

Operation and Maintenance Manual

4006-E23TRS3 and 4006-E23TRS4 Gas Industrial Engines (50Hz)

WG6 (Engine)

Important Safety Information

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

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

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

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

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



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

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

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

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

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



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

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

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

Table of Contents

Foreword	4
----------------	---

Safety Section

Safety Messages	6
Additional Messages	12
General Hazard Information.....	13
Burn Prevention.....	16
Fire Prevention and Explosion Prevention.....	17
Crushing Prevention and Cutting Prevention..	19
Mounting and Dismounting	19
Ignition Systems	19
Before Starting Engine	19
Engine Starting.....	20
Engine Stopping	20
Electrical System.....	20

Product Information Section

Model Views and Specifications.....	22
Product Identification Information	26

Operation Section

Lifting and Storage	27
Gauges and Indicators	29
Features and Controls.....	30
Engine Starting.....	37
Engine Operation	40
Engine Stopping	41

Maintenance Section

Refill Capacities.....	43
------------------------	----

Maintenance Recommendations	50
-----------------------------------	----

Maintenance Interval Schedule.....	52
------------------------------------	----

Reference Information Section

Reference Materials	69
---------------------------	----

Index Section

Index.....	72
------------	----

Foreword

California Proposition 65 Warning

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



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

www.P65Warnings.ca.gov

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



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

www.P65Warnings.ca.gov

Wash hands after handling components that may contain lead.

Literature Information

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

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

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

Safety

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

Operation

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

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

Maintenance

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

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

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

Maintenance Intervals

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

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

Overhaul

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

Safety Section

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Safety Messages

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

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

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

Engine Safety Messages

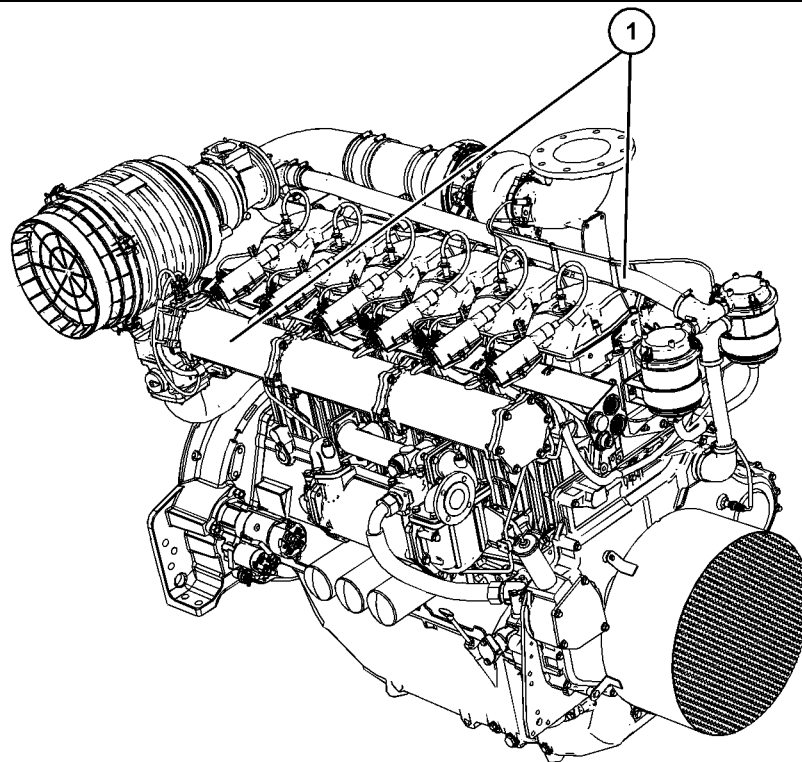


Illustration 1

g06225221

Typical example

(1) Universal warning label locations

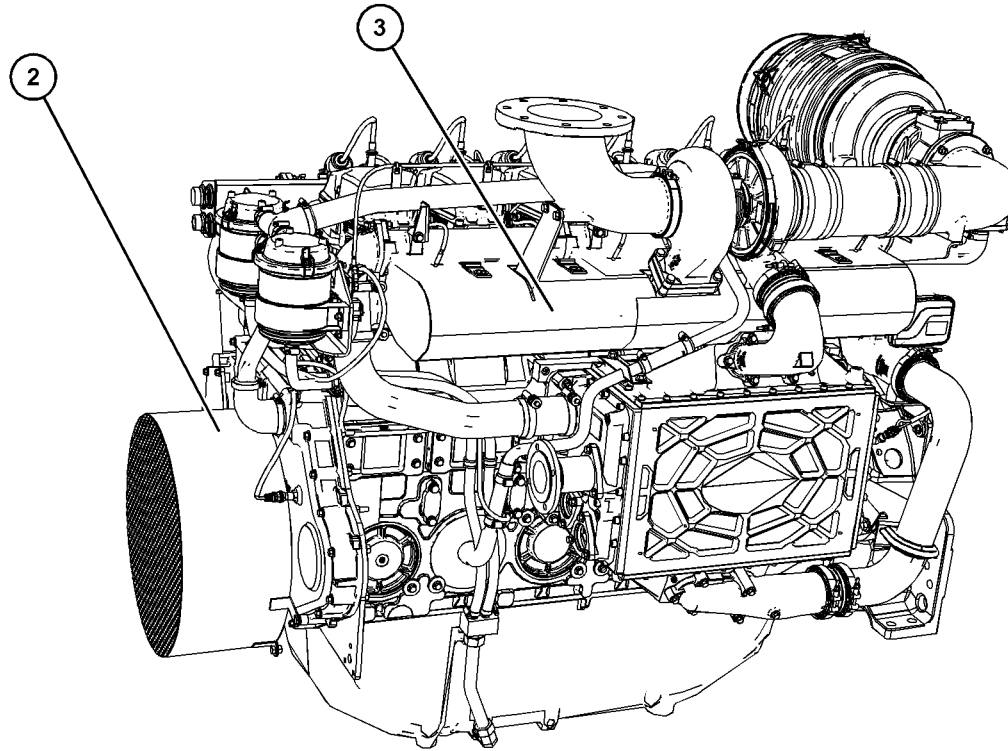


Illustration 2

g06225246

Typical example

(2) Rotating Shaft Hand Crush Hazard

(3) Hot Surface

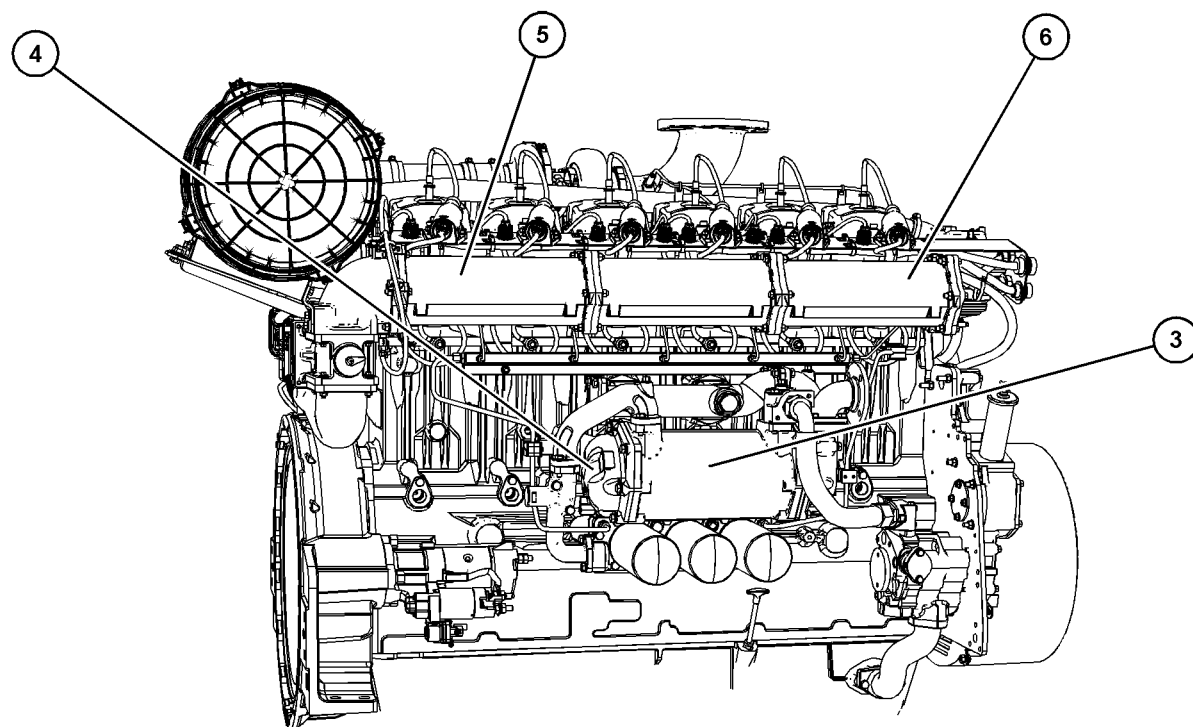


Illustration 3

g06225254

(4) Hot Fluid Under Pressure
(5) Ether Warning

(6) Do Not Step
(3) Hot Surface

1 Universal Warning

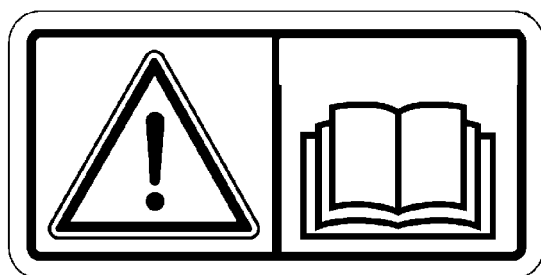


Illustration 4

g06019365

Universal Warning label

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.

The universal warning labels (1) are installed in two locations on the engine. One universal warning label is installed on the breather tube. The other universal warning label is installed on the rear of the intake manifold.

2 Rotating Shaft Hand Crush Hazard

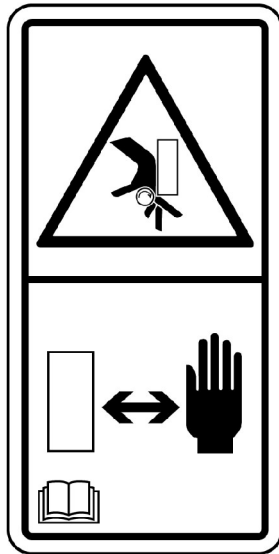


Illustration 5

g02781437

WARNING

Rotating shaft pinch hazard. The shaft under this cover is rotating anytime the engine is running. Contact with a rotating shaft could cause injury or death. Keep hands away.

The rotating shaft hand crush hazard label (2) is on the cover of the crankshaft vibration dampers.

3 Hot Surface



Illustration 6

g01372256

WARNING

Hot parts or hot components can cause burns or personal injury. Do not allow hot parts or components to contact your skin. Use protective clothing or protective equipment to protect your skin.

The hot surface warning labels (3) are located in two locations. The intake manifold and on the oil cooler.

4 Hot Fluid Under Pressure



Illustration 7

g01371640

WARNING

Pressurized system! Hot coolant can cause serious burns, injury or death. 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. Read and understand the Operation and Maintenance Manual before performing any cooling system maintenance.

The hot fluid under pressure label (4) is on the end cover of the oil cooler.

5 Ether Warning

WARNING

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

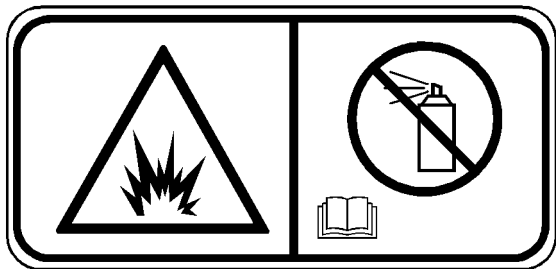


Illustration 8

g06295560

The ether warning label (5) is on the inlet manifold close to the air cleaner.

6 Do Not Step

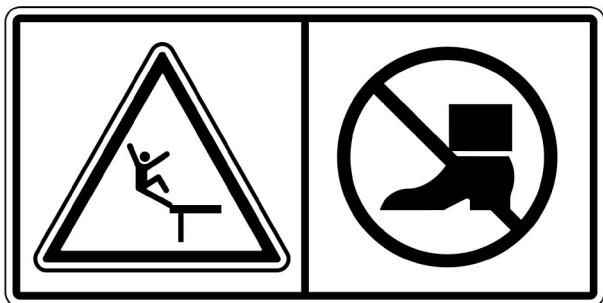


Illustration 9

g01393287

WARNING

Do not use this surface as a step or platform. This surface may not support additional weight or may be slippery. Serious injury or death could occur from a fall.

The warning label no step (6) is on the front of the inlet manifold.

Enclosure Safety Messages

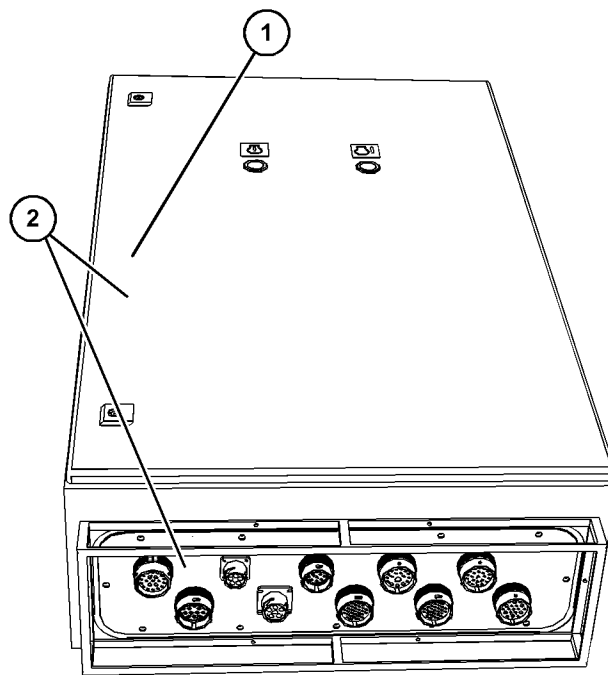


Illustration 10

g06295527

1 Universal Warning

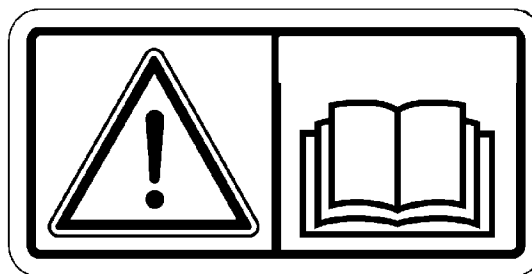


Illustration 11

g06019365

Universal Warning label

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.

The universal warning labels (1) are installed in two locations on the engine. One universal warning label is installed on the breather tube. The other universal warning label is installed on the rear of the intake manifold.

The universal warning label (1) is also installed on the front of the control enclosure.

Electrocution (2)

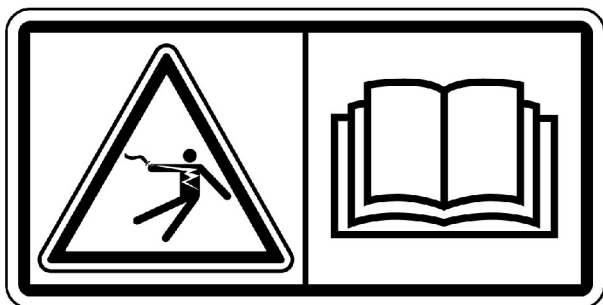


Illustration 12

g01392482

DANGER

DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.

This safety message electrocution (2) is located in two positions on the enclosure door. Also, the safety message electrocution (2) is on the bottom panel of the enclosure.

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Additional Messages

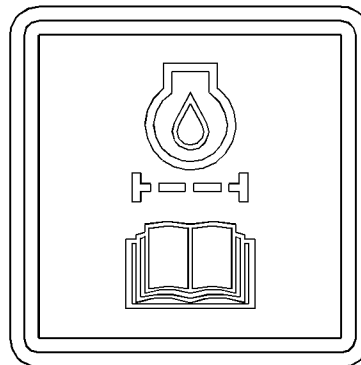


Illustration 13

g06249496

Typical example

The label will be installed on the engine oil cooler. A special starting procedure may be required. Refer to this Operation and Maintenance Manual, Before Starting Engine for the correct procedure.

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General Hazard Information

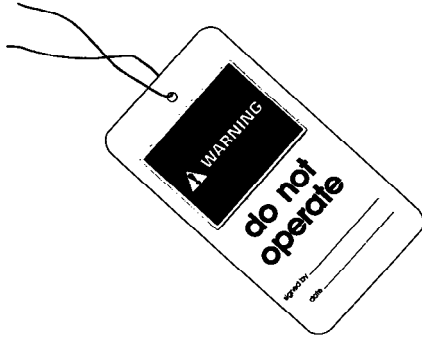


Illustration 14

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.
- 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.
- 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 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.

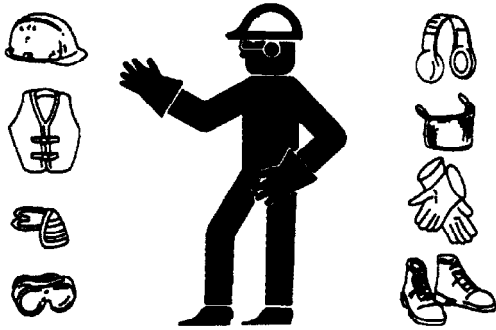


Illustration 15

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.

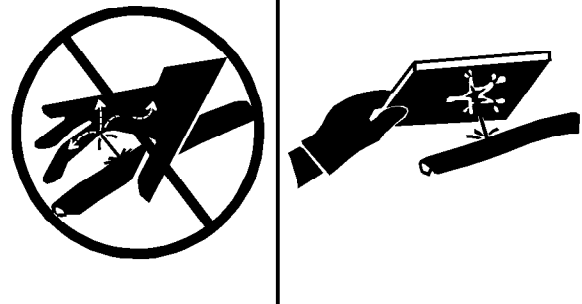


Illustration 16

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.

Inhalation

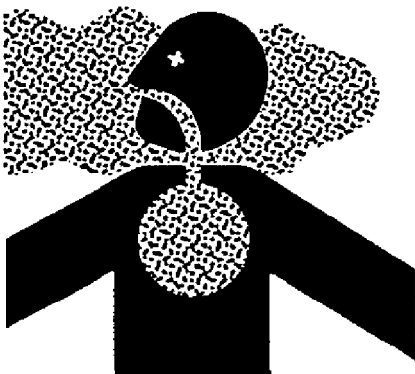


Illustration 17

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

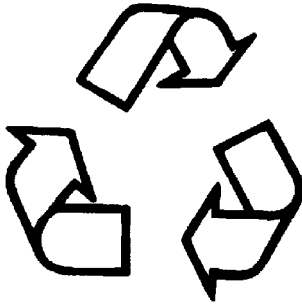


Illustration 18

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.

i06948028

Burn Prevention

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check that the coolant level after the engine has stopped and the engine has been allowed to cool. Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly to relieve pressure. Refer to this Operation and Maintenance Manual, Cooling System Coolant Level - Check for more information.

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.

Viton Seals

WARNING

If Viton is burned, a product of this burnt material is an acid which is hazardous. Do not allow burnt material to come into contact with the skin or with the eyes. Use the appropriate set of Personal Protective Equipment to protect your skin and eyes. Failure to follow the instructions or heed the warning could result in serious injury or death.

If there is need to come into contact with components which have been burnt, ensure that the precautions which follow are used:

- Ensure that the components have cooled.
- Use Neoprene gloves and discard the gloves safely after use.
- Wash the area with calcium hydroxide solution and then with clean water.
- Disposal of components and gloves which are contaminated must be in accordance with local regulations.

If there is contamination of the skin or eyes, wash the affected area with a continuous supply of clean water or with calcium hydroxide solution. Wash the area effected for 15 to 60 minutes and obtain immediate medical attention.

Batteries

The liquid in a battery is an electrolyte. Electrolyte is an acid that can cause personal injury. Do not allow electrolyte to contact the skin or the eyes.

Do not smoke whilst checking the battery electrolyte levels. Batteries give off flammable fumes which can explode.

Always wear protective glasses when you work with batteries. Wash hands after touching batteries. The use of gloves is recommended.

i06948035

Fire Prevention and Explosion Prevention



Illustration 19

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 if there was a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not carry out any work on the fuel lines or tanks that could ignite residual fuel. Grinding, welding, cutting, chiseling, and sawing have the potential to create a source of ignition must be avoided.

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 damage, leakage 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 20

g00704059

Use caution when you are refueling an engine. Do not smoke whilst 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 21

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 whilst you are replacing an ether cylinder or whilst 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 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.

i05875651

Mounting and Dismounting

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

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

i06210914

Ignition Systems

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring.

If the control is in the AUTOMATIC or START position the ignition system may discharge, and a spark plug will operate. The spark plug will ignite any gas that has accumulated in that cylinder. The crankshaft and the driven equipment can move. Personal injury may result. Gas that has accumulated in the exhaust system can also be ignited.

Ensure that the power supply is isolated before any service or repairs are performed.

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.

i02426322

Engine Starting

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

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

If there is a possibility that unburned gas remains in the exhaust system, refer to the purge procedure in this Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section.

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

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

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

i08173082

Engine Stopping

To avoid overheating of the engine and accelerated wear of the engine components, stop the engine according to the instructions in this Operation and Maintenance Manual, "Engine Stopping".

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.

On the initial start-up of a new engine or an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. This procedure may be accomplished by shutting off the fuel supply to the engine, or shutting off the ignition system.

i02436641

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 Practices

Note: All ground lines must return to the battery ground.

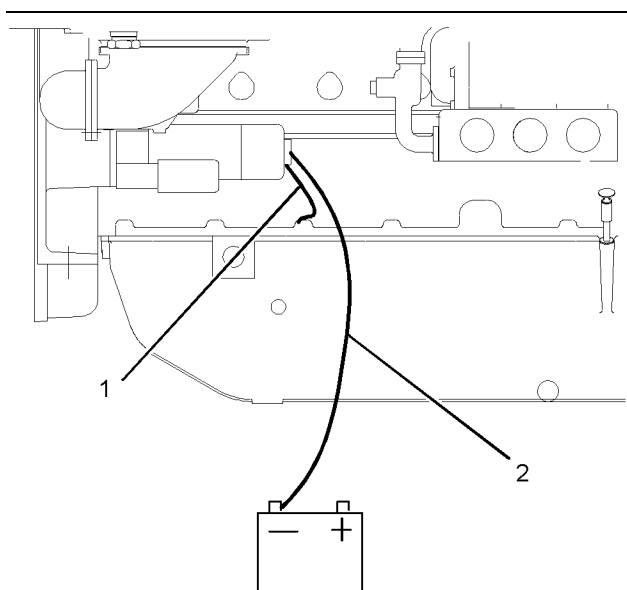


Illustration 22

g01217202

Typical example

- (1) Starting motor to ground
- (2) Battery negative to engine

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.

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

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

Product Information Section

Model Views and Specifications

i06949284

Model View Illustrations

The illustrations show various typical features of 4006-E23TRS3 and 4006-E23TRS4 industrial engines. The illustrations do not show all the options that are available.

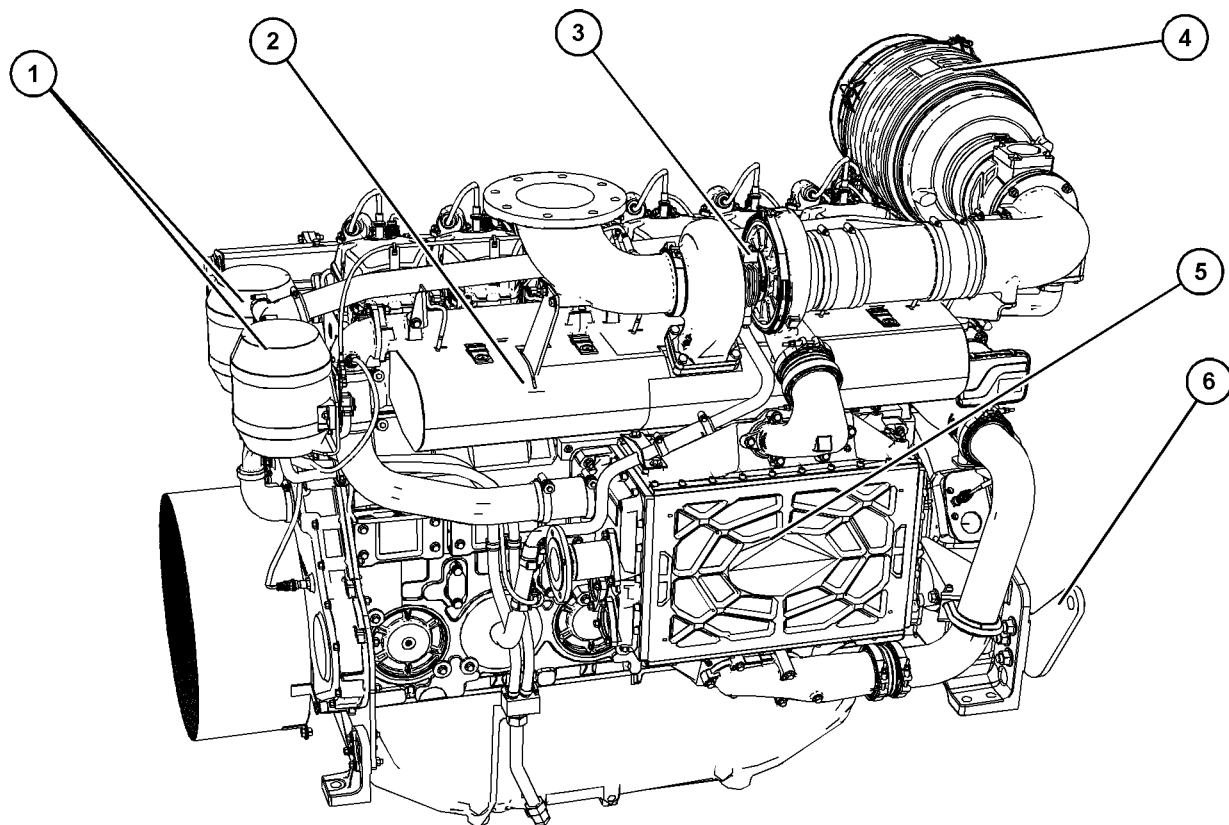


Illustration 23

g06265869

Typical example

(1) Cranks case breathers with insulation
cover installed
(2) Heat shield

(3) Turbocharger
(4) Air cleaner
(5) Charge cooler

(6) Left side lifting eye

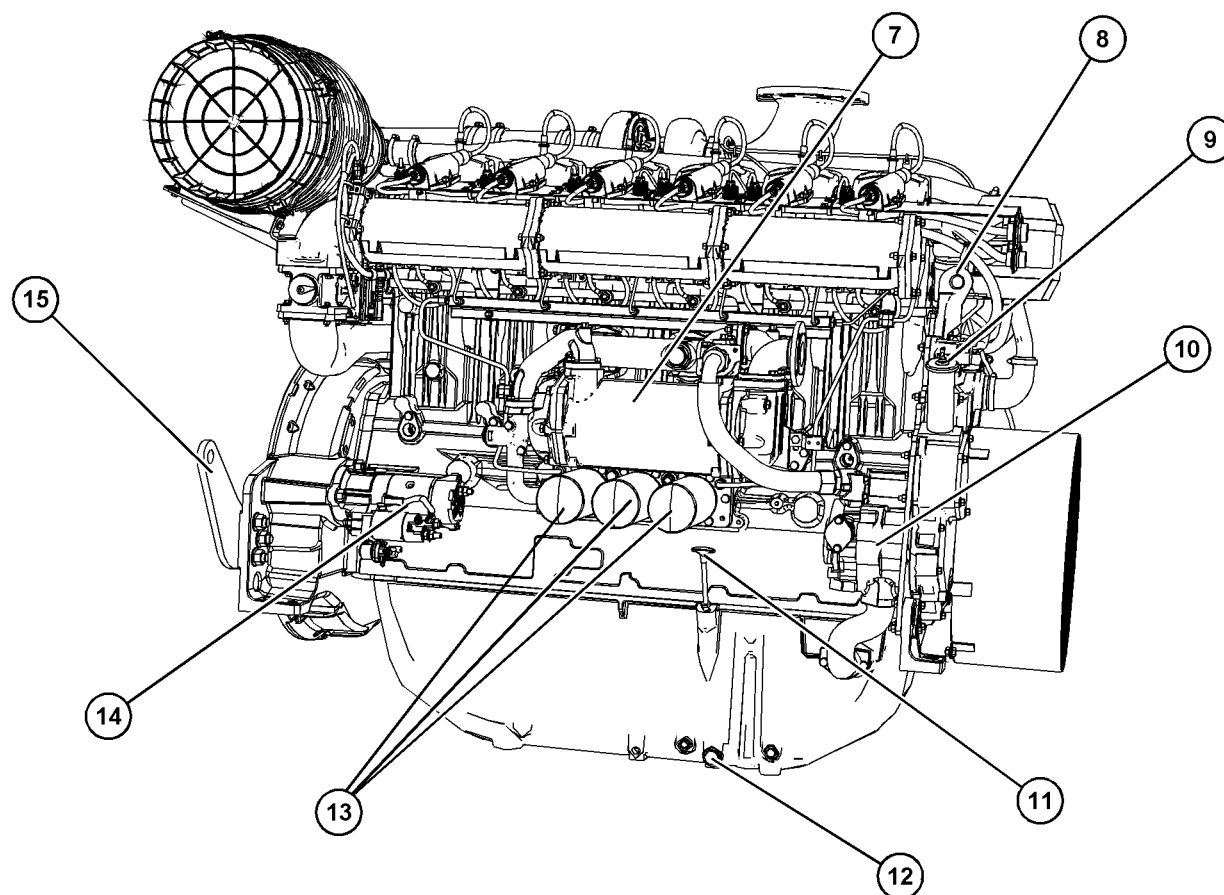


Illustration 24

g06265878

Typical example

- (7) Oil cooler
- (8) Front lifting eye
- (9) Oil filler cap

- (10) Oil pump
- (11) Oil gauge (Dipstick)
- (12) Oil drain plug

- (13) Oil filters
- (14) Starting motor
- (15) Right side lifting eye

i06953353

Lubrication System**Product Description****Engine**

The Perkins Engines were developed to provide gas engines for generator set applications. The engines can burn a wide variety of gaseous fuels.

The engine lubrication oil is supplied by a pump that is driven by a gear. The oil is cooled and the oil is filtered. A bypass valve provides unrestricted flow of lubrication oil to the engine parts if the oil filter elements become plugged. The bypass valve will open if the oil filter differential pressure reaches 34.4 to 48.2 kPa (5 to 7 psi). The engine oil pressure operates in a range of 413.6 to 470 kPa (60 to 68 psi).

Note: The engine lubrication oil is not filtered when the bypass valve is open. Do not allow the engine to operate when the bypass valve is open. This action can damage the engine components.

Cooling System

The water enters the engine from the oil cooler and the water is passed through the cylinder block. The water exits the cylinder head into the rail. The water exits the engine from the water outlet.

Ignition System

The ignition system uses an electronic ignition system with a negative ground. The spark plug is a pre-chamber type and the static timing at full power for natural gas applications is 26° BTDC.

Cogeneration Engine

Cogeneration uses energy from heat which would otherwise be wasted.

The following items are not supplied:

- Water pumps
- Water temperature regulator (thermostat)
- All water tube assemblies

This system is the responsibility of the OEM.

Engine Specification

(Table 1, contd)

Displacement	22.9 L (1397.4436 in³)
Compression ratio	14:1
Aspiration	Turbocharged
Rotation (flywheel end)	Counterclockwise
Inlet valve lash (cold)	0.40 mm (0.0157 inch)
Exhaust valve lash (cold)	0.40 mm (0.0157 inch)
Firing order	1, 5, 3, 6, 2, 4

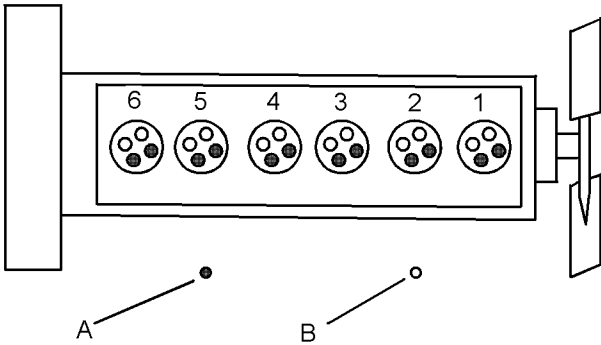


Illustration 25 g01216853

Typical example

- (A) Inlet valves
(B) Exhaust valves

Table 1

4006-E23TRS3 and 4006-E23TRS4 Engines Specifications	
Rated rpm	1500
Cylinders and arrangement	In-line six cylinders
Bore	160 mm (6.2992 inch)
Stroke	190 mm (7.4803 inch)

(continued)

Piston Positions for Valve Lash Setting

Table 2

4006-E23TRS3 and 4006-E23TRS4		
Top Center Position	Engine cylinder with valves on the rock	Set the bridge adjustment and set valve lash.
1-6	6	1
2-5	2	5
3-4	4	3
1-6	1	6
2-5	5	2
3-4	3	4

Electronic Engine Features

The ECM Control System provides integrated control of governing, ignition, misfire, Air Fuel Ratio (AFR), knock detection. Also, the system provides monitoring, for safety-related alarms functions.

The key features of the system are:

- Speed / Load Control
- Air / Fuel Ratio Control using the gas regulation and metering Valve for consistent starting
- Integrated internal ignition and knock sensing
- Individual cylinder knock mitigation
- Integrated misfire (crank speed) detection
- Boost Control
- Engine sensor and AFR diagnostics
- NOx sensor and closed loop control with kW sensor backup
- Ambient pressure compensation
- Ignition timing speed control assists

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 period of time.

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

i07104860

Plate Locations and Film Locations

The engine serial number plate is on the right side rear of the engine.

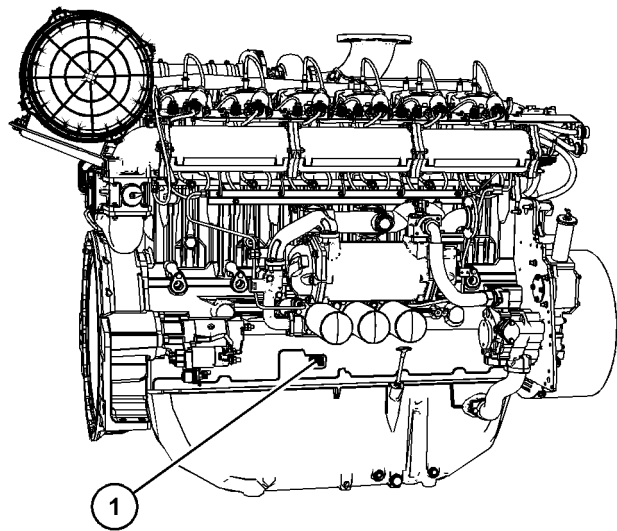


Illustration 26
Typical example
(1) Engine serial number plate

g06225865

 **PERKINS**®

Perkins Engine Company Ltd, England

SER. NO. #####

DESIGNATION #####

kW ##### AT ##### RPM TIMING ### ° BTDC

Designed and Manufactured in the U.K.

Illustration 27
g06016214

Typical example
(1) Engine serial number plate

Your Perkins distributor needs all the number from the plate when service information is required.

Operation Section

Lifting and Storage

i07448444

Engine Lifting

Engine Lifting Only

NOTICE

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

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

Use a hoist to remove heavy components. Use a 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.

To remove the engine **ONLY**, use the lifting eyes that are on the engine. If necessary, remove engine components to avoid damage from the lifting device.

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

When storing, moving, or lifting the engine separate to the application or base frame the engine must not be stood on the sump/oil pan. There is a risk of the engine toppling if the engine is stood on the sump/oil pan. Refer to the installation manual, the General Arrangement drawing, or Perkins Engine Company Limited, Stafford, ST16 3UB for more information on engine storage.

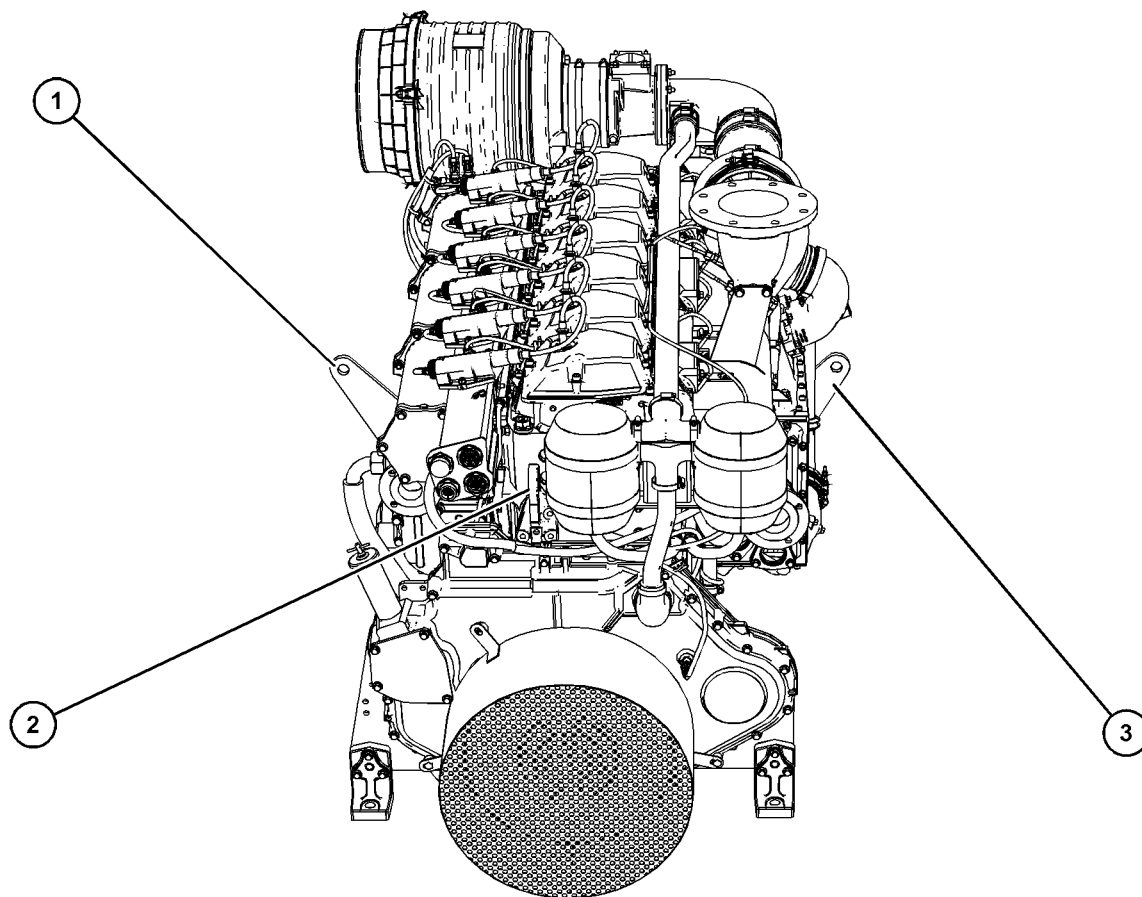


Illustration 28

g06266525

Typical example

(1) Right side lifting eye

(2) Left side lifting eye

(3) Front lifting eye

i03781209

Engine Storage

Refer to Perkins Engine Company Limited, Stafford, ST16 3UB for information on engine storage.

There are three different levels of engine storage. Level "A, B and C".

Level "A "

Level "A" will give protection for 12 months for diesel engines and for gas engines. This level is used for engines that are transported in a container or by a truck.

Level "B "

This level is additional to level "A". Level "B" will give protection under normal conditions of storage from -15° to $+55^{\circ}\text{C}$ (5° to 99°F) and "90%" relative humidity, for a maximum of 2 year.

Level "C "

This level is additional to level "B". Level "C" will give protection for five years in tropical or in arctic climates. Level "C" also meets MOD NES 724 Level "J" for Europe, when engines are stored in an unheated building or in the open under a waterproof cover.

Gauges and Indicators

i07316328

Gauges and Indicators

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

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

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

NOTICE

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



Engine Oil Pressure – The range for the engine oil pressure is 413.6 to 470 kPa (60 to 68 psi).



Jacket Water Coolant Temperature – Typical water temperature into the engine is 71°C (160°F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed 96°C (204°F).

1. A high water temperature switch is installed in the cooling system.



Tachometer – This gauge indicates engine speed (rpm).



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



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

Features and Controls

i07104867

Sensors and Electrical Components

Electronic Ignition System (EIS)

WARNING

The ignition system generates high voltage. Do not come in contact with the ignition system with the engine in operation. This voltage can cause personal injury or death.

The Electronic Ignition System includes the following components:

- The control module for the ignition
- Timing sensor
- Ignition coil on each cylinder
- Spark plugs
- Ignition harness

The EIS control module is a sealed unit with no serviceable parts. There are two speed/timing magnet pick-up sensors installed.

Sensors

The engine is installed with the following sensors.

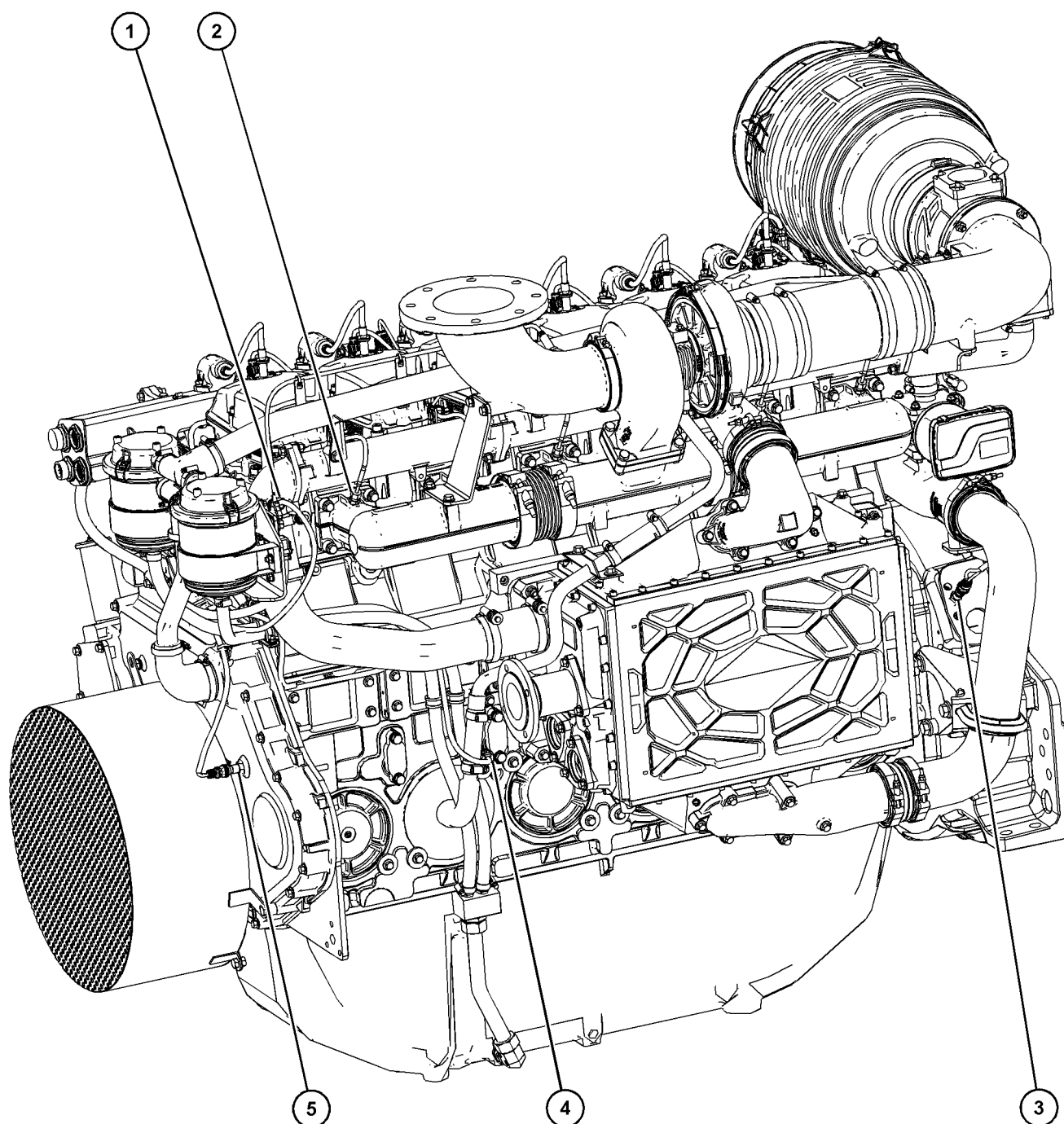


Illustration 29

g06223775

Typical example

(1) Coolant temperature sensor
(2) Exhaust temperature probe

(3) Flywheel speed/timing sensor
(4) Oil pressure sensor

(5) Camshaft speed/timing sensor

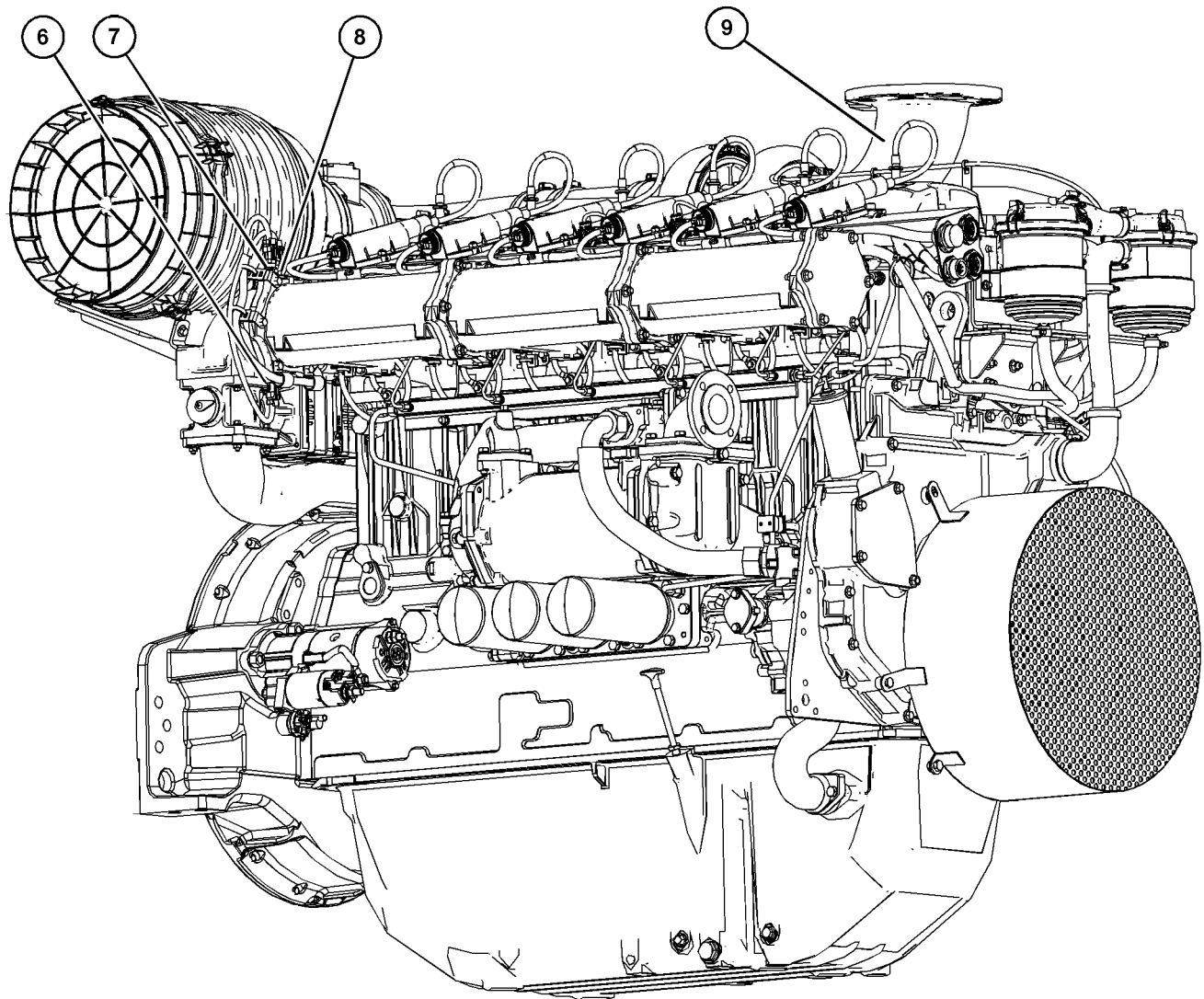


Illustration 30

g06225971

Typical example

(6) Inlet manifold temperature sensor
(7) Inlet manifold pressure sensor (1)

(8) Inlet manifold pressure sensor (2)
(9) NOx sensor probe location.

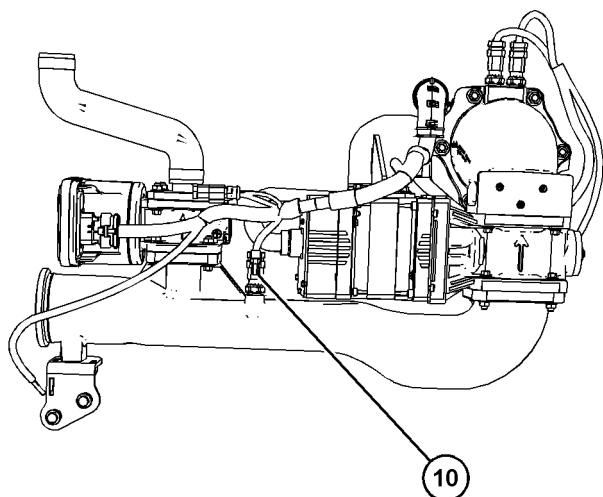


Illustration 31

g06225976

Typical example

(10) Pressure sensor before throttle valve

Detonation System

The equipment for the detonation system is available to sense detonation or knock which may be caused by poor gas or may be caused by high combustion temperatures.

The detonation system includes the following components:

- Detonation sensor on each cylinder
- Control module for detonation
- Wiring harness

The detonation system operates by measuring vibrations on the crankcase.

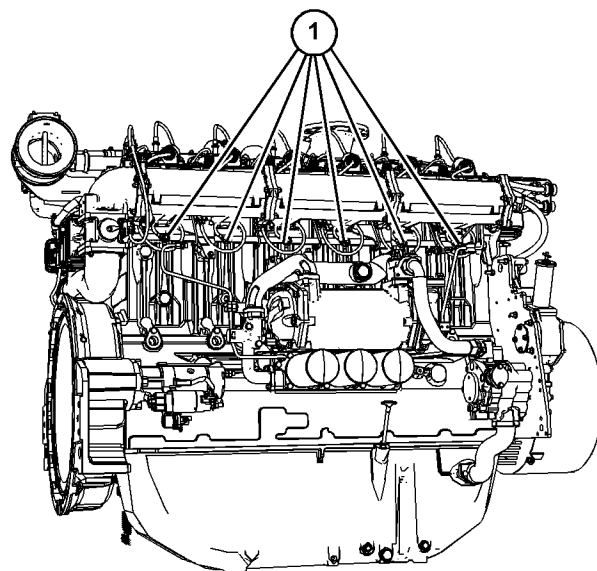


Illustration 32

g06225928

Typical example

Detonation sensors

Gas System

The gas system is controlled by three main valves that are monitored and controlled by the electronic control module.

The gas regulation and metering valve is supplied loose by Perkins and is part of the gas line installation.

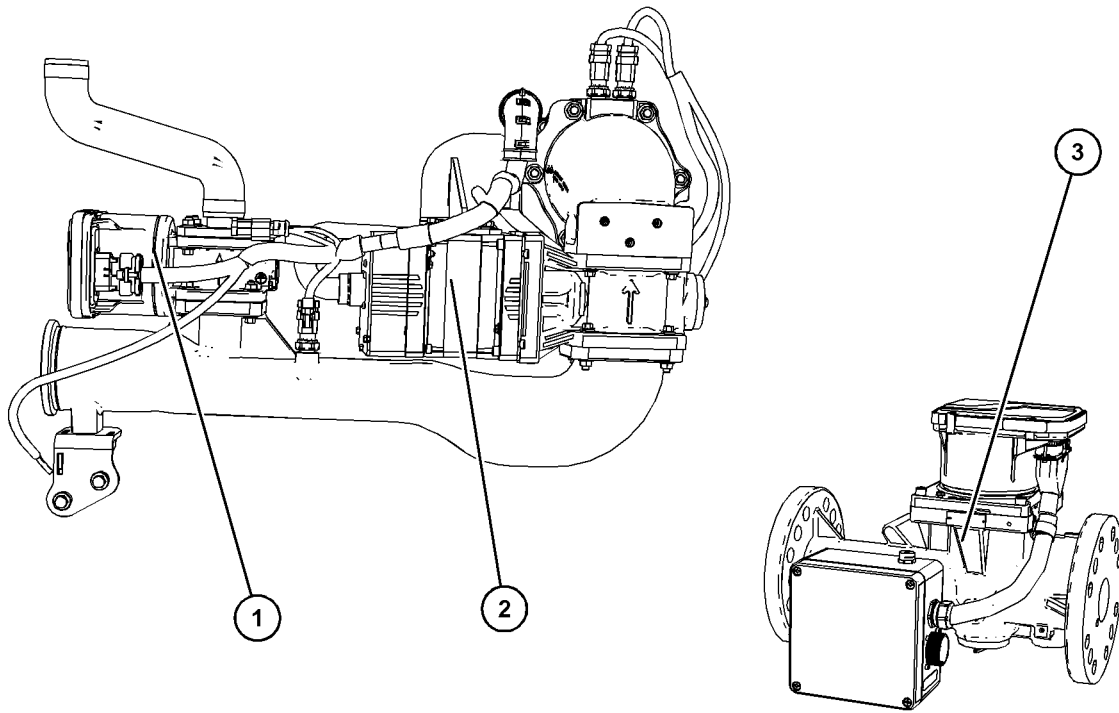


Illustration 33

g06226036

Typical example

(1) Bypass valve

(2) Throttle valve

(3) Gas regulation and metering valve

i07248812

Control Panel (Enclosure)

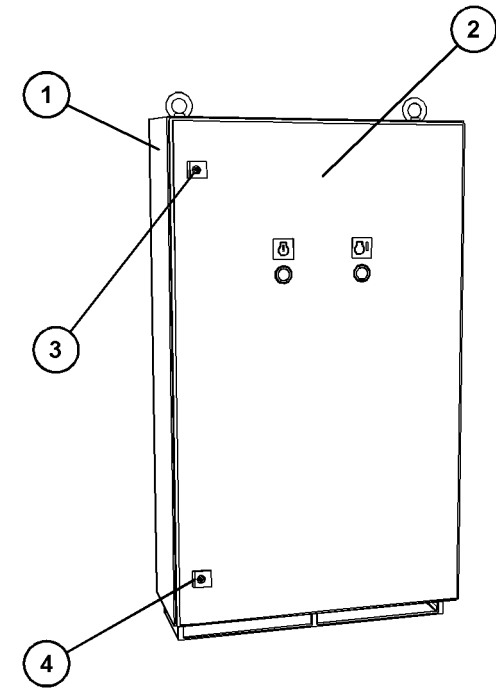


Illustration 34

g06265510

Typical example

- (1) Enclosure
- (2) Enclosure door
- (3) Top lock
- (4) Bottom lock

Opening Enclosure Door

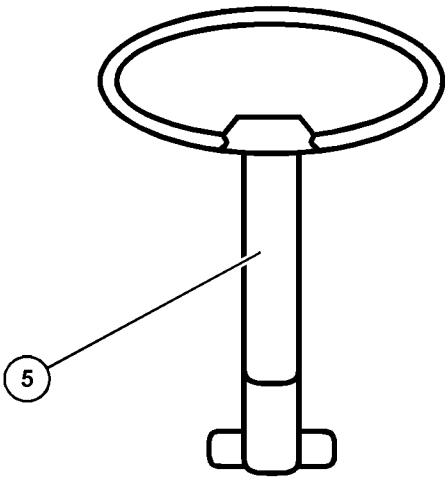


Illustration 35

g06274446

Typical example

- (5) Enclosure key

1. Using enclosure key (5) unlock top lock (3) and unlock bottom lock (4). To unlock enclosure door, rotate enclosure key anticlockwise.

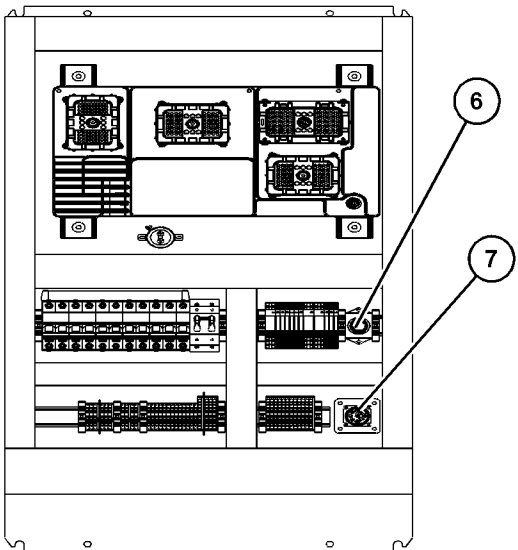


Illustration 36

g06265549

Typical example

- (6) Reset button
- (7) Diagnostic connector

2. With both locks in the unlocked position , open enclosure door (2). Secure the enclosure door in the open position by opening the door to the full extent. The latch (not shown) in the top right corner will lock door in place.

Note: If necessary connect to diagnostic connector (6). If system is to be reset, press the reset button (7).

Closing Enclosure Door

1. If necessary, disconnect the electronic service tool from the diagnostic connect.
2. Lift the latch and close the enclosure door.
3. Using enclosure key (5) lock top lock (3) and lock bottom lock (4). Turn enclosure key clockwise to lock enclosure door.
4. Ensure that the enclosure key is stored in a safe place close to the enclosure.

Engine Starting

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Before Starting Engine

General Checks Before Starting Engine

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

- For the maximum service life of the engine, make a thorough inspection within the engine compartment before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts, and excessive dirt and/or grease. Remove any excess dirt and/or grease buildup. Repair any faults that were identified during the inspection.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Open the fuel supply valve (if equipped).
- Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all the shutoffs or alarm components (if equipped).
- Check the engine lubrication oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the engine oil level gauge.

- Check the coolant level. Observe the coolant level in the header tank (if equipped). Maintain the coolant level to the "FULL" mark on the header tank.
- If the engine is not equipped with a header tank, maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator. Service the air cleaner when the diaphragm enters the red zone, or when the red piston locks in the visible position.
- Remove any electrical loads.

Prime the Oil System

Note: Always perform the general checks before priming the oil system.

- If the engine has not been started for 3 months, rebuilt, or the engine oil and filter has been changed, then the oil system must be primed.
- Ensure that the gas supply is in the closed position. Refer to the Original Equipment Manufacturer (OEM) for more information.
- Turn the keyswitch to the START position. Hold the keyswitch in this position until the oil pressure gauge indicates 100 kPa (14 psi). Continue to hold the keyswitch in the START position for an extra 10 seconds.
- Only crank the engine for 30 seconds when building engine oil pressure. After 30 seconds, stop cranking and allow 2 minutes for the starter to cool.
- When oil system is primed, open the gas supply valve, then refer to this Operation and Maintenance Manual, Starting the Engine

i02427758

Cold Weather Starting

A jacket water heater is required for starting when the temperature is below 10 °C (50 °F). The temperature of the jacket water should be maintained at 40 °C (104 °F).

Note: A oil pan immersion heater must not be installed.

Extra battery capacity may be necessary in order to start the engine.

Consult your Perkins dealer for more information on the starting aids that are available for cold weather starting.

i07286696

Starting 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.

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 fuel supply and/or the ignition to the engine.

WARNING

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the "Starting the Engine" section.

The OEM will supply this system. Refer to the OEM for more information.

Note: Using the "EMERGENCY STOP" button will shut off both the fuel and the ignition.

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 no one will be endangered before the engine is started and when the engine is started.

Perform the procedures that are described in this Operation and Maintenance Manual, "Before Starting Engine" (Operation Section).

Final Checks and First Engine Start

Note: The fuel system must comply with all local regulations.

The OEM will supply this system. Refer to the OEM for more information.

1. The starting and the stopping of the engine must be on no load.
2. The procedure for starting and stopping a radiator cooled and CHP gas engine will be determined by the OEM relative to each individual engine installation.
3. Operate the engine at rated speed for 10 minutes.
4. Inspect the engine for leaks in the oil system and the coolant systems.
5. Stop the engine and check the engine oil and the engine coolant level.
6. Operate the engine under normal working conditions. Check the gauges to see the condition of the engine.
7. If the engine fails to start after two attempts, turn off the gas supply and investigate the cause.

First Engine Start

The reset button must be pressed before attempting to start the engine.

1. With power on both warning lights will be illuminated.
2. Open enclosure door, refer to this Operation and Maintenance Manual, Control Panel for the procedure to open and close the enclosure door.
3. With the enclosure door open, press the reset button. Both warning light should be extinguished and the engine is now ready to start.
4. Close and lock the enclosure door. Start the engine. Refer to OEM for instructions on starting the engine.
5. If the warning lamps are not extinguished, the service tool will need to be connected, then refer to troubleshooting.

Engine Starting Procedure

The starting procedure may differ because of the OEM system that is installed.

Note: The reset button may need to be pressed before starting.

Purging Unburned Gas

The following events cause unburned gas to remain in the air inlet and in the exhaust manifold:

- Emergency stop
- Engine overspeed

- Unsuccessful successive attempts to start the engine

Unburned gas may remain in the air inlet and exhaust system after several unsuccessful attempts to start the engine. The unburned gas may increase to a concentration that may ignite during a successive attempt to start the engine.

Perform the following procedure to purge the unburned gas:

1. Turn the manual gas shutoff valve to the CLOSED position.
2. Disable the ignition system. Remove the fuses from the ignition.
3. Turn the engine control switch to the START position. Crank the engine for a minimum of 6 seconds.
4. Enable the ignition by connecting the fuses that were disconnected in Step 2.
5. Turn the manual gas shutoff valve to the OPEN position.
6. Start the engine. Refer to the engine starting procedure and refer to OEM to start the engine.

i02428473

Starting with Jump Start Cables

Do not use jump start cables in order to start the engine. Charge the batteries or replace the batteries. Refer to Operation and Maintenance Manual, "Battery - Replace".

i02428529

After Starting Engine

For new installations and engines that are recently rebuilt, carefully monitor the engine in order to detect any unusual engine performance.

Check for leaks in the air and in the fluid systems.

Engine Operation

i02428569

Engine Operation

Proper operation and maintenance are key factors in attaining the maximum service life and economy for the engine. Follow the instructions in this Operation and Maintenance Manual in order to minimize operating costs and maximize the service life of the engine.

Observe the gauges frequently while the engine is operating. Record the data from the gauges in a log regularly. Compare the data to the specifications for normal engine operation. Comparing the data over time will help to detect changes in engine performance.

Investigate any significant change in the gauge readings. Monitor the engine operation and take action when discrepancies are found.

Partial load and Low Load Operation

Extended operation at low load or reduced load will cause the following results:

- Carbon formation in the cylinder
- Detonation
- Power loss
- Poor performance
- Accelerated wear of components
- Increased oil consumption
- The cylinder bore to glaze

Engine Stopping

i02428635

Emergency Stopping

The OEM will supply the system.

NOTICE

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

Pressing the Emergency Stop Button may cause unburned gas to remain in the air inlet and in the exhaust manifold.

WARNING

Unburned gas in the air inlet and exhaust system may ignite when the engine is started. Personal injury and/or property damage may result.

Before starting an engine that may contain unburned gas, purge the unburned gas from the air inlet and exhaust system. Refer to the topic on purging unburned gas in the “Starting the Engine” section.

The emergency stop button is in the OUT position for normal engine operation. Push the button for emergency stopping. This shuts off both the fuel and the ignition. The engine will not start when the button is locked. To reset the button, turn the button clockwise. The spring-loaded button will return to the OUT position.

NOTICE

Do not use this method to stop the engine unless an emergency has occurred. Continuous emergency shutdowns can cause damage to some engine components. This will leave unburned fuels in the combustion chambers and in the exhaust system. If an emergency shutdown occurs, purge the system by cranking the engine for 5 to 10 seconds with the ignition shutoff.

Typical Procedure in Order to Stop the Engine

Note: The stopping procedure will differ because of the different types of OEM controls that can be installed.

1. In order to stop the engine, switch off the gas valve.

2. With the engine stopped, switch off the ignition and switch off the governor.
3. If an overspeed occurs, switch off the ignition, the gas valve and the governor..
4. If another engine fault occurs switch off the gas valve.

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Manual Stop Procedure

In order to manually stop the engine, refer to the OEM for information. The procedure will depend on the system that has been installed.

NOTICE

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

Allow the engine to gradually cool before stopping the engine.

i08148458

After Stopping Engine

- Check the engine crankcase oil level. Maintain the oil level between the “ADD” and “FULL” marks on the “ENGINE STOPPED” side of the oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten loose bolts.
- Note the service hour reading. Perform the maintenance that is scheduled in this Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section).

NOTICE

Only use antifreeze/coolant mixtures recommended in the Refill Capacities and Recommendations section of this manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
- If freezing temperatures are expected, check the coolant for protection against freezing. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.

Operation Section
After Stopping Engine

- Perform all required periodic maintenance on all driven equipment. Refer to the instructions that are provided by the OEM of the driven equipment.

Maintenance Section

Refill Capacities

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Fluid Recommendations (Gas Engine Oil Specification)

General Lubrication Information

Engine Oil

The engine oil recommendation for an application can change due to advances in the specification of the oil. Refer to Perkins distributor for the latest information.

Note: The engine oil change schedule must be agreed by Perkins Engine Stafford.

Do not use multigrade oils.

Engines that operate on natural gas should be lubricated by oils that have a nominal sulphated ash content of 0.5% by weight and a TBN (Total Base Number) between 5 and 7.

The following SAE40 monograde engine oils comply:

- Mobil - Pegasus 705
- Mobil - Pegasus 805
- Mobil - Pegasus 1005
- Mobil - Pegasus 1105
- Addinol-EcoGas 4000XD
- Texaco/Caltex - Geotex LA
- Q8 - Mahler MA
- Castrol - Duratec L
- BP - Energas NGL
- Shell - Mysella S3 N40
- Shell - Mysella S5 N40
- Total - Nateria MH40
- Chevron/Caltex - HDAX (0% and 0.5% sulphated ash). This oil has a lower TBN value than the recommended minimum value, but the additive elements give the equivalent performance.
- Chevron - HPLX low ash

- Petro Canada - Sentron LD 5000

Note: Chevron/Caltex - HDAX has a lower TBN value than the recommended minimum value, but the additive elements give the equivalent performance.

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Fluid Recommendations (Fuel Specification)

Gas Specification

Natural Gas

Table 3

Requirements for the use of Natural Gas			
Description	Designation	Value	Remarks
Lower calorific value	LCV	>31 MJ/Nm ³	-
Maximum variation of LCV	-	<±5 percent	During operation
Minimum methane number	-	>75	Derate required below this figure
Minimum methane content	-	>50 vol-percent	Derate required below this figure
Hydrogen Sulphide	H ₂ S	<100 ppm	-
Maximum humidity (relative)	-	<80 percent	At lowest inlet temperature, no condensation in inlet manifold and gas train allowed
Min/max. gas pressure TRS engine with Elektra	70 to 280 mbar	7 to 28 kPa (1.01 to 4.06 psi)	At inlet to air fuel ratio regulator
Maximum fluctuation in gas pressure	-	3 mbar	Maximum rate of change of gas pressure is 3 mbar/min, variation frequency < 5/h
Min/max. gas temperature	-	10° to 40°C (18° to 72°F)	-

The gas specification requirements are to be used as a guide only. Perkins require a full gas analysis to be supplied at the inquiry stage of an engine order. Engine rating depends on the methane number and the low calorific value of the fuel and may be adapted to suit the specifics of the fuel.

Total possible derate is calculated by adding individual derate for:

- Charge cooler water inlet temperature
- Altitude
- Ambient temperature
- Lower calorific value
- Methane number

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Fluid Recommendations (General Coolant Information)

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 to transfer heat.

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

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

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

Table 4

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

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

- Local water utility company
- Agricultural agent
- Independent laboratory

Additives

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

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

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

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

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

Glycol

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

- Boiling
- Freezing
- Cavitation of the water pump

For optimum performance, Perkins recommends a 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 5 and refer to table 6.

Table 5

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

NOTICE

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

Table 6

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

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 gas engines:

Preferred – Perkins ELC

Acceptable – A commercial heavy-duty antifreeze that meets “ASTM D4985” specifications

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 industrial engines equipped with NOx reduction system must be operated with 50 % vol. mix of glycol and water.

For applications that do not require freeze protection consult Perkins Engines Stafford Applications department.

Table 7

Coolant Service Life	
Coolant Type	Service Life ⁽¹⁾
Perkins ELC	6,000 Service Hours or Three Years
Commercial Heavy-Duty Antifreeze that meets “ASTM D4985”	3000 Service Hours or One Year

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

ELC

Perkins provides ELC for use in the following applications:

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

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

ELC is available in a premixed cooling solution with distilled water. ELC is a 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.

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

NOTICE

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

Do not use 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 to set the heater control. After the cooling system is drained and the cooling system is refilled, operate the engine until the coolant level reaches the normal operating temperature and until the coolant level stabilizes. As needed, add the coolant mixture to fill the system to the specified level.

Changing to Perkins ELC

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

NOTICE

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

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant into a suitable container.
2. Dispose of the coolant according to local regulations.
3. 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 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 a 5 to 10 percent solution of Perkins ELC. 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) 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 8 to determine the amount of SCA that is required when the cooling system is initially filled.

Table 8

Equation For Adding The SCA To The Heavy-Duty Coolant At The Initial Fill
$V \times 0.7 = X$
V is the total volume of the cooling system.
X is the amount of SCA that is required.

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

Table 9

Example Of The Equation For Adding The SCA To The Heavy-Duty Coolant At The Initial Fill		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
15 L (4 US gal)	$\times 0.07$	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 10 to determine the amount of SCA that is required, if necessary:

Table 10

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

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

Table 11

Example Of The Equation For Adding The SCA To The Heavy-Duty Coolant For Maintenance		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
15 L (4 US gal)	$\times 0.023$	0.2 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.

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Refill Capacities

Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require extra oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information.

Table 12

Refill Capacities		
Compartment or System	Liters	Quarts
Crankcase Oil Sump ⁽¹⁾	122.7	129.6
Total Lubrication System ⁽²⁾		

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

(continued)

(Table 12, contd)

(2) The Total Lubrication System includes the capacity for the Crankcase Oil Sump plus the capacity of factory installed oil filters and other filters added to the lubrication system. Enter the value for the capacity of the Total Lubrication System in this row.

Cooling System

To maintain the cooling system, the Total Cooling System capacity must be known. The approximate capacity is for the engine cooling system. external system capacities will vary among applications. Refer to the OEM specifications for the external system capacity. This capacity information will be needed to determine the amount of coolant that is required for the total cooling system.

Table 13

Refill Capacities		
Compartment or System	Liters	Quarts
Engine and charge cooler only	34 L	35.9 qt
External System Per OEM ⁽¹⁾		
Total Cooling System ⁽²⁾		

(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.

(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

Maintenance Recommendations

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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 dealer regarding welding on a chassis frame or rail.

Proper welding procedures are necessary 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.

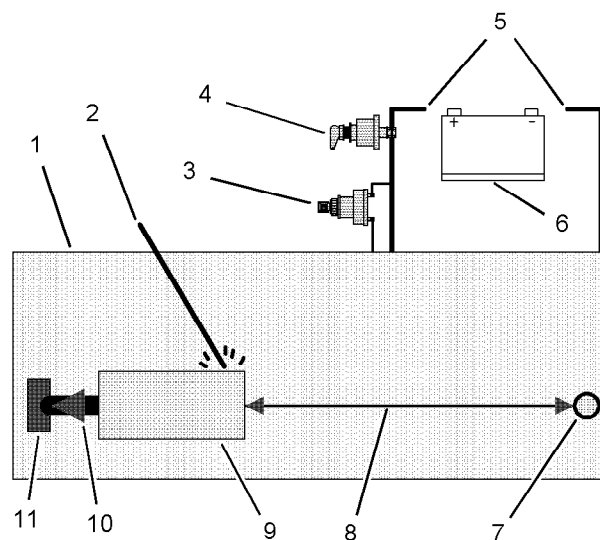


Illustration 37

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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 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.

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Maintenance Interval Schedule

The Maintenance Interval Schedule is for a cogen unit only.

When Required

" Battery - Replace"	53
" Engine Air Cleaner Element - Replace"	57
" Engine Oil - Change"	59
" Engine Oil Filter - Change"	60
" Overhaul (In-Frame)"	65
"Overhaul (Major)"	65
"Overhaul (Top End)"	66
" Overhaul Considerations"	67

Daily

" Control Panel - Inspect"	54
" Cooling System Coolant Level - Check"	56
" Driven Equipment - Inspect/Replace/Lubricate"	57
" Engine Air Cleaner Service Indicator - Inspect"	58
" Engine Oil Level - Check"	61
" Exhaust Piping - Inspect"	63
" Fuel System Fuel Filter Differential Pressure - Check"	63
" Hoses and Clamps - Inspect/Replace"	63
"Walk-Around Inspection"	67

Initial 500 Service Hours

" Engine Oil - Change"	59
" Engine Oil Filter - Change"	60
" Engine Valve Lash - Inspect/Adjust"	63

Every 1000 Service Hours or 1 Year

" Crankshaft Vibration Damper - Inspect"	56
" Engine - Clean"	57

" Engine Mounts - Check"	59
------------------------------------	----

Every Year

" Engine Speed/Timing Sensor - Clean/Inspect"	61
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Every 2000 Service Hours

" Battery Electrolyte Level - Check"	53
" Engine Valve Lash - Inspect/Adjust"	63

Every 4000 Service Hours

" Cylinders - Inspect"	56
" Driven Equipment - Check"	56
" Inlet Air System - Inspect"	64
" Turbocharger - Inspect"	67

Every 6000 Service Hours

" Cooling System Coolant Extender (ELC) - Add"	56
" Engine Crankcase Breather - Replace"	58
" Ignition System Spark Plugs - Replace"	64

Every 12 000 Service Hours or 6 Years

" Cooling System Coolant (ELC) - Change"	54
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Battery - Replace

WARNING

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

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

1. Refer to the OEM for instruction for switching the engine to the OFF position.
2. Turn off any battery chargers. Disconnect any battery chargers.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the NEGATIVE “-” terminal on the starting motor. Ensure that the NEGATIVE “-” battery terminal is disconnected first.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the POSITIVE “+” terminal on the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

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

5. Remove the used battery.
6. Ensure that all the battery connections are clean and free from corrosion.
7. Install the new battery.

Note: Before the cables are connected, ensure that the engine start switch is OFF.

8. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
9. Connect the NEGATIVE “-” cable to the NEGATIVE “-” battery terminal.

Battery Electrolyte Level - Check

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

WARNING

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

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

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

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

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

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

Thoroughly rinse the battery case with clean water.

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Control Panel - Inspect (Enclosure)

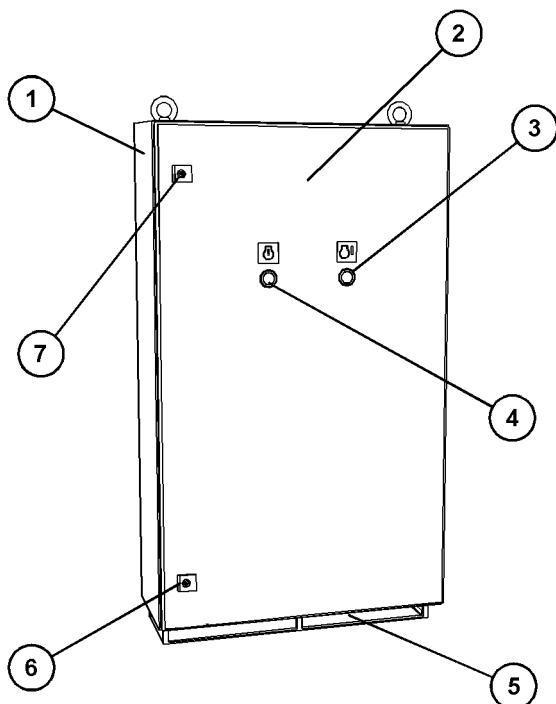


Illustration 38

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Typical example

- (1) Enclosure
- (2) Enclosure door
- (3) Red Indicator stop lamp
- (4) Orange Indicator warning lamp
- (5) Electrical connector to enclosure
- (6) Bottom lock
- (7) Top lock

The enclosure contains the electronic control module, engine diagnostic connector, and the engine reset button.

The ECM within the enclosure has a constant power supply. Insure that the area around the control panel and the control panel is clean and dry. Inspect the control panel for damage and inspect the electrical connector for security. Ensure that the enclosure door is closed and locked. The door is locked by two locks. One lock at the top of the door and one lock at the bottom of the door. A special key is required to unlock the door.

If the power supply to the enclosure has been disconnected, the reset button will need to be depressed. Refer to this Operation and Maintenance Manual, Starting the Engine for more information.

Cooling System Coolant (ELC - Change

NOTICE

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

Dispose of all fluids according to Local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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

- The engine overheats frequently.
- Foaming of the coolant 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 Extended Life Coolant (ELC) is drained and replaced.

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.

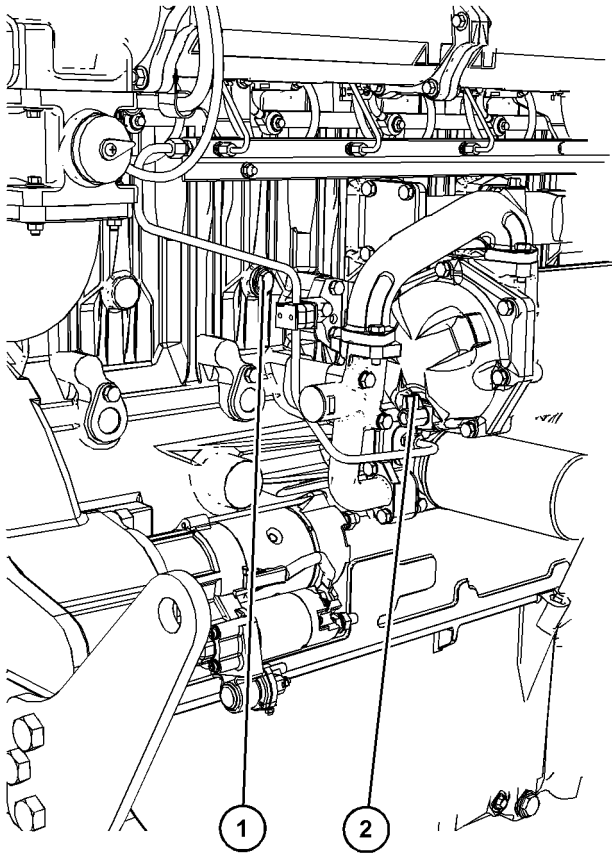


Illustration 39

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1. Stop the engine and allow the engine to cool. Isolate the electrical supply to the engine. Remove the drain plug (1)
2. Open the drain valve (2) on the oil cooler.
3. Allow the coolant to drain.

NOTICE

Dispose of used engine coolant or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Perkins to reclaim the coolant.

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

Flush

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

2. Install drain plug (1) and tighten the drain plug (1) securely. Close valve (2).

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.
4. Install power to the engine. Start the engine. Operate the engine until the temperature reaches 49 °C to 66 °C (120 °F to 150 °F).
5. Stop the engine and allow the engine to cool. Isolate the electrical supply to the engine. Open the drain plug (1) in the cylinder block. Open the drain valve (2). Allow the water to drain. Flush the cooling system with clean water.

Fill

1. Install the drain plug (1) in the cylinder block and tighten securely. Close the drain valve (2).

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 Perkins (ELC). Refer to the Operation and Maintenance Manual, "Fluid Recommendations" topic (Maintenance Section) for more information on cooling system specifications.

Note: Ensure that the cooling system is full before operating the engine.

3. Install power to the engine. Start the engine. Operate the engine to purge the air from the cavities of the engine block. Use the normal shutdown procedure to stop the engine.
4. Isolate the electrical supply to the engine. Check that the coolant system is full.

5. Install power to the engine. Start the engine and operate the engine. Inspect the cooling system for leaks. Ensure that the cooling system operates at the correct temperature.

i06533110

Cooling System Coolant Extender (ELC) - Add

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

i07106720

Cooling System Coolant Level - Check

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.

Refer to the OEM for instructions on how to check the coolant level, when the engine is operated as combined heat and power application. Refer to the OEM for how to add coolant if coolant is required. Perkins recommends checking the coolant level daily.

i07106794

Crankshaft Vibration Damper - Inspect

The crankshaft vibration damper limits the torsional vibration of the crankshaft. Damage to the crankshaft vibration damper can increase torsional vibrations. A damaged vibration damper can result in damage to the crankshaft and to other engine components.

Inspect the damper for signs of damage, fluid leakage, or heat discoloration.

For more information on inspection the vibration dampers, refer to Systems Operation Testing and Adjusting, Vibration Damper.

i02450387

Cylinders - Inspect

Use a borescope to inspect the cylinders. The inspection will provide information about the internal condition of the engine.

A borescope with a lens that can be angled up and down is recommended. This type of borescope provides a clear view of the combustion chamber and of the bottom deck of the cylinder head. Photographic documentation or video documentation is also recommended. Consult your Perkins dealer for information on available borescopes.

To perform this procedure, insert the borescope through the openings for the spark plugs. Use the borescope to look for the following conditions:

- Valve wear
- Deposits on the valve seat
- Deposits on the valve face
- Polishing of the cylinder walls
- Scratching of the cylinder walls
- Deposits on the cylinder walls that are above the upper limit of the piston stroke

Note: If you use a borescope be aware of the effect of magnification. Minor scratches and marks can be misunderstood. This can result in unnecessary maintenance.

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.

i02453750

i02947520

Driven Equipment - Inspect/Replace/Lubricate

Observe the driven equipment during operation. Look for the following items:

- Unusual noise and vibration
- Loose connections
- Damaged parts

Perform any maintenance that is recommended by the OEM of the driven equipment. Refer to the literature of the OEM of the driven equipment for the following service instructions.

- Inspection
- Lubricating grease and lubricating oil requirements
- Specifications for adjustment
- Replacement of components
- Requirements for ventilation

i02453751

Engine - Clean

WARNING

Personal injury or death can result from high voltage.

Moisture could create paths of electrical conductivity.

Make sure the unit is off line (disconnected from utility and/or other generators), locked out and tagged "Do Not Operate".

NOTICE

Water or condensation can cause damage to generator components. Protect all electrical components from exposure to water.

A clean engine provides the following benefits:

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

Engine Air Cleaner Element - Replace

NOTICE

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

NOTICE

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

Renew the air filter element if the service indicator is triggered. Refer to this manual, "Engine Air cleaner Service Indicator - Inspect" for more information.

Clean the air intake precleaner (if equipped) before maintenance is performed on the air filter. Refer to "Engine Air Precleaner - Check/Clean" for more information.

severe operating conditions may require more frequent service of the air filter.

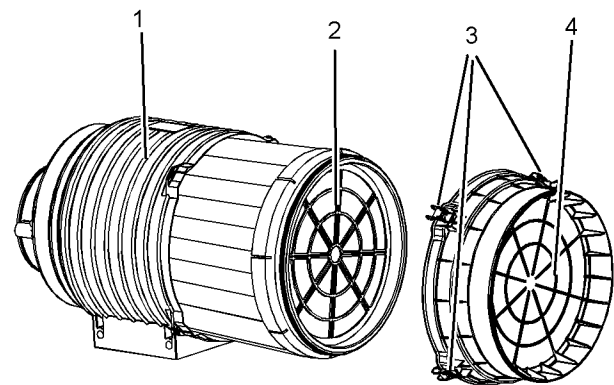


Illustration 40

g01461009

Typical example

1. Remove the retaining clips (3). Remove the cover (4).
2. Remove the old element (2). Dispose of the old element.

Note: Ensure that dirt can not enter the air filter assembly.

3. Install a new element into the air filter housing (1).
Install the cover (4). Fit the retaining clips (3).

i02451134

Engine Air Cleaner Service Indicator - Inspect

Some engines may be equipped with a different service indicator.

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

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

Observe the service indicator.

Replace the air filter element if the indicator is triggered by the following event:

- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

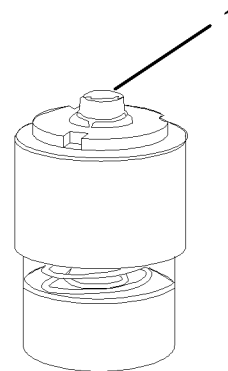


Illustration 41

g01223729

Typical service indicator

In order to reset the indicator, you must press the button (1).

If the service indicator does not reset easily, the service indicator should be replaced.

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

i06952493

Engine Crankcase Breather - Replace

The engine has two crankcase breathers installed. Ensure that both breather elements are serviced at the same time.

Element Replace

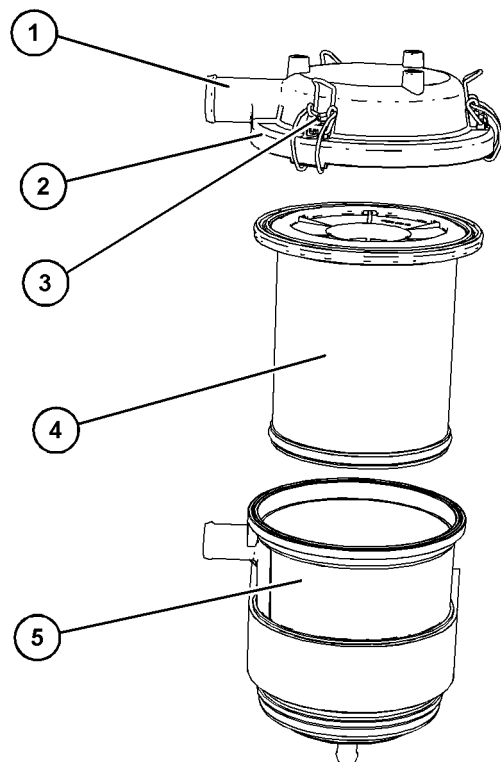


Illustration 42

g06180878

Typical example

1. Before performing maintenance, clean the filter assembly outer body.

Note: On some applications an insulating cover is installed over the breathers. Before servicing breathers, remove the top cover. Ensure that the top cover is installed after the breathers are serviced.

2. If necessary, remove outlet hose (not shown) from connection (1). Release the 3 clips (3) and remove the cover assembly (2).
3. Remove the filter element (4) from the body of the filter (5) and discard the old filter element (4).
4. Ensure that the body inner of the filter (5) is clean and free from dirt. Install a new filter element (4) into the body of the filter (5).

5. Align the cover assembly (2) and install the clips (3). If necessary, install the outlet hose to connector (1).

i02463642

Engine Mounts - Check

Misalignment of the engine and the driven equipment will cause extensive damage. Excessive vibration can lead to misalignment. Excessive vibration of the engine and the driven equipment can be caused by the following conditions:

- Improper mounting
- Loose bolts
- Deterioration of the isolators

Ensure that the mounting bolts are tightened to the proper torque.

Ensure that the isolators are free of oil and contamination. Inspect the isolators for deterioration. Ensure that the bolts for the isolators are tightened to the correct torque.

Replace any isolator that shows deterioration. For more information, see the literature that is provided by the OEM of the isolators.

i07104503

Engine Oil - Change

WARNING

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

NOTICE

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

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Maintenance Section

Engine Oil Filter - Change

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

1. Operate the engine so that the lubricating oil is warm, then stop the engine. Isolate the electrical power to the stator.

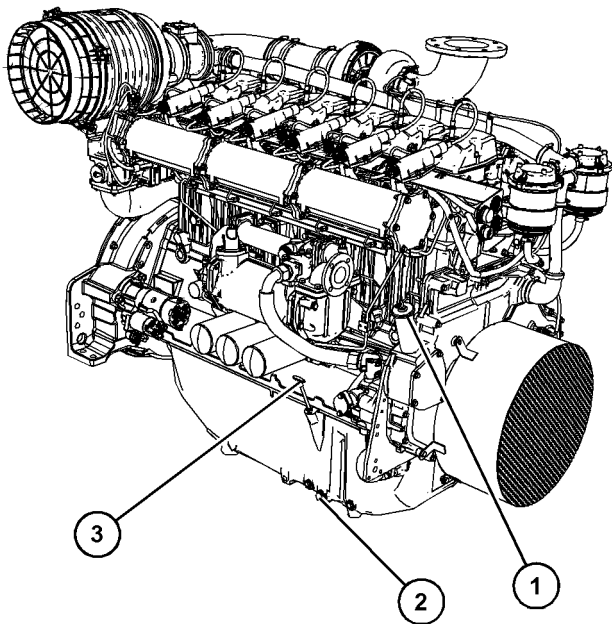


Illustration 43

g06225625

2. Place a suitable container below the engine oil pan. Remove the drain plug (2). Allow the engine oil to drain.

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

3. Remove the sealing washer from the drain plug (2). Discard the sealing washer (not shown).
4. Install a new sealing washer to the drain plug (2). Install the drain plug to the engine oil pan. Tighten the plug to a torque of 68 N·m (50 lb ft).
5. Remove the engine oil filters, refer to Operation and Maintenance Manual, Engine Oil Filter - Change.

6. With the engine oil filters installed fill the engine with engine oil. For more information on the correct specification of engine oil, refer to Operation and Maintenance Manual, Fluid Recommendations.
7. Remove cap (1). Fill the engine with the required amount of engine oil.
8. Check the oil gauge (dipstick) (3). Ensure that the oil level is at the correct level.

Note: Connect power supply. Before starting the engine, crank the engine on the starter to obtain oil pressure. Refer to the "Operation and Maintenance Manual" Before Starting Engine and **Priming the Oil System** section of the manual.

9. After the oil system has been primed. Start the engine and run the engine for 2 minutes. Perform this procedure to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filters for oil leaks.
10. Stop the engine and allow the oil to drain back to the oil pan for a minimum of 10 minutes.

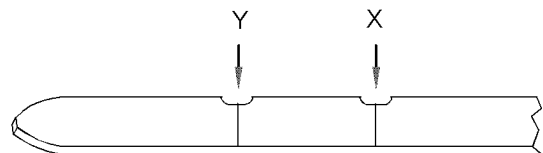


Illustration 44

g01165836

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

11. Remove the engine oil level gauge (3) to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the engine oil level gauge.

i07104561

Engine Oil Filter - Change

Note: Refer to the Operation and Maintenance Manual, "Engine Oil Sample - Obtain" before performing maintenance.

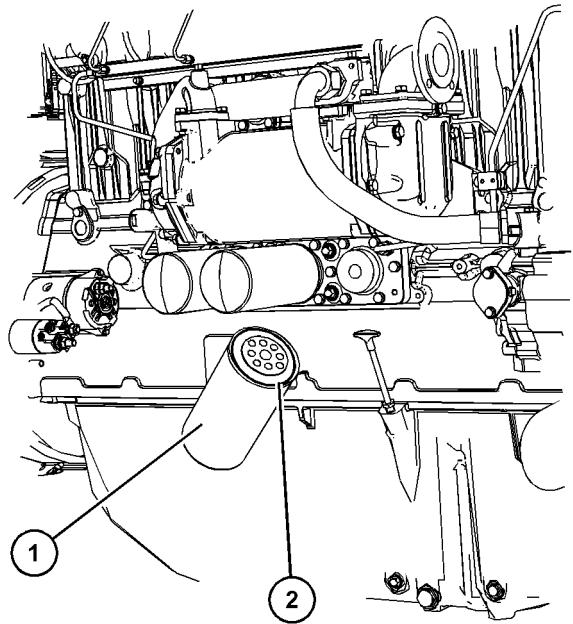


Illustration 45
Typical example

1. Use a suitable tool to remove the oil filter (2).
Ensure that the sealing housing is clean.
2. Lubricate the sealing ring (1). Install the new oil filter. Apply hand pressure only to install the oil filter.
3. When all three oil filters have been installed, fill the engine with engine oil. Refer to this manual, "Engine Oil - Change".

i02463768

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.

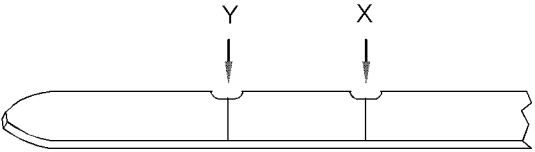


Illustration 46
(Y) "Min" mark. (X) "Max" mark.

NOTICE
Perform this maintenance with the engine stopped.

Note: After the engine has been switched OFF, wait for ten minutes in order to allow the engine oil to drain to the oil pan before checking 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
If you operate the engine with the oil level above the "FULL" mark, this may cause your crankshaft and balance weights to be dipped in oil. If you drive the crankshaft and balance weights through oil, excessive drag will occur and this will increase the load on the engine. Air bubbles will be created when the crankshaft and balance weights are driven through oil. This will reduce the lubricating characteristics of the oil and result in a loss of power.

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

i07108566

Engine Speed/Timing Sensor - Clean/Inspect

Ensure that all power is disconnected to the engine before performing these procedures.

Table 14

Required Tools			
Tool	Part Number	Part Name	Qty
A	SE252	Engine cranking device	1

Flywheel Sensor

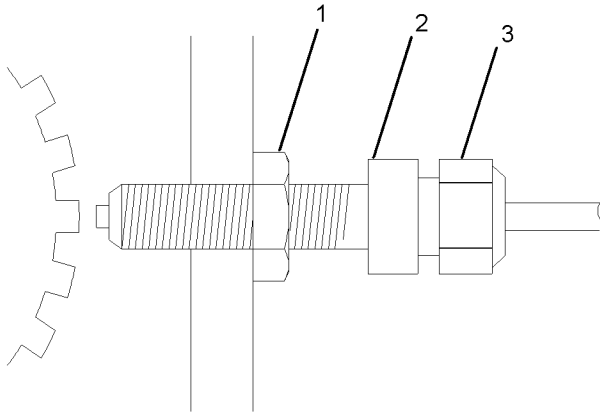


Illustration 47

g01234089

Typical example

1. Remove the connection (3). Loosen the locknut (1).
2. Remove the sensor (2). Clean any debris from the sensor.
3. Install tooling (A).
4. Rotate the engine to align one teeth to the tapped hole. By hand, install the sensor. When light contact is made with the teeth, you must stop. Unscrew the sensor half of one turn. This action will give a clearance of 0.5 to 0.8 mm (0.02 to 0.03 inch).
5. Tighten the locknut. Do not allow the sensor to rotate. Connect the connection (3).
6. Remove tooling (A).

Camshaft Sensor

The camshaft timing sensor is a hall effect sensor that is located in the gear case.

1. Remove the connection (3). Loosen the locknut (1).

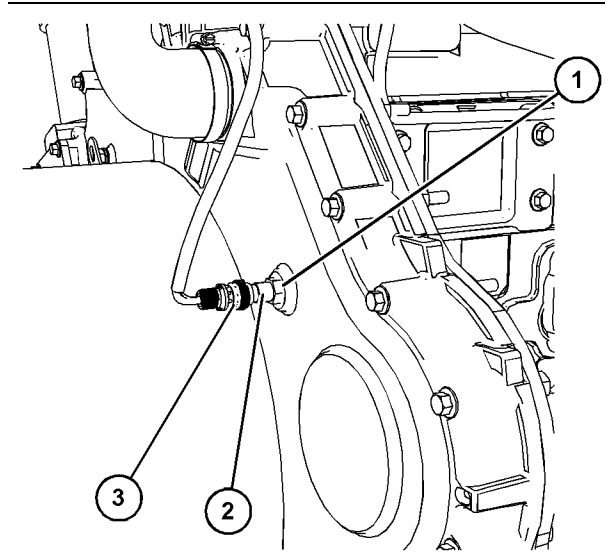


Illustration 48

g06227344

Typical example

2. Remove the sensor (2). Clean any debris from the sensor.
3. Install tooling (A).
4. Rotate the engine to align a magnet to the tapped hole. By hand, install the sensor. When light contact is made with the magnet, you must stop. Unscrew the sensor. Unscrew one complete turn. This action will give a clearance of 1 mm (0.04 inch).
5. Tighten the locknut. Do not allow the sensor to rotate. Connect the connection (3).
6. Remove tooling (A).

Connect the power to the engine.

i03783789

Engine Valve Lash - Inspect/ Adjust (Valves and Valve Bridges)

NOTICE

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

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

WARNING

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

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

Note: The valve bridges must be equalized before the valve lash is adjusted.

Refer to Systems Operation, Testing and Adjusting, "Valve Lash - Adjust" for the correct procedure.

i02430592

Exhaust Piping - Inspect

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

Inspect the components of the exhaust system. Repair the components or replace the components if any of the following conditions occur:

- Damage
- Cracks
- Leaks

- Loose connections

Consult your Perkins dealer for assistance.

i02478685

Fuel System Fuel Filter Differential Pressure - Check

A fuel filter differential pressure gauge may be installed in order to determine when the fuel filter requires service.

A fuel filter differential pressure gauge indicates the difference in fuel pressure between the inlet side and the outlet side of the fuel filter. The differential pressure increases as the fuel filter becomes plugged.

Operate the engine at the rated speed and at the normal operating temperature. Check the fuel filter differential pressure. Service of the fuel filter depends on the pressure of the fuel system:

- For the service of the fuel filter on the low pressure gas fuel system, refer to the OEM for information.
- For the service of the fuel filter on the high pressure gas fuel system, refer to the OEM for information.

i07106738

Hoses and Clamps - Inspect/ Replace

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.

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

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

- Cracking
- Softness
- Loose clamps

Maintenance Section

Ignition System Spark Plugs - Replace

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

Check for the following conditions:

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

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

Due to extreme temperature changes, the hose will harden. Hardening of the hoses will cause hose clamps to loosen. This 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

i07106836

Ignition System Spark Plugs - Replace

WARNING

Ignition systems can cause electrical shocks. Avoid contacting the ignition system components and wiring.

Do not attempt to remove the valve covers when the engine is operating. The transformers are grounded to the valve covers. Personal injury or death may result and the ignition system will be damaged if the valve covers are removed during engine operation. The engine will not operate without the valve covers.

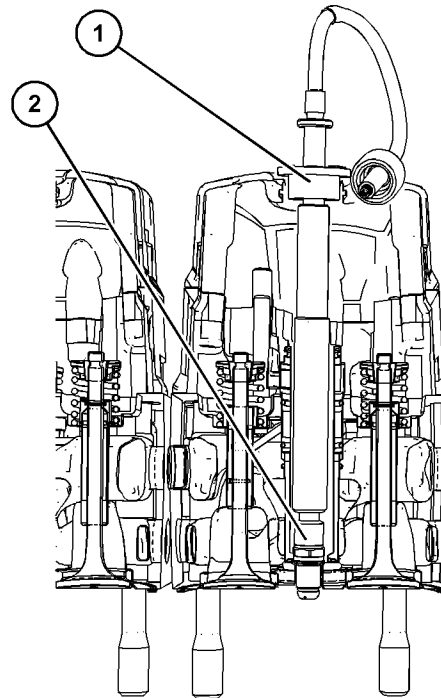


Illustration 49

g06227430

Typical example

1. Ensure that the power to the engine is isolated and the engine cannot start.
2. Remove the ignition lead (1). Use spark plug socket T403636 remove spark plug (2) and discard the old spark plug.

Note: The spark plug size is 22 mm.

3. Before installation visually inspect the new spark plug (2) for damage. Install spark plug (2) and tighten to 50 N·m (36 lb ft). Install the ignition lead (1). Insure that all the spark plugs are replaced. Then, restore power to the engine.

i02477819

Inlet Air System - Inspect

Inspect the components of the air inlet system for the following conditions:

- Cracks
- Leaks
- Loose connections

Inspect the following components:

- Piping between the air cleaner and the turbocharger
- Turbocharger
- Piping between the turbocharger and the aftercooler
- Aftercooler
- Connection of the aftercooler to the air inlet manifold
- Connection of the air inlet manifold to the cylinder head

Ensure that all of the connections are secure. Ensure that the components are in good condition.

i02484880

Overhaul (In-Frame)

Scheduling an In-Frame Overhaul

Scheduling an in-frame overhaul normally depends on the following conditions:

- An increase of oil consumption
- An increase of crankcase blowby
- A decrease or a variation of cylinder compression

Each individual condition may not indicate a need for an overhaul. However, evaluating the three conditions together is the most accurate method of determining when an overhaul is necessary.

The engine does not require an overhaul if the engine is operating within acceptable limits for oil consumption, crankcase blowby, and cylinder compression.

Periodically measure each of the three conditions. The first measurement should occur during the engine commissioning. This establishes a baseline for future measurements. Additional measurements are scheduled at regular intervals in order to determine a schedule for the next in-frame overhaul.

The following changes in the three conditions normally require a scheduled overhaul:

- An increase in oil consumption
- An increase in crankcase blowby
- A loss of cylinder compression

Note: Oil consumption will be initially high. This will be reduced when the rings are seated to the bore.

Note: These indications do not require an engine to be shut down for service. These indications only mean that an engine should be scheduled for service in the near future. If the engine operation is satisfactory, an immediate overhaul is not a requirement.

Monitor the engine as the engine accumulates service hours.

Usually, an in-frame overhaul does not require removal of the engine. Instead, the service is performed with the engine in place.

In-Frame Overhaul Information

An in-frame overhaul includes all of the work that is done for a top end overhaul. Additionally, some other components that wear are replaced. The condition of components is inspected. Those components are replaced, if necessary.

Your Perkins dealer can provide these services and components. Your Perkins dealer can ensure that the components are operating within the appropriate specifications.

i07104849

Overhaul (Major)

Scheduling a Major Overhaul

Generally, a major overhaul is performed at 64000 hours. The need for a major overhaul is determined by several factors. Some of those factors are the same factors that determine the in-frame overhaul:

- An increase of oil consumption
- An increase of crankcase blowby
- A decrease and variation of cylinder compression

Other factors must also be considered for determining a major overhaul:

- The service hours of the engine
- The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

An increase of wear metals in the lube oil indicates that the bearings and the surfaces that wear may need to be serviced. An increase in the levels of noise and vibration indicates that rotating parts require service.

Note: Oil analysis may indicate a decrease of wear metals in the lube oil. The cylinder liners may be worn so that polishing of the bore occurs. Also, the increased use of lube oil will dilute the wear metals.

Monitor the engine as the engine accumulates service hours. Consult your Perkins dealer about scheduling a major overhaul.

Note: The driven equipment may also require service when the engine is overhauled. Refer to the literature that is provided by the OEM of the driven equipment.

Major Overhaul Information

A major overhaul includes all the work that is done for top end overhauls and in-frame overhauls. Sometimes, the engine is relocated for disassembly. Components that wear are disassembled and inspected. If necessary, the parts are replaced. The crankshaft is measured for wear. The crankshaft may require regrinding. Alternatively, the crankshaft may be replaced with a Perkins replacement part. Your Perkins dealer can provide these services and components. Your Perkins dealer can ensure that the components are operating within the appropriate specifications.

If you elect to perform an overhaul without the services of a Perkins dealer, be aware of the following recommendations.

Replacing of Components

Replace the following components during the major overhaul.

- Connecting rod bearings
- Cylinder liners
- Piston rings
- Cylinder heads
- Joints and bolts
- Gaskets and seals
- Main bearings

Rebuilding or Replacing of Components

Rebuild the following components during the major overhaul.

- Gas Regulation and Metering Valve
- Bypass Valve
- Throttle Valve
- Turbochargers
- Engine Water pumps

Inspecting Components

Inspect the following components:

- Chargecooler
- Camshafts
- Camshaft bearings
- Camshaft followers
- Connecting rods
- Crankshaft
- Gear train and bearings
- Governor
- Inlet air piping
- Oil cooler
- Oil pump
- Pistons
- Transformers
- Valve train that includes the rocker gear

i07189415

Overhaul (Top End)

Scheduling a Top End Overhaul

Top end overhauls are scheduled according to the valve recession. Recorded the valve clearance at each service and then calculating the valve recession. This measurement provides an accurate indication of the rate of valve wear. This measurement can be used to predict when a cylinder head must be replaced. Plan for the top end overhaul as the valve stem projection approaches the maximum limit.

- Inlet valve maximum limit _____ 2 mm (0.07874 inch)
- Exhaust valve maximum limit _____ 1.5 mm (0.05906 inch)

Do not allow the recession of the valves to exceed this limit.

Note: Generally, cylinder heads wear out at different rates. Sometimes, servicing the cylinder heads at different times may be the most economic decision. The decision depends on the valve recession of the individual cylinders. However, this decision must include the costs of extra downtime that is caused by this procedure. Perform an economic analysis to determine if cylinder heads should be serviced as a group or divided into smaller groups.

Note: The generator or the driven equipment may also require service when the engine overhaul is performed.

i02484859

Overhaul Considerations

Overhaul Information

An overhaul is replacing the major worn components of the engine. An overhaul is a maintenance interval that is planned. The engine is rebuilt with certain rebuilt parts or new parts that replace the worn parts.

An overhaul also includes the following maintenance:

- Inspection of all the parts that are visible during the disassembly
- Replacement of the seals and gaskets that are removed
- Cleaning of the internal passages of the engine and the engine block

It is not practical to wait until the engine exhibits symptoms of excessive wear or failure. It is not less costly to wait. A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the guidelines for reusable parts.
- The service life of the engine can be extended without the risk of a major catastrophe due to engine failure.
- Achieve the best cost/value relationship per hour of extended service life.

Overhaul Intervals

Top end overhauls are determined by the recession of the valves. In-frame overhauls are determined by cylinder compression, crankcase blowby, and oil consumption. Major overhauls are determined by the in-frame tests, and by results of oil analysis.

Some other factors that are important for determining the overhaul intervals include the following considerations:

- Performance of preventive maintenance
- Use of recommended lubricants
- Use of recommended coolants
- Use of recommended fuels

- Operating conditions
- Operation within acceptable limits
- Engine load
- Engine speed

Overhaul Inspection

If the parts are not within the inspection specifications, the parts should be replaced. The use of parts that are not in wear limits could result in unscheduled downtime and/or costly repairs. This can also contribute to increased fuel consumption and reduction of engine efficiency.

Your Perkins dealer can provide the parts that are needed to rebuild the engine at the least possible cost.

Overhaul recommendation

Perkins recommends a scheduled overhaul in order to minimize downtime. A scheduled overhaul will provide the lowest cost and the greatest value. Schedule an overhaul with your Perkins dealer.

i06532154

Turbocharger - Inspect

Periodic inspection and cleaning are recommended for the turbochargers. Fouling of the turbine wheels can contribute to loss of engine power and overall loss of engine efficiency.

If a turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to a turbocharger compressor wheel could allow parts from the compressor wheel to enter an engine cylinder. This debris can damage the pistons, the valves, and the cylinder head.

For information on inspection of the turbocharger, refer to "Systems Operation Testing and Adjusting" Turbocharger.

i07106761

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.

Maintenance Section
Walk-Around Inspection

For maximum engine service life, thoroughly inspect the engine room before starting the engine. Look for items such as leaks, loose bolts, 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 to reduce the chance of system contamination.

NOTICE

For any type of leak, 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 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.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters, and the valve covers.

 WARNING

NEVER use a flame to check for gas leaks. Use a gas detector.

An open flame can ignite mixtures of air and fuel. This will cause explosion and/or fire which could result in severe personal injury or death.

- Check the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground straps for good connections and for good condition.
- Check the condition of the gauges. Replace any gauge that is damaged. Replace any gauge that cannot be calibrated.
- Inspect the exhaust system for leaks. If a leak is found, make repairs.

Reference Information Section

Reference Materials

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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 a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well 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.

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Maintenance Log

Table 15

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

(continued)

[illegible]

Valve Data Sheet

Engine Model		Serial Number	Service Hours		-
Cylinder	Cylinder Pressure	Valve Location	Current Measure	Reset size	Wear
1		Inlet			
		Inlet			
		Exhaust			
		Exhaust			
2		Inlet			
		Inlet			
		Exhaust			

(continued)

(Table 16, contd)

		Exhaust			
3		Inlet			
		Inlet			
		Exhaust			
		Exhaust			
4		Inlet			
		Inlet			
		Exhaust			
		Exhaust			
5		Inlet			
		Inlet			
		Exhaust			
		Exhaust			
6		Inlet			
		Inlet			
		Exhaust			
		Exhaust			
7		Inlet			
		Inlet			
		Exhaust			
		Exhaust			
8		Inlet			
		Inlet			
		Exhaust			
		Exhaust			

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Warranty Information

The engine installation and the service interval for the engine must be approved. The engine must be operated with the approved fuel, lubricant and coolant. Refer to Perkins Engines Stafford for more information.

Index

A

Additional Messages	12
After Starting Engine	39
After Stopping Engine	41

B

Battery - Replace	53
Battery Electrolyte Level - Check	53
Before Starting Engine	19, 37
General Checks Before Starting Engine	37
Prime the Oil System	37
Burn Prevention	16
Batteries	16
Coolant	16
Oils	16
Viton Seals	16

C

Cold Weather Starting	37
Control Panel - Inspect (Enclosure)	54
Control Panel (Enclosure)	35
Opening Enclosure Door	35
Cooling System Coolant (ELC) - Change	54
Drain	54
Fill	55
Flush	55
Cooling System Coolant Extender (ELC) - Add	56
Cooling System Coolant Level - Check	56
Crankshaft Vibration Damper - Inspect	56
Crushing Prevention and Cutting Prevention ..	19
Cylinders - Inspect	56

D

Driven Equipment - Check	56
Driven Equipment - Inspect/Replace/ Lubricate	57

E

Electrical System	20
Grounding Practices	20
Emergency Stopping	41
Typical Procedure in Order to Stop the Engine	41
Engine - Clean	57

Engine Air Cleaner Element - Replace	57
Engine Air Cleaner Service Indicator - Inspect	58
Test the Service Indicator	58
Engine Crankcase Breather - Replace	58
Element Replace	59
Engine Lifting	27
Engine Lifting Only	27
Engine Mounts - Check	59
Engine Oil - Change	59
Engine Oil Filter - Change	60
Engine Oil Level - Check	61
Engine Operation	40
Partial load and Low Load Operation	40
Engine Speed/Timing Sensor - Clean/ Inspect	61
Camshaft Sensor	62
Flywheel Sensor	62
Engine Starting	20, 37
Engine Stopping	20, 41
Engine Storage	28
Level "A "	28
Level "B "	28
Level "C "	28
Engine Valve Lash - Inspect/Adjust (Valves and Valve Bridges)	63
Exhaust Piping - Inspect	63

F

Features and Controls	30
Fire Prevention and Explosion Prevention	17
Ether	18
Fire Extinguisher	18
Lines, Tubes, and Hoses	19
Fluid Recommendations (Fuel Specification)	43
Gas Specification	43
Fluid Recommendations (Gas Engine Oil Specification)	43
General Lubrication Information	43
Fluid Recommendations (General Coolant Information)	44
ELC Cooling System Maintenance	46
General Coolant Information	44
Foreword	4
California Proposition 65 Warning	4
Literature Information	4
Maintenance	4

Maintenance Intervals	5
Operation	4
Overhaul	5
Safety	4

Fuel System Fuel Filter Differential Pressure - Check	63
---	----

G

Gauges and Indicators	29
General Hazard Information	13
Containing Fluid Spillage	14
Dispose of Waste Properly	16
Fluid Penetration	14
Inhalation	15
Pressurized Air and Water	14

H

Hoses and Clamps - Inspect/Replace	63
--	----

I

Ignition System Spark Plugs - Replace	64
Ignition Systems	19
Important Safety Information	2
Inlet Air System - Inspect	64

L

Lifting and Storage	27
---------------------------	----

M

Maintenance Interval Schedule	52
Daily	52
Every 1000 Service Hours or 1 Year	52
Every 12 000 Service Hours or 6 Years	52
Every 2000 Service Hours	52
Every 4000 Service Hours	52
Every 6000 Service Hours	52
Every Year	52
Initial 500 Service Hours	52
When Required	52
Maintenance Log	69
Maintenance Recommendations	50
Maintenance Records	69
Maintenance Section	43
Manual Stop Procedure	41
Model View Illustrations	22
Model Views and Specifications	22
Mounting and Dismounting	19

O

Operation Section	27
Overhaul (In-Frame)	65
In-Frame Overhaul Information	65
Scheduling an In-Frame Overhaul	65
Overhaul (Major)	65
Major Overhaul Information	66
Scheduling a Major Overhaul	65
Overhaul (Top End)	66
Scheduling a Top End Overhaul	66
Overhaul Considerations	67
Overhaul Information	67

P

Plate Locations and Film Locations	26
Product Description	23
Engine	23
Product Identification Information	26
Product Information Section	22

R

Reference Information Section	69
Reference Materials	69
Refill Capacities	43, 48
Cooling System	49
Lubrication System	48

S

Safety Messages	6
1 Universal Warning	11
Electrocution (2)	12
Enclosure Safety Messages	11
Engine Safety Messages	7
Safety Section	6
Sensors and Electrical Components	30
Detonation System	33
Electronic Ignition System (EIS)	30
Gas System	33
Sensors	30
Starting the Engine	38
Engine Starting Procedure	38
Final Checks and First Engine Start	38
First Engine Start	38
Purging Unburned Gas	38
Starting with Jump Start Cables	39

T

Table of Contents	3
-------------------------	---

Turbocharger - Inspect 67

V

Valve Data Sheet..... 70

W

Walk-Around Inspection 67

 Inspect the Engine for Leaks and for Loose
 Connections 67

Warranty Information..... 71

Welding on Engines with Electronic
Controls 50

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: _____

	<u>Dealer Contact</u>	<u>Phone Number</u>	<u>Hours</u>
Sales:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____

