SEBU9070-03 (en-us)
January 2021

Perkins®

THE HEART OF EVERY GREAT MACHINE

Operation and Maintenance Manual

1506A-E88TA, 1506C-E88TA, 1506D-E88TA Industrial Engines

LG (Engine)
PK9 (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.

⚠ WARNING

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.

⚠ WARNING

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.

Table of Contents

Foreword 4

Safety Section

Safety Messages 6

General Hazard Information 8

Burn Prevention 11

Fire Prevention and Explosion Prevention 12

Crushing Prevention and Cutting Prevention 14

Mounting and Dismounting 15

Before Starting Engine 15

Engine Starting 15

Engine Stopping 15

Electrical System 16

Engine Electronics 17

Product Information Section

General Information 18

Product Identification Information 27

Operation Section

Lifting and Storage 29

Features and Controls 32

Engine Diagnostics 40

Engine Starting 42

Engine Operation 45

Cold Weather Operation 46

Engine Stopping 48

Maintenance Section

Refill Capacities 49

Maintenance Recommendations 74

Maintenance Interval Schedule 77

Warranty Section

Warranty Information 104

Reference Information Section

Engine Ratings 105

Reference Materials 107

Index Section

Index 110

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

i06229776

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. Please become familiar with all warning signs.

Ensure that all of 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.

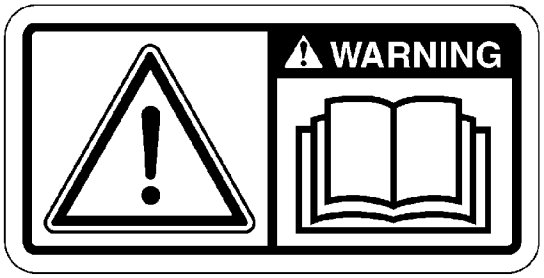


Illustration 1 g01154807

Typical example

The Universal Warning label (1) is located in two positions. The warning labels are located on the right side of the valve mechanism cover and located on the left side of the valve mechanism cover .

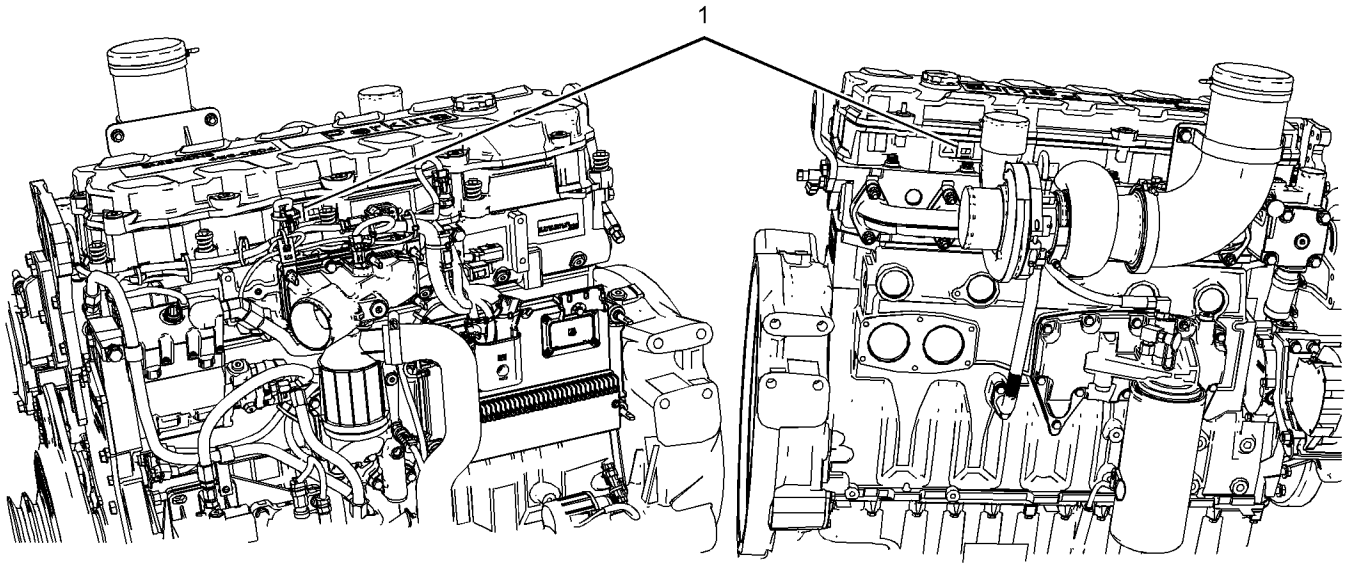


Illustration 2 g03732105
1506A and C

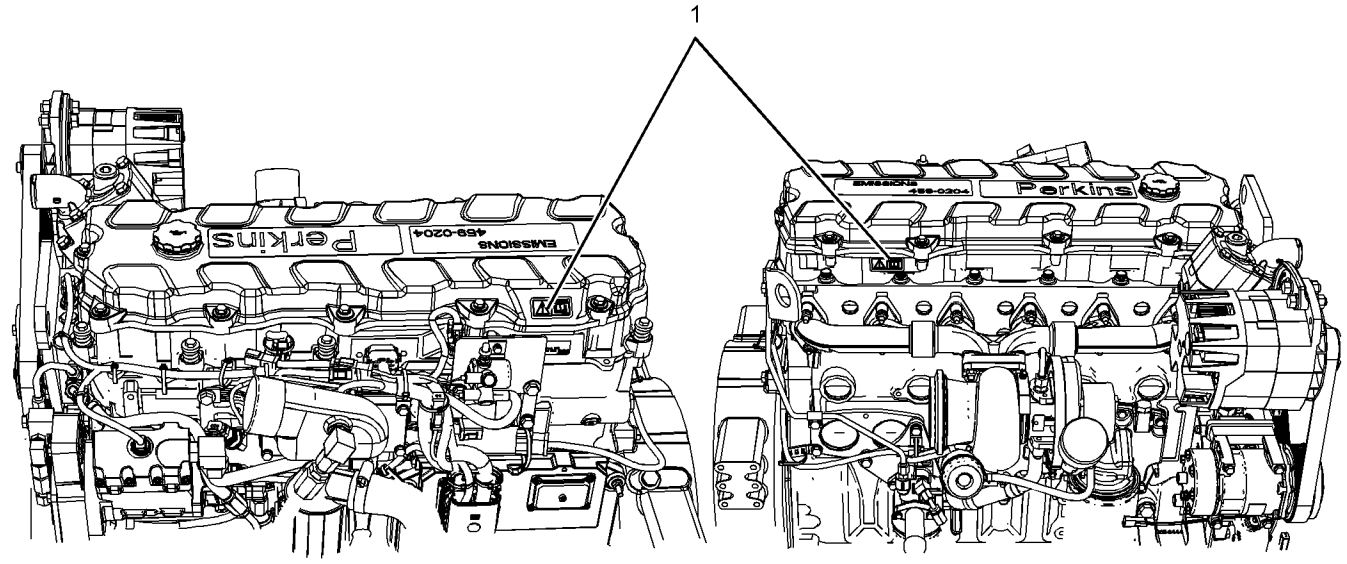


Illustration 3 g03863615
1506D

i08330649

General Hazard Information



Illustration 4 g00104545

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.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

- Tampering with the engine installation or tampering with the OEM supplied wiring can be dangerous. Personal injury, death and/or engine damage could result.
- Vent the engine exhaust to the outside when the engine is operated in an enclosed area.
- If the engine is not running, do not release the secondary brake or the parking brake systems unless the vehicle is blocked or unless the vehicle is restrained.
- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears to help prevent damage to hearing.
- 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.
- Never put maintenance fluids into glass containers. Glass containers can break.
- Use all cleaning solutions with care.
- Report all necessary repairs.

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

- The engine is stopped. Ensure that the engine cannot be started.
- The protective locks or the controls are in the applied position.
- Engage the secondary brakes or parking brakes.
- Block the vehicle or restrain the vehicle before maintenance or repairs are performed.
- 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. If equipped, allow the diesel exhaust fluid to be purged before disconnecting the battery.
- If equipped, disconnect the connectors for the unit injectors that are on the valve cover base. This action will help prevent personal injury from the high voltage to the unit injectors. Do not come in contact with the unit injector terminals while the engine is operating.
- Do not attempt any repairs or any adjustments to the engine while the engine is operating.
- Do not attempt any repairs that are not understood. Use the proper 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 well-ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps

- Grease fittings
- Pressure taps
- Breathers
- Drain plugs

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.

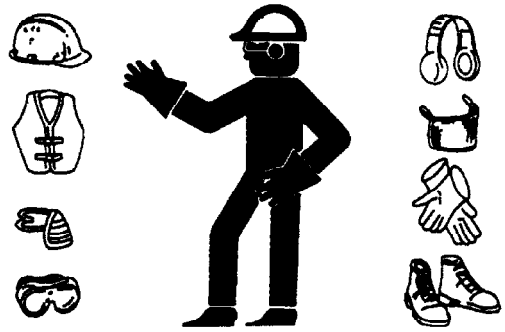


Illustration 5 g00702020

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears to help prevent damage to hearing.
- 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.
- Never put maintenance fluids into glass containers. Glass containers can break.
- Use all cleaning solutions with care.
- Report all necessary repairs.

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

- The engine is stopped. Ensure that the engine cannot be started.
- 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.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

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.

When pressurized air and/or pressurized 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.

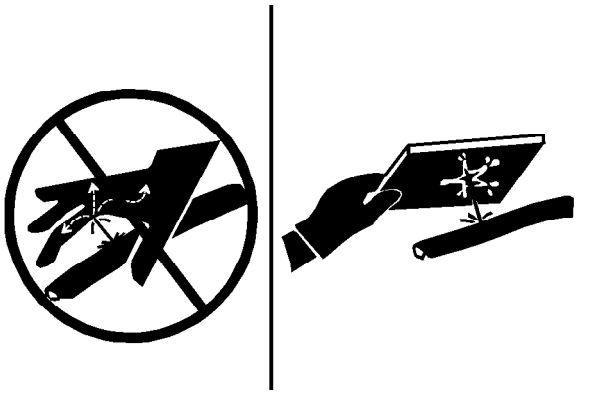


Illustration 6 g00687600

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 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.

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 proper 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

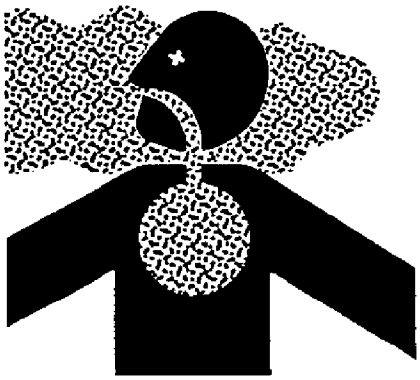


Illustration 7 g00702022

Exhaust

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

Hexavalent Chromium

Perkins equipment and replacement parts comply with applicable regulations and requirements where originally sold. Perkins recommends the use of only genuine Perkins replacement parts.

Hexavalent chromium has occasionally been detected on exhaust and heat shield systems on Perkins engines. Although laboratory testing is the only accurate way to know if hexavalent chromium is, in fact, present, the presence of a yellow deposit in areas of high heat (for example, exhaust system components or exhaust insulation) may be an indication of the presence of hexavalent chromium.

Use caution if you suspect the presence of hexavalent chromium. Avoid skin contact when handling items that you suspect may contain hexavalent chromium, and avoid inhalation of any dust in the suspect area. Inhalation of, or skin contact with, hexavalent chromium dust may be hazardous to your health.

If such yellow deposits are found on the engine, engine component parts, or associated equipment or packages, Perkins recommends following local health and safety regulations and guidelines, utilizing good hygiene, and adhering to safe work practices when handling the equipment or parts. Perkins also recommends the following:

- Wear appropriate Personal Protective Equipment (PPE)
- Wash your hands and face with soap and water prior to eating, drinking, or smoking, and also during rest room breaks, to prevent ingestion of any yellow powder
- Never use compressed air for cleaning areas suspected of containing hexavalent chromium
- Avoid brushing, grinding, or cutting materials suspected of containing hexavalent chromium
- Obey environmental regulations for the disposal of all materials that may contain or have come into contact with hexavalent chromium
- Stay away from areas that might have hexavalent chromium particles in the air.

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

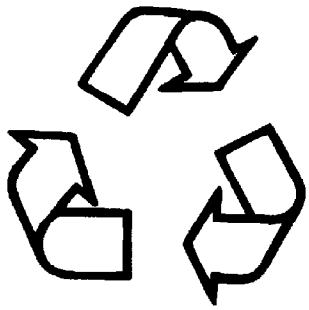


Illustration 8 g00706404

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.

i05943062

Burn Prevention

Do not touch any part of an operating engine. 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 in order 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.

i05945996

Fire Prevention and Explosion Prevention



Illustration 9 g00704000

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

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.

After the emergency stop button is operated, ensure that you allow 15 minutes, before the engine covers are removed.

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.

Ensure that the engine is stopped. Inspect all lines and hoses for wear or for deterioration. Ensure that the hoses are correctly routed. The lines and hoses must have adequate support and secure clamps.

Oil filters and fuel filters must be installed correctly. The filter housings must be tightened to the correct torque. Refer to the Disassembly and Assembly manual for more information.



Illustration 10 g00704059

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.

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 content. Avoid death or serious injury from fire or explosion. Consult your fuel or fuel system supplier to ensure that the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

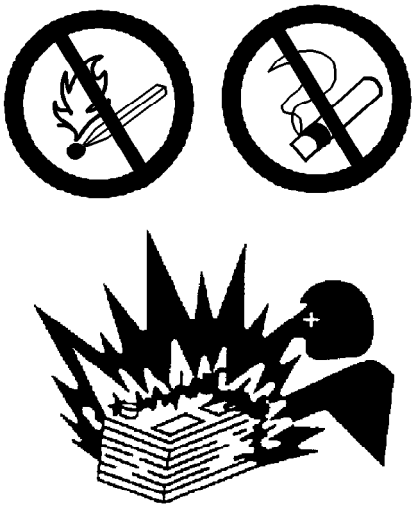


Illustration 11 g00704135

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. A frozen battery 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 damaged.

Leaks can cause fires. Consult your Perkins dealer or your Perkins distributor for replacement parts.

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.

i02143194

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.

i05463929

Mounting and Dismounting

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

Refer to the Original Equipment Manufacture (OEM) for the location of foot and hand holds for your specific application.

i04257031

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 in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not start an engine when the governor linkage is disconnected.

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

i07828827

Engine Starting

⚠ WARNING

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

⚠ 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.

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 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) is working correctly, check the water temperature gauge and/or the oil temperature gauge during the heater operation.

Note: The engine may be equipped with a device for cold starting. 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.

i07668288

Engine Stopping

- Remove the load in increments.
- Open the circuit breaker.

- Allow the engine to run for five minutes to cool.
- Stop the engine.

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. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

To stop an electronically controlled engine, cut the power to the engine.

i06230746

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 should be connected last from the external power source 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 Practice

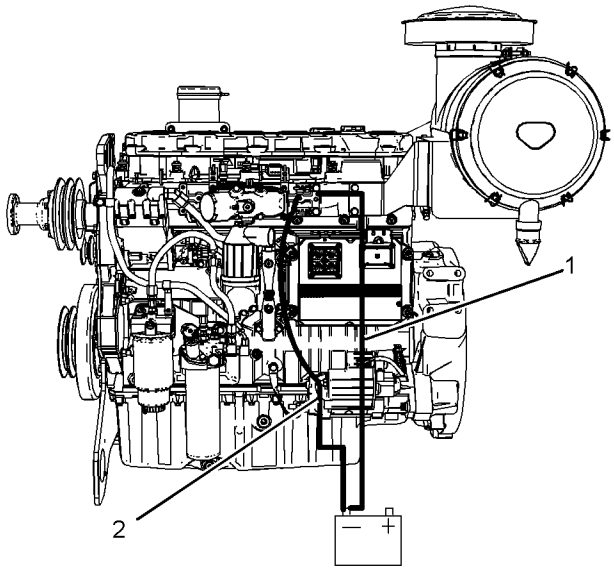


Illustration 12 g03864331

Typical example

(1) Battery to grounding stud
(2) Battery to starter to grounding stud

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. The wire that is used must be adequate to handle the full charging current of the alternator.

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

i05986490

Engine Electronics

⚠ WARNING

Tampering with the electronic system installation or the OEM wiring installation can be dangerous and could result in personal injury or death and/or engine damage.

This engine has a comprehensive, programmable Engine Monitoring System. The Engine Control Module (ECM) will monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control: WARNING, DERATE and SHUTDOWN. These engine monitoring modes can limit engine speed and/or the engine power.

Many of the parameters that are monitored by the ECM can be programmed for the engine monitoring functions. The following parameters can be monitored as a part of the Engine Monitoring System:

- Operating Altitude
- Engine Coolant Level
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Fuel Temperature
- Intake Manifold Air Temperature
- System Voltage

The Engine Monitoring package can vary for different engine models and different engine applications. However, the monitoring system and the engine monitoring control will be similar for all engines.

Note: Many of the engine control systems and display modules that are available for Perkins Engines will work in unison with the Engine Monitoring System. Together, the two controls will provide the engine monitoring function for the specific engine application. Refer to the Troubleshooting Manual for more information.

Product Information Section

General Information

i06230810

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.

1506A and C Engine and Radiator Views

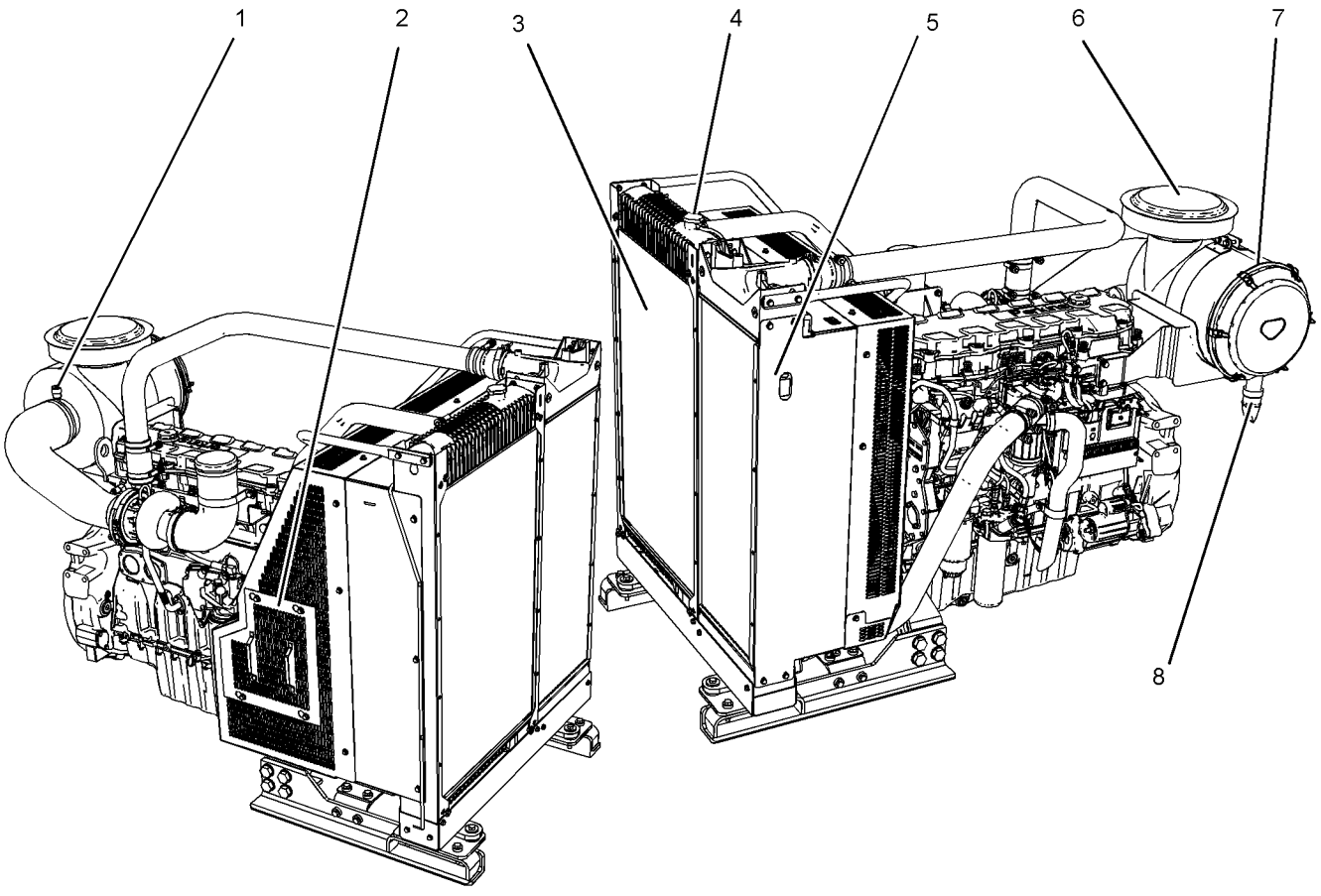


Illustration 13 g03733708

Typical example

(1) Engine air cleaner service indicator
(2) Inspection guard
(3) Radiator
(4) Radiator pressure cap
(5) Air-to-air aftercooler
(6) Rain cap
(7) Air cleaner
(8) Vacuator valve (Dust valve)

1506A and C Engine Views

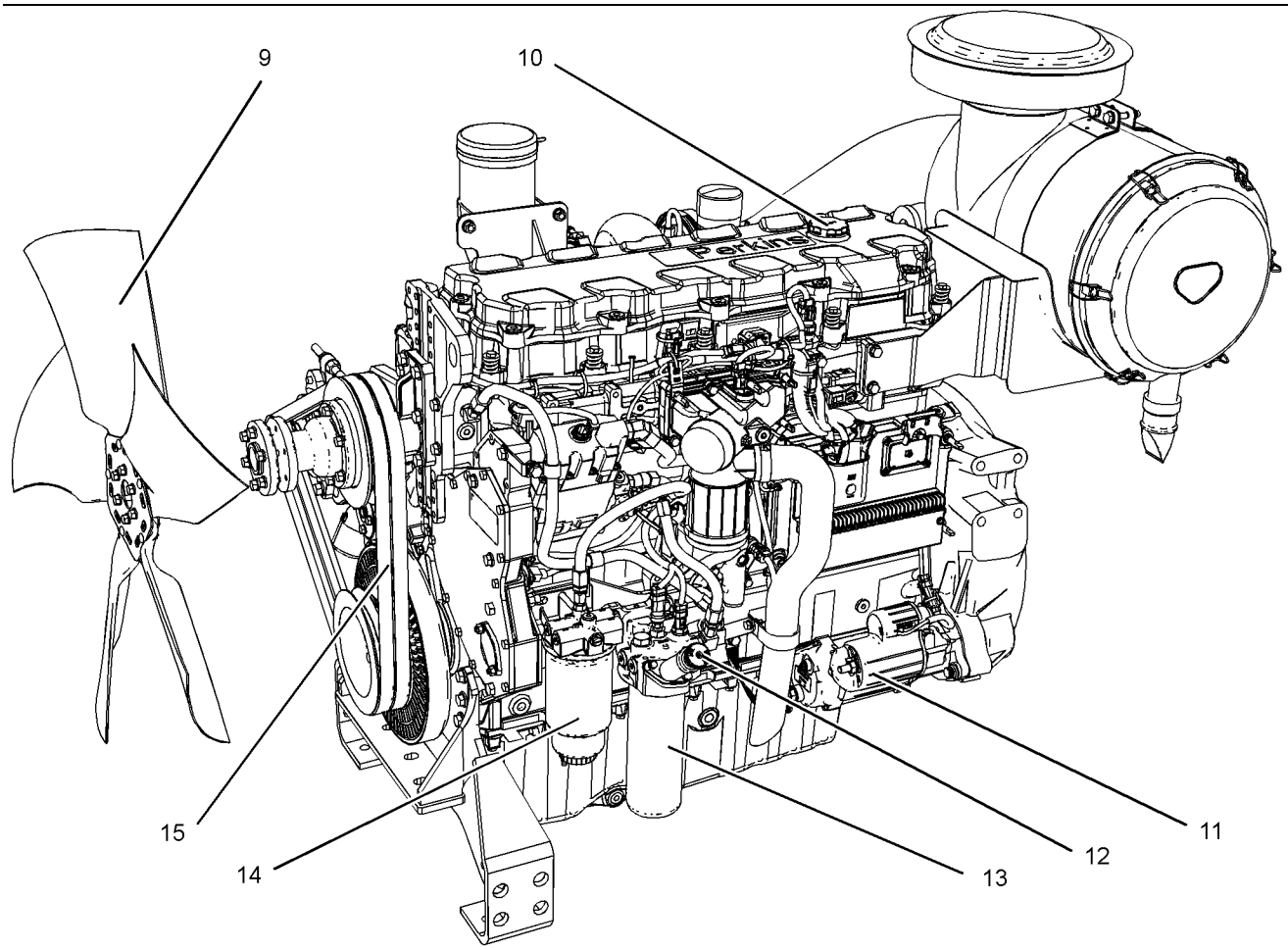


Illustration 14 g03734120

Typical example

(9) Cooling fan
(10) Oil filler cap
(11) Starting motor assembly
(12) Fuel priming pump
(13) Secondary fuel filter
(14) Primary fuel filter
(15) V Belts for fan

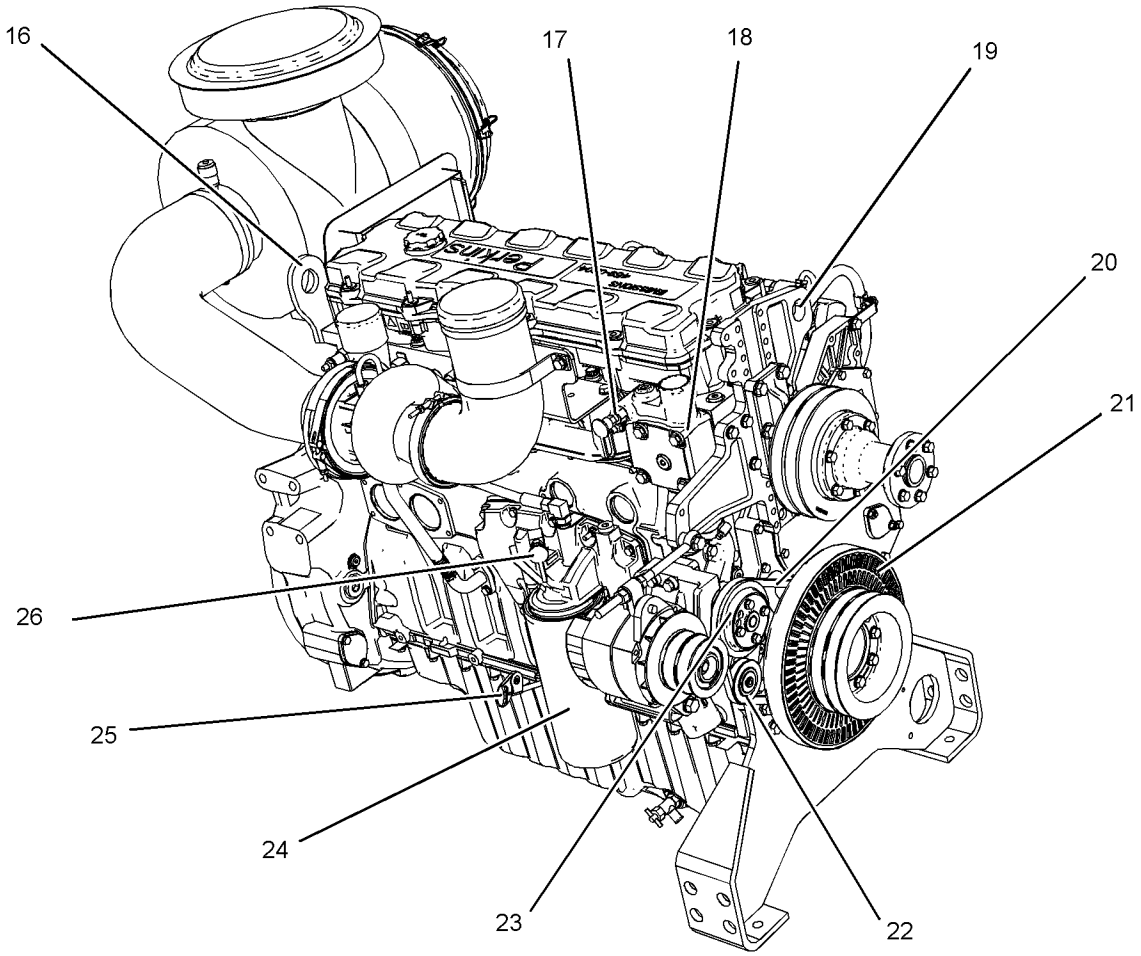


Illustration 15 g03734121

Typical example

(16) Rear lifting eye
(17) Coolant sampling valve
(18) Housing for coolant temperature regulator
(19) Front lifting location
(20) Belt for coolant pump
(21) Crankshaft damper
(22) Idler for coolant belt
(23) Coolant pump
(24) Oil filter
(25) Oil gauge (Dipstick)
(26) Sample valve for engine oil

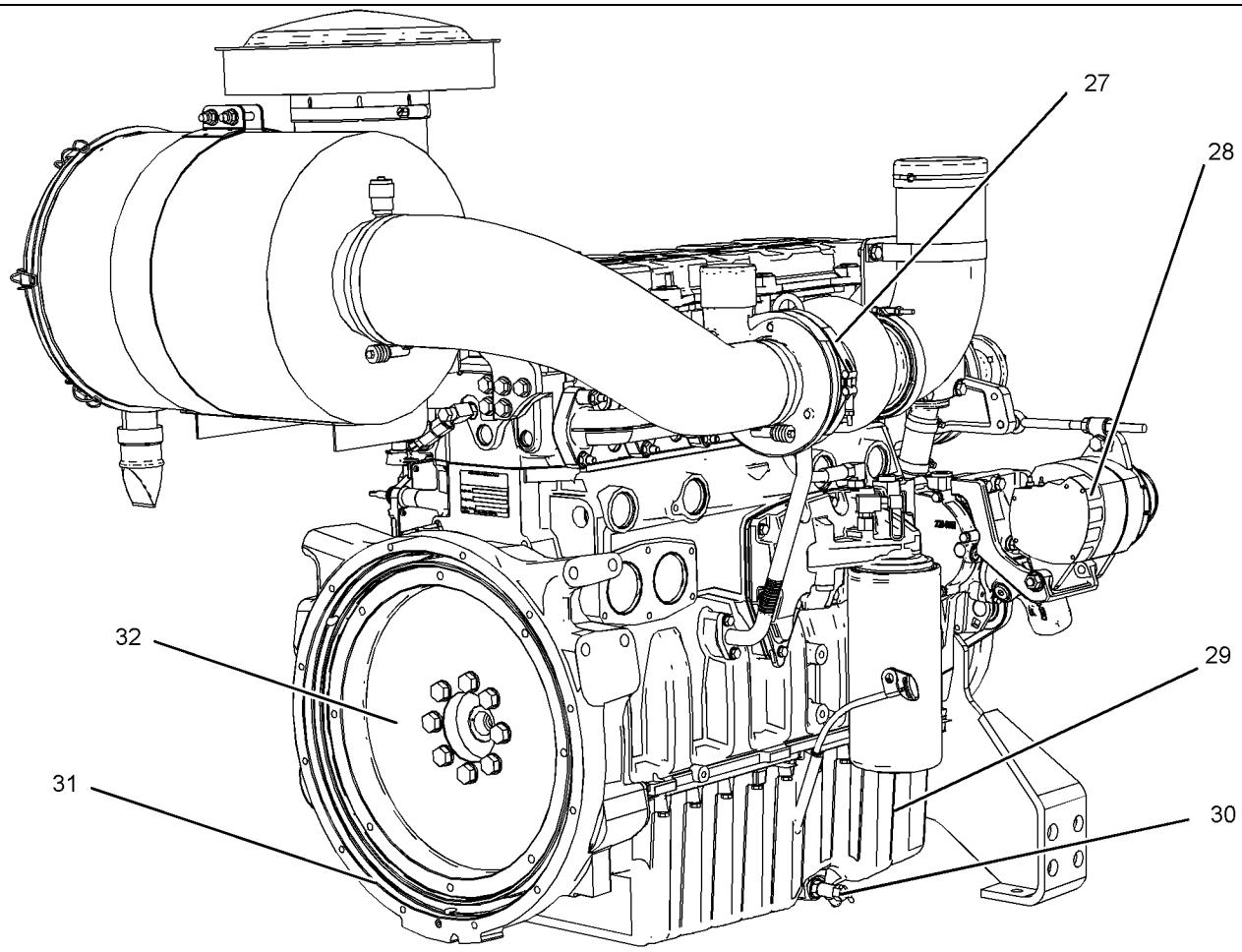


Illustration 16 g03734133

Typical example

(27) Turbocharger
(28) Alternator
(29) Oil pan
(30) Oil drain tap
(31) Flywheel housing
(32) Flywheel

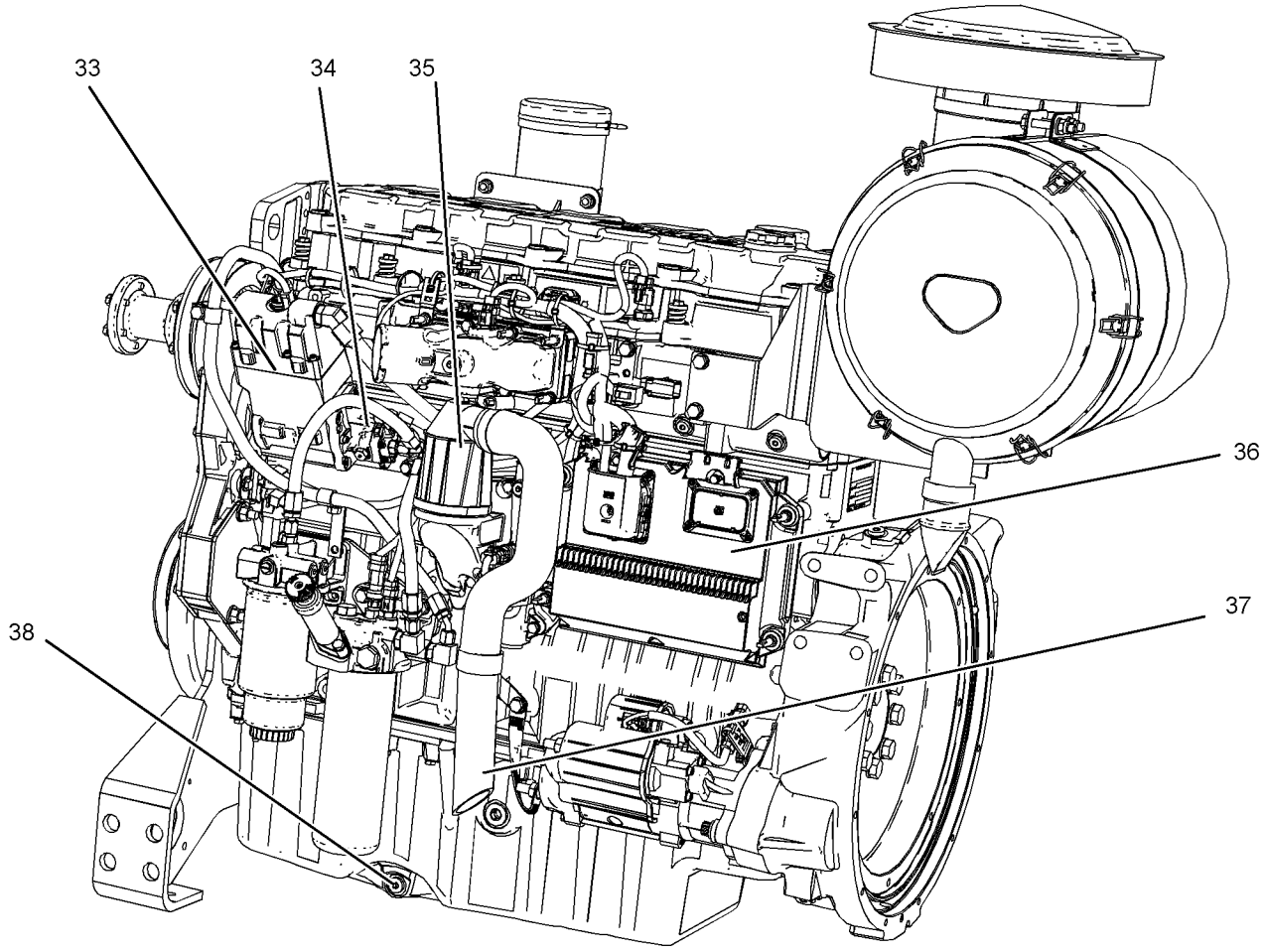


Illustration 17 g03734135

Typical example

(33) Unit injector hydraulic pump
(34) Fuel transfer pump
(35) Crankcase breather
(36) Electronic control module
(37) Breather outlet hose
(38) Oil drain plug

1506D Engine Views

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

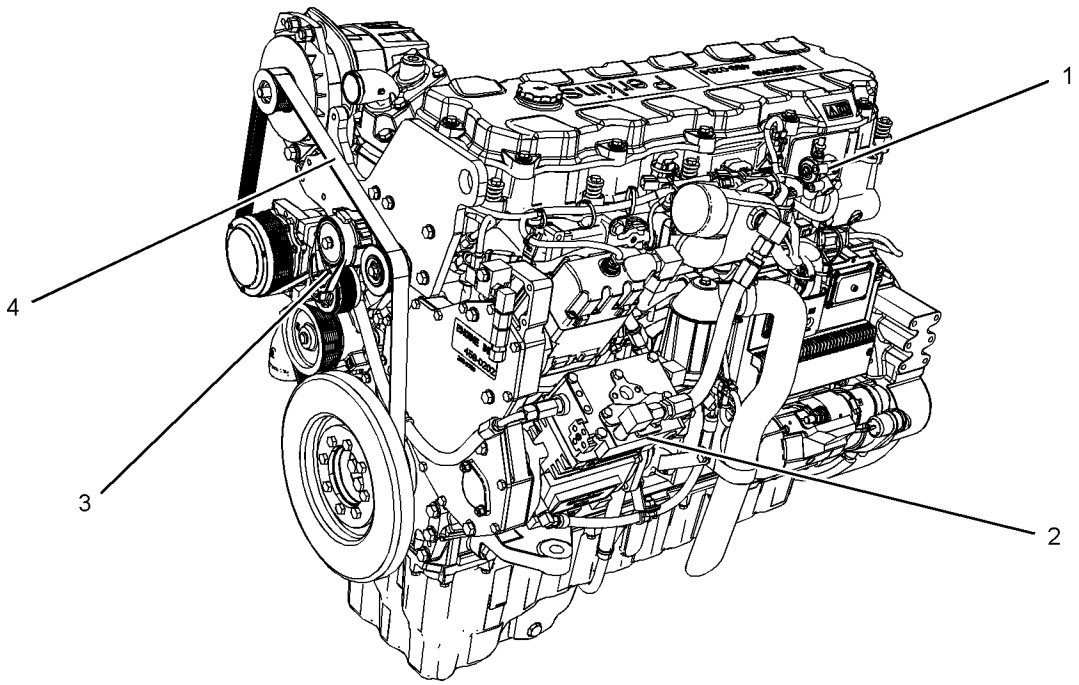


Illustration 18 g03864374

Typical example

(1) Switch for air inlet heater
(2) Twin compressor
(3) Auto tensioner
(4) Multi V belt

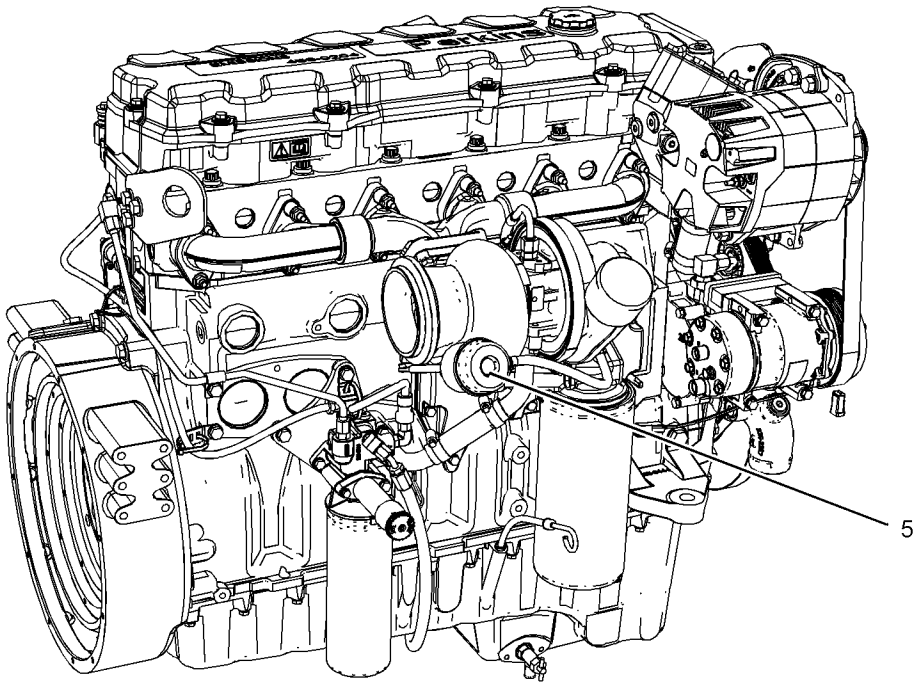


Illustration 19 g03864386

Typical example

(5) Wastegate actuator

i06231479

Product Description

The 1506 industrial engine has three different emissions ratings A, C, and D. The 1506 industrial engine can be configured for variable speed applications or constant speed applications.

The 1506A and C industrial engines have five different ratings. Visually the engines will look similar the difference is due to the software that is loaded into the engine Electronic Control Module (ECM).

The 1506D may be configured differently, with an air inlet heater, automatic tensioner for the drive belt, and a turbocharger with a wastegate actuator.

The Perkins 1506A, 1506C and 1506D industrial engines have the following characteristics:

- In-Line 6-cylinder
- Four-stroke cycle
- Hydraulically Actuated Electronic Unit Injection (HEUI)
- Turbocharged with air-to-air aftercooled (ATAAC)

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.

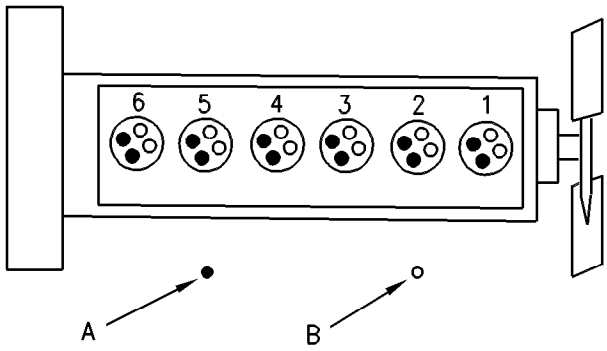


Illustration 20 g00609479

Cylinder and valve location

(A) Exhaust valve
(B) Inlet valve

Table 1

1506 Engine Specifications	
Arrangement and Cylinders	In-Line 6-cylinder
Bore	112.0 mm (4.41 inch)
Stroke	149.0 mm (5.87 inch)
Aspiration	ATAAC
Displacement	8.8 L (537 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise

Electronic Engine Features

The engine operating conditions are monitored. The ECM controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine speed governor
- Automatic air/fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics

For more information on electronic engine features, refer to the Operation and Maintenance Manual, “Engine Diagnostics” topic.

Additional Features

The following additional features provide increased engine fuel economy and serviceability:

- Cold starting capability
- Tampering detection
- Diagnostics

Hydraulic Electronic Unit Injectors

Hydraulically Actuated Electronic Unit Injectors (HEUI) perform the following function:

- Atomizes the fuel

The unit injectors are controlled by the ECM which uses the camshaft position, the engine speed signals, and the inlet air pressure sensors. The ECM controls when the fuel is injected into each cylinder. The rated rpm is identified on the information plate.

Engine Diagnostics

The engine has built-in diagnostics in order to ensure that all of the components are functioning properly. In the event of a deviation from the programmed limits, the operator will be alerted to the condition by a “DIAGNOSTIC” lamp. Under certain conditions, the engine horsepower and the vehicle speed may be limited. The electronic service tool may be used to display the diagnostic code.

There are three types of diagnostic codes: active, logged and event.

Most of the diagnostic codes are logged and stored in the ECM. For additional information, refer to the Operation and Maintenance Manual, “Engine Diagnostics” topic.

The ECM provides an electronic governor that controls the injector output in order to maintain the desired engine rpm.

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Centrifugal pump that is driven by a belt
- Cooling fan driven by belts
- Water temperature regulator which regulates the engine coolant temperature
- Oil cooler and radiator

The drive belt can be a multi V belt or a single V belt design.

The engine lubricating oil that is supplied is cooled. The engine lubricating oil is also filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine components during the following conditions:

- High oil viscosity
- Plugged oil cooler or plugged oil filter element

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on the adherence to proper operation and maintenance recommendations. In addition, use recommended fuels, coolants, and lubricants. Use the Operation and Maintenance Manual as a guide for required engine maintenance.

Expected engine life is generally predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over a time. Reduced hours of operation at full throttle and/or operating at reduced throttle settings result in a lower average power demand. Reduced hours of operation will increase the length of operating time before an engine overhaul is required.

Aftermarket Products and Perkins Engines

Perkins does not warrant the quality or performance of non-Perkins fluids and filters.

When auxiliary devices, accessories, or consumables (filters, additives, catalysts,) 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.

Product Identification Information

i05951766

Plate Locations and Film Locations

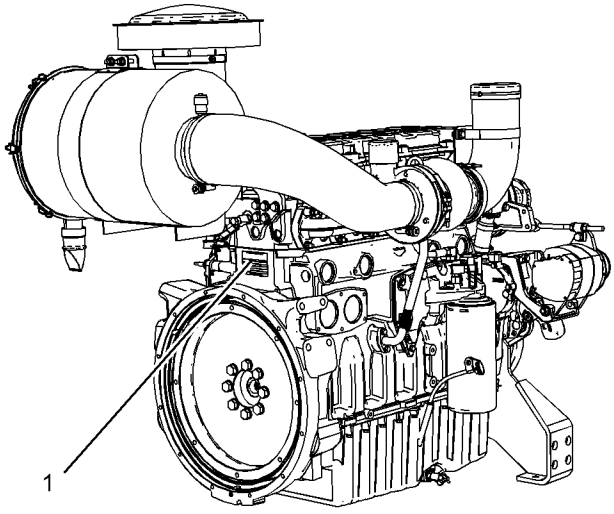


Illustration 21 g03735788

Typical example

(1) Location of engine serial plate.

Perkins engines are identified by serial numbers. These numbers are shown on the engine serial number plate. Perkins distributors need these numbers in order to determine the components that were included with the engine. This information permits accurate identification of replacement part numbers.

Serial Number Plate 1

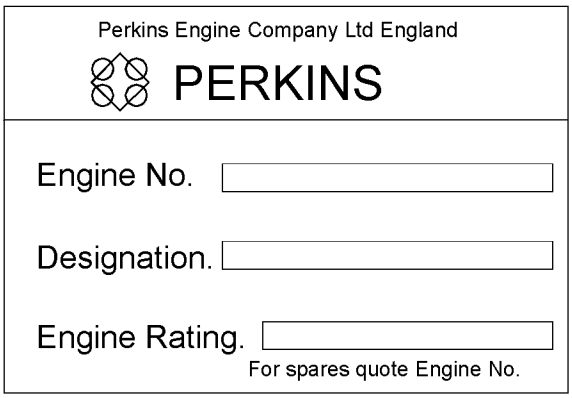


Illustration 22 g01403841

Engine Identification

Perkins engines are identified by an engine serial number.

A typical example of an engine serial number is LGE F**** N00001W.

L _____ Type of engine

G _____ Application (Table 2)

E _____ Rating Type (Table 3)

F _____ Number of cylinders (Table 4)

***** _____ Fixed build number

N _____ Built in the USA

00001 _____ Engine Number

W _____ Year of Manufacture

Table 2

Application	
G	Genset

Table 3

Type of engine (Diesel)	
A	TAG1
B	TAG2
D	TAG3

(continued)

(Table 3, contd)

E	TAG4
F	TAG5
H	TAG6

Table 4

Number of Cylinders	
F	6
H	8
M	12
R	16

Perkins dealers and Perkins distributors require all of these numbers in order to determine the components that were included in the engine. This information permits accurate identification of replacement part numbers.

i05951816

Emissions Certification Film

Note: This information is pertinent in the United States, in Canada and in Europe.

The emissions label is located on the top of the valve mechanism cover.

i05951812

Reference Information

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information in the appropriate space. Make a copy of this list for a record. Keep the information for future reference.

Record for Reference

Engine Model _____

Engine Serial Number _____

Engine RPM _____

Primary Fuel Filter _____

Secondary Fuel Filter Element _____

Lubrication Oil Filter Element _____

Total Lubrication System Capacity _____

Total Cooling System Capacity _____

Air Cleaner Element _____

Fan Drive Belt _____

Coolant Pump Belt _____

Operation Section

Lifting and Storage

i07449107

Product Lifting

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.

NOTICE
Never bend the eyebolts and the brackets. 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.

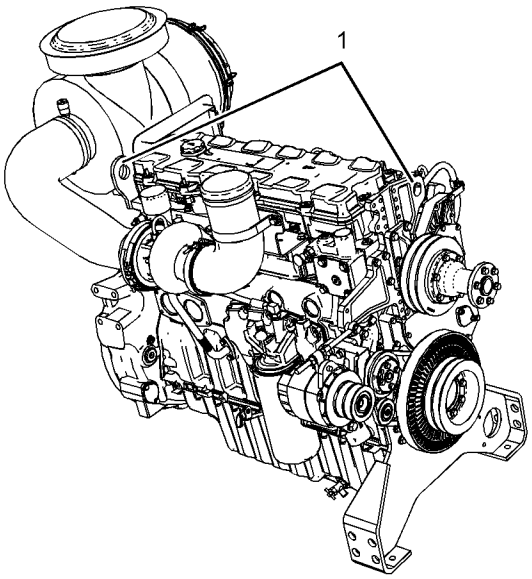


Illustration 23 g03735832

The lifting eyes (1) are the lifting locations for lifting the engine and radiator.

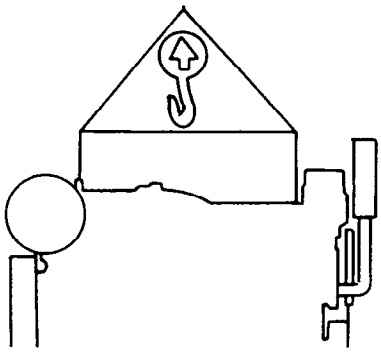


Illustration 24 g00103219

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.

Lifting eyes are designed and installed for the specific engine arrangement. 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 distributor for information regarding fixtures for proper engine lifting.

i05951855

Product Storage

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 a correct specification of 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. Change the engine oil and filter. Refer to this Operation and Maintenance Manual, “Engine Oil and Filter - Change”. Ensure that the engine is operated after the oil and filter has been changed. Ensure that engine oil pressure is correct before stopping the engine.

4. For the correct specification of engine oil refer to this Operation and Maintenance Manual, “Fluid recommendations”.

5. Loosen the fan drive belts and loosen the coolant pump belt. Refer to this Operation and Maintenance Manual, “Belts - Inspect/Adjust” for more information.

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 ref 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. Also, rotate the coolant pump pulley. 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.

Removal from Storage

1. Remove all covers from engine and air cleaner. Check the condition of the air filter element.

2. Check the condition of the coolant pump belt and the fan drive belts before tensioning the belts. Tension the coolant pump belts and tension the fan drive belts. Refer to this Operation and Maintenance Manual, “Belts - Inspect/Adjust” for more information.

3. Check the coolant level. Refer to Operation and Maintenance Manual, “Coolant Level - Check”

4. Remove valve cover, refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install”. Lubricate the valve train. Install the valve cover.

5. Replace the fuel filters. Refer to the following section within the Operation and Maintenance Manual.

- Fuel System Primary Filter (Water Separator) Element - Replace
- Fuel System Secondary Filter - Replace
- Fuel System - Prime

6. Use a bar or a turning tool in order to turn the engine in the normal direction of rotation. The procedure ensures that no hydraulic locks or resistance exist.

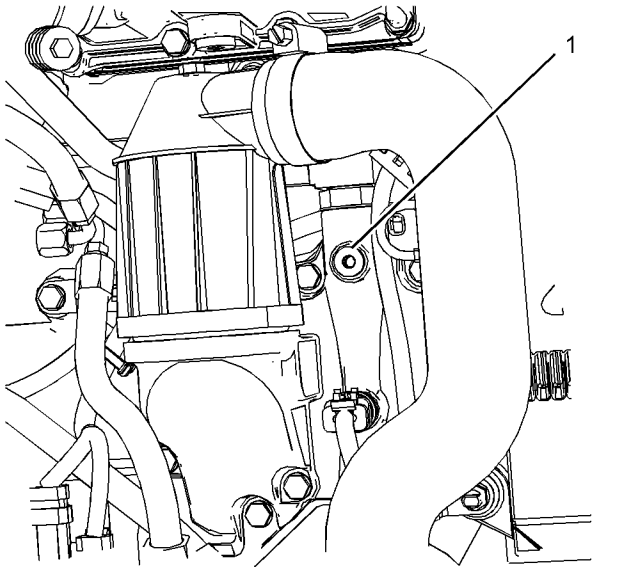


Illustration 25 g03774288

(1) Plug

7. If an engine is stored for more than 1 year, Perkins recommends Pre lubrication of the engine in order to avoid dry starting. Use a suitable pump in order to put engine oil into the engine oil system.

The pump will need to create a minimum pressure within the engine of 0.25 bar (3.6 psi). This pressure is needed for 15 seconds in order to lubricate the internal surfaces. Remove plug (1) in order to connect to the engine oil system. The connection required is 9/16" x 18 tpi. Ensure that the correct oil specification is used, refer to this Operation and Maintenance Manual, “Fluid Recommendations” for more information. After the engine internal surfaces have been lubricated, remove connector and install plug (1). Tighten plug to a torque of 30 N·m (265 lb in). Perkins recommends that the procedure must be performed in a minimum ambient temperature of 10° C (50° F).

8. Check engine oil level and visually inspect all hoses and connections before starting the engine. Start the engine, refer to this Operation and Maintenance Manual, “Starting the Engine” for more information.

After starting the engine and after correct operation of the engine, stop the engine and check again the engine oil level. Ensure that engine oil level is correct.

Features and Controls

i05952344

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 literature that is provided by the OEM.

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 distributor or the Perkins dealer for assistance.



Engine Oil Pressure – Typical oil pressure for an engine at rated speed with SAE 10W30 or with SAE 15W40 is 240 to 480 kPa (35 to 70 psi).



Engine Oil Temperature – This gauge indicates the engine oil temperature. An oil temperature that is higher than normal indicates a heat problem in the lubrication system and/or the cooling system. This problem can damage the cylinder heads, the cylinder liners, the pistons, and the crankshaft bearings.



Jacket Water Coolant Temperature – Typical temperature range is 88 to 102 °C (190 to 215 °F). The maximum allowable temperature with the pressurized cooling system is 105 °C (220 °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 or steam becomes apparent, perform the following procedure:

1. Reduce the engine load .

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.

⚠ 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.

4. Check the coolant level.



Tachometer – This gauge indicates engine speed. 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.



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



Service Hour Meter – This gauge indicates the total number of clock hours of engine operation. Hours of operation are logged in the ECM. A service tool is needed to retrieve the hours from the ECM. A Service Hour Meter may be installed on the engine.



Fuel Level – This gauge indicates the level of fuel in the fuel tank. The fuel level gauge registers the fuel level only when the ignition switch is in the ON position.

Warning Indicators

There are two warning lamps available.

- Warning Lamp
- Shutdown Lamp

Instrument Panels and Displays

In order to monitor the engine a wide verity of instrument panels are available. These instrument panels can contain the indicator lamps and the gauges for the application.

Also available are mini power displays and performance monitors.

i05964915

Monitoring System

The engine has protection in three stages:

- Warning
- Action Alert
- Shutdown

The engine protection may be overridden by the critical condition mode.

The Electronic Control Module (ECM) monitors the following parameters:

- Engine Temperatures
- Engine Pressures
- Engine Speed

The indicator lamp will be illuminated after the trip point is triggered. The ECM will log the event code.

The following parameters are monitored for event codes:

- Lubricating Oil Pressure
- Coolant Temperature
- Overspeed
- Intake Manifold Temperature
- Intake Manifold Pressure
- Fuel Temperature

The temperature protection is disabled for a period when the engine is cranking in order to compensate for heat soak solutions.

The ECM has dedicated alarm outputs for each of the three stages of protection. There are also dedicated alarm outputs for oil pressure, coolant temperature, and overspeed events which are energized at any stage of protection.

Warning Alarm

The Warning alarm informs the user that the engine is approaching a critical condition.

If the engine is in the warning condition, then the event will be logged in the memory of the ECM. An event code will be transmitted over the Perkins data link and the hard wired Warning output will be energized. If the engine is in the warning condition, the event code and output will remain while the condition exists. The electronic service tool is used to remove the event code from the memory of the ECM. The trip point for the warning alarm will be set to a factory default in production. The electronic service tool may be used to alter the trip point for a warning within predefined limits.

Action Alert

The action alert informs the OEM that the engine is approaching a critical condition. The engine should be stopped in a controlled manner. Further running of the engine may result in an immediate shutdown.

If the engine is in the action alert condition, the event will be logged in the memory of the ECM. An event code will be transmitted over the Perkins data link and the hard wired action alert will be energized. If the engine is in the action alert condition, the event code and output will remain while the condition exists. The event code cannot be cleared from the memory of the ECM without using a factory password.

Shutdown

If the engine reaches the Shutdown condition, one of the following events has occurred: low lubricating oil pressure, high coolant temperature, or overspeed. The event will be logged in the memory of the ECM. The engine will be shut down. An event code will be transmitted over the Perkins data link and the hard wired Shutdown output will be energized. The Shutdown condition will latch until the ECM is reset. The event code for the shutdown cannot be cleared from the memory of the ECM without using a factory password.

Critical Protection Override

If the engine is in an application that is critical for safety, the protection system can be overridden. This action is in order to ensure the continuation of the power supply during engine fault conditions.

Critical Protection Override will be set by a switch input from the OEM. For example, a switch to battery + in order to disable a critical override. Critical Protection Override input can be enabled in the electronic service tool by use of a factory password.

When the Critical Protection Override feature is active, the ECM will continue to run the engine in all shutdown conditions except for Overspeed shutdown. If the shutdown is overridden, an event code is generated. The ECM will log the event code. The ECM will energize the following: Warning, Action Alert, Shutdown, oil pressure, coolant temperature and overspeed outputs as normal. The warranty of the engine will be invalidated if the engine is operated in the following conditions: active event code and Critical Protection Override mode.

Standard Warning Outputs

The ECM provides individual outputs in order to drive warning lamps or relays to indicate each of the following fault conditions:

- Diagnostic Fault
- Oil Pressure
- Coolant Temperature
- Overspeed
- Action Alert
- Warning
- Shutdown

If the ECM detects a warning from the coolant temperature sensor, the ECM will energize a warning output.

If the ECM detects a warning from the coolant temperature sensor, the ECM will energize a warning output. If the ECM detects a warning for the low oil pressure, the output on the oil pressure will be energized. The warning output will be energized.

If the Action Alert alarms are enabled and the ECM detects a coolant temperature condition, the output on the coolant temperature will be energized. The output on the Action Alert will be energized.

If the engine shuts down on low oil pressure, the output on the low oil pressure will be energized. The output on the shutdown will be energized. If the engine shuts down on coolant temperature, or the engine shuts down on overspeed, the dedicated output, and the shutdown output will be energized.

Shutdown Reset

The cause of an engine shutdown must be investigated. Corrective action must be taken before the system is reset in order to operate the engine.

After an engine shutdown, operate the reset input of the ECM or power down the controller.

Powering down the electronic control module can be achieved by the operation of the keyswitch into sleep mode. The electronic control module can be powered down by isolating the power supply to the electronic control module.

Note: The ECM cannot be reset using the reset input until the engine has stopped.

Diagnostic

If there is a fault with an engine protection sensor on the engine, the engine activates a diagnostic code. The engine communicates the diagnostic code to the operator via the Diagnostic output. The diagnostic code provides an indication to the operator of a fault with the engine protection system. Running of the engine for a prolonged period in this condition may result in engine failure. The output can be used to drive lamps or relays.

The following sensors are monitored in order to determine if the sensors are out of the normal range, an open circuit, or a short circuit:

- Atmosphere Pressure
- Lubricating Oil Pressure
- Inlet Manifold Pressure
- Inlet Manifold Temperature
- Fuel Temperature
- Coolant Temperature
- Engine Speed
- Desired Speed Input

The Diagnostic output differs from the Warning and Shutdown outputs. The Warning and Shutdown outputs refer to the operation of the engine. The Diagnostic output refers to the condition of the electronic system and software system.

A diagnostic fault may develop on the lubricating oil pressure or coolant temperature sensors. For example, if a Shutdown protection sensor has a fault, this fault will result in an engine shutdown. Unless the system, is in critical protection override. If a diagnostic fault occurs, with one of the engine speed sensors while the engine is running. The engine continues to run by using the other timing sensor for reference.

i06231547

Sensors and Electrical Components

The illustration within the section shows the typical locations of the sensors and other electrical components on the Industrial engine. Specific engines may appear different due to the application.

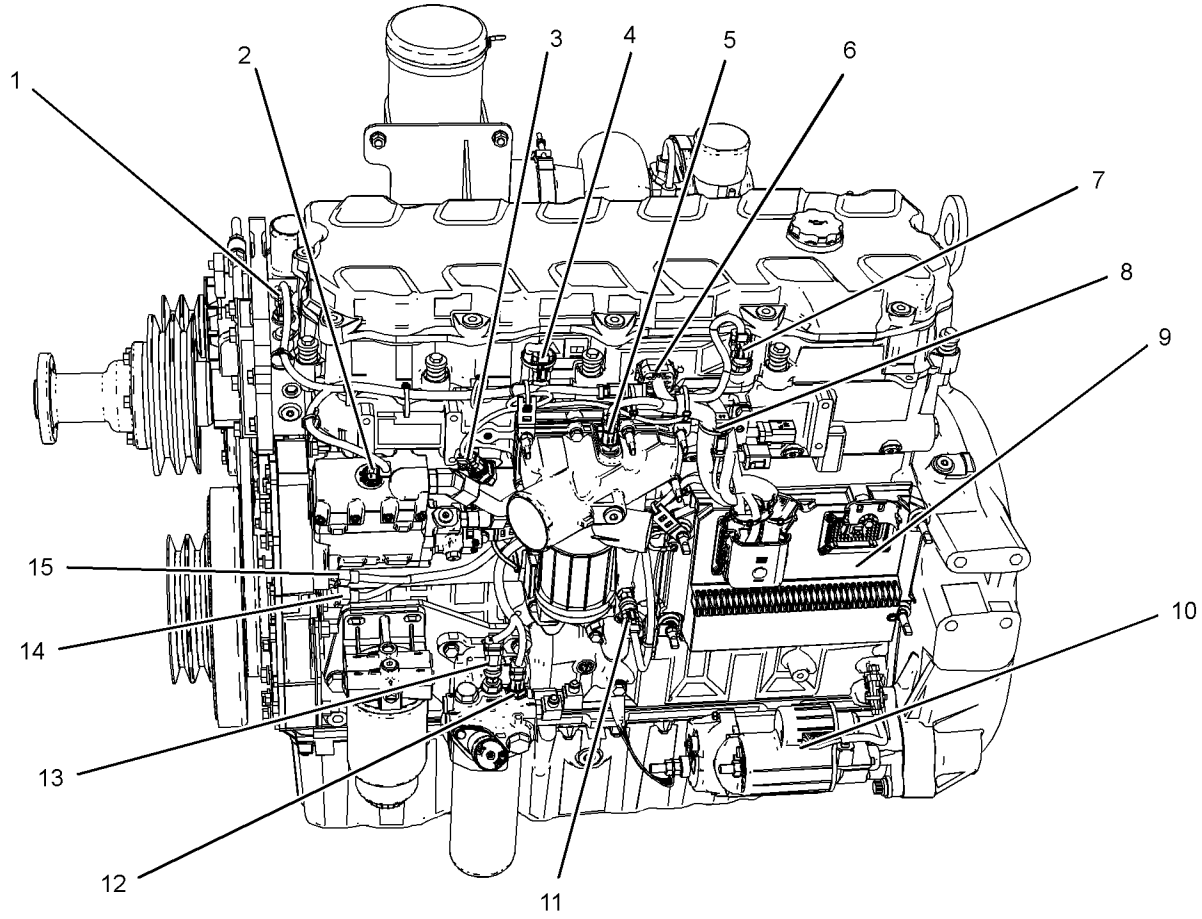


Illustration 26 g03745560

Typical example

(1) Coolant sensor
(2) Injection actuation pressure control valve
(3) Fuel rail pressure sensor
(4) Intake air pressure sensor
(5) Intake air temperature sensor
(6) Injector harness connection
(7) Atmospheric pressure sensor
(8) Probe for top center position

(9) Electronic control module
(10) Starting motor
(11) Oil pressure sensor
(12) Fuel temperature sensor
(13) Fuel pressure sensor
(14) Speed timing sensor
(15) Speed timing sensor

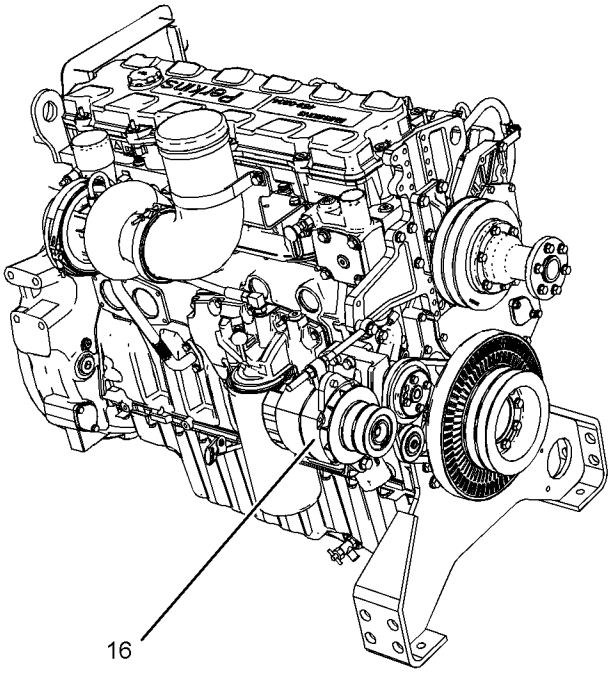


Illustration 27 g03745561

Typical example

(16) Alternator

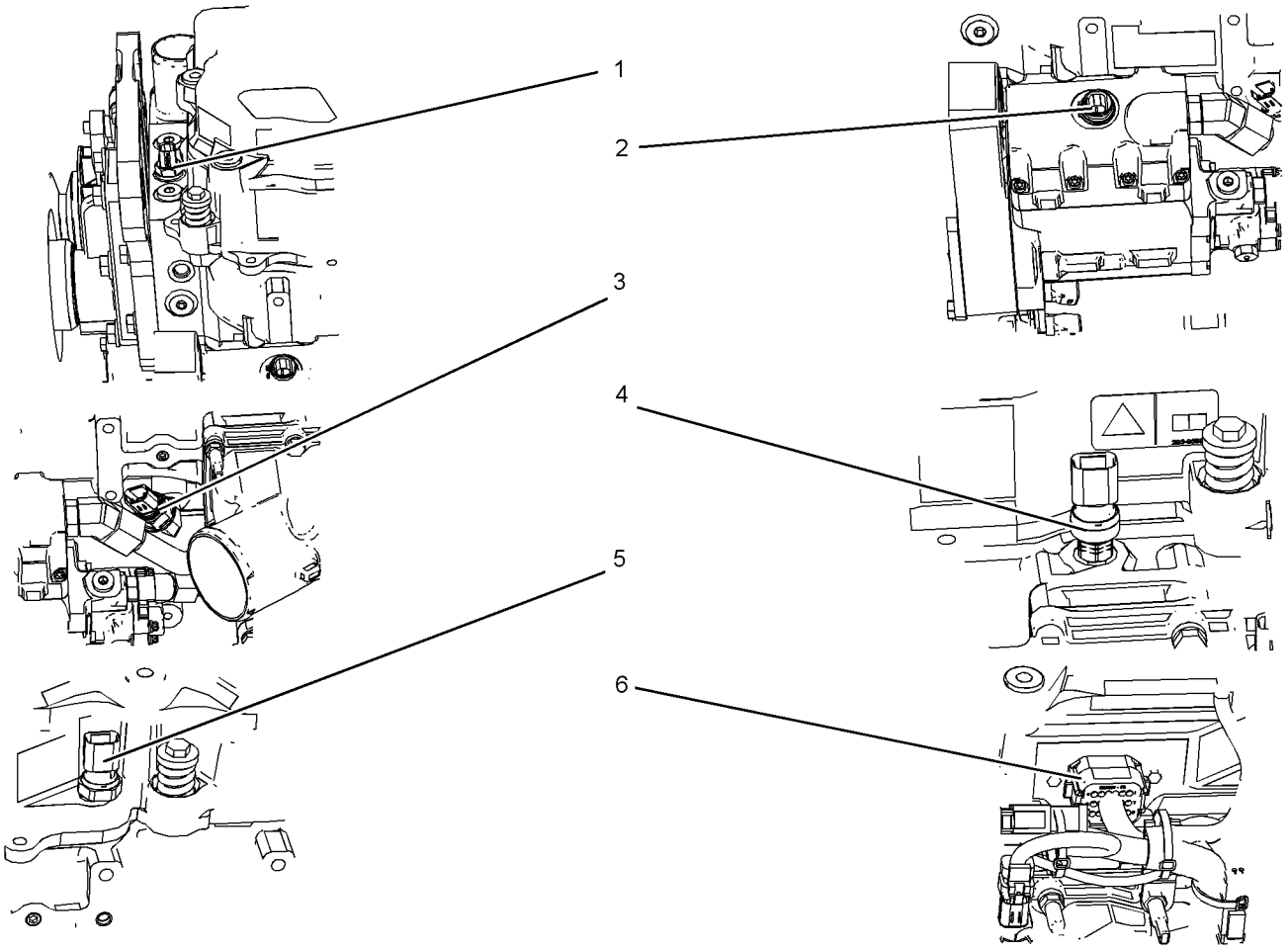


Illustration 28 g03745623

Typical example

(1) Coolant sensor
(2) Injection actuation pressure control valve
(3) Fuel rail pressure sensor
(4) Intake air pressure sensor
(5) Intake air temperature sensor
(6) Injector harness connection

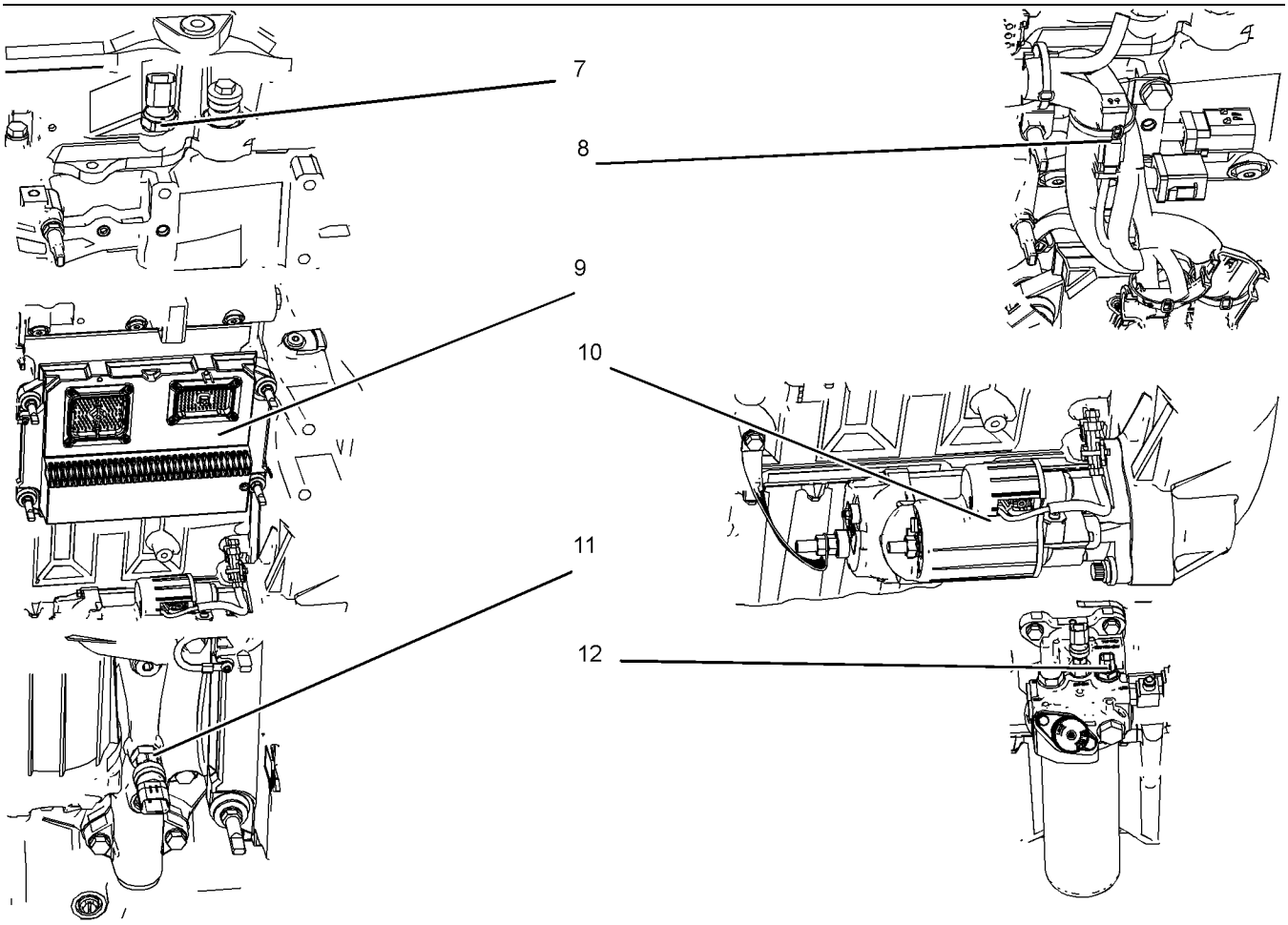


Illustration 29 g03746096

Typical example

(7) Atmospheric pressure sensor
(8) Probe for top center position
(9) Electronic control module
(10) Starting motor
(11) Oil pressure sensor
(12) Fuel temperature sensor

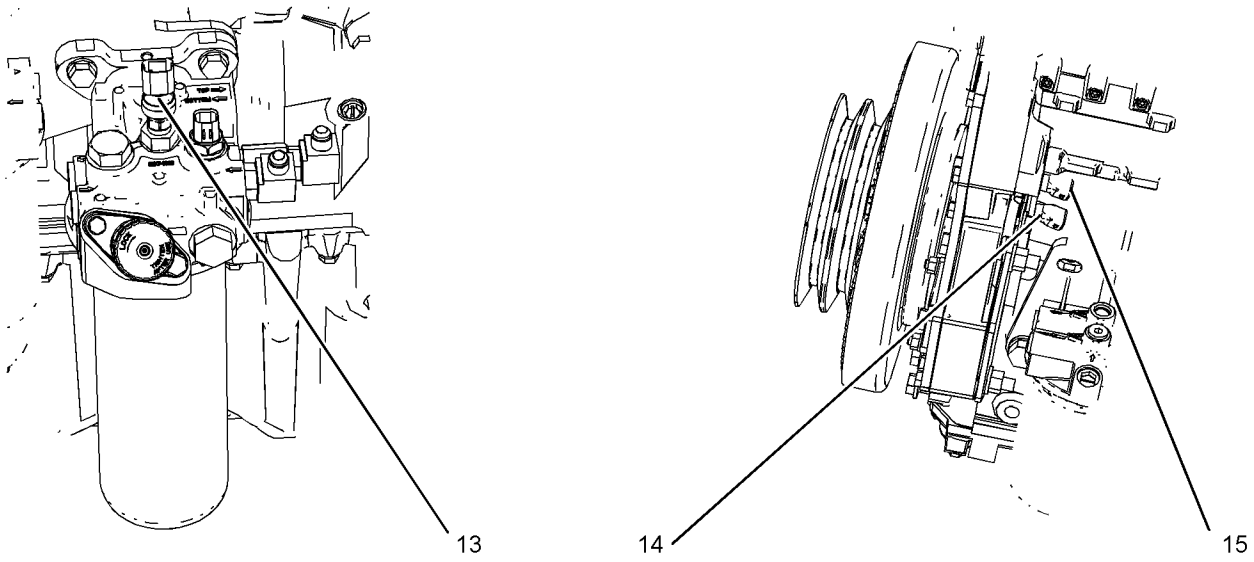


Illustration 30 g03746099

Typical example

(13) Fuel pressure sensor (14) Speed timing sensor (15) Speed timing sensor

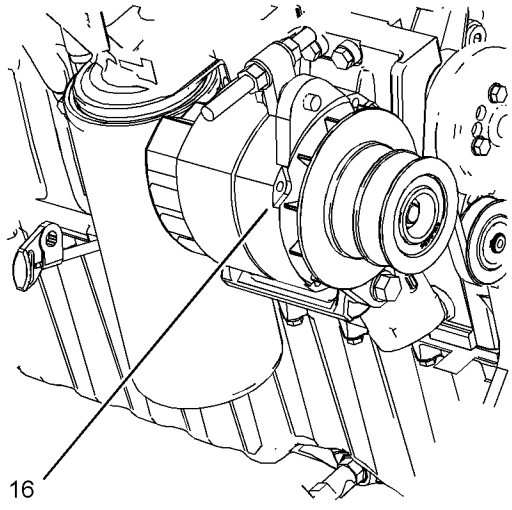


Illustration 31 g03746100

Typical example

(16) Alternator

1506D Configuration

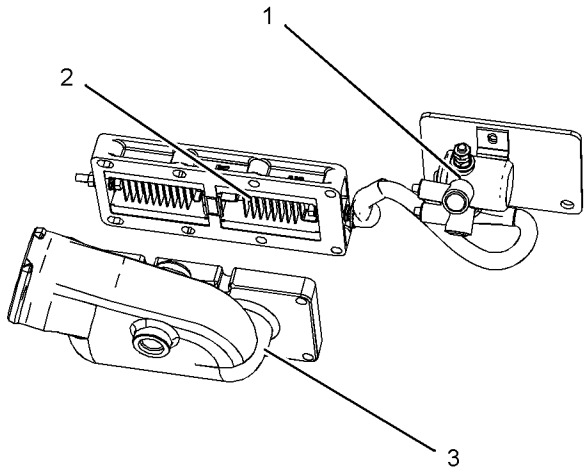


Illustration 32 g03864788

Typical example

(1) Switch
(2) Heating element
(3) Air inlet cover

Engine Diagnostics

i02784187

Self-Diagnostics

The electronic control module has some self-diagnostic ability. When an electronic problem with an input or an output is detected, a diagnostic code is generated. This indicates the specific problem with the circuitry.

A diagnostic code which represents a problem that currently exists is called an active code.

A diagnostic code that is stored in memory is called a logged code. Always service active codes prior to servicing logged codes. Logged codes may indicate intermittent problems.

Logged codes may not indicate that a repair is needed. The problems may have been repaired since the logging of the code. Logged codes may be helpful to troubleshoot intermittent problems.

i02572812

Diagnostic Lamp

The “DIAGNOSTIC” lamp is used to indicate the existence of an active fault.

A fault diagnostic code will remain active until the problem is repaired.

i02784192

Fault Logging

The system provides the capability of Fault Logging. When the Electronic Control Module (ECM) generates an active diagnostic code, the code will be logged in the memory of the ECM. The Perkins electronic service tool can retrieve codes that have been logged. The codes that have been logged can be cleared with the Perkins electronic service tool. The codes that have been logged in the memory of the ECM will be automatically cleared from the memory after 100 hours.

i02651197

Engine Operation with Active Diagnostic Codes

If a diagnostic lamp illuminates during normal engine operation, the system has identified a situation that is not within the specification. Use the electronic service tool to check the active diagnostic codes.

The active diagnostic code should be investigated. The cause of the problem should be corrected as soon as possible. If the cause of the active diagnostic code is repaired and there is only one active diagnostic code, the diagnostic lamp will turn off.

Operation of the engine and performance of the engine can be limited as a result of the active diagnostic code that is generated. Acceleration rates may be significantly slower and power outputs may be automatically reduced. Refer to Troubleshooting , “Troubleshooting with a Diagnostic Code” for more information on the relationship between each active diagnostic code and the possible effect on engine performance.

i02784585

Engine Operation with Intermittent Diagnostic Codes

If a diagnostic lamp illuminates during normal engine operation and the diagnostic lamp shuts OFF, an intermittent fault may have occurred. If a fault has occurred, the fault will be logged into the memory of the Electronic Control Module (ECM).

In most cases, it is not necessary to stop the engine because of an intermittent code. However, the operator should retrieve the logged fault codes and the operator should reference the appropriate information in order to identify the nature of the fault. The operator should log any observation that could have caused the lamp to light.

- Low power
- Limits of the engine speed
- Excessive smoke, etc

This information can be useful to help troubleshoot the situation. The information can also be used for future reference. For more information on diagnostic codes, refer to the Troubleshooting guide for this engine.

i05985293

Configuration Parameters

The engine electronic control module (ECM) has two types of configuration parameters. The system configuration parameters and the customer specified parameters.

The electronic service tool is required in order to alter the configuration parameters.

System Configuration Parameters

System configuration parameters affect the emissions of the engine or the power of the engine. System configuration parameters are programmed at the factory. Normally, system configuration parameters would never require changing through the life of the engine. System configuration parameters must be reprogrammed if an ECM is replaced. System configuration parameters do not require reprogrammed if the ECM software is changed. Factory passwords are required to change these parameters.

For more information on refer to Troubleshooting, “Configuration Parameters”.

Engine Starting

i05953831

Before Starting Engine

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date.

- For the maximum service life of the engine, make a thorough inspection before starting the engine. Look for the following items: oil leaks, coolant leaks, loose bolts and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- 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.

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 run 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 space will be left in the housing. 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 of 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 (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset any of the shutoff components or alarm components.
- Check the engine lubrication oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level gauge.
- Check the coolant level, maintain the coolant level within 13 mm (0.5 inch) from the neck of the radiator cap.
- Observe the air cleaner service indicator. Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.

i06231552

Cold Weather Starting

⚠ WARNING

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

(If equipped), ensure operation of water jacket heater before starting the engine.

Ensure that all daily maintenance checks are performed before starting the engine.

If the engine has not been run for several weeks, fuel may have drained. Air may have moved into the filter housing. Also, when fuel filters have been changed, some air will be left in the filter housing. Refer to Operation and Maintenance Manual, “Fuel System - Prime” in order to remove air from the fuel system.

NOTICE
Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait 30 seconds to allow the starting motor to cool before attempting to start the engine again.

1. Disengage any equipment that is driven by the engine.

2. Turn the keyswitch to the ON position and check that all indicator lamps operate correctly. When the key is turned to the next position, some engines will operate an air inlet heater. Allow time for the heater to heat the incoming air.

3. Turn the keyswitch to the START position in order to engage the electric starting motor and crank the engine.

4. During the start procedure, if a warning indicator becomes active the warning should be investigated.

5. Repeat steps 2 through to step 3 three times if the engine fails to start. If the engine fails to start, refer to Troubleshooting, “Engine Cranks but Does Not Start”.

Note: Check all gauges and indicators for correct operation. A system fault may be indicated after the engine is started. If this indication occurs, the ECM has detected a problem with the system. The fault must be investigated.

6. Oil pressure should rise within 15 seconds after the engine starts. The engine electronic controls monitor the engine oil pressure. The electronic controls will stop the engine if the oil pressure is below normal.

The original equipment manufacturer may have their own systems for starting an engine in cold weather.

i05975875

Starting the Engine

1. Disengage any equipment that is driven by the engine.

2. Turn keyswitch to the ON position and check for correct operation of gauges and indicators. Refer to original equipment manufacturer for information on the starting control panel.

NOTICE
Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

3. Turn keyswitch in order to crank engine and when engine fires release keyswitch.

4. If the engine fails to start, repeat step 2 to 3 repeat these steps three times only.

5. If the engine fails to start, refer to Troubleshooting, “Engine Cranks but Does Not Start”.

i05954108

Starting with Jump Start Cables

⚠ 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. Refer to Troubleshooting, “Engine Will Not Crank and Engine Cranks But Will Not Start” for further information. 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
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.

Note: The engine ECM must be powered before the starting motor is operated or damage can occur.

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 completely the 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”.

i06231640

After Starting Engine

Ensure that the self test for the monitoring system is completed before operating the engine under load.

Constant Speed Engines

The engine will operate at a content speed. The speed will be programmed in to the electronic control unit. Check all gauges and indicator lamps after starting for correct reading and correct actions.

Visually check for coolant, oil, or fuel leaks.

Allow the engine 3 minutes warm up time before applying load.

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

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.

Variable Speed Engines

The engine should not be raced in order to speed up the warm-up process. Allow the engine to idle for 3 to 5 minutes, or allow the engine to idle until the water temperature indicator begins to rise. Then, the engine can be operated normally.

Engine Operation

i05954288

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 time that is needed for the engine to reach normal operating temperature can be less than the time needed for a walk-around inspection of the engine.

After the engine is started and after the engine reaches normal operating temperature, the engine can be operated at load.

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.

i05954310

Engaging the Driven Equipment

If possible, engage the driven equipment without a load. With the engine in a stable operating mode, apply the load.

With load applied check for correct operation of gauges and indicators.

i05954305

Fuel Conservation Practices

The efficiency of the engine can affect the fuel economy. The design and technology used byPerkins 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 operation at no load.

Shut off the engine instead of operating the engine at no load for long periods of time.

- Observe the service indicator for the air cleaner frequently. Keep the air cleaner elements clean.
- Maintain a good electrical system.

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

- Ensure that the belts are properly adjusted. The 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. 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.

Cold Weather Operation

i05954317

Radiator Restrictions

Perkins discourages the use of airflow restriction devices that are mounted in front of radiators. Airflow restriction can cause the following conditions:

- High exhaust temperatures
- Power loss
- Excessive fan usage
- Reduction in fuel economy

If an airflow restriction device must be used, the device should have a permanent opening directly in line with the fan hub. The device must have a minimum opening dimension of at least 770 cm^2 (120 in^2).

A centered opening that is directly in line with the fan hub is specified in order to prevent an interrupted airflow on the fan blades. Interrupted airflow on the fan blades could cause a fan failure.

Perkins recommends a warning device for the inlet manifold temperature and/or the installation of an inlet air temperature gauge. The warning device for the inlet manifold temperature should be set at 75 °C (167 °F). The inlet manifold air temperature should not exceed 75 °C (167 °F). Temperatures that exceed this limit can cause power loss and potential engine damage.

i05954321

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. It is critical that the low temperature properties of diesel fuel are acceptable for the minimum ambient temperature the engine is expected to see in the 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 the diesel fuel begin to form crystals. The cloud point of the fuel must be below lowest ambient temperature to prevent filters from plugging.

Cold Filter Plugging Point is a temperature at which a particular fuel will pass through a standardized filtration device. This 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, “Fuel For Cold Weather Operation”

Another important fuel property which can affect cold start and operation of diesel engine is Cetane number. Detail and requirements of this property are given in this Operation and Maintenance Manual, “Fluid Recommendations”.

i05955135

Fuel Related Components in Cold Weather

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after operating 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
- Refueling of the fuel tank

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

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in order for the fuel to be heated before the fuel enters the primary fuel filter.

Select a fuel heater that is mechanically simple, yet adequate for the application. The fuel heater should also help to prevent overheating of the fuel. High fuel temperatures reduce engine performance and the availability of engine power. Choose a fuel heater with a large heating surface. The fuel heater should be practical in size. Small heaters can be too hot due to the limited surface area.

Disconnect the fuel heater in warm weather.

Note: Fuel heaters that are controlled by the water temperature regulator or self-regulating fuel heaters should be used with this engine. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65° C (149° F). A loss of engine power can occur if the fuel supply temperature exceeds 37° C (100° F).

Note: Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel in warm-weather operation.

For further information on fuel heaters, consult your Perkins dealer or your Perkins distributor.

Engine Stopping

i05955161

Emergency Stopping

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

The 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.

i05955160

Manual Stop Procedure

Stopping the Engine

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

Avoid accelerating the engine prior to shutting it down.

Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life.

Note: Individual applications will have different control systems. Ensure that the shutoff procedures are understood. Use the following general guidelines in order to stop the engine.

1. Remove the load from the engine. Allow the engine to run under no load conditions for 5 minutes in order to cool the engine.

2. Stop the engine after the cool down period according to the shutoff system on the engine and turn the ignition keyswitch to the OFF position. If necessary, refer to the instructions that are provided by the OEM.

i02583411

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 “LOW” mark and the “HIGH” mark on the oil level gauge.

Note: Only use oil that is recommended in this Operation and Maintenance Manual, “Fluid Recommendations”. Failure to use the recommended oil may result in engine damage.

- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
- Note the service hour meter reading. 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.
- Allow the engine to cool. Check the coolant level. Maintain the cooling system at 13 mm (0.5 inch) from the bottom of the pipe for filling.

Note: Only use coolant that is recommended in this Operation and Maintenance Manual, “Fluid Recommendations”. Failure to use the recommended oil may result in engine damage.

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

Maintenance Section

Refill Capacities

i05955174

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 additional oil. Refer to the 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 5

Engine Refill Capacities		
Compartment or System	**At Commissioning**	**In Service**
Crankcase Oil Sump (1)	41 L	39 L

(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.

Cooling System

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

Table 6

Engine Refill Capacities	
Compartment or System	**Liters**
Engine Only	14
External System Per OEM(1)	33

(continued)

(Table 6, contd)

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

i06231649

Fluid Recommendations

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

Water is used in the cooling system in order 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 7 .

Table 7

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 1:1 mixture of a water/glycol solution.

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 water, ethylene and propylene glycol provide similar protection against freezing and boiling. Refer to Table 8 and refer to table 9 .

Table 8

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 9

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

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

Coolant Recommendations

- ELC_____Extended Life Coolant
- SCA_____Supplement Coolant Additive
- ASTM_____American Society for Testing and Materials

The following two coolants are used in Perkins diesel engines:

Preferred – Perkins ELC

Acceptable – A commercial heavy-duty antifreeze that meets “ASTM D6210 ” specifications

NOTICE
The 1500 series industrial engines must be operated with a 1:1 mixture of water and glycol. This concentration allows the NOx reduction system to operate correctly at high ambient temperatures.

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.

Perkins recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as an antifreeze. This ratio may be increased to 1:2 water to glycol if extra freezing protection is required.

A mixture of SCA inhibitor and water is acceptable but will not give the same level of corrosion, boiling and, freezing protection as ELC. Perkins recommends a 6 percent to 8 percent concentration of SCA in those cooling systems. Distilled water or deionized water is preferred. Water which has the recommended properties may be used.

Table 10

Coolant Service Life	
Coolant Type	**Service Life (1)**
Perkins ELC	6,000 Service Hours or Three Years
Commercial Heavy-Duty Antifreeze that meets “ASTM D6210”	3000 Service Hours or Two Year
Commercial SCA inhibitor and Water	3000 Service Hours or One Year

(1) Use the interval that occurs first. The cooling system must also be flushed out at this time.

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 in order 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 1:1 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
Use only Perkins products for pre-mixed or concentrated coolants.

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.

In order 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. This lowering will lower the ability of the coolant to protect the system from 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 standard supplemental coolant additive (SCA).

When using Perkins ELC, do not use standard SCA's or SCA filters.

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.

Clean 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 in order 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 in order 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. Fill the cooling system with a 33 percent solution of Perkins ELC and operate the engine, ensure that the thermostat opens. Stop the engine and allow the engine to cool. Drain the coolant.

Note: Use distilled or deionized water in the solution.

4. Again, fill the cooling system with a 33 percent solution of Perkins ELC and operate the engine ensure that the thermostat opens. Stop the engine and allow to cool.

5. Drain the drain the cooling system.

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

6. Fill the cooling system with the Perkins Premixed ELC. Operate the engine. Ensure that all coolant valves open then stop the engine. When cool check the coolant level.

ELC Cooling System Contamination

NOTICE
Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Use only Perkins Products for premixed or concentrate coolants. Failure to follow these recommendations can result in shortened cooling system component life.

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 clean water. Fill the system with the Perkins ELC.
- Drain a portion of the cooling system into a suitable container according to local regulations. Then, fill the cooling system with premixed ELC. This procedure should lower the contamination to less than 10 percent.
- 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 Amine 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) in order to ensure adequate protection against boiling or freezing. Perkins recommends the use of a refractometer for checking the glycol concentration. A hydrometer should not be used.

Perkins engine cooling systems should be tested at 500 hour intervals for the concentration of SCA.

Additions of SCA are based on the results of the test. An SCA that is liquid may be needed at 500 hour intervals.

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

Use the equation that is in Table 11 to determine the amount of SCA that is required when the cooling system is initially filled.

Table 11

Equation For Adding The SCA To The Heavy-Duty Coolant At The Initial Fill
V × 0.045 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 12 is an example for using the equation that is in Table 11 .

Table 12

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)	× 0.045	0.7 L (24 oz)

Adding The SCA to The Heavy-Duty Coolant For Maintenance

Heavy-duty antifreeze of all types REQUIRE periodic additions of an SCA.

Test the antifreeze periodically for the concentration of SCA. For the interval, refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section). Cooling System Supplemental Coolant Additive (SCA) Test/Add.

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 13 to determine the amount of SCA that is required, if necessary:

Table 13

Equation For Adding The SCA To The Heavy-Duty Coolant For Maintenance
V × 0.014 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 14 is an example for using the equation that is in Table 13 .

Table 14

Example Of The Equation For Adding The SCA To The 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)	× 0.014	0.2 L (7 oz)

Cleaning the System of Heavy-Duty Antifreeze

- 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.

i06231742

Fluid Recommendations (Lubricant Information for 1506A and 1506C Engines)

S/N: LG

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.
- ACEA Association des Constructers European Automobiles.
- ECF Engine Crankcase Fluid
- TBN Total Base Number
- PPM Parts Per Million

Licensing

The Engine Oil Licensing and Certification System by the API and the ACRA 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.

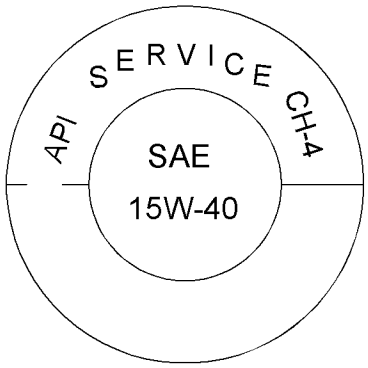


Illustration 33 g03739817

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” 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 15

Classifications for the 1506A and C Industrial Engine
Oil Specification
CH-4

Total Base Number (TBN) and Fuel Sulfur Levels

The minimum required TBN for oil depends on the fuel sulfur level. The TBN for new oil is typically determined by the “ASTM D2896” procedure. For direct injection engines that use distillate fuel, the following guidelines apply:

Table 16

TBN Recommendations (1)	
Fuel Sulfur Level percent (ppm)	TBN of Commercial Engine Oils
≤0.05 percent (≤500 ppm)	Min 7
0. 1- 0.05 percent (1000-500 ppm)	Min 7
Above 0.1 percent (above 1000 ppm) (2)	Min 10

(1) When using fuel with 0.10% sulfur (1000 ppm) or higher, refer to this Operation and Maintenance Manual, “Severe Service Application” for more information.
(2) For fuels of sulfur levels that exceed 1.0 percent (10,000 ppm), refer to TBN and engine oil guidelines given in this section.

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 34 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to illustration 34 (maximum temperature) in order 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.

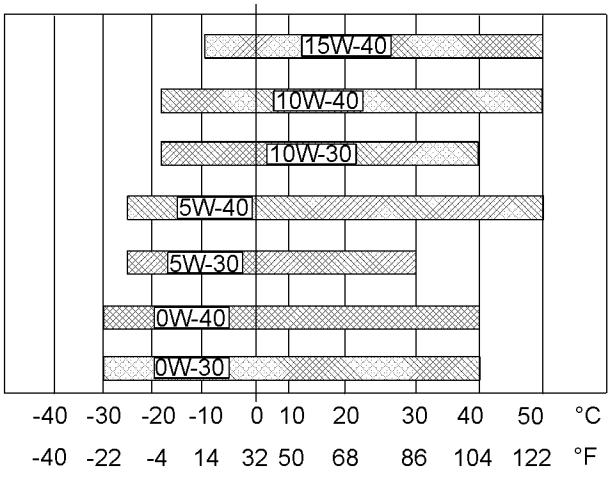


Illustration 34 g03329707

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.

Synthetic Base Stock Oils

Synthetic base oils are acceptable for use in these engines if these oils meet the performance requirements that are specified for the engine.

Synthetic base oils generally perform better than conventional oils in the following two areas:

- Synthetic base oils have improved flow at low temperatures especially in arctic conditions.
- Synthetic base oils have improved oxidation stability especially at high operating temperatures.

Some synthetic base oils have performance characteristics that enhance the service life of the oil. Perkins does not recommend the automatic extending of the oil change intervals for any type of oil.

Aftermarket Oil Additives

Perkins does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives in order 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 in order 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 and 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:

- Select the correct oil, or a commercial oil that meets the recommended API classification.
- See the appropriate “Lubricant Viscosities” table in order 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”.

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 the 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 in order 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.

i06231746

Fluid Recommendations

S/N: PK9

General Lubricant Information for the 1506D Engine

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.

Licensing

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API). 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.

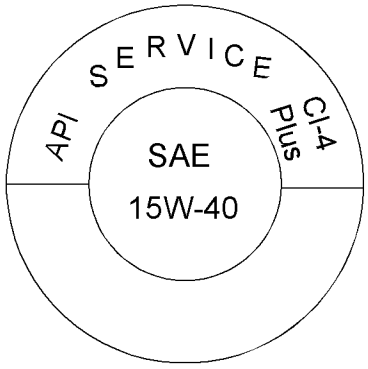


Illustration 35 g03813274

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” 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 17

Oil Specification for the 1506D Industrial Engine	
Preferred Oil Specification	**Acceptable**
API CI-4 Plus	API CI-4

API CI-4 Plus meets the designed life of the product, the use of the appropriate engine oil is essential.

API CI-4 Plus provide two design improvements over API CI-4 oil specification, soot viscosity control and product shear stability.

Maintenance intervals for engines that use biodiesel – The oil change interval can be adversely affected by the use of biodiesel. Use oil analysis in order to monitor the condition of the engine oil. Use oil analysis also in order to determine the oil change interval that is optimum.

Note: These engine oils are not approved by Perkins and these engine oils must not be used: CC, CD, CD-2, CF-4, CG-4 and CH-4.

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 36 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to illustration 36 (maximum temperature) in order 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.

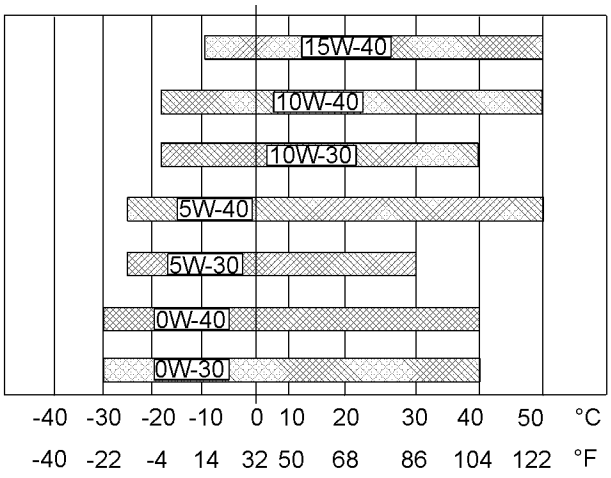


Illustration 36 g03329707

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. The requirement also depends on the parasitic load and other factors. Cold soaked starts occur when the engine has not been operated for a longtime. 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. The use of aftermarket additives in order to achieve the engines maximum service life or rated performance is not necessary. Fully formulated, finished oils consist of base oils and of commercial additive packages. Additive packages are blended into the base oils at precise percentages in order to 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 36 in order 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”.

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 in order 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.

i06231780

Fluid Recommendations
(Fuel Recommendations for the 1506A and 1506C Engines)

S/N: LG

- **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
- RME Rape Methyl Ester
- SME Soy Methyl Ester
- EPA Environmental Protection Agency of the United States

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

Perkins is not in a position to evaluate continuously and monitor all worldwide distillate diesel fuel specifications that are published by governments and technological societies.

Table 18 provides a known reliable baseline in order to judge the expected performance of distillate diesel fuels that are derived from conventional sources.

Satisfactory engine performance is dependent 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 18 .

NOTICE
The footnotes are a key part of the Perkins Specification for Distillate Diesel Fuel Table. Read ALL of the footnotes.

Table 18

Perkins Specification for Distillate Diesel Fuel				
Property	**UNITS**	**Requirements**	**“ASTM Test”**	**“ISO Test”**
Aromatics	%Volume	35% maximum	D1319	“ISO 3837”
Ash	%Weight	0.01% maximum	D482	“ISO 6245”
Carbon Residue on 10% Bottoms	%Weight	0.35% maximum	D524	“ISO 4262”
Cetane Number (1)	-	40 minimum	D613 or D6890	“ISO 5165”
Cloud Point	°C	The cloud point must not exceed the lowest expected ambient temperature.	D2500	“ISO 3015”
Copper Strip Corrosion	-	No. 3 maximum	D130	“ISO 2160”
Distillation	°C	10% at 282 °C (539.6 °F) maximum 90% at 360 °C (680 °F) maximum	D86	“ISO 3405”
Density at 15 °C (59 °F) (2)	Kg / M ^{3}	800 minimum and 860 maximum	No equivalent test	“ISO 3675 ” or “ISO 12185”
Flash Point	°C	legal limit	D93	“ISO 2719”
Thermal Stability	-	Minimum of 80% reflectance after aging for 180 minutes at 150 °C (302 °F)	D6468	No equivalent test
Pour Point	°C	6 °C (10°F) Minimum below ambient temperature	D97	“ISO 3016”
Sulfur	%mass	(3)	D5453 or /D26222	“ISO 20846 ” or “ISO 20884”
Kinematic Viscosity (4)	“MM”^{2}“/S (cSt)”	The viscosity of the fuel that is delivered to the fuel injection pump. “1.4 minimum and /4.5 maximum”	D445	“ISO 3405”
Water and sediment	% weight	0.05% maximum	D1796	“ISO 3734”
Water	% weight	0.05% maximum	D1744	No equivalent test
Sediment	% weight	0.05% maximum	D473	“ISO 3735”
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”
Fuel cleanliness (7)	-	“ISO”18/16/13	7619	“ISO 4406”

(1) In order to insure minimum cetane number of 40 a distillate diesel fuel should have minimum cetane index of 44 when ASTM D4737 test method is used. A fuel with a higher cetane number is recommended in order to operate at a higher altitude or in cold weather.

(2) Density range allowed includes summer and winter diesel fuel grades. Fuel density varies depending on the sulfur level where high sulfur fuels have higher densities. Some unblended alternative fuels have lower densities which are acceptable, if all the other properties meet this specification.

(3) Regional regulations, national regulations, or international regulations can require a fuel with a specific sulfur limit. Consult all applicable regulations before selecting a fuel for a given engine application. Perkins fuel systems and engine components can operate on high sulphur fuels 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 0.5% may significantly shorten the oil change interval. For additional information, refer to **General lubricant Information**.

(continued)

(Table 18, contd)

(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 or the "ISO 3104" test method. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order 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.

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.

Engines that are manufactured by Perkins are certified with the fuel that is prescribed by the United States Environmental Protection Agency. Engines that are manufactured by Perkins are certified with the fuel that is prescribed by the European Certification and other regulatory agencies. Perkins does not certify diesel engines on any other fuel.

Note: The owner and the operator of the engine has the responsibility of using the fuel that is prescribed by the Environmental Protection Agency (EPA) and other appropriate regulatory agencies.

Diesel Fuel Characteristics

Perkins Recommendations

Cetane Number

Fuel that has a high cetane number will give a shorter ignition delay. A high cetane number 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.

Cetane numbers in excess of 45 are normally expected from current diesel fuel. However, a cetane number of 40 may be experienced in some territories. The United States of America is one of the territories that can have a low cetane value. A minimum cetane value of 40 is required during average starting conditions. A higher cetane value may be required for operations at high altitudes or in cold-weather operations.

Fuel with a low cetane number can be the root cause of problems during cold start.

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 in order to lubricate the fuel system in both cold temperatures and hot temperatures. If the kinematic viscosity of the fuel is lower than 1.4 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 1.4 and 4.5 cSt 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 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order 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 the following kg/m3 at 15 °C (59 °F).

Perkins recommends a value of density of 841 kg/m3 in order 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 international 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 0.05 percent (≤ 15 ppm (mg/kg)) sulfur is strongly recommended for use in these engine models.

ULSD and sulphur fuel diesel fuels are acceptable to use in all engine models. The lubricity of these fuels must not exceed 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 0.05 percent (500 PPM) can be used where allowed by legislation.

In some parts of the world and for some applications, high sulfur fuels above 0.5% by mass might only be available. Fuel with a high sulfur content can cause engine wear. High sulfur fuel will have a negative impact on emissions of particulates. High sulfur fuel can be used if the local emissions legislation will allow the use. High sulfur fuel can be used in countries that do not regulate emissions.

When only high sulfur fuels are available, it will be necessary that high alkaline lubricating oil is used in the engine or that the lubricating oil change interval is reduced. Refer to Operation and Maintenance Manual, “Fluid Recommendations (Lubricant Information)” for information on sulfur in fuel.

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 in order to meet stringent exhaust emissions.

The lubricity of these fuels must not exceed 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.

In case of the fuels which do not meet specified lubricity requirement appropriate lubricity additive can be used to enhance the lubricity of the fuel. UMK8276 Perkins Diesel Fuel Conditioner is the approved additive refer to “Perkins Diesel Fuel Conditioner, and Perkins”.

Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can make recommendations for additives to use and for the proper level of treatment.

Distillation

Distillation will give an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light weight hydrocarbons can affect the characteristics of combustion.

Classification of the Fuels

Diesel engines have an ability to burn wide variety of fuels. Below is a list of typically encountered fuel specifications that have been assessed as to their acceptability and are divided into following categories:

Group 1: Preferred Fuels

The following fuel specifications are considered acceptable.

Fuels that meet the requirements that are listed in the table 18 .

“EN590 - Grades A to F and class 0 to 4”

“ASTM D975 Grade No. 1-D and 2-D”

“JIS K2204 Grades 1, 2 & 3 & Special Grade 3” acceptable provided lubricity ware scar diameter does not exceed of 0.46 mm (0.01811 inch) as per “ISO 12156-1” .

“BS2869 - Class A2 Off Highway Gas Oil, Red Diesel”

Note: The lubricity of these fuels must not exceed wear scar diameter of 0.46 mm (0.01811 inch) as per “ISO 12156-1” . Refer to “Lubricity”.

Group 2: Aviation Kerosene Fuels

Following kerosene and jet fuel specifications are acceptable alternative fuels, and may be used on a contingency base for emergency or continuous use, where standard diesel fuel is not available and where legislation allows their use:

“MIL-DTL-83133 NATO F34 (JP-8)”

“MIL-DTL-83133 NATO F35”

“MIL-DTL-5624 NATO F44 (JP-5)”

“MIL-DTL-38219 (USAF) (JP7)”

“NATO XF63”

“ASTM D1655 JET A”

“ASTM D1655 JET A1”

NOTICE
These fuels are only acceptable when used with appropriate lubricity additive and must meet minimum requirements that are listed in table 18 . The lubricity of these fuels must not exceed wear scar diameter of 0.46 mm (0.01811 inch) as per “ISO 12156-1” . Refer to “Lubricity”.

Note: Minimum cetane number of 40 is recommended otherwise cold starting problems or light load misfire might occur. Since jet fuel specifications do not mention cetane requirements, Perkins recommends that a fuel sample is taken to determine the cetane number.

Note: Fuels must have minimum viscosity of 1.4 cSt delivered to the fuel injection pump. Cooling of the fuel may be required to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Perkins recommends that the actual viscosity of the fuel, be measured in order to determine if a fuel cooler is needed. Refer to “Viscosity”.

Note: Rated power loss of up to 10 percent is possible due to lower density and lower viscosity of jet fuels compared to diesel fuels.

Biodiesel Fuel

Biodiesel is a fuel that can be defined as mono-alkyl esters of fatty acids. Biodiesel is a fuel that can be made from various feedstock. The most commonly available biodiesel in Europe is Rape Methyl Ester (REM). This biodiesel is derived from rapeseed oil. Soy Methyl Ester (SME) is the most common biodiesel in the United States. This biodiesel is derived from soybean oil. Soybean oil or rapeseed oil are the primary feedstocks. These fuels are together known as Fatty Acid Methyl Esters (FAME).

Raw pressed vegetable oils are NOT acceptable for use as a fuel in any concentration in compression engines. Without esterification, these oils may gel in the crankcase and the fuel tank. These fuels may not be compatible with many of the elastomers that are used in engines that are manufactured today. In original forms, these oils are not suitable for use as a fuel in compression engines. Alternate base stocks for biodiesel may include animal tallow, waste cooking oils, or various other feedstocks. In order to use any of the products that are listed as fuel, the oil must be esterified.

Fuel made of 100 percent FAME is generally referred to as B100 biodiesel or neat biodiesel.

Biodiesel can be blended with distillate diesel fuel. The blends can be used as fuel. The most commonly available biodiesel blends are B5, which is 5 percent biodiesel and 95 percent distillate diesel fuel. B20, which is 20 percent biodiesel and 80 percent distillate diesel fuel.

Note: The percentages given are volume-based. The U.S. distillate diesel fuel specification “ASTM D975-09a” includes up to B5 (5 percent) biodiesel.

European distillate diesel fuel specification “EN590:2010” includes up B7 (7 percent) biodiesel.

Note: Engines that are manufactured by Perkins are certified by use of the prescribed Environmental Protection Agency (EPA) and European Certification fuels. Perkins does not certify engines on any other fuel. The user of the engine has the responsibility of using the correct fuel that is recommended by the manufacturer and allowed by the EPA and other appropriate regulatory agencies.

Specification Requirements

The neat biodiesel must conform to “EN14214” or “ASTM D6751” (in the USA) and can only be blended in mixture of up to 20 percent, by volume in acceptable mineral diesel fuel meeting requirements that are listed in table 18 or the latest edition of “EN590” and “ASTM D 975” commercial standards. This blend is commonly known as B20.

Biodiesel blends are denoted as “BXX” with “XX” representing the content of neat biodiesel contained in the blend with mineral diesel fuel (for example B5, B10, B20).

In United States Biodiesel blends of B6 to B20 must meet the requirements listed in the latest edition of “ASTM D7467” (B6 to B20) and must be of an API gravity of 30-45.

In North America biodiesel and biodiesel blends must be purchased from the BQ-9000 accredited producers and BQ-9000 certified distributors.

In other areas of the world, the use of biodiesel that is BQ-9000 accredited and certified, or that is accredited and certified by a comparable biodiesel quality body to meet similar biodiesel quality standards is required.

Engine Service Requirements with B20

Aggressive properties of biodiesel fuel may cause debris in the fuel tank and fuel lines. The aggressive properties of biodiesel will clean the fuel tank and fuel lines. This cleaning of the fuel system can prematurely block of the fuel filters. Perkins recommends that after the initial usage of B20 biodiesel blended fuel the fuel filters must be replaced at 50 hours.

Glycerides present in biodiesel fuel will also cause fuel filters to become blocked more quickly. Therefore the regular service interval should be reduced to 250 hours.

When biodiesel fuel is used, crank case oil and aftertreatment systems may be influenced. This influence is due to the chemical composition and characteristics of biodiesel fuel, such as density and volatility, and to chemical contaminants that can be present in this fuel, such as alkali and alkaline metals (sodium, potassium, calcium, and magnesium).

- Crankcase oil fuel dilution can be higher when biodiesel or biodiesel blends are used. This increased level of fuel dilution when using biodiesel or biodiesel blends is related to the typically lower volatility of biodiesel. In cylinder emissions control strategies utilized in many of the industrial latest engine designs may lead to a higher level of biodiesel concentration in the engine oil pan. The long-term effect of biodiesel concentration in crankcase oil is currently unknown.
- Perkins recommends the use of oil analysis in order to check the quality of the engine oil if biodiesel fuel is used. Ensure that the level of biodiesel in the fuel is noted when the oil sample is taken.

Performance Related Issues with B20

Due to the lower energy content than the standard distillate fuel B20 will cause a power loss in order of 2 to 4 percent. In addition, over time the power may deteriorate further due to deposits in the fuel injectors.

Biodiesel and biodiesel blends are known to cause an increase in fuel system deposits, most significant of which are deposits within the fuel injector. These deposits can cause a loss in power due to restricted or modified fuel injection or cause other functional issues associated with these deposits.

Perkins T400012 Fuel Cleaner is most effective in cleaning and preventing the formation of deposits. Refer to “Perkins Diesel Fuel System Cleaner, and Perkins” for more information. Perkins UMK8276 Perkins Diesel Fuel Conditioner helps to limit deposit issues by improving the stability of biodiesel while also hindering the production of new deposits. For more information refer to “Perkins Diesel Fuel Conditioner, and Perkins”. Therefore the use of Diesel Fuel Cleaner and or Diesel Fuel Conditioner is strongly recommended when running biodiesel blends, especially B20.

General Requirements

Biodiesel has poor oxidation stability, which can result in long-term problems in the storage of biodiesel. Biodiesel fuel should be used within 6 months of manufacture. Equipment should not be stored with the B20 biodiesel blends in the fuel system for longer than 3 months.

Due to poor oxidation stability and other potential issues, Perkins strongly recommends that engines with limited operational time either not use B20 biodiesel blends or, while accepting some risk, limit biodiesel blend to a maximum of B5. Examples of applications that should limit the use of biodiesel are the following: Standby generator sets and certain emergency vehicles.

Perkins strongly recommends that seasonally operated engines have the fuel systems, including fuel tanks, flashed with conventional diesel fuel before prolonged shutdown periods. An example of an application that should seasonally flush the fuel system is a combine harvester.

Microbial contamination and growth can cause corrosion in the fuel system and premature plugging of the fuel filter. Consult your supplier of fuel for assistance in selecting appropriate antimicrobial additive.

Water accelerates microbial contamination and growth. When biodiesel is compared to distillate fuels, water is naturally more likely to exist in the biodiesel. It is therefore essential to check frequently and if necessary, drain the water separator.

Materials such as brass, bronze, copper, led, tin, and zinc accelerate the oxidation process of the biodiesel fuel. The oxidation process can cause deposits formation therefore these materials must not be used for fuel tanks and fuel lines.

Fuel for Cold Weather Operation

The European standard “EN590” contains climate dependant requirements and a range of options. The options can be applied differently in each country. There are five classes that are given to arctic climates and severe winter climates. 0, 1, 2, 3 and 4.

Fuel that complies with “EN590” CLASS 4 can be used at temperatures as low as −44 °C (−47.2 °F). Refer to “EN590” for a detailed discretion of the physical properties of the fuel.

The diesel fuel “ASTM D975 1-D” that is used in the United States of America may be used in cold temperatures that are below −18 °C (−0.4 °F).

In extreme cold ambient conditions, you may use the aviation kerosene fuels that are specified in “Classification of the Fuels”. These fuels are intended to be used in temperatures that can be as low as −54 °C (−65.2 °F). Refer to “Classification of the Fuels” for detail and conditions of use of the aviation kerosene fuels.

⚠ WARNING

Mixing alcohol or gasoline with diesel fuel can produce an explosive mixture in the engine crankcase or the fuel tank. Alcohol or gasoline must not be used in order to dilute diesel fuel. Failure to follow this instruction may result in death or personal injury.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in table 18 . To ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are stated in the table 18 .

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 and is due to 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. Fuel additives need to be used with caution. Contact your fuel supplier for those 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 18 .

Perkins Diesel Fuel System Cleaner

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

If biodiesel or biodiesel blends of fuel are to be used, Perkins require the use of Perkins fuel cleaner. For more information on the use of biodiesel and biodiesel blends refer to “Biodiesel Fuel”.

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 must be use are on the container.

Perkins Diesel Fuel Conditioner

The Perkins Diesel Fuel Conditioner part number 21820275/(U5MK8276) is the only fuel conditioner recommended by Perkins. The diesel fuel conditioner is a proprietary metal and ash free formulation that has been extensively tested for use with distillate diesel fuels for use in Perkins diesel engines. The diesel fuel conditioner helps address many of the challenges that various fuels worldwide present in regards to fuel life/stability, engine startability, injector deposits, fuel system life, and long-term engine performance.

Note: Diesel fuel additives/conditioners may not improve markedly poor diesel fuel properties enough to make poor diesel acceptable for use.

Diesel fuel conditioner is a proven high performance, multipurpose diesel fuel conditioner that is designed to improve:

- Fuel economy (through fuel system clean-up)
- Lubricity
- Oxidation stability
- Detergency/dispersancy
- Moisture dispersancy
- Corrosion protection
- Cetane (typically 2-3 cetane numbers)

The diesel fuel conditioner also reduces the formation of gums, resins, and sludge, and disperses insoluble gums.

For maximum overall benefits, ask your fuel supplier to add the fuel conditioner at the recommended treat rate before fuel delivery. Or you may add the fuel conditioner at the recommended treat rate during the early weeks of fuel storage.

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. Reduce power loss, failures, and related down time of engines will result. This cleanliness level is important for new fuel system designs such as common rail injection systems and unit injection systems. Injection system designs utilize higher fuel pressures and tight clearances between moving parts in order to meet required stringent emissions regulations. Peak injection pressures in current fuel injection systems may exceed 30,000 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 nozzles.

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.

In order 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) in order to reach the recommended cleanliness level. This filtration should be located 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 500 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 per the Operation and Maintenance Manual 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 in order 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 in order 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.

i06231828

Fluid Recommendations
(Fuel Recommendations for the 1506D Engine)

S/N: PK9

- **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
- RME Rape Methyl Ester
- SME Soy Methyl Ester
- EPA Environmental Protection Agency of the United States

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

Perkins is not in a position to evaluate continuously and monitor all worldwide distillate diesel fuel specifications that are published by governments and technological societies.

Table 19 provides a known reliable baseline in order to judge the expected performance of distillate diesel fuels that are derived from conventional sources.

Satisfactory engine performance is dependent 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 19 .

NOTICE
The footnotes are a key part of the Perkins Specification for Distillate Diesel Fuel Table. Read ALL of the footnotes.

Table 19

Perkins Specification for Distillate Diesel Fuel				
Property	**UNITS**	**Requirements**	**“ASTM Test”**	**“ISO Test”**

(continued)

(Table 19, contd)

Aromatics	%Volume	35% maximum	**“D1319”**	“ISO 3837”
Ash	%Weight	0.01% maximum	**“D482”**	“ISO 6245”
Carbon Residue on 10% Bottoms	%Weight	0.35% maximum	**“D524”**	“ISO 4262”
Cetane Number (1)	-	40 minimum	**“D613 or D6890”**	“ISO 5165”
Cloud Point	°C	The cloud point must not exceed the lowest expected ambient temperature.	**“D2500”**	“ISO 3015”
Copper Strip Corrosion	-	No. 3 maximum	**“D130”**	“ISO 2160”
Distillation	°C	10% at 282 °C (539.6 °F) maximum 90% at 360 °C (680 °F) maximum	**“D86”**	“ISO 3405”
Density at 15 °C (59 °F) (2)	Kg / M^3	800 minimum and 860 maximum	No equivalent test	“ISO 3675 ” or “ISO 12185”
Flash Point	°C	legal limit	**“D93”**	“ISO 2719”
Thermal Stability	-	Minimum of 80% reflectance after aging for 180 minutes at 150 °C (302 °F)	**“D6468”**	No equivalent test
Pour Point	°C	6 °C (10°F) Minimum below ambient temperature	**“D97”**	“ISO 3016”
Sulfur	%mass	(3)	**“D5453 or /D26222”**	“ISO 20846 ” or “ISO 20884”
Kinematic Viscosity (4)	“MM^2/S (cSt)”	The viscosity of the fuel that is delivered to the fuel injection pump. “1.4 minimum and /4.5 maximum”	**“D445”**	“ISO 3405”
Water and sediment	% weight	0.05% maximum	**“D1796”**	“ISO 3734”
Water	% weight	0.05% maximum	**“D1744”**	No equivalent test
Sediment	% weight	0.05% maximum	**“D473”**	“ISO 3735”
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”
Fuel cleanliness (7)	-	“ISO”18/16/13	**“7619”**	“ISO 4406”

(1) In order to insure minimum cetane number of 40 a distillate diesel fuel should have minimum cetane index of 44 when ASTM D4737 test method is used. A fuel with a higher cetane number is recommended in order to operate at a higher altitude or in cold weather.

(2) Density range allowed includes summer and winter diesel fuel grades. Fuel density varies depending on the sulfur level where high sulfur fuels have higher densities. Some unblended alternative fuels have lower densities which are acceptable, if all the other properties meet this specification.

(3) Regional regulations, national regulations, or international regulations can require a fuel with a specific sulfur limit. Consult all applicable regulations before selecting a fuel for a given engine application. LSD fuel with less than 0.05 percent (≤ 500 ppm (mg/kg)) sulfur is strongly recommended for use in these engine models. Diesel fuel with more than 0.05 percent (≥ 500 ppm (mg/kg)) sulphur 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 0.05% may significantly shorten the oil change interval. For additional information, refer to **General lubricant Information**.

(continued)

(Table 19, contd)

(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 or the "ISO 3104" test method. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order 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.

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.

Engines that are manufactured by Perkins are certified with the fuel that is prescribed by the United States Environmental Protection Agency. Engines that are manufactured by Perkins are certified with the fuel that is prescribed by the European Certification and other regulatory agencies. Perkins does not certify diesel engines on any other fuel.

Note: The owner and the operator of the engine has the responsibility of using the fuel that is prescribed by the Environmental Protection Agency (EPA) and other appropriate regulatory agencies.

Diesel Fuel Characteristics

Perkins Recommendations

Cetane Number

Fuel that has a high cetane number will give a shorter ignition delay. A high cetane number 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.

Cetane numbers in excess of 45 are normally expected from current diesel fuel. However, a cetane number of 40 may be experienced in some territories. The United States of America is one of the territories that can have a low cetane value. A minimum cetane value of 40 is required during average starting conditions. A higher cetane value may be required for operations at high altitudes or in cold-weather operations.

Fuel with a low cetane number can be the root cause of problems during cold start.

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 in order to lubricate the fuel system in both cold temperatures and hot temperatures. If the kinematic viscosity of the fuel is lower than 1.4 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 1.4 and 4.5 cSt 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 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order 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 the following kg/m3 at 15 °C (59 °F).

Perkins recommends a value of density of 841 kg/m3 in order 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 international 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 0.05 percent (≤ 500 ppm (mg/kg)) sulfur is strongly recommended for use in these engine models.

ULSD less than 0.0015% (≤15 PPM (mg/Kg)) sulphur is acceptable to use in these engine models. The lubricity of these fuels must not exceed 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 0.05 percent (500 PPM) can be used where allowed by legislation.

Fuel with a high sulfur content can cause engine wear. High sulfur fuel will have a negative impact on emissions of particulates. High sulfur fuel can be used if the local emissions legislation will allow the use. High sulfur fuel can be used in countries that do not regulate emissions.

When only high sulfur fuels are available, it will be necessary that high alkaline lubricating oil is used in the engine or that the lubricating oil change interval is reduced. Refer to Operation and Maintenance Manual, “Fluid Recommendations (Lubricant Information)” for information on sulfur in fuel.

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 in order to meet stringent exhaust emissions.

The lubricity of these fuels must not exceed 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.

In case of the fuels which do not meet specified lubricity requirement appropriate lubricity additive can be used to enhance the lubricity of the fuel. 21820275 Perkins Diesel Fuel Conditioner is the approved additive refer to “Perkins Diesel Fuel Conditioner, and Perkins”.

Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can make recommendations for additives to use and for the proper level of treatment.

Distillation

Distillation will give an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light weight hydrocarbons can affect the characteristics of combustion.

Classification of the Fuels

Diesel engines have an ability to burn wide variety of fuels. Below is a list of typically encountered fuel specifications that have been assessed as to their acceptability and are divided into following categories:

Group 1: Preferred Fuels

The following fuel specifications are considered acceptable.

- Fuels that meet the requirements that are listed in the table 19 .
- “EN590 - Grades A to F and class 0 to 4”
- “ASTM D975 Grade No. 1-D and 2-D”
- “JIS K2204 Grades 1, 2 & 3 & Special Grade 3” acceptable provided lubricity ware scar diameter does not exceed of 0.46 mm (0.01811 inch) as per “ISO 12156-1” .
- “BS2869 - Class A2 Off Highway Gas Oil, Red Diesel”

Note: The lubricity of these fuels must not exceed wear scar diameter of 0.46 mm (0.01811 inch) as per “ISO 12156-1” . Refer to “Lubricity”.

Group 2: Aviation Kerosene Fuels

Following kerosene and jet fuel specifications are acceptable alternative fuels, and may be used on a contingency base for emergency or continuous use, where standard diesel fuel is not available and where legislation allows their use:

- “MIL-DTL-83133 NATO F34 (JP-8)”
- “MIL-DTL-83133 NATO F35”
- “MIL-DTL-5624 NATO F44 (JP-5)”

- “MIL-DTL-38219 (USAF) (JP7)”
- “NATO XF63”
- “ASTM D1655 JET A”
- “ASTM D1655 JET A1”

NOTICE
These fuels are only acceptable when used with appropriate lubricity additive and must meet minimum requirements that are listed in table 19 . The lubricity of these fuels must not exceed wear scar diameter of 0.46 mm (0.01811 inch) as per “ISO 12156-1” . Refer to “Lubricity” and Perkins Diesel Fuel Conditioner.

Note: Minimum cetane number of 40 is recommended otherwise cold starting problems or light load misfire might occur. Since jet fuel specifications do not mention cetane requirements, Perkins recommends that a fuel sample is taken to determine the cetane number.

Note: Fuels must have minimum viscosity of 1.4 cSt delivered to the fuel injection pump. Cooling of the fuel may be required to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Perkins recommends that the actual viscosity of the fuel, be measured in order to determine if a fuel cooler is needed. Refer to “Viscosity”.

Note: Rated power loss of up to 10 percent is possible due to lower density and lower viscosity of jet fuels compared to diesel fuels.

Biodiesel Fuel

Biodiesel is a fuel that can be defined as mono-alkyl esters of fatty acids. Biodiesel is a fuel that can be made from various feedstock. The most commonly available biodiesel in Europe is Rape Methyl Ester (REM). This biodiesel is derived from rapeseed oil. Soy Methyl Ester (SME) is the most common biodiesel in the United States. This biodiesel is derived from soybean oil. Soybean oil or rapeseed oil are the primary feedstocks. These fuels are together known as Fatty Acid Methyl Esters (FAME).

Raw pressed vegetable oils are NOT acceptable for use as a fuel in any concentration in compression engines. Without esterification, these oils may gel in the crankcase and the fuel tank. These fuels may not be compatible with many of the elastomers that are used in engines that are manufactured today. In original forms, these oils are not suitable for use as a fuel in compression engines. Alternate base stocks for biodiesel may include animal tallow, waste cooking oils, or various other feedstocks. In order to use any of the products that are listed as fuel, the oil must be esterified.

Fuel made of 100 percent FAME is generally referred to as B100 biodiesel or neat biodiesel.

Biodiesel can be blended with distillate diesel fuel. The blends can be used as fuel. The most commonly available biodiesel blends are B5, which is 5 percent biodiesel and 95 percent distillate diesel fuel. B20, which is 20 percent biodiesel and 80 percent distillate diesel fuel.

Note: The percentages given are volume-based. The U.S. distillate diesel fuel specification “ASTM D975-09a” includes up to B5 (5 percent) biodiesel.

European distillate diesel fuel specification “EN590:2010” includes up B7 (7 percent) biodiesel.

Note: Engines that are manufactured by Perkins are certified by use of the prescribed Environmental Protection Agency (EPA) and European Certification fuels. Perkins does not certify engines on any other fuel. The user of the engine has the responsibility of using the correct fuel that is recommended by the manufacturer and allowed by the EPA and other appropriate regulatory agencies.

Specification Requirements

The neat biodiesel must conform to “EN14214” or “ASTM D6751” (in the USA) and can only be blended in mixture of up to 20 percent, by volume in acceptable mineral diesel fuel meeting requirements that are listed in table 19 or the latest edition of “EN590” and “ASTM D 975” commercial standards. This blend is commonly known as B20.

Biodiesel blends are denoted as “BXX” with “XX” representing the content of neat biodiesel contained in the blend with mineral diesel fuel (for example B5, B10, B20).

In United States Biodiesel blends of B6 to B20 must meet the requirements listed in the latest edition of “ASTM D7467” (B6 to B20) and must be of an API gravity of 30-45.

In North America biodiesel and biodiesel blends must be purchased from the BQ-9000 accredited producers and BQ-9000 certified distributors.

In other areas of the world, the use of biodiesel that is BQ-9000 accredited and certified, or that is accredited and certified by a comparable biodiesel quality body to meet similar biodiesel quality standards is required.

Engine Service Requirements with B20

Aggressive properties of biodiesel fuel may cause debris in the fuel tank and fuel lines. The aggressive properties of biodiesel will clean the fuel tank and fuel lines. This cleaning of the fuel system can prematurely block of the fuel filters. Perkins recommends that after the initial usage of B20 biodiesel blended fuel the fuel filters must be replaced at 50 hours.

Glycerides present in biodiesel fuel will also cause fuel filters to become blocked more quickly. Therefore the regular service interval should be reduced to 250 hours.

When biodiesel fuel is used, crank case oil and aftertreatment systems (if installed) may be influenced. This influence is due to the chemical composition and characteristics of biodiesel fuel, such as density and volatility, and to chemical contaminants that can be present in this fuel, such as alkali and alkaline metals (sodium, potassium, calcium, and magnesium).

- Crankcase oil fuel dilution can be higher when biodiesel or biodiesel blends are used. This increased level of fuel dilution when using biodiesel or biodiesel blends is related to the typically lower volatility of biodiesel. In cylinder emissions control strategies utilized in many of the industrial latest engine designs may lead to a higher level of biodiesel concentration in the engine oil pan. The long-term effect of biodiesel concentration in crankcase oil is currently unknown.
- Perkins recommends the use of oil analysis in order to check the quality of the engine oil if biodiesel fuel is used. Ensure that the level of biodiesel in the fuel is noted when the oil sample is taken.

Performance Related Issues with B20

Due to the lower energy content than the standard distillate fuel B20 will cause a power loss in order of 2 to 4 percent. In addition, over time the power may deteriorate further due to deposits in the fuel injectors.

Biodiesel and biodiesel blends are known to cause an increase in fuel system deposits, most significant of which are deposits within the fuel injector. These deposits can cause a loss in power due to restricted or modified fuel injection or cause other functional issues associated with these deposits.

Perkins T400012 Fuel Cleaner is most effective in cleaning and preventing the formation of deposits. Refer to “Perkins Diesel Fuel System Cleaner, and Perkins” for more information. Perkins UMK8276 Diesel Fuel Conditioner helps to limit deposit issues by improving the stability of biodiesel while also hindering the production of new deposits. For more information refer to “Perkins Diesel Fuel Conditioner, and Perkins”. Therefore the use of Diesel Fuel Cleaner and or Diesel Fuel Conditioner is strongly recommended when running biodiesel blends, especially B20.

General Requirements

Biodiesel has poor oxidation stability, which can result in long-term problems in the storage of biodiesel. Biodiesel fuel should be used within 6 months of manufacture. Equipment should not be stored with the B20 biodiesel blends in the fuel system for longer than 3 months.

Due to poor oxidation stability and other potential issues, Perkins strongly recommends that engines with limited operational time either do not use biodiesel blends or, while accepting some risk, limit biodiesel blend to a maximum of B5. Examples of applications that should limit the use of biodiesel are the following: Standby generator sets and certain emergency vehicles.

If biodiesel must be used, then the quality of the fuel needs to be periodically tested. The test must comply with “EN15751”, commonly known as the Rancimat Test.

Perkins strongly recommends that seasonally operated engines have the fuel systems, including fuel tanks, flashed with conventional diesel fuel before prolonged shutdown periods. An example of an application that should seasonally flush the fuel system is a combine harvester.

Microbial contamination and growth can cause corrosion in the fuel system and premature plugging of the fuel filter. Consult your supplier of fuel for assistance in selecting appropriate antimicrobial additive.

Water accelerates microbial contamination and growth. When biodiesel is compared to distillate fuels, water is naturally more likely to exist in the biodiesel. It is therefore essential to check frequently and if necessary, drain the water separator.

Materials such as brass, bronze, copper, led, tin, and zinc accelerate the oxidation process of the biodiesel fuel. The oxidation process can cause deposits formation therefore these materials must not be used for fuel tanks and fuel lines.

Fuel for Cold Weather Operation

The European standard “EN590” contains climate dependant requirements and a range of options. The options can be applied differently in each country. There are five classes that are given to arctic climates and severe winter climates. 0, 1, 2, 3 and 4.

Fuel that complies with “EN590” CLASS 4 can be used at temperatures as low as −44 °C (−47.2 °F). Refer to “EN590” for a detailed discretion of the physical properties of the fuel.

The diesel fuel “ASTM D975 1-D” that is used in the United States of America may be used in cold temperatures that are below −18 °C (−0.4 °F).

In extreme cold ambient conditions, you may use the aviation kerosene fuels that are specified in “Group 1: Preferred Fuels”. These fuels are intended to be used in temperatures that can be as low as −54 °C (−65.2 °F). Refer to “Group 1: Preferred Fuels” for detail and conditions of use of the aviation kerosene fuels.

⚠ WARNING

Mixing alcohol or gasoline with diesel fuel can produce an explosive mixture in the engine crankcase or the fuel tank. Alcohol or gasoline must not be used in order to dilute diesel fuel. Failure to follow this instruction may result in death or personal injury.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in table 19 . To ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are stated in the table 19 .

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 and is due to 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. Fuel additives need to be used with caution. Contact your fuel supplier for those 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 19 .

Perkins Diesel Fuel System Cleaner

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

If biodiesel or biodiesel blends of fuel are to be used, Perkins require the use of Perkins fuel cleaner. For more information on the use of biodiesel and biodiesel blends refer to “Biodiesel Fuel”.

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 must be use are on the container.

Perkins Diesel Fuel Conditioner

The Perkins Diesel Fuel Conditioner part number 21820275/(U5MK8276) is the only fuel conditioner recommended by Perkins. The diesel fuel conditioner is a proprietary metal and ash free formulation that has been extensively tested for use with distillate diesel fuels for use in Perkins diesel engines. The diesel fuel conditioner helps address many of the challenges that various fuels worldwide present in regards to fuel life/stability, engine startability, injector deposits, fuel system life, and long-term engine performance.

Note: Diesel fuel additives/conditioners may not improve markedly poor diesel fuel properties enough to make poor diesel acceptable for use.

Diesel fuel conditioner is a proven high performance, multipurpose diesel fuel conditioner that is designed to improve:

- Fuel economy (through fuel system cleanup)
- Lubricity
- Oxidation stability
- Detergency/dispersancy
- Moisture dispersancy
- Corrosion protection
- Cetane (typically 2-3 cetane numbers)

The diesel fuel conditioner also reduces the formation of gums, resins, and sludge, and disperses insoluble gums.

For maximum overall benefits, ask your fuel supplier to add the fuel conditioner at the recommended treat rate before fuel delivery. Or you may add the fuel conditioner at the recommended treat rate during the early weeks of fuel storage.

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. Reduce power loss, fuel system failures, and related down time of engines will result. This cleanliness level is important for new fuel system designs such as common rail injection systems and unit injection systems. Injection system designs utilize higher fuel pressures and tight clearances between moving parts in order to meet required stringent emissions regulations. Peak injection pressures in current fuel injection systems may exceed 30,000 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 nozzles.

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.

In order 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) in order to reach the recommended cleanliness level. This filtration should be located 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 500 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 per the Operation and Maintenance Manual 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. Centrifugal filters 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 in order 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 in order 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

i07819420

System Pressure Release

Coolant System

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

⚠ WARNING

When the engine is in the AUTOMATIC mode, the engine can start at any moment. To avoid personal injury, always remain clear of the the engine when the engine is in the AUTOMATIC mode.

The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

To relieve the pressure from the coolant system, turn off the engine. Allow the cooling system pressure cap to cool. Remove the cooling system pressure cap slowly to relieve pressure.

Fuel System

To relieve the pressure from the fuel system, turn off the engine.

High-Pressure Fuel Lines

⚠ 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.

The high-pressure fuel lines are the fuel lines that are between the high-pressure fuel pump and the high-pressure fuel manifold and the fuel lines that are between the fuel manifold and the fuel injectors.

The high-pressure fuel lines are different from fuel lines on other fuel systems, the differences are as follows:

- The high-pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high-pressure fuel lines are higher than other types of fuel system.

Before any service or repair is performed on the engine fuel lines, perform the following tasks:

1. Stop the engine.

2. Wait for 10 minutes.

Do not loosen the high-pressure fuel lines to remove air from the fuel system.

Engine Oil

To relieve pressure from the lubricating system, turn off the engine.

i05963859

Welding on Engines with Electronic Controls

NOTICE
Because the strength of the frame may decrease, some manufacturers do not recommend welding onto a chassis frame or rail. Consult the OEM of the equipment or your Perkins distributor regarding welding on a chassis frame or rail.

Proper welding procedures are necessary in order to avoid damage to the engines ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the following procedure must be followed when you weld on a unit equipped with an Electronic Engine. The following procedure is considered to be the safest procedure to weld on a component. This procedure should provide a minimum risk of damage to electronic components.

NOTICE
Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

Note: Perform the welding in areas that are free from explosive hazards.

1. Stop the engine. Turn the switched power to the OFF position.

2. Ensure that the fuel supply to the engine is turned off.

3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.

4. Disconnect all electronic components from the wiring harnesses. Include the following components:

- Electronic components for the driven equipment
- ECM
- Sensors
- Electronically controlled valves
- Relays

NOTICE
Do not use electrical components (ECM or ECM sensors) or electronic component grounding points for grounding the welder.

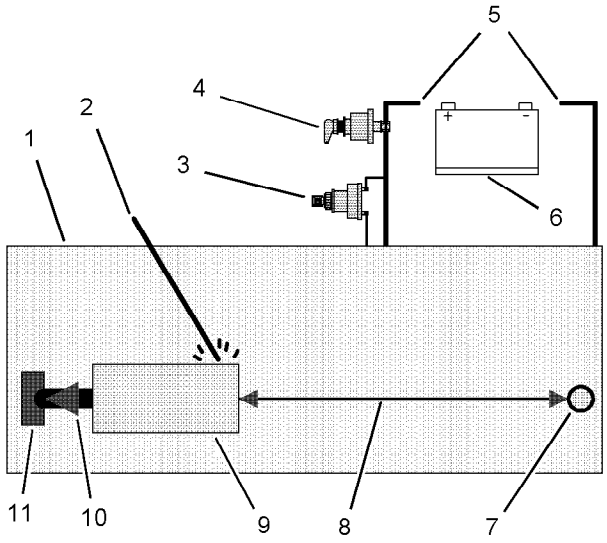


Illustration 37 g01075639

Use the example above. The current flow from the welder to the ground clamp of the welder will not damage any associated components.

(1) Engine
(2) Welding electrode
(3) Keyswitch in the OFF position
(4) Battery disconnect switch in the open position
(5) Disconnected battery cables
(6) Battery
(7) Electrical/Electronic component
(8) Minimum distance between the component that is being welded and any electrical/electronic component
(9) The component that is being welded
(10) Current path of the welder
(11) Ground clamp for the welder

5. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld in order to reduce the possibility of welding current damage to the following components. Bearings, hydraulic components, electrical components, and ground straps.

Note: If electrical/electronic components are used as a ground for the welder, or electrical/electronic components are located between the welder ground and the weld, current flow from the welder could severely damage the component.

6. Protect the wiring harness from welding debris and spatter.

7. Use standard welding practices to weld the materials.

i04150276

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

i08330686

Maintenance Interval Schedule

When Required

“ Battery - Replace“ 80
“ Battery or Battery Cable - Disconnect“ 81
“ Engine - Clean“ 88
“ Engine Oil Sample - Obtain“ 92
“ Fuel System - Prime“ 95

Daily

“ Coolant Level - Check“ 86
“ Driven Equipment - Check“ 88
“ Engine Air Cleaner Service Indicator - Inspect“ . . 90
“ Engine Oil Level - Check“ 91
“ Fuel System Primary Filter/Water Separator - Drain“ 97
“ Walk-Around Inspection“ 102

Every Week

“ Engine Air Precleaner - Check/Clean“ 90
“ Jacket Water Heater - Check“ 100

Every 50 Service Hours or Weekly

“ Fuel Tank Water and Sediment - Drain“ 99

Every 500 Service Hours

“ Battery Electrolyte Level - Check“ 80
“ Engine Air Cleaner Element (Single Element) - Inspect/Replace“ 89
“ Fan Clearance - Check“ 94

Every 500 Service Hours or 1 Year

“ Air Shutoff - Test“ 79
“ Belt Tensioner - Check“ 81
“ Belts - Inspect/Adjust“ 82
“ Belts - Inspect/Adjust“ 83
“ Engine Oil and Filter - Change“ 92
“ Fuel System Primary Filter (Water Separator) Element - Replace“ 96
“ Fuel System Secondary Filter - Replace“ 98
“ Hoses and Clamps - Inspect/Replace“ 100
“ Radiator - Clean“ 101

Every 2000 Service Hours

“ Aftercooler Core - Inspect/Clean/Test“ 79
“ Alternator - Inspect“ 80
“ Belt Tensioner - Check“ 81
“ Belts - Replace“ 83
“ Engine Valve Lash - Check“ 94

Every 2000 Service Hours or 1 Year

“ Engine Crankcase Breather - Clean“ 90

Every 3000 Service Hours or 2 Years

“ Coolant (DEAC) - Change“ 84

Every 4000 Service Hours or 2 Years

“ Coolant Temperature Regulator - Replace“ 87
“ Crankshaft Vibration Damper - Inspect“ 87
“ Engine Mounts - Inspect“ 91

Every 5000 Service Hours

“ Starting Motor - Inspect“ 101
“ Turbocharger - Inspect“ 101
“ Water Pump - Inspect“ 103

Every 6000 Service Hours or 3 Years

“ Coolant Extender (ELC) - Add“ 86

Every 10 000 Service Hours

“ Grounding Stud - Inspect/Clean/Tighten“ 99

“ Overhaul Considerations“ 101

Every 12 000 Service Hours or 6 Years

“ Coolant (ELC) - Change“. 85

Commissioning

“ Fan Clearance - Check“ 94

i05963992

Aftercooler Core - Inspect/ Clean/Test

Inspect

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

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

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

Clean

Note: Adjust the frequency of cleaning according to the effects of the operating environment. Clean and test the aftercooler every 4000 service hours unless the inspection indicates the need for more frequent cleaning.

Remove the core. Refer to the Disassembly and Assembly Manual for the procedure.

1. Place the aftercooler on the side in order to remove debris Remove the debris that is accessible.

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.

2. Back flush the core with cleaner.

Table 20

Hydrosolv Liquid Cleaners[1]		
Part Number	**Description**	**Size**
Hydrosolv 4165		19 L (5 US gallon)
Hydrosolv 100		19 L (5 US gallon)

(1) Use a 2 percent to a 5 percent concentration of the cleaner at temperatures up to 93°C (200°F). Consult your Perkins distributor for more information on a suitable cleaner.

3. Use a pressure steam cleaner in order to remove residue from the core. Flush the fins of the aftercooler core. Remove any other trapped debris from the inside and from the outside of the core.

Note: Do not use high pressure when the fins are cleaned. High pressure can damage the fins.

4. Wash the core with hot, soapy water.

5. Flush the core thoroughly in order to remove residue and remaining debris. Flush the core with clean, fresh water until the water that is exiting the core is clear and free of 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.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.

6. Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.

Test

1. Inspect the core for trapped debris and cleanliness. If necessary, remove the debris and repeat the cleaning procedure.

2. Inspect the core for damage and perform a pressure test in order to detect leaks. Many shops that service radiators are equipped to perform pressure tests.

3. Plug both ends of the aftercooler core and pressurize the core to 205 kPa (30 psi). Submerge the core in water. Look for bubbles which are being emitted from the core. The bubbles are evidence of leaks.

4. If any leaks are found, do not attempt to repair the core.

Install a core that is clean and that passes the pressure test in step 3. Refer to the Disassembly and Assembly Manual for the procedure.

i05975681

Air Shutoff - Test

If the engine has been equipped with an air shutoff valve, the valve should be tested regularly. For information on the test procedure, refer to the original equipment manufacturer for the correct procedure.

i02322311

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.

i05425759

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.

1. 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.

2. Turn off any battery chargers. Disconnect any battery chargers.
3. Ensure that the battery disconnect switch is in the OFF position.
4. Disconnect the NEGATIVE “-” cable from the NEGATIVE “-” battery terminal.
5. 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.

6. Remove the used battery.
7. Install the new battery.

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

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

i02747977

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.

i07819485

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.

i06233840

Belt Tensioner - Check (Model LG)

S/N: LG1

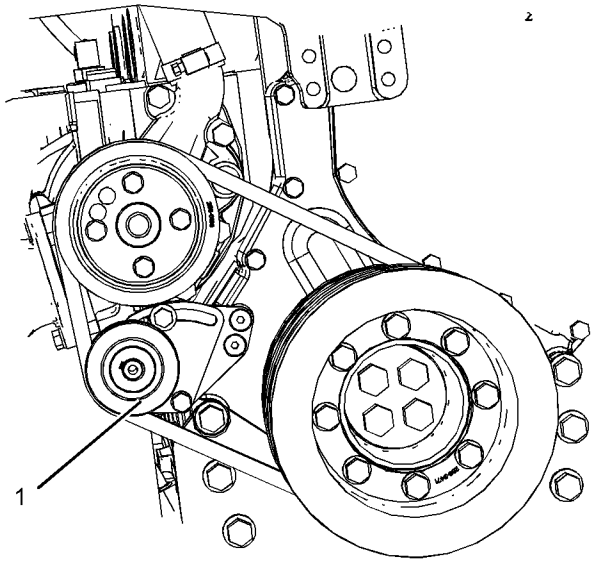


Illustration 38 g03748098

Typical example

With this design of belt the tensioning pulley (1) should be checked at 500 hours or each year.

Remove the belt. Refer to Disassembly and Assembly, “Alternator Belt - Remove and Install”.

Ensure that the belt tensioner is securely installed. Visually inspect the belt tensioner (1) for damage. Check that the pulley on the tensioner rotates freely and that the bearing is not loose.

i06233841

Belt Tensioner - Check (Model PK9)

S/N: PK9

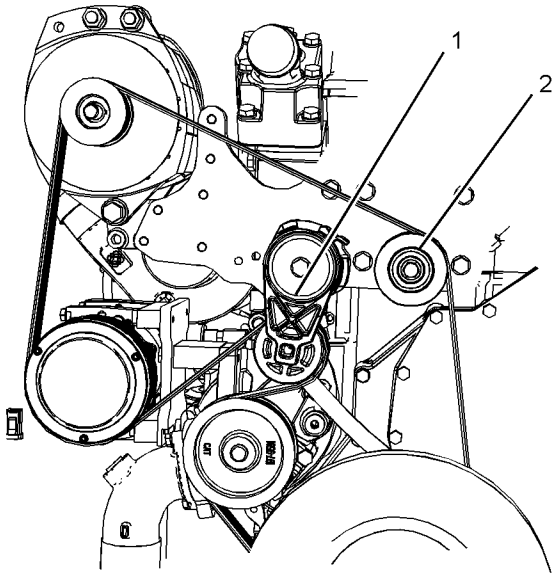


Illustration 39 g03865369
Typical example

Remove the belt. Refer to Disassembly and Assembly, “Alternator Belt - Remove and Install”.

Ensure that the belt tensioner (1) is securely installed. Visually inspect the belt tensioner for damage. Check that the pulley on the tensioner rotates freely and that the bearing is not loose. Inspect the idler pulley (2). Ensure that the idler pulley is securely installed. Visually inspect the idler pulley for damage. Ensure that the idler pulley can rotate freely and that the bearing is not loose. If necessary, replace damaged components.

Install the belt. Refer to Disassembly and Assembly, “Alternator Belt - Remove and Install”.

i06233845

Belts - Inspect/Adjust
(Model LG)

S/N: LG

To maximize the engine performance, inspect the belt for wear and for cracking. Replace the belt if the belt is worn or damaged.

Fan Belts

- Inspect each belt for cracks, splits, glazing, grease, displacement of the cord and evidence of fluid contamination.

Fan Belts Adjust

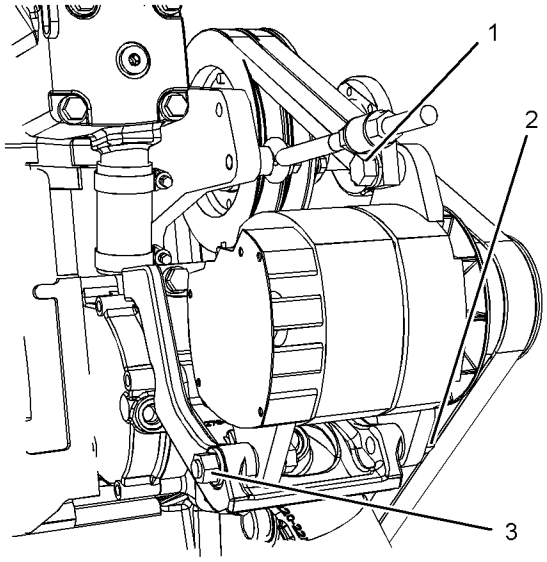


Illustration 40 g03748150
Typical example

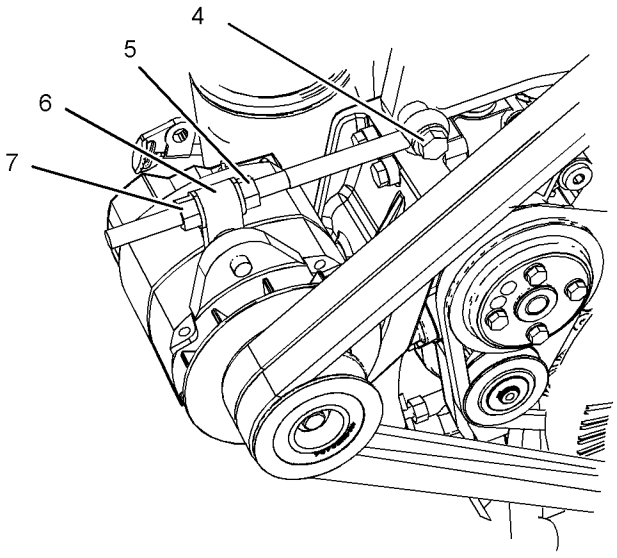


Illustration 41 g03748169
Typical example

1. Loosen bolts (1) and (2), also loosen nut (3).

2. Loosen bolt (4) and nut (7).

Adjust nuts (5) and (7) in order to increase or decrease the tension on union (6). This action will tension the belts, the belts must be tensioned to 730 N (164 lb). To check accurately the belt tension, a suitable gauge should be used.

1. Tighten nuts (5) and (7) securely. Tighten bolts (1) and (2), also tighten nut (3). Tighten nut and bolts to a torque of 89 N·m (65 lb ft). Tighten bolt (4) to a torque of 100 N·m (73 lb ft).

Coolant Pump Drive Belt

- Inspect the belt for cracks, splits, glazing, grease, displacement of the cord and evidence of fluid contamination.

Coolant Pump Drive Belt Adjust

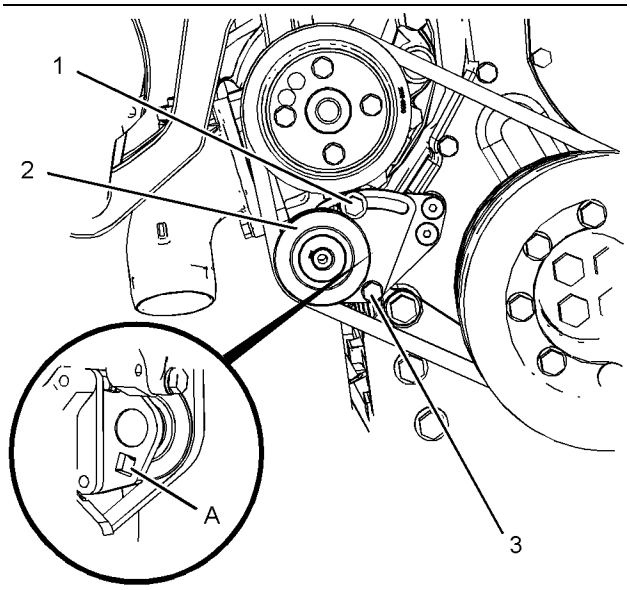


Illustration 42 g03748152

Typical example

1. Loosen bolts (1) and (3). Using square (A) adjust pulley assembly (2) in order to increase or decrease the tension on the coolant drive belt.

2. The tension on the belt must be set to 560 N (125 lb).

3. With the correct tension on the belt, tighten bolts (1) and (3). Tighten bolts to a torque of 28 N·m (247 lb in).

New belts

Table 21

Tension for New Belts		
Tension	Fan belt	Coolant pump Drive Belt
	912 N (205 lb)	734 N (165 lb)

Recheck new belts after 10 hours of operation.

i06233847

Belts - Inspect/Adjust (Model PK9)

S/N: PK9

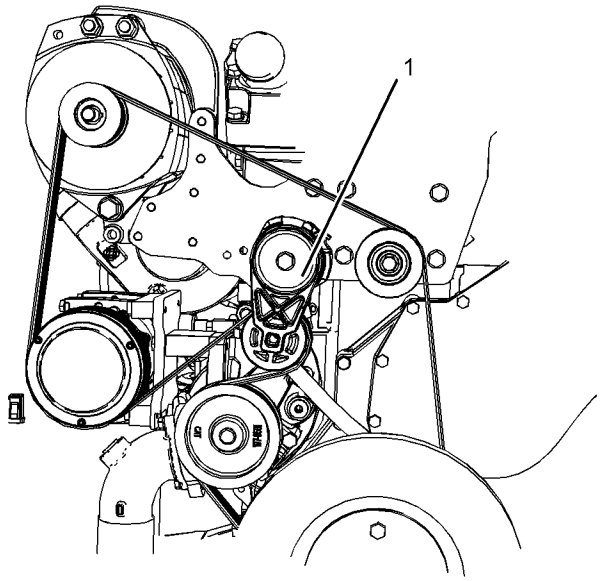


Illustration 43 g03866010

(1) Auto tensioner

Inspect

To maximize the engine performance, inspect the belt for wear and for cracking. Replace the belt if the belt is worn or damaged.

- Inspect the belt for cracks, splits, glazing, grease, displacement of the cord and evidence of fluid contamination.

Adjust

This engine option the belt adjustment is automatic. Also, the belt tension is controlled by the auto tensioner (1).

i05985281

Belts - Replace

The fan belts must be replaced as a set.

For the correct procedure for removing and installing the drive belts, refer to the Disassembly and Assembly, “V-Belts remove and Install”.

i05985305

Coolant (DEAC) - Change

- DEAC _____Diesel Engine Antifreeze Coolant

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 in order to relieve any pressure. Remove the cooling system filler cap.

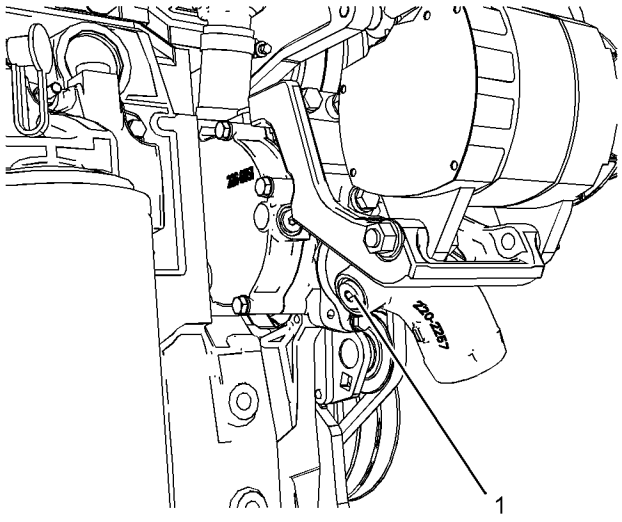


Illustration 44 g03748670
Typical example

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

2. Remove drain plug (1). Also 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

1. Flush the cooling system with clean water and a suitable cleaning agent in order to remove any debris. Refer to your Perkins distributor for suitable cleaning agents.

2. Install the system drain plugs.

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 until normal operating temperature.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water.
6. Check the O ring seal on the drain plugs, replace if damaged. Install the system drain plugs. Tighten the drain plug (1) to a torque of 80 N·m (59 lb ft).

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 until normal operating temperature.
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.

i05985294

Coolant (ELC) - Change

NOTICE
Perkins ELC must be using with an extender in order to achieve 12000 hours operation. For more information on a suitable extender contact your Perkins distributor.

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: 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 in order to check the coolant level. The engine must be level in order 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 in order to relieve any pressure. Remove the cooling system filler cap.

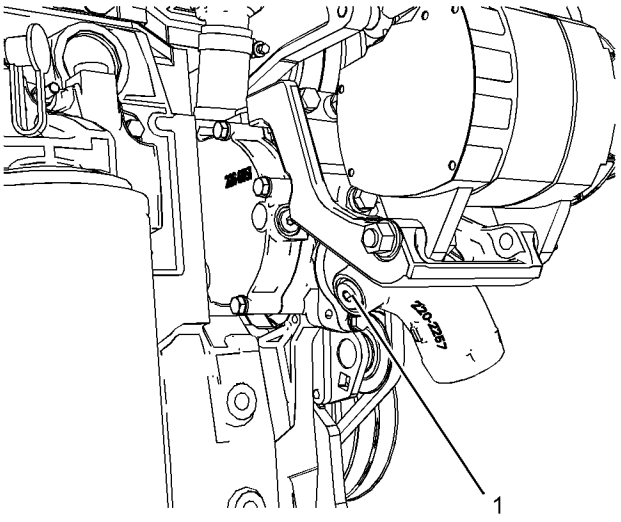


Illustration 45 g03748670

2. Remove drain plug (1). Also, remove the drain plug from the radiator.

Allow the coolant to drain.

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

Flush

1. Flush the cooling system with clean water in order to remove any debris.

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.

2. Fill the cooling system with clean water. Install the cooling system filler cap.

3. Start and run the engine until normal operating temperature.

4. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water.

5. Check the O ring seal on the drain plug, replace if damaged. Install the system drain plugs. Tighten the drain plug (1) to a torque of 80 N·m (59 lb ft).

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 until normal operating temperature. 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, 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.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i05197396

Coolant Extender (ELC) - Add

In order for Perkins ELC to achieve 12000 hours an extender must be added at 6000 hours. For a suitable extender, contact your Perkins dealer or Perkins distributor.

i05966993

Coolant Level - Check

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

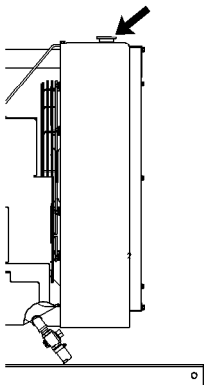


Illustration 46 g00285520
Cooling system filler cap

⚠ 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 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 to the proper level in the sight glass.

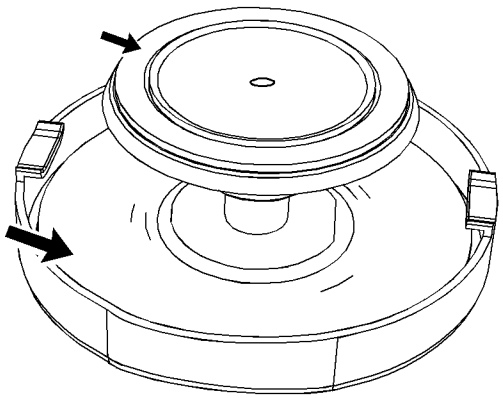


Illustration 47 g02590196
Typical filler cap gaskets

3. Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
4. Inspect the cooling system for leaks.

i05975694

Coolant Temperature Regulator - Replace

Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

Refer to Disassembly and Assembly, “Water Temperature Regulator Housing - Remove and Install” for the replacement procedure of the water temperature regulator, or consult your Perkins distributor.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the housing.

i05967790

Crankshaft Vibration Damper - Inspect

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This torsional vibration can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

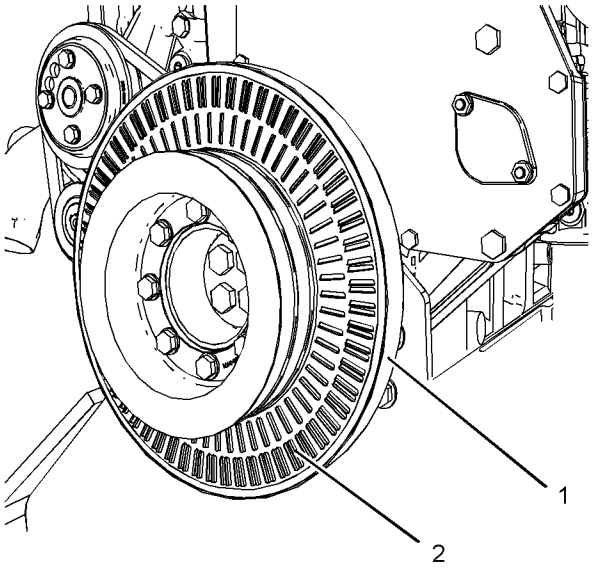


Illustration 48 g03741828

Typical example

(1) Vibration damper
(2) Cooling fins

Inspection

Inspect the damper for the following conditions:

- The damper is dented, cracked, or fluid is leaking from the damper.
- The paint on the damper is discolored from excessive heat.
- The damper is bent.
- The bolt holes are worn or there is a loose fit for the bolts.
- The engine has had a crankshaft failure due to torsional forces.

Replace the damper if any of these conditions exist.

Ensure that the cooling fins (2) are clean and free from damage.

Removal and Installation

Refer to the Disassembly and Assembly Manual, “Vibration Damper and Pulley - Remove and Install” for information on removing and installing the damper.

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.

i02568158

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.

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 in order to prevent electrical components from being damaged by excessive water when you clean the engine. Avoid electrical components such as the alternator, the starter, and the Electronic Control Module (ECM).

i05985308

Engine Air Cleaner Element (Single Element - Inspect/ Replace

Perform the Operation and Maintenance Manual, “Engine Air Cleaner Service Indicator-Inspect” procedure and perform the Operation and Maintenance Manual, “Engine Air Precleaner Check/ Clean” procedure (if equipped before performing the following procedure.

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.

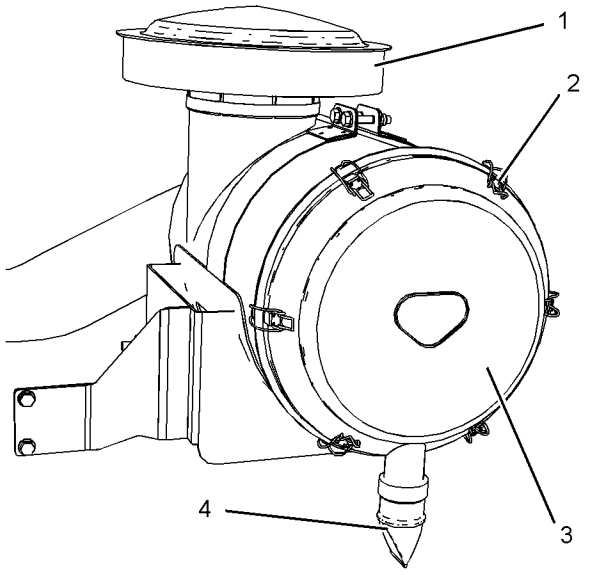


Illustration 49 g03748730

1. Remove the six clips (2) and remove the cover (3).

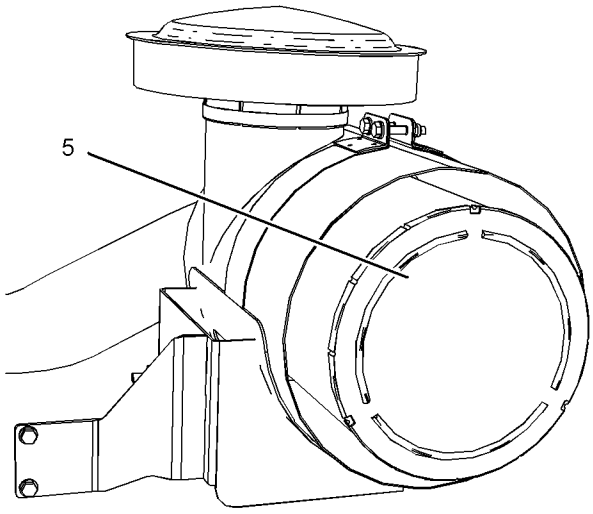


Illustration 50 g03748780

2. Remove element (5) and discard old element.

3. Ensure that the cover (3) cap (1) and valve (4) are clean and free from dirt.

4. Install new element (5), install cover (3). Install clips (2). Insure that valve (4) is vertically down.

5. If necessary, reset the air cleaner service indicator.

i05967801

Engine Air Cleaner Service Indicator - Inspect
(If Equipped)

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 housing.

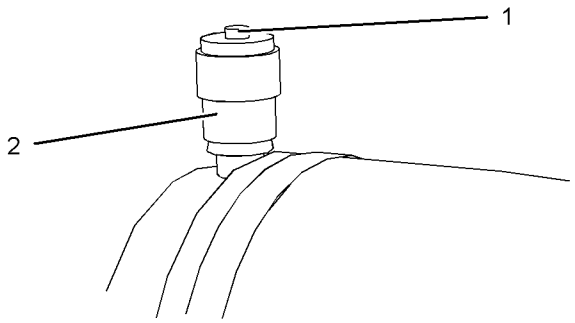


Illustration 51 g03741837

(1) Reset button
(2) View area

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when the following condition occurs:

- The red piston locks in the visible position of the view area (2).

The reset button (1) reset the red piston.

i05967804

Engine Air Precleaner - Check/ Clean
(If Equipped)

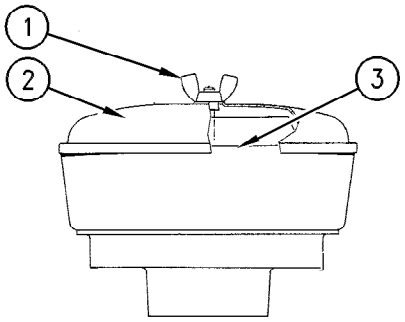


Illustration 52 g00287039

Typical example

(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 applications, more frequent cleaning is required.

i05967836

Engine Crankcase Breather - Clean

NOTICE
Perform this maintenance with the engine stopped.

NOTICE
If the crankcase breather is not maintained on a regular basis, it can become plugged. A plugged breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.

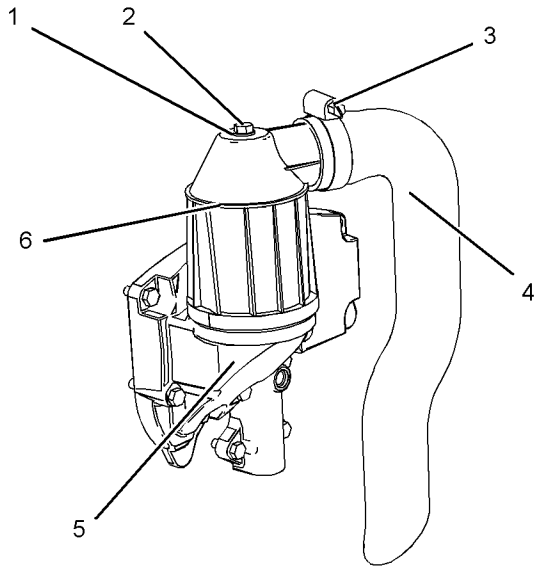


Illustration 53 g03741874

(1) Sealing washer
(2) Bolt
(3) Hose clamp
(4) Hose
(5) Housing
(6) Breather assembly

1. Thoroughly clean the breather assembly before removing any parts.

2. Loosen hose clamp (3) and remove hose (4) from breather assembly (6).

3. Remove bolt (2) and the washer (1). Remove the breather assembly (6) from housing (5).

4. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.

5. Ensure that the hose (4) is clean and free from damage.

6. Install a breather element that is clean and dry. Install breather assembly (6) to housing (5).

7. Install new sealing washer (1) to bolt (2) and install into breather assembly. Tighten bolt (2) to a torque of 28 N (6.3 lb).

8. Install hose (4) and clip (3) to breather assembly. Tighten clip (3) to a torque of 7 N·m (62 lb in).

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.

i05967878

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.

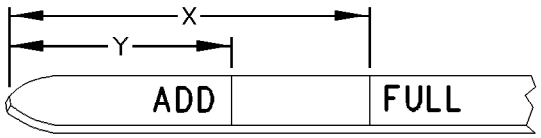


Illustration 54 g00110310

(Y) “Add” mark. (X) “Full” 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. Do not fill the crankcase above the “FULL” mark (X).

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.

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

i05969787

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 (1 as an option. The oil sampling valve is included in order to sample regularly the engine lubricating oil.

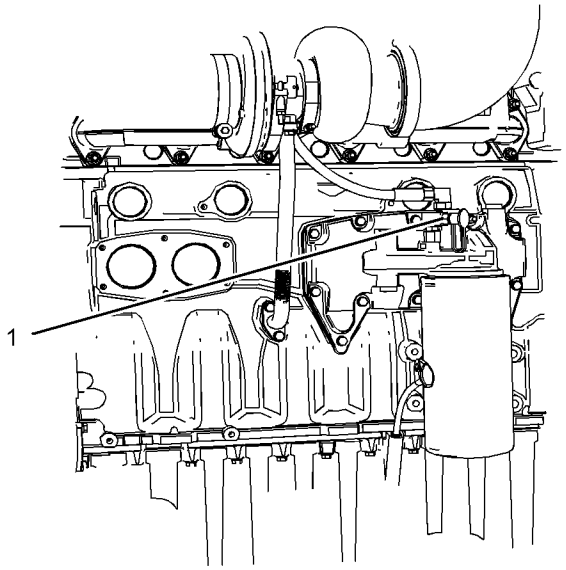


Illustration 55 g03742403
Typical example

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 labeled.

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

i05969790

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.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase 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 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 crankcase oil:

- Use a container that is large enough to collect the engine oil.
- 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 in order to allow the oil to drain. Discard the O ring seal. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plug should be cleaned. Install a new O ring seal to the oil drain plug. Reinstall the oil drain plug. Tighten drain plug to 40 N·m (29 lb ft), for aluminum oil pan. Remove container and disposal of the waste oil in accordance with local regulations.

Replace the Oil Filter

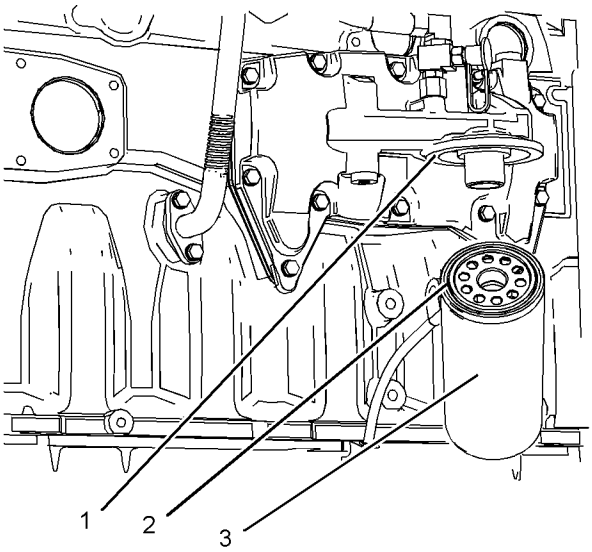


Illustration 56 g03742429

Typical example

1. Ensure that the oil filter assembly is clean before starting the procedure for removing the spin on filter. Place a suitable container below the oil filter assembly.

2. Using a suitable tool, remove the oil filter (3) from housing (1). Discard old 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.

3. Apply clean engine oil to the O ring seal (2) and install the new spin on oil filter.

4. Install the spin on oil filter (3) and tighten by hand only. When the O ring seal contacts the sealing surface, rotate the oil filter 1 full turn. Remove the container and disposal of the waste oil in accordance with local regulations.

Fill the Engine Crankcase

1. Remove the oil filler cap. Refill the engine crankcase with engine oil. Refer to the Operation and Maintenance Manual, “Refill Capacities ” and Operation and Maintenance Manual, “Fluid recommendations” for more information.

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

2. Start the engine and run the engine for 2 minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filter is filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the sump for a minimum of 10 minutes.

4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the “Low” and “High” marks on the oil level gauge.

i07512811

Engine Valve Lash - Check

⚠ 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.

NOTICE
Only qualified service personel 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.

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended only on engine ratings 522 kW (700 hp) and greater. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

This maintenance is recommended as part of a lubrication and preventive maintenance schedule to help provide maximum engine life. For engine ratings less than 522 kW (700 hp), the initial valve lash adjustment is not necessary.

Note: All engine ratings must have the engine valve lash performed at 2500 hours.

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

During valve adjustment, visibly inspect the valve train of wear or damage.

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

i06023929

Fan Clearance - Check

Ensure that the engine is stopped and that the battery disconnect switch is in the OFF position.

Ensure that the radiator is full of the correct coolant.

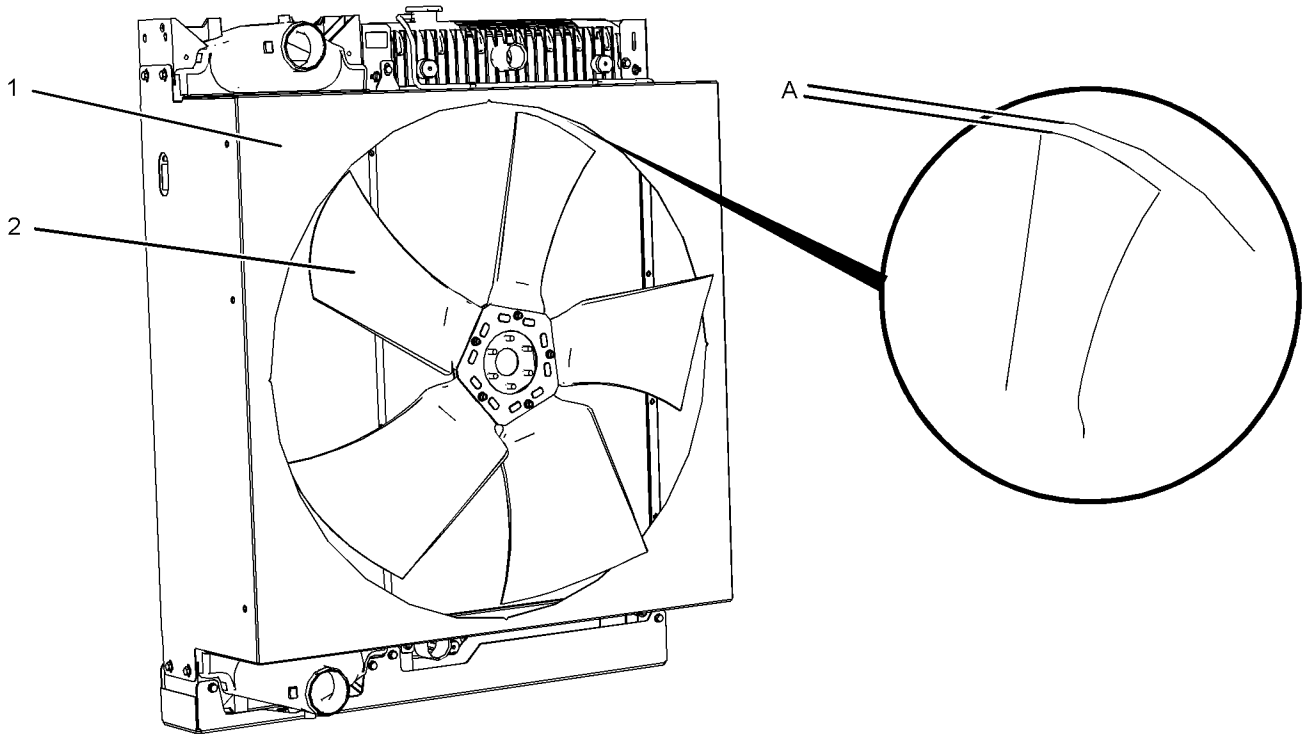


Illustration 57 g03779353
Typical example

1. The clearance between the cover (1) and the fan (2) must be checked at four equal distances. Measure the distance between the fan tip and the edge of the cover.

2. The gap (A) must be between 8 to 10 mm (0.31 to 0.39 inch).

i05969962

Fuel System - Prime

⚠ 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.

Refer to this Operation and Maintenance Manual , “General Hazard Information” before any adjustments or repairs are performed

If necessary, perform minor adjustments. Repair any leaks from the fuel system and from the cooling, lubrication, or air systems. Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

The fuel system should be primed under the following conditions:

- The fuel tank is empty or the fuel tank has been partially drained.
- The engine has been in storage.
- The fuel filter has been replaced.
- The pressure fuel lines have been disconnected.

1. Ensure that the key switch is in the OFF position. Ensure that the fuel tank is full of clean diesel fuel. Check that the fuel supply valve (if equipped) is in the “ON” position.

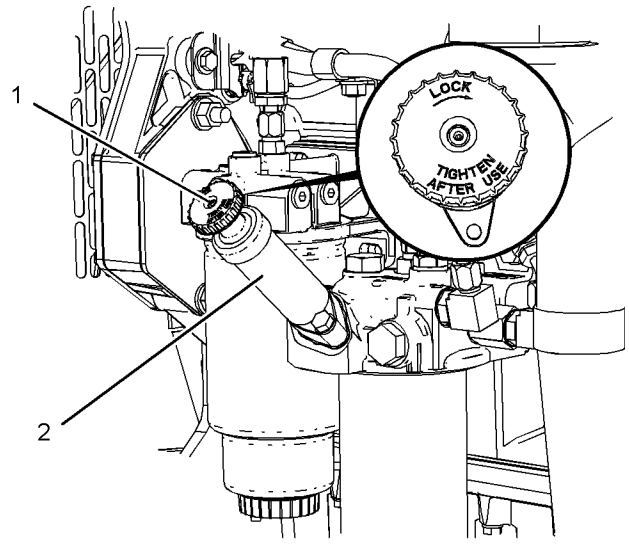


Illustration 58 g03742605

2. Unlock the fuel priming pump handle (1). Turn handle counter clockwise. Operate the fuel pump handle until strong pressure can be felt.

3. When strong pressure can be felt, press in the fuel pump handle and lock the handle into the fuel pump body (2). In order to lock the handle, turn handle clockwise.

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.

4. Start the engine, refer to this Operation and Maintenance Manual, “Starting the Engine” for more information.

5. If the engine will not start, repeat Steps 2 to Step 3.

6. Once the engine starts, allow the engine to operate with no load for 5 minutes.

7. If the engine will not start, refer to Troubleshooting, “Engine Cranks but will not Start”.

i05970884

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.

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 disconnected fuel system component.

1. Turn the fuel supply valve (if equipped) to the OFF position. Place a suitable container under the fuel filter assembly. Clean the outside of the primary fuel filter assembly.

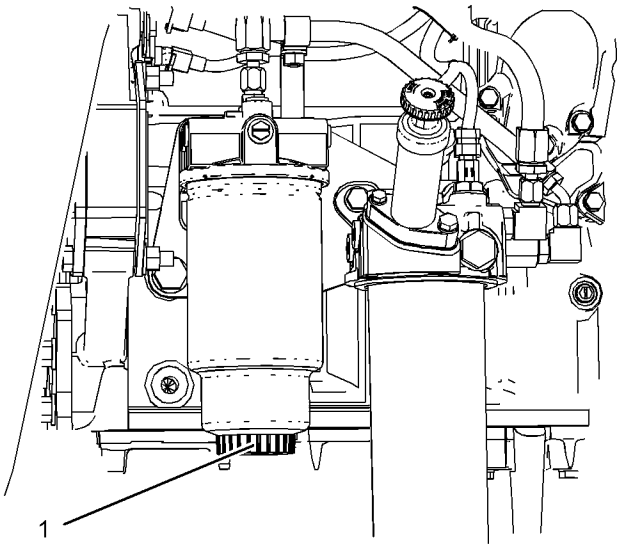


Illustration 59 g03742960

2. Pace a suitable container below the primary fuel filter. Drain the fuel from the primary fuel filter. Open the drain valve (1) and allow the fluid to drain. Then, close the drain valve.

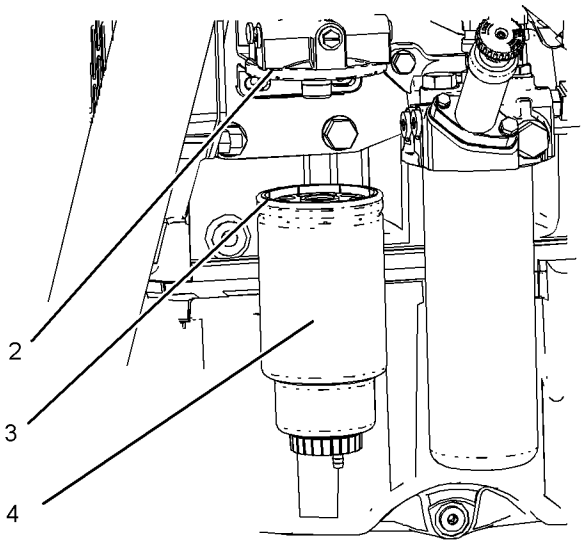


Illustration 60 g03742961

3. Using a suitable tool, remove the primary fuel filter (4) from housing (2). Discard the old primary fuel filter.

4. Lubricate the O ring seal (3) with clean diesel fuel. Install the new primary fuel filter (4).

5. Spin on the fuel filter by hand. When the O ring seal (3) contacts the sealing surface rotate the fuel filter ¾ of a full turn. Remove the container and disposal of the waste fuel in accordance with local regulations.

6. Turn the valves for the fuel lines (if equipped) to the ON position. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information.

The primary fuel filter and the secondary fuel filter should be serviced together.

i05970923

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

1. Place a suitable container below the primary filter.

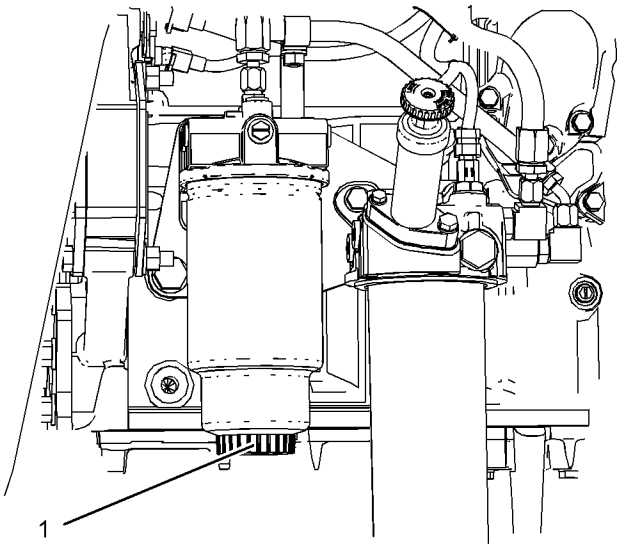


Illustration 61 g03742960

2. Open drain valve (1) and allow the fluid to drain. When clean fuel can be seen, close the drain valve. Remove the container and disposal of the waste fuel in accordance with local regulations.

i05970937

Fuel System Secondary Filter - 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.

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.

1. Residual fuel pressure should be relieved from the fuel system before the fuel filter is removed. After the engine has stopped, wait for one to 5 minutes until the fuel pressure has lowered. Use a suitable container in order to catch any fuel that may spill.

2. Turn the fuel supply valve (if equipped) to the OFF position. Place a suitable container under the fuel filter assembly. Clean the outside of the secondary fuel filter assembly.

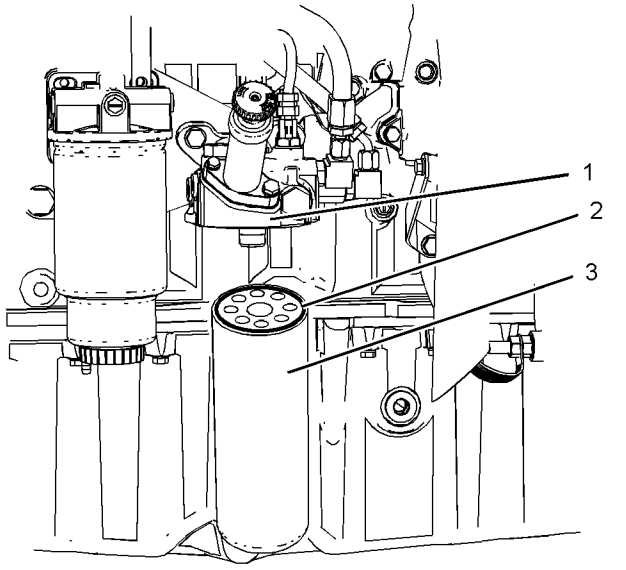


Illustration 62 g03743006

3. Using a suitable tool, remove the secondary fuel filter (3) from housing (1). Discard the old secondary fuel filter.

NOTICE
Do not fill the secondary fuel filter with fuel before installing. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

4. Lubricate O ring seal (2) with clean diesel fuel. Install new secondary fuel filter (3) to housing (1).

5. Spin on new secondary fuel filter, when the O ring seal (2) contacts the sealing surface rotate the fuel filter ¾ of a full turn. Remove the container and disposal of the waste fuel in accordance with local regulations.

6. Turn the valves for the fuel lines (if equipped) to the ON position. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information.

The primary fuel filter and the secondary fuel filter should be serviced together.

i02568194

Fuel Tank Water and Sediment - Drain

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:

- 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.

i05970985

Grounding Stud - Inspect/ Clean/Tighten

⚠ 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.

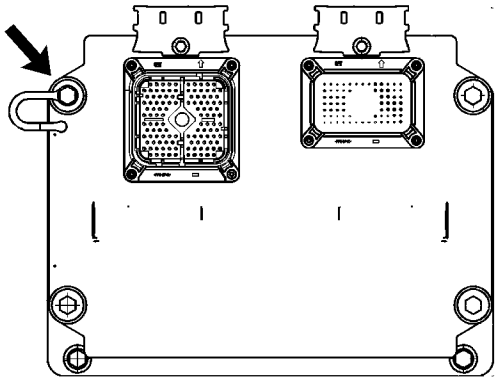


Illustration 63 g01376112

The electronics grounding stud is located on the upper left corner of the engine control module.

Inspect the OEM harness for good connections. Inspect the condition of the OEM harness.

The electronics grounding stud must have a wire ground to the battery. Tighten the electronics grounding stud 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 electronics grounding stud and the terminals for the ground strap with a clean cloth.
- If the connections are corroded, clean the connections with a solution of baking soda and water.
- Keep the electronics grounding stud and the strap clean and coated with MPGM grease or petroleum jelly.

i05971027

Hoses and Clamps - Inspect/ Replace

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

- Cracking
- Softness
- Loose clamps

NOTICE
Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

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 heat set. Heat setting causes hose clamps to loosen. This action 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

Replace hoses that are cracked or soft. Tighten any loose clamps. For information on replacing hoses and clamps refer to the Disassembly and Assembly Manual.

i05971073

Jacket Water Heater - Check

Jacket water heaters help to improve startability in ambient temperatures that are below 21 °C (70 °F. All installations that require automatic starting should have jacket water heaters.

Check the operation of the jacket water heater. Check the operation of the circulation pump, if equipped. For an ambient temperature of 0 °C (32 °F, the heater should maintain the jacket water coolant temperature at approximately 32 °C (90 °F.

i05971077

Overhaul Considerations

For an overhaul solution, contact your Perkins distributor.

i05971137

Radiator - Clean

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.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This movement 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.

After cleaning, start the engine and operate the engine with no load. This procedure 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”. Inspect these items for good condition: welds, mounting brackets, connections, clamps and seals. Make repairs, if necessary.

i02568202

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 proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Perkins distributors for assistance.

i02568203

Turbocharger - Inspect

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side. Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

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 inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing 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 repaired or replaced.

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

Note: Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Perkins distributor. Refer to the Service Manual for this engine for the procedure and specifications.

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from 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. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.
3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the 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 inlet air (plugged air filters), which causes the turbocharger to slobber.
4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.
5. Inspect the bore of the turbine housing for corrosion.
6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.
7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i02568213

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 proper 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 or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that the cooling lines are properly clamped and that the cooling lines are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pumps for coolant leaks.

Note: The water pump seal is lubricated by 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 water pumps and the installation of water pumps and/or seals, refer to the Service Manual for the engine or consult 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 valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps or for loose fuel line tie-wraps.
- Inspect the piping for the air inlet 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 belt and the 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 fuel tanks 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.
- Inspect the ECM to the cylinder head 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.

i02568235

Water Pump - Inspect

A failed water pump might 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

Visually inspect the water pump for leaks. If any leaking is observed, replace the water pump seal or the water pump assembly. Refer to the Service Manual for the disassembly and assembly procedure.

Note: Refer to the Service Manual or consult your Perkins distributor if any repair is needed or any replacement is needed.

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

Engine Ratings

i08274659

Engine Rating Conditions

All engine ratings are in compliance with the following standard ambient air conditions of “SAE J1349”:

- 99 kPa (29.3 inches of Hg)
- 30 percent relative humidity
- A temperature of 25 °C (77 °F)

Ratings relate to the standard conditions of “ISO8665”, of “ISO3046/1”, of “DIN6271”, and of “BS5514”.

The engine ratings are based on the following fuel specifications:

- Low heat value (LHV) of the fuel of 42 780 kJ/kg (18,390 Btu/lb) at 29 °C (84 °F)
- Gravity (API) of 35 degrees at 15 °C (60 °F)
- Specific gravity of .849 at 15 °C (60 °F)
- Density of 850 kg/m^3 (7.085 lb/US gal)

The engine ratings are gross output ratings.

Gross Output Ratings – The total output capability of the engine that is equipped with standard accessories.

Standard accessories include the following components:

- Oil pumps
- Fuel pumps
- Water pumps

Subtract the power that is required to drive auxiliary components from the gross output. This action will produce the net power that is available for the external load (flywheel).

i05986477

Engine Rating Definitions

It is important to know the use of the engine so that the rating will match the operating profile. The proper rating selection is also important so that the customers perception of price and value is realized.

In selecting a rating for a specific application, the most important consideration is the time that is spent at full throttle. These rating definitions identify the percent of time at full throttle. The definitions also identify the corresponding times below rated rpm.

Note: The examples of the applications are only for reference. For an exact determination of the appropriate rating, follow the OEM specifications or consult your Perkins distributor .

A Rating – This rating is used for heavy-duty applications that are operated at rated load and at rated rpm up to 100 percent. This rating is used for engines that operate without interruption of load cycling. Typical applications include the following examples: pipeline pumping and ventilation.

B Rating – This rating is used when power and/or rpm are cyclic. The engine should be run at full load. The engine should not exceed 80 percent of the duty cycle. Typical applications include the following examples: irrigation, operation where normal pump demand is 85 percent of the engine rating, oil pumping/drilling, field mechanical pumping/drilling and stationary/plant air compressors.

C Rating – This rating is used when power and/or rpm are cyclic. The horsepower and the rpm of the engine can be utilized continuously for 1 hour. Followed by 1 hour of operation at the A rating or below the A rating. The engine should be run at full load. The engine should not exceed 50 percent of the duty cycle. Typical applications include the following examples: agricultural tractors, harvesters and combines, off-highway trucks, fire pumps, blast hole drills, rock crushers, wood chippers with high torque rise and oil field hoisting.

D Rating – This rating is used when rated power is required for periodic overloads. The maximum horsepower and the rpm of the engine can be utilized continuously for a maximum of 30 minutes. Followed by 1 hour of operation at the C rating. The engine should be run at full load. The engine should not exceed 10 percent of the duty cycle. Typical applications include the following examples: offshore cranes, runway snow blowers, water well drills, portable air compressors and fire pump certification power.

E Rating – This rating is used when rated power is required for a short time for initial starting or for sudden overload. The rating is also used for emergency service when standard power is not

available. The horsepower and the rpm of the engine can be utilized continuously for a maximum of 15 minutes. Followed by 1 hour of operation at the C rating or by the duration of the emergency. The engine should be run at full load. The engine should not exceed 5 percent of the duty cycle. Typical applications include the following examples: standby centrifugal water pumps, oil field well servicing, crash trucks, portable air compressors and gas turbine starting motors.

NOTICE
Operating engines above the rating definitions can result in shorter service life before overhaul.

Reference Materials

i05204672

Maintenance Records

Perkins recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.
- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for various other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is correctly managed. Accurate maintenance records can help your Perkins dealer to fine-tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owners repair costs
- Owners receipts
- Maintenance log

i05204675

Maintenance Log

Table 22

Engine Model		**Customer Identifier**		
Serial Number		**Arrangement Number**		
Service Hours	**Quantity Of Fuel**	**Service Item**	**Date**	**Authorization**

i07677995

Reference Material
(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 is 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:

www.perkins.com

NOTICE
Dependant upon engine type and application.

Index

A

After Starting Engine 44
  Constant Speed Engines 44
  Variable Speed Engines 44
After Stopping Engine 48
Aftercooler Core - Inspect/Clean/Test 79
  Clean 79
  Inspect 79
  Test 79
Air Shutoff - Test 79
Alternator - Inspect 80

B

Battery - Replace 80
Battery Electrolyte Level - Check 80
Battery or Battery Cable - Disconnect 81
Before Starting Engine 15, 42
Belt Tensioner - Check (Model LG) 81
Belt Tensioner - Check (Model PK9) 81
Belts - Inspect/Adjust (Model LG) 82
  Coolant Pump Drive Belt 83
  Fan Belts 82
  New belts 83
Belts - Inspect/Adjust (Model PK9) 83
  Inspect 83
Belts - Replace 83
Burn Prevention 11
  Batteries 12
  Coolant 12
  Diesel Fuel 12
  Oils 12

C

Cold Weather Operation 46
Cold Weather Starting 42
Configuration Parameters 41
  System Configuration Parameters 41
Coolant (DEAC) - Change 84
  Drain 84
  Fill 85
  Flush 84
Coolant (ELC) - Change 85
  Drain 85
  Fill 86
  Flush 86
Coolant Extender (ELC) - Add 86
Coolant Level - Check 86
Coolant Temperature Regulator - Replace 87
Crankshaft Vibration Damper - Inspect 87
  Inspection 88
  Removal and Installation 88
Crushing Prevention and Cutting Prevention .. 14

D

Diagnostic Lamp 40
Driven Equipment - Check 88

E

Electrical System 16
  Grounding Practice 16
Emergency Stopping 48
Emissions Certification Film 28
Emissions Warranty Information 104
Engaging the Driven Equipment 45
Engine - Clean 88
Engine Air Cleaner Element (Single Element) - Inspect/Replace 89
Engine Air Cleaner Service Indicator - Inspect (If Equipped) 90
Engine Air Precleaner - Check/Clean (If Equipped) 90
Engine Crankcase Breather - Clean 90
Engine Diagnostics 40
Engine Electronics 17
Engine Mounts - Inspect 91
Engine Oil and Filter - Change 92
  Drain the Engine Oil 93
  Fill the Engine Crankcase 94
  Replace the Oil Filter 93
Engine Oil Level - Check 91
Engine Oil Sample - Obtain 92
  Obtain the Sample and the Analysis 92
Engine Operation 45
Engine Operation with Active Diagnostic Codes 40
Engine Operation with Intermittent Diagnostic Codes 40
Engine Rating Conditions 105
Engine Rating Definitions 105
Engine Ratings 105
Engine Starting 15, 42
Engine Stopping 15, 48
Engine Valve Lash - Check 94

F

Fan Clearance - Check 94
Fault Logging 40
Features and Controls 32
Fire Prevention and Explosion Prevention 12
Ether 14
Fire Extinguisher 14
Lines, Tubes, and Hoses 14
Fluid Recommendations 49, 56
ELC Cooling System Maintenance 51
Engine Oil 56
General Coolant Information 49
General Lubricant Information for the 1506D Engine 56
Fluid Recommendations (Fuel Recommendations for the 1506A and 1506C Engines) 57
Contamination Control Recommendations for Fuels 65
Diesel Fuel Characteristics 60
Diesel Fuel Requirements 58
General Information 58
Fluid Recommendations (Fuel Recommendations for the 1506D Engine) 65
Contamination Control Recommendations for Fuels 73
Diesel Fuel Characteristics 68
Diesel Fuel Requirements 66
General Information 66
Fluid Recommendations (Lubricant Information for 1506A and 1506C Engines) 53
Engine Oil 54
General Lubricant Information 53
Foreword 4
California Proposition 65 Warning 4
Literature Information 4
Maintenance 4
Maintenance Intervals 5
Operation 4
Overhaul 5
Safety 4
Fuel and the Effect from Cold Weather 46
Fuel Conservation Practices 45
Fuel Related Components in Cold Weather 46
Fuel Heaters 47
Fuel Tanks 46
Fuel System - Prime 95
Fuel System Primary Filter (Water Separator) Element - Replace 96
Fuel System Primary Filter/Water Separator - Drain 97
Fuel System Secondary Filter - Replace 98
Fuel Tank Water and Sediment - Drain 99
Drain the Water and the Sediment 99
Fuel Storage Tanks 99
Fuel Tank 99

G

Gauges and Indicators 32
Instrument Panels and Displays 32
Warning Indicators 32
General Hazard Information 8
Containing Fluid Spillage 10
Dispose of Waste Properly 11
Fluid Penetration 9
Inhalation 10
Pressurized Air and Water 9
Static Electricity Hazard when Fueling with Ultra-low Sulfur Diesel Fuel 10
General Information 18
Grounding Stud - Inspect/Clean/Tighten 99

H

Hoses and Clamps - Inspect/Replace 100
Replace the Hoses and the Clamps 100

I

Important Safety Information 2

J

Jacket Water Heater - Check 100

L

Lifting and Storage 29

M

Maintenance Interval Schedule 77
Commissioning 78
Daily 77
Every 10 000 Service Hours 77
Every 12 000 Service Hours or 6 Years 78
Every 2000 Service Hours 77
Every 2000 Service Hours or 1 Year 77
Every 3000 Service Hours or 2 Years 77
Every 4000 Service Hours or 2 Years 77
Every 50 Service Hours or Weekly 77
Every 500 Service Hours 77
Every 500 Service Hours or 1 Year 77

Every 5000 Service Hours 77
Every 6000 Service Hours or 3 Years 77
Every Week 77
When Required 77
Maintenance Log 108
Maintenance Recommendations 74
Maintenance Records 107
Maintenance Section 49
Manual Stop Procedure 48
Stopping the Engine 48
Model View Illustrations 18
1506A and C Engine and Radiator Views ... 18
1506D Engine Views 22
Monitoring System 33
Action Alert 33
Critical Protection Override 33
Diagnostic 34
Shutdown 33
Shutdown Reset 34
Standard Warning Outputs 34
Warning Alarm 33
Mounting and Dismounting 15

O

Operation Section 29
Overhaul Considerations 101

P

Plate Locations and Film Locations 27
Engine Identification 27
Serial Number Plate 1 27
Product Description 24
Aftermarket Products and Perkins Engines 26
Electronic Engine Features 25
Engine Cooling and Lubrication 25
Engine Service Life 25
Engine Specifications 24
Product Identification Information 27
Product Information Section 18
Product Lifting 29
Product Storage 29
Condition for Storage 29
Removal from Storage 30

R

Radiator - Clean 101
Radiator Restrictions 46
Reference Information 28
Record for Reference 28
Reference Information Section 105
Reference Material (Extended Service Contract) 109
Reference Materials 107
Refill Capacities 49
Cooling System 49
Lubrication System 49

S

Safety Messages 6
(1) Universal Warning 6
Safety Section 6
Self-Diagnostics 40
Sensors and Electrical Components 35
1506D Configuration 39
Severe Service Application 76
Environmental Factors 76
Incorrect Maintenance Procedures 76
Incorrect Operating Procedures 76
Starting Motor - Inspect 101
Starting the Engine 43
Starting with Jump Start Cables 43
System Pressure Release 74
Coolant System 74
Engine Oil 74
Fuel System 74

T

Table of Contents 3
Turbocharger - Inspect 101
Cleaning and Inspecting 102
Removal and Installation 102

W

Walk-Around Inspection 102
Inspect the Engine for Leaks and for Loose Connections 102
Warranty Information 104
Warranty Section 104
Water Pump - Inspect 103
Welding on Engines with Electronic Controls 74

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:	_____	_____	_____

©2021 Perkins Engines Company Limited
All Rights Reserved