged engines only.

Preservation Guidelines

Storage – One Month

1. While the engine is running, treat upper cylinders by spraying engine fogging agent into the air intake for two minutes. Shut off engine and allow it to come to a stop while continuing to spray into the air intake.
2. Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs and cover all openings into engine with dust proof caps or shields (suitable non-hygroscopic material).
3. Check coolant protection. Store indoors in a dry area.

Storage – Indefinite Period

1. Run engine and treat upper cylinders by spraying engine fogging agent into the air intake for two minutes. Shut off engine and allow it to come to a stop while continuing to spray into the air intake.
2. Drain crankcase completely and refill with recommended engine oil.
3. Check coolant protection.
4. Disconnect and remove battery.
5. Clean exterior surface of engine.
6. Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs.
7. Seal all openings in engine and accessories with non-hygroscopic material. Mask off all areas to be used for electrical contact.
8. Coat or spray non-painted parts with corrosion inhibitor for external preservation.