

Operation and Maintenance Manual

1106AA-70TG1, 1106AA-70TAG2 and 1106AA-70TAG3 Industrial Engines

LT (Engine)
LU (Engine)
LV (Engine)



Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions correctly.

Incorrect operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Perkins cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Perkins is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Perkins dealers or Perkins distributors have the most current information available.



When replacement parts are required for this product Perkins recommends using Perkins replacement parts.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Foreword

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.



WARNING – This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Do not ingest this chemical. Wash hands after handling to avoid incidental ingestion.



WARNING – This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Wash hands after handling components that may contain lead.

Literature Information

This manual contains safety, operation instructions, lubrication, and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study, and keep the manual with the literature and engine information.

English is the primary language for all Perkins publications. The English used facilitates translation and consistency.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Perkins dealer or your Perkins distributor for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance, and repair on this product.

Operation

Operating techniques outlined in this manual are basic. The operating techniques assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and the capabilities of the engine.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating, and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under severe, dusty, wet, or freezing cold operating conditions, more frequent lubrication, and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation, and application. Perkins recommends that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. Perkins also recommends that a maintenance record be maintained as part of the permanent record of the engine.

Your authorized Perkins dealer or your Perkins distributor can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Perkins distributor or dealer. Your Perkins dealer or your Perkins distributor offers various options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available. Consult with your Perkins dealer or your Perkins distributor for information regarding these options.

Safety Section

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Safety Messages

There may be several specific warning signs on your engine. The exact location and a description of the warning signs are reviewed in this section. Become familiar with all warning signs.

Ensure that all the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the illustrations are not visible. Use a cloth, water, and soap to clean the warning signs. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off the engine.

Replace any warning sign that is damaged or missing. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Your Perkins distributor can provide new warning signs.

(1) Universal Warning

WARNING

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.

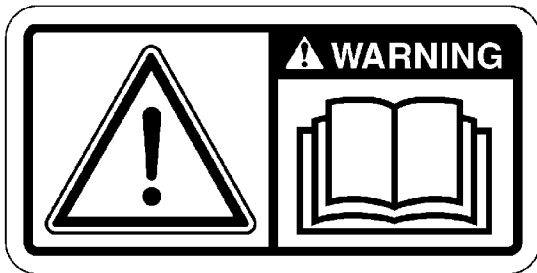


Illustration 1

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Typical example

The Universal Warning label (1) is on both sides of the valve mechanism cover base.

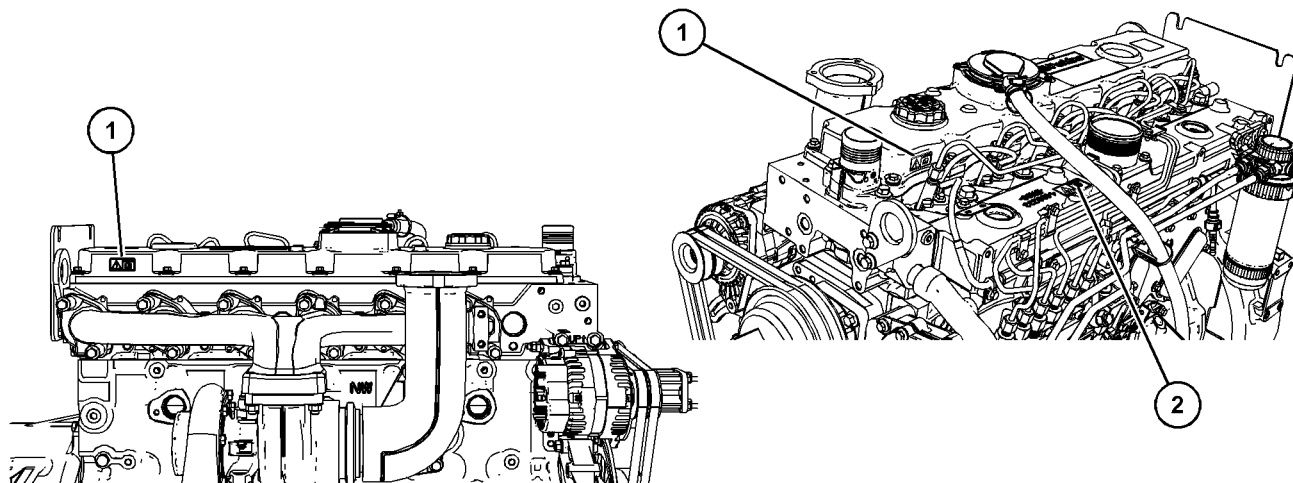


Illustration 2

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Typical example of label location

(1) Universal warning

(2) Ether warning

(2) Ether

⚠ WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

The ether warning label (2) is on the cover of the inlet manifold.

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General Hazard Information



Illustration 3

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Typical example

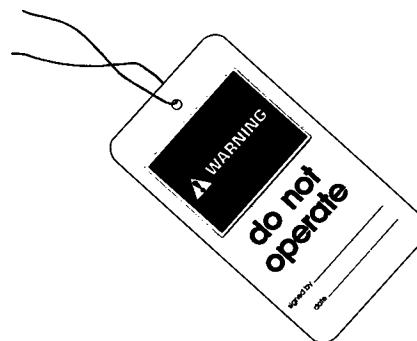


Illustration 4

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Attach a “Do Not Operate” warning tag or a similar warning tag to the start switch or to the controls before the engine is serviced or before the engine is repaired. Attach the warning tags to the engine and to each operator control station. When appropriate, disconnect the starting controls.

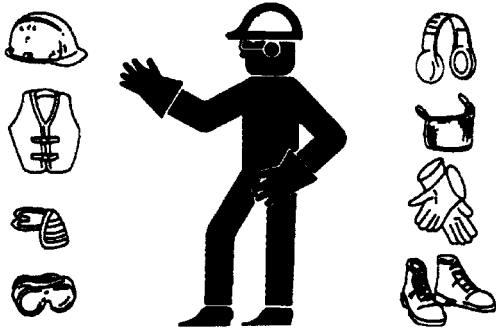


Illustration 5

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Wear a hard hat, protective glasses, and other protective equipment, as required.

Perkins recommend that you do not stand next to an exposed running engine unless it is necessary when carrying out daily checks or maintenance procedures. The appropriate Personal Protective Equipment (PPE) must be worn when standing next to an exposed running engine.

Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.

Ensure that all protective guards and all covers are secured in place on the engine.

Keep the engine free from foreign material. Remove debris, oil, tools, and other items from the deck, from walkways, and from steps.

Never put maintenance fluids into glass containers. Glass containers can break.

Drain all liquids into a suitable container.

Dispose of all fluids according to local regulations and mandates.

Use all cleaning solutions with care.

Report all necessary repairs.

Do not allow unauthorized personnel on the equipment.

Unless other instructions are provided, perform the maintenance under the following conditions:

Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads to help prevent sparks.

Perform maintenance on the engine with the equipment in the servicing position. Refer to the OEM information for the procedure for placing the equipment in the servicing position.

Do not attempt any repairs that are not understood. Use the correct tools. Replace any equipment that is damaged or repair the equipment.

For initial start-up of a new engine or for starting an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. The stopping of the engine may be accomplished by shutting off the fuel supply and/or the air supply to the engine. Ensure that only the fuel supply line is shut off. Ensure that the fuel return line is open.

Start the engine from the operators station (cab). Never short across the starting motor terminals or the batteries. This action could bypass the engine neutral start system and/or the electrical system could be damaged.

Engine exhaust contains products of combustion which may be harmful to your health. Always start the engine and operate the engine in a ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose to relieve any spring pressure or other pressure.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This action could result in personal injury.

The direct application of pressurized air or pressurized water to the body could result in personal injury.

When pressurized air and/or water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the OEM information for any procedures that are required to relieve the hydraulic pressure.

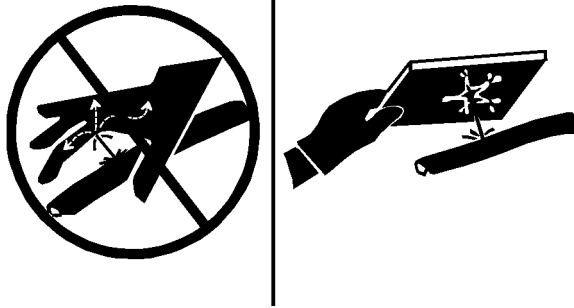


Illustration 6

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Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the engine. Make provision to collect the fluid with a suitable container before any compartment is opened or before any component is disassembled.

- Only use the tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids.
- Only use the tools that are suitable for containing fluids and equipment that is suitable for containing fluids.

Dispose of all fluids according to local regulations and mandates.

Static Electricity Hazard when Fueling with Ultra-low Sulfur Diesel Fuel

The removal of sulfur and other compounds in ultra-low sulfur diesel fuel (ULSD fuel) decreases the conductivity of ULSD and increases the ability of ULSD to store static charge. Refineries may have treated the fuel with a static dissipating additive. Many factors can reduce the effectiveness of the additive over time. Static charges can build up in ULSD fuel while the fuel is flowing through fuel delivery systems. Static electricity discharge when combustible vapors are present could result in a fire or explosion. Ensure that the entire system used to refuel your machine (fuel supply tank, transfer pump, transfer hose, nozzle, and others) is properly grounded and bonded. Consult with your fuel or fuel system supplier to ensure that the delivery system complies with fueling standards for correct grounding and bonding.

⚠ WARNING

Avoid static electricity risk when fueling. Ultra-low sulfur diesel fuel (ULSD fuel) poses a greater static ignition hazard than earlier diesel formulations with a higher sulfur contents. Avoid death or serious injury from fire or explosion. Consult with your fuel or fuel system supplier to ensure the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

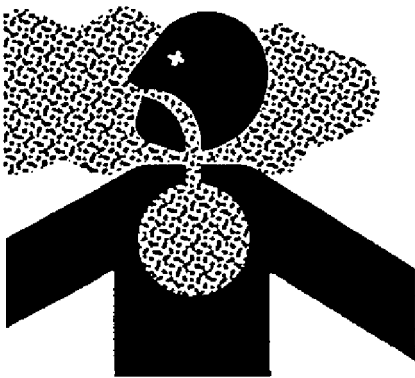
Inhalation

Illustration 7

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Exhaust

Use caution. Exhaust fumes can be hazardous to health. If you operate the equipment in an enclosed area, adequate ventilation is necessary.

Asbestos Information

Perkins equipment and replacement parts that are shipped from Perkins engine company limited are asbestos free. Perkins recommends the use of only genuine Perkins replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.

- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in "29 CFR 1910.1001".
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

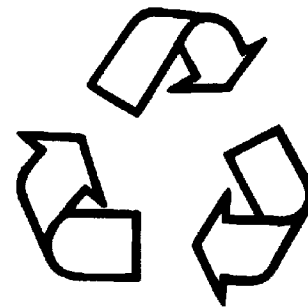
Dispose of Waste Properly

Illustration 8

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Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

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Burn Prevention

Do not touch any part of an operating engine. Operating engines exhaust gases could burn, do not come in contact with hot gases. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings, or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check that the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Skin may be irritated following repeated or prolonged exposure to mineral and synthetic base oils. Refer to your suppliers Material Safety Data Sheets for detailed information. Hot oil and lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Appropriate personal protective equipment should be used.

Diesel Fuel

Diesel may be irritating to the eyes, respiratory system, and skin. Prolonged exposure to diesel may cause various skin conditions. Appropriate personal protective equipment should be used. Refer to supplier Material safety Data sheets for detailed information.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

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Fire Prevention and Explosion Prevention



Illustration 9

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All fuels, most lubricants, and some coolant mixtures are flammable.

Safety Section
Fire Prevention and Explosion Prevention

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within 15 minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Perkins dealer and/or your Perkins distributor for additional information about suitable protection devices.

Remove all flammable combustible materials or conductive materials such as fuel, oil, and debris from the engine. Do not allow any flammable combustible materials or conductive materials to accumulate on the engine.

Store fuels and lubricants in correctly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame-cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. Ensure that all electrical wires are correctly installed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and correctly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be correctly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be correctly installed. The filter housings must be tightened to the correct torque.



Illustration 10

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Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.



Illustration 11

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Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Incorrect jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This action may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Ether

Ether is flammable and poisonous.

Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the engine compartment. Do not store ether cylinders in direct sunlight or in temperatures above 49° C (120° F). Keep ether cylinders away from open flames or sparks.

Lines, Tubes, and Hoses

Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install any lines that are bent or damaged. Do not clip any other items to the high-pressure lines.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Perkins dealer or your Perkins distributor for repair or for replacement parts.

Check lines, tubes, and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible parts of the hoses are kinked.
- Outer covers have embedded armoring.

- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During engine operation, correct installation will help to prevent vibration, rubbing against other parts, and excessive heat.

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Crushing Prevention and Cutting Prevention

Support the component correctly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

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Mounting and Dismounting

Do not climb on the engine. The engine has not been designed with mounting or dismounting locations.

Refer to the OEM for the location of foot and hand holds for your specific application.

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Before Starting Engine

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

⚠ WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

Inspect the engine for potential hazards.

Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided to help prevent personal injury. The circuits are also provided to help prevent engine damage.

Before starting the engine, ensure that the drive belt is securely in place. The coolant pump is operated by the drive belt.

See the Service Manual for repairs and for adjustments.

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Engine Starting

⚠ WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working correctly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

Note: The engine is equipped with an automatic device for cold starting for normal conditions of operation. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.

The engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air in order to improve starting.

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Engine Stopping

Stop the engine according to the procedure in the Operation and Maintenance Manual, "Engine Stopping (Operation Section)" in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

Stop the engine if an overspeed condition occurs during the initial start-up of a new engine or an engine that has been overhauled.

To stop an electronically controlled engine, cut the power to the engine and/or shutting off the air supply to the engine.

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Electrical System

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative “-” cable from the external power source should be connected last to the negative “-” terminal of the starting motor. If the starting motor is not equipped with a negative “-” terminal, connect the cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical connections before the engine is started. Repair all frayed electrical wires before the engine is started. See the Operation and Maintenance Manual for specific starting instructions.

Grounding Practices

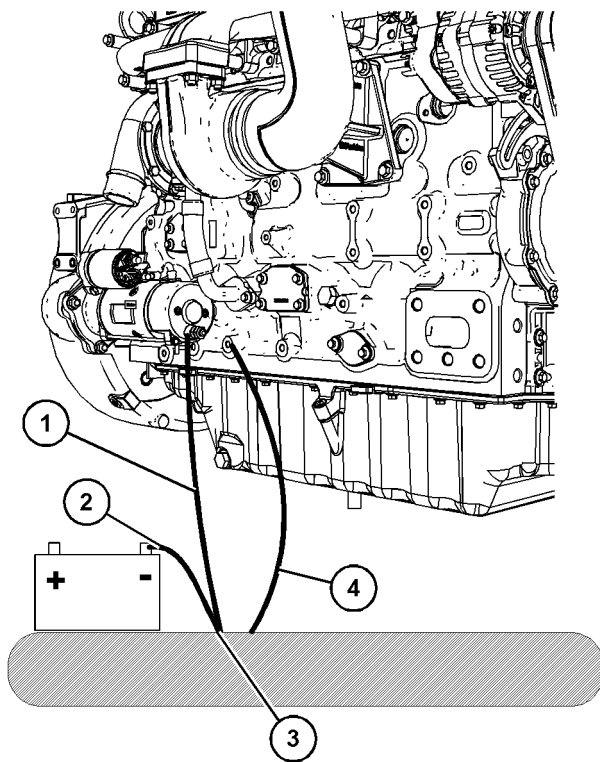


Illustration 12

g06432258

Typical example

- (1) Ground to the starting motor
- (2) Ground to the battery
- (3) Primary position for grounding
- (4) Ground to the engine block

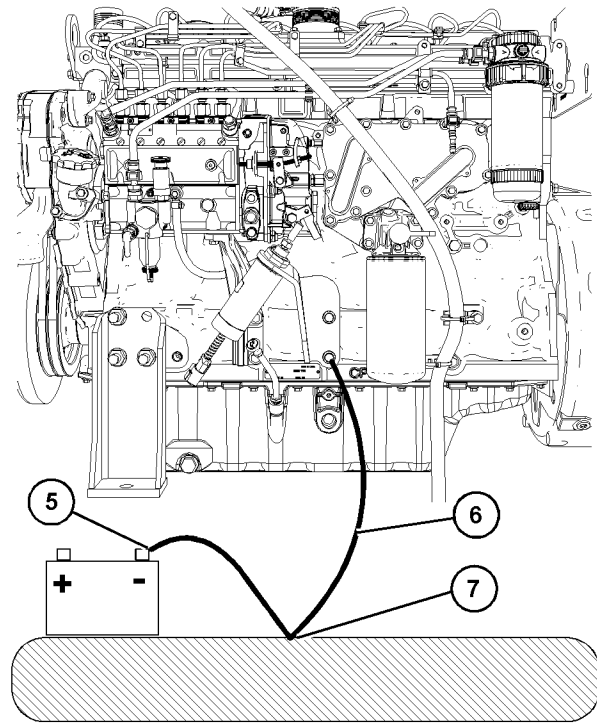


Illustration 13

g06432268

Typical example

- (1) Ground to the battery
- (2) Ground to the engine block
- (3) Primary position for grounding

Correct grounding for the engine electrical system is necessary for optimum engine performance and reliability. Incorrect grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to the crankshaft bearing journal surfaces and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function correctly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a direct engine ground to the frame.

The connections for the grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative “-” battery terminal with a wire that is adequate to handle the full charging current of the alternator.

The power supply connections and the ground connections for the engine electronics (if equipped) should always be from the isolator to the battery.

Product Information Section

Model Views

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Model View Illustrations

The following model views show typical features of the engine. Due to individual applications, your engine may appear different from the illustrations.

Note: Only major components are identified on the following illustrations.

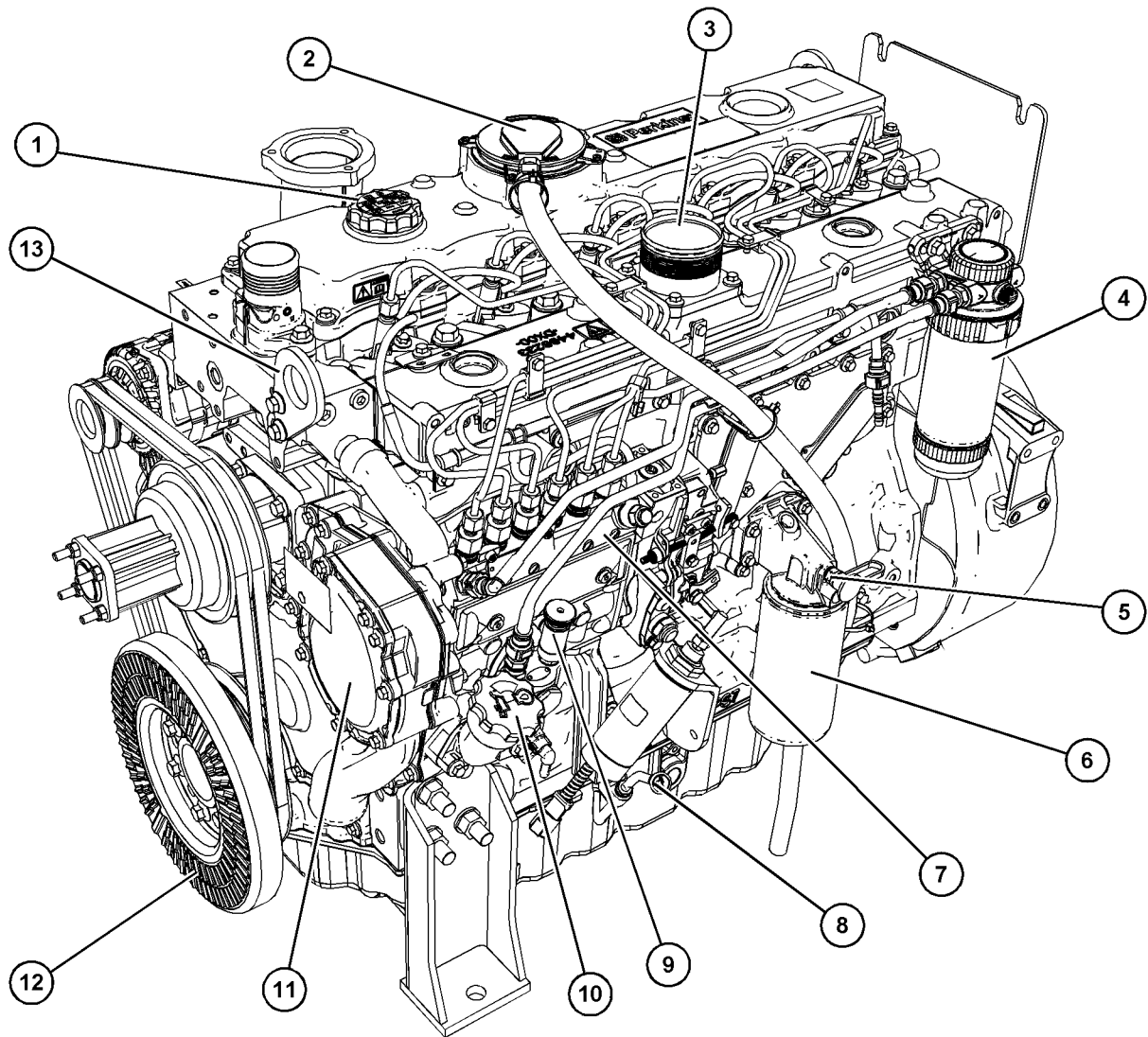
1106AA Engine

Illustration 14

g06432571

Typical example

- (1) Oil filler (upper)
- (2) Valve mechanism breather
- (3) Air intake
- (4) Primary fuel filter
- (5) Oil sampling valve

- (6) Oil filter
- (7) Fuel injection pump
- (8) Oil gauge (dipstick)
- (9) Fuel priming
- (10) Oil filler (lower)

- (11) Water pump
- (12) Damper
- (13) Front lifting eye

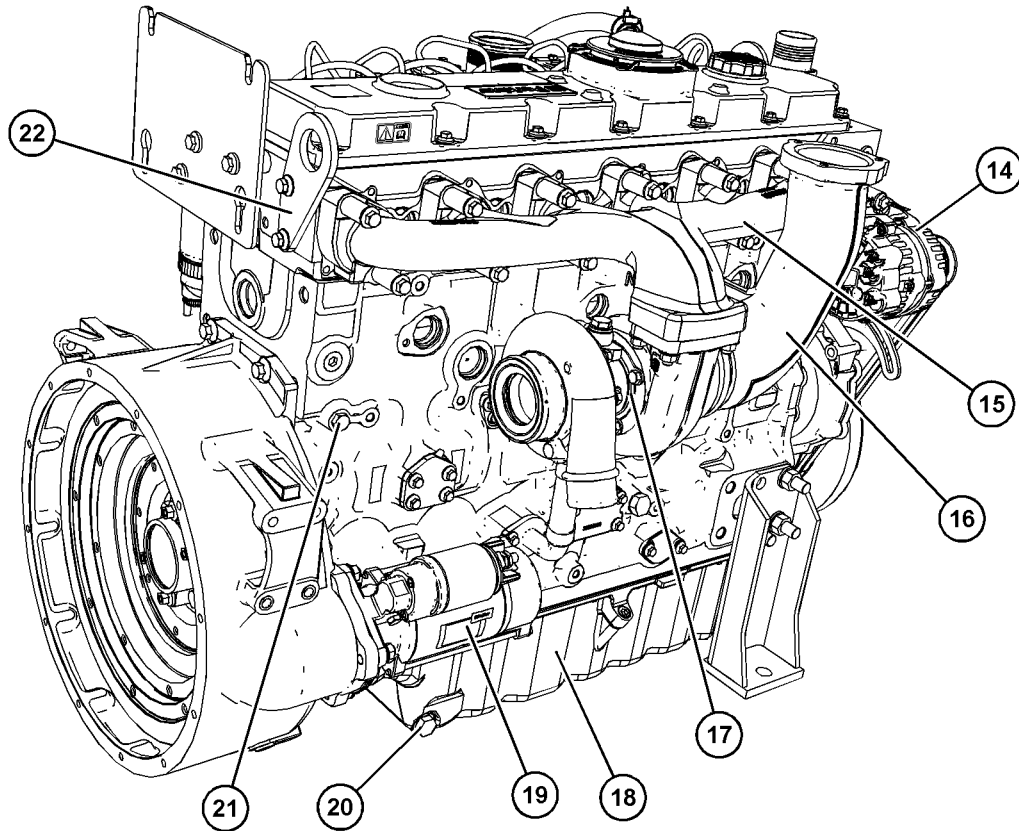


Illustration 15

g06432581

Typical example

(14) Alternator
(15) Exhaust manifold
(16) Exhaust elbow

(17) Turbocharger
(18) Oil pan
(19) Starting motor

(20) Drain plug (oil)
(21) Drain plug (coolant)
(22) Rear lifting eye

i07776877

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

Product Description

The Perkins 1106AA-70T, and 1106AA-70TA Industrial Engines have the following characteristics.

- In-line 6 cylinder
- Four stroke cycle
- Two valves in each cylinder

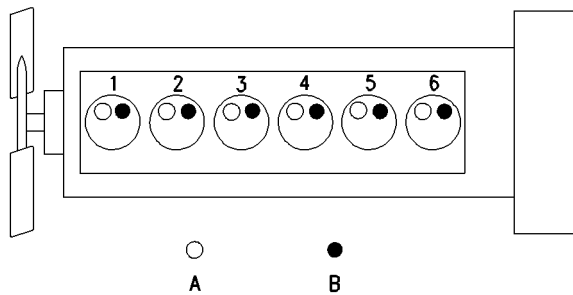


Illustration 16

g00939480

Cylinder and valve location

- (A) Inlet valve
(B) Exhaust valve

Table 1

Engine Specifications for the 1106AA-70T, and 1106AA-70TA engines	
Operating Range (rpm)	1500 to 1575 ⁽¹⁾ 1800 to 1890 ⁽²⁾
Number of Cylinders	6 In-Line
Bore	105 mm (4.13385 inch)
Stroke	135 mm (5.31495 inch)
Aspiration	Turbocharged Turbocharged aftercooled
Compression Ratio	16:1
Displacement	7.01 L (427.78 cubic inch)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise
Valve Lash Setting (Inlet)	0.35 mm (0.013 inch)
Valve Lash Setting (Exhaust)	0.45 mm (0.018 inch)

⁽¹⁾ For fixed speed applications with a frequency of 50Hz, the operating rpm depends on the engine rating, and the application.

⁽²⁾ For fixed speed applications with a frequency of 60Hz, the operating rpm depends on the engine rating, and the application.

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Gear-driven centrifugal water pump
- Water temperature regulator which regulates the engine coolant temperature
- Gear-driven rotor type oil pump
- Oil cooler

The engine lubricating oil is supplied by a rotor type oil pump. The engine lubricating oil is cooled and the engine lubricating oil is filtered. The bypass valve can provide unrestricted flow of lubrication oil to the engine if the oil filter element should become plugged.

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. Engine performance and efficiency also depend on the use of recommended fuels, lubrication oils, and coolants. Refer to Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information on maintenance items.

Product Identification Information

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Plate Locations and Film Locations

Perkins engines are identified by an engine serial number.

An example of an engine number is LU12345S000001E.

LU _____ Type of engine

LU12345 _____ The list number for the engine

S _____ Built-in India

000001 _____ Engine Serial Number

E _____ Year of Manufacture

Perkins dealers or Perkins distributors need all these numbers to determine the components that were included with the engine. This information will enable accurate identification of replacement part numbers.

Serial Number Plate (1)

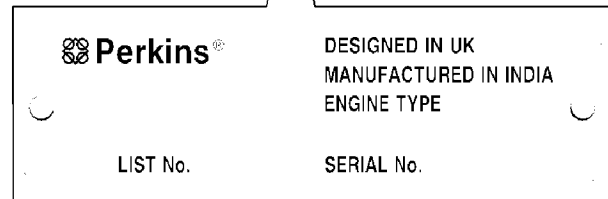
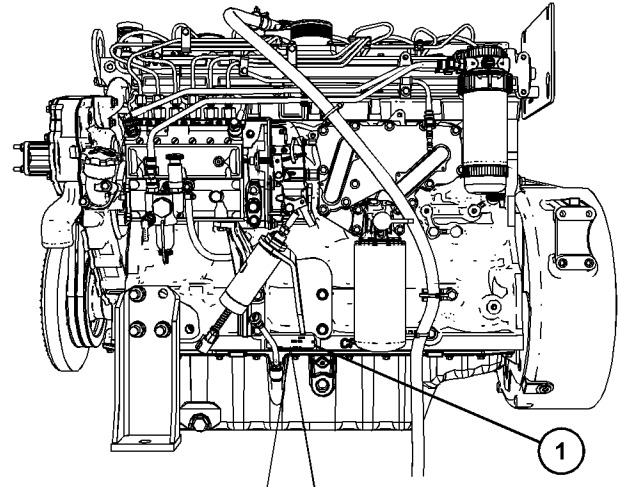


Illustration 17

g06432311

A typical example of the location of the serial number plate

The engine serial number plate is on the left side of the cylinder block to the rear of the front engine mounting.

i07748311

Emissions Certification Film


EMISSIONS CONTROL INFORMATION		
ENGINE FAMILY: *****	MODEL YEAR: 2005	
ENGINE DISPLACEMENT: *****		
<p>This non - road engine may be used as a REPLACEMENT engine within the EU, as per the provisions of Directive 97/68/EC</p> <p style="text-align: center;">INFORMATION APPLICABLE TO USA ONLY</p> <p>This non - road engine does not comply with either federal non - road or California off - road engine emission regulation requirements. Sale or installation of this engine is a violation of federal and Californian law subject to civil penalty for any purpose other than as an EXPORT - ONLY or REPLACEMENT engine.</p> <p>Export - only engine is indicated by an additional attached tag.</p>		
Hanger No**	Position ****	Label No. 3181A081

Illustration 18

g01156734

A typical example of a label is installed on engines that do not comply with emissions.

Operation Section

Lifting and Storage

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Product Lifting

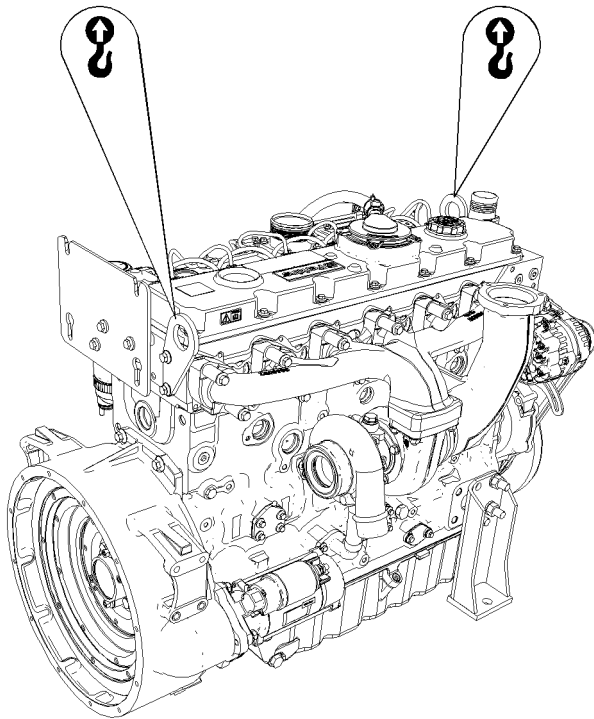


Illustration 19

g06432369

NOTICE

Always inspect lifting eyebolts and all other lifting equipment for damage before performing any lifting. Never bend the eyebolts and the brackets. Never perform product lifting if components are damaged. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for specific engine arrangements. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Perkins dealer for information regarding fixtures for proper engine lifting.

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Product Storage

Perkins are not responsible for damage which may occur when an engine is in storage after a period in service.

Your Perkins dealer or your Perkins distributor can assist in preparing the engine for extended storage periods.

Condition for Storage

The engine must be stored in a water proof building. The building must be kept at a constant temperature. Engines that are filled with Perkins ELC will have coolant protection to an ambient temperature of -36°C (-32.8°F). The engine must not be subjected to extreme variations in temperature and humidity.

Storage Period

An engine can be stored for up to 6 months provided all the recommendation are adhered to.

Storage Procedure

Keep a record of the procedure that has been completed on the engine.

Note: Do not store an engine that has biodiesel in the fuel system.

1. Ensure that the engine is clean and dry.
 - a. If the engine has been operated using biodiesel, the system must be drained and new filters installed. The fuel tank will require flushing.
 - b. Fill the fuel system with an acceptable fuel. For more information on acceptable fuels refer to this Operation and Maintenance Manual, "Fluid recommendations". Operate the engine for 15 minutes in order to remove all biodiesel from the system.

2. Drain any water from the primary filter water separator. Ensure that the fuel tank is full.
3. The engine oil will not need to be drained in order to store the engine. Provided the correct specification of engine oil is used the engine can be stored for up to 6 months. For the correct specification of engine oil refer to this Operation and Maintenance Manual, "Fluid recommendations".
4. Remove the drive belt from the engine.

Sealed Coolant System

Ensure that the cooling system is filled with Perkins ELC, or an antifreeze that meets "ASTM D6210" specification.

Open Cooling System

Ensure that all cooling drain plugs have been opened. Allow the coolant to drain. Install the drain plugs. Place a vapor phase inhibitor into the system. The coolant system must be sealed once the vapor phase inhibitor has been introduced. The effect of the vapor phase inhibitor will be lost if the cooling system is open to the atmosphere.

For maintenance procedures refer to this Operation and Maintenance Manual.

Monthly Checks

The crankshaft must be rotated in order to change the spring loading on the valve train. Rotate the crankshaft more than 180 degrees. Visibly check for damage or corrosion to the engine.

Ensure that the engine is covered completely before storage. Log the procedure in the record for the engine.

Gauges and Indicators

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Gauges and Indicators

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the OEM information.

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings indicate potential gauge or engine problems. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine and correct the cause of any significant change in the readings. Consult your Perkins dealer or your Perkins distributor for assistance.

NOTICE

If no oil pressure is indicated, STOP the engine. If maximum coolant temperature is exceeded, STOP the engine. Engine damage can result.



Engine Oil Pressure – The oil pressure should be greatest after a cold engine is started. The typical engine oil pressure with SAE10W30 is 207 to 413 kPa (30 to 60 psi) at rated rpm.

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.
2. Reduce engine speed to low idle.
3. Check and maintain the oil level.



Jacket Water Coolant Temperature – Typical temperature range is 71 to 96°C (160 to 205°F). The maximum allowable temperature with the pressurized cooling system at 48 kPa (7 psi) is 110°C (230°F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

1. Reduce the load and the engine rpm.
2. Inspect the cooling system for leaks.

3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.



Tachometer – This gauge indicates engine speed (rpm). When the throttle control lever is moved to the full throttle position without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle control lever is at the full throttle position with maximum rated load.

NOTICE

To help prevent engine damage, never exceed the high idle rpm. Overspeeding can result in serious damage to the engine. The engine can be operated at high idle without damage, but should never be allowed to exceed high idle rpm.



Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of “0” (zero).



Fuel Level – This gauge indicates the fuel level in the fuel tank. The fuel level gauge operates when the “START/STOP” switch is in the “ON” position.



Service Hour Meter – The gauge indicates operating time of the engine.

Engine Starting

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Before Starting Engine

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

Before the engine is started, perform the required daily maintenance and any other periodic maintenance that is due. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information.

- For the maximum service life of the engine, make a thorough inspection within the engine compartment before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts, and excessive dirt and/or grease. Remove any excess dirt and/or grease buildup. Repair any faults that were identified during the inspection.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage. Ensure that the drive belt is securely in position and correctly tensioned.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve (if equipped).
- Inspect the engine for potential hazards.

NOTICE

All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information on priming the fuel system.

WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

- Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all the shutoffs or alarm components (if equipped).
- Check the engine lubrication oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the engine oil level gauge.
- Check the coolant level. Observe the coolant level in the header tank (if equipped). Maintain the coolant level to the "FULL" mark on the header tank.
- If the engine is not equipped with a header tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any equipment that is driven by the engine has been disengaged from the engine. Minimize electrical loads or remove any electrical loads.

i07762183

Starting the Engine

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

Refer to the Operation and Maintenance Manual for your type of controls for the engine.

If a warning tag is attached to the engine start switch, or to the controls DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure described in the Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working correctly, check the water temperature gauge. Also, check the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

1. Use the following procedure to start the engine.

If equipped, move the throttle lever to the full throttle position before you start the engine.

NOTICE

Do not crank the engine for more than 30 seconds. Allow the electric starting motor to cool for two minutes before cranking the engine again.

2. Turn the engine start switch to the START position. Hold the engine start switch in the START position and crank the engine.

3. When the engine starts, release the engine start switch.
4. If equipped, slowly move the throttle lever to the low idle position and allow the engine to idle. Refer to the Operation and Maintenance Manual, "After Starting Engine" topic.
5. If the engine does not start, release the engine start switch and allow the electric starting motor to cool. Then, repeat steps 2 through step 4.
6. Turn the engine start switch to the OFF position to stop the engine.

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Starting with Jump Start Cables

(Do Not Use This Procedure in Hazardous Locations that have Explosive Atmospheres)

WARNING

The connection of battery cables to a battery and the disconnection of battery cables from a battery may cause an explosion which may result in injury or death. The connection and the disconnection of other electrical equipment may also cause an explosion which may result in injury or death. The procedures for the connection and the disconnection of battery cables and other electrical equipment should only be performed in a nonexplosive atmosphere.

WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

Note: If possible, first diagnose the reason for the starting failure and make any necessary repairs. If the engine will not start only due to the condition of the battery, either charge the battery, or start the engine by using another battery with jump-start cables. The condition of the battery can be rechecked after the engine has been switched OFF.

NOTICE

Ensure that a 12 VDC or 24 VDC battery source is used to start the engine. Never attempt to start an engine from an external power source such as electric welding equipment, which has a voltage that is unsuitable for engine starting and will damage the electrical system.

NOTICE

Using a battery source with the same voltage as the electric starting motor. Use **ONLY** equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all the engines accessories.
2. Connect one positive end of the jump-start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump-start cable to the positive cable terminal of the electrical source.
3. Connect one negative end of the jump-start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump-start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting the combustible gases that are produced by some batteries.
4. Start the engine in the normal operating procedure. Refer to this Operation and Maintenance Manual, "Starting the Engine".
5. Immediately after the engine is started, disconnect the jump-start cables in reverse order.

After jump starting, the alternator may not be able to recharge fully batteries that are severely discharged. The batteries must be replaced or charged to the proper voltage with a battery charger after the engine is stopped. Many batteries which are considered unusable are still rechargeable. Refer to Operation and Maintenance Manual, "Battery - Replace" and Testing and Adjusting Manual, "Battery - Test".

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After Starting Engine

Note: In temperatures from 0°C to 60°C (32°F to 140°F), the warm-up time is approximately 3 minutes. In temperatures below 0°C (32°F), extra warm-up time may be required.

When the engine idles during warm-up, observe the following conditions:

- Check for any fluid or for any air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load. This action may not be possible in some applications.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

Constant speed engines should be allowed to operate at low idle for 3 minutes before used at operational speed. If the low idle option is not available, then operate the engine at operational speed with no load for 2 minutes.

Note: Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engine Operation

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Engine Operation

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The engine can be operated at the rated rpm after the engine reaches operating temperature. The engine will reach normal operating temperature sooner during a low engine speed (rpm) and during a low-power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

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Engine Warm-up

Variable Speed Engine

1. Run the engine at low idle for 3 to 5 minutes. Or run the engine at low idle until the jacket water temperature starts to rise.

More time may be necessary when the temperature is below -18°C (0°F).

2. Check all of the gauges during the warm-up period.
3. Perform a walk-around inspection. Check the engine for fluid leaks and air leaks.
4. Increase the rpm to the rated rpm. Check for fluid leaks and air leaks. The engine may be operated at full rated rpm and at full load when the temperature of the water jacket reaches 60°C (140°F).

Constance Speed Engine

1. Run the engine for 3 to 5 minutes.

More time may be necessary when the temperature is below -18°C (0°F).

2. Check all of the gauges during the warm-up period.
3. Perform a walk-around inspection. Check the engine for fluid leaks and air leaks, only then apply the load.

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Fuel Conservation Practices

The efficiency of the engine can affect the fuel economy. Perkins design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels.
- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

- Observe the air cleaner service indicator frequently. Keep the air cleaner elements clean.
- Maintain the electrical systems.

One damaged battery cell will overwork the alternator. This will consume excess power and excess fuel.

- Ensure that the drive belts are correctly adjusted. The drive belts should be in good condition.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.
- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

Engine Stopping

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Stopping the Engine

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NOTICE

Stopping the engine immediately after it has been working under load can result in overheating and accelerated wear of the engine components.

If the engine has been operating at high rpm and/or high loads, run at low idle for at least three minutes to reduce and stabilize internal engine temperature before stopping the engine.

Avoiding hot engine shutdowns will maximize turbo-charger shaft and bearing life.

Prior to stopping an engine that is being operated at low loads, operate the engine at low idle for 30 seconds before stopping. If the engine has been operating at highway speeds and/or at high loads, operate the engine at low idle for at least three minutes. This procedure will cause the internal engine temperature to be reduced and stabilized.

Ensure that the engine stopping procedure is understood. Stop the engine according to the shutoff system on the engine or refer to the instructions that are provided by the OEM.

- To stop the engine, turn the ignition key switch to the OFF position.

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Emergency Stopping

NOTICE

Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

The Original Equipment Manufacturer (OEM) may have equipped the application with an emergency stop button. For more information about the emergency stop button, refer to the OEM information.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

After Stopping Engine

Note: Before you check the engine oil, do not operate the engine for at least 10 minutes in order to allow the engine oil to return to the oil pan.

- Check the crankcase oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level dipstick.
- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
- Note the required service interval. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

NOTICE

Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance Manual. Failure to do so can cause engine damage.

-
- Allow the engine to cool. Check the coolant level.
 - If freezing temperatures are expected, check the coolant for the correct antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the correct coolant/water mixture, if necessary.
 - Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Cold Weather Operation

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Cold Weather Operation

Perkins Diesel Engines can operate effectively in cold weather. During cold weather, the starting and the operation of the diesel engine depends on the following items:

- The type of fuel that is used
- The viscosity of the engine oil
- The operation of the glow plugs
- Optional Cold starting aid
- Battery condition
- Ambient air temperature and altitude
- Parasitic load of the application
- Application hydraulic and transmission oil viscosities

This section will cover the following information:

- Potential problems that are caused by cold-weather operation
- Suggest steps which can be taken to minimise starting problems and operating problems when the ambient air temperature is between 0° to -40 °C (32° to 40 °F).

The operation and maintenance of an engine in freezing temperatures is complex. This complexity is because of the following conditions:

- Weather conditions
- Engine applications

Recommendations from your Perkins dealer or your Perkins distributor are based on past proven practices. The information that is contained in this section provides guidelines for cold-weather operation.

Hints for Cold-Weather Operation

- After starting the engine, the engine should be operated at low loads until a minimum operating temperature of 80° C (176° F) is achieved.
- Achieving operating temperature will help prevent the intake valves and exhaust valves from sticking.

- The cooling system and the lubrication system for the engine do not lose heat immediately upon shutdown. This means that an engine can be shut down for a period of time and the retained heat within the engine will allow the engine to readily start.
- Install the correct specification of engine lubricant before the beginning of cold weather. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended viscosity of oil.
- Check all rubber parts (hoses, fan drive belts) weekly.
- Check all electrical wiring and connections for any fraying or damaged insulation.
- Keep all batteries fully charged and warm by ensuring that the engine is allowed to operate at normal operating temperature.
- Fill the fuel tank at the end of each shift.
- Check the air cleaners and the air intake daily. Check the air intake more often when you operate in snow.

WARNING

Personal injury or property damage can result from alcohol or starting fluids.

Alcohol or starting fluids are highly flammable and toxic and if improperly stored could result in injury or property damage.

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

- For jump starting with cables in cold weather, refer to the Operation and Maintenance Manual, "Starting with Jump-Start Cables." for instructions.

Viscosity of the Engine Lubrication Oil

Correct engine oil viscosity is essential. Oil viscosity affects lubrication properties and wear protection that the oil provides for the engine. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended viscosity of oil.

At temperatures below -10°C (14°F) damage to engine components can occur if the engine is allowed to operate at high load and speed immediately after starting.

Recommendations for the Coolant

Provide cooling system protection for the lowest expected outside temperature. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended coolant mixture.

In cold weather, check the coolant often for the correct glycol concentration to ensure adequate freeze protection.

Engine Block Heaters

Engine block heaters (if equipped) heat the engine jacket water that surrounds the combustion chambers. This heat provides the following functions:

- Startability is improved.
- Warm up time is reduced.

An electric block heater can be activated once the engine is stopped. A block heater can be 120 V ac 600W or 240 V ac 550W. The output can be 550 or 600W. Consult your Perkins dealer or your Perkins distributor for more information.

Idling the Engine

When idling after the engine is started in cold weather, increase the engine rpm from 1000 to 1200 rpm. This idling will warm up the engine more quickly. Maintaining an elevated low idle speed for extended periods will be easier with the installation of a hand throttle. The engine should not be "raced" to speed up the warm-up process.

While the engine is idling, the application of a light load (parasitic load) will help in achieving the minimum operating temperature. The minimum operating temperature is 80°C (176°F).

Recommendations for Coolant Warm Up

Warm up an engine that has cooled below normal operating temperatures due to inactivity. This warm up should be performed before the engine is returned to full operation. During operation in cold temperature conditions, damage to engine valve mechanisms can result from engine operation for short intervals. This damage can happen if the engine is started and the engine is stopped many times without being operated to warm up completely.

When the engine is operated below normal operating temperatures, fuel and oil are not burned completely in the combustion chamber. This fuel and oil causes soft carbon deposits to form on the valve stems. Generally, the deposits do not cause problems and the deposits are burned off during operation at normal engine operating temperatures.

When starting and stopping an engine many times without being operated to warm up completely, the carbon deposits become thicker. This starting and stopping can cause the following problems:

- Free operation of the valves is prevented.
- Valves become stuck.
- Push-rods may become bent.
- Other damage to valve train components can result.

For these reasons, when the engine is started, the engine must be operated until the coolant temperature is 80°C (176°F) minimum. Carbon deposit on the valve stems will be kept at a minimum. The free operation of the valves and the valve components will be maintained.

The engine must be warmed thoroughly to keep other engine parts in better condition. The service life of the engine will be extended. Lubrication will be improved. There will be less acid and less sludge in the oil. This condition will provide longer service life for the engine bearings, the piston rings, and other parts. However, limit unnecessary idle time to 10 minutes to reduce wear and unnecessary fuel consumption.

The Water Temperature Regulator and Insulated Heater Lines

The engine is equipped with a water temperature regulator. When the engine coolant is below the correct operating temperature, jacket water circulates through the engine cylinder block and into the engine cylinder head. The coolant then returns to the cylinder block via an internal passage that bypasses the valve of the coolant temperature regulator. This return ensures that coolant flows around the engine under cold operating conditions. The water temperature regulator begins to open when the engine jacket water has reached the correct minimum operating temperature. As the jacket water coolant temperature rises above the minimum operating temperature, the water temperature regulator opens further allowing more coolant through the radiator to dissipate excess heat.

The progressive opening of the water temperature regulator operates the progressive closing of the bypass passage between the cylinder block and head. This action ensures maximum coolant flow to the radiator to achieve maximum heat dissipation.

Note: Do not restrict the air flow. Restriction of the air flow can damage the fuel system. Perkins discourages the use of all air flow restriction devices such as radiator shutters. Restriction of the air flow can result in the following: high exhaust temperatures, power loss, excessive fan usage, and reduction in fuel economy.

A cab heater is beneficial in cold weather. The feed from the engine and the return lines from the cab should be insulated to reduce heat loss to the outside air.

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Fuel and the Effect from Cold Weather

Note: Only use grades of fuel that are recommended by Perkins. Refer to this Operation and Maintenance Manual, “Fluid Recommendations”.

Properties of the diesel fuel can have a significant effect on the engine cold start capability. Critical to the low temperature properties of diesel fuel is the acceptability for the minimum ambient temperature the engine is expected to see in operation. Following properties are used to define fuels low temperature capability:

- Cloud point
- Pour point
- Cold Filter Plugging Point (CFPP)

The cloud point of the fuel is the temperature at which waxes naturally found in diesel fuel begins to form crystals. The cloud point of the fuel must be below lowest ambient temperature to prevent filters from plugging.

CFPP is a temperature at which a particular fuel will pass through a standardized filtration device. The CFPP gives an estimate of the lower operability temperature of fuel.

Pour point is the last temperature before the fuel flow stops and waxing of the fuel will start.

Be aware of these properties when diesel fuel is purchased. Consider the average ambient air temperature for the engines application. Engines that are fueled in one climate may not operate well if the engines are shipped to colder climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the fuel for waxing.

The following components can provide a means of minimizing fuel waxing problems in cold weather:

- Fuel heaters, which may be an OEM option
- Fuel line insulation, which may be an OEM option

Winter and arctic grades of diesel fuel are available in the countries and territories with severe winters. For more information refer to the Operation and Maintenance Manual, “Cold Weather Operation”

Another important fuel property which can affect cold start and operation of diesel engine is cetane number. For more information refer to the Operation and Maintenance Manual, “Fluid Recommendations”.

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Fuel Related Components in Cold Weather

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after you operate the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, oil changes and refueling of the fuel tank. This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Filters

It is possible that a primary fuel filter is installed between the fuel tank and the engine fuel inlet. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

The micron rating and the location of a primary fuel filter is important in cold weather operation. The primary fuel filter and the fuel supply line are the most common components that are affected by cold fuel.

Fuel Heaters

Note: The OEM may equip the application with fuel heaters. If this is the case, disconnect an electric type of fuel heater in warm weather in order to prevent overheating of the fuel. If the type of fuel heater is a heat exchanger, the OEM should have included a bypass for warm weather. Ensure that the bypass is operational during warm weather in order to prevent overheating of the fuel.

For more information about fuel heaters (if equipped), refer to the OEM information.

Maintenance Section

Refill Capacities

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Refill Capacities

Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require more oil. Refer to the Original Equipment Manufacturer (OEM) specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, "Maintenance Section" for more information on Lubricant Specifications.

Table 2

Engine Refill Capacities		
Compartment or System	Minimum	Maximum
Crankcase Oil Sump ⁽¹⁾	13.5 L (3.56 US gal)	16.5 L (4.36 US gal)

⁽¹⁾ These values are the approximate capacities for the crankcase oil sump (aluminum) which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. The design of the oil pan can change the oil capacity of the oil pan.

Cooling System

Refer to the OEM specifications for the External System capacity. This capacity information will be needed to determine the amount of coolant/antifreeze that is required for the Total Cooling System.

Table 3

Engine Refill Capacities	
Compartment or System	Liters
Engine Only	9 L (2.38 US gal)
Engine and radiator	

Fluid Recommendations

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General Coolant Information

NOTICE

Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE

If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE

Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: Overheating, leakage of the water pump and plugged radiators or heat exchangers.

These failures can be avoided with correct cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: Water, additives, and glycol.

Water

NOTICE

Never use water alone as coolant. Water alone is corrosive and does not provide any protection against boiling or freezing.

Water is used in the cooling system to transfer heat.

Distilled water or deionized water is recommended for use in engine cooling systems.

DO NOT use the following types of water in cooling systems: Hard water, softened water that has been conditioned with salt and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 4.

Table 4

Acceptable Water	
Property	Maximum Limit
Chloride (Cl)	40 mg/L
Sulfate (SO ₄)	100 mg/L
Total Hardness	170 mg/L
Total Solids	340 mg/L
Acidity	pH of 5.5 to 9.0

For a water analysis, consult one of the following sources:

- Local water utility company
- Agricultural agent
- Independent laboratory

Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically.

Additives must be added at the correct concentration. Over concentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump

For optimum performance, Perkins recommends a 50 percent by volume of glycol in the finished coolant (also referred to as 1:1 mixture).

Note: Use a mixture that will provide protection against the lowest ambient temperature.

Note: 100 percent pure glycol will freeze at a temperature of -13°C (8.6°F).

Most conventional antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with distilled or deionized water, ethylene and propylene glycol provide similar protection against freezing and boiling. Refer to Table 5 and refer to table 6.

Table 5

Ethylene Glycol	
Concentration	Freeze Protection
50 Percent	-36°C (-33°F)
60 Percent	-51°C (-60°F)

NOTICE

Do not use propylene glycol in concentrations that exceed 50 percent glycol because of the reduced heat transfer capability of propylene glycol. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 6

Propylene Glycol	
Concentration	Freeze Protection
50 Percent	-29°C (-20°F)

Some commercially available coolants are based on alternative fluids, such as 1, 3-propanediol (beta-propylene glycol, PDO), glycerin (glycerol), or mixtures of these alternatives with ethylene/propylene glycols. At the time of publication of this document no industry standard exists for coolants based on these chemicals. Until such standard/specifications are published and evaluated, use of PDO, glycerine, or other alternative coolants are not recommended in Perkins engines.

To check the concentration of glycol in the coolant, measure the specific gravity of the coolant.

Coolant Terminology

- ELC _____ Extended Life Coolant. A coolant that relies on organic inhibitors for corrosion and cavitation protection. Also known as Organic Acid Technology (OAT) coolant.
- ELI _____ Extended Life Inhibitor
- SCA _____ Supplement Coolant Additive, concentrated inorganic inhibitor package
- ASTM _____ American Society for Testing and Materials
- Conventional Coolant _____ a coolant that relies on inorganic inhibitors for corrosion and cavitation protection
- Hybrid Coolant _____ a coolant in which the corrosion and cavitation protection is based on a mixture of organic and inorganic inhibitors.
- Extender _____ concentrated organic inhibitor package

Coolant Recommendations

The following three glycol-based coolants are recommended for use in Perkins diesel engines:

Preferred – Perkins ELC

Acceptable – A commercial heavy-duty antifreeze that meets “ASTM D6210” specifications. Must be replaced after 2 years.

Adequate – A commercial heavy-duty antifreeze that meets “ASTM D4985” specifications. Must be replaced after 1 year.

NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 specification. This type of coolant/antifreeze is made for light automotive applications.

NOTICE

A commercial heavy-duty antifreeze that meets “ASTM D4985” specification requires a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the manufacturer of the product.

NOTICE

A commercial heavy-duty antifreeze that meets either “ASTM D4985” or “ASTM D6210” specification requires the SCA concentration to be checked at 500-hour service intervals.

Perkins recommends a 50 percent volume glycol and distilled or deionized water of the correct specification. This mixture will provide optimum performance as a coolant/antifreeze.

Distilled or deionized water is preferred. Water which has the recommended properties may be used.

Table 7

Coolant Service Life		
Coolant Type	Service Life ⁽¹⁾	Required Maintenance
Commercial Heavy-Duty Anti-freeze that meets “ASTM D6210”	3000 Service Hours or Two Years	SCA at maintenance intervals
Commercial Heavy-Duty Anti-freeze that meets “ASTM D4985”	3000 Service Hours or One Year	SCA at initial fill and SCA at maintenance intervals
Perkins ELC	6,000 Service Hours or Three Years	-

⁽¹⁾ Use the interval that occurs first. The cooling system must also be flushed out at this time. These service lives can only be met if regular coolant sampling, analysis, and proper maintenance are carried out, with the engine in normal service.

ELC

Perkins provides ELC for use in the following applications:

- Heavy-duty spark ignited gas engines
- Heavy-duty diesel engines
- Automotive applications

The anti-corrosion package for ELC is different from the anti-corrosion package for other coolants. ELC is an ethylene glycol base coolant. However, ELC contains organic corrosion inhibitors and antifoam agents with low amounts of nitrite. Perkins ELC has been formulated with the correct amount of these additives to provide superior corrosion protection for all metals in engine cooling systems.

ELC is available in a premixed cooling solution with distilled water. ELC is a 50 percent by volume of glycol mixture. The Premixed ELC provides freeze protection to -36°C (-33°F). The Premixed ELC is recommended for the initial fill of the cooling system. The Premixed ELC is also recommended for topping off the cooling system.

Containers of several sizes are available. Consult your Perkins distributor for the part numbers.

ELC Cooling System Maintenance

Correct additions to the Extended Life Coolant

NOTICE

Mixing Extended Life Coolant with other products reduces the Extended Life Coolant service life. Failure to follow the recommendations can reduce cooling system components life unless appropriate corrective action is performed.

To maintain the correct balance between the antifreeze and the additives, you must maintain the recommended concentration of ELC. Lowering the proportion of antifreeze lowers the proportion of additive. Lowering the ability of the coolant to protect the system will form pitting, from cavitation, from erosion, and from deposits.

NOTICE

Do not use a conventional coolant to top-off a cooling system that is filled with Extended Life Coolant (ELC).

Do not use Supplemental Coolant Additive (SCA).

Do not use ELC in systems with SCA filters. When switching from conventional coolant to ELC in a system equipped with SCA filter, remove the filter from the system to prevent ELC contamination and filter corrosion and leaks.

ELC Cooling System Cleaning

Note: If the cooling system is already using ELC, cleaning agents are not required to be used at the specified coolant change interval. Cleaning agents are only required if the system has been contaminated by the addition of some other type of coolant or by cooling system damage.

Distilled or deionized water is the only cleaning agent that is required when ELC is drained from the cooling system.

Before the cooling system is filled, the heater control (if equipped) must be set to the HOT position. Refer to the OEM to set the heater control. After the cooling system is drained and the cooling system is refilled, operate the engine until the coolant level reaches the normal operating temperature and until the coolant level stabilizes. As needed, add the coolant mixture to fill the system to the specified level.

Changing to Perkins ELC

To change from heavy-duty antifreeze to the Perkins ELC, perform the following steps:

NOTICE

Care must be taken to ensure that all fluids are contained during performance of inspection, maintenance, testing, adjusting and the repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

-
1. Drain the coolant into a suitable container.
 2. Dispose of the coolant according to local regulations.
 3. Flush the system with distilled or deionized water to remove any debris.
 4. Use an appropriate cleaner to clean the system. Follow the instruction on the label.
 5. Drain the cleaner into a suitable container. Flush the cooling system with distilled or deionized water.
 6. Fill the cooling system with distilled or deionized water and operate the engine until the engine is warmed to 49° to 66°C (120° to 150°F).

NOTICE

Incorrect or incomplete flushing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure that the cooling system is completely flushed with distilled or deionized water. Continue to flush the system until all signs of the cleaning agent are gone.

Most commercial cooling system cleaning agents are corrosive and their use is not recommended by Perkins. If these agents have to be used to remove heavy deposits, then they should not be left in the system any longer than recommended by the agent manufacturer and engine temperature should not exceed 30°C . The system must be thoroughly flushed with distilled or deionized water after use of these cleaning agents.

7. Drain the cooling system into a suitable container and flush the cooling system with distilled or deionized water.

Note: The cooling system cleaner must be thoroughly flushed from the cooling system. Cooling system cleaner that is left in the system will contaminate the coolant. The cleaner may also corrode the cooling system.

8. Repeat Steps 6 and repeat steps 7 until the system is completely clean.
9. Fill the cooling system with the Perkins Premixed ELC.

ELC Cooling System Contamination

NOTICE

Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Failure to follow these recommendations can result in shortened cooling system component life.

Do not mix types and specifications of coolant.

Do not mix types and specifications of SCAs.

ELC cooling systems can withstand contamination to a maximum of 10 percent of conventional heavy-duty antifreeze or SCA. If the contamination exceeds 10 percent of the total system capacity, perform ONE of the following procedures:

- Drain the cooling system into a suitable container. Dispose of the coolant according to local regulations. Flush the system with a 5 to 10 percent solution of Perkins ELC. Fill the system with the Perkins ELC.
- Maintain the system as a conventional Heavy-Duty Coolant. Treat the system with an SCA. Change the coolant at the interval that is recommended for the conventional Heavy-Duty Coolant.

Commercial Heavy-Duty Antifreeze and SCA

NOTICE

Commercial Heavy-Duty Coolant which contains Amines as part of the corrosion protection system must not be used.

NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the correct operating temperature. Cooling system problems can develop without water temperature regulators.

Check the antifreeze (glycol concentration) to ensure adequate protection against boiling or freezing. Perkins recommends the use of a refractometer for checking the glycol concentration. Do not use a hydrometer.

NOTICE

Do not mix types and specifications of coolant.

Do not mix types and specifications of SCAs.

Do not mix SCAs and Extenders.

Only use SCAs or Extender approved by coolant manufacturer and are compatible with coolant.

Adding the SCA to Heavy-Duty Coolant at the Initial Fill

Use the equation that is in Table 8 to determine the amount of SCA that is required when the cooling system is initially filled.

Coolants that conform to "ASTM D4985" and do not conform to "ASTM D6210" will require addition of SCA at initial fill.

Table 8

Equation For Adding The SCA To The Heavy-Duty Coolant At The Initial Fill
$V \times 0.07 = X$
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 9 is an example for using the equation that is in Table 8 .

Table 9

Example Of The Equation For Adding The SCA To The Heavy-Duty Coolant At The Initial Fill		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
15 L (4 US gal)	× 0.07	1.05 L (35.5 oz)

Adding SCA to the Commercial Heavy-Duty Coolant for Maintenance

Heavy-duty antifreezes of all types require periodic additions of SCA.

Test the antifreeze periodically for the concentration of SCA.

Additions of SCA are based on the results of the test. The size of the cooling system determines the amount of SCA that is needed.

Use the equation that is in Table 10 to determine the amount of SCA that is required, if necessary:

Table 10

Equation for Adding the SCA to the Commercial Heavy-Duty Coolant for Maintenance
$V \times 0.023 = X$
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 11 is an example for using the equation that is in Table 10 .

Table 11

Example of the Equation for Adding the SCA to the Commercial Heavy-Duty Coolant for Maintenance		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
15 L (4 US gal)	$\times 0.023$	0.35 L (11.7 oz)

Cleaning the System of Heavy-Duty Antifreeze

Clean the cooling system for the following conditions.

- Clean the cooling system after used coolant is drained or before the cooling system is filled with new coolant
- Clean the cooling system whenever the coolant is contaminated or whenever the coolant is foaming
- The cooling system must be free from rust, scale, and any deposits, before corrosion inhibitors can be effective

To clean the cooling system of heavy-duty antifreeze, perform the following steps:

1. Drain the cooling system.
2. Fill the system with suitable distilled or deionized water.

NOTICE

Most commercial cooling system cleaning agents are corrosive and their use is not recommended by Perkins. If these cleaning agents have to be used to clean heavy deposits, then they should not be left in the system any longer than recommended by manufacturers. Also the engine temperature should not exceed 30° C (86° F).

The system must be thoroughly flushed with distilled or deionized water after use of cleaning agents.

NOTICE

Cleaning agents for industrial cooling system must not be used. These cleaning agents are very aggressive and cause damage to cooling system components.

3. Dissolve a suitable cleaning agent in water: use non-foaming detergent to clean oil contamination or a cooling system cleaner to clean deposits. Consult your Perkins dealer for suitable product.
4. Run the engine for approximately 30 minutes, leave the engine to cool down, and drain the system.
5. Take a sample of the solution from the system. Allow the sample to sit for at least 30 minutes and check for signs of oil or deposits. If contaminant is still present repeat step 1 to step 4.
6. Flush the system with distilled or deionized water.
7. Fill the system with new coolant.

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Fluid Recommendations (Engine Oil Specification)

General Lubricant Information

Because of government regulations regarding the certification of exhaust emissions from the engine, the lubricant recommendations must be followed.

- API_____American Petroleum Institute
- SAE_____Society Of Automotive Engineers Inc.
- ECF_____Engine Crankcase Fluid

Licensing

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Perkins. For detailed information about this system, see the latest edition of the "API publication No. 1509". Engine oils that bear the API symbol are authorized by API.

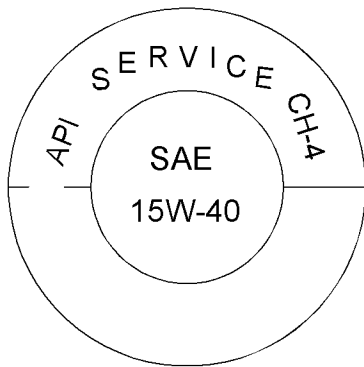


Illustration 20

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Typical API symbol

Terminology

Certain abbreviations follow the nomenclature of "SAE J754". Some classifications follow "SAE J183" abbreviations, and some classifications follow the "EMA Recommended Guideline on Diesel Engine Oil". In addition to Perkins definitions, there are other definitions that will be of assistance in purchasing lubricants. Recommended oil viscosities can be found in this publication, "Fluid Recommendations/ Engine Oil Specification" topic (Maintenance Section).

Engine Oil

Commercial Oils

NOTICE

Perkins require the use of the following specification of engine oil. Failure to use the appropriate specification of engine oil will reduce the life of your engine.

Table 12

Minimum Oil Specification for 1106AA-70T and 1106AA-70TA Industrial Engines	
Minimum Oil specification	API CH-4 ECF 1

Engines Operating on Biodiesel

Refer to this Manual Fluid Recommendations, "Fuel Specification" for the required service interval for operating with Biodiesel.

Engines Operating on High Sulfur Fuel

Refer to this Manual Fluid Recommendations, "Fuel Specification" for the required service interval for operating with high sulfur fuel.

Lubricant Viscosity Recommendations for Direct Injection (DI) Diesel Engines

The correct SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to illustration 21 (minimum temperature) to determine the required oil viscosity for starting a cold engine.

Refer to illustration 21 (maximum temperature) to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

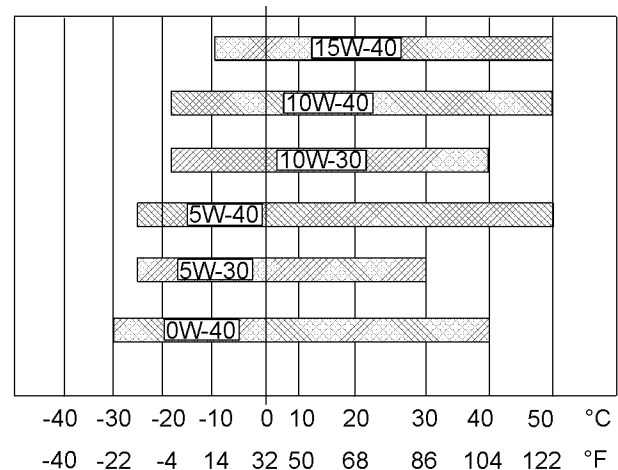


Illustration 21

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Lubricant Viscosities

Supplemental heat is recommended for cold soaked starts below the minimum ambient temperature. Supplemental heat may be required for cold soaked starts that are above the minimum temperature that is stated, depending on the parasitic load and other factors. Cold soaked starts occur when the engine has not been operated for a period of time. This interval will allow the oil to become more viscous due to cooler ambient temperatures.

Aftermarket Oil Additives

Perkins does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives to achieve the engines maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages to help provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance or the compatibility of aftermarket additives in finished oil. Aftermarket additives may not be compatible with the finished oils additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This failure could produce sludge in the crankcase. Perkins discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Perkins engine, conform to the following guidelines:

- See the appropriate “Lubricant Viscosities”. Refer to the illustration 21 to find the correct oil viscosity grade for your engine.
- At the specified interval, service the engine. Use new oil and install a new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, “Maintenance Interval Schedule or Fluid Recommendations Fuel Specification”.

Oil analysis

Some engines may be equipped with an oil sampling valve. If oil analysis is required, the oil sampling valve is used to obtain samples of the engine oil. The oil analysis will complement the preventive maintenance program.

The oil analysis is a diagnostic tool that is used to determine oil performance and component wear rates. Contamination can be identified and measured by using oil analysis. The oil analysis includes the following tests:

- The Wear Rate Analysis monitors the wear of the engines metals. The amount of wear metal and type of wear metal that is in the oil is analyzed. The increase in the rate of engine wear metal in the oil is as important as the quantity of engine wear metal in the oil.
- Tests are conducted to detect contamination of the oil by water, glycol, or fuel.

- The Oil Condition Analysis determines the loss of the oils lubricating properties. An infrared analysis is used to compare the properties of new oil to the properties of the used oil sample. This analysis allows technicians to determine the amount of deterioration of the oil during use. This analysis also allows technicians to verify the performance of the oil according to the specification during the entire oil change interval.

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Fluid Recommendations (Fuel Recommendations)

- **Glossary**
- ISO International Standards Organization
- ASTM American Society for Testing and Materials
- HFRR High Frequency Reciprocating Rig for Lubricity testing of diesel fuels
- FAME Fatty Acid Methyl Esters
- CFR Co-ordinating Fuel Research
- LSD Low Sulfur Diesel
- ULSD Ultra Low Sulfur Diesel
- MEP China’s Ministry of Environmental Protection

General Information

NOTICE

Every attempt is made to provide accurate, up-to-date information. By use of this document you agree that Perkins Engines Company Limited is not responsible for errors or omissions.

NOTICE

These recommendations are subject to change without notice. Contact your local Perkins distributor for the most up-to-date recommendations.

Diesel Fuel Requirements

Satisfactory engine performance depends on the use of a good quality fuel. The use of a good quality fuel will give the following results: long engine life and acceptable exhaust emissions levels. The fuel must meet the minimum requirements that are stated in table 13 .

Maintenance Section
Fuel Recommendations

NOTICE

The footnotes are a key part of Perkins specification requirements for China distillate diesel fuel. Read **ALL** of the footnotes.

Table 13

Specification for China Distillate Diesel Fuel					
Property	UNITS	Requirements	"ASTM Test"	"ISO Test"	"China Test"
Ash	%Weight	0.01% maximum	"D482"	"ISO 6245"	"GB/T 508"
Carbon Residue on 10% Bottoms	%Weight	0.3% maximum	"D524"	"ISO 4262"	"GB/T 268"
Cetane Number (1)	-	45 minimum	"D613" or "D6890"	"ISO 5165"	"GB/T 386"
Cetane index	-	43 minimum	"D4737"	"ISO 4264"	"GB/T 11139"
Cloud Point	°C	The cloud point must not exceed the lowest expected ambient temperature.	"D2500"	"ISO 3015"	"GB/T 510"
Copper Strip Corrosion	-	No. 3 maximum	"D130"	"ISO 2160"	"GB/T 5096"
Distillation	°C	95% at 365° C (689° F) maximum	"D86"	"ISO 3405"	"GB/T 6536"
Density at 15 °C (59 °F) (2)	Kg / m ³	800 minimum and 845 maximum	No equivalent test	"ISO 3675" or "ISO 12185"	"GB/T 1884" or "GB/T 1885"
Flash Point Pensky-Martens	°C	Legal limit	"D93"	"ISO 2719"	"GB/T 261"
Thermal Stability	-	Minimum of 80% reflectance after aging for 180 minutes at 150 °C (302 °F)	"D6468"	No equivalent test	-
Sulfur	mg/kg	350 maximum(3)	"D5453" or "D2622"	"ISO 20846" or "ISO 20884"	"GB/T 380" or "SH/T 0689"
Kinematic Viscosity (4)	mm ² /s (cSt)	The viscosity of the fuel that is delivered to the fuel injection pump. 2 minimum and 4.5 maximum	"ASTM D445"	"ISO 3104"	"GB/T 265"
Water	mg/kg	200 maximum	"D1744"	"ISO 12937"	"GB/T 260"
Gums and Resins (5)	mg/100mL	10 mg per 100 mL maximum	"D381"	"ISO 6246"	
Lubricity corrected-wear scar diameter at 60 °C (140 °F). (6)	mm	0.46 maximum	"D6079"	"ISO 12156-1"	"SH/T 0765"
Fuel cleanliness (7)	-	"ISO 18/16/13"	"D7619"	"ISO 4406"	
Oxidation Stability	g/m ³	Maximum 25	"D2274"	"ISO 12205"	"SH/T 0175"

(1) A fuel with a higher cetane number is recommended to operate at a higher altitude or in cold weather.

(2) Density range allowed includes summer and winter diesel fuel grades and regional variations.

(continued)

(Table 13, contd)

- (3) The level of sulfur is governed by emissions legislations, national, regional, or local regulations can require a fuel with a specific sulfur limit. The sulfur content of the fuel and the fuel quality must comply with all existing local regulations for emissions. LSD fuel with less than 0.035 percent (≤ 350 ppm (mg/kg)) sulfur is strongly recommended for use in these engine models. Diesel fuel with more than 0.035 percent (≥ 350 ppm (mg/kg)) sulfur can be used only where allowed by legislation. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 0.035% may significantly shorten the oil change interval. For additional information, refer to Operation and Maintenance Manual, "Fluid Recommendations (Lubricant Information)".
- (4) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. Fuel should also meet the minimum viscosity requirement and the fuel should meet the maximum viscosity requirements at 40° C (104° F) of either the "ASTM D445" test method, "ISO 3104" test method or the "GB/T 265" test method. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain 2.0 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters to lower the viscosity to 4.5 cSt at the fuel injection pump.
- (5) Follow the test conditions and procedures for gasoline (motor).
- (6) The lubricity of a fuel is a concern with low sulfur and ultra low sulfur fuel. To determine the lubricity of the fuel, use the "ISO 12156-1" or "ASTM D6079" High Frequency Reciprocating Rig (HFRR) test. If the lubricity of a fuel does not meet the minimum requirements, consult your fuel supplier. Do not treat the fuel without consulting the fuel supplier. Some additives are not compatible. These additives can cause problems in the fuel system.
- (7) Recommended cleanliness level for fuel as dispensed into machine or engine fuel tank is "ISO 18/16/13" or cleaner as per "ISO 4406". Refer to the "Contamination Control Recommendations for Fuels" in this chapter.

Note: The owner and the operator of the engine has the responsibility of using the fuel that is prescribed by the China's Ministry of Environmental Protection and other appropriate regulatory agencies.

NOTICE

Operating with fuels that do not meet the Perkins recommendations can cause the following effects: Starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber and reduced service life of the engine.

The specifications that are listed in table 14 , are released as acceptable to use

Table 14

Acceptable Fuel Specification for 1100AA Genset Engines	
Fuel Specification	Description
"GB 19147"	Automobile diesel fuel
"GB 252"	General diesel fuels

Diesel Fuel Characteristics

Cetane Number

Cetane number is a measure of the ignition quality of diesel fuel. Fuel that has a higher cetane number will give a shorter ignition delay and will produce a better ignition quality. Cetane numbers are derived for fuels against proportions of cetane and heptamethylnonane in the standard CFR engine. Refer to "ISO 5165" for the test method.

For these engines minimum recommended cetane number 45. Cetane number affect engine cold start ability, exhaust emissions, combustion noise, and altitude performance. Fuel with higher cetane number is desirable and recommended. Fuel with higher cetane number is of particular importance for operations in cold weather and at high altitude.

Viscosity

Viscosity is the property of a liquid of offering resistance to shear or flow. Viscosity decreases with increasing temperature. This decrease in viscosity follows a logarithmic relationship for normal fossil fuel. The common reference is to kinematic viscosity. Kinematic viscosity is the quotient of the dynamic viscosity that is divided by the density. The determination of kinematic viscosity is normally by readings from gravity flow viscometers at standard temperatures. Refer to "ISO 3104" for the test method.

The viscosity of the fuel is significant because fuel serves as a lubricant for the fuel system components. Fuel must have sufficient viscosity to lubricate the fuel system in both extremely cold temperatures and extremely hot temperatures. If the kinematic viscosity of the fuel is lower than 2 cSt at the fuel injection pump, damage to the fuel injection pump can occur. This damage can be excessive scuffing and seizure. Low viscosity may lead to difficult hot restarting, stalling, and loss of performance. High viscosity may result in seizure of the pump.

Perkins recommends kinematic viscosities of 2 and 4.5 mm²/s that is delivered to the fuel injection pump. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain 2 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters to lower the viscosity to 4.5 cSt at the fuel injection pump.

Density

Density is the mass of the fuel per unit volume at a specific temperature. This parameter has a direct influence on engine performance and a direct influence on emissions. This influence determines the heat output from a given injected volume of fuel. This parameter is quoted in kg/m at 15 °C (59 °F).

Perkins recommends a value of density of 820 kg/m to 845 kg/m to obtain the correct power output. Lighter fuels are acceptable but these fuels will not produce the rated power.

Sulfur

The level of sulfur is governed by emissions legislations. Regional regulation, national regulations, or local regulations can require a fuel with a specific sulfur limit. In China fuel quality and sulfur level can vary significantly across the country, some cities, and regions can require fuels with sulfur levels stricter than the available national standard. The sulfur content of the fuel and the fuel quality must comply with all existing local regulations for emissions.

It is recommended that these engine models use at least fuel that meets China stage 3 or China stage 4 specification.

China stage 3 regulations require use of low sulfur diesel fuel with less than 0.035 percent (350 PPM) (mg/kg) sulfur content.

The lubricity of these fuels must not exceed a wear scar diameter of 0.46 mm (0.01811 inch) as per "ISO 12156-1". Refer to "Lubricity" for more information.

Fuels with sulphur content higher than 0.035 percent (350 PPM) can be only used where allowed by legalization. High sulfur fuel will have a negative impact on emissions of particulates. High sulfur fuels also increase potential for corrosion and wear of internal component and may significantly shorten the oil change interval.

Lubricity

Lubricity is the capability of the fuel to prevent pump wear. The lubricity of the fluid describes the ability of the fluid to reduce the friction between surfaces that are under load. This ability reduces the damage that is caused by friction. Fuel injection systems rely on the lubricating properties of the fuel. Until fuel sulfur limits were mandated, the lubricity of the fuel was believed to be a function of fuel viscosity.

The lubricity has particular significance to the current low viscosity fuel, low sulfur fuel, and low aromatic fossil fuel. These fuels are made to meet stringent exhaust emissions. The lubricity of these fuels must not exceed a wear scar diameter of 0.46 mm (0.01811 inch). The fuel lubricity test must be performed on an HFRR, operated at 60 °C (140 °F). Refer to "ISO 12156-1".

NOTICE

The fuels system has been qualified with fuel having lubricity up to 0.46 mm (0.01811 inch) wear scar diameter as tested by "ISO 12156-1". Fuel with higher wear scar diameter than 0.46 mm (0.01811 inch) will lead to reduced service life and premature failure of the fuel system.

If fuels do not meet specified lubricity requirement, appropriate lubricity additive can be used to enhance the lubricity of the fuel. Contact your fuel supplier in circumstances when fuel additives are required. Your fuel supplier can make recommendations for additives to use and for the correct level of treatment.

Aftermarket Fuel Additives

NOTICE

Perkins does not warrant the quality or performance of non-Perkins fluids and filters. When auxiliary devices, accessories, or consumables (filters, additives) which are made by other manufacturers are used on Perkins products, the Perkins warranty is not affected simply because of such use.

However, failures that result from the installation or use of other manufacturers devices, accessories, or consumables are NOT Perkins defects. Therefore, the defects are NOT covered under the Perkins warranty.

Supplemental diesel fuel additives are not recommended, because of potential damage to the fuel system or the engine. Your fuel supplier or the fuel manufacturer will add the appropriate supplemental diesel fuel additives.

Perkins recognizes the fact that additives may be required in some special circumstances. Use these fuel additives with caution. Contact your fuel supplier in circumstances when fuel additives are required. Your fuel supplier can recommend the appropriate fuel additive and the correct level of treatment.

Note: For the best results, your fuel supplier should treat the fuel when additives are required. The treated fuel must meet the requirements that are stated in table 13 .

Perkins Diesel Fuel System Cleaner

Perkins T400012 Fuel Cleaner is the only fuel cleaner that is recommended by Perkins.

Perkins fuel cleaner will remove deposits that can form in the fuel system with the use of biodiesel and biodiesel blends. These deposits can create a loss of power and engine performance.

Once the fuel cleaner has been added to the fuel, the deposits within the fuel system are removed after 30 hours of engine operation. For maximum results, continue to use the fuel cleaner for up to 80 hours. Perkins fuel cleaner can be used on an on-going basis with no adverse impact on engine or fuel system durability.

Detailed instructions on the rate of which the fuel cleaner is to be used, are on the container.

Contamination Control Recommendations for Fuels

Fuels of "ISO 18/16/13" cleanliness level or cleaner as dispensed into the engine or application fuel tank should be used. This action will reduce risk of power loss, fuel system failures, and related down time of engines. This cleanliness level is important for new fuel system designs such as common rail injection systems and unit injectors. These fuels systems utilize higher fuel injection pressures and have tight clearances between moving parts to meet required stringent emissions regulations. Peak injection pressures in current fuel injection systems may exceed 2000 bar (29000 psi). Clearances in these systems are less than 5 µm. As a result, particle contaminants as small as 4 µm can cause scoring and scratching of internal pump and injector surfaces and of injector nozzle.

Water in the fuel causes cavitation, corrosion of fuel system parts, and provides an environment where microbial growth in the fuel can flourish. Other sources of fuel contamination are soaps, gels, or other compounds that may result from undesirable chemical interactions in the fuels, particularly in ULSD. Gels and other compounds can also form in biodiesel fuel at low temperatures or if biodiesel is stored for extended periods. The best indication of microbial contamination, fuel additives, or cold temperature gel is rapid filter plugging of bulk fuel filters or application fuel filters.

To reduce downtime due to contamination, follow these fuel maintenance guidelines.

- Use high-quality fuels per recommended and required specifications
- Fill fuel tanks with fuels of "ISO 18/16/13" cleanliness level or cleaner, in particular for engines with common rail and unit injection systems. When you refuel the tank, filter the fuel through a 4 µm absolute filter (Beta 4 = 75 up to 200) to reach the recommended cleanliness level. This filtration should be at the device that dispenses the fuel to the fuel tank. In addition, filtration at the dispensing point should remove water to ensure that fuel is dispensed at 200 ppm water or less.
- Perkins recommends the use of bulk fuel filter / coalescer units which clean the fuel of both particulate contamination and water in a single pass.
- Ensure that you use Perkins Advanced Efficiency Fuel Filters. Change your fuel filters per recommended service requirements or as needed.
- Drain your water separators daily .
- Drain your fuel tanks of sediment and water. Refer to Operation and Maintenance Manual, Fuel Tank Water and Sediment - Drain for instructions.
- Install and maintain a properly designed bulk filter / coalescer filtration system. Continuous bulk filtration systems may be required to ensure that dispensed fuel meets the cleanliness target. Consult your Perkins distributor for availability of bulk filtration products.
- Centrifugal filters may need to be used as a pre-filter with fuel that is severely contaminated with gross amounts of water and/or large particulate contaminants. Centrifugal filters can effectively remove large contaminants, but may not be able to remove the small abrasive particles required to achieve the recommended "ISO" cleanliness level. Bulk filter / coalescers are necessary as a final filter to achieve the recommended cleanliness level.
- Install desiccant type breathers of 4 µm or less absolute efficiency with the ability to remove water on bulk storage tanks.
- Follow proper practices of fuel transportation. Filtration from the storage tank to the application promotes the delivery of clean fuel. Fuel filtration can be installed at each transport stage to keep the fuel clean.
- Cover, protect, and ensure cleanliness of all connection hoses, fittings, and dispensing nozzles.

Consult your local Perkins distributor for additional information on Perkins designed and produced filtration products.

Maintenance Recommendations

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Severe Service Application

Severe service is the application of an engine that exceeds the current published standards for that engine. Perkins maintains standards for the following engine parameters:

- Performance such as power range, speed range, and fuel consumption
- Fuel quality
- Operational Altitude
- Maintenance intervals
- Oil selection and maintenance
- Coolant type and maintenance
- Environmental qualities
- Installation
- The temperature of the fluid in the engine

Refer to the standards for the engine or consult your Perkins dealer or your Perkins distributor in order to determine if the engine is operating within the defined parameters.

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Perkins dealer or your Perkins distributor for the unique maintenance that is necessary for the engine.

The operating environment, incorrect operating procedures, and incorrect maintenance procedures can be factors which contribute to a severe service application.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in cold temperatures. Hot intake air reduces engine performance.

Quality of the air – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt, and dust can encase components. Maintenance can be difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals, and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Incorrect Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Incorrect Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants, and coolant/antifreeze

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Maintenance Interval Schedule

When Required

- “ Battery - Replace” 51
- “ Battery or Battery Cable - Disconnect” 52
- “ Engine - Clean” 57
- “ Engine Air Cleaner Element - Replace” 58
- “ Engine Oil Sample - Obtain” 61
- “ Fuel System - Prime” 69

Daily

- “ Cooling System Coolant Level - Check” 56
- “ Driven Equipment - Check” 57
- “ Engine Air Cleaner Service Indicator - Inspect” .. 59
- “ Engine Air Precleaner - Check/Clean” 59
- “ Engine Oil Level - Check” 60
- “ Fuel System Primary Filter/Water Separator - Drain” 72
- “Walk-Around Inspection” 76

Every Week

- “ Hoses and Clamps - Inspect/Replace” 74

Every 50 Service Hours or Weekly

- “ Fuel Tank Water and Sediment - Drain” 73

Every 100 Service Hours

- “ Fuel Control Linkage - Check/Lubricate” 64

Every 250 Service Hours

- “ Engine Oil and Filter - Change” 61
- “ Fuel Inlet Screen - Clean/Inspect/Replace” 67

- “ Fuel System Primary Filter (Water Separator) Element - Replace” 70

Every 300 Service Hours

- “ Fuel Control Linkage - Check/Lubricate” 64

Initial 500 Service Hours

- “ Engine Valve Lash - Check” 63

Every 500 Service Hours

- “ Alternator and Fan Belts - Inspect/Adjust/Replace” 50
- “ Fan Clearance - Check” 63

Every 500 Service Hours or 1 Year

- “ Battery Electrolyte Level - Check” 51
- “ Engine Air Cleaner Element - Replace” 58
- “ Engine Ground - Inspect/Clean” 59
- “ Radiator - Clean” 75

Every 6 Months

- “ Fuel Control Linkage - Check/Lubricate” 64

Every 1000 Service Hours

- “ Engine Valve Lash - Check” 63
- “ Water Pump - Inspect” 77

Every 2000 Service Hours

- “ Aftercooler Core - Inspect” 49
- “ Alternator - Inspect” 50
- “ Engine Mounts - Inspect” 60
- “ Starting Motor - Inspect” 75

“ Turbocharger - Inspect” 75

Every 3000 Service Hours

“ Fuel Injector - Test/Change” 66

Every 3000 Service Hours or 2 Years

“ Cooling System Coolant (Commercial Heavy-Duty)
- Change” 52

Every 4000 Service Hours

“ Aftercooler Core - Clean/Test” 49

Every 6000 Service Hours or 3 Years

“ Cooling System Coolant (ELC) - Change” 54

Commissioning

“ Fan Clearance - Check” 63

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Aftercooler Core - Clean/Test

1. Remove the core. Refer to the OEM information for the correct procedure.
2. Turn the aftercooler core upside-down in order to remove debris.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

3. Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.
4. Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

5. Back flush the core with a suitable cleaner.
6. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.
7. Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

8. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
9. Inspect the core in order to ensure cleanliness. Pressure test the core. If necessary, repair the core.
10. Install the core. Refer to the OEM information for the correct procedure.
11. After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

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Aftercooler Core - Inspect

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb".

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

Inspect these items for good condition: Welds, mounting brackets, air lines, connections, clamps and seals. Make repairs, if necessary.

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Alternator - Inspect

Perkins recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and correct battery charging. Check the ammeter (if equipped) during engine operation in order to ensure correct battery performance and/or correct performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for correct operation. If the batteries are correctly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

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Alternator and Fan Belts - Inspect/Adjust/Replace

Inspection

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

To check accurately the belt tension, a suitable gauge should be used.

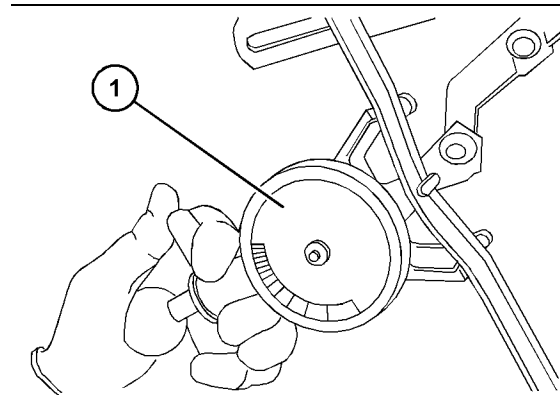


Illustration 22

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Typical example

(1) Burroughs Gauge

Fit the gauge (1) at the center of the longest free length and check the tension. The correct tension is 535 N (120 lb). If the tension of the belt is below 250 N (56 lb), adjust the belt to 535 N (120 lb).

If twin belts are installed, check and adjust the tension on both belts.

Adjustment

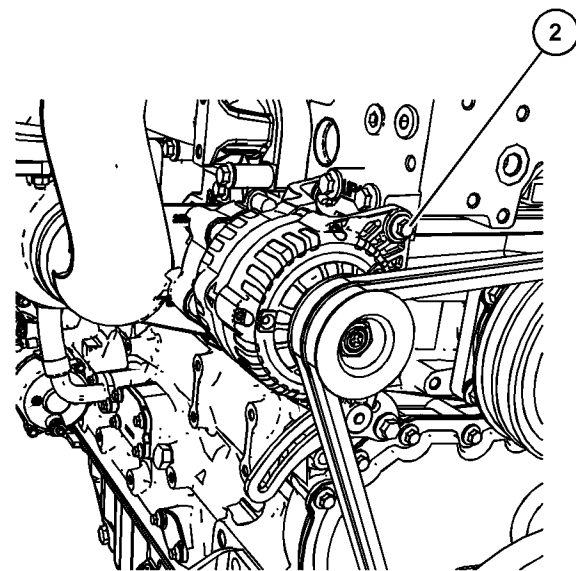


Illustration 23

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1. Loosen the alternator pivot bolt (2).

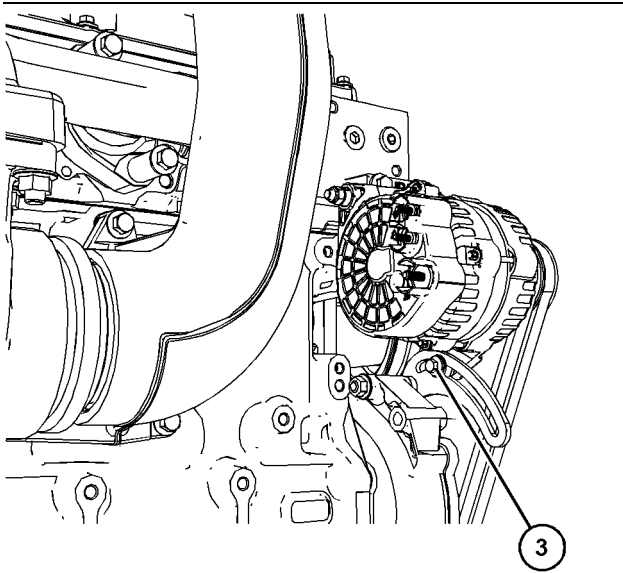


Illustration 24

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- Loosen the link bolt (3). Move the alternator to increase or decrease the belt tension. Tighten the alternator link bolt (3) and the pivot bolt (2) to 22 N·m (16 lb ft).

Replacement

Refer to the Disassembly and Assembly Manual for the installation procedure and the removal procedure for the belt.

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Battery - Replace

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

- Switch the engine to the OFF position. Remove all electrical loads.

Note: After the engine has stopped, allow 2 minutes in order for the diesel exhaust fluid lines to be purged before disconnecting the power.

- Turn off any battery chargers. Disconnect any battery chargers.
- Ensure that the battery disconnect switch is in the OFF position.
- Disconnect the NEGATIVE “-” cable from the NEGATIVE “-” battery terminal.
- Disconnect the POSITIVE “+” cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Dispose of used batteries to an appropriate recycling facility.

- Remove the used battery.
- Install the new battery.

Note: Before the cables are connected, ensure that the battery disconnect switch is in the OFF position.

- Connect the POSITIVE “+” cable to the POSITIVE “+” battery terminal.
- Connect the NEGATIVE “-” cable to the NEGATIVE “-” battery terminal.
- Turn the battery disconnect switch to the ON position.

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Battery Electrolyte Level - Check

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are correctly charged, the ammeter reading should be very near zero, when the engine is in operation.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the "FULL" mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with a suitable battery tester.
3. Install the caps.
4. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- Use a solution of 0.1 kg (0.2 lb) baking soda and 1 L (1 qt) of clean water.
- Use a solution of ammonium hydroxide.

Thoroughly rinse the battery case with clean water.

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Battery or Battery Cable - Disconnect

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, two negative connection must be disconnected.
3. Remove the positive connection.

4. Clean all disconnected connection and battery terminals.
5. Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit correctly. Coat the clamps and the terminals with a suitable silicone lubricant or petroleum jelly.
6. Tape the cable connections to help prevent accidental starting.
7. Proceed with necessary system repairs.
8. To connect the battery, connect the positive connection before the negative connection.

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Cooling System Coolant (Commercial Heavy-Duty) - Change

Note: This procedure is for coolants that meets a commercial heavy-duty coolant specification of "ASTM D6210" .

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

NOTICE

When any servicing or repair of the engine cooling system is performed, the procedure must be performed with the engine on level ground. Level ground will allow you to check accurately the coolant level. This procedure will also help in avoiding the risk of introducing an air lock into the coolant system.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This inspection is a good opportunity to replace the water pump, the water temperature regulator, and the hoses, if necessary.

Drain

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap.

Note: Refer to Operation and Maintenance Manual, "General Hazard Information" for information on Containing Fluid Spillage.

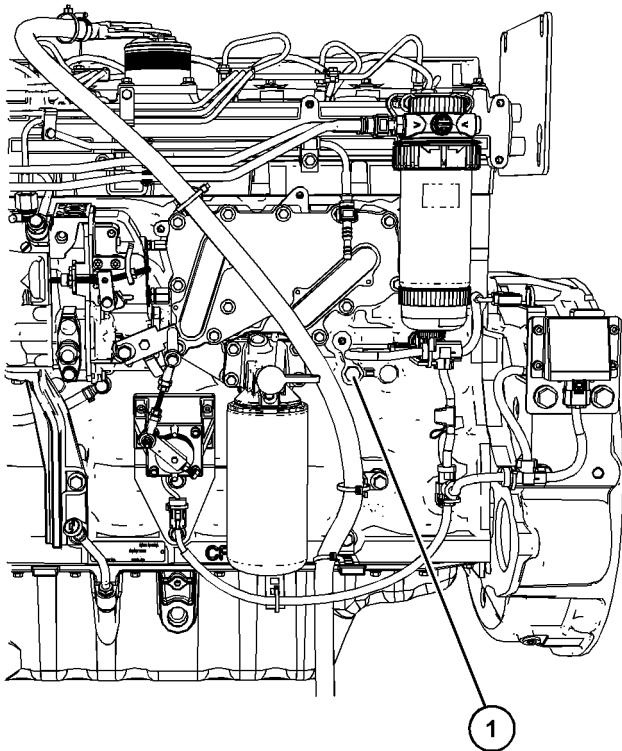


Illustration 25

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Cylinder block coolant drain plug location

2. Remove drain plug (1) on the engine. Open the drain cock or remove the drain plug on the radiator.

Allow the coolant to drain into a suitable container.

3. Properly dispose of the drained material. Obey local regulations for the disposal of the material.

Flush

NOTICE

Cleaning agents for an industrial cooling system must not be used. These cleaning agents are very aggressive and cause damage to the cooling system components.

1. Flush the cooling system with clean water and a suitable cleaning agent to remove any debris. Refer to your Perkins dealer or distributor for suitable cleaning agents.
2. Clean the drain plugs. Install the drain plugs. Tighten drain plug securely.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with clean water and install the cooling system filler cap.
4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap. Remove the connection hose or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Install the connection hose.

6. Install the drain plugs and tighten securely.

Fill

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

1. Fill the cooling system with the coolant/antifreeze. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to high idle. Operate the engine to open the engine thermostat. This operation will allow any air in the system to be purged. Decrease the engine speed to low idle. Stop the engine.
3. Maintain the coolant level at the maximum mark that is correct for your application.
4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for the correct operating temperature.

i07766761

Cooling System Coolant (ELC) - Change

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: Use non-foaming detergent to clean oil or fuel contamination.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. Replace the water pump, the water temperature regulator, and the hoses, if necessary.

NOTICE

Service or repair of the engine cooling system must be performed on level ground. The engine must be level to check the coolant level. The engine must be level to avoid the risk of introducing an air lock into the coolant system.

Drain

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap.

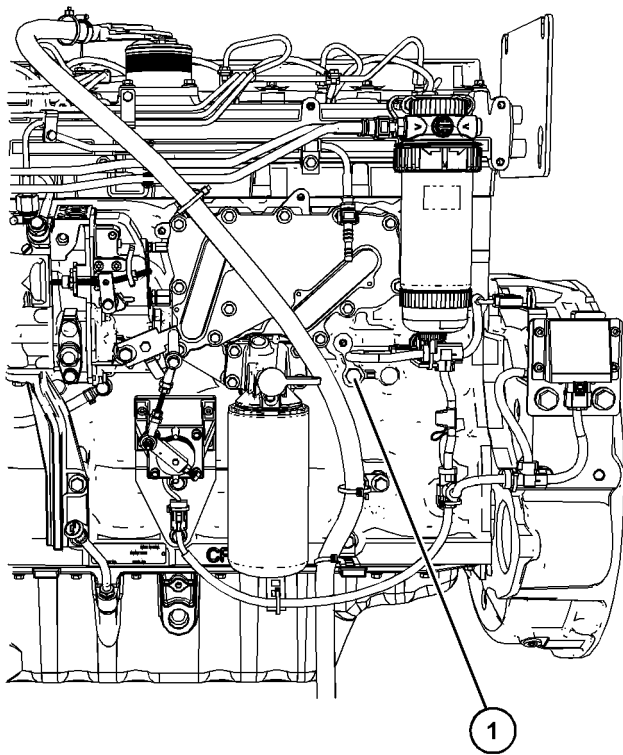


Illustration 26

g06428346

Cylinder block coolant drain plug

2. Remove drain plug (1) on the engine. Open the drain cock or remove the drain plug on the radiator and allow the coolant to drain.

For information regarding the disposal and the recycling of used coolant, consult your Perkins dealer or Perkins distributor.

Flush**NOTICE**

Cleaning agents for an industrial cooling system must not be used. These cleaning agents are very aggressive and cause damage to the cooling system components.

1. Flush the cooling system with distilled or deionized water to remove any debris.
2. Install the connection hose. Clean the drain plugs and install the drain plugs. Tighten the drain plugs securely.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with distilled or deionized water. Install the cooling system filler cap.
4. Start and run the engine at low idle until the temperature reaches 50° to 70°C (122° to 158°F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap. Remove the connection hose and remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Install the connection hose.
6. Install the drain plugs and securely.

Fill**NOTICE**

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to this Operation and Maintenance Manual, "Refill Capacities" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to high idle. Operate the engine to open the engine thermostat. An open thermostat will allow any air in the system to be purged. Decrease the engine speed to low idle. Stop the engine.
3. Maintain the coolant level at the maximum mark that is correct for your application.

- Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
- Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i04408743

Cooling System Coolant Level - Check

Engines With a Coolant Recovery Tank

Note: The cooling system may not have been provided by Perkins. The procedure that follows is for typical cooling systems. Refer to the OEM information for the correct procedures.

Check the coolant level when the engine is stopped and cool.

NOTICE

When any servicing or repair of the engine cooling system is performed, the procedure must be performed with the engine on level ground. This will allow you to accurately check the coolant level. This will also help in avoiding the risk of introducing an air lock into the coolant system.

- Observe the coolant level in the coolant recovery tank. Maintain the coolant level to "COLD FULL" mark on the coolant recovery tank.

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

- Loosen filler cap slowly in order to relieve any pressure. Remove the filler cap.

- Pour the correct coolant mixture into the tank. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" for information on the correct mixture and type of coolant. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" for the cooling system capacity. Do not fill the coolant recovery tank above "COLD FULL" mark.

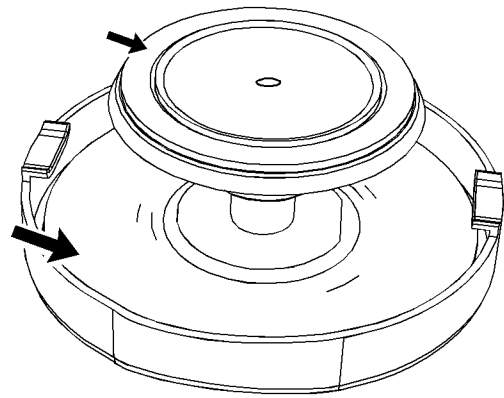


Illustration 27

g02590196

Filler cap

- Clean filler cap and the receptacle. Reinstall the filler cap and inspect the cooling system for leaks.

Note: The coolant will expand as the coolant heats up during normal engine operation. The additional volume will be forced into the coolant recovery tank during engine operation. When the engine is stopped and cool, the coolant will return to the engine.

Engines Without a Coolant Recovery Tank

Check the coolant level when the engine is stopped and cool.

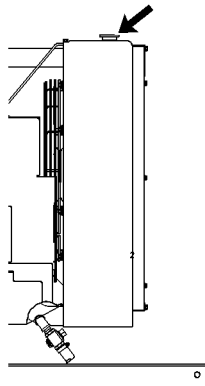


Illustration 28

g00285520

Cooling system filler cap

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level at the maximum mark that is correct for your application. If the engine is equipped with a sight glass, maintain the coolant level to the correct level in the sight glass.
3. Clean the cooling system filler cap and inspect the gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a suitable pressurizing pump in order to pressure test the filler cap. The correct pressure is stamped on the face of the filler cap. If the filler cap does not retain the correct pressure, install a new filler cap.
4. Inspect the cooling system for leaks.

i02151646

Driven Equipment - Check

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication

- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i07766787

Engine - Clean

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE" .

NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

NOTICE

Failure to protect some engine components from washing may make your engine warranty invalid. Allow the engine to cool for one hour before washing the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used to prevent electrical components from being damaged by excessive water when the engine is cleaned. Do not direct the flow of water from pressure washers or steam cleaners at any electrical connectors or the junction of cables. Avoid electrical components such as the alternator and the starter motor. Protect the fuel injection pump from fluids when washing the engine.

i07091086

Engine Air Cleaner Element - Replace

NOTICE

Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

NOTICE

Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

Note: The air filter system may not have been provided by Perkins. The procedure that follows is for a typical air filter system. Refer to the OEM information for the correct procedure.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Refer to the OEM information for the correct air cleaner elements for your application.

- Check the precleaner (if equipped) and the dust bowl daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating in dirty conditions may require more frequent service of the air cleaner element.
- The air cleaner element should be replaced at least one time per year.

Replace the dirty air cleaner elements with clean air cleaner elements. Before installation, the new air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Air Cleaners

Some application can have dual elements. The dual air cleaner contains a primary air cleaner element and a secondary air cleaner element. Both element must be replaced at the same time.

Do not replace the air cleaner filter elements in a dirty environment, as dirt can enter the air system when the elements are removed.

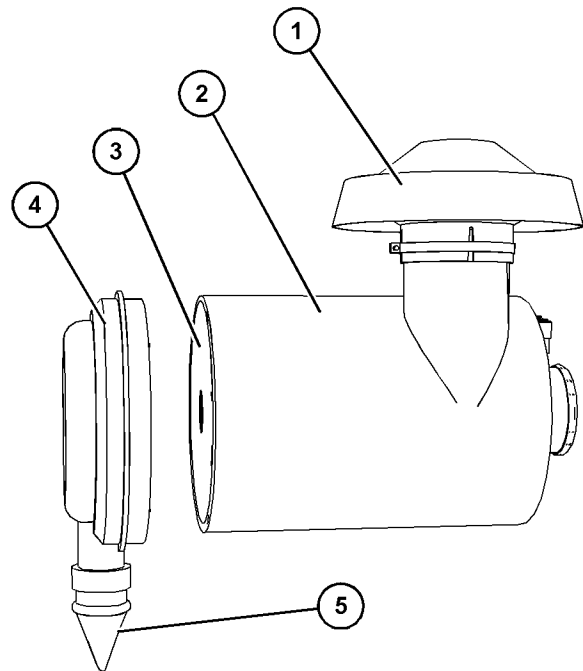


Illustration 29

g06217098

Typical example

1. Ensure that the outer body of the air cleaner to be serviced is clean and free from dirt.
2. Inspect the top cover (1) and if necessary remove top cover to clean cover. Ensure that dirt cannot enter the air cleaner system with top cover removed. If necessary, clean top cover and install.
3. Remove end cover (4) from air cleaner body (2). If necessary, clean end cover and ensure that the valve (5) is clean and free from dirt. Check the valve (5) for wear or damage, replace if necessary.
4. Remove primary air filter element (3) and if equipped, remove the secondary air filter element (Not Shown). Discard all old air filter elements.
5. If equipped, install new secondary air filter element (Not Shown) and install new primary air filter element (3).

6. Install end cover (4) to air cleaner body (2) and secure end cover. If necessary, reset the air service indicator, refer to this Operation and Maintenance Manual, Engine Air Cleaner Service Indicator - Inspect for more information.

i02335405

Engine Air Cleaner Service Indicator - Inspect

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.

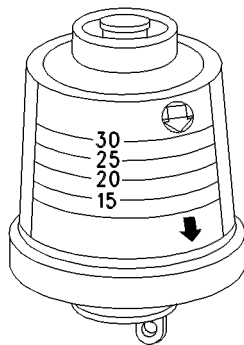


Illustration 30

g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.

- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be restricted.

The service indicator may need to be replaced frequently in environments that are severely dusty.

i07819526

Engine Air Precleaner - Check/Clean

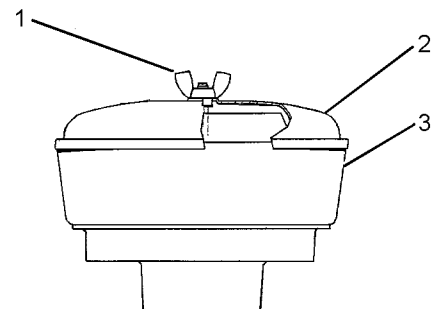


Illustration 31

g01453058

Typical engine air precleaner

- (1) Wing nut
- (2) Cover
- (3) Body

Remove wing nut (1) and cover (2). Check for an accumulation of dirt and debris in body (3). Clean the body, if necessary.

After cleaning the precleaner, install cover (2) and wing nut (1).

Note: When the engine is operated in dusty conditions, more frequent cleaning is required.

Do not tap or strike the air cleaner element.

i01941505

Engine Ground - Inspect/Clean

Inspect the wiring harness for good connections.

Perkins use the starter motor in order to ground the engine. Check the connection on the starter motor at every oil change. Ground wires and straps should be combined at engine grounds. All grounds should be tight and free of corrosion.

- Clean the grounding stud on the starter motor and the terminals with a clean cloth.
- If the connections are corroded, clean the connections with a solution of baking soda and water.
- Keep the grounding stud and the strap clean and coated with suitable grease or petroleum jelly.

i07819538

Engine Mounts - Inspect

Note: The engine mounts may not have been supplied by Perkins. Refer to the Original Equipment Manufacturer (OEM) information for further details on the engine mounts and the correct bolt torque.

Inspect the engine mounts for deterioration and for correct bolt torque. Excessive engine vibration can be caused by the following conditions:

- Incorrect mounting of the engine
- Deterioration of the engine mounts
- Loose engine mounts

Any engine mount that shows deterioration should be replaced. Refer to the OEM information for the recommended torques.

When the engine mounts are supplied by Perkins the maintenance procedure will be supplied in the Disassembly and Assembly manual for your engine.

i05909059

Engine Oil Level - Check

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

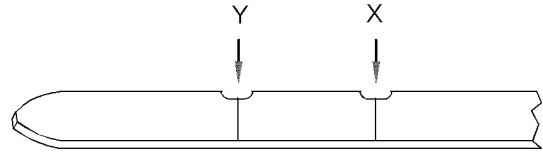


Illustration 32

g01165836

(Y) "Min" mark. (X) "Max" mark.



Illustration 33

g02173847

(L) "Min" mark. (H) "Max" mark.

NOTICE

Perform this maintenance with the engine stopped.

Note: Ensure that the engine is either level or that the engine is in the normal operating position in order to obtain a true level indication.

Note: After the engine has been switched OFF, wait for 10 minutes in order to allow the engine oil to drain to the oil pan. Then, check the oil level.

1. Maintain the oil level between the "ADD" mark (Y) and the "FULL" mark (X) on the engine oil dipstick. Or maintain the engine oil level between the H and L mark. Do not over fill the crankcase.

NOTICE

Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

- Remove the oil filler cap and add oil, if necessary.
Clean the oil filler cap. Install the oil filler cap.

i02202699

Engine Oil Sample - Obtain

The condition of the engine lubricating oil may be checked at regular intervals as part of a preventive maintenance program. Perkins include an oil sampling valve as an option. The oil sampling valve (if equipped) is included in order to regularly sample the engine lubricating oil. The oil sampling valve is positioned on the oil filter head or the oil sampling valve is positioned on the cylinder block.

Perkins recommends using a sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when a sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

Obtain the Sample and the Analysis

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

In order to help obtain the most accurate analysis, record the following information before an oil sample is taken:

- The date of the sample
- Engine model
- Engine number
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

Ensure that the container for the sample is clean and dry. Also ensure that the container for the sample is clearly labelled.

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

The sample can be checked for the following: the quality of the oil, the existence of any coolant in the oil, the existence of any ferrous metal particles in the oil and the existence of any nonferrous metal particles in the oil.

i04150473

Engine Oil and Filter - Change

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Do not drain the engine lubricating oil when the engine is cold. As the engine lubricating oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with draining cold oil. Drain the oil pan with the engine stopped. Drain the oil pan with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Drain the Engine Lubricating Oil

Note: Ensure that the vessel that will be used is large enough to collect the waste oil.

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine oil pan:

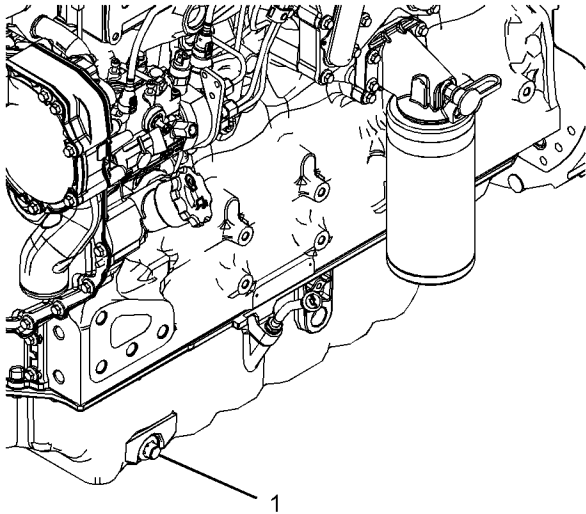


Illustration 34

g02343856

Typical example

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug (1) in order to allow the oil to drain. If the engine is equipped with a shallow oil pan, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed. If necessary, replace the O ring seal. Tighten the drain plug to 34 N·m (25 lb ft).

Replace the Oil Filter

NOTICE

Perkins oil filters are manufactured to Perkins specifications. Use of an oil filter that is not recommended by Perkins could result in severe damage to the engine bearings, or crankshaft, as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Perkins.

1. Remove the oil filter with a suitable tool.

Note: The following actions can be carried out as part of the preventive maintenance program.

2. Cut the oil filter open with a suitable tool. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts, or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings and turbocharger bearings.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter.

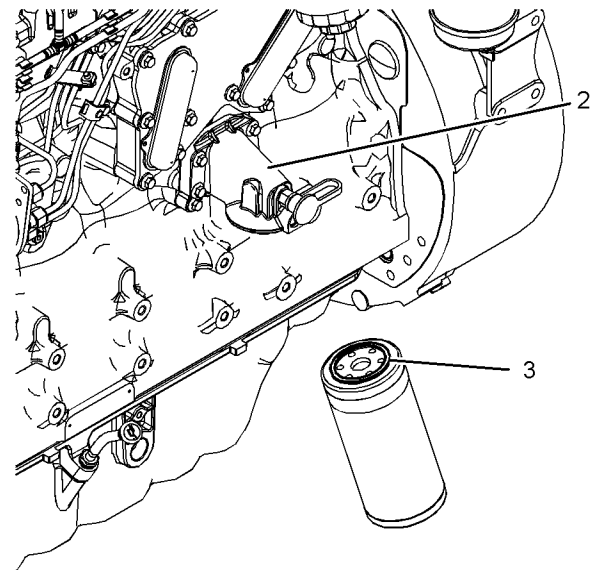


Illustration 35

g02343857

Typical example

3. Clean sealing surface of the oil filter base (2).
4. Apply clean engine oil to O ring seal (3) for the new oil filter.

NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the new oil filter. Spin on the oil filter until the O ring contacts the sealing surface (2). Then rotate the oil filter $\frac{3}{4}$ of a full turn.

Fill the Oil Pan

1. Remove the oil filler cap. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information on suitable oils. Fill the oil pan with the correct amount of new engine lubricating oil. Refer to this Operation and Maintenance Manual, "Refill Capacities" for more information on refill capacities.

NOTICE

If equipped with an auxiliary oil filter system or a remote filter system, follow the OEM or the filter manufacturer's recommendations. Under filling or over filling the crankcase with oil can cause engine damage.

2. Start the engine and run the engine at "LOW IDLE" for 2 minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
3. Stop the engine and allow the oil to drain back to the oil pan for a minimum of 10 minutes.

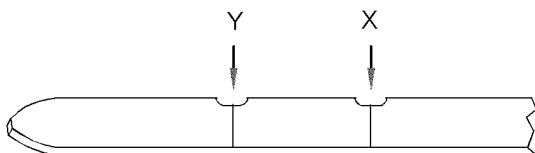


Illustration 36

g01165836

(Y) "Min" mark. (X) "Max" mark.

4. Remove the engine oil level gauge in order to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the engine oil level gauge.

i04243870

Engine Valve Lash - Check

This maintenance is recommended by Perkins as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

NOTICE

Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your authorized Perkins dealer or your Perkins distributor for the complete valve lash adjustment procedure.

Operation of Perkins engines with incorrect valve lash can reduce engine efficiency, and also reduce engine component life.

WARNING

Ensure that the engine cannot be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. The engine valve lash can be inspected and adjusted when the temperature of the engine is hot or cold.

Refer to Systems Operation, Testing, and Adjusting, "Engine Valve Lash - Inspect/Adjust" for more information.

i04145852

Fan Clearance - Check

There are different types of cooling systems. Refer to the OEM for information on clearance for the fan.

Ensure that the engine is stopped. Ensure that the cooling system is full. The clearance between the cover (1) and the fan (2) will require checking. The gap (A) between the edge of the cover and the tip of the fan blade must be checked in four equally spaced positions.

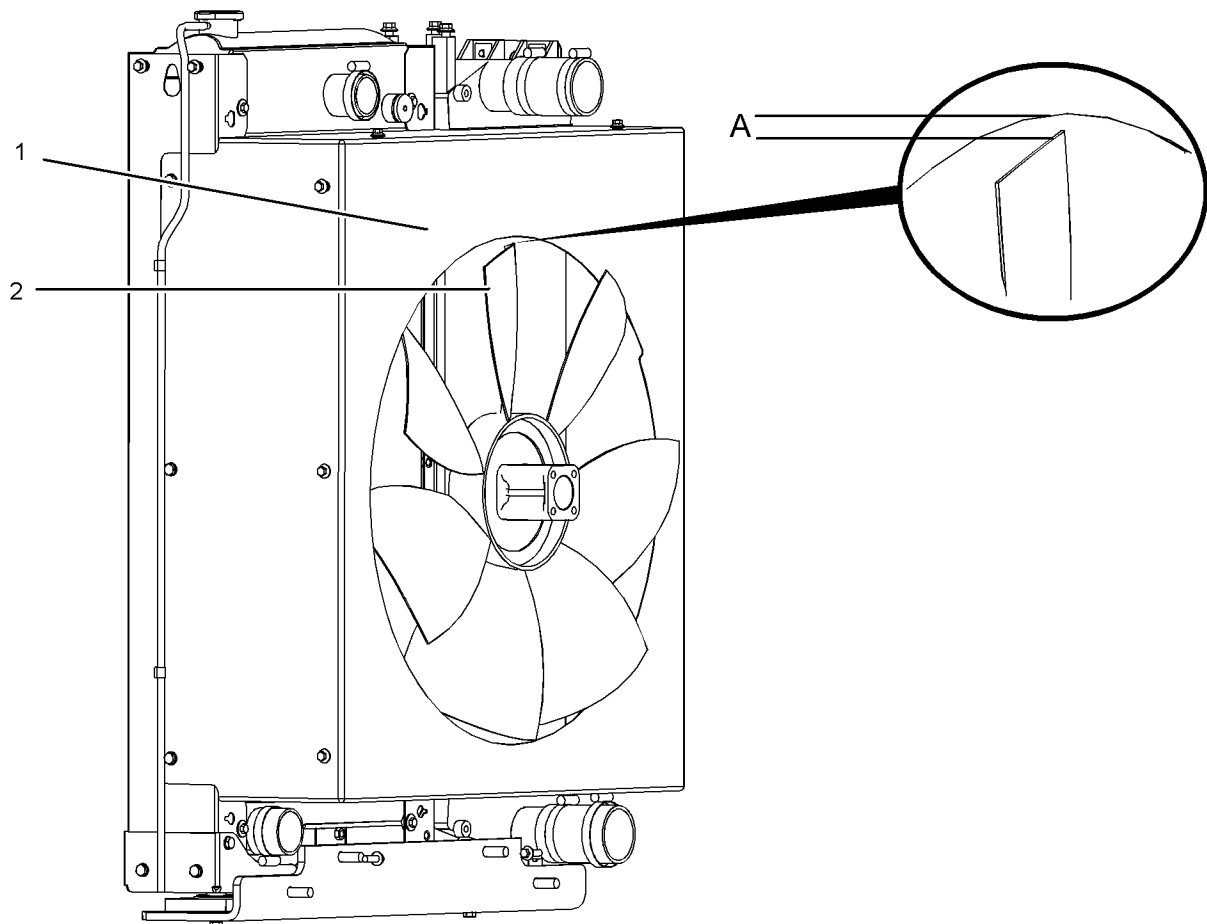


Illustration 37

g01348394

Typical example

Adjustment of the cover will change the clearance (gap) between the edge of the cover and the tip of the fan blade. Ensure that the cover is centralized to the fan.

The maximum clearance is 15 mm (0.591 inch). The minimum clearance is 10 mm (0.394 inch).

i07766418

Fuel Control Linkage - Check/Lubricate

Do not work on the engine unless the instructions and warnings are understood. Refer to the safety section in this Operation and Maintenance Manual for more information.

Perkins recommends a scheduled inspection of the fuel control linkage for the fuel injection pump for loose components and free movement of the linkage. The fuel control linkage for the fuel injection pump and solenoid ball joint plunger is lubricated at defined intervals.

To maximize the engine performance, check the fuel control linkage for wear, secure installation, and unrestricted movement of the mechanism. Ensure that the fuel control linkage is sufficiently lubricated.

Check

WARNING

Accidental engine starting can cause injury or death to personnel working on the equipment.

To avoid accidental engine starting, disconnect the battery cable from the negative (-) battery terminal. Completely tape all metal surfaces of the disconnected battery cable end in order to prevent contact with other metal surfaces which could activate the engine electrical system.

Place a Do Not Operate tag at the Start/Stop switch location to inform personnel that the equipment is being worked on.

At a service interval of every 100 hours, perform the following procedure:

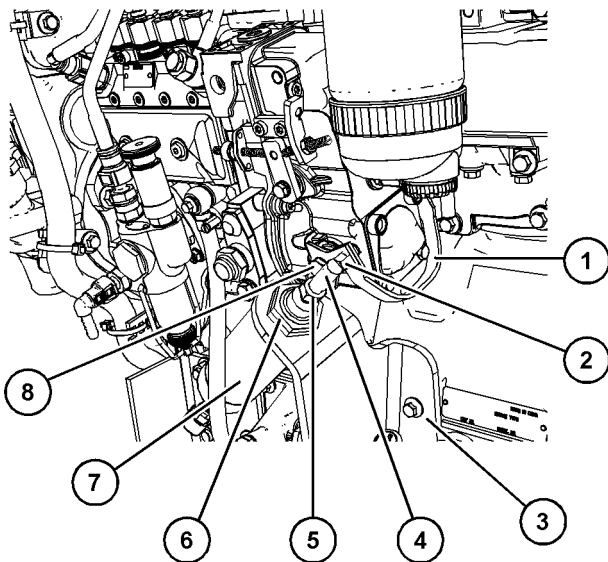


Illustration 38

g06428411

Typical example

1. Check the fuel control linkage for correct operation by gently pulling and pushing the stop lever (1) on the fuel injection pump.
2. Check the stop lever bracket retaining bolts (8) are securely tightened.
3. Check the solenoid ball joint stud (2) is securely attached to the stop lever (1) on the fuel injection pump.
4. Check that the nut (5) is secure. If necessary hand tighten the nut.
5. Check that the solenoid locking nuts (6) are securely hand-tightened.

6. Check that the solenoid attachment bracket (3) is not damaged and is securely tightened to the engine block.

Lubricate with Grease

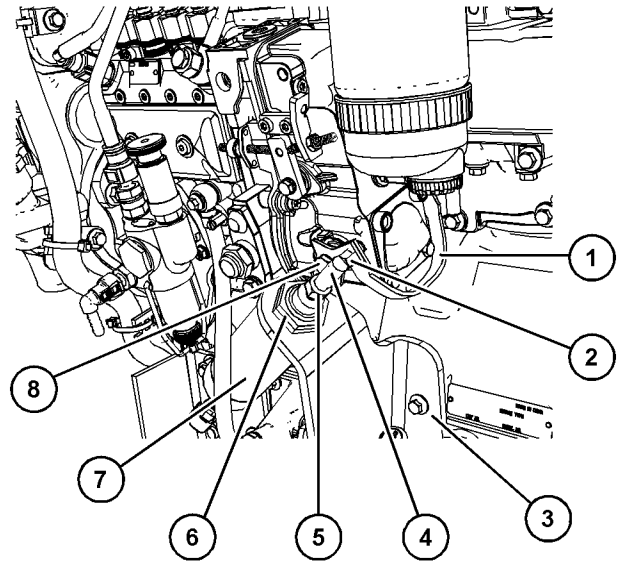


Illustration 39

g06428411

Typical example

The stop lever on the fuel injection pump and the actuating mechanism on the solenoid (7) needs to be lubricated at specific intervals.

Lubricate the stop lever attachment points (8) on the fuel injection pump with suitable grease at a service interval of every 300 hours.

Lubricate the solenoid ball joint stud (2) with suitable grease at a service interval of every 6 months.

Lubricate with Engine Oil

The stop lever on the fuel injection pump and the actuating mechanism on the solenoid needs to be lubricated at specific intervals.

Lubricate the solenoid ball joint plunger (4) and plunger seal with clean engine oil at a service interval of every 6 months.

i07754449

Fuel Injector - Test/Change

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

NOTICE

If a fuel injector is suspected of operating outside of normal parameters it should be removed by a qualified technician. The suspect fuel injector should be taken to an authorised agent for inspection.

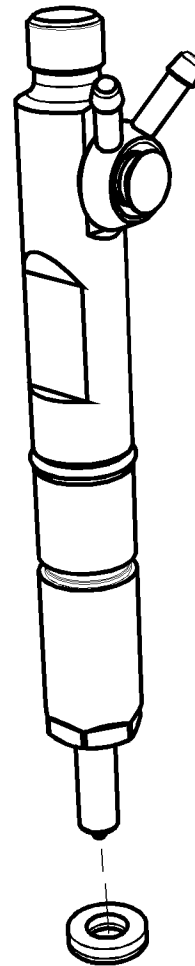


Illustration 40

g06421506

Typical example of a fuel injector

The fuel injector will need to be removed and the injector will need to be checked for performance.

Do not clean the fuel injectors, as cleaning with incorrect tools can damage the nozzle. The fuel injectors should be renewed only if a fault with the fuel injectors occurs. Some of the problems that may indicate that new fuel injectors are needed are listed below:

- The engine will not start or the engine is difficult to start.
- Not enough power
- The engine misfires or the engine runs erratically.
- High fuel consumption
- Black exhaust smoke
- The engine knocks or there is vibration in the engine.
- Excessive engine temperature

Removal and Installation of the Fuel Injectors

WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

WARNING

Make sure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

NOTICE

If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.

Operate the engine at a fast idle speed to identify the faulty fuel injector. Individually loosen and tighten the union nut for the high-pressure pipe to each fuel injector. Do not loosen the union nut more than half a turn. There will be little effect on the engine speed when the union nut to the faulty fuel injection nozzle is loosened. Refer to the Disassembly and Assembly Manual for more information. Consult your authorized Perkins dealer or your Perkins distributor for assistance.

i07777086

Fuel Inlet Screen - Clean/Inspect/Replace

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

Before starting this procedure, the Fuel Injection Pump (FIP) driveshaft should be locked by reversing the lock pin. Refer to the Disassembly and Assembly, "Fuel Injection Pump - Remove" for more information.

Turn the valves for the fuel lines (if equipped) to the OFF position before performing this maintenance. Place a tray under the fuel injection pump to catch any fuel that might spill. Clean up any spilled fuel immediately.

Recommendations are that the screen is replaced along with rubber gasket at every (500 hours) scheduled fuel filter replacement. Inspection can be done to check on the accumulation of particles in the aluminum bowl to determine if the screen needs to be changed and the interval frequency. The screen can be cleaned using diesel fuel / air from inside out. Ensure that the diesel fuel used, meets the required specification. Refer to the Operation and Maintenance Manual, "Fluid Recommendations" for more information.

Screen - Remove

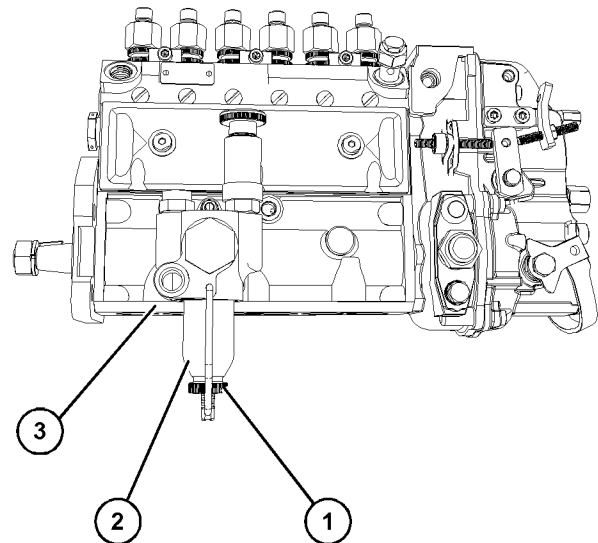


Illustration 41

g06433721

Typical example of a fuel injection pump

1. Clean the outside body of the screen assembly.
2. Using a suitable wrench, turn the knurled nut (1) anticlockwise until the aluminum bowl (2) separates from the fuel injection pump body (3).

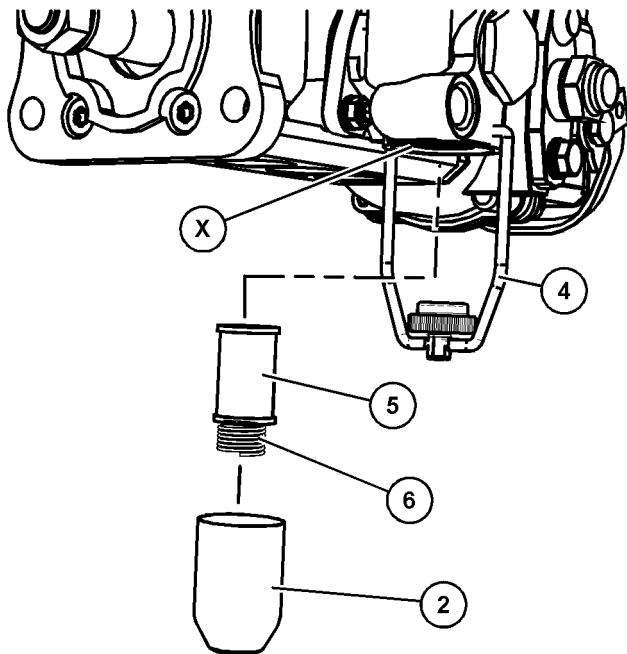


Illustration 42

g06422926

Typical example of fuel inlet screen

3. Swing the tension bracket (4) out of the way to enable the removal of the aluminum bowl (2) containing the fuel screen (5). Remove aluminum bowl.
4. Remove the screen (5) from the aluminum bowl (2). The screen (5) will have a spring (6) attached to the base of the screen (5). Remove the rubber gasket (not shown), which may be attached to the fuel injection pump body housing at Position X.
5. Inspect the screen for damage and clogging.
6. Check and assess the accumulation of particles contained in the aluminum bowl (2) and clogging of the screen (5) to determine if the screen (5) needs to be replaced.

7. If the accumulation of particles found in the aluminum bowl is found to be acceptable, the screen can be cleaned. The screen and aluminum can be cleaned with diesel fuel / air from inside out. Clean the screen (5) and aluminum bowl (2) ensuring the diesel fuel used is of the correct specification.

Screen - Install

To ensure the correct orientation of screen inside the aluminum bowl, the spring needs to be attached to the new screen. The spring is a conical design. The larger diameter should be attached to the base of the screen.

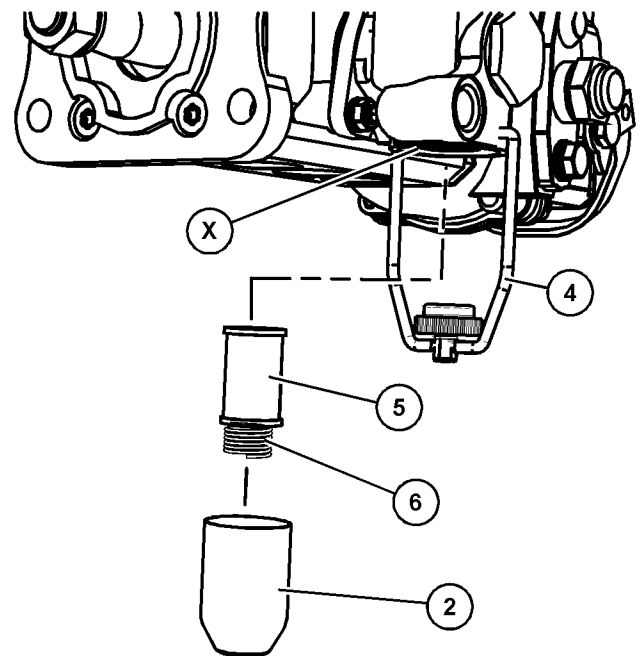


Illustration 43

g06422926

Typical example of fuel inlet screen

1. Assemble the spring (6) to the base of the screen (5).
2. Install a new rubber gasket (not shown) in the fuel injection pump body in Position X.
3. Insert the screen (5) and spring (6) assembly centrally into the aluminum bowl (2), spring in first.
4. Position the aluminum bowl (2) centrally into the opening (Position X) on the fuel injection pump.

5. Swing the tension bracket (4) into position so that the knurled nut (1) is central to the aluminum bowl (2). Tighten the knurled nut (1) until the aluminum bowl (2) is securely in place.
6. Using a suitable wrench, tighten the knurled nut (1) to a torque of $6 \pm 1 \text{ N}\cdot\text{m}$ ($53 \pm 8.9 \text{ lb in}$).
7. If equipped, turn the fuel supply valve to the ON.
8. Remove the container with the spilled diesel fuel and dispose of the fuel in accordance with local regulations.
9. Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information.
10. Unlock fuel injection pump driveshaft by reversing the lock pin. Refer to the Disassembly and Assembly, "Fuel Injection Pump - Remove" for more information.
11. Check for leaks around the aluminum bowl (2).

i0777547

Fuel System - Prime

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The engine has been in storage.
- The low-pressure fuel lines are disconnected.
- A leak exists in the low-pressure fuel system.
- The fuel filter is replaced.
- A new injection pump is installed.

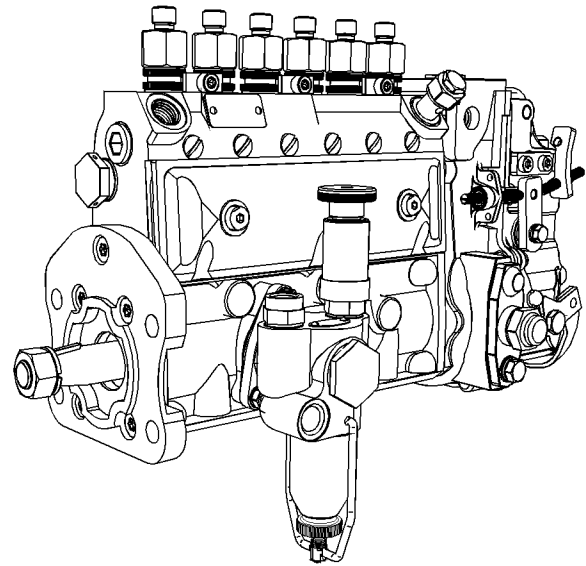


Illustration 44

g06433852

Typical example of the fuel injection pump

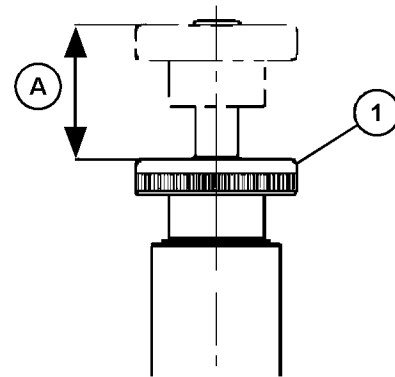


Illustration 45

g06422137

Typical example

The fuel injection pump is equipped with manual fuel priming pump. The manual fuel priming pump handle (1) is on the fuel injection pump above the fuel transfer pump. With the manual fuel priming pump handle, fuel can be pumped from the tank through the fuel filter when the engine is stopped. The quantity delivered on each stroke of the plunger is approximately 0.6 cc (0.03661 cubic inch).

Note: The length (A) of the stroke of the fuel priming pump handle is approximately 25 mm (1 inch).

Use the following procedure to remove air from the fuel system:

i07756290

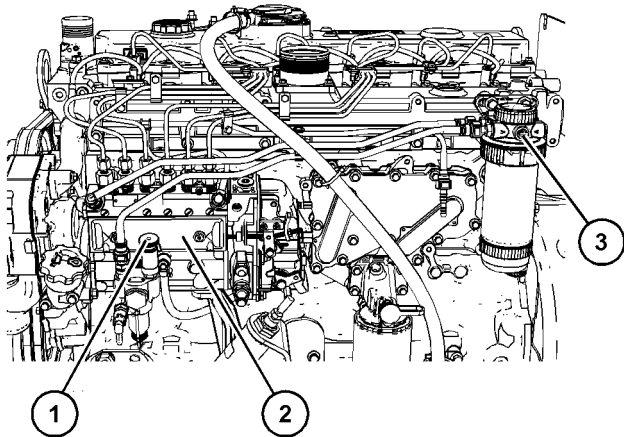


Illustration 46

g06433885

Typical example

1. Unlock the fuel priming pump handle (1). Turn handle counter clockwise. Pull the fuel priming pump handle upwards.
2. Loosen the vent screw (3) on the fuel filter.
3. Push down and pull up the fuel priming pump handle for approximately 30 seconds.
4. Continue to operate the fuel pump handle until strong pressure can be felt, or until fuel free from air can be seen coming out of the fuel filter vent screw (3).
5. Press in the fuel pump handle and lock the handle into the fuel pump body. To lock the handle, turn handle clockwise. Tighten fuel filter vent screw to a torque of 1.5 N·m (13 lb in).

Note: The stronger the pressure in the fuel system the quicker the engine will start.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

6. Wait 30 seconds and start the engine. This procedure will remove any air that could be trapped within the fuel system. Check for leaks in the fuel system.

Refer to Operation and Maintenance Manual, "Starting the Engine" for more information.

Fuel System Primary Filter (Water Separator) Element - Replace

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

Fuel Filter Remove

1. Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance.
2. Clean the outside of the fuel filter assembly before removal. Install a suitable container below the filter assembly to catch any diesel fuel spillages.
3. Drain the water separator. Refer to Operation and Maintenance Manual, "Fuel System Primary Filter/Water Separator - Drain" for the correct procedure.

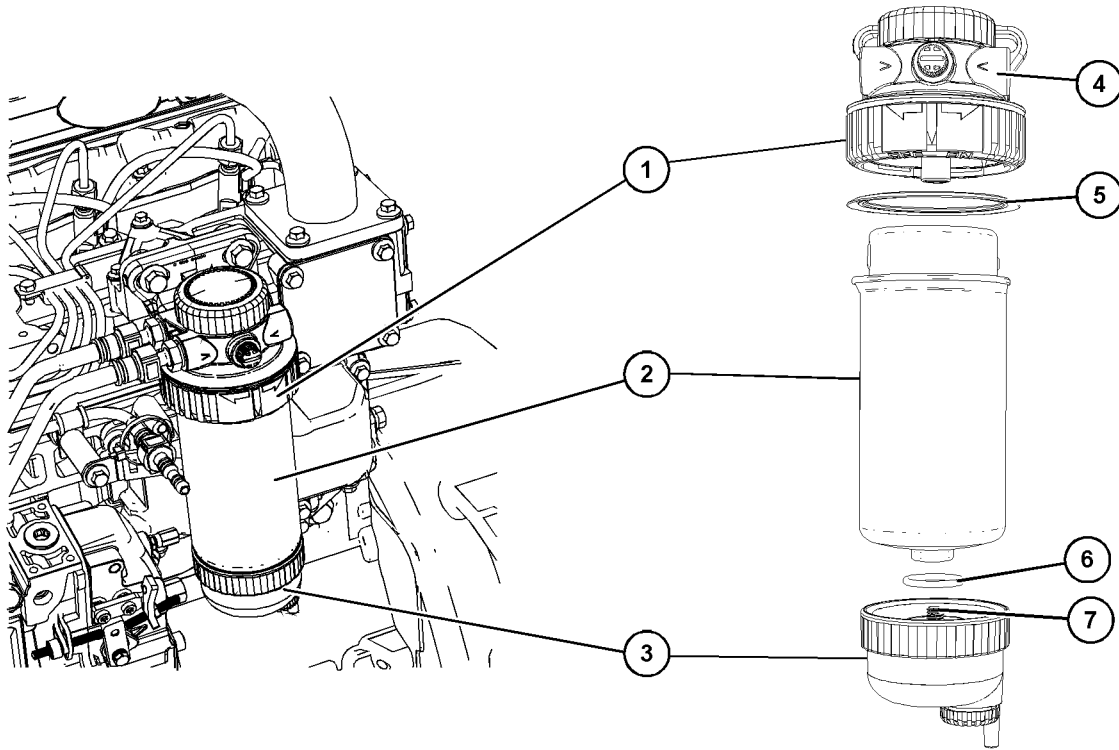


Illustration 47

g06423641

Typical example

4. Support filter canister (2) and rotate the clamp ring (1) to the left.
5. Remove the filter canister (2) from the fuel filter base (4) by a direct pull downwards.
6. Remove O-ring (5) and discard.
7. Unscrew the bowl (3) from the filter canister (2). Remove O-ring (6) and discard.
8. Discard the filter canister (2) in accordance with local regulations.
9. Ensure that the bowl (3) is clean and free from dirt.

Disposal of all diesel fuel-related parts must be in accordance with local regulation.

Fuel Filter Install

Install new O ring seals.

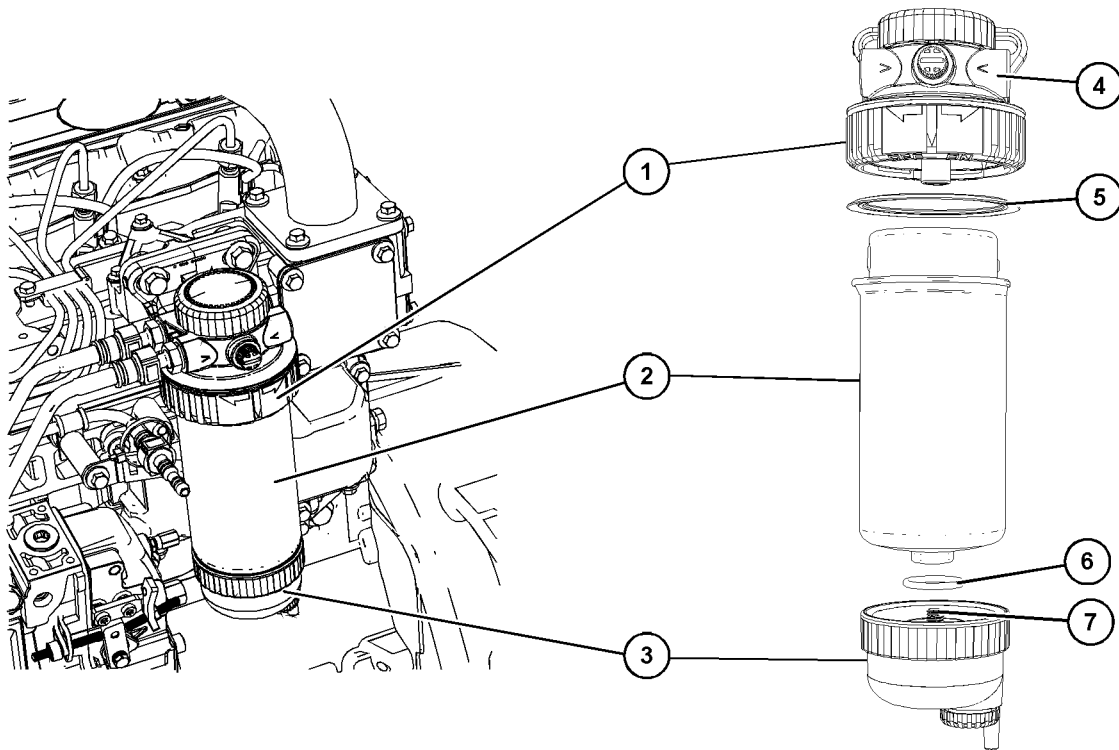


Illustration 48

g06423641

Typical example

1. Install new O ring seal (5) onto new filter canister (2).
2. Install O ring (6) onto the screw (7) on bowl (3). Assemble bowl (3) to filter canister (2).
3. Install a new O-ring (5) onto filter canister (2).
4. Align the filter canister (2) with the opening on the fuel filter base (4). Push the canister directly up and rotate the clamp ring (1) to the right. Ensure the filter canister (2) is securely in place.
5. Turn the fuel supply valve (if equipped) to the ON and check for leaks around the filter.

6. Remove the container below the filter assembly and dispose any diesel fuel spillages in accordance with local regulations.

i07756868

Fuel System Primary Filter/ Water Separator - Drain

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

The water separator is not a filter. The water separator separates water from the fuel. The engine should never be allowed to run with the water separator more than half full. Engine damage may result.

NOTICE

The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

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Fuel Tank Water and Sediment - Drain

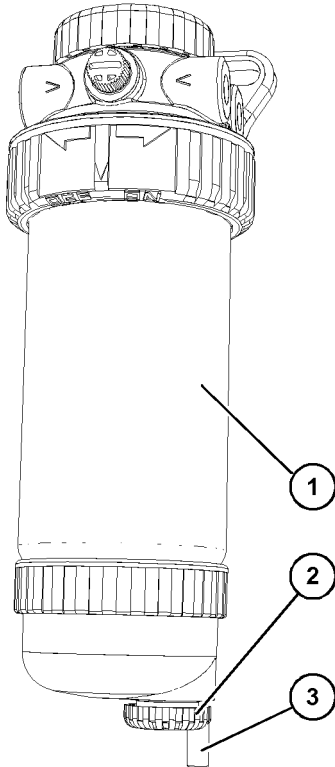


Illustration 49

g06424026

Typical examples

1. Place a suitable container below the fuel filter water separator (1).
2. Attach suitable tubing to the drain (3) and place the open end in the container.
3. Open the drain (2). Allow the fluid to drain into the container.
4. When clean fuel drains from the water separator close the drain (2). Tighten the drain by hand pressure only.
5. Remove the tubing and dispose of the drained fluid in accordance with local regulations.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system.

Water can be introduced into the fuel tank when the fuel tank is being filled.

Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Allow five minutes after the fuel tank has been filled before draining water and sediment from the fuel tank.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank at the following intervals:

- Weekly
- Service intervals
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i02349879

Hoses and Clamps - Inspect/Replace

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will harden. Hardening of the hoses will cause hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

Refer to the OEM information for further information on removing and replacing fuel hoses (if equipped).

The coolant system and the hoses for the coolant system are not usually supplied by Perkins. The following text describes a typical method of replacing coolant hoses. Refer to the OEM information for further information on the coolant system and the hoses for the coolant system.

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: For the correct coolant, see this Operation and Maintenance Manual, "Fluid Recommendations".

8. Refill the cooling system. Refer to the OEM information for further information on refilling the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's seals. Replace the cooling system filler cap if the seals are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i02335774

Radiator - Clean

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The radiator is not usually supplied by Perkins. The following text describes a typical cleaning procedure for the radiator. Refer to the OEM information for further information on cleaning the radiator.

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: Damaged fins, corrosion, dirt, grease, insects, leaves, oil and other debris. Clean the radiator, if necessary.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction to the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the radiator fins. Slowly move the air nozzle in a direction that is parallel with the radiator tube assembly. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

If the radiator is blocked internally, refer to the OEM Manual for information regarding flushing the cooling system.

After cleaning the radiator, start the engine. Allow the engine to operate at low idle speed for three to five minutes. Accelerate the engine to high idle. This will help in the removal of debris and the drying of the core. Slowly reduce the engine speed to low idle and then stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: Welds, mounting brackets, air lines, connections, clamps and seals. Make repairs, if necessary.

Starting Motor - Inspect

Perkins recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for correct operation. Check the electrical connections and clean the electrical connections. Refer to the Systems Operation, Testing and Adjusting Manual, "Electric Starting System - Test" for more information on the checking procedure and for specifications or consult your Perkins dealer or your Perkins distributor for assistance.

i04149590

Turbocharger - Inspect

A regular visual inspection of the turbocharger is recommended. If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air intake and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of oil into a turbocharger under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is renewed.

A visual inspection of the turbocharger can minimize unscheduled downtime. A visual inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Removal and Installation

For options regarding the removal, installation, and replacement, consult your Perkins dealer or your Perkins distributor. Refer to the Disassembly and Assembly, "Turbocharger - Remove and Turbocharger - Install" and Systems Operation, Testing and Adjusting, "Turbocharger - Inspect" for further information.

Inspecting

NOTICE

The compressor housing for the turbocharger must not be removed from the turbocharger for inspection or removed for the cleaning of the compressor.

1. Remove the pipe from the turbocharger exhaust outlet and remove the air intake pipe to the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.
2. Check for obvious heat discoloration of the turbocharger. Check for any loose bolts or any missing bolts. Check for damage to the oil supply line and the oil drain line. Check for cracks in the housing of the turbocharger. Ensure that the compressor wheel can rotate freely.
3. Check for the presence of oil. If oil is leaking from the back side of the compressor wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the intake air (clogged air filters), which causes the turbocharger to slobber.

4. Inspect the bore of the housing of the turbine outlet for corrosion.
5. Fasten the air intake pipe and the exhaust outlet pipe to the turbocharger housing. Ensure that all clamps are installed correctly and that all clamps are tightened securely.

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Walk-Around Inspection

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the correct place. Repair damaged guards or replace missing guards.
 - Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.
-

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

- Ensure that the cooling system hoses are correctly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.

- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of the water pump and the installation of water pump and/or seal, refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" for more information or consult your Perkins dealer or your Perkins distributor.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the rocker cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps and/or tie-wraps.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from the fuel tank on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.

- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that can not be calibrated.

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Water Pump - Inspect

A failed water pump may cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and parts contract.

Visually inspect the water pump for leaks. Renew the water pump seal or the water pump if there is an excessive leakage of coolant. Refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" for the disassembly and assembly procedure.

Warranty Section

Warranty Information

i06590874

Emissions Warranty Information

This engine may be certified to comply with exhaust emission and gaseous emission standards that are prescribed by the law at the time of manufacture. This engine may be covered by an Emissions Warranty. Consult your authorized Perkins dealer or distributor to determine if your engine is emissions certified and if your engine is subject to an Emissions Warranty.

Reference Information Section

www.perkins.com

NOTICE
Dependant upon engine type and application.

Reference Materials

i04149570

Engine Protection Plans (Extended Service Contract)

Extended Service Contracts-purchased in minutes, protected for years.

Extended Service Contracts (ESC) protect you from the stress that unexpected repair work brings to your life by covering the cost of getting your engine up and running again. Unlike other extended warranties, Perkins Platinum ESC protects you against all component part failures.

Purchase peace of mind from only £0.03 / \$0.05 / euro 0.04 a day and let an ESC make your dreams a reality.

Why buy an Extended Service Contract?

1. No surprises - total protection from unexpected repair cost (parts, labor, and travel).
2. Enjoy longer lasting product support from Perkins global network.
3. Genuine Perkins parts ensure continued engine performance.
4. Highly trained technicians carry out all repairs.
5. Transferable coverage should you sell your machine.

Flexible coverage provides the right level of protection for your Perkins Engine. Coverage can be extended to 2 years/ 1,000 hours right up to 10 year/ 40,000

You can buy an ESC at any time during standard warranty - even the last day!

Each Perkins Distributor has highly trained and experienced Perkins Product Support Service Technicians. The Support Service are equipped, and available around the clock to get your engine running again with the minimum of downtime. Buying an ESC means that you get all this for free.

To purchase an Extended Service Contract, is quick and simple! Contact your local Perkins Distributor now and the distributor can provide you with a quote in minutes. You can locate your nearest Perkins Distributor by visiting:

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Product and Dealer Information

Note: For product identification plate locations, see the section "Product Identification Information" in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

Dealer Contact

Phone Number

Hours

Sales: _____

Parts: _____

Service: _____

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