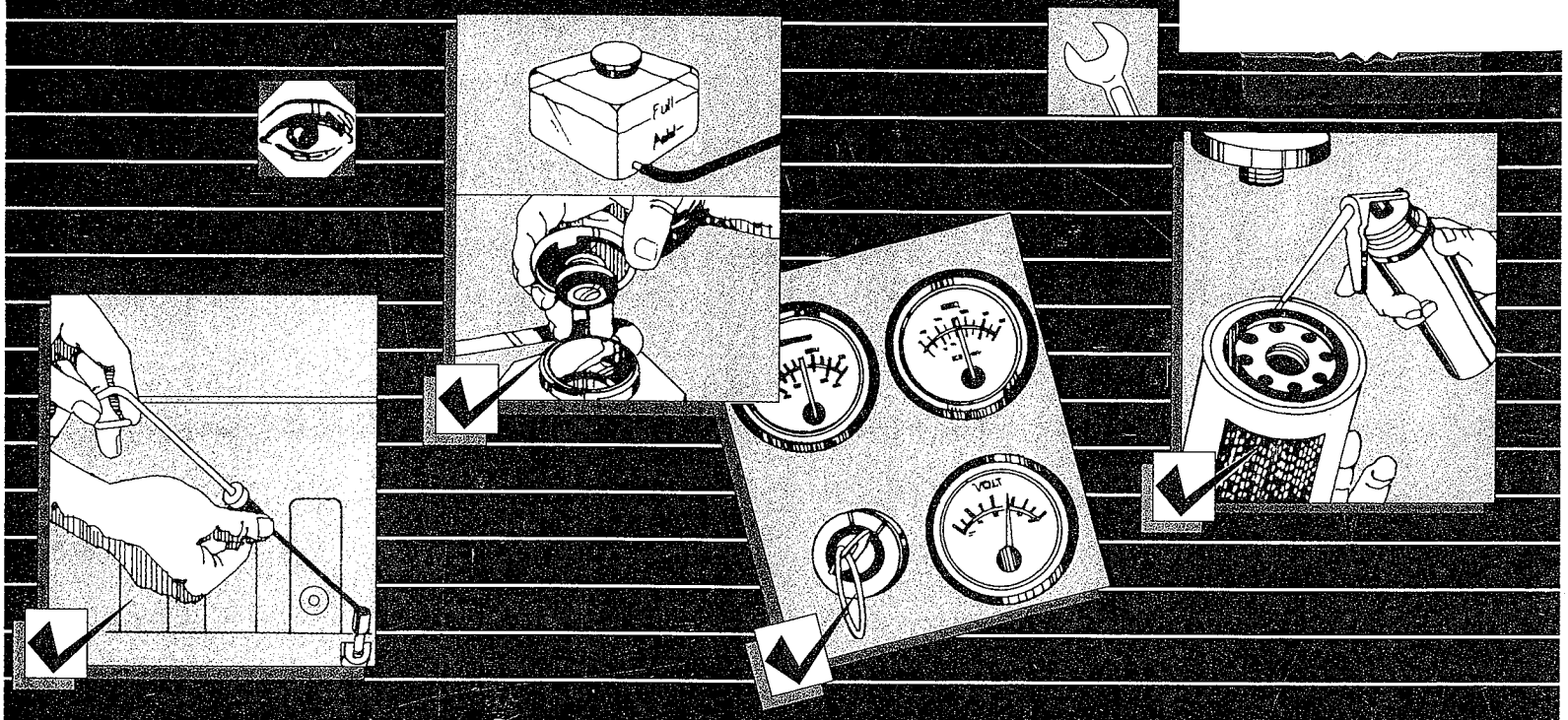
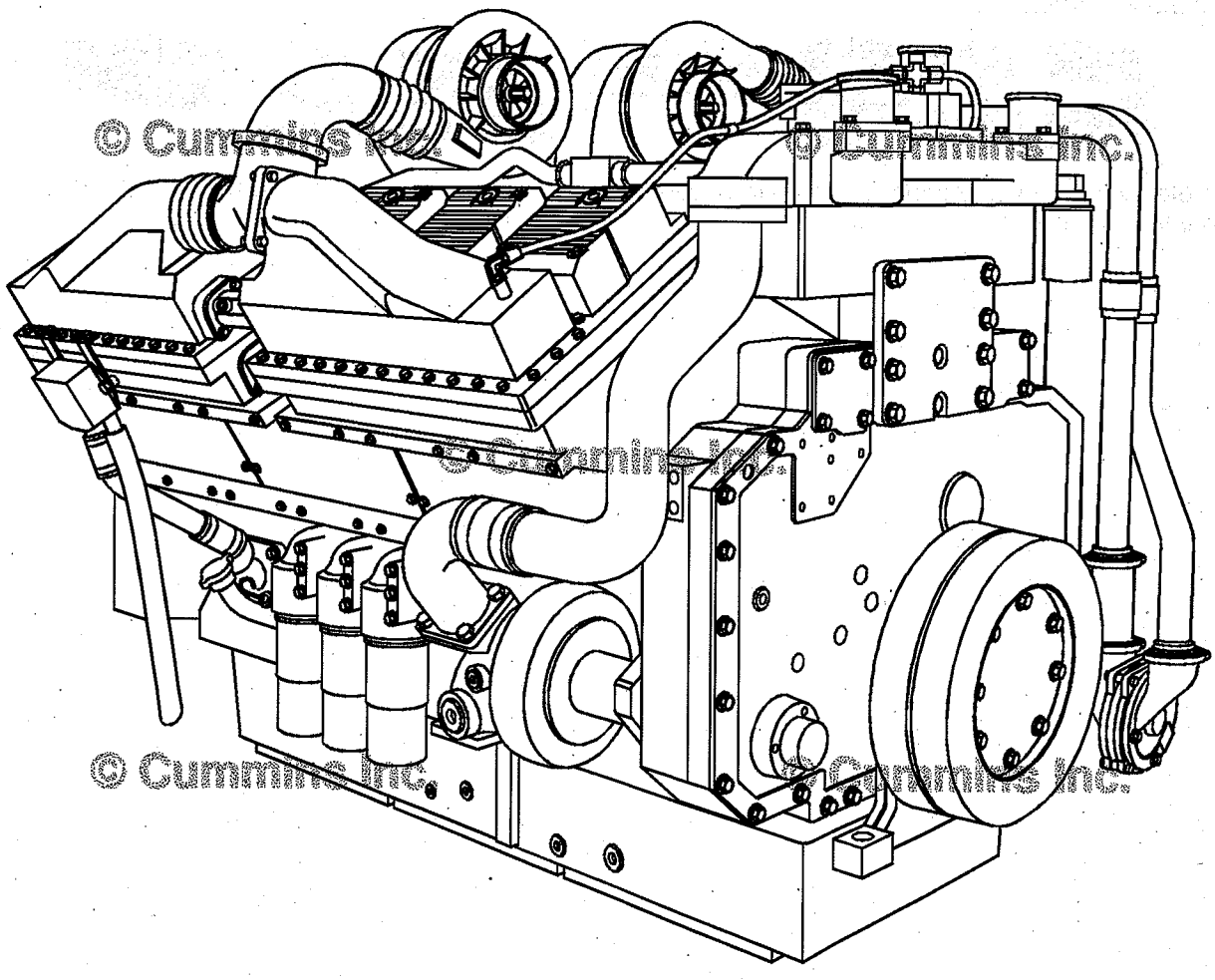
Operation and Maintenance Manual
QSK45 and QSK60 Series Engines



Cummins Customer Assistance Center
1-800-DIESELS (1-800-343-7357)
APPLICABLE ONLY IN U.S.A. AND CANADA

Operation and Maintenance Manual
QSK45 and QSK60 Series Engines



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Foreword

This manual contains information for the correct operation and maintenance of your Cummins engine. It also includes important safety information, engine and systems specifications, troubleshooting guidelines, and listings of Cummins Authorized Repair Locations and component manufacturers.

Read and follow all safety instructions. Refer to the WARNING in the General Safety Instructions in Section i - Introduction.

Keep this manual with the equipment. If the equipment is traded or sold, give the manual to the new owner.

The information, specifications, and recommended maintenance guidelines in this manual are based on information in effect at the time of printing. Cummins Inc. reserves the right to make changes at any time without obligation. If you find differences between your engine and the information in this manual, contact your local Cummins Authorized Repair Location or call 1-800-DIESELS (1-800-343-7357) toll free in the U.S. and Canada.

The latest technology and the highest quality components were used to produce this engine. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts. These parts can be identified by the following trademarks:



NOTE: Note: Warranty information is located in Section W. Make sure you are familiar with the warranty or warranties applicable to your engine.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 15, COLUMBUS INDIANA

–POSTAGE WILL BE PAID BY ADDRESSEE–

Cummins Inc.
Product Registration Dept. (CAC)
P O Box 3005 M/C 91200
Columbus, IN 47202-3005

In order to serve you better it is very important that you fill out and return this card **within** 30 days of purchase.

Customer Name _____

Address _____

City / State _____

Zip Code _____

Home Phone Number (____)_____

Truck Phone / Cell Phone (____)_____

E-mail Address _____

Engine Serial Number _____

Date Purchased ____/____/____ VIN # _____

THANK YOU!!

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Important Reference Numbers

Fill in the part name and number in the blank spaces provided below. This will give you a reference whenever service or maintenance is required.

Part Name	Part Number	Part Number
Engine Model		
Engine Serial Number (ESN)		
Control Parts List (CPL)		
Fuel Pump Part Number		
Electronic Control Module (ECM)		
Electronic Control Module Serial Numbers (ECM)		
Filter Part Numbers:		
• Air Cleaner Element		
• Lubricating Oil Filter		
• Fuel		
• Fuel-Water Separator		
• Coolant		
• Remote Gas		
Governor Control Module (GCM) (if applicable)		
Belt Part Numbers:		
•		
•		
•		
Clutch or Marine Gear (if applicable):		
• Model		
• Serial Number		
• Part Number		
• Oil Type		
• Sea Water Pump		
- Model		
- Part Number		

Section i - Introduction

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To the Owner and Operator

General Information

Preventive maintenance is the easiest and least expensive type of maintenance. Follow the maintenance schedule recommendations outlined in Maintenance Guidelines (Section 2).

Keep records of regularly scheduled maintenance.

Use the correct fuel, lubricating oil, and coolant in your engine as specified in Maintenance Specifications (Section V).

Cummins Inc. uses the latest technology and the highest quality components to produce its engines. Cummins Inc. recommends using genuine Cummins new parts and ReCon® exchange parts.

Personnel at Cummins Authorized Repair Locations have been trained to provide expert service and parts support. If you have a problem that can **not** be resolved by a Cummins Authorized Repair Location, follow the steps outlined in the Service Assistance (Section S).

Product coverage, warranty limitations and owner responsibilities are available in Warranty (Section W).

⚠CAUTION⚠

Disconnect both the positive (+) and negative (-) battery cables from the battery before welding on the vehicle. Attach the welder ground cable no more than 0.61 meters [2 feet] from the part being welded. Do not connect the ground cable of the welder to the ECM cooling plate or ECM. Welding on the engine or engine mounted components is not recommended.

About the Manual

General Information

This manual contains information needed to correctly operate and maintain your engine as recommended by Cummins Inc. For additional service literature and ordering locations, refer to Service Literature (Section L).

This manual does not cover vehicle, vessel, or equipment maintenance procedures. Consult the original vehicle, vessel, or equipment manufacturer for specific maintenance recommendations.

Both metric and U.S. customary values are listed in this manual. The metric value is listed first, followed by the U.S. customary in brackets.

Numerous illustrations and symbols are used to aid in understanding the meaning of the text. Refer to Symbols in this section for a complete listing of symbols and their definitions.

Each section of the manual is preceded by a Section Contents to aid in locating information.

How to Use the Manual

General Information

This manual is organized according to intervals at which maintenance on your engine is to be performed. A maintenance schedule, that states the required intervals and maintenance checks, is located in Maintenance Guidelines (Section 2). Locate the interval at which you are performing maintenance; then follow the steps given in that section for all the procedures to be performed.

Keep a record of all the checks and inspections made. A maintenance record form is located in Maintenance Guidelines (Section 2).

Engine troubleshooting procedures for your engine are located in Troubleshooting Symptoms (Section TS).

Specifications for your engine are located in Maintenance Specifications (Section V).

Symbols

General Information

The following symbols have been used in this manual to help communicate the intent of the instructions. When one of the symbols appears, it conveys the meaning defined below:



WARNING - Serious personal injury or extensive property damage can result if the warning instructions are **not** followed.



CAUTION - Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are **not** followed.



Indicates a **REMOVAL or DISASSEMBLY** step.



Indicates an **INSTALLATION or ASSEMBLY** step.



INSPECTION is required.



CLEAN the part or assembly.



PERFORM a mechanical or time **MEASUREMENT.**



LUBRICATE the part or assembly.



Indicates that a **WRENCH or TOOL SIZE** will be given.



TIGHTEN to a specific torque.



PERFORM an electrical **MEASUREMENT.**



Refer to another location in this manual or another publication for additional information.



The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

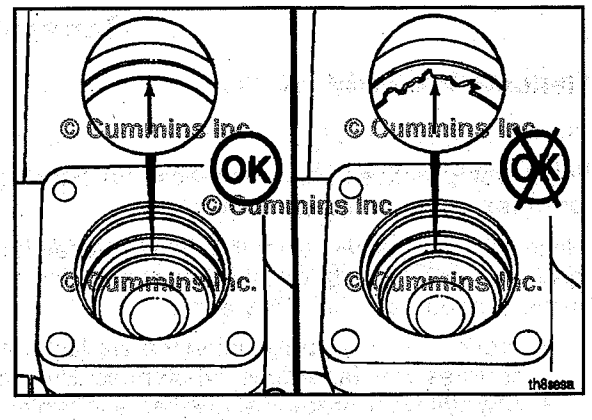
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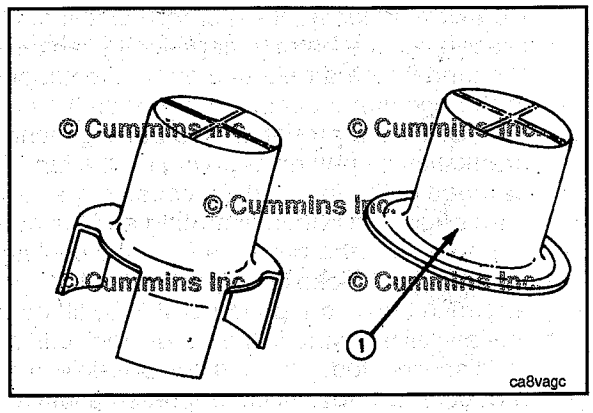
Illustrations

General Information

Some of the illustrations throughout this manual are generic and will **not** look exactly like the engine or parts used in your application. The illustrations can contain symbols to indicate an action required and an acceptable or **not** acceptable condition.



The illustrations are intended to show repair or replacement procedures. The procedure will be the same for all applications, although the illustration can differ.



General Safety Instructions

Important Safety Notice

⚠WARNING⚠

Improper practices, carelessness, or ignoring the warnings can cause burns, cuts, mutilation, asphyxiation or other personal injury or death.

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that **must** be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

- Work in an area surrounding the product that is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- **Always** wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do **not** wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do **Not** Operate" tag in the operator's compartment or on the controls.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do **not** attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before slowly loosening the filler cap to relieve the pressure from the cooling system.
- **Always** use blocks or proper stands to support the product before performing any service work. Do **not** work on anything that is supported ONLY by lifting jacks or a hoist.
- Relieve all pressure in the air, oil, fuel, and cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do **not** check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect liquid refrigerant (Freon) lines in a well ventilated area. To protect the environment, liquid refrigerant systems **must** be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capturing and recycling refrigerant.
- To reduce the possibility of personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. **Always** use a spreader bar when necessary. The lifting hooks **must not** be side-loaded.
- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do **not** get the substance in eyes. Avoid prolonged or repeated contact with skin. Do **not** swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and **must** be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.
- To reduce the possibility of burns, be alert for hot parts on products that have just been turned off, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use the tools before performing any service work. Use ONLY genuine Cummins or Cummins ReCon® replacement parts.
- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lesser quality if replacements are necessary.
- Do **not** perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.
- Liquified petroleum gas is heavier than air and can accumulate near the floor, in sumps, and low-lying areas.
- Natural gas is lighter than air and can accumulate under hood and awnings.
- To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect natural gas and liquified petroleum gas lines in a well ventilated area.
- Coolant is toxic. If **not** reused, dispose of in accordance with local environmental regulations.
- The catalyst reagent contains urea. Do not get the substance in your eyes. In Case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Avoid prolonged contact with skin. In case of contact, immediately wash skin with soap and water. Do not swallow internally. In the event the catalyst reagent is ingested, contact a physician immediately.

- The catalyst substrate contains Vanadium Pentoxide. Vanadium Pentoxide has been determined by the State of California to cause cancer. Always wear protective gloves and eye protection when handling the catalyst assembly. Do not get the catalyst material in your eyes. In Case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Avoid prolonged contact with skin. In case of contact, immediately wash skin with soap and water.
- The Catalyst substrate contains Vanadium Pentoxide. Vanadium Pentoxide has been determined by the State of California to cause cancer. In the event the catalyst is being replaced, dispose of in accordance with local regulations.

General Repair Instructions

General Information

This engine incorporates the latest technology at the time it was manufactured; yet, it is designed to be repaired using normal repair practices performed to quality standards.

- **Cummins Inc. does not recommend or authorize any modifications or repairs to engines or components except for those detailed in Cummins Service Information. In particular, unauthorized repair to safety-related components can cause personal injury or death. Below is a partial listing of components classified as safety-related:**

1. **Air Compressor**
2. **Air Controls**
3. **Air Shutoff Assemblies**
4. **Balance Weights**
5. **Cooling Fan**
6. **Fan Hub Assembly**
7. **Fan Mounting Bracket(s)**
8. **Fan Mounting Capscrews**
9. **Fan Hub Spindle**
10. **Flywheel**
11. **Flywheel Crankshaft Adapter**
12. **Flywheel Mounting Capscrews**
13. **Fuel Shutoff Assemblies**
14. **Fuel Supply Tubes**
15. **Lifting Brackets**
16. **Throttle Controls**
17. **Turbocharger Compressor Casing**
18. **Turbocharger Oil Drain Line(s)**
19. **Turbocharger Oil Supply Line(s)**
20. **Turbocharger Turbine Casing**
21. **Vibration Damper Mounting Capscrews**

- **Follow all safety instructions noted in the procedures**
  - Follow the manufacturer's recommendations for cleaning solvents and other substances used during the repair of the engine. Some solvents and used engine oil have been identified by government agencies as toxic or carcinogenic. Avoid excessive breathing, ingestion and contact with such substances. **Always** use good safety practices with tools and equipment.
- **Provide a clean environment and follow the cleaning instructions specified in the procedures**
  - The engine and its components **must** be kept clean during any repair. Contamination of the engine or components will cause premature wear.
- **Perform the inspections specified in the procedures**
- **Replace all components or assemblies which are damaged or worn beyond the specifications**
- **Use genuine Cummins new or ReCon® service parts and assemblies**
  - The assembly instructions have been written to use again as many components and assemblies as possible. When it is necessary to replace a component or assembly, the procedure is based on the use of new Cummins or Cummins ReCon® components. All of the repair services described in this manual are available from all Cummins Distributors and most Dealer locations.
- **Follow the specified disassembly and assembly procedures to reduce the possibility of damage to the components**

Complete rebuild instructions are available in the shop manual which can be ordered or purchased from a Cummins Authorized Repair Location. Refer to Section L — Service Literature for ordering instructions.

Welding on a Vehicle with an Electronic Controlled Fuel System

⚠CAUTION⚠

Disconnect both the positive (+) and negative (-) battery cables from the battery before welding on the vehicle. Attach the welder ground cable no more than 0.61 meters [2 feet] from the part being welded. Do not connect the ground cable of the welder to the ECM cooling plate or ECM. Welding on the engine or engine mounted components is not recommended or damage to the engine or components can result.

General Cleaning Instructions

Definition of Clean

Parts **must** be free of debris that can contaminate any engine system. This does **not** necessarily mean they have to appear as new.

Sanding gasket surfaces until the factory machining marks are disturbed adds no value and is often harmful to forming a seal. It is important to maintain surface finish and flatness tolerances to form a quality sealing surface. Gaskets are designed to fill small voids in the specified surface finish.

Sanding gasket surfaces where edge-molded gaskets are used is most often unnecessary. Edge-molded gaskets are those metal carriers with sealing material bonded to the edges of the gasket to seal while the metal portion forms a metal to metal joint for stability. Any of the small amounts of sealing material that can stick to the parts are better removed with a blunt-edged scraper on the spots rather than spending time polishing the whole surface with an air sander or disc.

For those gaskets that do **not** have the edge molding, nearly all have a material that contains release agents to prevent sticking. Certainly this is **not** to say that some gaskets are **not** difficult to remove because the gasket has been in place a long time, has been overheated or the purpose of the release agent has been defeated by the application of some sealant. The object however is just to remove the gasket without damaging the surfaces of the mating parts without contaminating the engine (don't let the little bits fall where they can not be removed).

Bead blasting piston crowns until the dark stain is removed is unnecessary. All that is required is to remove the carbon build-up above the top ring and in the ring grooves. There is more information on bead blasting and piston cleaning later in this document.

Cummins Inc. does **not** recommend sanding or grinding the carbon ring at the top of cylinder liners until clean metal is visible. The liner will be ruined and any signs of a problem at the top ring reversal point (like a dust-out) will be destroyed. It is necessary to remove the carbon ring to provide for easier removal of the piston assembly. A medium bristle, high quality, steel wire wheel that is rated above the rpm of the power tool being used will be just as quick and there will be less damage. Yes, one **must** look carefully for broken wires after the piston is removed but the wires are more visible and can be attracted by a magnet.

Oil on parts that have been removed from the engine will attract dirt in the air. The dirt will adhere to the oil. If possible, leave the old oil on the part until it is ready to be cleaned, inspected and installed, and then clean it off along with any attracted dirt. If the part is cleaned then left exposed it can have to be cleaned again before installation. Make sure parts are lubricated with clean oil before installation. They do **not** need to be oiled all over but do need oil between moving parts (or a good lube system priming process conducted before cranking the engine).

Bead blasting parts to remove exterior paint is also usually unnecessary. The part will most likely be painted again so all that needs happen is remove any loose paint.

Abrasive Pads and Abrasive Paper

The keyword here is "abrasive". There is no part of an engine designed to withstand abrasion. That is they are all supposed to lock together or slide across each other. Abrasives and dirt particles will degrade both functions.

⚠WARNING⚠

Abrasive material must be kept out of or removed from oil passages and parts wear points. Abrasive material in oil passages can cause bearing and bushing failures that can progress to major component damage beyond reuse. This is particularly true of main and rod bearings.

Cummins Inc. does **not** recommend the use of emery cloth or sand paper on any part of an **assembled** engine or component including but **not** limited to removing the carbon ridge from cylinder liners or to clean block decks or counterbores.

Great care **must** be taken when using abrasive products to clean engine parts, particularly on partially assembled engines. Abrasive cleaning products come in many forms and sizes. All of them contain aluminum oxide particles, silicon carbide, or sand or some other similar hard material. These particles are harder than most of the parts in the engine. Since they are harder, if they are pressed against softer material they will either damage the material or become embedded in it. These materials fall off the holding media as the product is used. If the products are used with power equipment the particles are thrown about the engine. If the particles fall between two moving parts, damage to the moving parts is likely.

If particles that are smaller than the clearance between the parts while they are at rest (engine stopped), but larger than the running clearance then damage will occur when the parts move relative to each other (engine started). While the engine is running and there is oil pressure, particles that are smaller than the bearing clearance are likely to pass between the parts without damage and be trapped in the oil filter. However, particles larger than the bearing clearance will remove material from one part and can become embedded in one of the parts. Once embedded in one part it will

abrade the other part until contact is no longer being made between the two parts. If the damage sufficiently degrades the oil film, the two parts will come into contact resulting in early wear-out or failure from lack of effective lubrication.

Abrasive particles can fly about during cleaning it is **very** important to block these particles from entering the engine as much as possible. This is particulary true of lubricating oil ports and oil drilling holes, especially those located downstream of the lubricating oil filters. Plug the holes instead of trying to blow the abrasive particles and debris with compressed air because the debris is often simply blown further into the oil drilling.

All old gasket material **must** be removed from the parts gasket surfaces. However, it is **not** necessary to clean and polish the gasket surface until the machining marks are erased. Excessive sanding or buffing can damage the gasket surface. Many newer gaskets are of the edge molded type (a steel carrier with a sealing member bonded to the steel). What little sealing material that can adhere is best removed with a blunt-edged scraper or putty knife. Cleaning gasket surfaces where an edge-molded gasket is used with abrasive pads or paper is usually a waste of time.

⚠WARNING⚠

Excessive sanding or grinding the carbon ring from the top of the cylinder liners can damage the liner beyond reuse. The surface finish will be damaged and abrasive particles can be forced into the liner material which can cause early cylinder wear-out or piston ring failures.

Tape off or plug all openings to any component interior before using abrasive pads or wire brushes. If really necessary because of time to use a power tool with abrasive pads, tape the oil drillings closed or use plug and clean as much of the surface as possible with the tool but clean around the oil hole/opening by hand so as to prevent contamination of the drilling. Then remove the tape or plug and clean the remaining area carefully and without the tool. DO NOT use compressed air to blow the debris out of oil drilling on an assembled engine! More likely than **not**, the debris can be blown further into the drilling. Using compressed air is fine if both ends of the drilling are open but that is rarely the case when dealing with an assembled engine.

Gasket Surfaces

The object of cleaning gasket surfaces is to remove any gasket material, not refinish the gasket surface of the part.

Cummins Inc. does **not** recommend any specific brand of liquid gasket remover. If a liquid gasket remover is used, check the directions to make sure the material being cleaned will **not** be harmed.

Air powered gasket scrapers can save time but care must be taken to **not** damage the surface. The angled part of the scraper must be against the gasket surface to prevent the blade from digging into the surface. Using air powered gasket scrapers on parts made of soft materials takes skill and care to prevent damage.

Do **not** scrape or brush across the gasket surface if at all possible.

Solvent and Acid Cleaning

Several solvent and acid-type cleaners can be used to clean the disassembled engine parts (other than pistons. See Below). Experience has shown that the best results can be obtained using a cleaner that can be heated to 90° to 95° Celsius (180° to 200° Fahrenheit). Kerosene emulsion based cleaners have different temperature specifications, see below. A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results. Cummins Inc. does not recommend any specific cleaners. Always follow the cleaner manufacturer's instructions. Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful not to damage any gasket surfaces. When possible, steam clean the parts before putting them in the cleaning tank.

⚠WARNING⚠

When using solvents, acids, or alkaline materials for cleaning, follow the manufacturers recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

Experience has shown that kerosene emulsion based cleaners perform the best to clean pistons. These cleaners should **not** be heated to temperature in excess of 77°C (170°F). The solution begins to break down at temperatures in excess of 82°C (180°F) and will be less effective.

Do **not** use solutions composed mainly of chlorinated hydrocarbons with cresols, phenols and/or cresylic components. They often do **not** do a good job of removing deposits from the ring groove and are costly to dispose of properly.

Solutions with a pH above approximately 9.5 will cause aluminum to turn black; therefore do **not** use high alkaline solutions.

Chemicals with a pH above 7.0 are considered alkaline and those below 7.0 are acidic. As you move further away from the neutral 7.0, the chemicals become highly alkaline or highly acidic.

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful to **not** damage any gasket surfaces. When possible use hot high

pressure water or steam clean the parts before putting them in the cleaning tank. Removing the heaviest dirt before placing in the tank will allow the cleaner to work more effectively and the cleaning agent will last longer.

Rinse all the parts in hot water after cleaning. Dry completely with compressed air. Blow the rinse water from all the capscrew holes and the oil drillings.

If the parts are **not** to be used immediately after cleaning, dip them in a suitable rust proofing compound. The rust proofing compound **must** be removed from the parts before assembly or installation on the engine.

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good method for cleaning the oil drillings and coolant passages

⚠WARNING⚠

When using a steam cleaner, wear safety glasses or a face shield, as well as protective clothing. Hot steam can cause serious personal injury.

Do **not** steam clean the following components:

- Electrical Components
- Wiring Harnesses
- Injectors
- Fuel Pump
- Belts and Hoses
- Bearings (ball or taper roller)
- Electronic Control Module (ECM)
- ECM Connectors
- Dosing Control Unit

Plastic Bead Cleaning

Cummins Inc. does **not** recommend the use of glass bead blast or walnut shell media on **any** engine part. Cummins Inc. recommends using **only** plastic bead media, Part Number 3822735 or equivalent on any engine part. **Never** use sand as a blast media to clean engine parts. Glass and walnut shell media when **not** used to the media manufacturer's recommendations can cause excess dust and can embed in engine parts that can result in premature failure of components through abrasive wear.

Plastic bead cleaning can be used on many engine components to remove carbon deposits. The cleaning process is controlled by the use of plastic beads, the operating pressure and cleaning time.

⚠CAUTION⚠

Do not use bead blasting cleaning methods on aluminum pistons skirts or the pin bores in any piston, piston skirt or piston crown. Small particles of the media will embed in the aluminum or other soft metal and result in premature wear of the cylinder liner, piston rings, pins and pin bores. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.

⚠CAUTION⚠

Do not contaminate wash tanks and tank type solvent cleaners with the foreign material and plastic beads. Remove the foreign material and plastic beads with compressed air, hot high pressure water or steam before placing them in tanks or cleaners. The foreign material and plastic beads can contaminate the tank and any other engine parts cleaned in the tank. Contaminated parts may cause failures from abrasive wear.

Plastic bead blasting media, Part Number 3822735, can be used to clean all piston ring grooves. Do **not** sure any bead blasting media on piston pin bores or aluminum skirts.

Follow the equipment manufacturer's cleaning instructions. Make sure to adjust the air pressure in the blasting machine to the bead manufacturer's recommendations. Turning up the pressure can move material on the part and cause the plastic bead media to wear out more quickly. The following guidelines can be used to adapt to manufacturer's instructions:

1. Bead size: U.S. size Number 16 — 20 for piston cleaning with plastic bead media, Part Number 3822735
2. Operating Pressure — 270 kPa (40 psd) for piston cleaning. Pressure should not cause beads to break.
3. Steam clean or wash the parts with solvent to remove all of the foreign material and plastic beads after cleaning. Rinse with hot water. Dry with compressed air.

⚠CAUTION⚠

The bead blasting operation must not disturb the metal surface. If the metal surface is disturbed the engine can be damaged due to increased parts clearance or inadequate surface finish on parts that move against other parts.

When cleaning pistons, it is **not** necessary to remove all the dark stain from the piston. All that is necessary is to remove the carbon on the rim and in the ring grooves. This is best done by directing the blast across the part as opposed to straight at the part. If the machining marks are disturbed by the blasting process, then the pressure is too high or the blast is being held on one spot too long. The blast operation **must not** disturb the metal surface.

Walnut shell bead blast material is sometimes used to clean ferrous metals (iron and steel). Walnut shell blasting produces a great amount of dust particularly when the pressure if the air pressure on the blasting machine is increased above media manufacturer's recommendation. Cummins Inc. recommends **not** using walnut shell media to clean engine parts due to the risk media embedment and subsequent contamination of the engine.

Cummins Inc. now recommends glass bead media **NOT** used to clean any engine parts. Glass media is too easily embedded into the material particularly in soft materials and when air pressures greater than media manufacturer's recommend are used. The glass is an abrasive so when it is in a moving part, that part is abrading all the parts in contact with it. When higher pressures are used the media is broken and forms a dust of a very small size that floats easily in the air. This dust is very hard to control in the shop, particularly if **only** compressed air (and not hot water) is used to blow the media after it is removed from the blasting cabinet (blowing the part off inside the cabinet may remove large accumulations but never removes all the media).

Bead blasting is best used on stubborn dirt/carbon build-up that has **not** been removed by first steam/higher pressure washing then washing in a heated wash tank. This is particularly true of pistons. Steam and soak the pistons first then use the plastic bead method to safely remove the carbon remaining in the grooves (instead of running the risk of damaging the surface finish of the groove with a wire wheel or end of a broken piston ring. Make sure the parts are dry and oil free before bead blasting to prevent clogging the return on the blasting machine.

Always direct the bead blaster nozzle "across" rather than directly at the part. This allows the bead to get under the unwanted material. Keep the nozzle moving rather than hold on one place. Keeping the nozzle directed at one-place too long causes the metal to heat up and be moved around. Remember that the spray is **not** just hitting the dirt or carbon. If the machining marks on the piston groove or rim have been disturbed then there has **not** been enough movement of the nozzle and/or the air pressure is too high.

Never bead blast valve stems. Tape or use a sleeve to protect the stems during bead blasting. Direct the nozzle across the seat surface and radius rather than straight at them. The object is to remove any carbon build up and continuing to blast to remove the stain is a waste of time.

Acronyms and Abbreviations

General Information

The following list contains some of the acronyms and abbreviations used in this manual.

API	American Petroleum Institute
ASTM	American Society of Testing and Materials
°C	Celsius
CARB	California Air Resources Board
C.I.D.	Cubic Inch Displacement
CNG	Compressed Natural Gas
CPL	Control Parts List
cSt	Centistokes
ECM	Electronic Control Module
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
°F	Fahrenheit
FMI	Failure Mode Indentifier
GVW	Gross Vehicle Weight
LPG	Liquified Petroleum Gas
Hg	Mercury
hp	Horsepower
H_2O	Water
ICM	Ignition Control Module
km/l	Kilometers per Liter
kPa	Kilopascal
LNG	Liquid Natural Gas
LTA	Low Temperature Aftercooling
MPa	Megapascal
mph	Miles Per Hour
mpq	Miles Per Quart
N•m	Newton-meter
NG	Natural Gas
OEM	Original Equipment Manufacturer
PID	Parameter Identification Descriptions
ppm	Parts Per Million
psi	Pounds Per Square Inch
PTO	Power Takeoff
rpm	Revolutions Per Minute
SAE	Society of Automotive Engineers
SCA	Supplemental Coolant Additive
STC	Step Timing Control
SID	Subsystem Identification Descriptions
VS	Variable Speed
VSS	Vehicle Speed Sensor

Notes

Section E - Engine and System Identification

Section Contents

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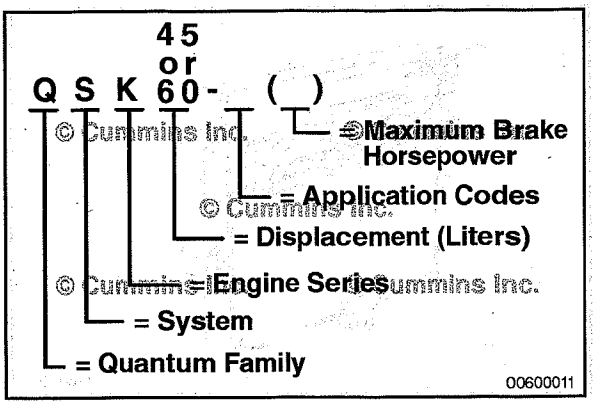
Engine Identification

Cummins® Engine Nomenclature

The model name provides identification data for the engine. Use the illustration for the model name identification.

The application codes are:

C = Construction
D = Generator Drive
L = Locomotive
M = Marine
P = Power Unit.



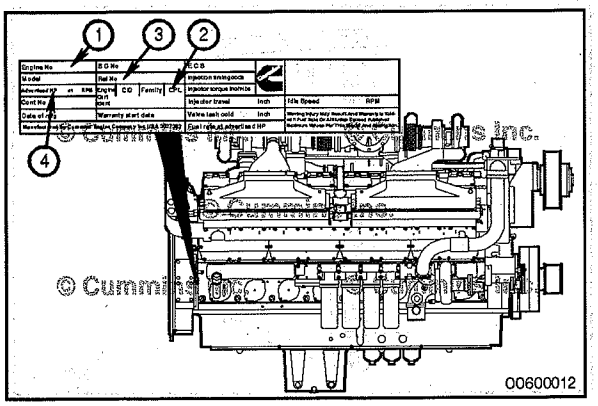
Engine Dataplate

The engine dataplate shows specific information about your engine.

- Engine serial number (ESN)
- Control parts list (CPL)
- Horsepower
- RPM.

NOTE: The engine dataplate **must not** be changed unless approved by Cummins Inc.

The dataplate on the QSK45 and QSK60 engines is located at the rear of the engine block opposite the starter.

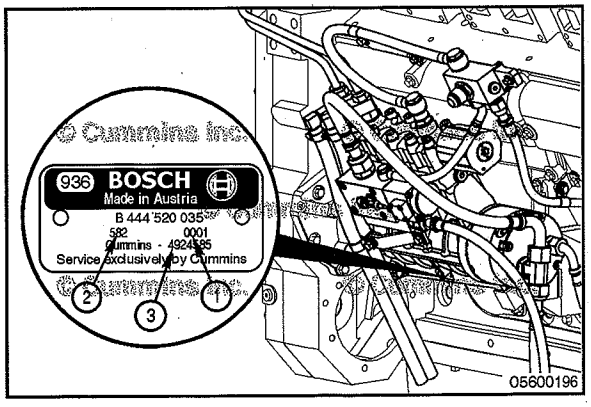


Fuel Injection Pump Dataplate

with Electronically Actuated Injector

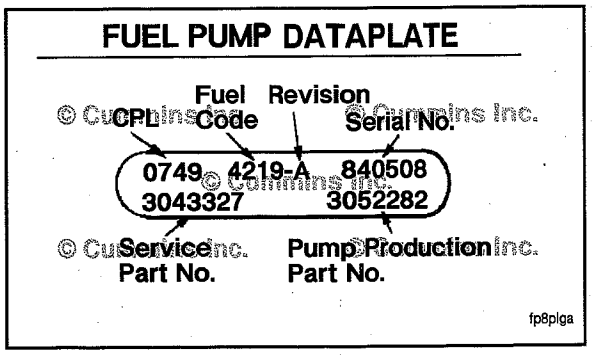
The Cummins® Modular Common Rail System dataplate is located on the side of the high pressure fuel pump. The dataplate contains the following information:

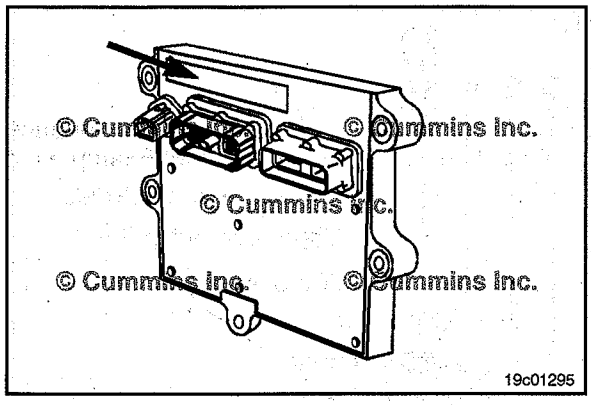
1. Serial number
2. Date code
3. Cummins® part number.



with Mechanically Actuated Injector

The fuel pump dataplate is located on the top of the fuel pump. It provides information needed to calibrate the fuel pump.





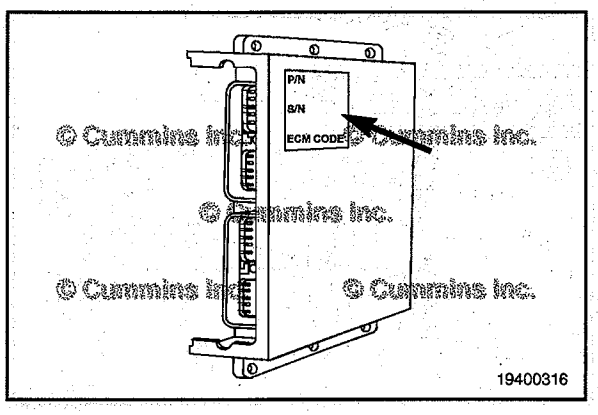
ECM Dataplate

with Electronically Actuated Injector

The external ECM dataplate is located on the front of the ECM.

The following information is found on the ECM dataplate:

- ECM part number (P/N)
- ECM serial number (S/N)
- ECM data code (D/C)
- Engine Serial Number (ESN)
- ECM code (identifies software in the ECM)



with Mechanically Actuated Injector

The external ECM dataplate is located on top of the ECM.

The dataplate contains the following:

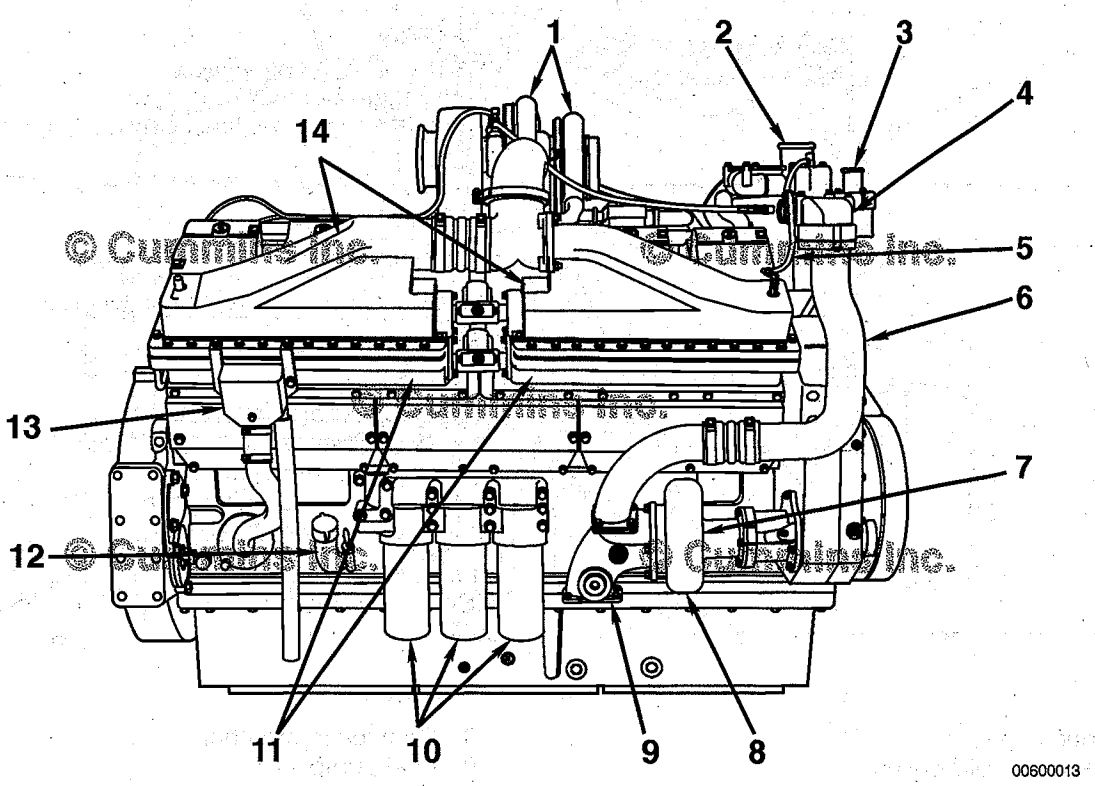
- ECM part number (P/N)
- ECM serial number (S/N)
- Manufacturer date code (D/C)
- Supplier identifier (S/I)
- Input voltage rating of the ECM (V/R).

The dataplate on the right contains engine and calibration information. This includes the engine serial number (ESN), ECM calibration date (Date), and ECM calibration code.

Engine Diagrams

Engine Views

The illustrations show the locations of the major external components, filters, and other service and maintenance points. The location of certain external components will vary by engine model and engine configuration. Examples of some configurations are shown.

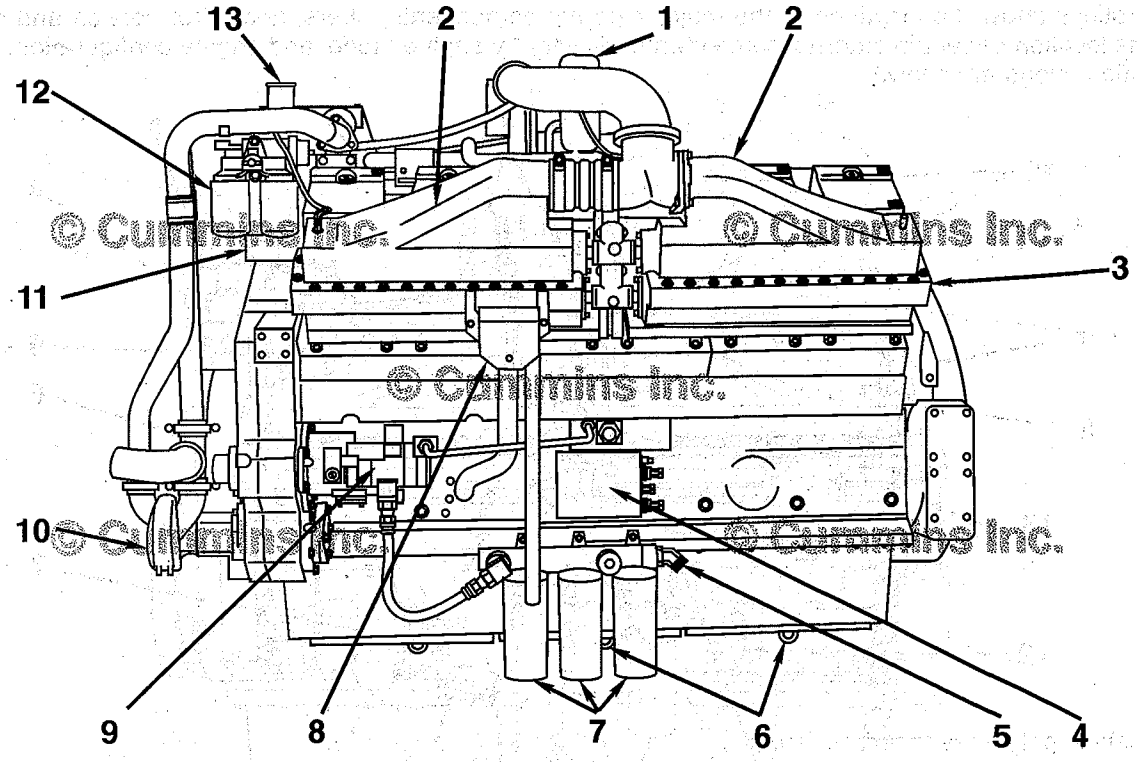


QSK45 - Right Side View

1. Turbochargers
2. LTA water outlet connections
3. Engine water outlet connections
4. Engine thermostat outlet
5. Aftercooler vent line
6. Water bypass tube
7. Water pump
8. Water pump drain
9. Coolant inlet connection
10. Oil filters
11. Aftercooler assemblies
12. Oil fill and dipstick tubes
13. Crankcase breather
14. Intake manifold cover.

Engine Diagrams

Engine Views

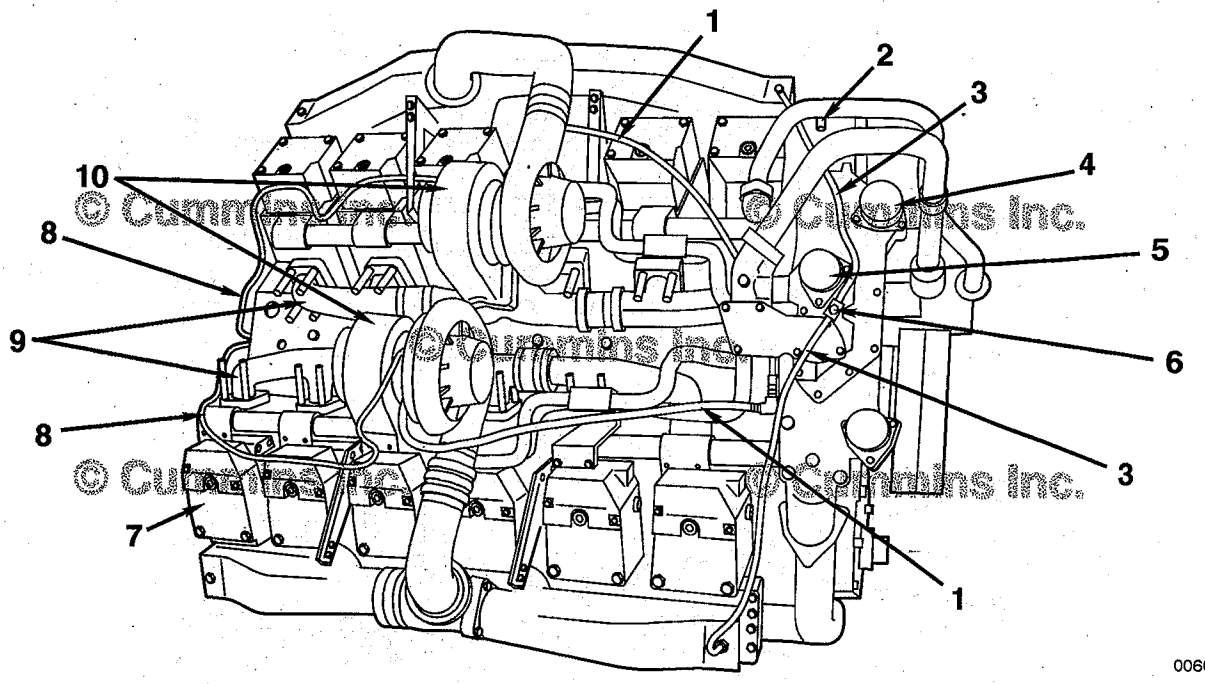


QSK45 - Left Side View

1. Turbocharger
2. Intake manifold covers
3. Aftercooler assemblies
4. Electronic control module (ECM)
5. Fuel inlet connection
6. Engine oil drains
7. Fuel filters
8. Crankcase breather
9. Fuel pump
10. LTA water pump
11. Thermostat housing support
12. Water filters
13. LTA water outlet connections.

Engine Diagrams

Engine Views

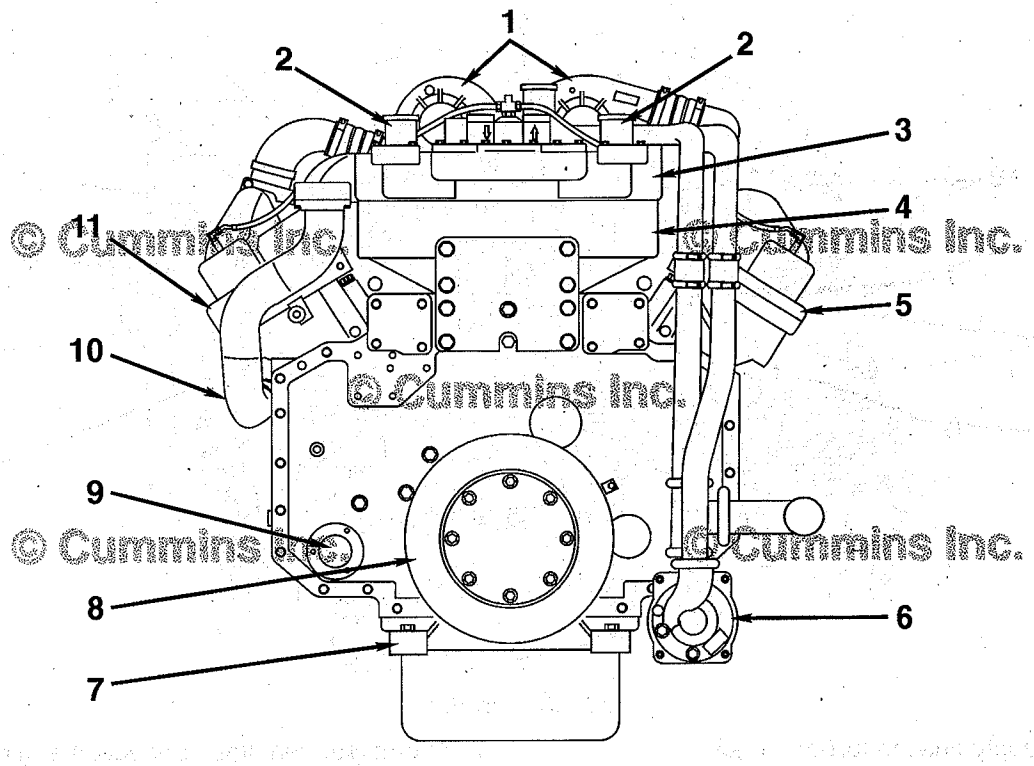


QSK45 -Top View

1. Coolant supply lines to turbocharger
2. Vent - test port
3. Aftercooler vent lines
4. Engine water outlet connections
5. LTA water outlet connection
6. Aftercooler vent line connection engine
7. Rocker lever cover
8. Oil supply lines to turbocharger
9. Exhaust manifolds
10. Turbochargers.

Engine Diagrams

Engine Views



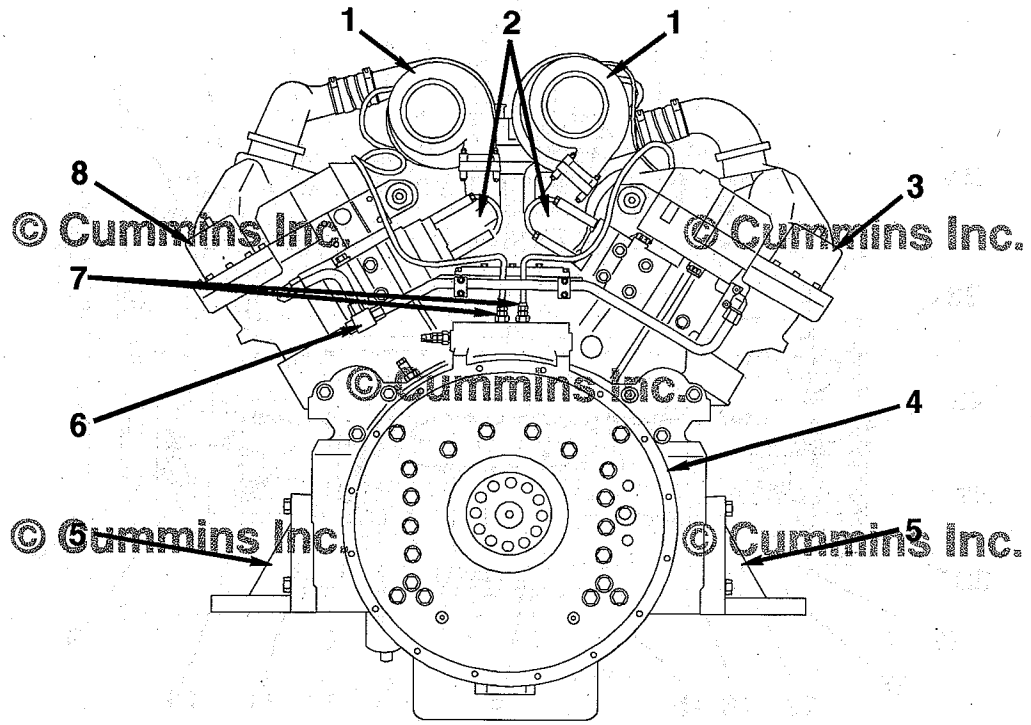
QSK45 - Front View

NOTE: Some engine configurations have the fuel return lines positioned at the front of the engine.

1. Turbochargers
2. Engine water outlet connections
3. Thermostat housing
4. Thermostat housing support
5. Left-Bank aftercooler assembly
6. LTA water pump
7. Front engine mount
8. Vibration damper
9. Alternator drive
10. Water bypass tube
11. Right-Bank aftercooler assembly.

Engine Diagrams

Engine Views



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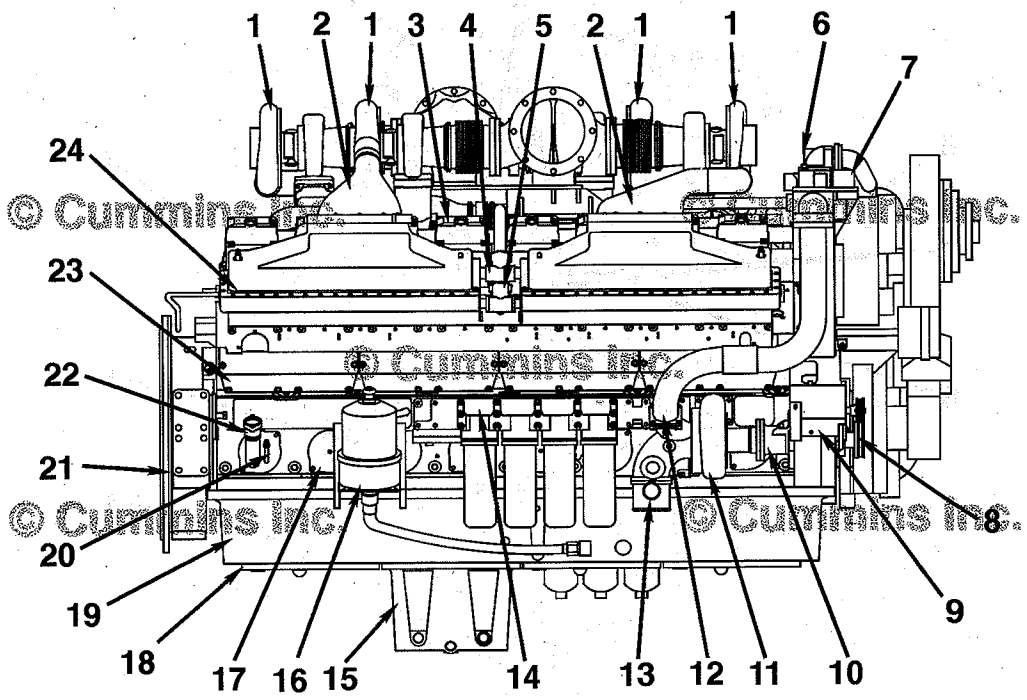
00600017

QSK45 - Rear View

1. Turbochargers
2. Exhaust manifold
3. Right-Bank aftercooler assembly
4. Flywheel housing
5. Rear engine mount
6. Fuel return line
7. Turbocharger oil supply lines
8. Left-Bank aftercooler assembly.

Engine Diagrams

Engine Views



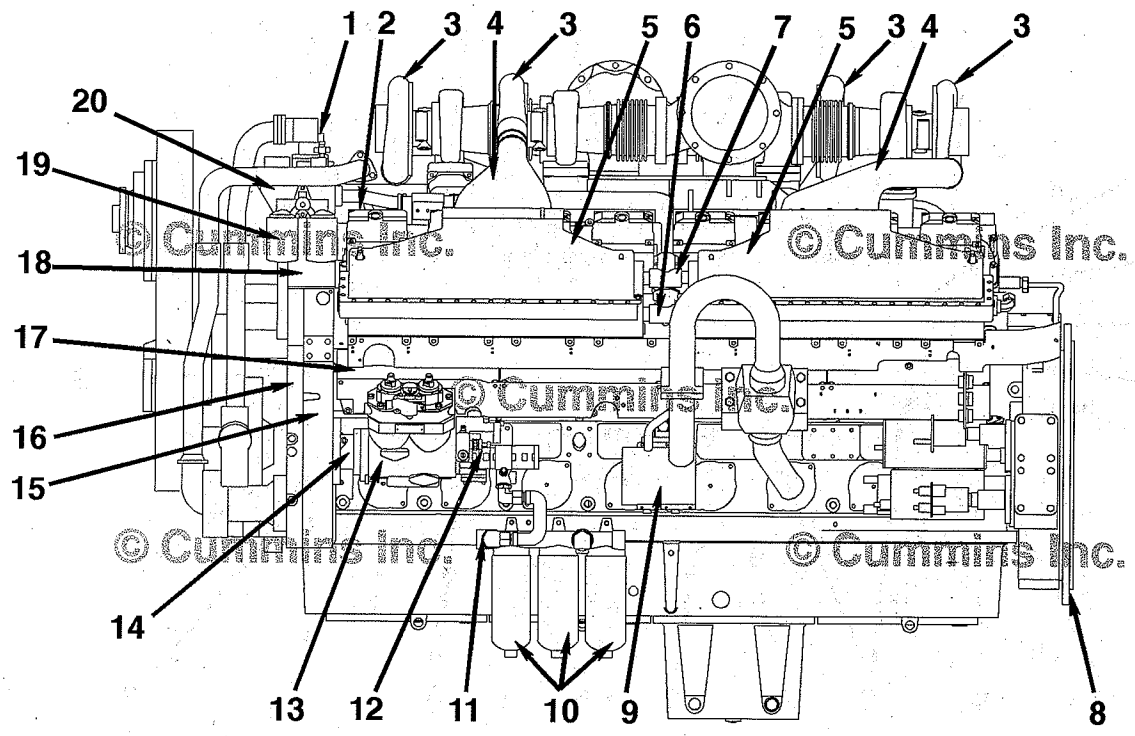
00600018

QSK60 - Right Side View with Mechanical Actuated Injectors

1. Turbochargers
2. Air crossover connections
3. Rocker lever cover
4. Aftercooler water outlet tube
5. Aftercooler water inlet tube
6. LTA water outlet connections
7. Engine water outlet connections
8. Alternator drive
9. Alternator
10. Water pump drive
11. Water pump
12. Water bypass tube
13. Water inlet connection
14. Oil filter head
15. Oil pan sump
16. Centrifuge bypass filter
17. Handhole covers
18. Oil pan adapter plate
19. Oil pan adapter
20. Dipstick
21. Flywheel housing
22. Oil fill tube
23. Cam follower cover
24. Aftercooler assembly.

Engine Diagrams

Engine Views



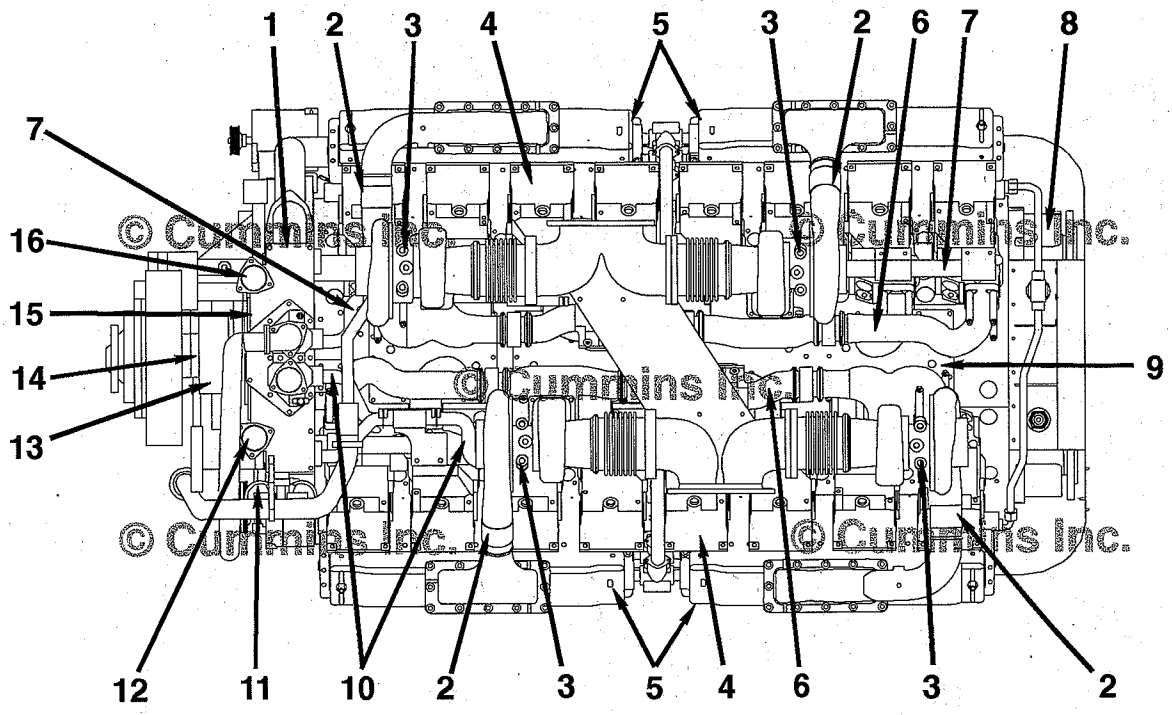
00600019

QSK60 - Left Side View with Mechanical Actuated Injectors

1. LTA water outlet connections
2. Rocker lever cover
3. Turbochargers
4. Air crossover connection
5. Aftercooler assemblies
6. Aftercooler water inlet tube
7. Aftercooler water outlet tube
8. Flywheel housing
9. Electronic control module
10. Fuel filter
11. Fuel filter head
12. Fuel pump
13. Air compressor
14. Accessory drive
15. Front gear housing
16. Front gear cover
17. Cam follower cover
18. Thermostat housing support
19. Coolant filters
20. Thermostat housing.

Engine Diagrams

Engine Views



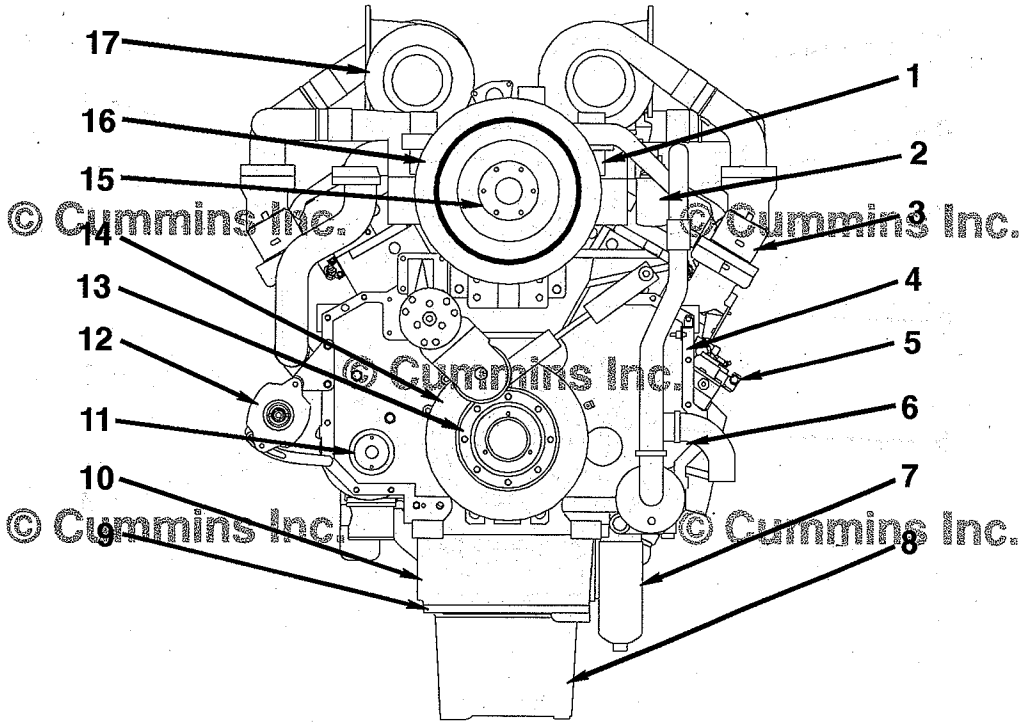
00600020

QSK60 - Top View with Mechanical Actuated Injectors

1. Thermostat housing
2. Air crossover connections
3. Turbochargers
4. Rocker lever cover
5. Aftercooler assemblies
6. Exhaust manifolds
7. Water transfer tube
8. Flywheel housing
9. Oil cooler cover plate
10. Aftercooler water tube
11. Coolant filter head
12. Left-Bank water outlet
13. Fan hub support
14. Fan hub shaft
15. Thermostat housing support
16. Right-Bank water outlet.

Engine Diagrams

Engine Views



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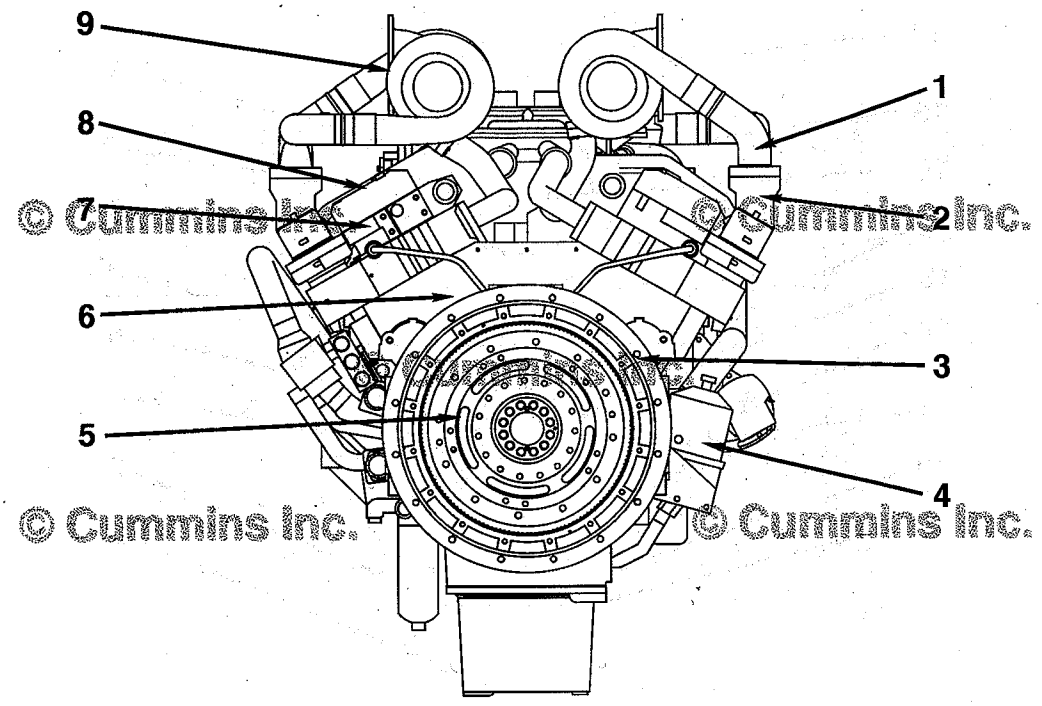
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QSK60 - Front View with Mechanical Actuated Injectors

1. Thermostat housing
2. Coolant filter
3. Aftercooler assembly
4. Gear cover
5. Air compressor
6. Accessory drive pulley location (**not** shown)
7. Fuel filter
8. Oil pan sump
9. Oil pan adapter plate
10. Oil pan adapter
11. Alternator drive pulley
12. Alternator
13. Crankshaft pulley
14. Vibration dampers
15. Fan hub spacer
16. Fan hub pulley
17. Turbocharger.

Engine Diagrams

Engine Views



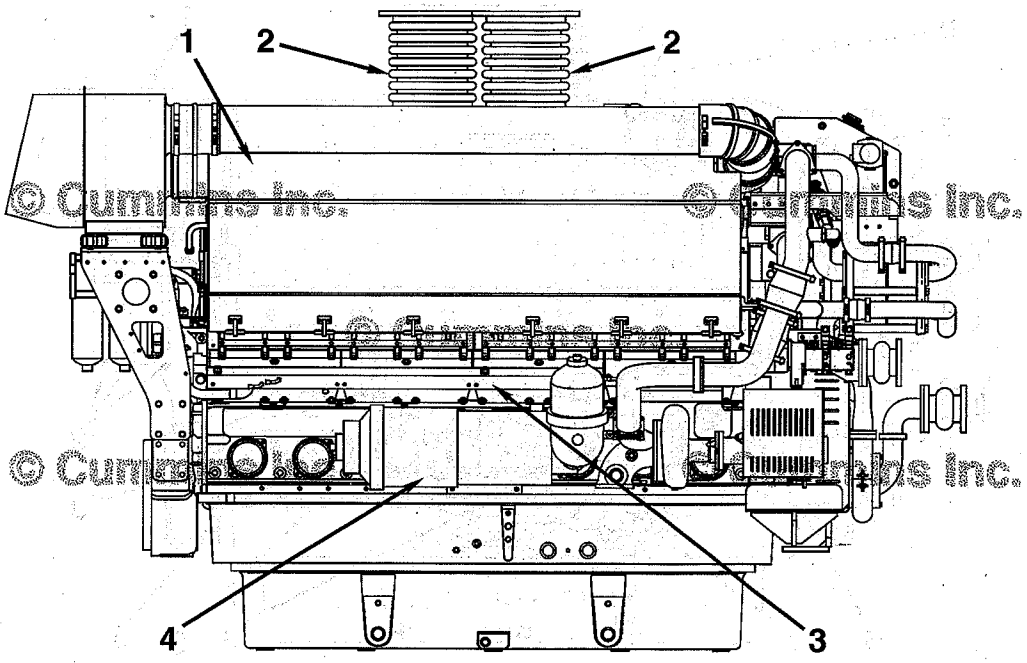
00600022

QSK60 - Rear View with Mechanical Actuated Injectors

1. Air crossover connector
2. Aftercooler assembly
3. Flywheel housing
4. Centrifuge bypass filter
5. Flex plate
6. Cylinder block
7. Rocker lever housing
8. Rocker lever cover
9. Turbocharger.

Engine Diagrams

Engine Views



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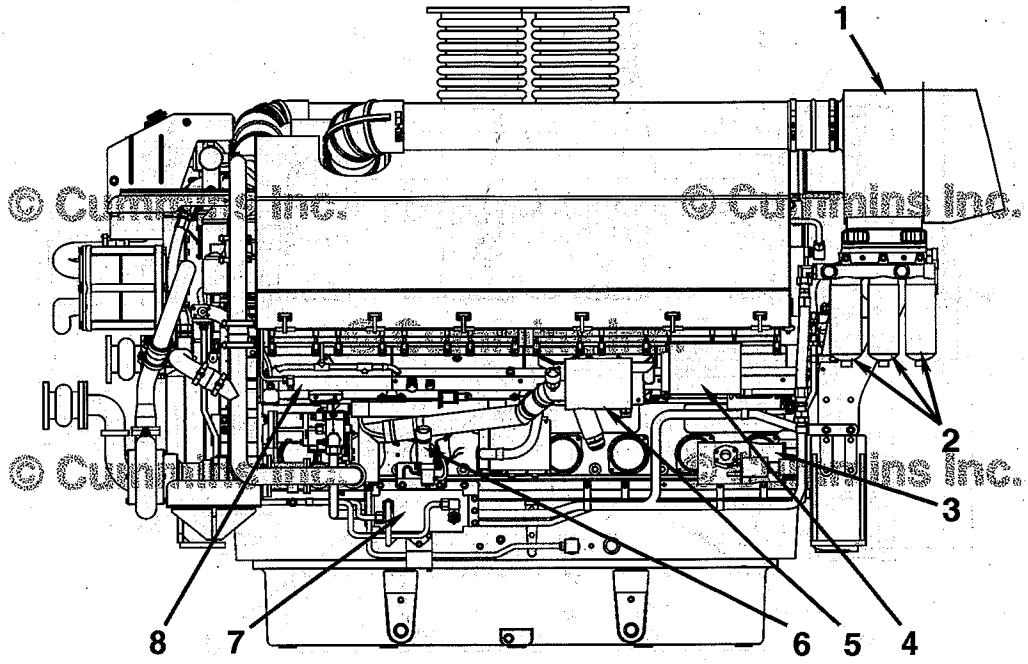
00600215

QSK60 Marine - Right Side View

1. Aftercooler heat shield
2. Exhaust outlet bellows
3. Right-bank wiring harness
4. Eliminator lubricating oil filter assembly.

Engine Diagrams

Engine Views

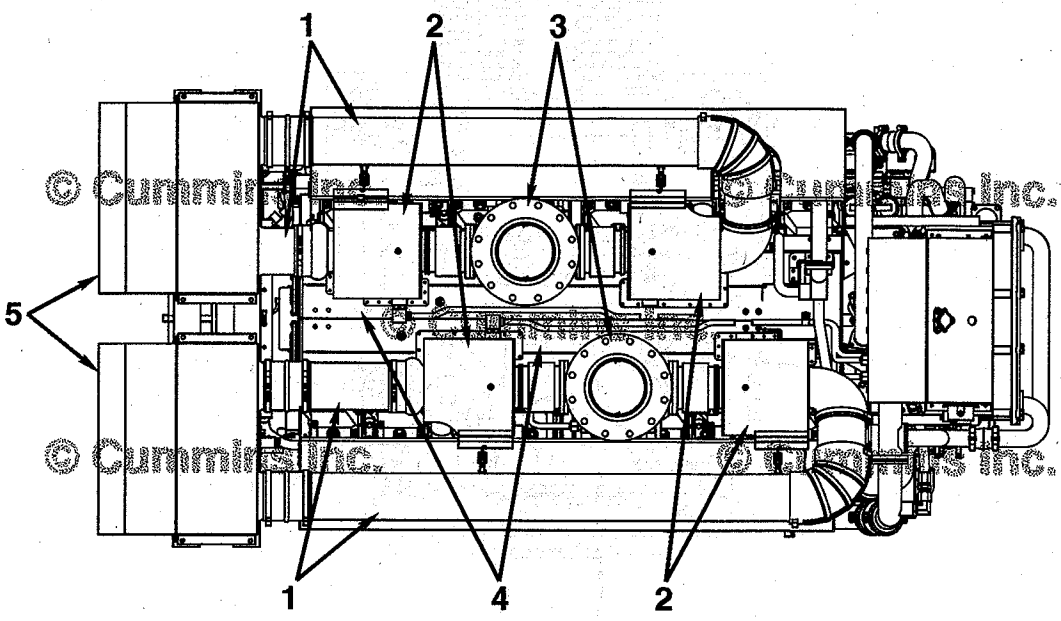


QSK60 Marine - Left Side View

1. Air cleaner assembly
2. Fuel filters
3. Starter
4. Electronic control module (ECM)
5. Crankcase breather
6. Oil fill and dipstick tubes
7. Fuel cooler (optional)
8. Left-bank wiring harness

Engine Diagrams

Engine Views



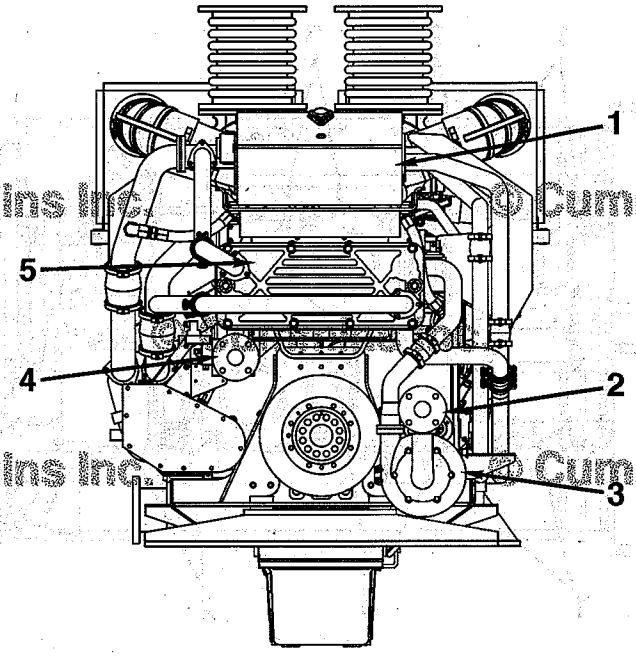
00600217

QSK60 Marine - Top View

1. Air intake tubes
2. Turbocharger heat shields
3. Exhaust outlet connections
4. Exhaust manifold heat shields
5. Air cleaner assemblies.

Engine Diagrams

Engine Views



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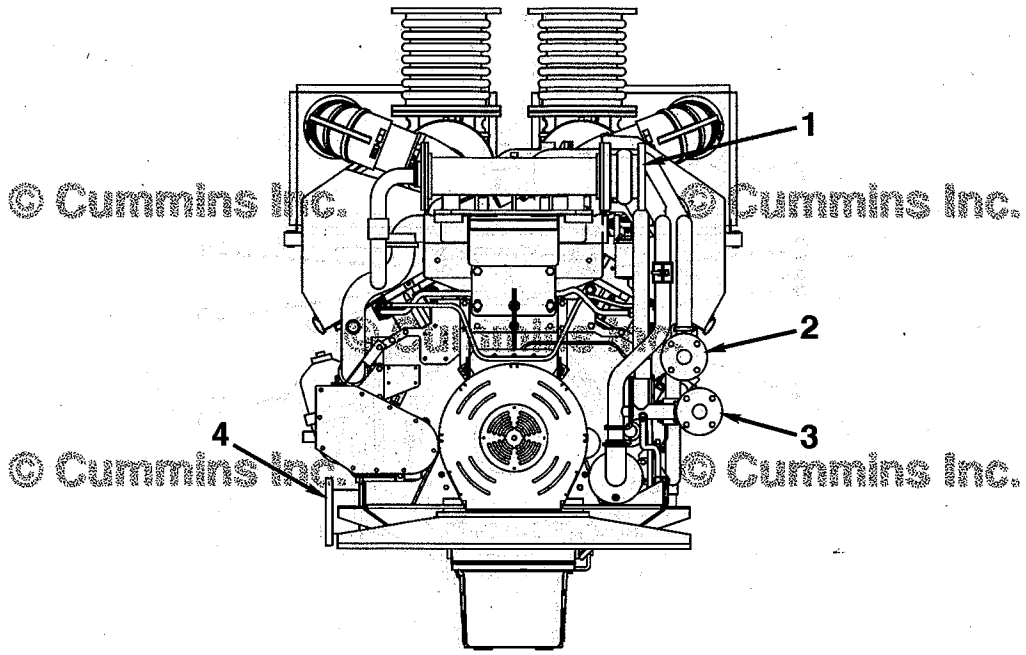
00600213

QSK60 Marine Heat Exchanger Cooled - Front View

1. Expansion tank
2. Seawater inlet connection
3. Seawater pump
4. Seawater outlet connection
5. Heat exchanger.

Engine Diagrams

Engine Views



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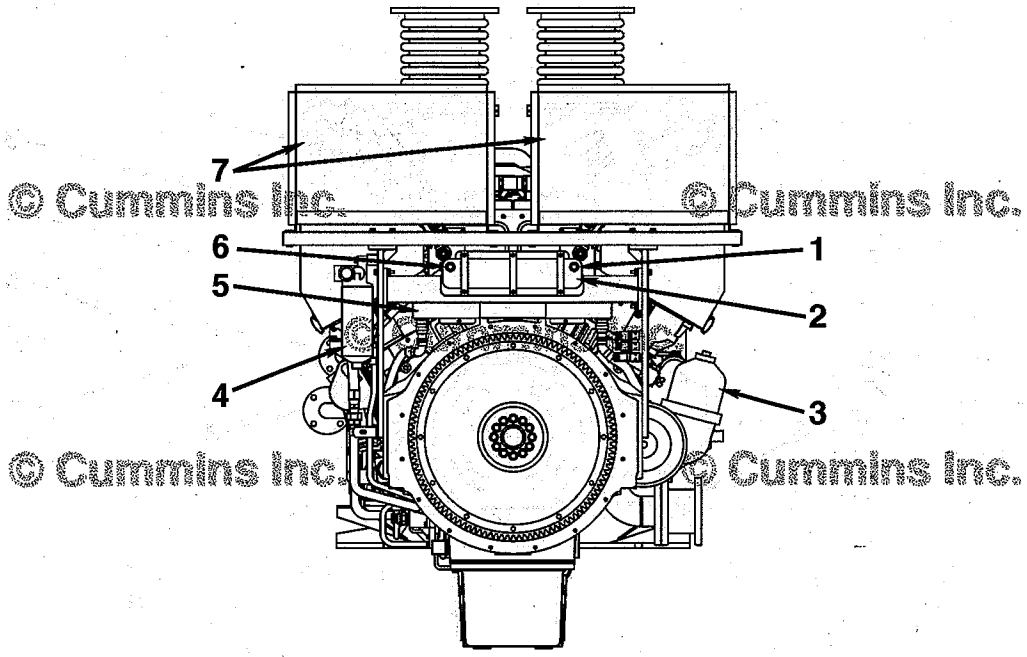
00600212

QSK60 Marine Keel Cooled - Front View

1. Engine coolant outlet connection to main engine cooler
2. LTA coolant outlet connection to LTA cooler
3. LTA coolant inlet connection from LTA cooler
4. Engine coolant inlet connection from main engine cooler.

Engine Diagrams

Engine Views



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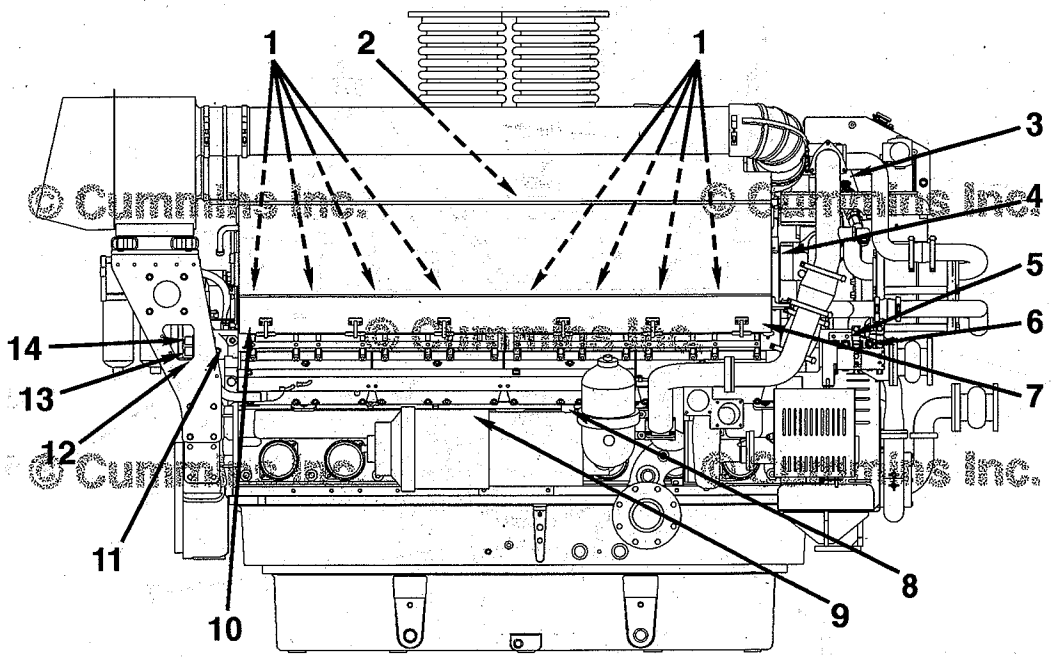
00600214

QSK60 Marine - Rear View

1. Gear oil inlet or outlet connection
2. Gear oil cooler (optional)
3. Eliminator lubricating oil filter assembly
4. Fuel filter
5. Rear engine harness
6. Gear oil inlet or outlet connection
7. Air filter assemblies.

Engine Diagrams

Engine Views

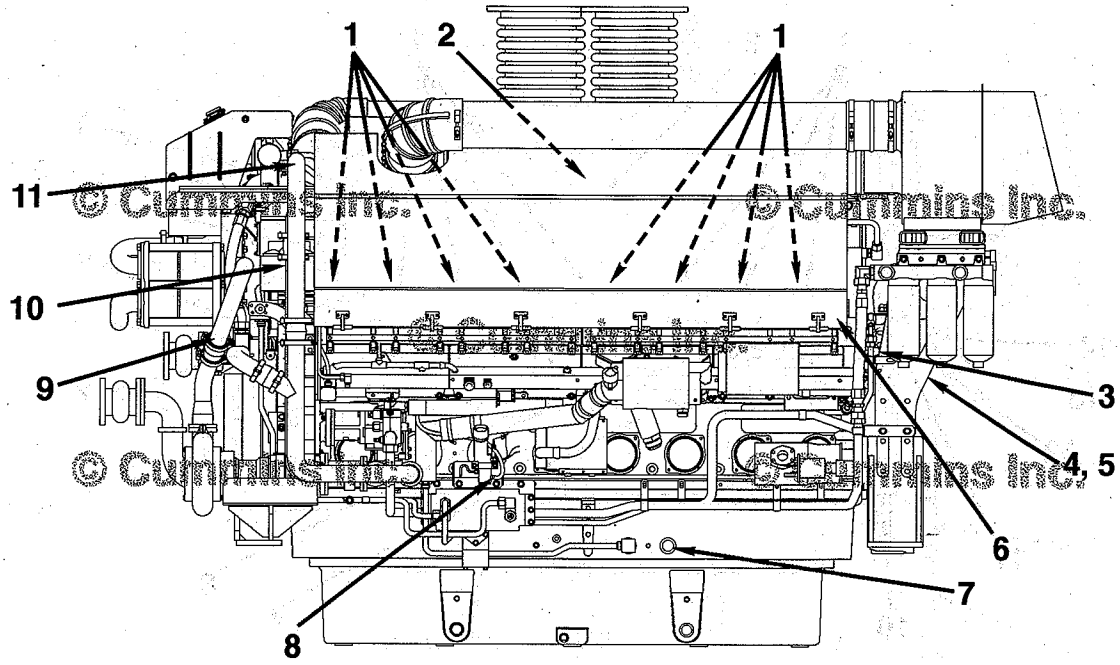


QSK60 Marine Alarm, Safety, and Panel Sensors - Right Side View

1. Cylinder exhaust gas temperature sensors
2. Exhaust stack temperature sensor
3. Coolant level switch (heat exchanger engines **only**)
4. Coolant temperature sensor
5. Coolant inlet pressure switch
6. Coolant inlet pressure sensor
7. Intake manifold temperature sensor
8. Lubricating oil pressure sensor (before lubricating oil filter head)
9. Lubricating oil pressure sensor (after lubricating oil filter head)
10. Intake manifold temperature sensor
11. Engine speed sensor (for alarm system)
12. Lubricating oil pressure switch
13. Lubricating oil pressure switch, high speed range
14. Lubricating oil pressure switch, low speed range.

Engine Diagrams

Engine Views

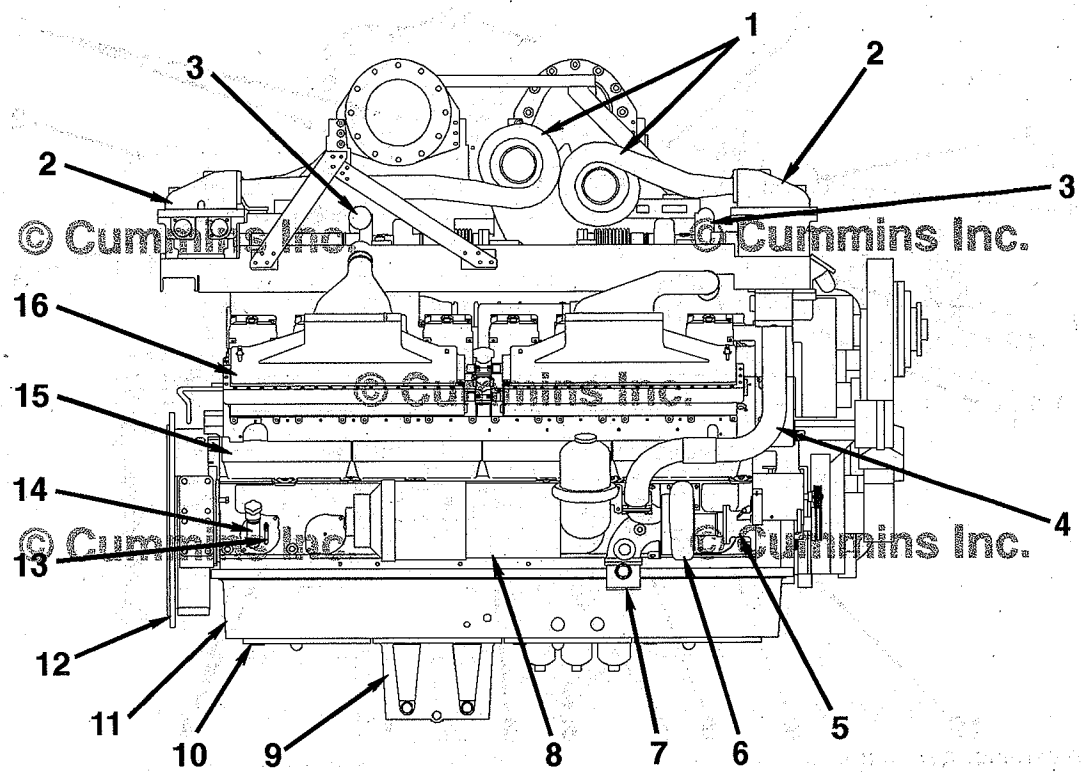


QSK60 Marine Alarm, Safety, and Panel Sensors - Left Side View

1. Cylinder exhaust gas temperature sensors
2. Exhaust stack temperature sensor
3. Engine speed sensor (safety system)
4. Fuel filter differential pressure sensor (located behind fuel filters)
5. Fuel filter outlet pressure sensor (located behind fuel filters)
6. Intake manifold temperature sensor
7. Oil temperature sensor
8. Fuel leakage sensor
9. Seawater pressure sensor (heat exchanger cooled engine **only**)
10. Coolant outlet temperature switch
11. Aftercooler water inlet temperature sensor.

Engine Diagrams

Engine Views

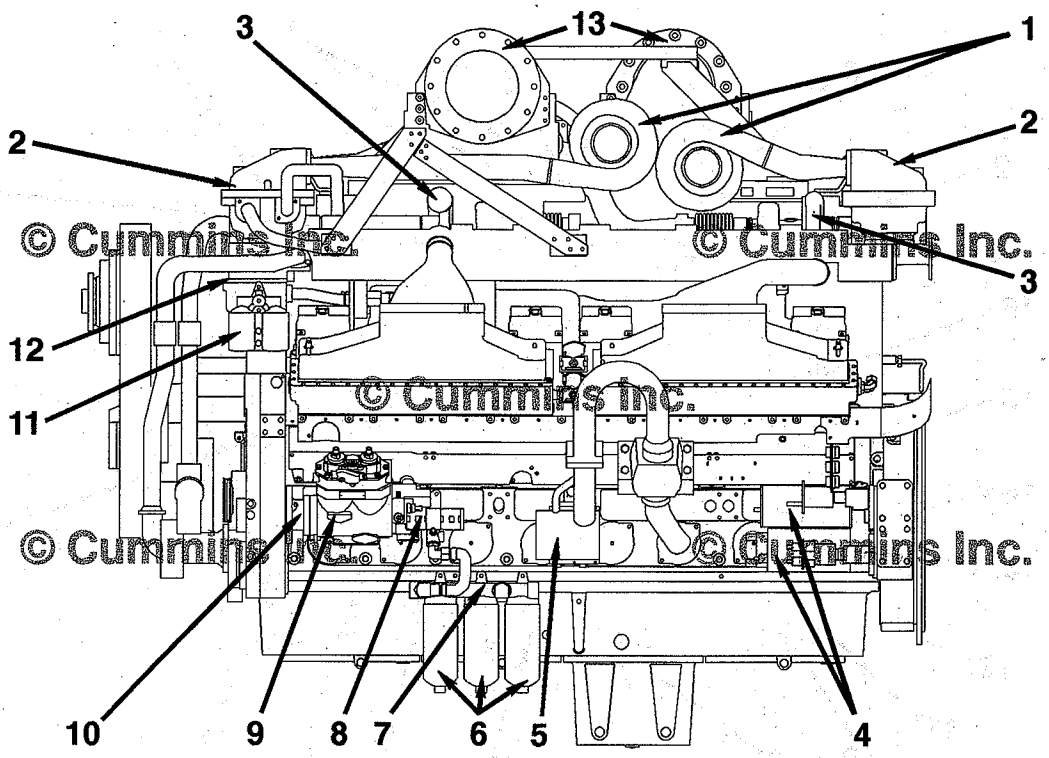


QSK60, Two-Stage - Right Side View with Mechanical Actuated Injectors

1. Low-Pressure turbochargers
2. Intercooler assemblies
3. High-Pressure turbochargers
4. Water bypass tube
5. Water pump drive
6. Water pump
7. Water pump inlet
8. Eliminator full-flow/bypass filtration system
9. Oil pan sump
10. Oil pan adapter plate
11. Oil pan adapter
12. Flywheel housing
13. Engine oil level dipstick
14. Oil fill tube
15. Cam follower cover
16. Aftercooler assembly.

Engine Diagrams

Engine Views

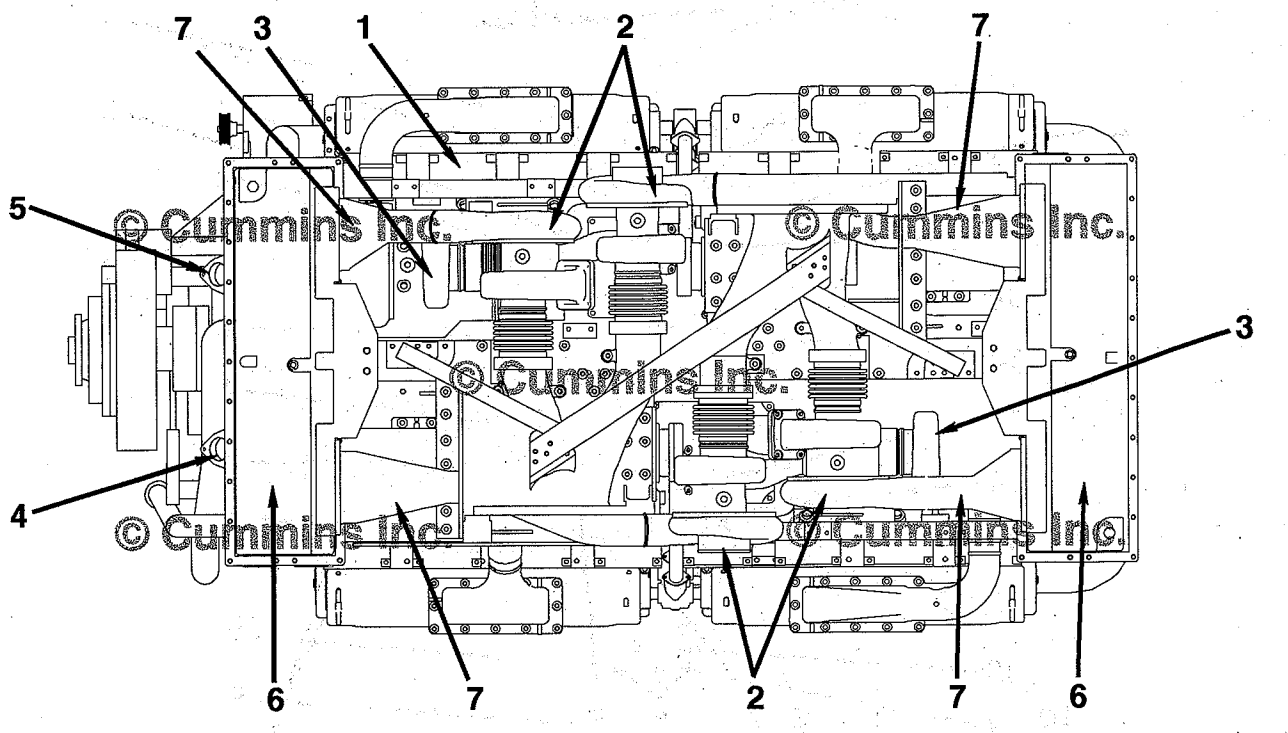


QSK60, Two-Stage - Left Side View with Mechanical Actuated Injectors

1. Low-Pressure turbochargers
2. Intercooler assemblies
3. High-Pressure turbochargers
4. Starters
5. Electronic control module
6. Fuel filters
7. Fuel filter head
8. Fuel pump
9. Air compressor
10. Compressor drive
11. Coolant filters
12. Thermostat housing
13. Exhaust outlet flange.

Engine Diagrams

Engine Views



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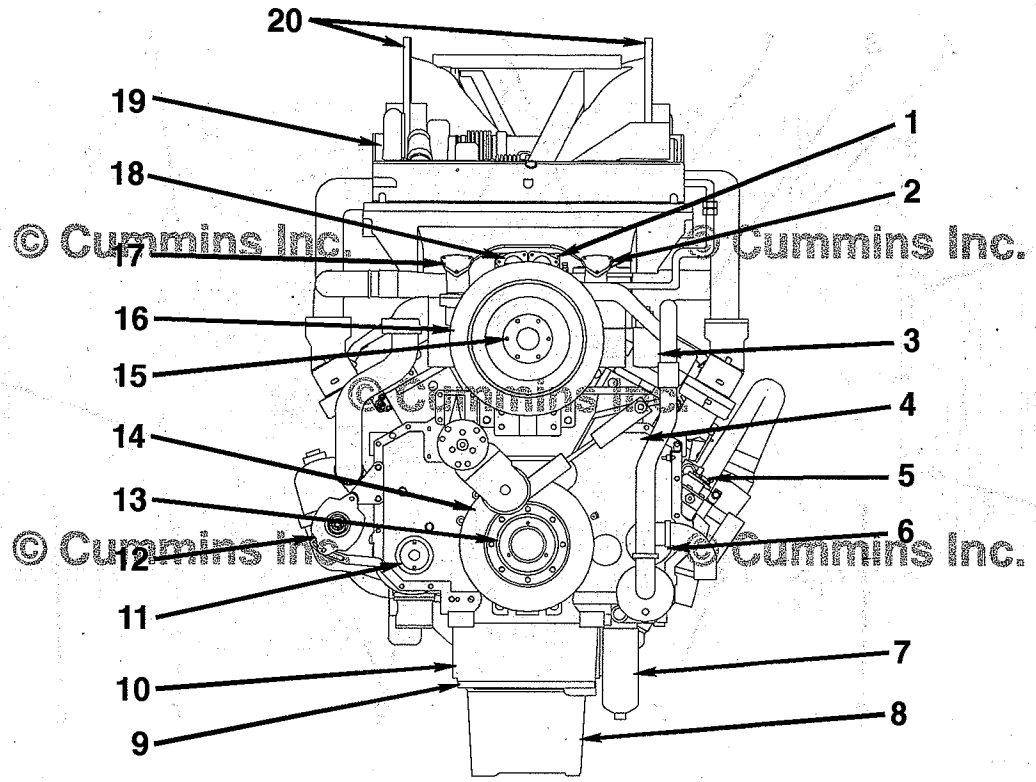
00600025

QSK60, Two-Stage - Top View with Mechanical Actuated Injectors

1. Rocker lever cover
2. Low-Pressure turbochargers
3. High-Pressure turbochargers
4. Left-Bank water outlet
5. Right-Bank water outlet
6. Intercoolers
7. Air crossovers into intercoolers.

Engine Diagrams

Engine Views



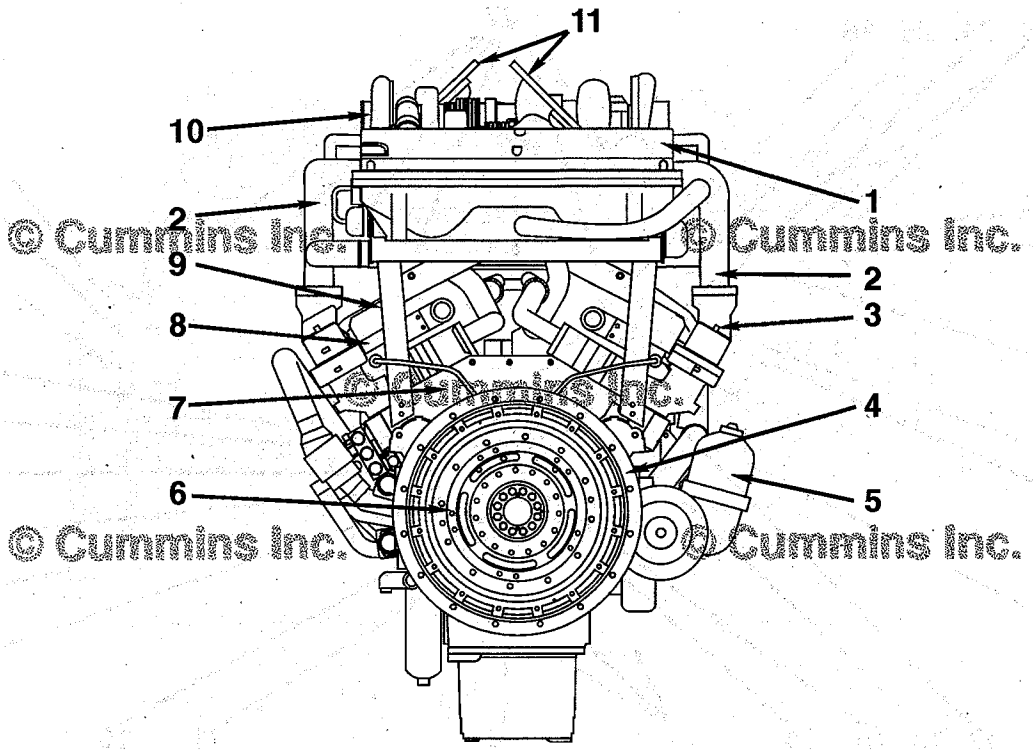
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QSK60, Two-Stage - Front View with Mechanical Actuated Injectors

1. LTA water inlet connection
2. Left-Bank water outlet connection
3. Coolant filters
4. Gear cover
5. Air compressor
6. Accessory drive pulley
7. Fuel filters
8. Oil pan sump
9. Oil pan adapter plate
10. Oil pan adapter
11. Alternator drive pulley
12. Alternator
13. Crankshaft pulley
14. Vibration damper
15. Fan hub
16. Fan hub pulley
17. Right-Bank coolant outlet connection
18. LTA water outlet connection
19. Turbocharger
20. Exhaust flange outlets.

Engine Diagrams

Engine Views



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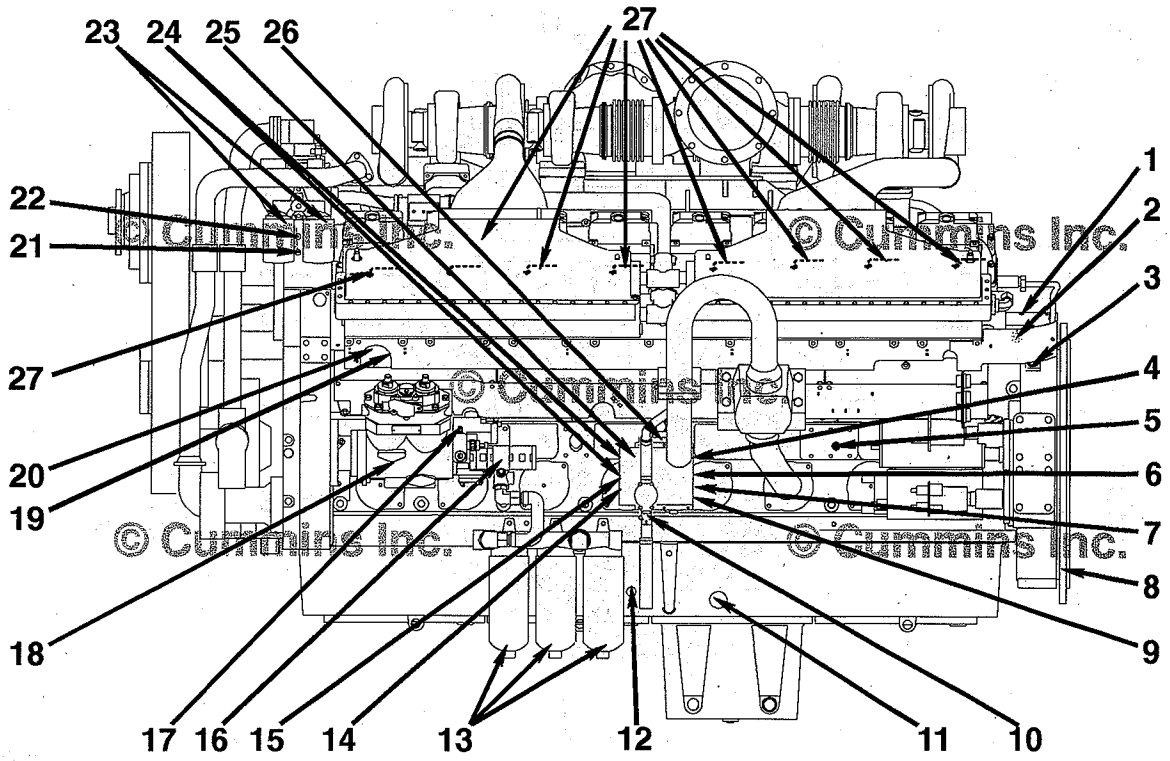
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QSK60, Two-Stage - Rear View with Mechanical Actuated Injectors

1. Intercooler assembly
2. Air crossover connection
3. Aftercooler assembly
4. Flywheel housing
5. Eliminator full-flow/bypass filtration system
6. Flex plate
7. Cylinder block
8. Rocker lever housing
9. Rocker lever cover
10. Turbocharger
11. Exhaust outlet flange.

Engine Diagrams

Engine Views



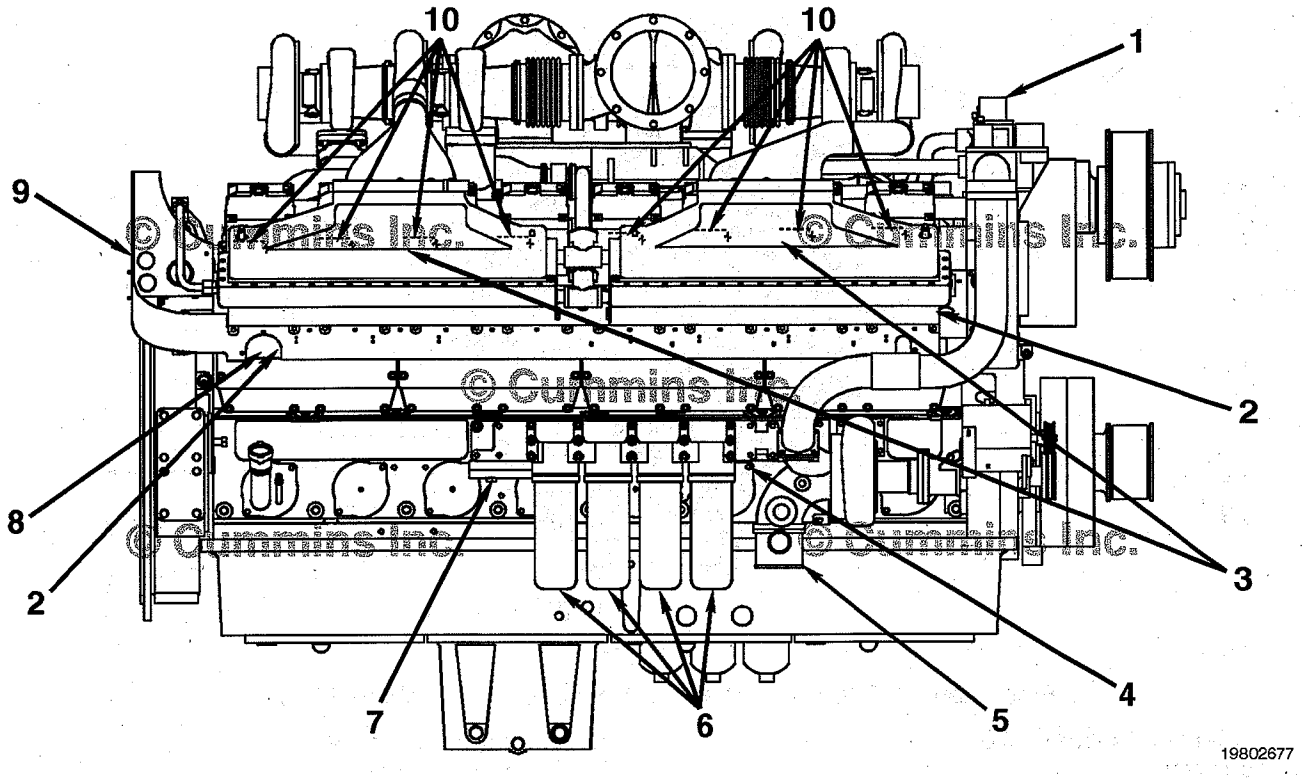
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QSK60 (QSK45 Similar) - Left Bank Sensor Locations (Quantum™ and CENSE™) with Mechanical Actuated Injectors

1. Compressor inlet temperature sensor (break out only - OEM installed)
2. Oil pressure sensor
3. Engine speed sensor
4. Timing pressure sensor
5. Service port
6. Ambient air pressure sensor
7. Fuel temperature sensor
8. Flywheel housing
9. Rail pressure sensor
10. Blowby sensor
11. Oil level sensor
12. Oil temperature sensor
13. Fuel filters
14. Rail actuator
15. Fuel shutoff valve
16. Fuel pump
17. Fuel pump quick-disconnect fitting
18. Air compressor
19. Intake manifold temperature sensor
20. Intake manifold pressure sensor
21. Coolant pressure sensor
22. Coolant temperature sensor
23. Coolant filters
24. Timing actuators
25. QUANTUM™ electronic control module (ECM)
26. Control valve body
27. Exhaust gas temperature sensor.

Engine Diagrams

Engine Views

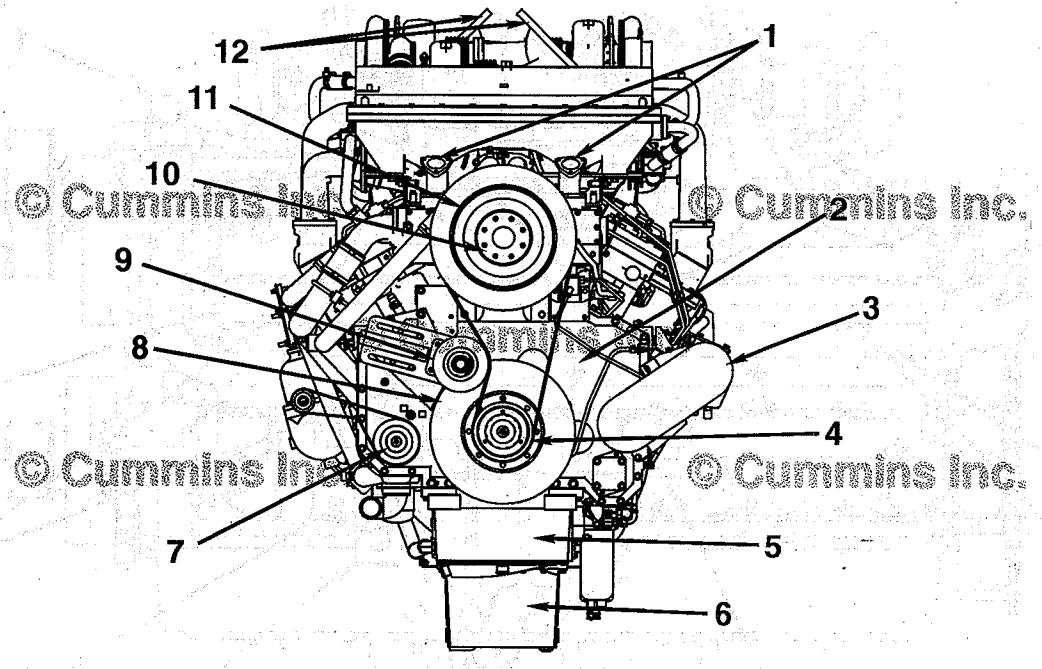


QSK60 (QSK45 Similar) - Right Bank Sensor Locations (Quantum™ and CENSE™) with Mechanical Actuated Injectors

1. Coolant outlet
2. Intake manifold temperature sensor
3. Aftercooler assembly
4. Prefilter oil pressure sensor
5. Coolant inlet
6. Oil filters
7. Post-filter pressure sensor
8. Intake manifold pressure sensor
9. CENSE™ electronic control module (ECM)
10. Exhaust gas temperature sensor.

Engine Diagrams

Engine Views



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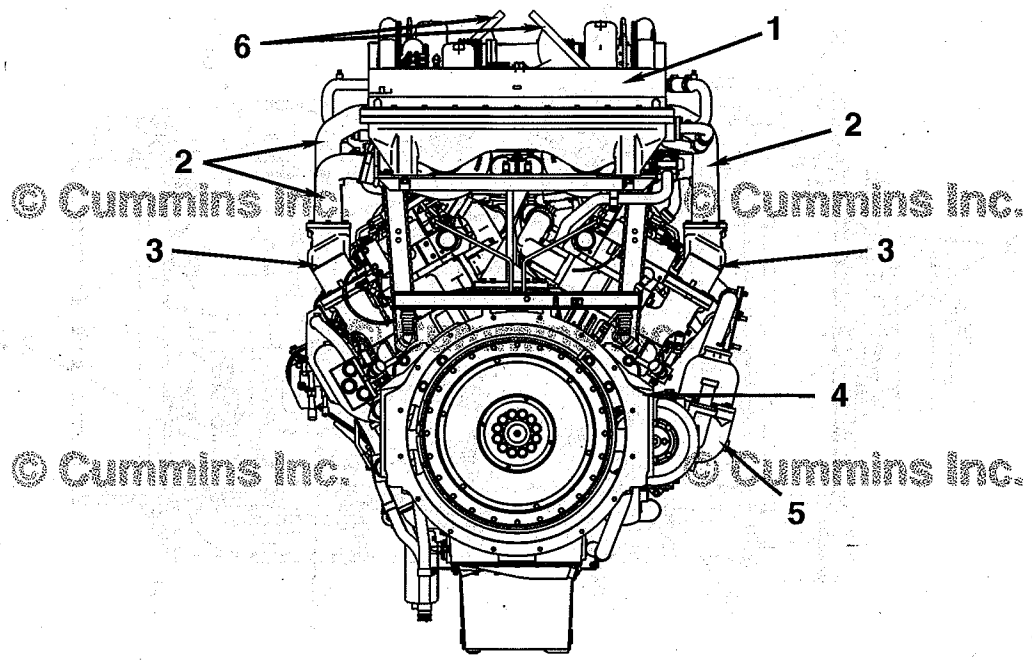
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Front View - QSK60, Two Stage with Electronically Actuated Injectors

1. Coolant outlet connection
2. Gear cover
3. Accessory drive cover
4. Crankshaft pulley
5. Oil pan adapter
6. Oil pan sump
7. Alternator drive pulley
8. Vibration damper
9. Fan belt tensioner
10. Fan hub
11. Fan hub pulley
12. Exhaust outlet flange.

Engine Diagrams

Engine Views



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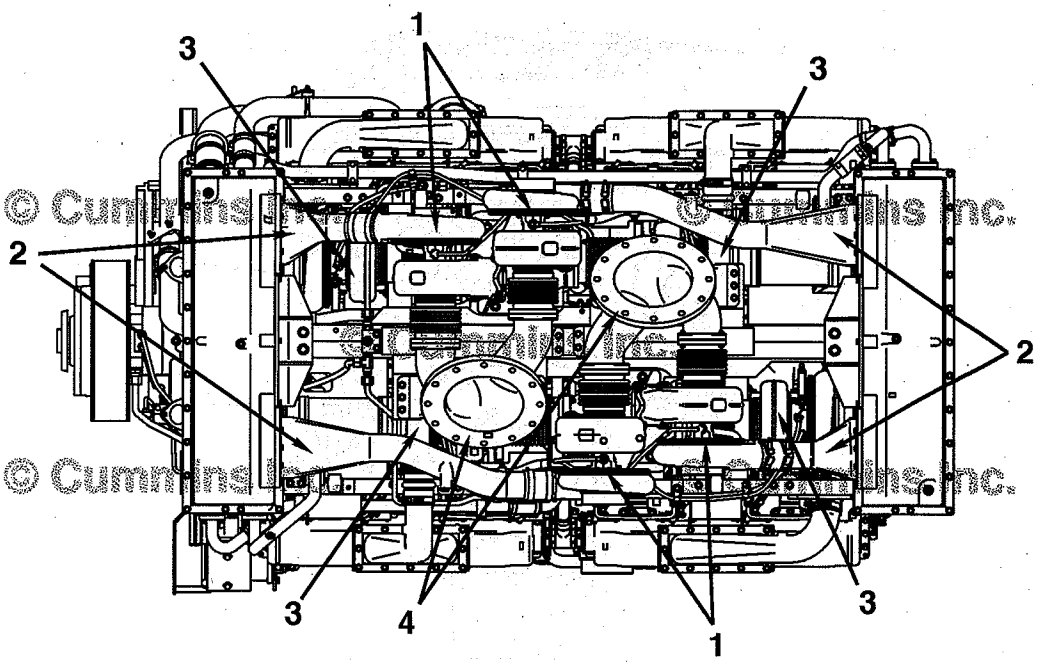
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Rear View - QSK60, Two Stage with Electronically Actuated Injectors

1. Rear intercooler assembly
2. Air crossover connections
3. Aftercooler assembly
4. Flywheel housing
5. Eliminator filtration system (optional)
6. Exhaust outlet flange.

Engine Diagrams

Engine Views



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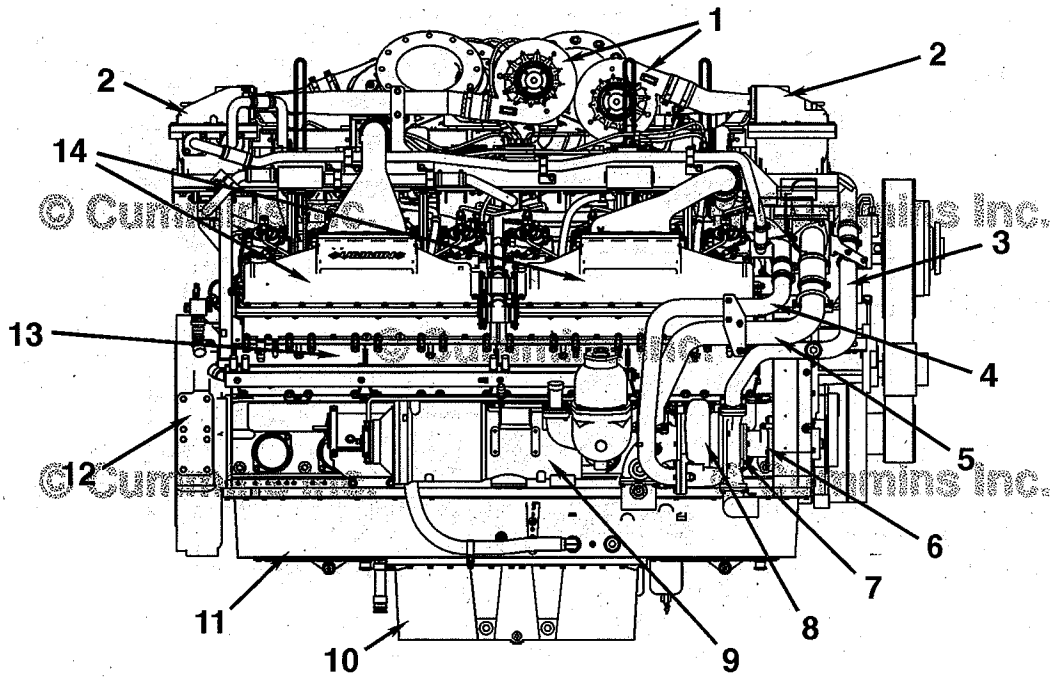
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Top View - QSK60, Two Stage with Electronically Actuated Injectors

1. Low pressure turbochargers (4)
2. Air crossover into intercooler
3. High pressure turbochargers (4)
4. Exhaust outlet flange.

Engine Diagrams

Engine Views

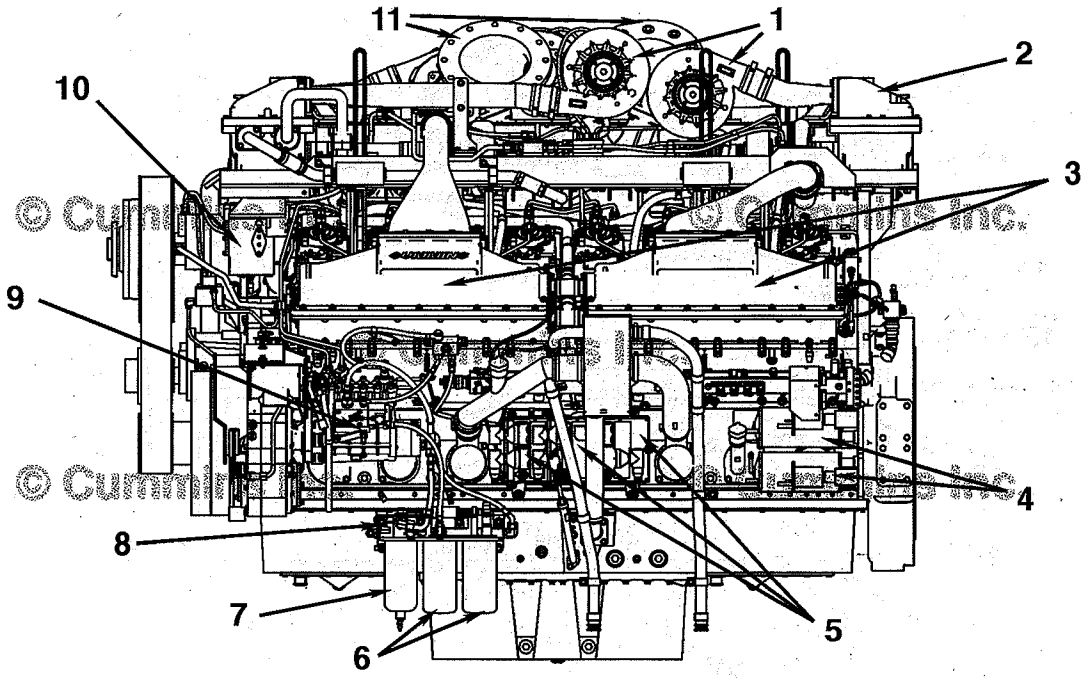


Right Side View - QSK60, Two Stage with Electronically Actuated Injectors

1. Low pressure turbochargers
2. Intercooler assemblies
3. Low temperature aftercooler bypass
4. Low temperature aftercooler outlet from water pump
5. Engine coolant bypass
6. Water pump drive
7. Low temperature aftercooler water pump
8. Jacket water pump
9. Eliminator filtration system (optional)
10. Oil pan sump
11. Oil pan adapter
12. Flywheel housing
13. Cam follower cover
14. Aftercooler assemblies.

Engine Diagrams

Engine Views

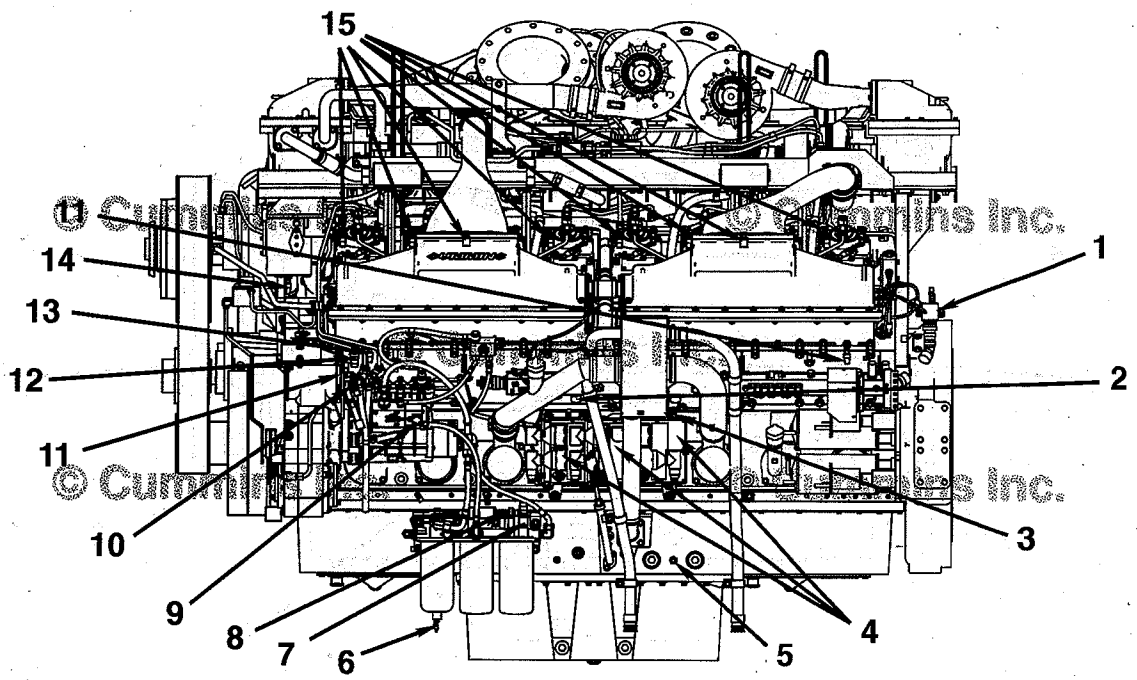


Left Side View - QSK60, Two Stage with Electronically Actuated Injectors

1. Low pressure turbochargers
2. Intercooler assemblies
3. Aftercooler assemblies
4. Starters
5. Electronic control modules (ECM's)
6. Stage 2 fuel filter
7. Stage 1 fuel filter
8. Fuel filter head
9. Fuel pump
10. Thermostat housing
11. Exhaust outlet flange.

Engine Diagrams

Engine Views

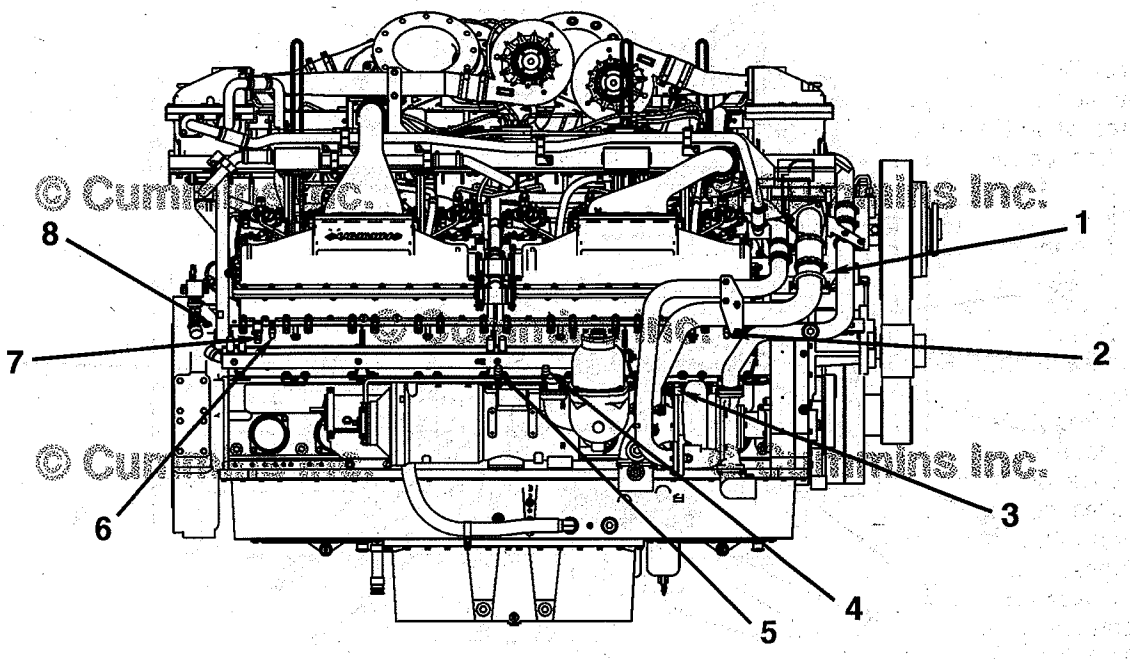


Left Bank Sensor Locations - QSK60, Two Stage with Electronically Actuated Injectors

1. Engine oil rifle pressure 1 sensor
2. Service port
3. Barometric pressure sensor
4. Electronic control modules (ECM's)
5. Engine oil temperature sensor 1
6. Water in fuel indicator sensor
7. Fuel delivery pressure sensor
8. Engine fuel temperature sensor 1
9. Fuel pump pressurizing assembly 1
10. Injector metering rail 1 pressure sensor
11. Engine camshaft speed/position sensor
12. Intake manifold 1 pressure sensor
13. Intake manifold 1 temperature sensor
14. Engine coolant temperature 1 sensor
15. Exhaust gas temperature sensor (eight on left bank).

Engine Diagrams

Engine Views



Right Side Sensor Locations - QSK60, Two Stage with Electronically Actuated Injectors

1. Crankcase pressure sensor
2. Intake manifold 2 temperature sensor
3. Coolant pressure sensor
4. Pre-oil filter pressure sensor
5. Post-oil filter pressure sensor
6. Intake manifold 4 temperature sensor
7. Intake manifold 2 pressure sensor
8. Engine crankshaft speed/position sensor.

* Exhaust gas temperature sensors (eight on right bank, **not** shown)

Section FB - Industrial Features

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Accelerator Options

Feature Description

This feature allows the user to determine the type of engine governor control. The two types available are the automotive (minimum or maximum) and Variable Speed or All Speed Governor types. The automotive governor provides a constant fueling for a given accelerator position. With the automotive governor selected the engine speed can vary with changes in engine loading for a constant accelerator position.

The Variable Speed governor provides a constant engine speed for a given accelerator position. With the Variable Speed governor selected the engine speed will remain constant with changes in engine loading for a constant accelerator position. The Variable Speed governor is an option. It is best suited for applications where a constant engine speed is desired to perform a desired task where engine or power take-off speed **must** remain constant.

Driver Activation/Deactivation

The selection of the governor type can be accomplished two ways. If the vehicle is equipped with a cab-mounted switch, the driver can activate this switch to select between the automotive or Variable Speed governor. If the cab switch is **not** available the INSITE™ service tool can be used to select the desired governor type.

Interaction with other Features and Parameters

This feature does **not** interact with any other feature or parameter.

Disadvantages

For applications that require a constant engine speed to perform a desired task, the automotive governor will **not** hold the engine or Power Take-Off speed constant for a given accelerator position.

Visual Aids

None

Idle Speed

Feature Description

The idle speed feature can reduce the amount of fuel burned or decrease cab noise and vibration. The low idle speed can be set to achieve the desired idle speed. The driver can override the preset value by using an OEM supplied idle speed adjustment switch.

Driver Activation/Deactivation

The driver can adjust the idle speed if an OEM supplied idle adjustment switch is available in the cab.

Interaction with other Features and Parameters

There is no interaction between other features and parameters.

Disadvantages

Incorrect adjustment of the low idle speed can cause excessive vehicle vibration or slightly decreased fuel economy.

Visual Aids

None

Intermediate Speed Control (ISC)

Feature Description

Industrial applications use an engine speed control feature called Intermediate Speed Control.

Up to three Intermediate Speed Control Set Speeds (1, 2, or 3) can be selected depending on Original Equipment Manufacturer (OEM) availability. To support this feature, a multi-position switch, or three toggle switches **must** be installed by the OEM.

Additionally, up to five Variable Intermediate Speed Control Set speeds (1, 2, 3, 4, or 5) can be selected and the operator can select these speeds using an OEM installed accelerator lever.

The Intermediate Speed Control set speeds will interact with the accelerator pedal in one of three different ways (modes A, B and C); the interaction between Intermediate Speed Control set speeds and the accelerator pedal is **not** adjustable, this interaction is determined by the OEM and built into the ECM calibration.

Mode A - Intermediate Speed Control set speed acts as low speed governor. In this mode, the Intermediate Speed Control set speed becomes the Minimum Engine Speed. The operator can use the accelerator pedal to increase the speed above the Intermediate Speed Control set speed.
Mode B - Intermediate Speed Control set speed acts as high speed governor. In this mode, the Intermediate Speed Control set speed becomes the Maximum Engine Speed. The operator can use the accelerator pedal to control engine speed up to the Intermediate Speed Control set speed.
Mode C - Intermediate Speed Control Constant Speed. In this mode, the Intermediate Speed Control runs at constant speed and accelerator pedal input is ignored.

The three Preset Intermediate Speed Control speeds can be adjusted with an increment or decrement switch and are INSITE™ service tool adjustable, but can **not** exceed the low or high idle governor engine speed limits.

The five Intermediate Speed Control Variable Speed Control set speeds are **not** adjustable with the increment or decrement switch, but are adjustable with the INSITE™ service tool.

Only one droop setting is available for all Intermediate Speed Control speeds.

One of the switch inputs can be used as a validation input (if used, the ECM pin for Intermediate Speed Control 3 will be used). If this is the case, the ECM calibration will use the ECM pin used for Intermediate Speed Control 3 as a validation input and **only** 2 Intermediate Speed Control speeds will be available while the five variable Intermediate Speed Control inputs will **not** be available.

If more than one Intermediate Speed Control switches is turned ON; the lowest speed turned ON will take priority.

Driver Activation/Deactivation

Using the Intermediate Speed Control Switched Set Speeds

The operator can operate the engine using the Intermediate Speed Control Set Speeds with OEM installed Intermediate Speed Control Switches, or an equivalent OEM installed device. Activating Intermediate Speed Control can or can **not** cause Accelerator Pedal inputs to be ignored.

Using the Intermediate Speed Control Variable Speed Set Points

The operator can operate the engine using the Intermediate Speed Control Variable Speeds; Intermediate Speed Control Variable Speeds are selected with an Accelerator Lever or an equivalent switching device that is installed by the OEM. This device can contain a potentiometer that sends a variable signal to the ECM. Based on the output of the potentiometer, the engine will be controlled to one of five Intermediate Speed Control Variable Speeds. Refer to the figure below for visual reference. It is recommended that all five speeds be chosen and entered in a sequential order so that as the operator increases the position of the hand throttle, the engine speed will change accordingly.

Interaction with other Features and Parameters

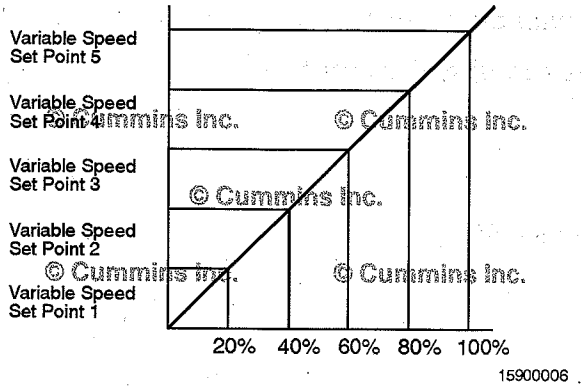
Intermediate Speed Control and Cruise Control can **not** be active at the same time. If the cruise control on/off switch is on, then Intermediate Speed Control is disabled. If the cruise on/off switch is off then Intermediate Speed Control will remain off until an Intermediate Speed Control switch transitions from off to on.

Remote Throttle and Variable Speed Intermediate Speed Control **must not** both be used on the same engine.

Disadvantages

Using the service tool, it is **not** possible to display the interaction between Intermediate Speed Control and the throttle pedal.

Visual Aids



Alternate Droop

Feature Description

Alternate Droop allows the droop characteristics to be changed for the automotive (minimum or maximum) and for Variable Speed (VS) governor or All Speed Governor. In general less governor droop (lower percentage) provides a more responsive governor for more precise engine control. More governor droop (higher percentage) provides smoother shifting and smoother mechanical clutch engagement. This feature, depending on Original Equipment Manufacturer (OEM) availability, provides the user the ability to select multiple breakpoint speeds and the droops associated with those speeds by way of an OEM-provided switch.

Driver Activation/Deactivation

Alternate Droop is calibration activated (except for CELECT™ Plus), but uses a switch to toggle between the alternate droop settings. Depending on the application the alternate droop switch can be a 2 or 3 position switch. Toggling the switch into the 2nd and 3rd positions will activate the 2nd and 3rd droop settings accordingly.

Interaction with other Features and Parameters

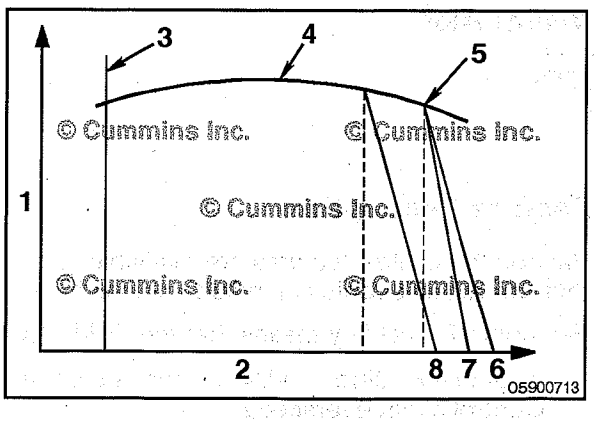
The Vehicle Speed Droop feature uses the droop settings for this feature.

Disadvantages

- Driver complains of low power.
- Driver complains of poor or unexpected throttle reaction.

Visual Aids

1. Torque
2. Engine Speed (RPM)
3. Low Idle Speed
4. Maximum Torque Curve
5. High speed Break Point
6. Normal Droop
7. Alternate Droop
8. Alternate Droop (available)



Switchable (Alternate) Torque

Feature Description

Switchable (Alternate) Torque provides derated torque curves other than the 100 percent torque curve. These torque curves are normally used to help limit the torque output of the engine and helps to protect driveline components such as axles and transmissions and in some cases can help protect the engine from damage.

Driver Activation/Deactivation

The operator can activate or deactivate the alternate torque curves through an OEM supplied switch.

Interaction with other Features and Parameters

None

Disadvantages

Possible operator complaints of low power

Visual Aids

None

Auxiliary Governor

Feature Description

The auxiliary governor is an application-specific feature that allows the engine to be governed by either an auxiliary speed or pressure signal. This feature uses a manual switch input to turn the governor operation on or off.

The auxiliary governor uses a throttle input that is scaled to the auxiliary speed governor minimum rpm (0 percent throttle) and the auxiliary speed governor maximum rpm (100 percent throttle). The auxiliary speed governor reference speed/auxiliary speed governor reference pressure, determined by the throttle position, is the desired auxiliary speed/pressure. The auxiliary governor algorithm will then control engine speed to match the actual auxiliary speed/pressure from the auxiliary device to the auxiliary speed governor reference speed/pressure.

INSITE™ can be used to monitor the auxiliary governor switch position, the auxiliary governor type (speed or pressure), and the auxiliary governor reference speed or the auxiliary governor reference pressure.

Driver Activation/Deactivation

When the auxiliary governor is enabled and the auxiliary governor switch is moved to the ON position, the fueling of the engine will be based upon the governed speed of the output shaft, **not** of the engine speed.

Interaction with other Features and Parameters

None

Disadvantages

None

Visual Aids

None

Fan Control

Feature Description

Various fan control features are available and while **not** all aspects of fan control are available on all engines, most (but **not** all) electronic controlled engines have some Electronic Control Module (ECM) fan control capability.

Fan control capability means that the ECM is able to turn the fan on or off in response to any of the following inputs:

- Engine operating conditions (coolant temperature, intake manifold temperature, etc.)
- Control of fan overspeed
- Air conditioner operation
- Manual fan switch
- Engine performance requirements (Example: engine braking)

NOTE: Many Industrial engines have fan controls as part of the ECM calibration that can **not** be adjusted using the service tool.

Driver Activation/Deactivation

The driver can override the ECM to turn the fan on, using the manual fan switch installed in the cab by the vehicle manufacturer. When the driver places the manual fan switch in the ON position, the fan will be on regardless of other engine operating conditions. When the manual fan switch is in the OFF position, the fan will operate according to engine operating conditions and according to how the fan control parameters are configured.

Interaction with other Features and Parameters

ISB and ISC have a single pin on the ECM that provides Pulse Width Modulation. This pin can be used to send a kick-down signal to an automatic transmission, in which case it **must not** be used to operate a variable speed fan.

Disadvantages

Due to heat rejection, the fan on during engine braking feature will appear inconsistent to some vehicle operators (Example: Consider an ISX calibration setting that the fan will engage 15 seconds after engine braking starts. It will be possible for the fan to sometimes come on sooner in response to air intake temperatures, coolant temperatures, or the air conditioner pressure switch).

Visual Aids

1. Fan Type
2. Drive Ratio
3. Maximum Fan Speed
4. Air Conditioner Speed Control
5. Fan On During Engine Braking
6. Minimum Fan On Time for Air Conditioner Pressure Switch
7. Manual Fan Switch
8. Air Conditioner Pressure Switch
9. Pulse Width Modulation Frequency
10. Clutch Logic
11. Fan Clutch 2 Enable

Idle Shutdown

Feature Description

The idle shutdown feature reduces the amount of fuel burned and increases engine life by shutting down the engine after a period of engine idling with no driver activity. Before the shutdown will occur a flashing warning lamp will warn the driver of an impending shutdown. The driver can override the shutdown by depressing the service brake, clutch or accelerator pedal during the warning period. This activity will override the idle shutdown. Idle shutdown operates when the engine is in the Power TakeOff (PTO) mode unless a specific load threshold is exceeded. Idle shutdown can be automatically overridden during cold ambient temperatures if equipped with an OEM supplied ambient air temperature sensor.

The following table indicates when manual and automatic overrides are available.

Driver Activation/Deactivation

The driver can **not** activate or deactivate the idle shutdown feature. This feature can **only** be activated or deactivated by the Cummins INSITE™ service tool.

To override the automatic idle shutdown the driver will need to activate the brake, clutch or accelerator pedal during the 30 second period prior to shutdown. 30 seconds prior to the shutdown a flashing warning lamp will notify the driver that engine shutdown is pending. This action will override idle shutdown. If the override is successful the warning lamp will flash every one half second for two minutes.

Interaction with other Features and Parameters

Idle shutdown can interact with the PTO feature. Idle shutdown can cause the engine to shutdown when in PTO mode. If the idle shutdown percent load threshold is **not** exceeded the engine will be shutdown.

It is required that this feature be enabled with the ICON™ product and the ambient air temperature override **must** be disabled.

Disadvantages

The idle shutdown feature will **not** activate if Fault Code 241 is active.

When stopped in traffic for extended periods the engine will be shutdown.

Visual Aids

The chart below indicates when manual and automatic overrides are available.

	Manual Override	Automatic Override
Below Cold Air Temperature	No	Yew
Between Cold Air and Intermediate Air Temperature	Yes	No
Between Intermediate Air and Hot Air Temperature	No	Yes
Above Hot Air Temperature	Yes	No

Water-in-Fuel Sensor

Feature Description

The water-in-fuel sensor protects the fuel system by alerting the vehicle operator that water has accumulated in the fuel filter and this water **must**be drained. The operator will be warned of a high water condition by a flashing warning lamp on the dash.

The fuel filter removes emulsified and free water from the fuel as it passes through the filter media. The removed water is heavier than fuel and falls to the bottom of the filter canister where it accumulates. The water-in-fuel sensor is installed in the base of the fuel filter canister. The sensor consists of two metallic probes that sense the electrical conductivity of the surrounding solution. A change in conductivity can be detected when sufficient water accumulates around the probes and displaces the diesel fuel. When this happens the ECM lights the warning light on the dash and Fault Code 418, Water-In-Fuel Indicator High - Maintenance is logged.

Driver Activation/Deactivation

The driver can **not**activate or deactivate the water-in-fuel sensor feature. This feature can **only**be activated or deactivated by the Cummins INSITE™ service tool.

Interaction with other Features and Parameters

This feature does **not**interact with any other feature or parameter.

Disadvantages

None

Visual Aids

None

Automatic Boost Power

Feature Description

Boost Power is a torque curve that is calibrated for a higher torque/horsepower than the normal engine rating and is available on QSB, QSC, CELECT™ Plus, QSM11, QSX15, QSK19, QSK45, and QSK60 industrial engines. The Electronic Control Module (ECM) will monitor engine speed, intake manifold temperature, and coolant temperature to determine if Boost Power can be activated. If Boost Power is available, the operator can activate Boost Power using a dash-mounted switch. The engine will switch to the higher torque curve or power rating for a limited period of time. The higher torque curve or power rating is calibrated for an intermittent or non-continuous torque or power rating which is higher than the normal torque or power rating for the engine. Boost power is **not** available if coolant temperature or intake manifold temperatures are above calibrated thresholds. If engine speed is below a calibrated threshold, then Boost Power will **not** be time limited.

Automatic Boost Power will provide the operator with enhanced torque or power for a fraction of the operating period. The ECM will monitor engine speed, intake manifold temperature, percent load, and coolant temperature to determine if automatic Boost Power can be activated. If automatic Boost Power is available, the engine will switch to the enhanced torque or power rating for a limited period of time. The Original Equipment Manufacturer (OEM) equipment users manual will document the time periods that automatic Boost Power is available, since it is application specific. Automatic Boost Power is **not** available if coolant temperature or intake manifold temperatures are above calibrated thresholds. If engine speed or percent load is below a calibrated threshold, automatic Boost Power will **not** be

available. If coolant temperature or intake manifold temperature rise above calibrated threshold, then automatic Boost Power will be deactivated. Automatic Boost Power is available on QSB, QSC, QSM11, and QSX15 industrial engines.

Driver Activation/Deactivation

To activate Boost Power, the operator **must** turn on a dash-mounted switch. To deactivate Boost Power, the operator **must** turn the switch off. Boost power will engage if the engine operating conditions are There is no operator interaction to activate or deactivate automatic Boost Power.

Interaction with other Features and Parameters

Boost power **must** be enabled in order to enable automatic Boost Power.

Disadvantages

A possible customer complaint associated with this feature will be intermittent low power.

Boost Power **must not** engage due to the Boost Power load threshold is set above the highest load experienced during normal engine operation

Visual Aids

None

Hot Shutdown Monitor

Feature Description

The Hot Shutdown Monitor will log a fault in the Electronic Control Module (ECM) if the engine is shut down, either by the key switch or by the engine protection feature or other Original Equipment Manufacturer (OEM) devices, while still hot. The engine is considered hot if the load on the engine is above the hot shutdown minimum load set by Cummins INSITE™ electronic service tool. Hot shutdown monitor is available on QSB, QSC, QSL9, QSM11, QSX15, QST30, QSK19, QSK45, QSK50, QSK38, QSK78, and QSK60 industrial engines.

The hot shutdown load percent is based on the duty cycle load factor that is determined from engine fueling levels. For example: If the hot shutdown load percent is set at 60 percent, every time the engine is shut down when the calculated engine load is over 60 percent, a hot shutdown fault will be logged.

Driver Activation/Deactivation

There is no operator activation or deactivation for hot shutdown monitor.

Interaction with other Features and Parameters

None

Disadvantages

None

Visual Aids

None

Dual Outputs Based on Sensed Parameters

Feature Description

Dual outputs based on sensed parameters provide up to two independent switched outputs for Original Equipment Manufacturer (OEM) use. The state of each switched output can be determined by up to 13 different inputs to the Electronic Control Module (ECM) depending on the engine. The ECM can provide different outputs to OEM devices if any of the inputs are above or below calibrated thresholds. Each switched output is independent of the other with respect to control parameter input and threshold settings. Cummins INSITE™ electronic service tool can enable or disable this feature, but can **not** adjust the thresholds, since they are typically specific to the OEM equipment.

The ECM can determine the state of the switched outputs based on the following possible inputs (either one or both switched outputs can use the same inputs).

Engine Speed (rpm)
Commanded Fueling Mg^3 per stroke [mm^3 per stroke]
Boost Pressure (inHg)
Auxiliary Speed Input (rpm)
Oil Pressure (psi)
Coolant Temperature (degrees F)
Commanded Throttle (percent)
Intermediate Speed Control 2 Status (off or active)
OEM Temperature (degrees F)
OEM Pressure (psi)
OEM Supplied Pressure (volts)
OEM Supplied Switch (open or ground)
Battery Voltage

Each of these inputs can have a specified threshold and threshold type (over or under). Each of the switched outputs can be calibrated to either ON or OFF after a threshold is passed. Also, each output can be calibrated to change states if any one or all thresholds are passed. Dual outputs based on sensed parameters is available on QSB, QSC and QSL9, ISB, ISC, QSM11, QSX15, QST30, QSK19, QSK38, QSK45, QSK50, QSK60, and QSK78 engines

Driver Activation/Deactivation

There is no operator activation or deactivation for Dual Outputs Based on Sensed Parameters.

Interaction with other Features and Parameters

None

Disadvantages

None

Visual Aids

None

Duty Cycle Monitor

Feature Description

The Duty Cycle Monitor tracks the time the engine speeds in 50 different operating regions. These operating regions are based on engine speed and engine torque. This feature provides two short term 500 hour resettable data blocks and one long term 100,000 hour non-resettable data block.

This feature can be enabled or disabled and the two short term data blocks can be reset by INSITE™.

The long term data block can **only** be reset by recalibration.

When both short term blocks are filled, the duty cycle monitor data will continue to be calculated, but this data will **not** be stored in the short term data blocks. A 100,000 hour map will be used to store long term data. The long term data can **not** be cleared by an electronic service tool. Both long term and short term data will be saved on powerdown, but cleared on a recalibration.

Driver Activation/Deactivation

None

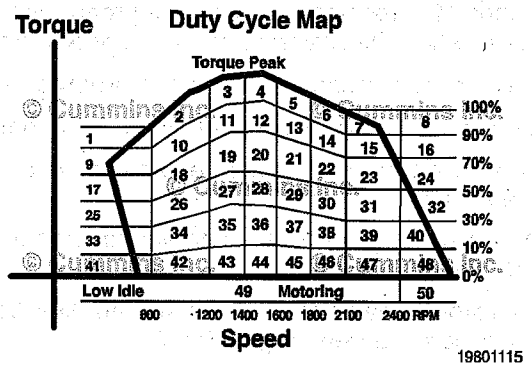
Interaction with other Features and Parameters

None

Disadvantages

None

Visual Aids



Centinel™

Feature Description

This describes the integrated Centinel™ system that is controlled by the Engine Control Module (ECM). There is also an aftermarket Centinel™ system available through PowerCare that can be used as a stand-alone system.

The integrated Centinel™ system is an electronically controlled oil replenishment system that allows extended oil drain intervals. Centinel™ can **only** be used on vehicles equipped with Centinel™ components, which consist of a burn valve, plumbing, and wiring connections to the ECM. Centinel™ can also be used with or without an external make-up oil tank with a low oil level sensor.

For proper engine oil and oil filter change intervals, consult the Operation and Maintenance manual for the engine and the Centinel™ Master Repair Manual. For proper lubricating oil and oil filter recommendations and required oil sampling rates for use with Centinel™, consult the Centinel™ Master Repair Manual.

The Centinel™ system extends engine oil and engine oil filter change intervals through continuous oil exchange. This is accomplished by injecting oil at a rate proportional to the fuel consumed into the fuel system for consumption. The grade of oil being used is also used to determine the rate of oil injected based on fuel burned. Make up oil is introduced into the engine at a rate equal to the amount injected for consumption. This oil addition occurs in one of two ways.

The first version is a burn with make-up system. In this case, there is an on-board fresh oil tank. Oil is delivered from this tank by the Centinel™ oil control valve to the engine sump during each cycle of the valve. The Centinel™ system monitors the oil level in the make up tank with a low oil level sensor.

The second version is a burn-**only** system. In this case, make-up oil is added manually to the engine oil sump during the daily preventative maintenance process. This burn-**only** system is **only** for those operators who have routine, daily maintenance practices in place.

The valve that controls the amount of oil injected in the fuel system is an electromechanical piston valve. It exchanges used engine oil with fresh engine oil if a make-up tank is used. The valve uses engine oil rifle pressure to drive piston displacement. The ECM monitors oil rifle pressure and prevents operation of the oil control valve until oil pressure increases enough to drive the valve. The ECM will **not** allow the valve to operate until a predetermined time period has elapsed (QSK45 and 60 engines) or until the engine reaches its operating temperature of 52°C [125°F] (Signature 600, ISX, and ISM engines).

During operation, Centinel™ tracks the number of times the burn valve will have injected used engine oil into the fuel system and counts the number of times when the valve did **not**, such as when the oil pressure is **not** high enough, the time or temperature requirements have **not** been met, or if there is a low oil level in the make-up tank. Centinel™ will then make-up for these missed burn pulses. This count can be reset with the INSITE™ service tool if desired, such as at an oil change.

Centinel™ does **not** extend the service interval for other maintenance items. Consult your Operation and Maintenance manual for proper maintenance intervals. Centinel™ does **not** compensate for engine oil leakage or engine oil consumption.

The Centinel™ feature is enabled using the INSITE™ service tool and also requires that a new calibration be loaded in the ECM. On QSK45 and 60 engines, the make-up tank option can also be enabled.

Driver Activation/Deactivation

Centinel™ operates automatically. There is no operator interaction to activate or deactivate the Centinel™ system.

Interaction with other Features and Parameters

The Centinel™ System and Maintenance Monitor use a different approach for the same purpose, and are mutually exclusive. Centinel™ will **not** be enabled when the Maintenance Monitor feature is enabled.

On QSK45 and 60 engines, the oil level monitor **must** be enabled in order to enable the Centinel™ feature.

For Signature, ISX, and ISM engines with Centinel™, Spicer Automate-2 transmissions can **not** be used.

The maintenance lamp will be illuminated if Centinel™ faults become active or if the oil level in the make-up tank is low. RoadRelay™ will also display these faults.

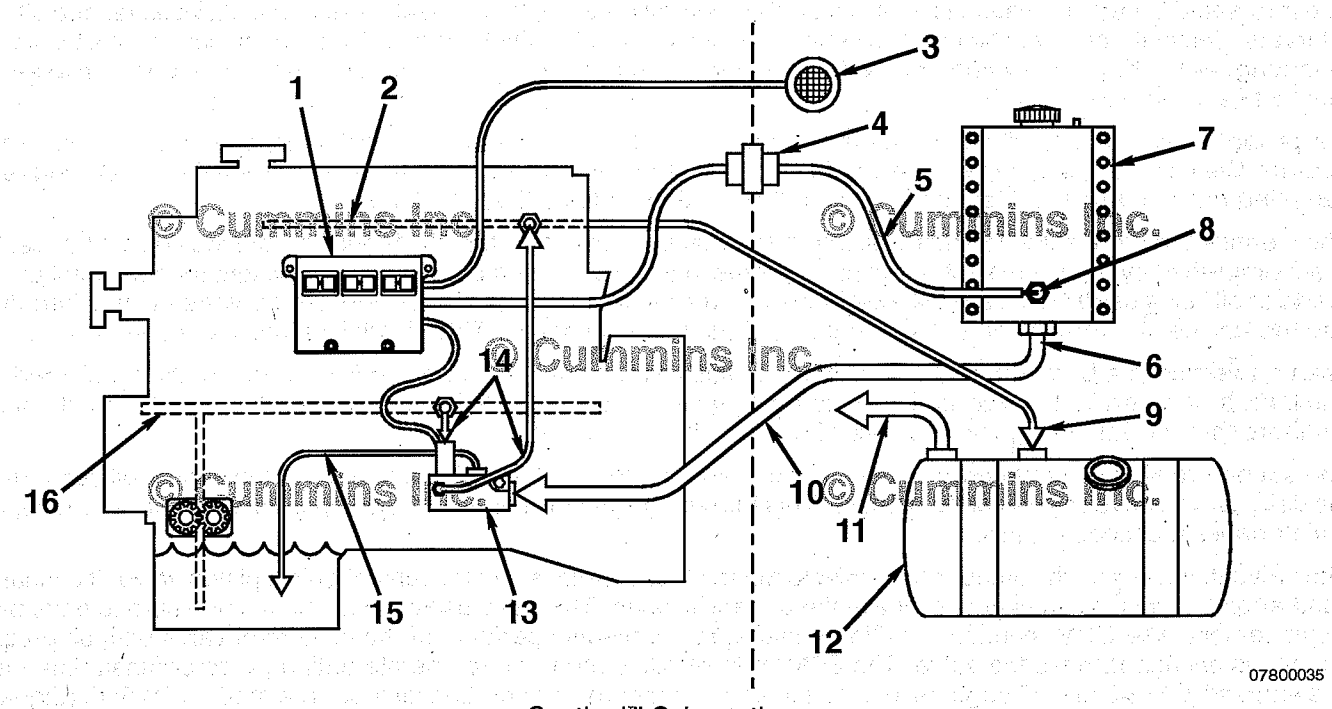
NOTE: For component installation instructions, oil drain interval recommendations, and required oil sampling intervals, consult the Centinel™ Master Repair Manual.

Vehicles or equipment domiciled in California can **not** use any system (like Centinel™) that blends used engine oil with diesel fuel (check California Air Research Bureau regulations).

Disadvantages

Maintenance lamp illuminated
Oil consumption excessive
Make-up oil level high or no add oil required when Centinel™ is installed
Oil level measured on dipstick fluctuates

Visual Aids



Centinel™ Schematic

Multiple Unit Synchronization

Feature Description

The multi unit synchronization feature allows two or more engines (up to a maximum of 11) to be controlled by a single throttle signal and run at a similar speed (See visual aids section). There is three engine configurations available with this feature: soft-coupled, hard-coupled, and soft-coupled marine.

The soft-coupled configuration has all secondary engines in parallel with each other. The primary engine outputs a throttle signal to all secondary engines. This setup allows all engines to remain running if a secondary engine stops running.

The hard-coupled configuration has the primary and all secondary engines in series with each other (See visual aids section). The primary engine outputs a throttle signal, which is received by the first secondary engine. This secondary engine then outputs the throttle signal to the next secondary engine in the series. This process repeats until the primary engine receives the throttle signal.

The soft-coupled marine configuration has all secondary engines in parallel with each other (See visual aids section) The primary engine outputs a throttle signal on the J1939 datalink to all secondary engines.

Driver Activation/Deactivation

This feature can **not** be activated or deactivated by the driver except in the case of the soft-coupled marine configuration. In this case, Multi Unit Synchronization is turned on or off by a user activated switch.

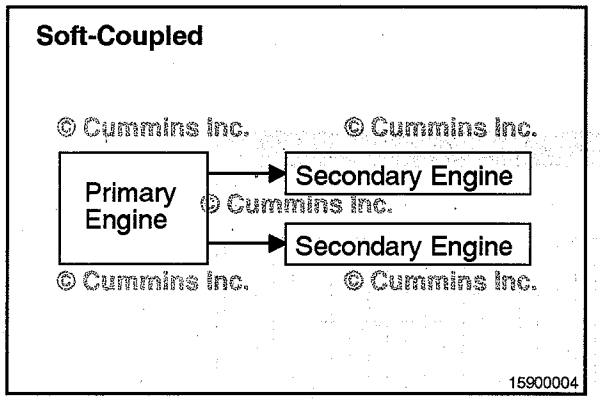
Interaction with other Features and Parameters

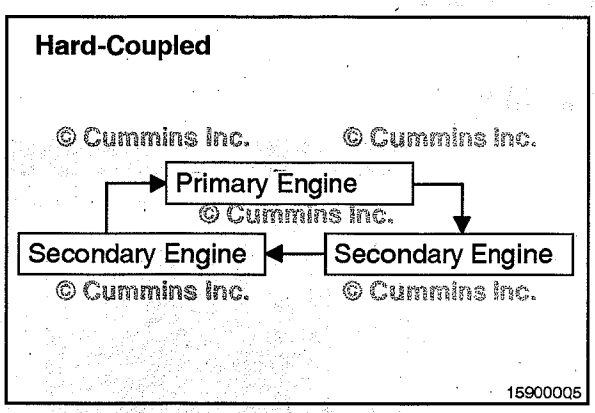
None

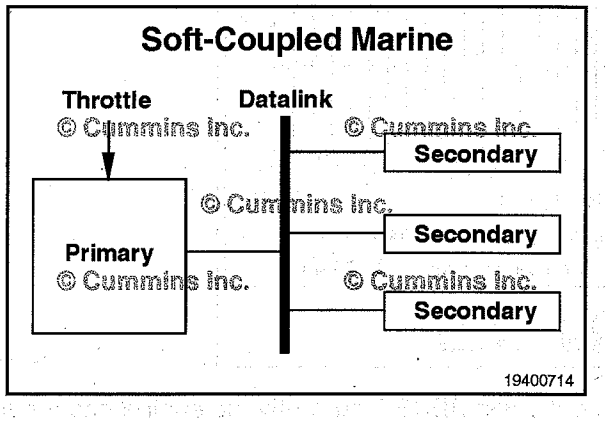
Disadvantages

In the hard-coupled configuration, if one engine in the series stops running, then the remaining engines in the circuit will also stop running.

Visual Aids







Fuel Consumption Rate Logger

Feature Description

Fuel Consumption Rate Logger is an industrial feature that monitors fuel usage over the life of the engine. The feature also maintains a bar graph (short term fuel consumption) that displays fuel consumption over the last 40 hours of engine operation. Fuel consumption is measured in Gallons Per Hour (gph).

The feature allows the following to be viewed under the Fuel Consumption Monitor heading with Cummins INSITE™:

Long Term Rate - Cumulative Fuel Economy (Gallons/Hour). The cumulative fuel economy is the fuel economy averaged over the life of the engine.
Long Term Time - Engine Hours Included in the calculation of the Long Term Rate
Instantaneous Rate - The instantaneous fuel economy (Gallons/Hour)
Short Term Rate - A graphical representation of fuel economy (Gallons/Hour) versus time (Hours). The graphical representation will span up to 40 hours of engine operation and display average fuel economy for each of the last 40 hours of engine operation.

Short Term Hour - Identifies which hour is being monitored in the current 40 hour period represented by the short term rate graphical display.
Hour Counter - Shows the minutes elapsed in the current hour being monitored.

If fuel consumption rate monitor is enabled, Cummins INSITE™ will display a bar graph representing fuel consumption for the last 40 hours of engine operation. The graphical display is a bar graph with engine hours on the horizontal axis and fuel consumption on the vertical axis. A maximum of 40 bars representing 40 hours of engine operation will be displayed; each bar represents fuel consumption averaged over one hour of engine operation. The graph will size itself to fit on the screen for easy viewing.

Driver Activation/Deactivation

None

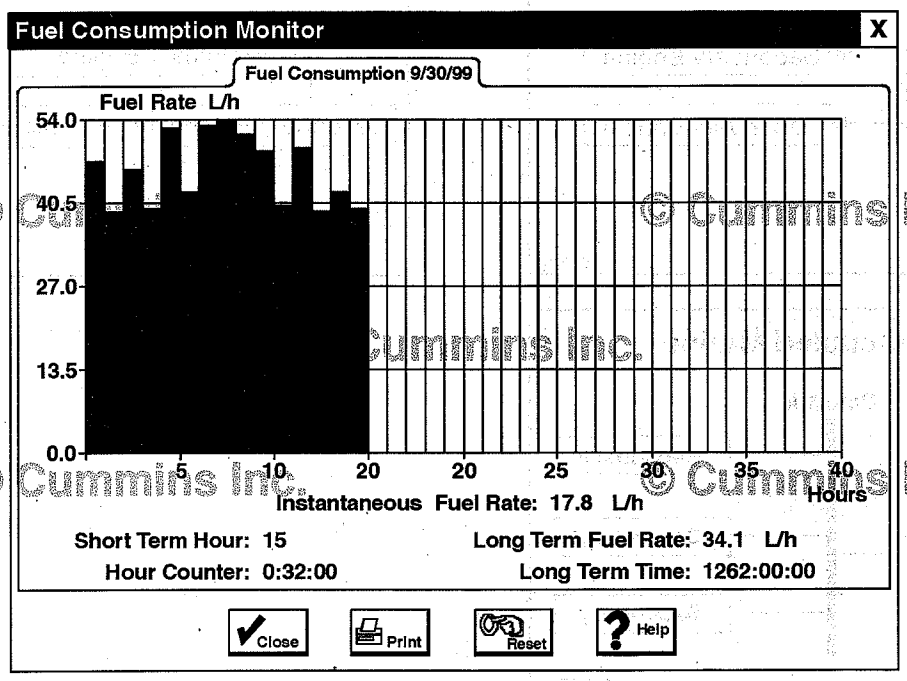
Interaction with other Features and Parameters

None

Disadvantages

None

Visual Aids



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05400134

The Short Term Rate Logger has logged 15 hours of data since the last RESET, currently the engine has run for 32 minutes into the 16th hour of engine operation. The engine has averaged 34.1 L [1 hour] over its life.

Section 1 - Operating Instructions

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Operating Instructions - Overview

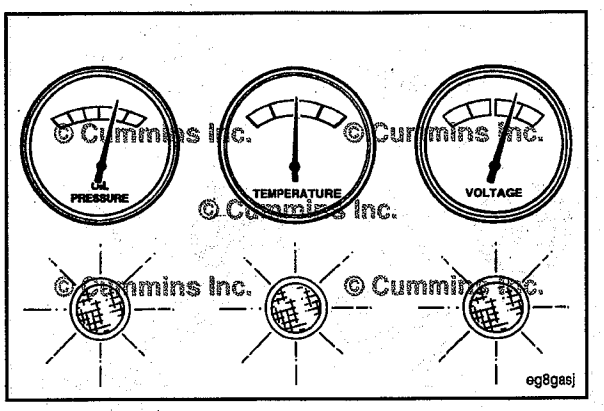
General Information

Correct care of your engine will result in longer life, better performance, and more economical operation.

Follow the daily maintenance checks listed in Maintenance Guidelines (Section 2).

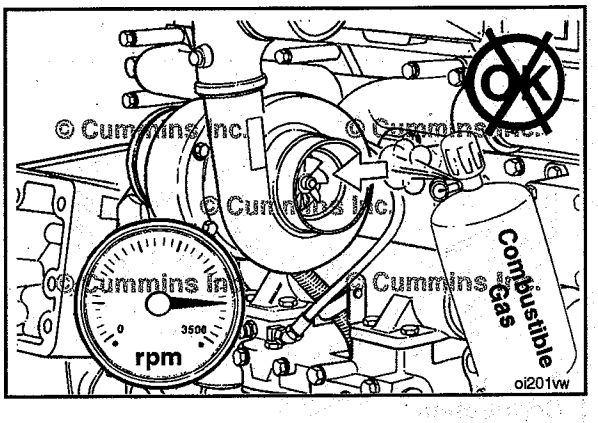
The **new** Cummins engine associated with this manual does **not** require a "break-in" procedure. This section of the manual provides all of the necessary information required for proper engine operation.

Check the oil pressure indicators, temperature indicators, warning lights, and other gauges daily to make sure they are operational.

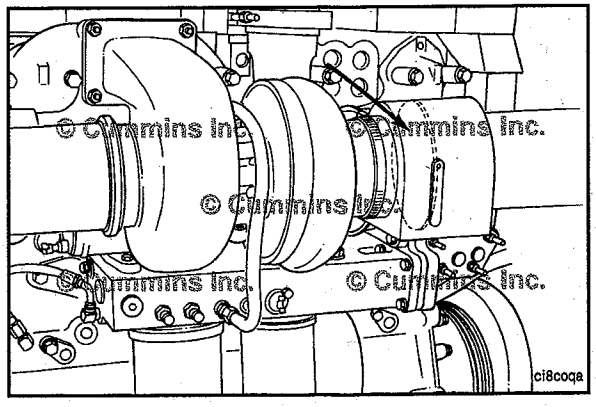


⚠WARNING⚠

DO NOT OPERATE A DIESEL ENGINE WHERE THERE ARE OR CAN BE COMBUSTIBLE VAPORS. The vapors can be sucked through the air intake system and cause engine acceleration and overspeeding that can result in a fire, an explosion, and extensive property damage. Numerous safety devices are available, such as air intake shutoff devices, to minimize the risk of overspeeding where an engine, due to its application, due to a fuel spill or gas leak. Remember, Cummins has no way of knowing the use you have for your engine. THE EQUIPMENT OWNER AND OPERATOR ARE RESPONSIBLE FOR SAFE OPERATION IN A HOSTILE ENVIRONMENT. CONSULT YOUR CUMMINS AUTHORIZED REPAIR LOCATION FOR FURTHER INFORMATION.

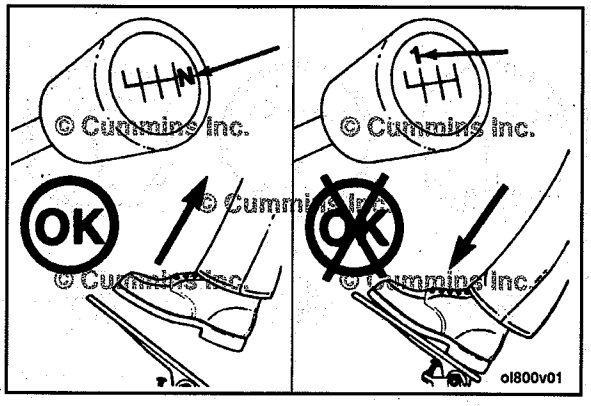


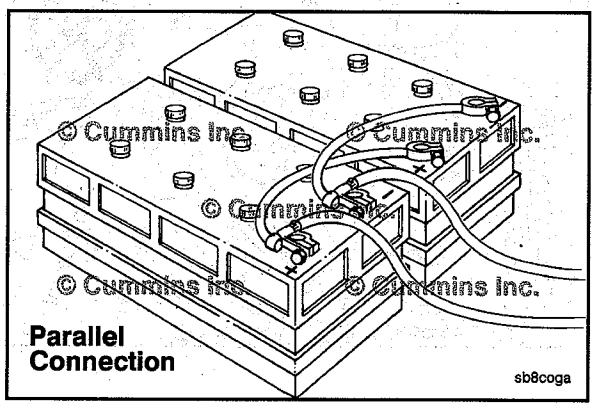
Cummins recommends the installation of an air intake shutoff device or a similar safety device to minimize the risk of overspeeding where an engine, due to the vehicle, vessel or equipment being operated in a combustible environment, such as due to a fuel spill or gas leak.



⚠CAUTION⚠

Do not expose the engine to corrosive chemicals. Corrosive chemicals can damage the engine.





Parallel Connection

Normal Starting Procedure

General Information

⚠CAUTION⚠

To reduce the possibility of damage to the starter, do not engage the starting motor for more than 30 seconds. Wait 2 minutes between each attempt to start the engine (electrical starting motors only).

Engines equipped with air starters require a minimum of 480 kPa [70 psi] compressed air pressure.

Disengage the driven unit, or, if equipped, put the transmission in neutral.

Start the engine with the throttle in the idle position.

⚠WARNING⚠

Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

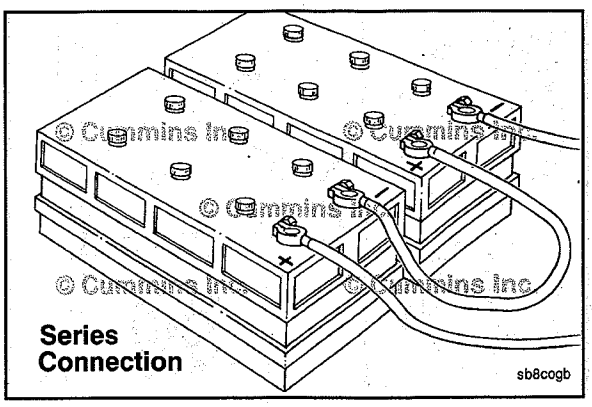
⚠CAUTION⚠

When using jumper cables to start the engine, make sure to connect the cables in parallel: positive (+) to positive (+) and negative (-) to negative (-). When using an external electrical source to start the engine, turn the disconnect switch to the OFF position. Remove the key before attaching the jumper cables.

The illustration shows a typical parallel battery connection. This arrangement doubles the cranking amperage.

The illustration shows a typical series battery connection. With this arrangement the positive (+) battery cable is connected to the adjoining negative (-) battery terminal.

This arrangement doubles the voltage.

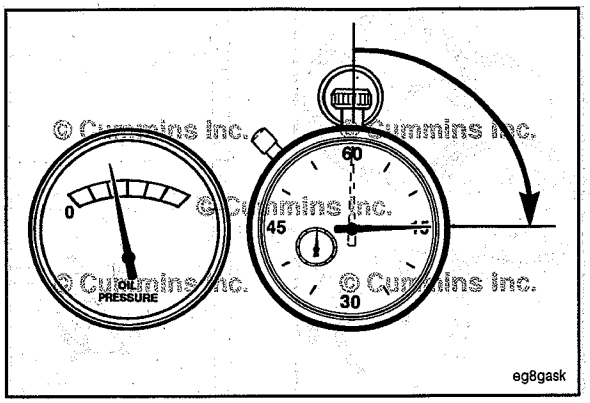


⚠CAUTION⚠

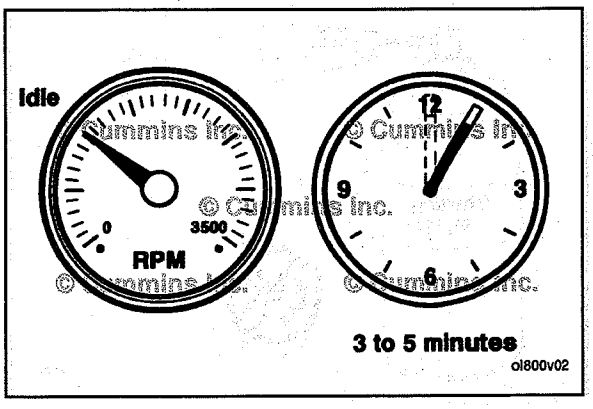
Engine oil pressure must be indicated on the gauge within 15 seconds after starting. If oil pressure is not registered within 15 seconds, shut off the engine immediately to avoid engine damage.

Confirm the correct oil level in the oil pan.

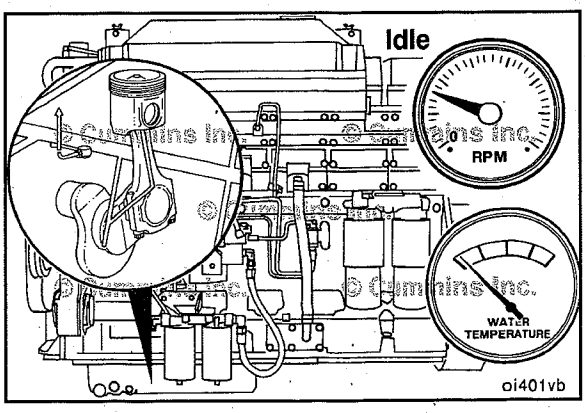
For engines equipped with a Prelub™ system, the starter will **not** engage until adequate oil pressure is obtained.

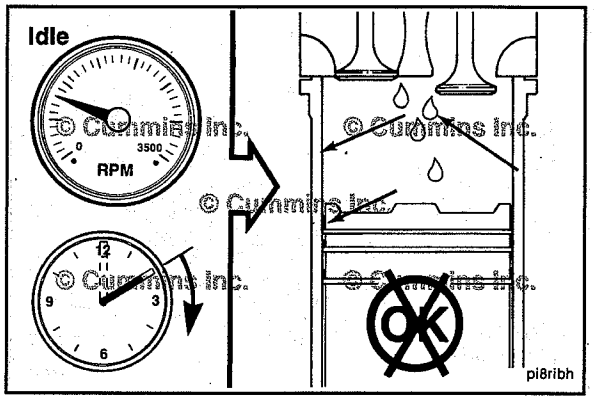


Idle the engine 3 to 5 minutes at approximately 1000 rpm, and attain a minimum water temperature of 60°C [140°F] before operating with a load.



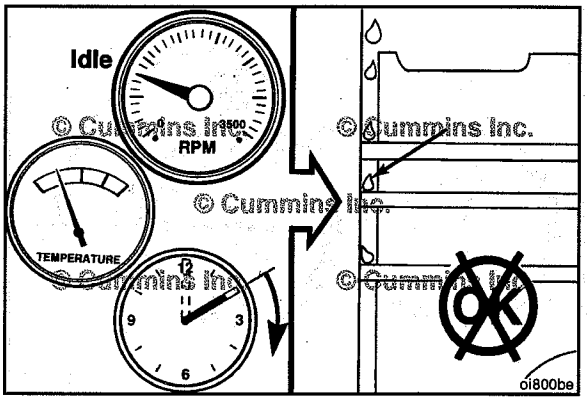
Increase engine speed (rpm) slowly to provide adequate lubrication to the bearings, and allow the oil pressure to stabilize.





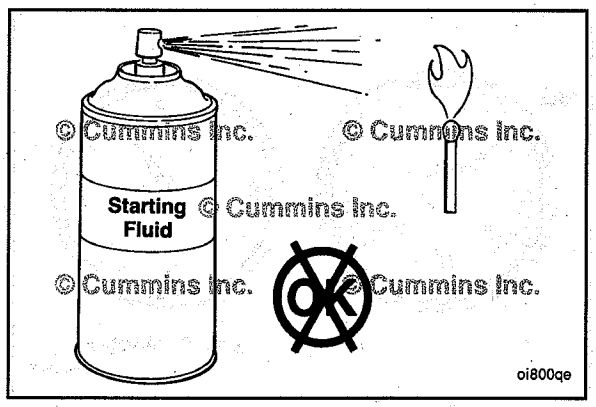
⚠CAUTION⚠

Do not idle the engine for excessively long period. Long periods of idling, more than 10 minutes, can damage an engine because combustion chamber temperatures drop so low the fuel will not burn completely. This will cause carbon to clog the injector spray holes and piston rings and can cause valves to stick.



⚠CAUTION⚠

If the engine coolant temperature becomes too low, 60°C [140°F], raw fuel from incomplete combustion, will wash the lubricating oil off the cylinder walls and dilute the crankcase oil; therefore, all moving parts of the engine will not receive the correct amount of lubrication.



Cold Weather Starting

With Mechanical or Electrical Metering Equipment (Ether)

⚠WARNING⚠

Do not use starting fluids on engines in marine applications. Starting fluid is highly flammable and explosive. Keep flames, sparks, and arcing switches away from starting fluid.

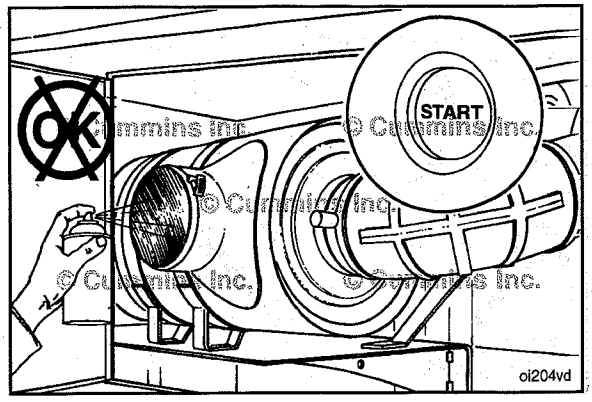
⚠WARNING⚠

Do not use volatile cold starting aids in marine applications due to the potential of an explosion.

⚠WARNING⚠

Because of the potential for an explosion, do not use volatile cold starting aids in underground mine or tunnel operations. Ask the local U.S. Bureau of Mines inspector for instructions.

Due to the increased safety hazards and potential for engine damage, do **not** use starting fluid without metering equipment.

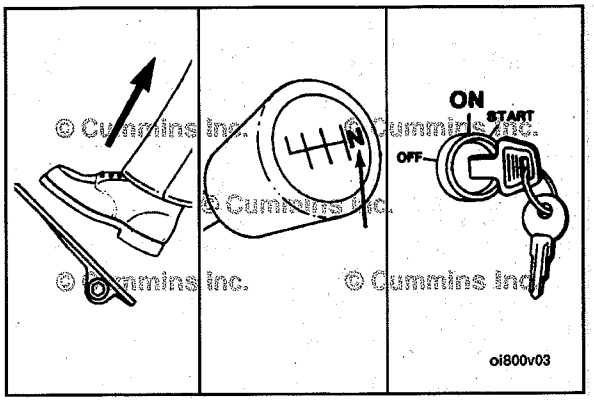


Set the throttle at idle.

Disengage any driven accessories, and, if equipped, shift the transmission in neutral.

NOTE: On engines equipped with a Prelub system, hold the key in the START position to allow lubrication oil pressure to build up.

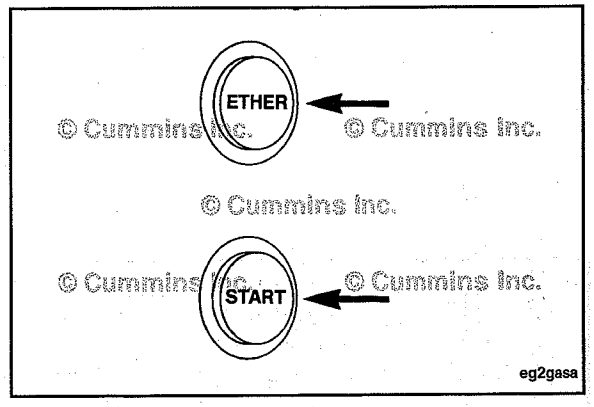
Turn the keyswitch to the ON position to power up the ECM.



⚠CAUTION⚠

Do not use excessive amounts of starting fluid when starting an engine. Using to much starting fluid can cause engine damage. On engines equipped with a Prelub system, do not use ether until the engine begins to crank.

While cranking the engine, inject a metered amount of starting fluid.

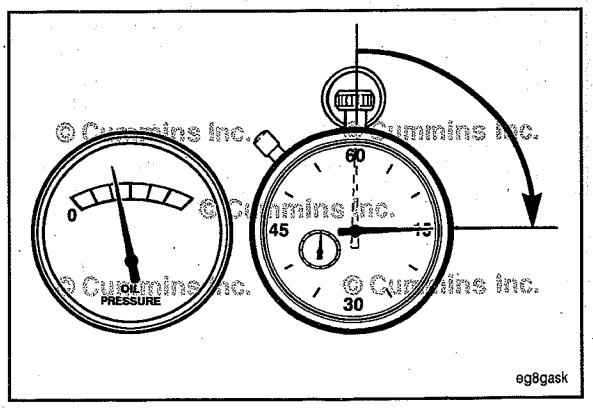


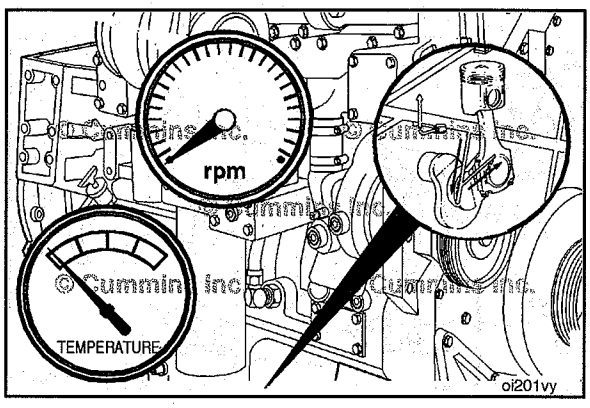
⚠CAUTION⚠

The engine must have adequate oil pressure within 15 seconds after starting. If the warning lamp indicating low oil pressure has not gone out or there is no oil pressure indicated on the oil pressure gauge within 15 seconds, shutoff the engine immediately to reduce the possibility of engine damage.

Confirm the correct oil level in the lubricating oil pan. Refer to Procedure 007-043 (Engine Lubricating Oil Level) in Section 3.

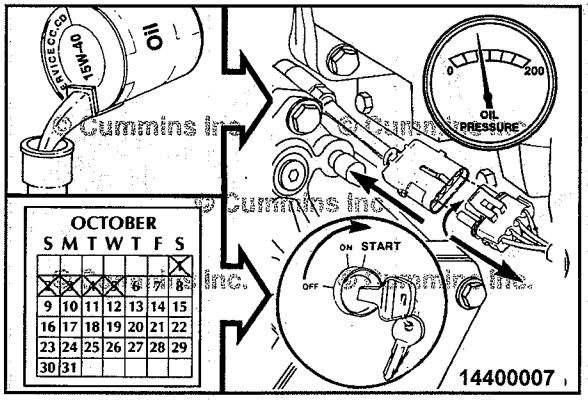
On engines equipped with a Prelub system, the starter will **not** engage until adequate oil pressure is obtained.





Do **not** increase the engine speed above low idle until the coolant temperature gauge starts to move and minutes have elapsed. This will provide adequate lubrication to the bearings.

Monitor the oil pressure gauge after normal operation is initiated.



Starting Procedure After Extended Shutdown or Oil Change

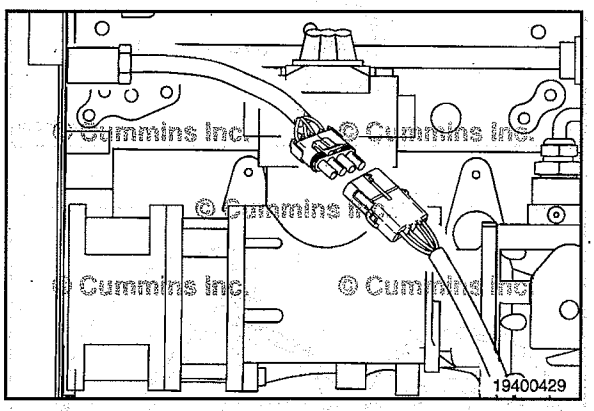
General Information

NOTE: This procedure will cause fault codes for the unplugged sensors to be logged. They will go inactive and have no effect on engine operation after the sensors are connected.

NOTE: Engines equipped with a Prelub™ system are self priming and will **not** require the following procedure.

The following steps **must** be completed after each oil change or after the engine has been shut off for more than 5 days to be sure the engine receives the correct flow through the lubricating system.

- Disconnect the engine speed sensor and the camshaft position sensor. Engines with mechanical injectors have **only** the engine speed sensor.
- Using the starting motor, rotate the crankshaft until the oil pressure is indicated on the gauge or the warning light goes out.



Connect the sensors.

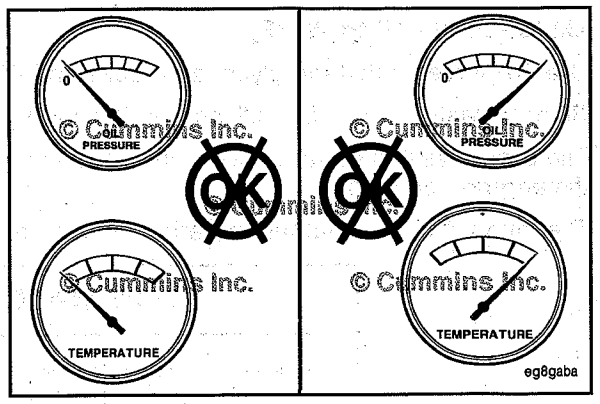
Start the engine. Refer to Procedure 101-014.

Operating the Engine

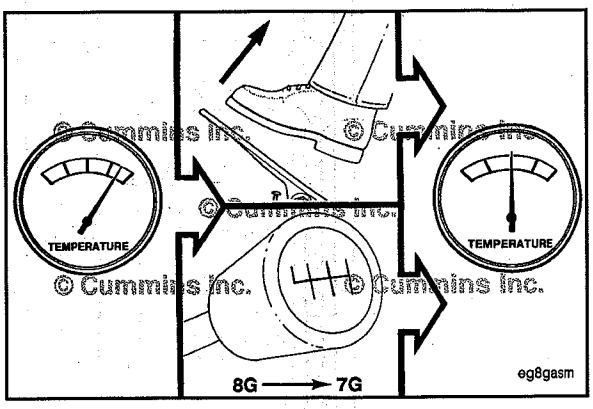
Normal

If equipped, monitor the oil pressure and coolant temperature gauges frequently. Refer to Lubricating Oil System specifications and Cooling System specifications, in Maintenance Specifications (Section V) for recommended operating pressures and temperatures. Shut off the engine if any pressure or temperature does **not** meet the specifications.

Continuous operation with engine coolant temperature above or below the engine coolant temperature specifications listed in Maintenance Specifications (Section V) can damage the engine.

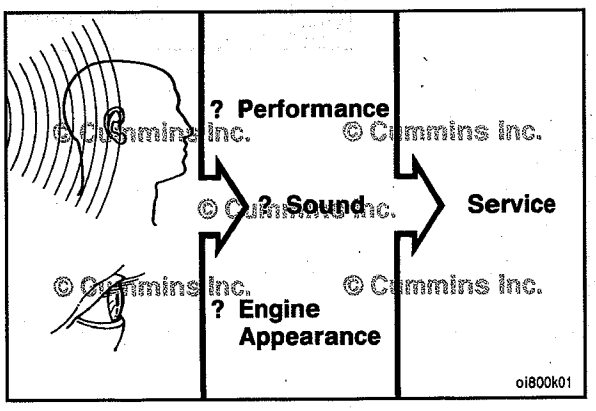


If an overheating condition starts to occur, reduce the power output of the engine by releasing the accelerator pedal or lever or shifting the transmission to a lower gear, or both, until the temperature returns to the normal operating range. If the engine temperature does **not** return to normal, shut off the engine, and refer to Troubleshooting Symptoms (Section TS), or contact a Cummins Authorized Repair Location.



Most failures give an early warning. Look and listen for changes in performance, sound, or engine appearance that can indicate service or engine repair is needed. Some changes to look for are:

- Engine misfires
- Vibration
- Unusual engine noises
- Sudden changes in engine operating temperatures or pressures
- Excessive smoke
- Loss of power
- An increase in oil consumption
- An increase in fuel consumption
- Fuel, oil, or coolant leaks.



Cold Weather

It is possible to operate engines in extremely cold environments if they are properly prepared and maintained. Satisfactory performance of an engine in low ambient temperature conditions requires modification of the engine, surrounding equipment, operating practices and maintenance procedures.

The correct engine coolant lubricating oil and fuels **must** be used for the cold weather range in which the engine is being operated. Below are the recommendations for these critical engine fluids:

Ambient Temperature

0 to -32°C [32 to -25°F]

Use 50-percent ethylene glycol antifreeze and 50-percent water for the engine coolant mixture.

Refer to Maintenance Specifications (Section V) Lubricating Oil recommendations for the correct specifications.

The Diesel fuel must have maximum cloud and pour points 6°C [10°F] lower than the ambient temperature in which the engine operates.

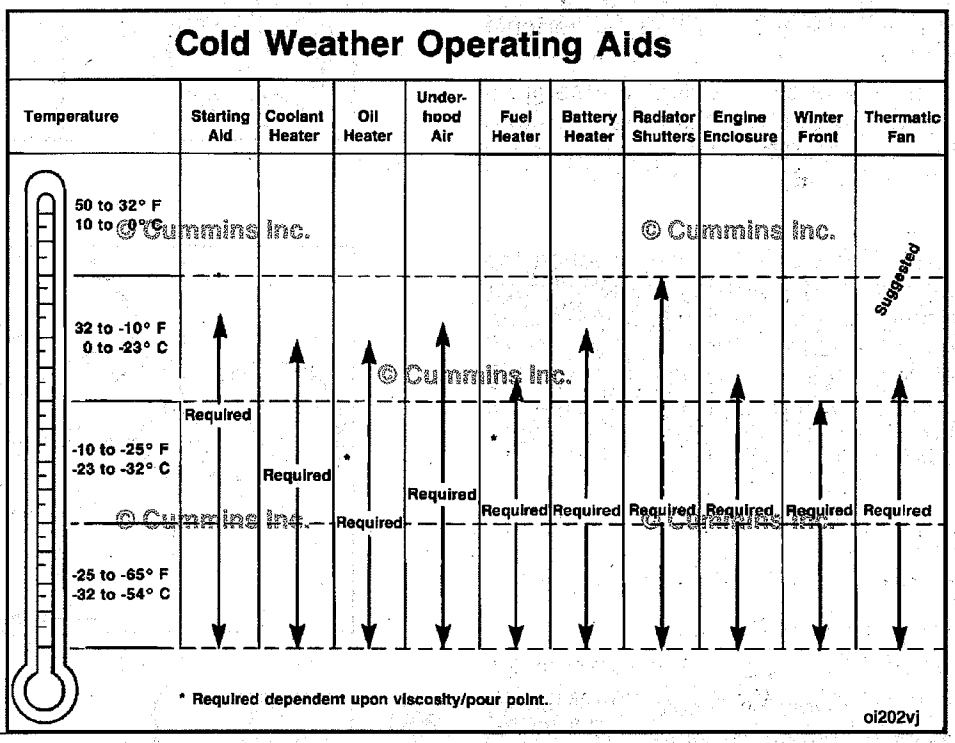
-32 to -54°C [-25 to -65°F]

Use 60-percent ethylene glycol antifreeze and 40-percent water for the engine coolant mixture.

Refer to Maintenance Specifications (Section V) Lubricating Oil recommendations for the correct specifications.

The Diesel fuel must have maximum cloud and pour points 6°C [10°F] lower than the ambient temperature in which the engine operates.

The following cold weather operating aids are required for cold weather situations:



Winterfronts and Shutters

Winterfronts and shutters can be used on a vehicle or equipment to reduce air flow through the radiator core into the engine compartment. This can reduce the time required to warm the engine and help maintain the engine coolant temperature. The engine coolant temperature specifications are in the Maintenance Specification (Section V).

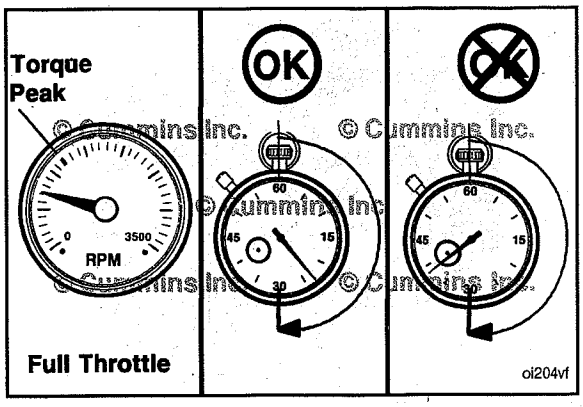
Engine Operating Range

General Information

⚠CAUTION⚠

Do not operate the engine at full throttle operation below peak torque rpm (refer to engine dataplate for peak torque rpm) for more than 30 seconds. Operating the engine at full throttle below peak torque will shorten engine life to overhaul, can cause serious engine damage, and is considered engine abuse.

Cummins® engines are designed to operate successfully at full throttle under transient conditions down to peak torque engine speed. This is consistent with recommended operating practices.



⚠CAUTION⚠

Do not operate the engine beyond the maximum engine speed. Operating the engine beyond the maximum engine speed can cause severe engine damage. Use proper operating techniques for the vehicle, vessel, or equipment to prevent engine overspeed. The maximum engine speed specification is listed in Maintenance Specifications (Section V).

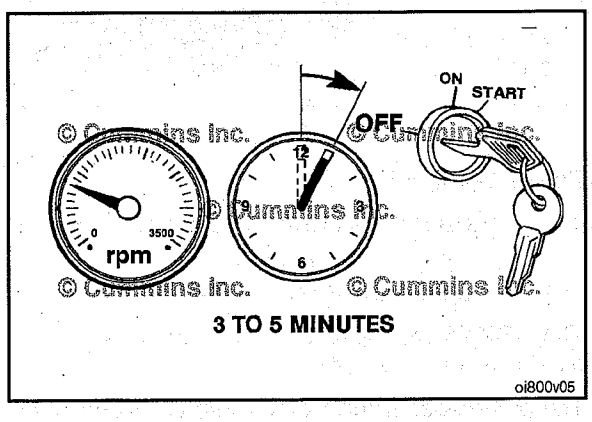
Engine Shutdown

General Information

Industrial and Power Generation

Allow the engine to idle 3 to 5 minutes before shutting it off after a full-load operation. This allows adequate cool down of pistons, cylinders, bearings, and turbocharger components.

Turn the ignition switch or keyswitch to the OFF position. If the engine does not shut down, refer to Troubleshooting Symptom (Section TS).



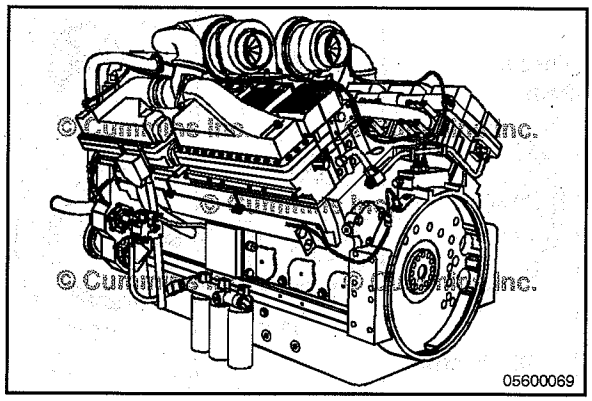
Marine Applications

For engines with shielded exhaust manifolds and turbochargers, allow the engines to idle for 10 to 12 minutes before shutting off after full load operation.

Allow the engine(s) to idle 3 to 5 minutes before shutting off after full load operation. This allows the cool down of pistons, cylinders, bearings and turbocharger components.

Push the stop button to stop the engine(s). If the engine does not shut down, refer to Troubleshooting Symptom (Section TS).

Turn the keyswitch to the OFF position.



Electronic Controlled Fuel System

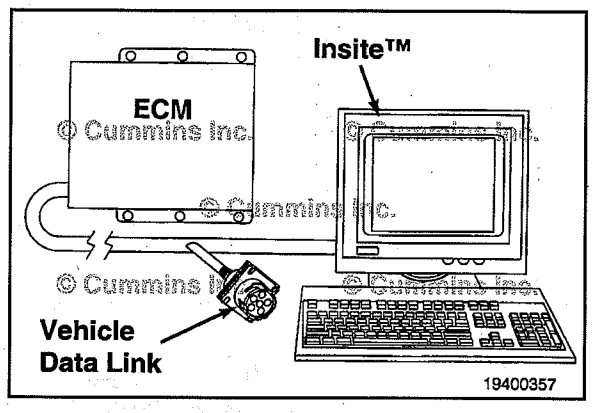
QSK System Description

Industrial Applications

The QSK fuel system is an electronically controlled system designed to optimize engine control and reduce exhaust emissions. The QSK fuel system controls engine speed and fuel pressure, based on input from the electric throttle and other equipment-specific, model-specific, or both, features.

Industrial applications fuel systems:

- Optimized engine control
- Reduced exhaust emissions.



INSITE™ is an electronic service tool for the industrial applications fuel systems. Use INSITE™ electronic service tool to:

- Program owner-specified information into the ECM (parameters and features)
- Aid in troubleshooting the engine
- Change the engine power or rated speed calibration.

Refer to a Cummins Authorized Repair Location for more specifics on this tool.

Power Generation

The generator-drive control system is an electronic control system designed to:

- Optimize engine control.
- Reduce exhaust emissions.

The QSK45 and QSK60 fuel system design controls engine speed and fuel pressure utilizing electronic sensors with the Quantum™ system.

The power-generation electronic control system has its own electronic tool called INPOWER™. INSITE™ is the **only** electronic service tool that can be used with power-generation engines with electronically actuated injectors. INPOWER™ electronic service tool can be purchased through Cummins Inc.

Refer to a Cummins Authorized Repair Location for specifics on the these tools:

- INPOWER™
- INPOWER PRO™.

INPOWER™ is an electronic service tool for the generator-drive control systems. Use the INPOWER™ electronic service tool to:

- Program owner-specified information into the ECM (parameters and features)
- Aid in troubleshooting the engine
- Change the engine power or rated speed calibration.

Refer to a Cummins Authorized Repair Location for specifics on this tool.

The INPOWER™ electronic service tool adjustment feature allows adjustments to be made to the generator-drive parameters for trims and settings. There are several adjustment parameters. **Not** all generator sets will have the same adjustments available.

The INPOWER™ electronic service tool monitor mode is a useful troubleshooting aid that displays the key ECM inputs and outputs. This feature can be used to spot constant or abnormally fluctuating values.

The ECM inputs show the data that is being fed into the ECM by the system's sensors and switches. The ECM outputs are values that the ECM commands to the generator-drive control system.

The monitor mode allows the relationship between the ECM inputs and outputs to be monitored and used during troubleshooting.

The INPOWER PRO™ electronic service tool allows the user to transfer new or updated calibration files for the generator-drive control system ECM from a central location to Cummins Inc. distributors.

A calibration file is electronic data that gives the engine its performance rating.

The calibration file will be loaded into the INPOWER™ electronic service tool, which is used to load the file into the ECM.

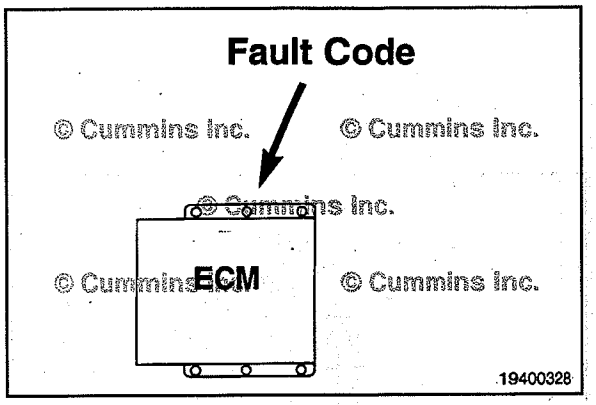
Refer to a Cummins Authorized Repair Location for more specifics on this tool.

The INPOWER™ electronic service tool test mode feature is a diagnostic tool that is used to perform internal self-checks on the PowerCommand™ control to verify inputs and outputs of the control system and test engine protection functions.

Diagnostic Fault Codes

Industrial Applications

The industrial application fuel system can display and record certain detectable fault conditions. These failures are displayed as fault codes, which make troubleshooting easier. The fault codes are retained in the ECM.



There are two types of fault codes:

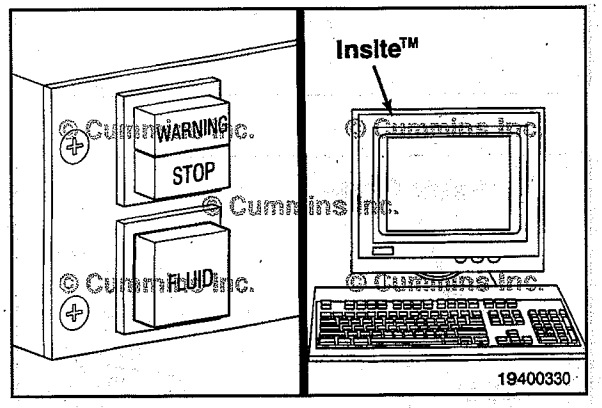
- Engine electronic fuel system fault codes
- Engine protection system fault codes.

All fault codes recorded will either be active (fault code is presently active on engine) or inactive (fault code was active at some time, but is **not** presently active).

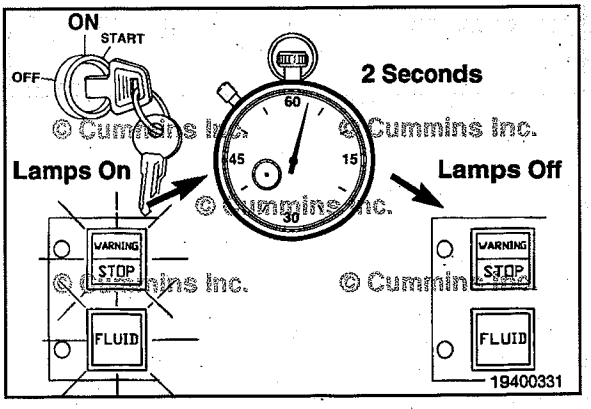
Active fault codes can be read using the WARNING (amber) and STOP (red) lamps in the cab panel.

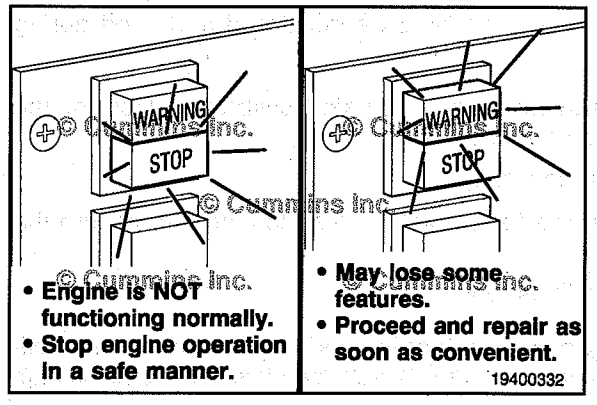
The active fault codes can also be accessed using INSITE™ electronic service tool, Part Number 3824801.

Inactive fault codes can **only** be read with the INSITE™ electronic service tool.



When the vehicle keyswitch is turned on and the diagnostic switch is off, the fault code lamps (red, yellow, and engine protection) will illuminate for approximately two seconds, one after the other to check their operation.





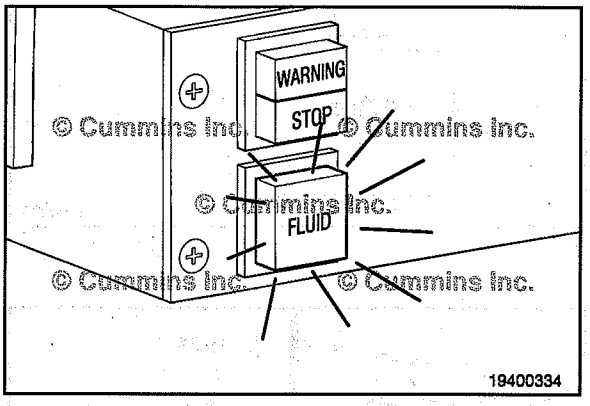
The lights will remain off until a fault code is recorded. If a STOP (red) light illuminates while the engine is in operation, the fault can be engine-disabling. Stop the engine in a safe manner as soon as possible.

If the WARNING (amber) lamp illuminates, the engine can still be operated, but it can lose some system features that can sometimes result in a power loss. The failure **must** be repaired as soon as it is convenient.

The engine protection system records separate fault codes when an out-of-range condition is found for any of the sensors in the engine protection system.

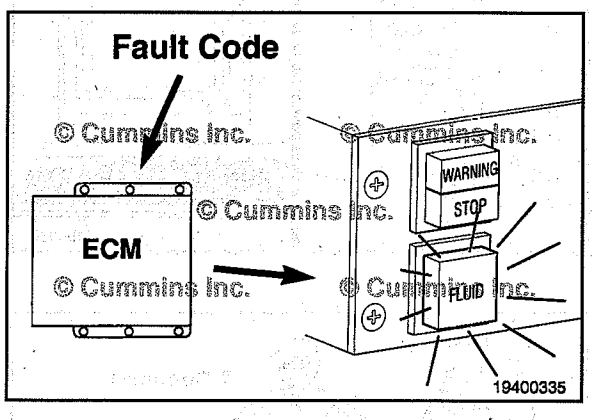
The following engine protection sensors will **only** be available with the CENSE™ electronic engine monitoring system option:

- Engine coolant pressure
- Fuel temperature
- Blowby pressure.



NOTE: Lamp colors and labels will vary by OEM.

The engine protection system will illuminate the maintenance lamp (orange) when an out-of-range condition occurs.



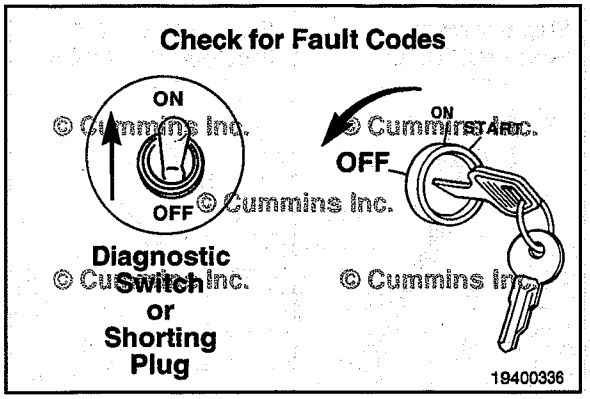
If the engine protection maintenance lamp illuminates while driving, it means that a fault code has been recorded. The lamp will remain illuminated as long as the fault is occurring.

The lamp will begin to flash if the condition continues to get worse. The engine power, speed, or both, will be gradually reduced. If the engine protection shutdown feature is enabled, the engine will shut down to prevent damage.

To check for active fault codes:

1. Turn the keyswitch to the OFF position.
2. Move the diagnostic switch to the ON position.

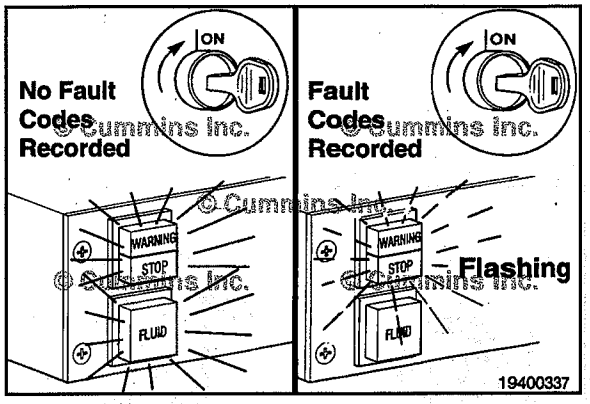
NOTE: Some OEM's use a shorting plug.



Turn the vehicle keyswitch to the ON position.

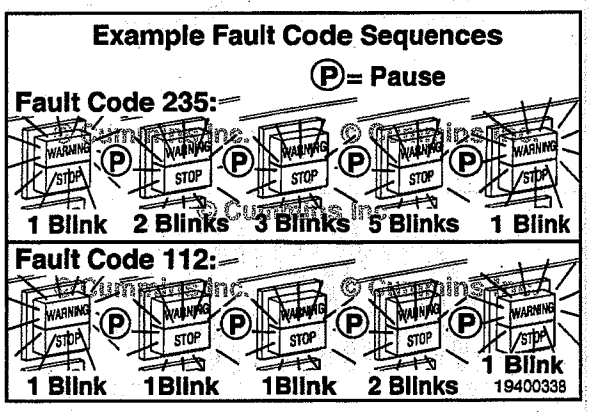
If active fault codes are **not** recorded, all three lamps will illuminate and stay illuminated.

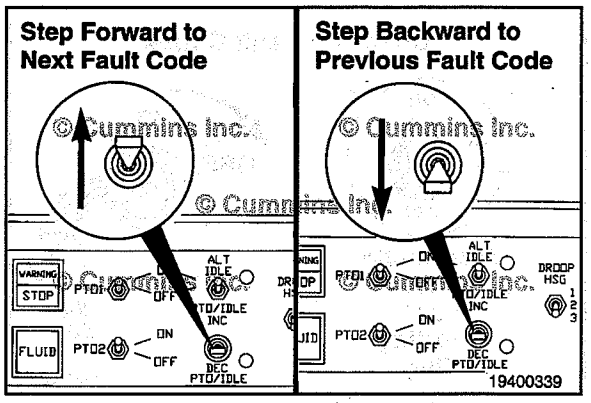
If active fault codes are recorded, all three lamps will illuminate momentarily. The WARNING (amber) and the STOP (red) lamps will begin to flash the code of the recorded fault.



The fault code will flash in the following sequence:

1. The WARNING (amber) lamp will flash.
2. A one second pause with both WARNING (amber) and STOP (red) lamps off.
3. The STOP (red) lamp will flash the recorded fault code with a one second pause between digits.
4. When the number has stopped flashing, the WARNING (amber) lamp will illuminate.
5. The fault code number will repeat in the same sequence.





The lights will continue to flash the same fault code until the system has advanced to the next active fault code.

To advance to the second fault code, move the idle speed adjust switch to the positive (+), then release it.

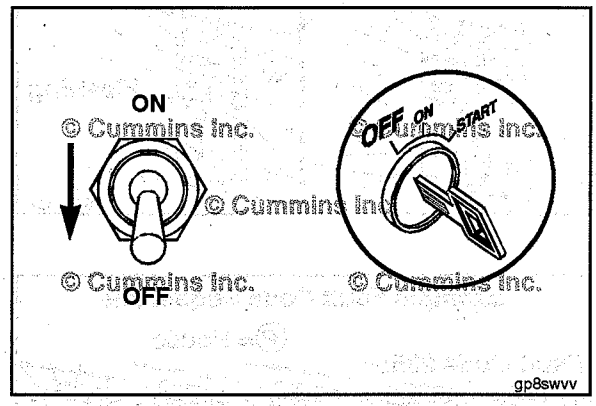
The previous fault code can be accessed by moving the switch to the negative (-) position, then releasing it.

To check the third or fourth fault code, move the switch to the positive (+) position, then release it.

When all active fault codes have been viewed, moving the switch to the positive (+) position will return the system to the first fault code.

The explanation and correction of all fault codes is in the troubleshooting charts of the Quantum™ fuel manual. Refer to a Cummins Authorized Repair Location.

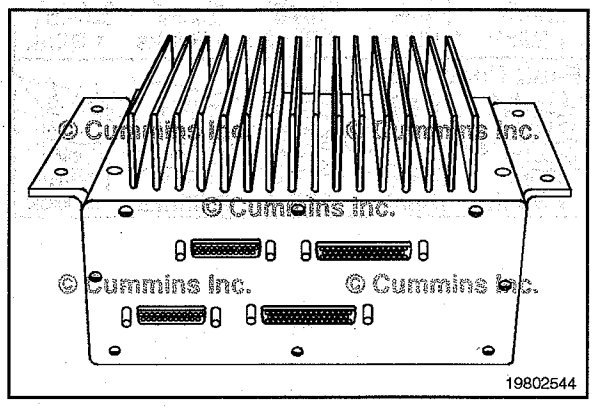
Electronic fault code troubleshooting trees are in ascending numerical order. An index is located at the beginning of the section.



NOTE: Some OEMs use a shorting plug

To stop the diagnostic system, move the diagnostic switch to the OFF position.

Turn the vehicle keyswitch to the OFF position.



Power Generation

The generator-drive system can display and record certain detectable fault conditions. These failures are displayed as fault codes, which make troubleshooting easier. The fault codes are retained in the ECM.

There are two types of fault codes. There are engine electronic fuel system fault codes and engine protection system fault codes.

All fault codes recorded will either be active (fault code is presently active on the engine) or inactive (fault code was active at some time, but is **not** presently active).

- Engine electronic fuel system fault codes
- Engine protection system fault codes.

Fault codes can be accessed in three different ways:

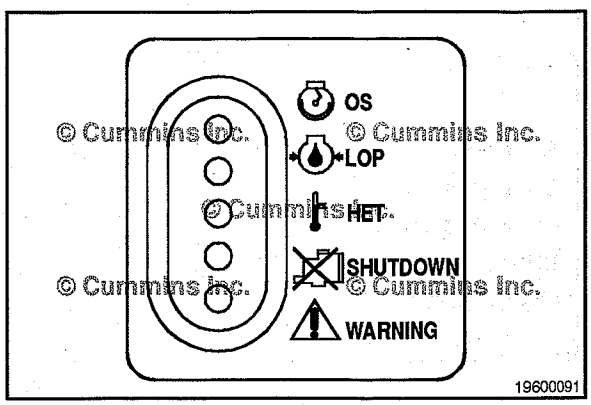
- Flashout
- Electronic service tool
- Operator interface panel.

The generator-drive control system ECM has five LEDs for diagnostics:

- OS - overspeed
- LOP - low oil pressure
- HET - high engine temperature
- Shutdown - engine protection shutdown has occurred
- Warning - engine protection warning condition exists.

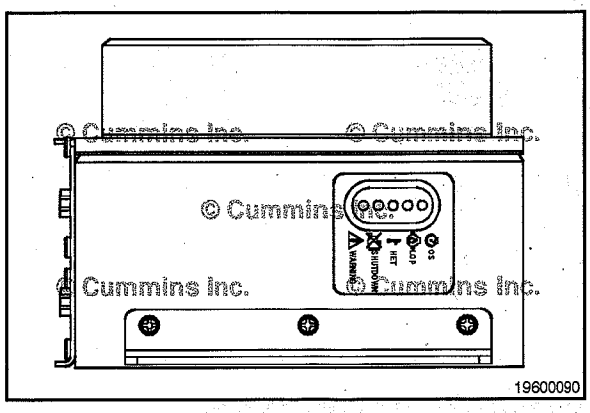
The generator-drive control system has eight relay drivers for customer-supplied relays:

- OS - Overspeed
- LOP - Low oil pressure
- HET - High engine temperature
- Shutdown - Engine protection shutdown has occurred
- Warning - Engine protection warning condition exists
- Prelow oil pressure
- Prehigh engine temperature
- Fail to start.



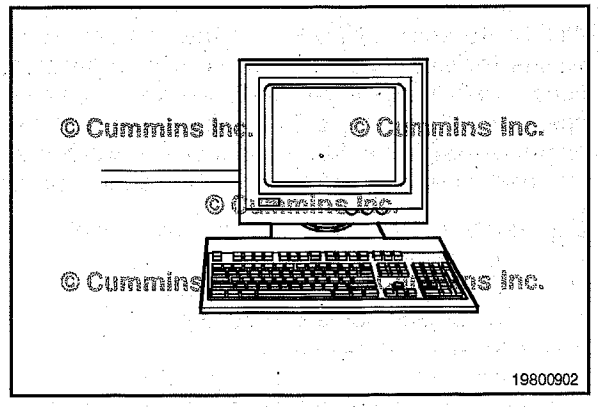
To flash out a fault code, the ECM **must** be put into the diagnostic mode. Enter the diagnostic mode using the diagnostic mode switch or by connecting together the two single-pin diagnostic mode enable connectors. During normal ECM operation, the two connectors are disconnected (open circuit). The ECM is placed in diagnostic mode when these two connectors are joined together (short circuit).

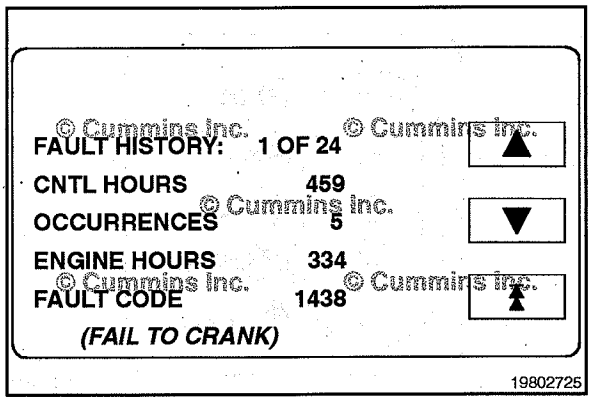
The warning lamp will flash (signifying the start of a new fault code), and then the fault code will flash out on the shutdown lamp.



The electronic service tool can be used to read the fault codes. Connect a personal computer, with the electronic service tool installed, to the engine using the service harness, Part Number 3163156.

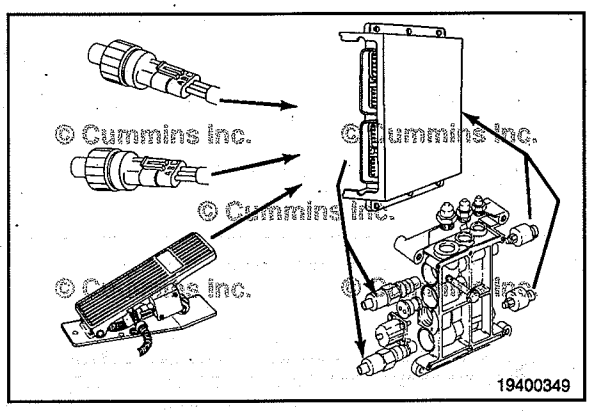
Refer to a Cummins® Authorized Repair Location for specifics on how to read the fault codes.





If the customer-supplied operator interface panel has been integrated with the generator-drive control system using the RS485 datalink, the ability to read the fault codes is available.

Refer to a Cummins Authorized Repair Location for specifics on how to read the fault codes.



Fault Code Snapshot Data

Industrial and Power Generation

When a diagnostic fault code is recorded in the ECM, ECM input and output data are recorded from all sensors and switches. Snapshot data allow the relationships between ECM inputs and outputs to be viewed and used during troubleshooting.

To Clear a Fault Code:

Only inactive fault codes can be cleared. The **only** way to clear an inactive fault code is to use the electronic service tool.

The engine **must** be shut down to clear inactive shutdown faults.

All fault codes recorded will either be active (fault code is presently active on the engine) or inactive (was active at some time, but is **not** presently active).

Engine Protection System

Industrial and Power Generation

All QSK45 and QSK60 series engines are equipped with an engine protection system. The system monitors critical engine temperatures, fluid level, switch position, and pressure and will log diagnostic faults when an over or under normal operating range condition occurs. If an out-of-range condition exists, engine derate action will be initiated. The operator will be alerted by the illumination of the in-cab maintenance lamp. The warning lamp will start to flash when an out-of-range condition continues to worsen and engine shutdown will occur. The operator **must** pull to the side of the road when it is safe to do so to reduce the possibility of engine damage.

Engine Protection System Monitors QSK Series Engines for:

- High engine coolant temperature
- Low engine coolant level (optional)
- Low engine coolant pressure
- High fuel temperature
- High intake manifold temperature
- Low and very low lubricating oil pressure
- High blowby pressure.

The engine protection system has three selectable features. If the engine protection enable feature has been selected, engine power and speed will be gradually reduced depending on the level of severity of the observed condition. If the engine protection shutdown feature has been selected, the engine will be shut down. If the engine restart feature has been selected, the engine can **not** be started again after shutdown.

Engine Protection Features

- Engine protection enable
- Engine protection shut down
- Engine protection restart.

Electromagnetic Interference (EMI)

General Information

Some engine applications utilize accessories (CB radios, mobile transmitters, etc.) that generate and use radio frequency energy that, if **not** installed and used properly, can cause electromagnetic interference (EMI) conditions to exist between the accessory and Cummins electronic controlled fuel system. Cummins is **not** liable for any performance problems with either the fuel system or the accessory due to EMI. EMI is **not** considered by Cummins to be an engine failure and therefore is **not** warrantable.

System EMI Susceptibility

Your Cummins product has been designed and tested for minimum sensitivity to incoming electromagnetic energy. Testing has shown that there is no engine performance degradation at relatively high energy levels; however, if very high energy levels are encountered, then some noncritical diagnostic fault code logging can occur. The fuel system EMI susceptibility level will protect your engine from most, if **not** all, electromagnetic energy-emitting devices that meet the Federal Communications Commission legal requirements.

System EMI Radiation Levels

Your Cummins product has been designed to emit minimum electromagnetic energy. Electronic components are required to pass various Cummins and industry EMI specifications. Testing has shown that when the engine is properly installed, it will not interfere with onboard communication equipment or with the vehicle's, equipment's, or vessel's ability to meet any applicable EMI standards and regulated specifications.

If an interference condition is observed, follow the suggestions below to reduce the amount of interference:

1. Locate the receiving antenna as far away from the engine and as high as possible.
2. Locate the receiving antenna as far away as possible from all metal obstructions (e.g., exhaust stacks)
3. Consult a representative of the accessory supplier in your area to:
   - Calibrate accurately the device for proper frequency, power output, and sensitivity (both base and remote site devices **must** be properly calibrated)
   - Obtain antenna reflective energy data measurements to determine the optimum antenna location
   - Obtain optimum antenna type and mounting arrangement for your application
   - Make sure your accessory equipment model is built for maximum filtering to reject incoming electromagnetic noise.

Notes

Section 2 - Maintenance Guidelines

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Maintenance Guidelines - Overview

General Information

Cummins Inc. recommends that the engine be maintained according to the Maintenance Schedule in this section.

If the engine is operating in ambient temperatures below -18°C [0°F] or above 38°C [100°F], perform maintenance at shorter intervals. Shorter maintenance intervals are also required if the engine is operated in a dusty environment or if frequent stops are made. Contact your local Cummins Authorized Repair Location for recommended maintenance intervals.

Some of these maintenance procedures require special tools or must be completed by qualified personnel. Contact your local Cummins Authorized Repair Location for detailed information.

If your engine is equipped with a component or accessory not manufactured by Cummins Inc., refer to the component manufacturer's maintenance recommendations.

Use the chart provided in this section as a convenient way to record maintenance performed.

Tool Requirements

General Information

Most of the maintenance operations described in this manual can be performed with common hand tools (metric wrenches, sockets, and screwdrivers).

The following is a list of special service tools required for some maintenance operations:

Tool Part Number	Description
ST-1293	Burroughs belt tension gauge (v-belts)
3375049	Oil filter wrench
3376807	Coolant and fuel filter wrench
3376592	Torque wrench - Inch-pound
3824901	Valve lash gauge set

Refer to the appropriate sections for a description of the tools and how to use them.

Contact the nearest Cummins Authorized Repair Location for the required service tools.

Maintenance Schedule

General Information

For convenience, listed below are the section numbers that contain specific instructions for performing the maintenance checks listed in the maintenance schedule.

Perform maintenance at whichever interval occurs first. At each scheduled maintenance interval, perform all previous maintenance checks that are required for scheduled maintenance.

The QSK45 and QSK60 Series engines have the following lubricating oil filtration options:

Marine and Industrial

- Spin-on Oil Filter without Centrifuge and without Centinel™
- Spin-on Oil Filter with Centrifuge and without Centinel™
- Spin-on Oil Filter without Centrifuge and with Centinel™
- Spin-on Oil Filter with Centrifuge and with Centinel™
- Eliminator without Centinel™
- Eliminator with Centinel™.

Power Generation

- Spin-on Oil Filter without Centrifuge and without Centinel™
- Spin-on Oil Filter with Centrifuge and without Centinel™
- Spin-on Oil Filter without Centrifuge and with Centinel™
- Spin-on Oil Filter with Centrifuge and with Centinel™
- Eliminator without Centinel™
- Eliminator with Centinel™.

Refer to the applicable maintenance schedule for the specific oil filtration option used.

Marine and Industrial

Spin-on Oil Filter without Centrifuge and without Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belt - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Lubricating Oil and Filters - Replace
- Oil Level Sensor - Clean and Inspect
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 10,000 Hours or 2 Years ....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Spin-on Oil Filter with Centrifuge and without Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belt - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Lubricating Oil and Filters- Replace
- Oil Level Sensor - Clean and Inspect
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust
- Fleetguard Centrifuge - Clean and Inspect

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Spin-on Oil Filter without Centrifuge and with Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Prelubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Centinel™ Oil Level - Fill
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Lubricating Oil Filters - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year ....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 4000 Hours or 2 Years....Section 8

- Lubricating Oil - Replace

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Inspect
- Vibration Damper, Viscous - Inspect

Spin-on Oil Filter with Centrifuge and with Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Centinel™ Oil Level - Fill
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Inspect
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Lubricating Oil Filters - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust
- Fleetguard Centrifuge - Clean and Inspect

Maintenance Procedures at 4000 Hours or 2 Years....Section 8

- Lubricating Oil - Replace

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Eliminator without Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Eliminator Filter - Inspect
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Lubricating Oil - Replace
- Oil Level Sensor - Clean and Inspect

- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Eliminator Filter Centrifuge - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Eliminator with Centinel™

If application is **not** specified in the title, assume all engines are affected.

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Centinel™ Oil Level - Fill
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Eliminator Filter - Inspect
- Intake Air Piping - Maintenance

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Eliminator Filter Centrifuge - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 4000 Hours or 2 Years....Section 8

- Lubricating Oil - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Power Generation

Spin-on Oil Filter without Centrifuge and without Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belt - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 250 Hours or 1 Year....Section 5

- Lubricating Oil and Filters - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 10,000 Hours or 2 Years ....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check

- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Spin-on Oil Filter with Centrifuge and without Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belt - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 250 Hours or 1 Year....Section 5

- Lubricating Oil and Filters - Replace
- Lubricating Oil Level - Maintenance Check

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust
- Fleetguard Centrifuge - Clean and Inspect

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Spin-on Oil Filter without Centrifuge and with Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Prelubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Centinel™ Oil Level - Fill
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean

- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Lubricating Oil Filters - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year ....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 4000 Hours or 2 Years....Section 8

- Lubricating Oil - Replace

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Inspect
- Vibration Damper, Viscous - Inspect

Spin-on Oil Filter with Centrifuge and with Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Centinel™ Oil Level - Fill
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace

- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Inspect
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Lubricating Oil Filters - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust
- Fleetguard Centrifuge - Clean and Inspect

Maintenance Procedures at 4000 Hours or 2 Years....Section 8

- Lubricating Oil - Replace

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Eliminator without Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Eliminator Filter - Inspect
- Intake Air Piping - Maintenance Check

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 250 Hours or 1 Year....Section 5

- Lubricating Oil - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Eliminator Filter Centrifuge - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust
- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Eliminator with Centinel™

Maintenance Procedures at Daily Interval....Section 3

- Pre-lubricating Oil Pump - Inspect
- Air Cleaner PreCleaner - Clean
- Air Cleaner Restriction - Maintenance Check
- Coolant Level - Maintenance Check
- Lubricating Oil Level - Maintenance Check
- Centinel™ Oil Level - Fill
- Marine Gear - Maintenance Check
- Sea Water Strainer - Clean
- Fuel-Water Separator - Drain
- Air Tanks and Reservoirs - Drain
- Eliminator Filter - Inspect
- Intake Air Piping - Maintenance

Maintenance Procedures at 250 Hours or 6 Months....Section 4

- Air Compressor Air Cleaner Element - Maintenance Check
- Drive Belt Alternator - Measure
- Fuel Filter (spin-on type) - Replace
- Drive Belts - Maintenance Check
- Cooling Fan - Inspect
- Belt Tensioner, Automatic (Alternator) - Maintenance Check
- Coolant Filter - Replace
- Crankcase Breather Tube - Maintenance Check
- Supplemental Coolant Additive (SCA) - Maintenance Check
- Hoses, Engine - Maintenance Check
- Zinc Anode - Inspect
- Engine Support Bracket, Front - Maintenance Check
- Engine Mounts - Maintenance Check
- CENSE™ Datalogger - Reset

Maintenance Procedures at 1000 Hours or 1 Year....Section 6

- Eliminator Filter Centrifuge - Clean and Inspect

Maintenance Procedures at 1500 Hours or 1 Year....Section 7

- Overhead Set - Adjust

Maintenance Procedures at 4000 Hours or 2 Years....Section 8

- Lubricating Oil - Replace
- Oil Level Sensor - Clean and Inspect

Maintenance Procedures at 10,000 Hours or 2 Years....Section 9

- Engine - Steam Clean
- Fan Drive Idler Arm Assembly - Maintenance Check
- Fan Drive Idler Pulley Assembly - Adjust

- Batteries - Maintenance Check
- Cold Weather Starting Aids - Maintenance Check
- Cooling System - Flush
- Fan Hub, Belt Driven - Maintenance Check
- Water Pump - Maintenance Check
- Turbocharger - Inspect
- Air Compressor Unloader and Valve Assembly - Maintenance Service
- Vibration Damper, Viscous - Inspect

Oil Drain Intervals

⚠CAUTION⚠

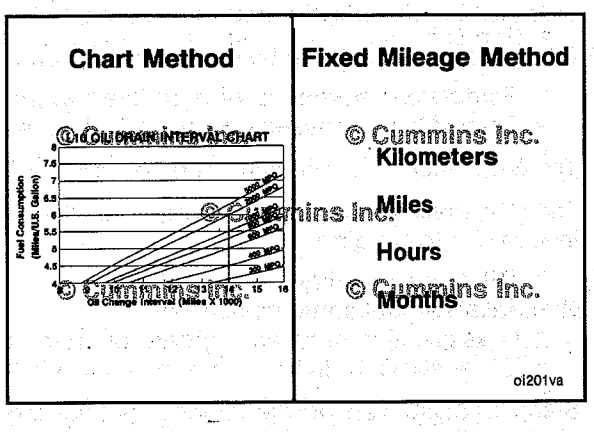
The use of a synthetic base oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as corrosion, deposits, and wear.

⚠CAUTION⚠

Do not extend oil change intervals beyond the maximum point shown when fuel consumption rates are less than the minimum shown. Doing so can result in shortened engine life due to oil degradation processes associated with lightly loaded engines.

Do **not** extend oil and filter change intervals beyond those specified configurations in the maintenance schedule, unless the chart method is used. See the oil interval charts in this section.

The chart method provides no benefit to a customer that is operating with a Centinel system. Therefore, the fixed hour method can **always** be used when Centinel™ is utilized.



⚠CAUTION⚠

Inaccurate fuel consumption records can result in incorrect oil change intervals that can result in premature engine wear and/or deposits.

⚠CAUTION⚠

Do not extend oil change intervals beyond the maximum point shown when fuel consumption rates are less than the minimum shown. Doing so can result in shortened engine life due to oil degradation processes associated with lightly loaded engines.

Oil change intervals can be determined by one of the following recommended methods:

- Fixed-Hour method (based on fixed hours or months, whichever occurs first)
- Chart Method (based on known fuel consumption rates, coupled with oil analysis program).

The chart method is recommended to provide the lowest total cost of operation, while still protecting the engine.

The information listed below is required when using the chart method to determine the correct oil and filter change interval for the engine.

- Oil sump capacity
- Average fuel consumption rate
- Classification of oil as standard or premium
- Oil analysis to demonstrate the chart method interval is acceptable.

Sump capacity can be determined by knowing the volume of the oil required to touch the high-level mark on the dipstick. Oil sump capacities are listed in the operation and maintenance manuals for all Cummins Inc. engines. It is imperative that the sump volume be known when using the chart method. Refer to Procedure 018-017 (Lubricating Oil System Specifications) in Section V for oil sump capacity.

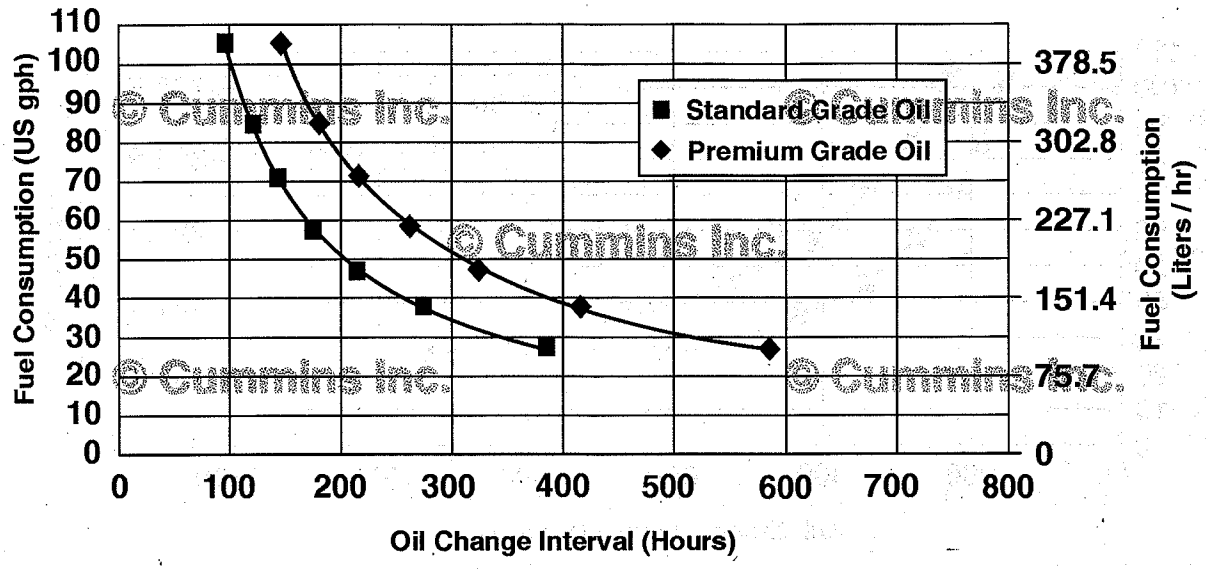
To use the chart method effectively, accurate fuel consumption records **must** be kept and maintained. Fuel consumption information **must** be in liters per hour or gallons per hour units to use the charts. Fuel consumption rates can change over time because of increasing or decreasing engine duty cycle. Accurate records are essential in determining average fuel consumption during a given oil change interval.

The charts are categorized and labeled by the sump size for a specific engine family. Select the chart representing the correct oil sump capacity for engine model in question. The left vertical axis of the chart represents fuel consumption in U.S. gallons per hour. Determine the intersection point of the fuel consumption rate on the applicable interval curve by drawing a horizontal line. From this point, draw a vertical line down until it intersects with the horizontal axis representing hours. This point represents the acceptable oil change interval.

Lubricating Oil Filters

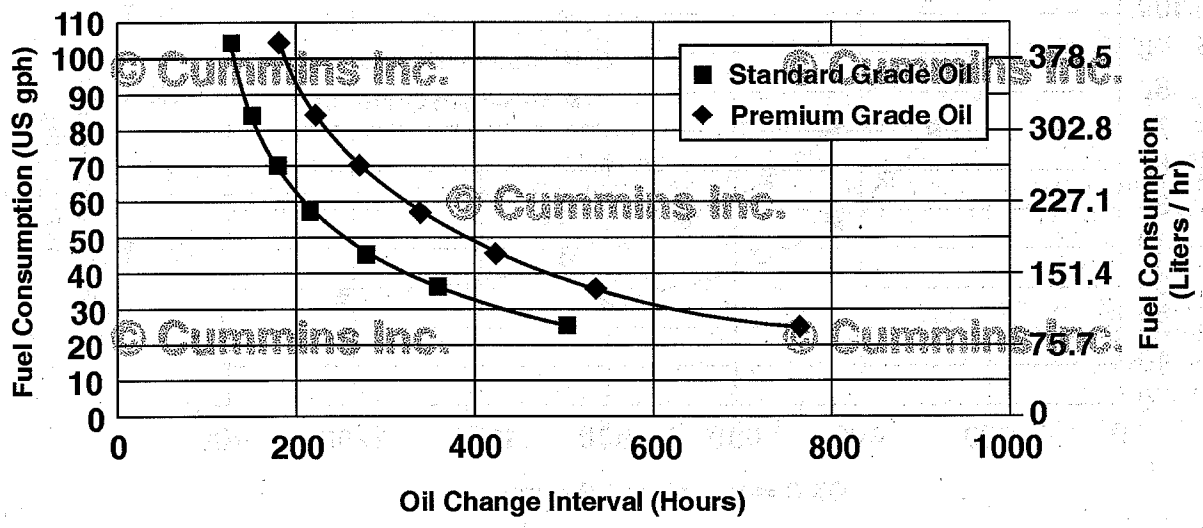
Premium filters are recommended, in conjunction with premium grade oils, when using the premium grade oil curves to determine oil change intervals. Premium filters contain synthetic media materials to provide more efficient filtration for the entire service life and to extend the media life over conventional cellulose media. Premium full-flow filters are made with synthetic media and have the StrataPore designation on the outside of the filter. StrataPore filters have the efficiency, capacity, and strength needed for this extended service.

QSK45 Oil Change Interval
132 Liter (35 US Gallon) Sump



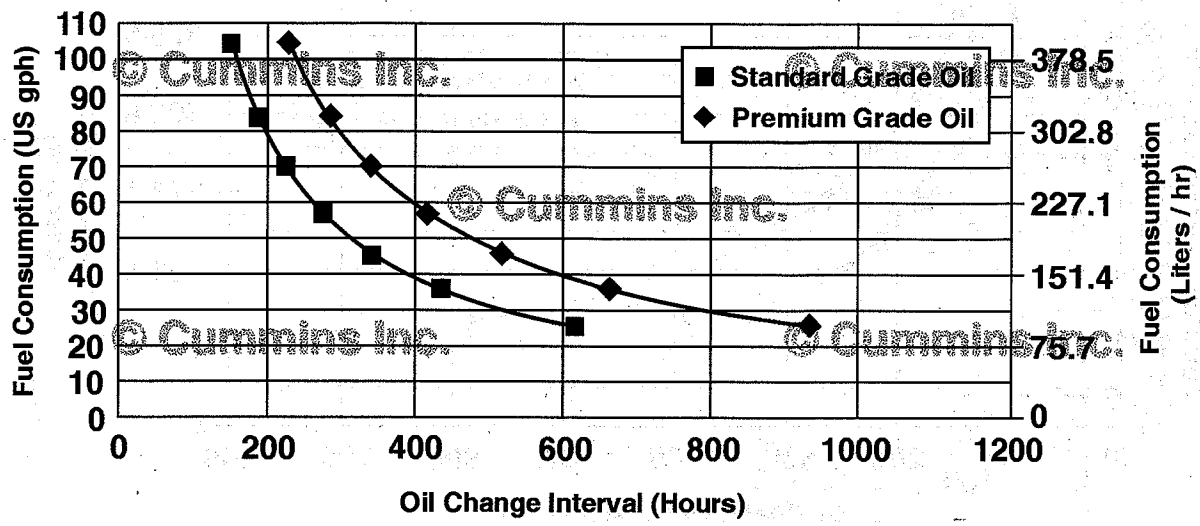
07600547

QSK45 Oil Change Interval
174 Liter (46 US Gallon) Sump



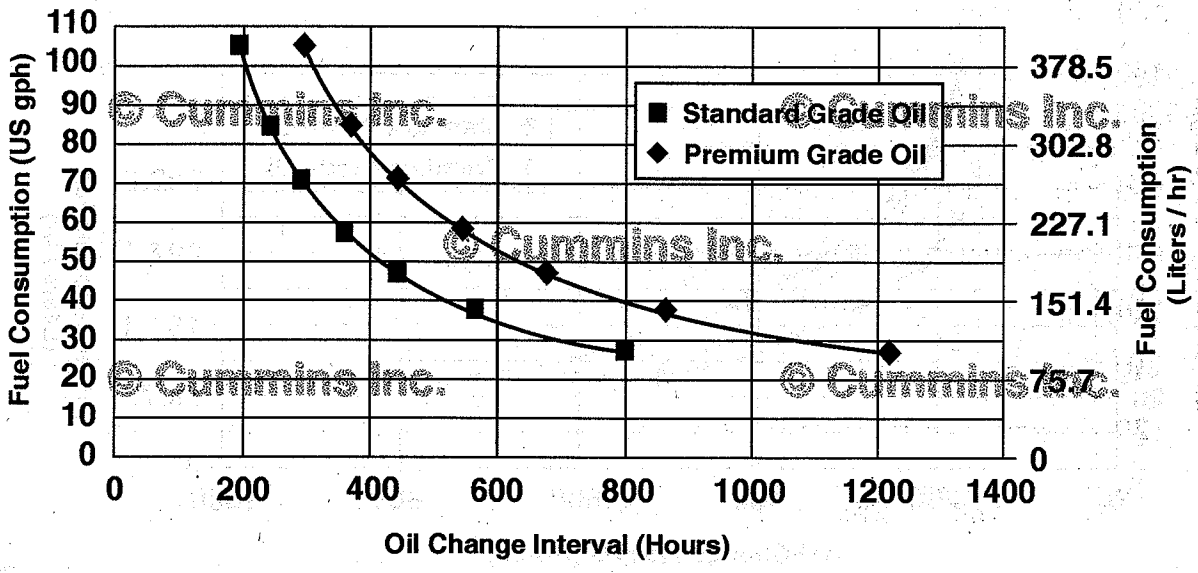
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QSK45 Oil Change Interval
215 Liter (57 US Gallon) Sump



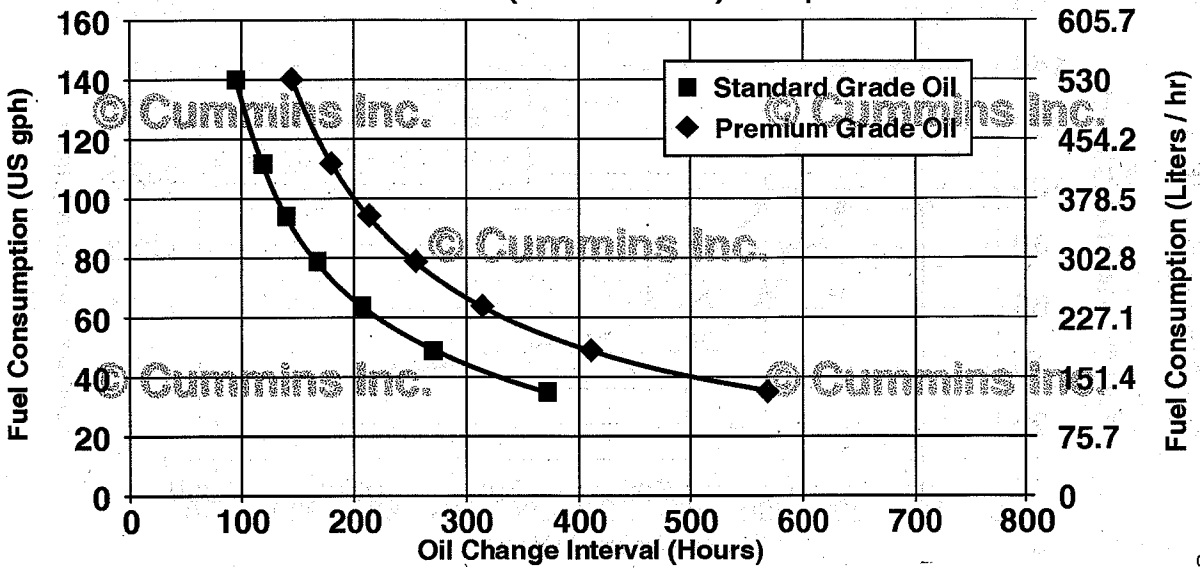
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QSK45 Oil Change Interval
284 Liter (75 US Gallon) Sump



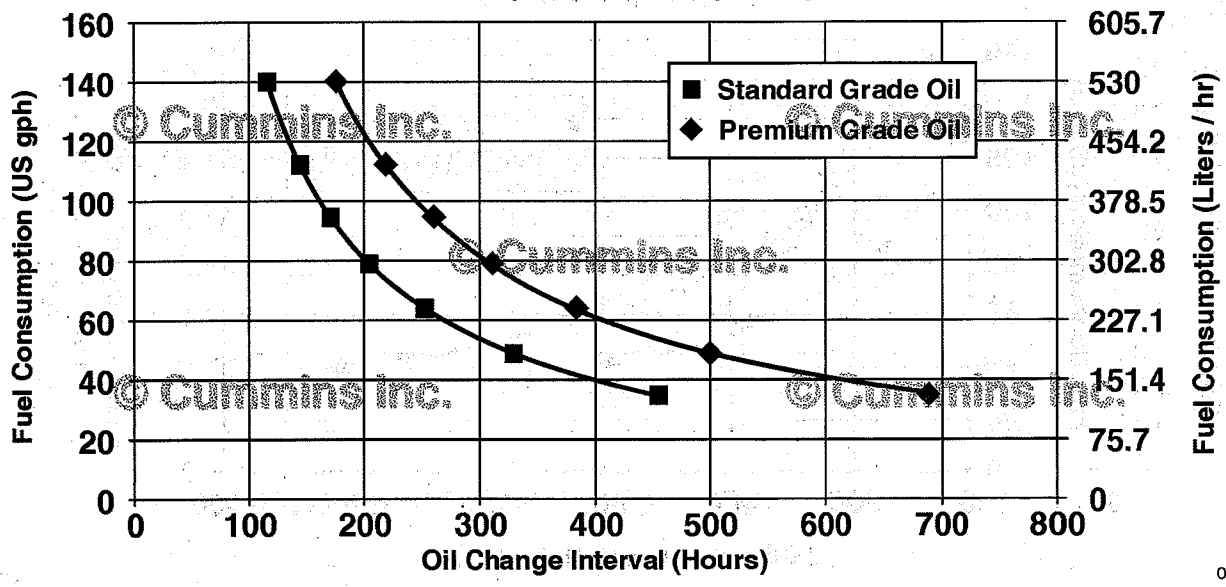
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QSK60 Oil Change Interval
177 Liter (47 US Gallon) Sump



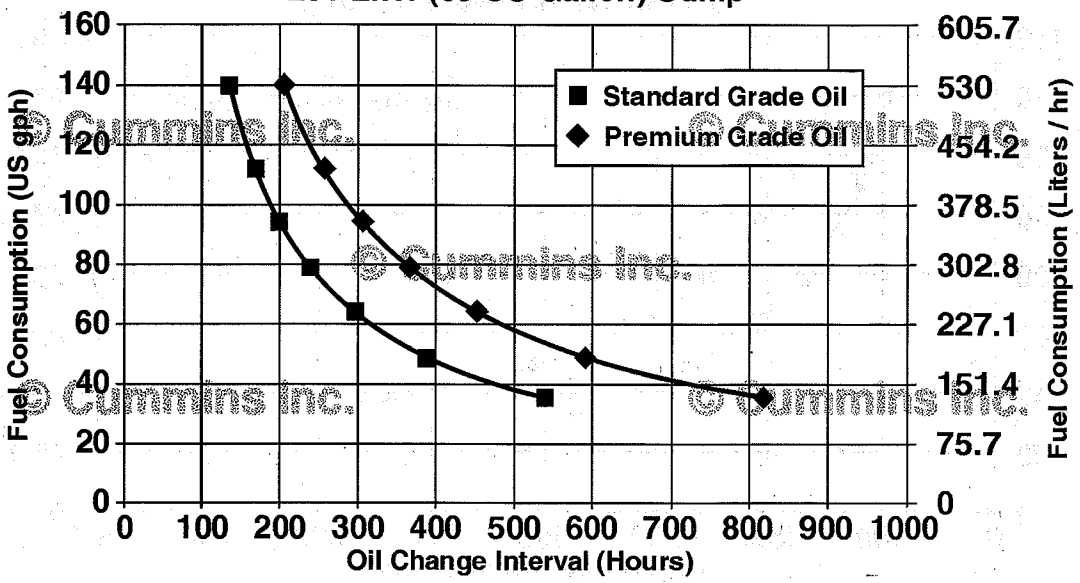
07600551

QSK60 Oil Change Interval
218 Liter (58 US Gallon) Sump



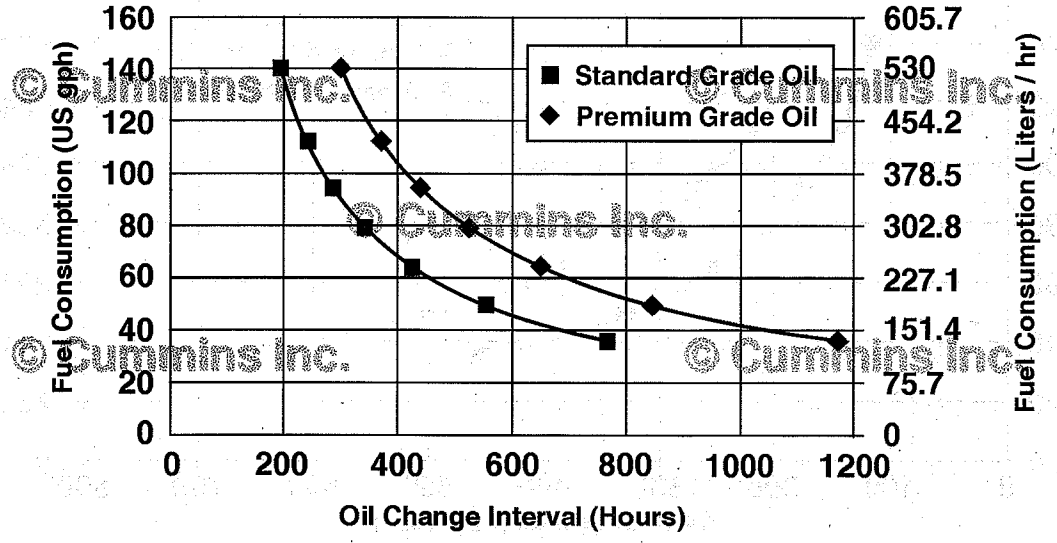
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QSK60 Oil Change Interval
261 Liter (69 US Gallon) Sump



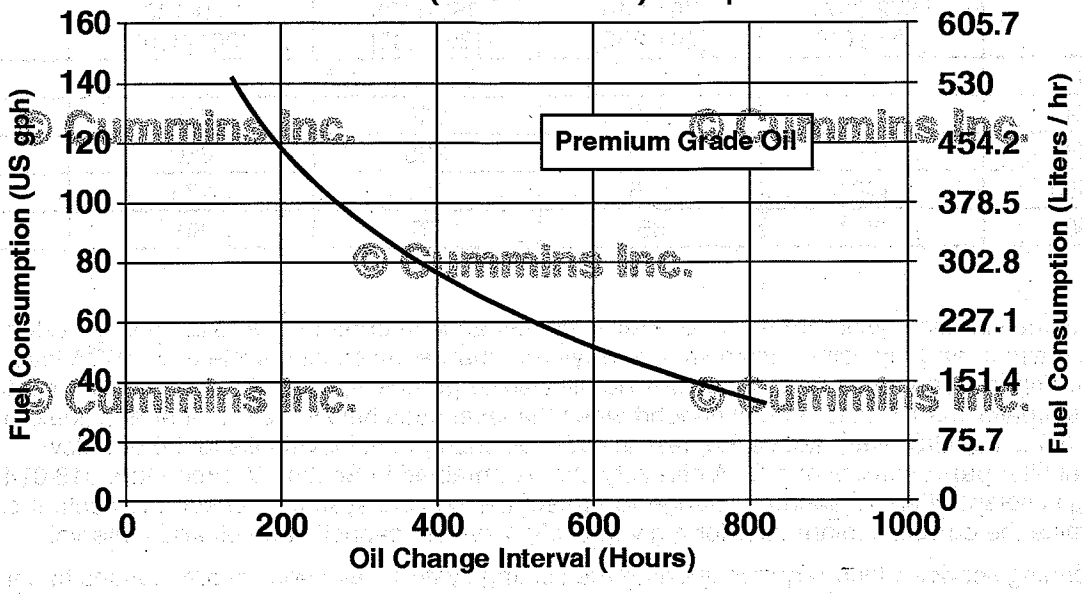
07600553

QSK60 Oil Change Interval
378 Liter (100 US Gallon) Sump



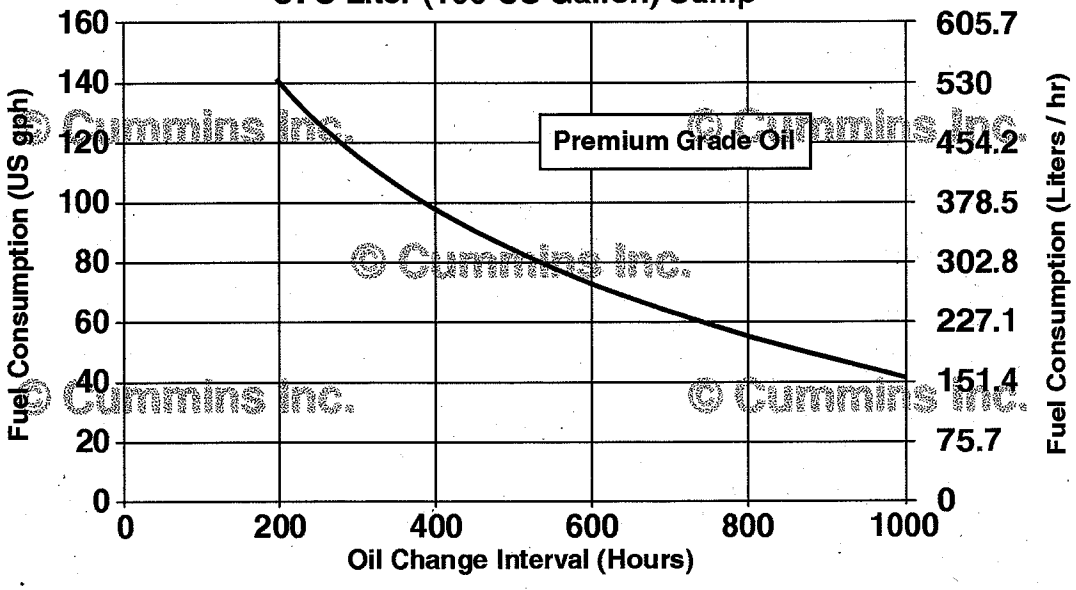
07600554

QSK60-G6 Low Nox (FR 6371) Oil Change Interval
261 Liter (69 US Gallon) Sump



07600555

QSK60-G6 Low Nox (FR 6371) Oil Change Interval
378 Liter (100 US Gallon) Sump



07600556

Coolant Drain Interval

Maintenance Intervals for Cooling System up to 568 liters [150 gal]					
System Size in liters [gal]					
	79-144 [21-30]	117-189 [31-50]	193-284 [51-75]	288-378 [76-100]	382-568 [101-150]
Hours	Units of SCA				
751-1000	25	50	80	75	150
501-750	20	35	60	100	110
251-500	15	25	40	50	75
0-250	10	15	20	25	40

Maintenance Intervals for Cooling Systems up to 1514 liters [400 gal]					
	System Size in liters [gal]				
	572-757 [151-200]	761-946 [201-250]	950-1135 [251-300]	1139-1325 [301-350]	1329-1514 [351-400]
Hours	Units of SCA				
751-1000	200	250	300	350	400
751-1000	150	190	225	260	300
251-500	100	125	150	175	200
0-250	50	65	75	90	100

Notes:

A. Consult the vehicle equipment manufacturer's maintenance information for total cooling system capacity.
B. When draining and replacing the coolant, **always** pre-charge the cooling system to a SCA level of 1.5 units per gallon. This concentration level **must not** be allowed to go below 1.2 units and **must** be controlled when the level is greater than 3 units. Action needed when the level goes below 1.2 is a filter and liquid pre-charge; from 1.2 to 3.0 units, filter **only**; above 3.0, test at every oil change until level falls to 3.0 or below.
C. Coolant filter part numbers and SCA capacity can be obtained in Section V, procedure 018-024.
A. Change coolant filters at each oil change to protect the cooling system. Consult the coolant capacity chart to determine the correct coolant filter for a given cooling system capacity and oil drain interval.

When performing service which requires draining the cooling system, take special precautions to collect it in a clean container, seal it to prevent contamination, and save for reuse.

Maintenance Record Form

Maintenance Data

Maintenance Record	
Engine Serial No.:	Engine Model:
Owner's Name:	Equipment Name/Number:

Key to table headings:
A = Date
B = km [Miles], Hours or Time Interval
C = Actual km [Miles] or Hours
D = Maintenance Check Performed
E = Check Performed By
F = Comments

A	B	C	D	E	F

Notes

Section 3 - Maintenance Procedures at Daily Interval

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Daily Maintenance Procedures - Overview

General Information

Preventative maintenance begins with day-to-day awareness of the engine and its system. Before starting the engine, check the oil and coolant levels. Look for:

- Leaks
- Loose or damaged parts
- Worn or damaged belts
- Any change in engine appearance.
- Odor of fuel

Engine Operation Report

The engine **must** be maintained in top mechanical condition if the operator is to get optimum satisfaction from its use. The maintenance department needs daily running reports from the operator to make necessary adjustments in the time allocated. The daily running report also helps to make provisions for more extensive maintenance work as the reports indicate the necessity.

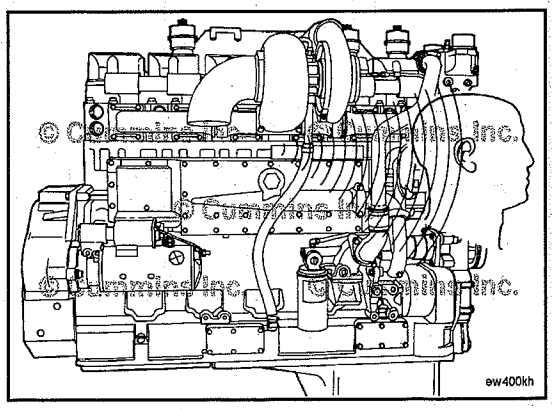
Comparison and intelligent interpretation of the daily report, along with a practical follow-up action, will eliminate most failures and emergency repairs.

Report to the maintenance department any of the following conditions:

- Low lubricating oil pressure
- Low power
- Power increases or engine surge
- Erratic or no accelerator control or response
- Any warning lights flashing or staying on
- Abnormal water or oil temperature
- Unusual engine noise
- Excessive smoke
- Excessive use of coolant, fuel, or lubricating oil
- Any fuel, coolant, or lubricating oil leaks
- Loose or damaged parts
- Worn or damaged belts

Unusual Engine Noise

During daily maintenance checks, listen for any unusual engine noise that can indicate that service is required.



Fuel-Water Separator

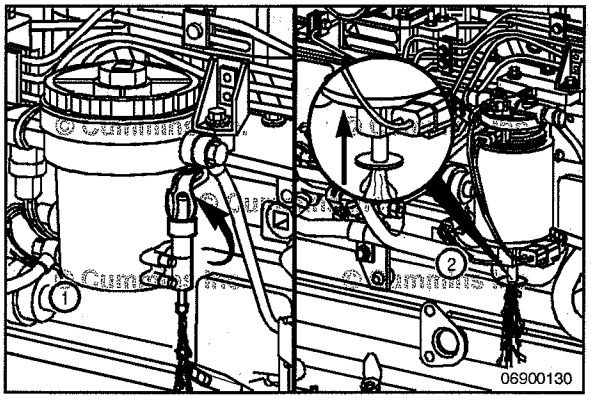
Drain

⚠WARNING⚠

Drain the water-fuel separator into a container and dispose of in accordance with local environmental regulations.

Cummins Inc. requires a fuel-water separator or fuel filter be installed in the fuel supply system.

Drain the water and sediment from the separator daily.

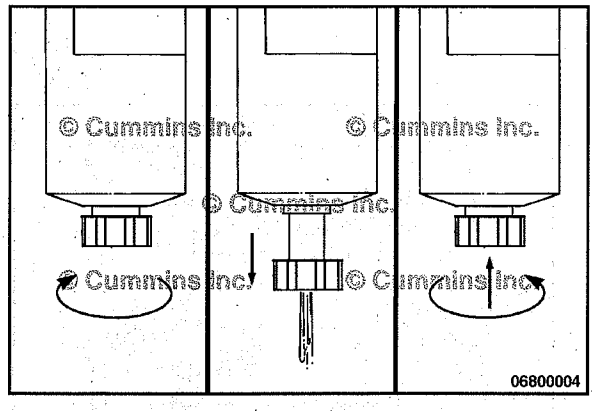


Canister Type

Shut off the engine.

Pull up on the drain valve lever until fluid drains out of the drain tube. Drain the filter sump until clear fuel is visible.

Push up on the drain valve until fluid drains out of the drain tube.



Spin-on Type

Shut off the engine.

Use your hand to open the drain valve. Turn the valve **counterclockwise** approximately 3½ turns until the valve drops down 25.4mm [1 in] and draining occurs.

Drain the filter sump until clear fuel is visible.

⚠CAUTION⚠

When closing the drain valve, do not overtighten the valve. Overtightening can damage the threads.

To close the valve, lift the valve and turn **clockwise** until it is hand-tight.

Lubricating Oil Level

Maintenance Check

Engine Off

⚠CAUTION⚠

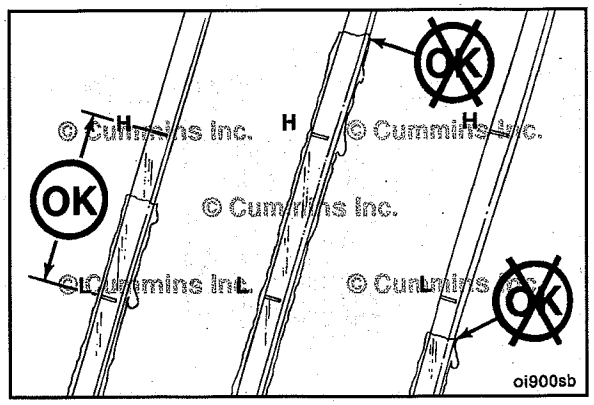
Never operate the engine with oil level below the L (low) mark or above the H (high) mark. Poor engine performance or engine damage can occur.

The engine **must** be level when checking the oil level to make sure the measurement is correct.

Shut off the engine for an accurate reading.

Wait at least 15 minutes after shutting off the engine to check the oil level. This allows time for the oil to drain into the oil pan.

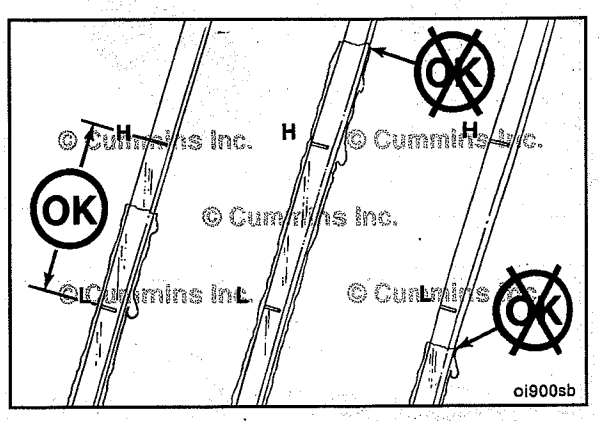
For additional lubricating oil recommendations and oil pan capacity information, refer to Maintenance Specifications (Section V).



Engine Running

- With the vehicle parked on level ground and the oil temperature 93°C [200°F] set the engine speed to low idle. Disengage any engine driven accessories and put transmission in neutral.
- Allow the engine to idle for 5 minutes for the oil in the oil pan to settle.
- Check the oil level 4 to 6 times.

For additional lubricating oil recommendations and oil pan capacity information, refer to Maintenance Specifications (Section V).



Marine Gear

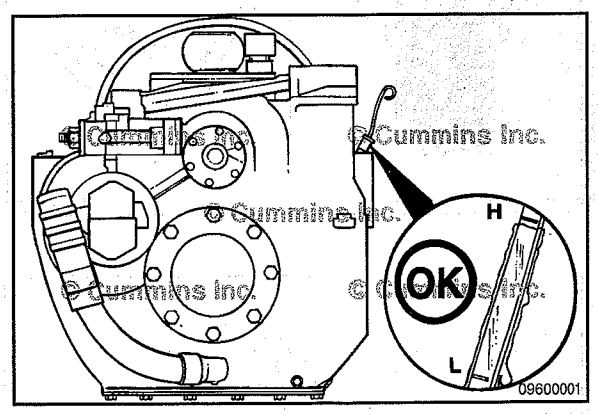
Maintenance Check

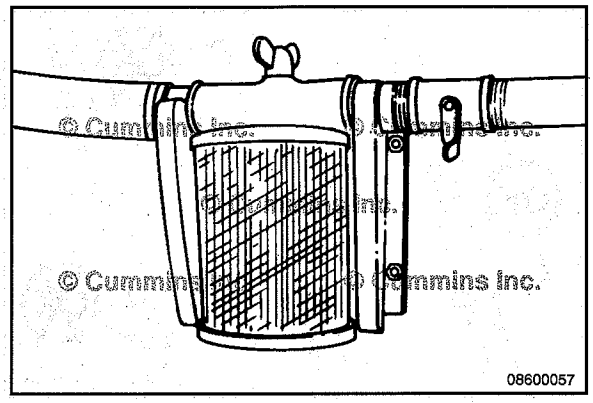
Marine Applications

Check the marine gear oil level daily.

Refer to the OEM's recommendations for the gear oil requirements.

NOTE: Different models of marine gears will have the marine gear oil dipstick and fill cap in different locations. The location shown is typical.



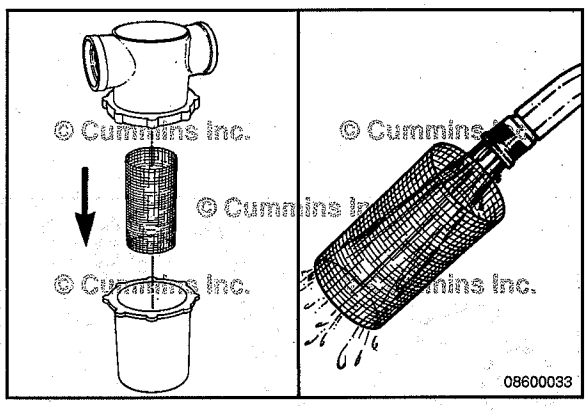


Sea Water Strainer

General Information

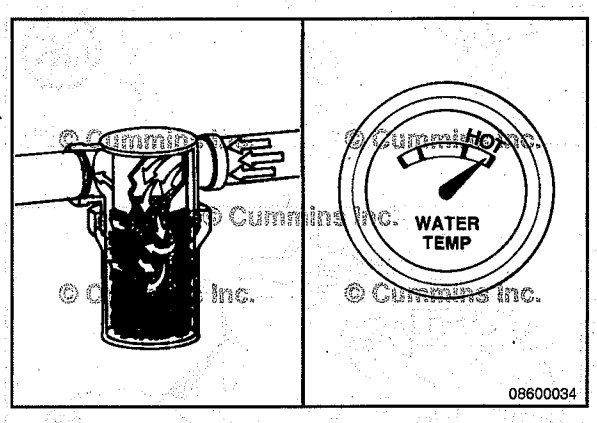
Marine Applications

NOTE: Most sea water systems for heat exchanger cooled engines use a sea water strainer. The strainer removes debris from the sea water before it enters the sea water pump.



NOTE: Sea water strainer arrangements may differ.

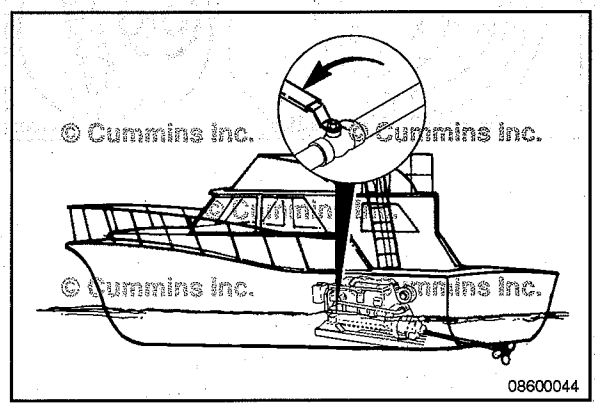
Inspect the sea water strainer daily for any foreign objects that could restrict water flow.



⚠CAUTION⚠

A restricted or clogged sea water strainer can result in hotter than normal, or overheated, engine coolant and marine gear oil temperatures.

For more detailed information, refer to Sea Water Strainer Cleaning in this section.

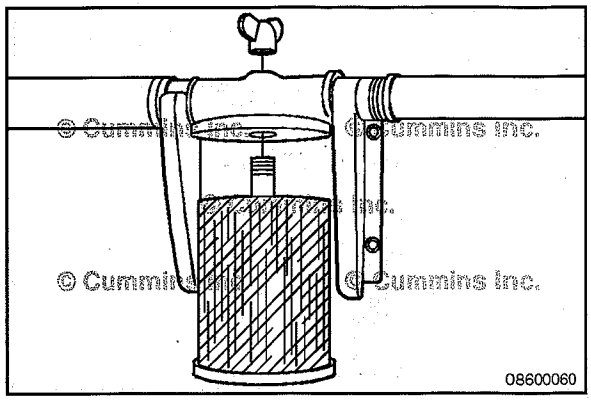


NOTE: If the sea water strainer is below the water level, close the sea water inlet valves before servicing the sea water strainer.

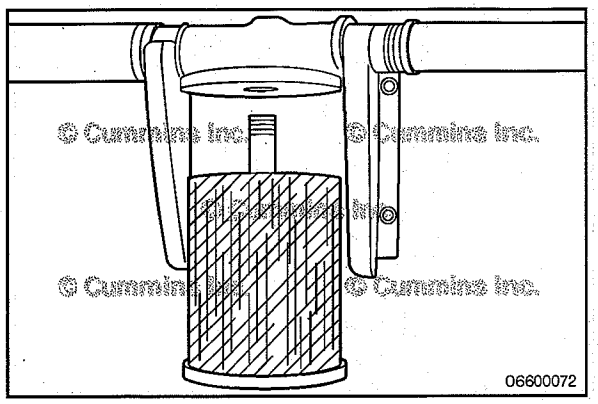
Disassemble

Marine Applications

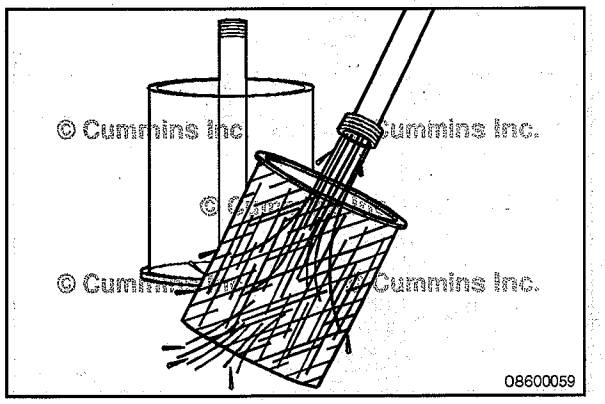
Loosen and remove the sea water strainer wing nut(s) as required.



Remove the sea water strainer assembly. Be careful **not** to damage o-ring. Retain and inspect for damage.



Remove the sea water strainer basket.

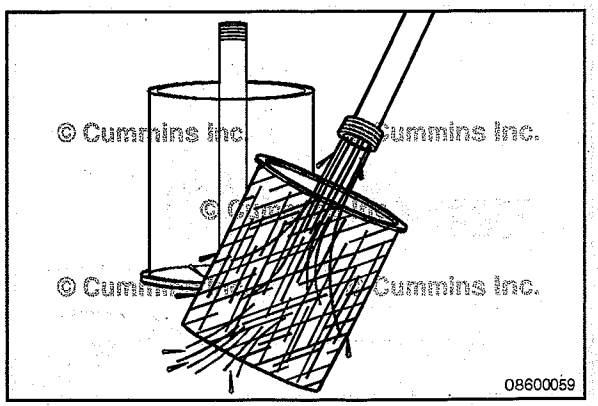


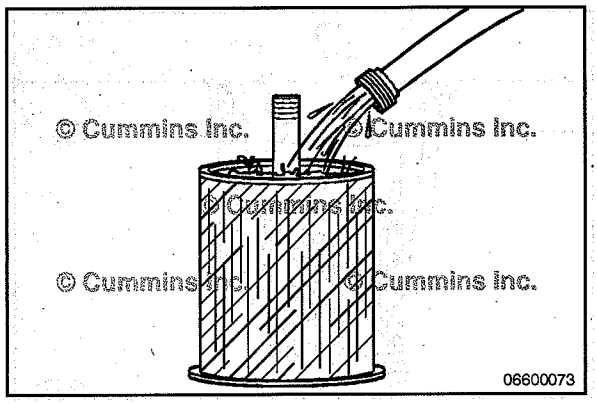
Clean

Marine Applications

Empty all debris from the sea water strainer basket.

Clean the sea water strainer.

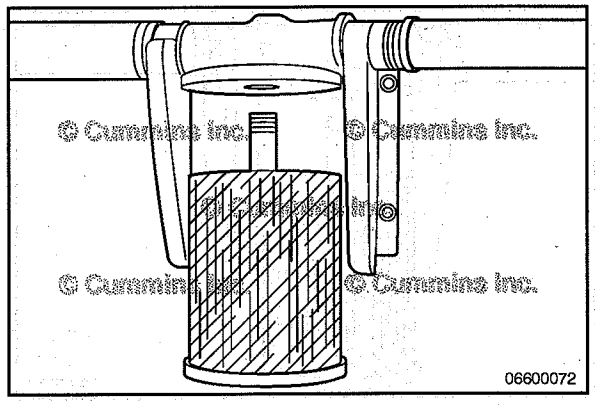




Prime

Marine Applications

Prime the sea water strainer with clean water.

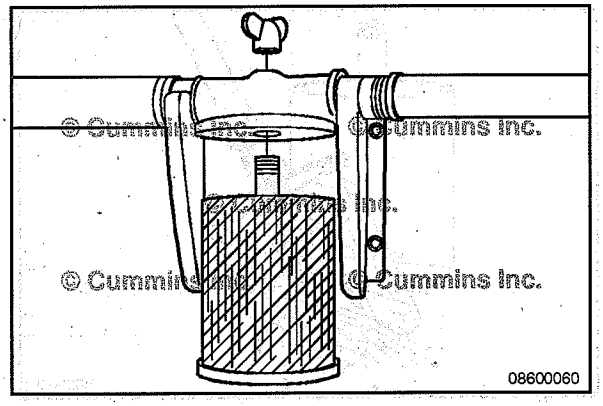


Assemble

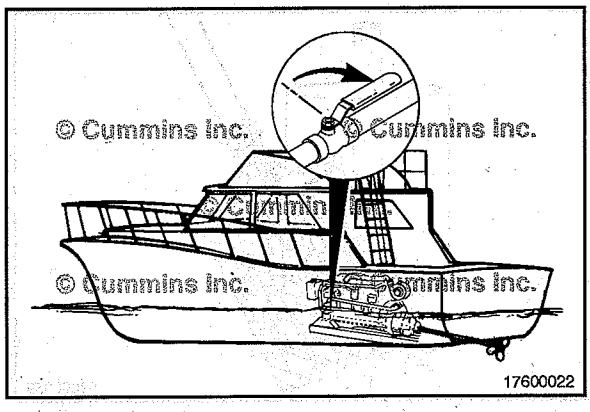
Marine Applications

Install the sea water strainer.

Inspect o-ring seal for tears or damage. Replace if necessary. Be sure o-ring is seated properly.



Install and tighten the wing nut(s).



Open the sea water inlet valves.

Eliminator Filter

Pressure Test

Perform the following steps to measure the pressure drop across the Eliminator Filter.

Remove one plug from each side at the top of the filter housing.

Install the pressure gauges in the ports.

Operate the engine to normal operating temperature.

Record the readings from both gauges.

The difference between the two measurements is the pressure drop across the filter.

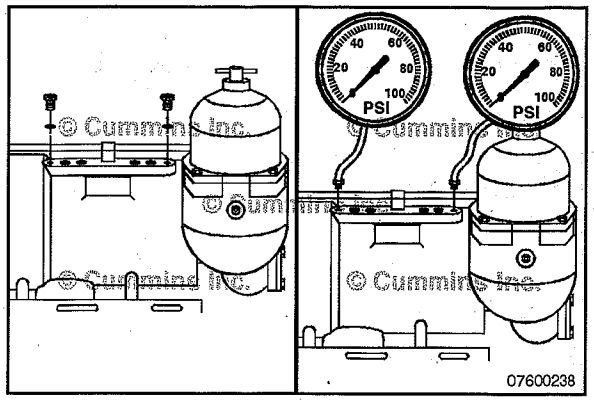
The maximum operating pressure drop **must not** exceed 39.9 kPa [5.8 psi]. If the pressure drop is greater, refer to Section TS.

Remove the pressure gauges.

Install the plugs.

Tighten the plugs.

Torque Value: 10 N•m [96 in-lb]



Rotation Check

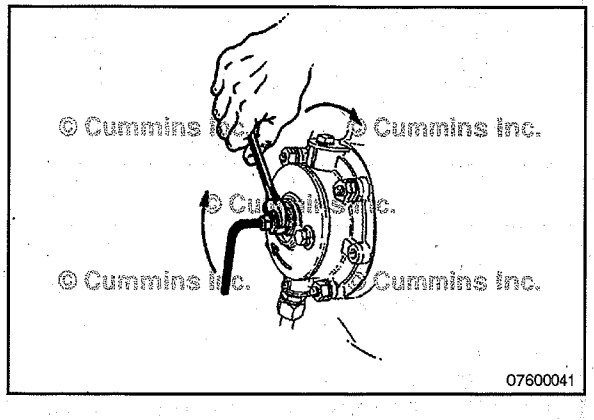
⚠CAUTION⚠

To reduce the possibility of damage to the operating indicator, do not use a pipe on the end of the operating indicator.

The rotation check is performed by manually turning the pump.

Only perform the rotation test when directed by the Troubleshooting Symptom Charts in Section TS.

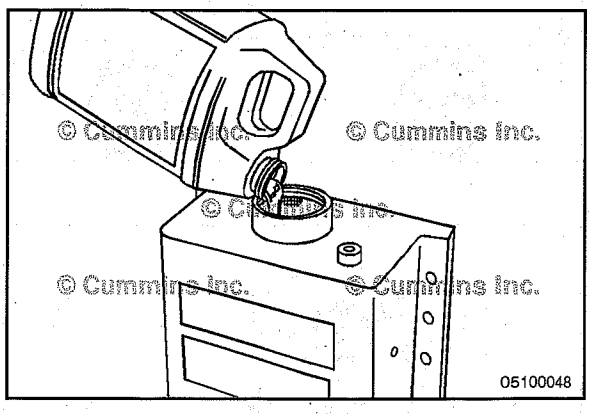
Manually turn the operating indicator two revolutions within 30 seconds.

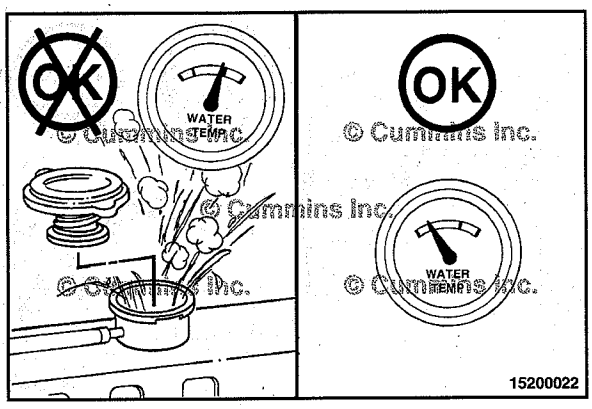


Centinel™ Oil Level

Maintenance Check

Centinel tank oil level should be checked daily to ensure that there is enough oil to operate the engine. Some tanks may be OEM supplied, refer to the OEM manufacturer's instructions for checking oil level in those installations. It is critical that engine oil level in the engine sump be checked daily even when using a makeup tank. Refer to procedure 007-043.





Coolant Level

Maintenance Check

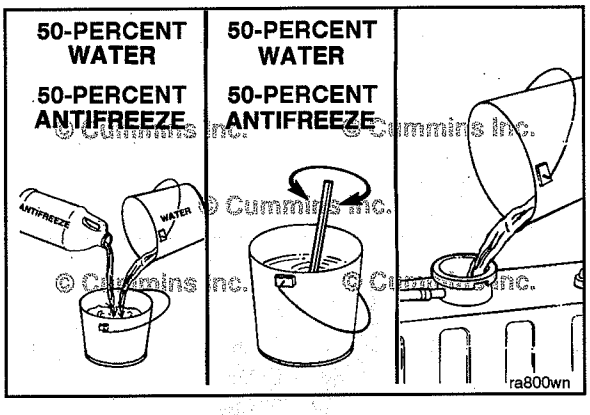
⚠WARNING⚠

Do not remove a pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

⚠CAUTION⚠

Never use a sealing additive to stop leaks in the cooling system. This can result in cooling system plugging and inadequate coolant flow, causing the engine to overheat.

The coolant level **must** be checked daily.

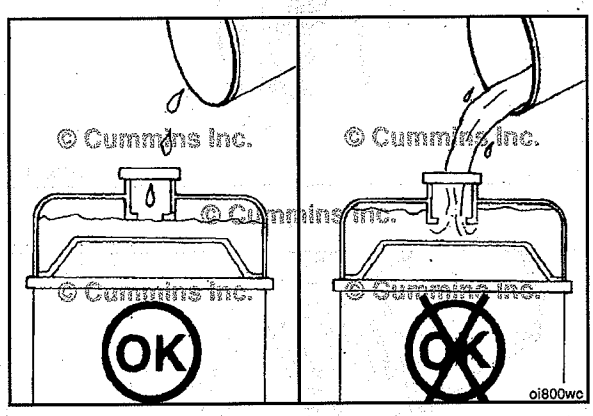


⚠CAUTION⚠

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50°C [120°F] before adding coolant.

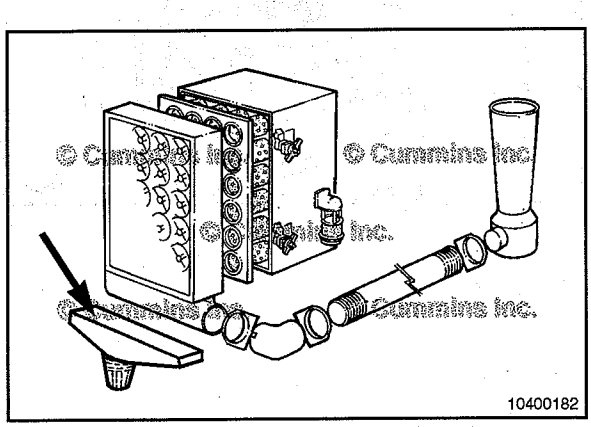
Make up coolant added to the engine **must** be mixed with the correct proportions of antifreeze, supplemental coolant additive, and water to avoid engine damage.

Coolant recommendations and specification details on correct mixing of coolant can be found in Maintenance Specifications (Section V).



Fill the cooling system with coolant to the bottom of the fill neck in the radiator fill or expansion tank.

NOTE: Some radiators have two fill necks, both of which **must** be filled when the cooling system is drained.



Air Cleaner Precleaner

Maintenance Check

Under extremely dirty conditions, an air precleaner can be used. Clean the precleaner jar and dry-type air cleaner dust pans daily or, if necessary, more often, depending on operating conditions.

Air Intake Piping

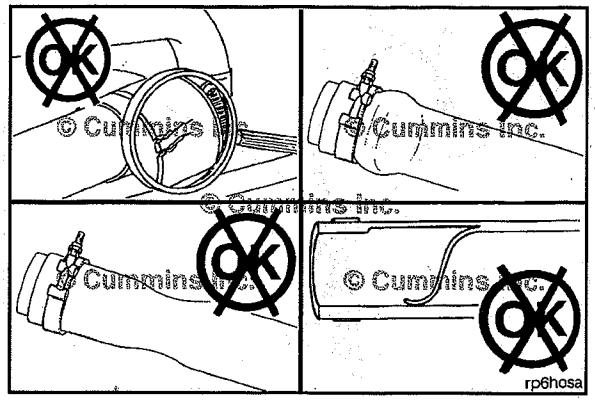
Maintenance Check

Visually inspect the intake piping daily for wear points and damage to piping, loose clamps, or punctures that can damage the engine.

Replace damaged pipes, and tighten loose clamps, as necessary, to prevent the air system from leaking.

Torque Value: 8 N•m [72 in-lb]

Check for corrosion under the clamps and hoses of the intake system piping. Corrosion can allow corrosive products and dirt to enter the intake system. Disassemble and clean, as required.



Air Cleaner Restriction

Maintenance Check

Mechanical Indicator

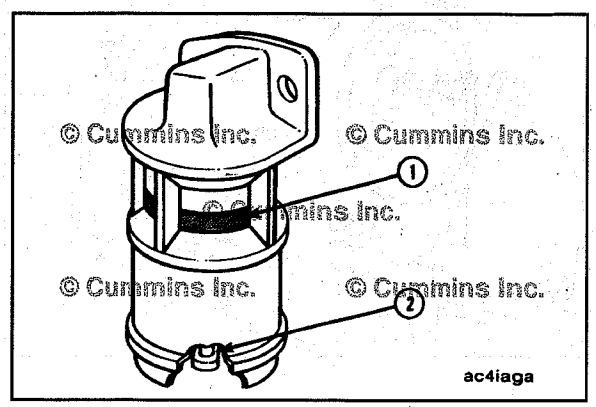
NOTE: Do **not** remove the felt washer from the indicator. The felt washer absorbs moisture.

A mechanical restriction indicator is available to indicate excessive air restriction through a dry-type air cleaner. This instrument can be mounted in the air cleaner outlet or on the instrument panel. The red flag (1) in the window gradually rises as the cartridge loads with dirt. After changing or replacing the cartridge, reset the indicator by pushing the reset button (2).

Restriction or vacuum indicators need to be installed as close as possible to the turbocharger air inlet in order to obtain a true indication of restrictions.

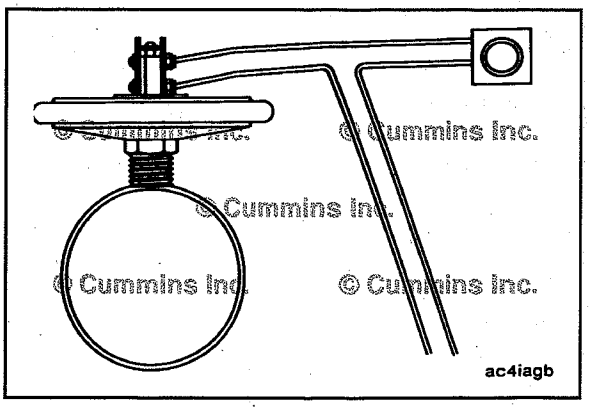
⚠CAUTION⚠

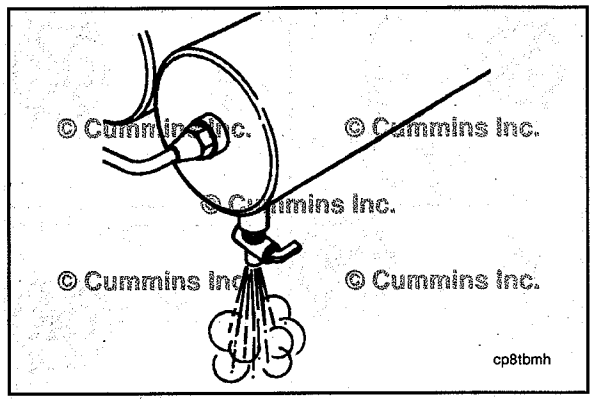
Never operate the engine without an air cleaner. Intake air must be filtered to prevent dirt and debris from entering the engine and causing premature wear.



Vacuum Indicator

Vacuum switches actuate a warning light on the instrument panel when the air restriction becomes excessive.

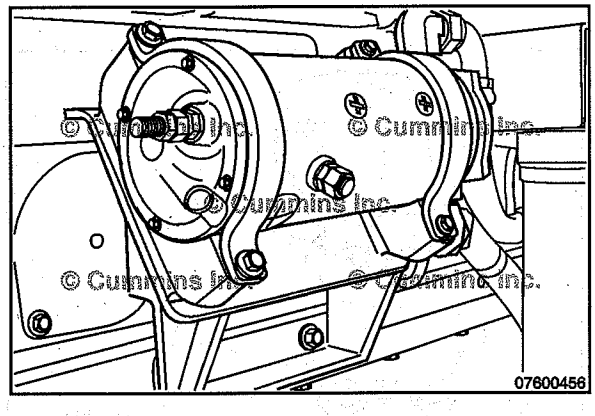




Air Tanks and Reservoirs

Drain

If automatic purging or spitter valves are used, confirm the valves are operating correctly. If a manual drain valve is used on the wet tank, open the draincock on the wet tank to drain any moisture accumulated in the air system. If oil is present, the air compressor system **must** be checked. Contact your Cummins Authorized Repair Location.



Pre-Lubricating Oil Pump

Inspect

Engines equipped with a prelubricating oil system **must not** be operated when the prelubricating oil system in **not** working.

Make sure the prelubricating oil system wiring is connected. Refer to Normal Starting procedures in Section 1 to start the engine. The starting motor will **not** engage until adequate oil pressure is obtained. If the engine has **not** been in operation for some time there will be a delay before the starting motor is engaged. This delay (up to 30-seconds) is normal.

Section 4 - Maintenance Procedures at 250 Hours or 6 Months

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Maintenance Procedures - Overview

General Information

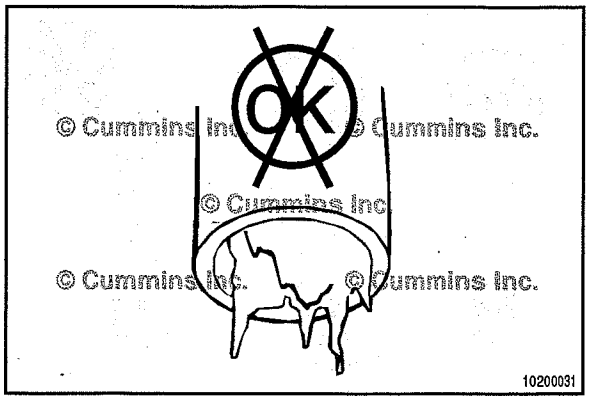
All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Crankcase Breather Tube

Maintenance Check

Inspect the breather tube for sludge, debris, or ice in the tube.

Inspect the tube more frequently in icy conditions.

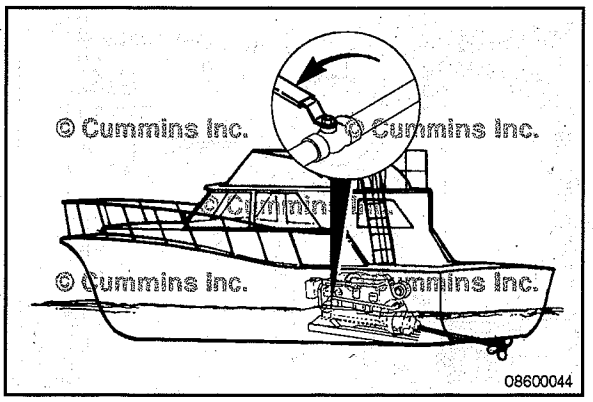


Zinc Anode

Remove

Marine Applications

Shut off the sea water inlet valve on the vessel hull.

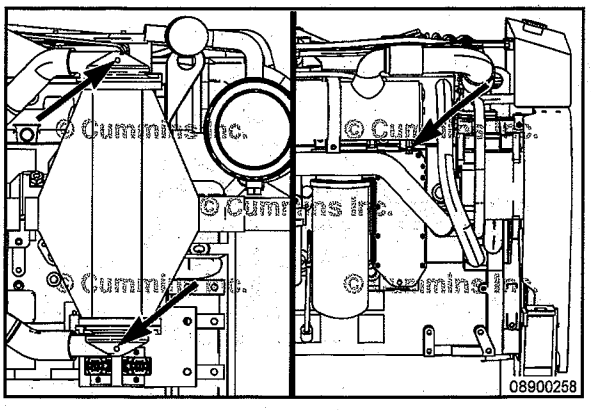


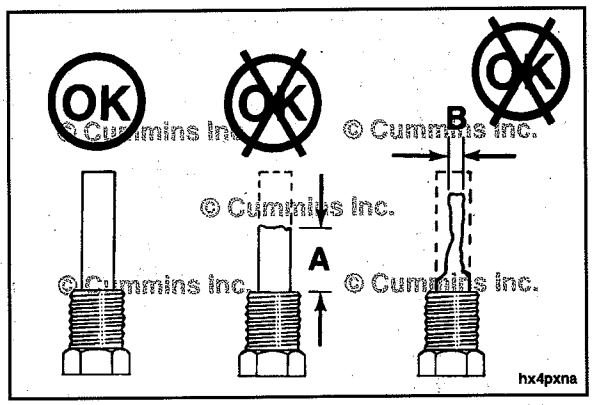
⚠CAUTION⚠

In some cases, it will be necessary to hold the welded fitting on the heat exchanger with an additional wrench to prevent damage to the heat exchanger.

Remove the zinc plug(s).

NOTE: The illustration shown is generic. For engine-specific locations, refer to Section E.



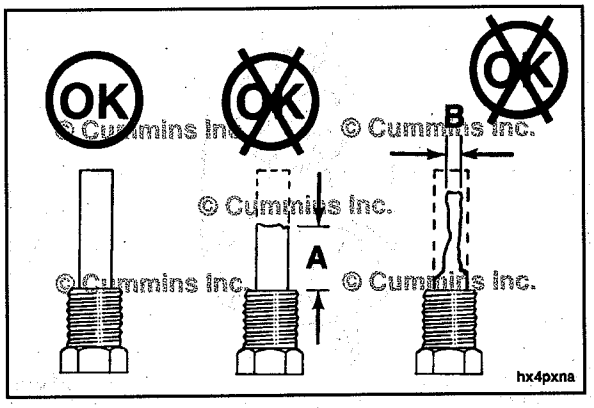


Inspect for Reuse

Marine Applications

Measure the length of the zinc plug(s) removed from the heat exchanger. Replace any zinc plug if it is 50 percent or more eroded.

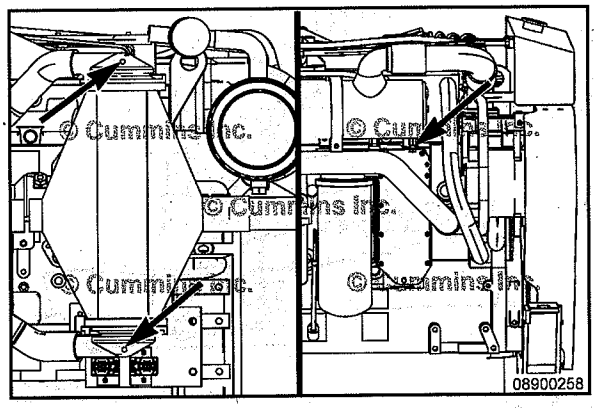
NOTE: The frequency of change depends on the chemical reaction of the sea water circulated through the heat exchanger.



Zinc Plug Erosion Limits

	mm		in
A	19.0	MIN	0.750
New	51.0	MAX	2.000
B	6.4	MIN	0.250
New	16.0	MAX	0.630

NOTE: If any zinc plug does **not** meet specification, replace it with a new zinc plug.



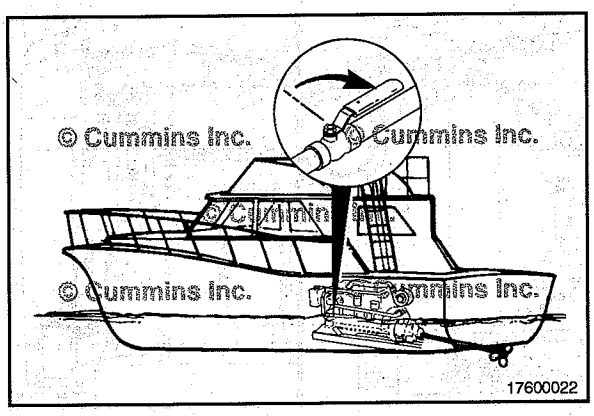
Install

Marine Applications

Install and tighten the zinc plug(s).

NOTE: Do **not** use Teflon™ tape or pipe sealant on the threads of the sacrificial zinc plugs. Use of any type of sealant will insulate the zinc anode and prevent a good ground.

Torque Value: 44 N•m [33 ft-lb]



Open the sea water valve on the vessel hull.

Supplemental Coolant Additive (SCA) and Antifreeze Concentration

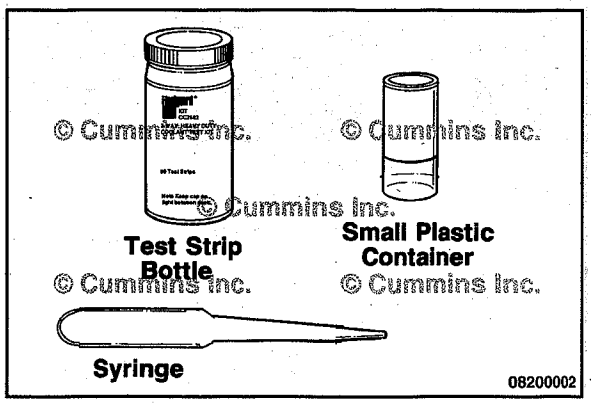
Maintenance Check

Supplemental Coolant Additive (SCA)

Check the SCA concentration level:

- At least twice a year
- At every subsequent oil drain interval if the concentration is above 3 units
- Whenever coolant is added to the cooling system between filter changes.

Use Fleetguard® coolant test kit, Part No. CC2602, to check the SCA concentration level. Instructions are included with the test kit. Refer to Coolant Recommendations and Specifications in Maintenance Specifications (Section V) for the correct SCA and antifreeze level.



Antifreeze

⚠CAUTION⚠

Overconcentration of antifreeze or use of high-silicate antifreeze can damage the engine.

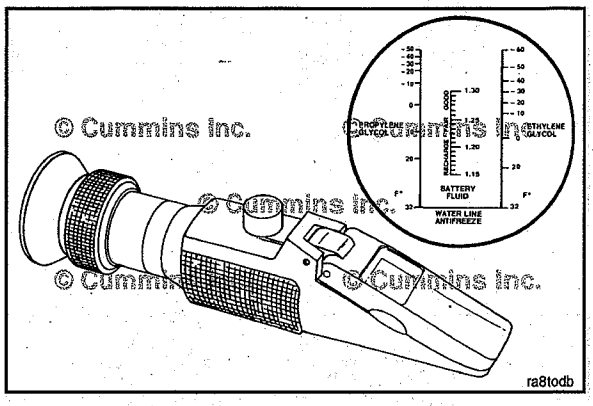
Check the antifreeze concentration. Use a mixture of 50-percent water and 50-percent ethylene glycol or propylene glycol-based antifreeze to protect the engine to -32°C [-26°F] year-around.

The Fleetguard® refractometer, Part Number C2800, provides a reliable, easy-to-read, and accurate measurement of freezing point protection and glycol (antifreeze) concentration.

Antifreeze is essential in every climate.

Antifreeze broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point.

The corrosion inhibitors also protect the cooling system components from corrosion and prolong component life.

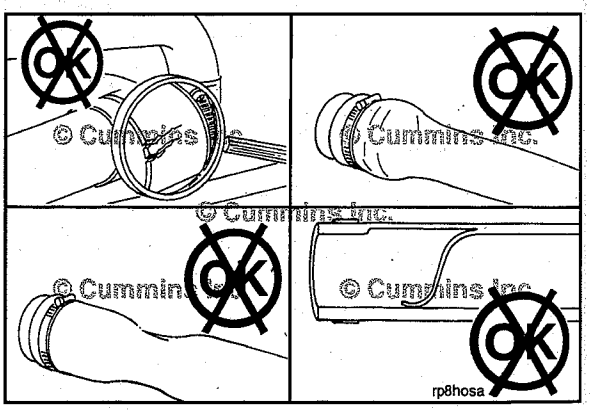


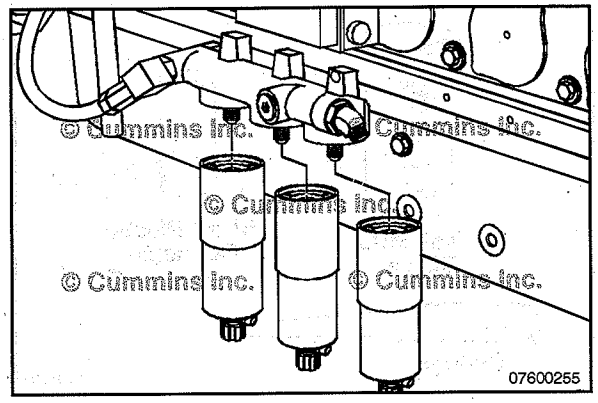
Hoses, Engine

Maintenance Check

Check all hoses for cracks, cuts, or collapsing.

NOTE: The silicone engine coolant hose will exhibit swelling due to the elasticity of the hose.





Fuel Filter (Spin-On Type)

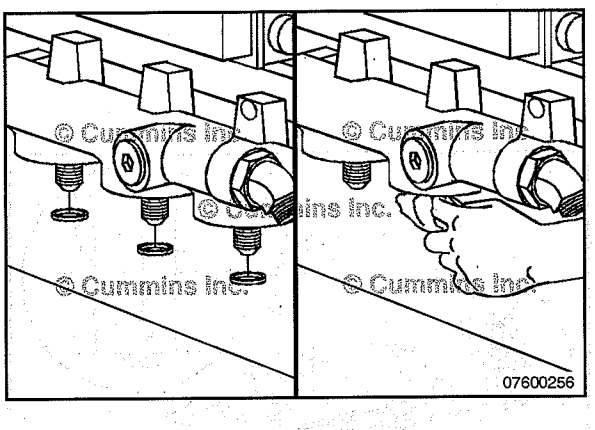
Remove

⚠WARNING⚠

Fuel is flammable. Keep all cigarettes, flames, pilot lights, arcing equipment, and switches out of the work area and areas sharing ventilation to reduce the possibility of severe personal injury or death when working on the fuel system.

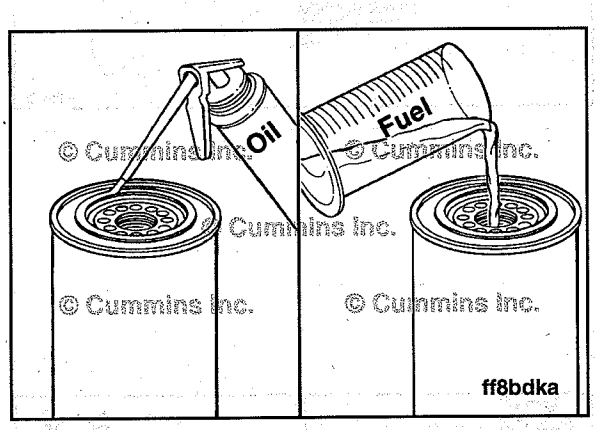
Close the fuel line shutoff valve before changing the fuel filters, or the overhead tank can drain, causing a fuel leak.

Remove the fuel filter with filter wrench.



Remove the thread adapter sealing ring(s).

Clean sealing surfaces of the filter head with a clean lint free towel.



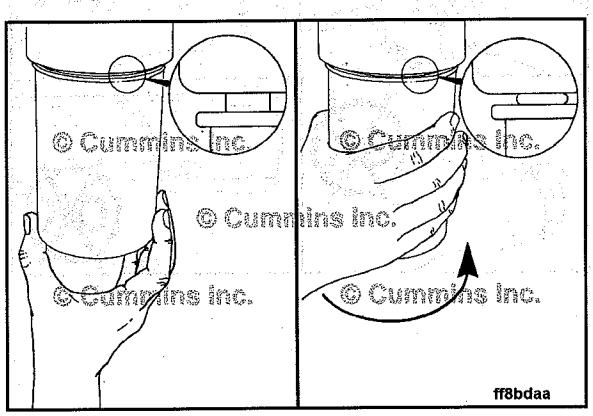
Install

A fuel-water separator or fuel filter and water separator combination **must** be installed.

Install a new thread adapter sealing ring supplied with the new filter. Refer to Procedure 018-024 (Cummins®/ Fleetguard®, Nelson Filter Specifications) in Section V of the Operation and Maintenance Manual, K38 and K50 Engines, Bulletin 3810497, or the Operation and Maintenance Manual, QSK45 and QSK60 Engines, Bulletin 3666260, for fuel filter specifications.

Apply a light coating of clean engine oil to the surface of the filter gasket.

Fill the fuel filter with clean fuel.



Install the filter on the filter head. Turn the filter until the gasket touches the surface of the filter head.

Tighten the filter an additional ½ to ¾ of a turn after the gasket touches the filter head surface.

Open the fuel line shutoff valve and check for leaks.

Drive Belts

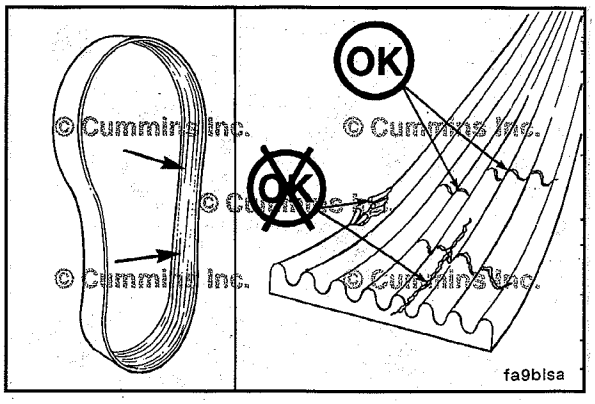
Maintenance Check

Poly-Vee Belt

Inspect the belts daily. Check the belt for intersecting cracks. Traverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are **not** acceptable. Replace the belt if it is frayed or has pieces of material missing. Refer to Section A for belt adjustment and replacement procedures.

Belt damage can be caused by:

- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil or grease on the side of belts.



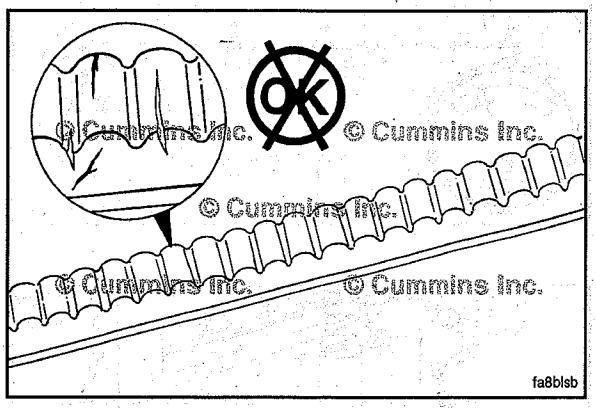
Cogged Belt

Inspect the belts daily. Replace the belts if they are cracked, frayed, or have chunks of material missing. Small cracks are acceptable.

Adjust the belts that have a glazed or shiny surface, which indicates belt slippage. Correctly installed and tensioned belts will show even pulley and belt wear. Refer to Section A for belt adjustment and replacement procedures.

Belt damage can be caused by:

- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil or grease on the belts

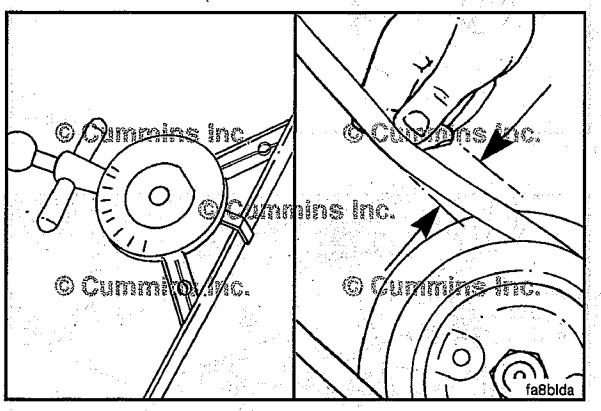


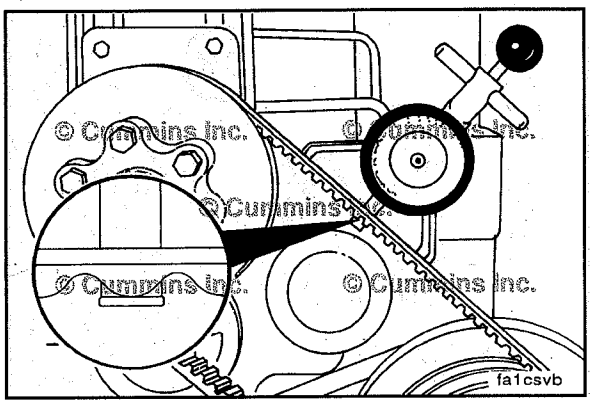
Measure the belt tension in the center span of the pulleys.

Refer to the Belt Tension Chart in Section V for the correct gauge and tension value for the belt width used.

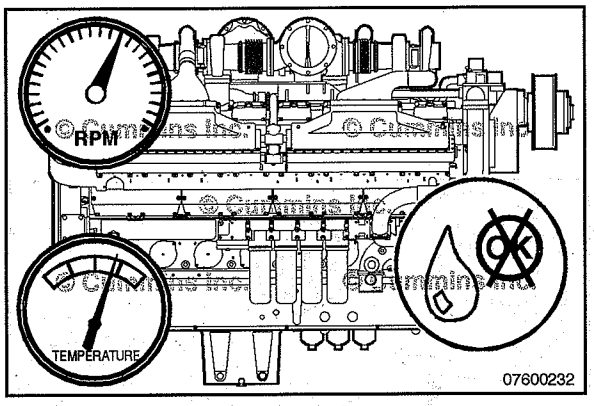
An alternate method (deflection method) can be used to check belt tension by applying 110 N [25 lbf] force between the pulleys on v-belts. If the deflection is more than one belt thickness per foot of pulley center distance, the belt tension **must** be adjusted.

Refer to Section A for adjustment procedures.





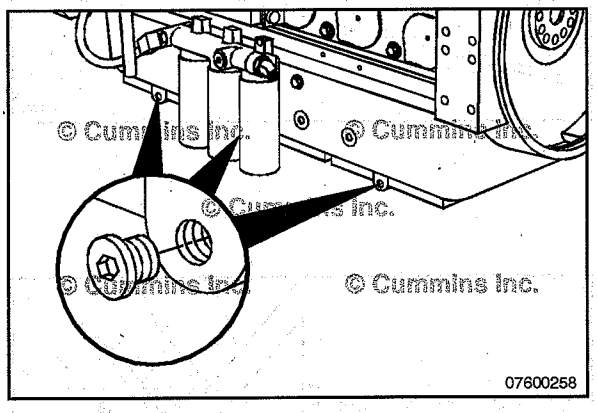
For cogged belts, **make sure** that the belt tension gauge is positioned so that the center tensioning leg is placed directly over the high point (hump) of a cog. Other positioning will result in incorrect measurement.



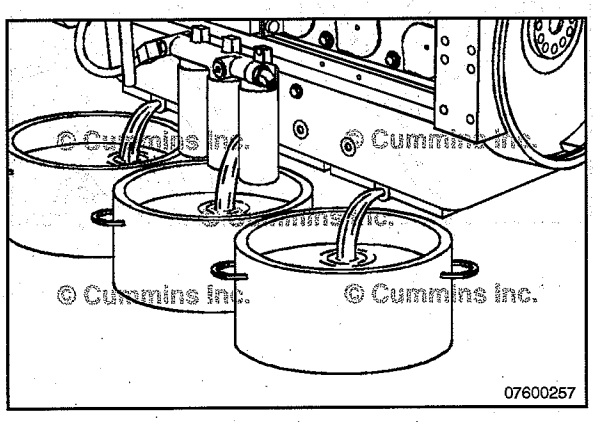
Lubricating Oil and Filters

Drain

Operate the engine until the water temperature reaches 60°C [140°F].



The QSK45 and QSK60 engines have various lubricating oil pan configurations. Remove all drain plugs when draining the oil pan.



⚠WARNING⚠

Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠WARNING⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

Remove the oil drain plugs and drain the oil immediately to make sure all of the suspended contaminates are removed from the engine.

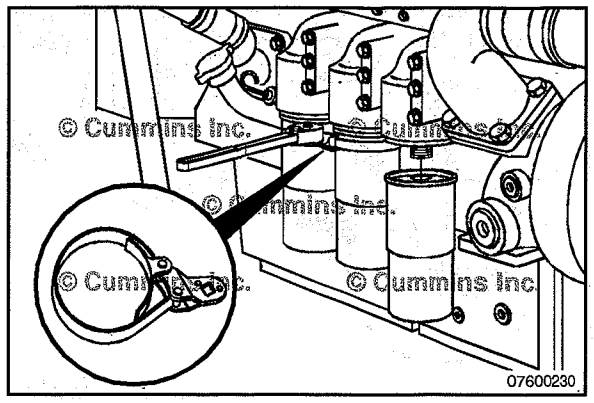
Remove

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

The QSK45 engine has three combination oil filters and the QSK60 has four combination oil filters.

Use an oil filter wrench, Part Number 3375049, or equivalent to remove the oil filters.

Discard the filter if **not** required for failure analysis.

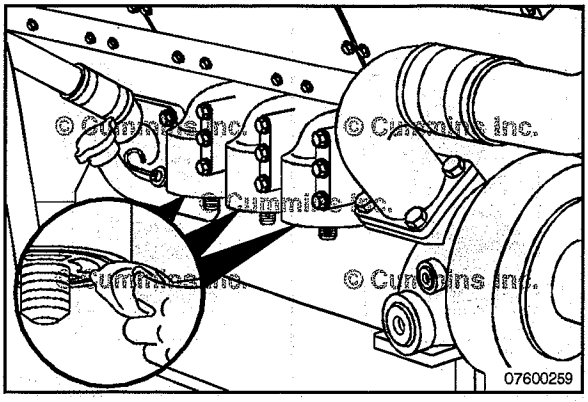


Clean

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

NOTE: The oil filter o-ring can stick on the filter head. Make sure it is removed.

Clean the oil filter head sealing surface with a lint free cloth.

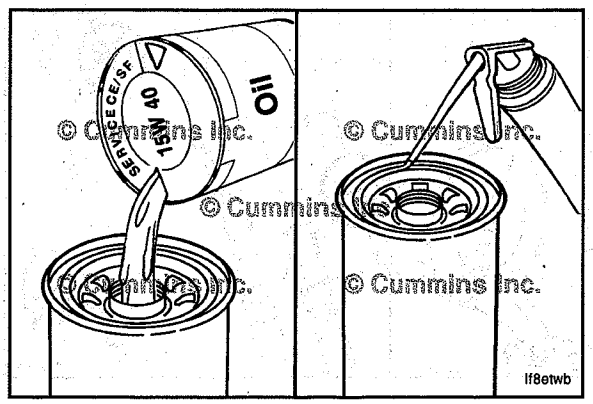


Install

The QSK45 engine has three combination oil filters and the QSK60 engine has four combination oil filters.

Use engine oil to lubricate the oil filter's rubber seal.

Fill the oil filters with clean engine oil.

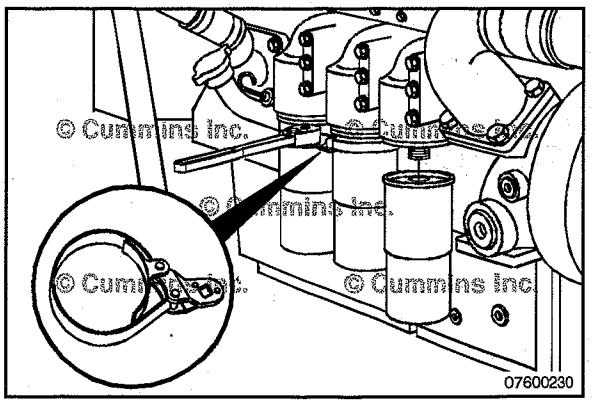


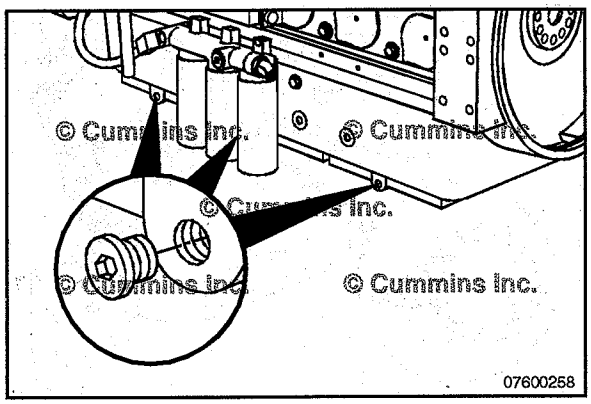
⚠CAUTION⚠
Mechanical overtightening can distort the threads or damage the filter element seal. If the threads appear damaged, replace the oil filter head adapter.

⚠CAUTION⚠
Locate the oil filter wrench, Part Number 3375049, near the top of the oil filter canister. This will reduce the possibility of damaging the oil filter.

Install the oil filter, turning it until the seal contacts the filter head's sealing surface.

Turn the oil filter an additional 3/4 to 1 turn.

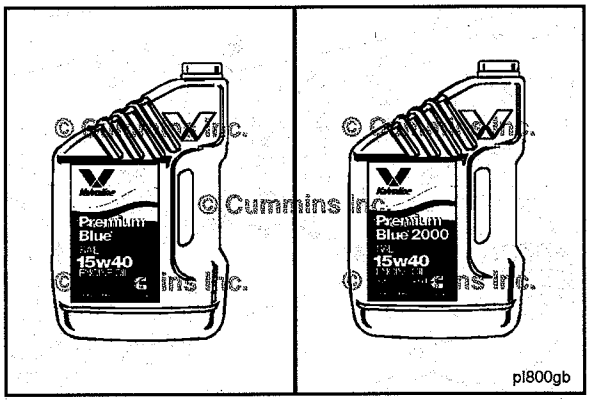




Fill

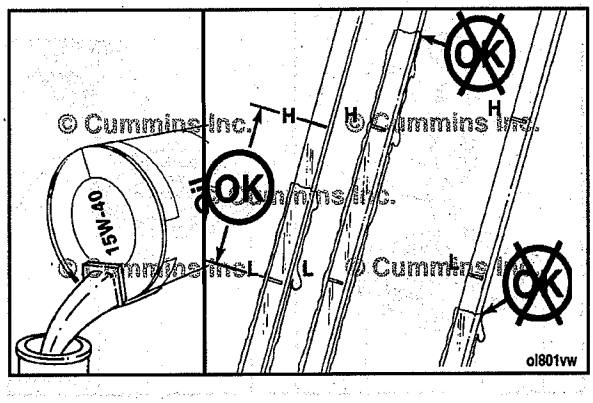
Install and tighten the drain plug(s).

Torque Value: 47 N•m [35 ft-lb]



Use a high quality 15W-40 multiviscosity oil that meets the American Petroleum Institute (API) performance classification CE or CF4 or better.

Choose the correct oil for the operating climate as outlined in Procedure 018-017.



Fill the engine to the correct level with clean engine oil.

Refer to Procedure 018-017 for engine oil capacity.

Check the oil level on the dipstick. The level **must** be to the high (H) mark on the dipstick.

Do **not** overfill. Drain off excess oil in a pan.

⚠CAUTION⚠

Before starting engines not equipped with a PRELUB™ system, complete the following steps. Engine damage will occur, because of inadequate lubrication at startup, if these steps are not followed.

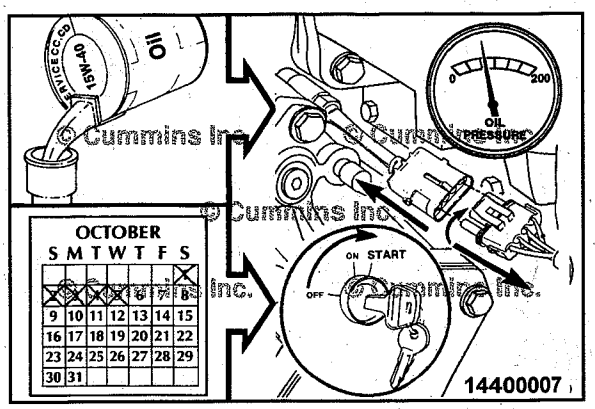
NOTE: This procedure will cause fault codes for the unplugged sensors to be logged. They will go inactive and have no effect on engine operation after the sensors are connected.

NOTE: Engines that are equipped with a PRELUB™ system are self priming and do **not** require completion of this and the next step.

The following steps **must** be completed after each oil change or after the engine has been shut down for more than five days to make sure the engine receives the correct oil flow through the lubricating system.

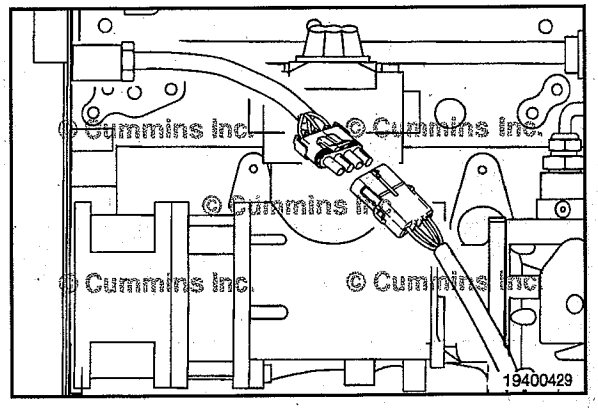
1. On engines using mechanically actuated injectors, disconnect the engine position sensor.
2. On engines using electronically actuated injectors, the following 2 sensors need to be disconnected for priming:
   - Engine speed sensor located in the flywheel housing
   - Camshaft position sensor located above the fuel pump on the left bank side.

Use the starter motor to rotate the engine crankshaft until oil pressure is indicated on the gauge or the warning light goes out.

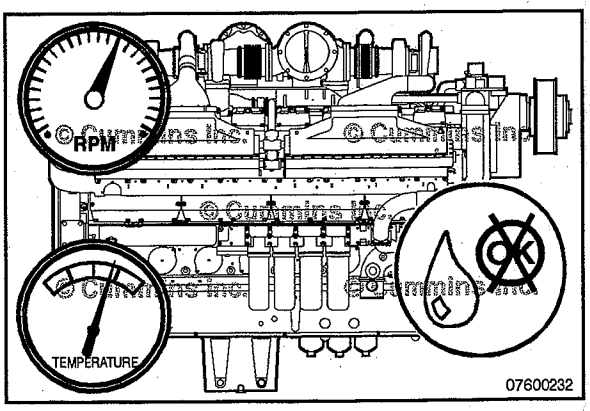


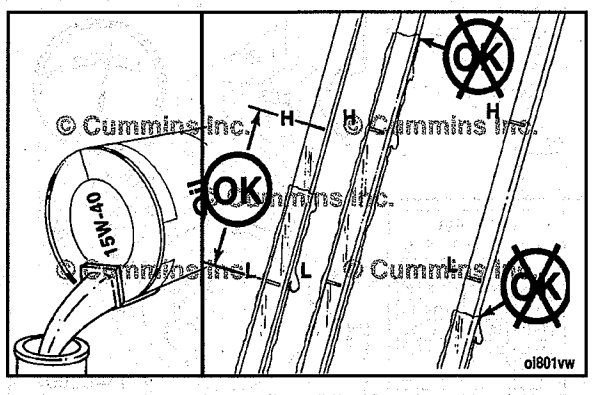
Connect the engine position sensor on engines with mechanically actuated injectors.

Connect the engine speed and camshaft position sensors on engines with electronically actuated injectors.



Operate the engine at idle speed to inspect for leaks at the filters and drain plug(s).



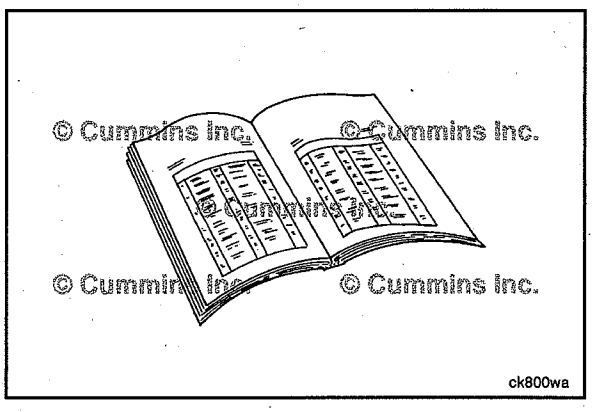


Shut off the engine.

Wait approximately 5 minutes to allow the oil to drain from the upper parts of the engine.

Check the oil level.

Add oil as necessary to bring the oil level to the high (H) mark on the dipstick.



Lubricating Oil Level Sensor

Preparatory Steps

⚠ WARNING ⚠

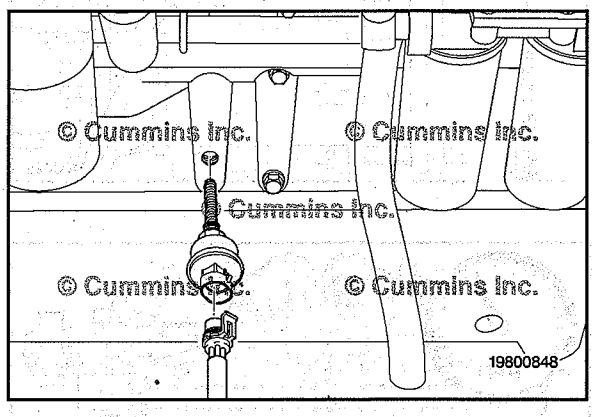
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠ WARNING ⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

NOTE: QSK60 engines with electronically actuated injectors, do **not** use oil level sensors in the oil sump.

- Partially drain the engine lubricating oil sump or the makeup tank, depending on sensor location. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.



Remove

Lift up on the locking tab and pull the electrical connectors apart.

Remove the sensor.

Clean and Inspect for Reuse

⚠WARNING⚠

To reduce the possibility of personal injury and property damage, never use starting fluid if the grid heater option is used. Starting fluid, which contains ether, can cause an explosion.

⚠WARNING⚠

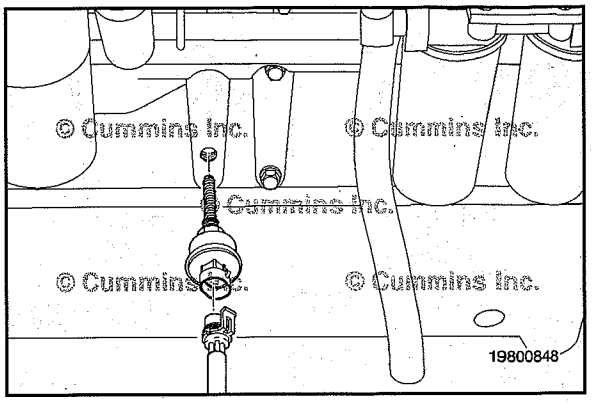
Because of the potential for an explosion, do not use volatile cold starting aids in underground mine or tunnel operations. Ask the local U.S. Bureau of Mines Inspector for instructions.

⚠WARNING⚠

Starting fluid is highly flammable and explosive. Keep flames, sparks, and arcing switches away from starting fluid.

Clean the sensor with ether.

Check the sensor for damaged threads.



Install

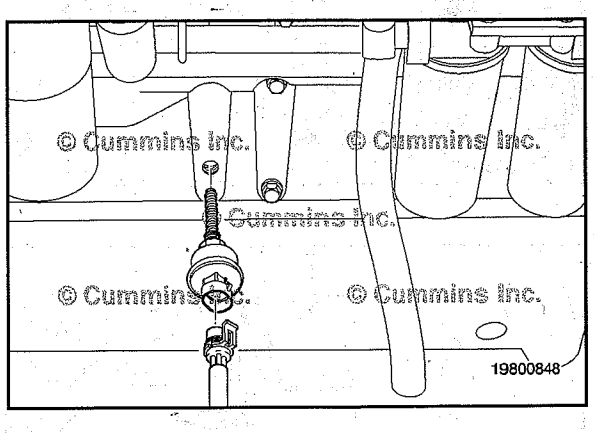
Lubricate the sensor o-ring.

Install the new sensor into the engine.

Tighten the sensor.

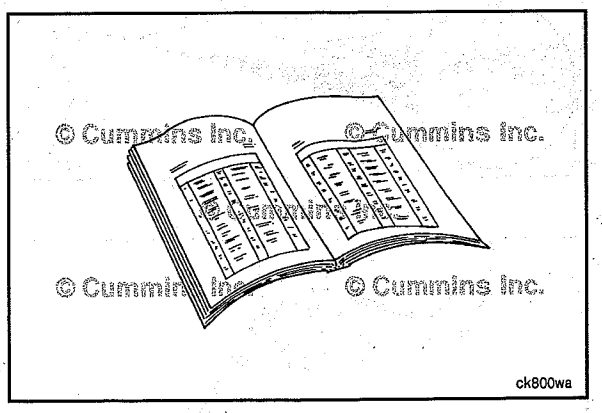
Torque Value: 14 N•m [124 in-lb]

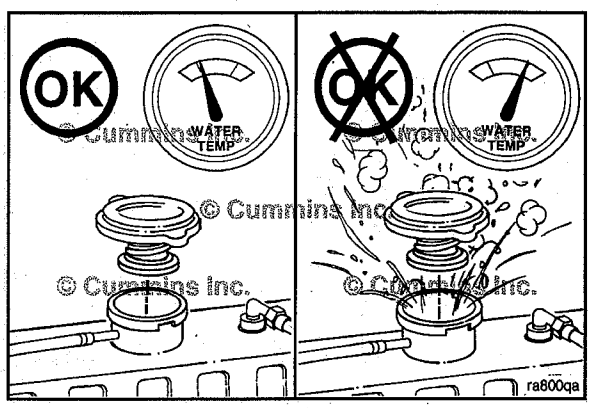
Push the electrical connectors together until they lock.



Finishing Steps

- Fill the engine and makeup tank to the proper level with lubricating oil. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.
- Operate the engine and check for leaks.





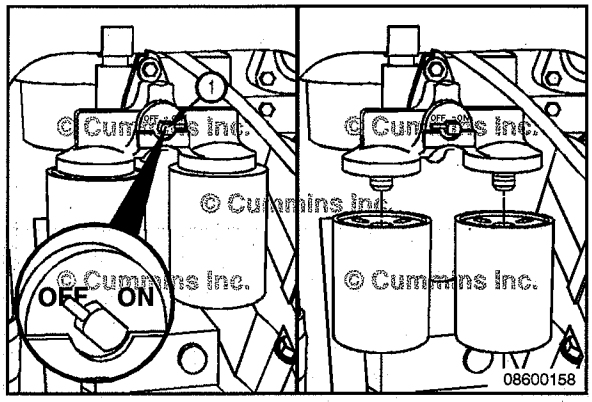
Coolant Filter

Remove

WARNING

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Remove the pressure cap from the radiator.

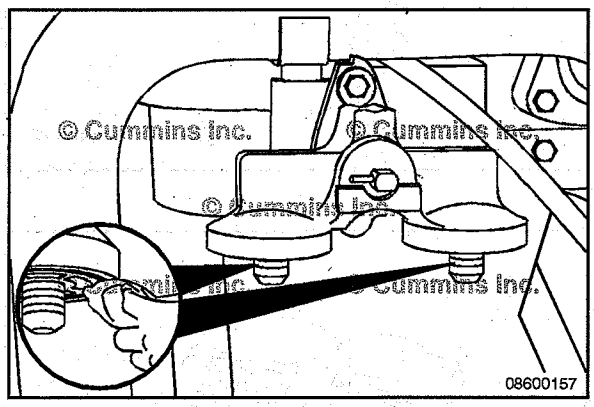


WARNING

Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

Turn valve (1) on the coolant filter head to the OFF position to prevent water loss.

Remove the coolant filters.

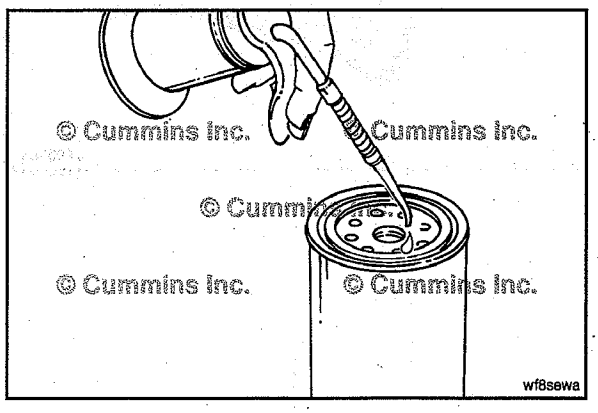


Install

Clean the area around the coolant filter head. Clean the gasket surface of the coolant filter head.

The o-ring can stick on the coolant filter head. Make sure the o-ring is removed.

Discard the coolant filters.



CAUTION

When lubricating the seal on the coolant filter do not allow oil to get into the coolant filter. It will adversely affect the SCA.

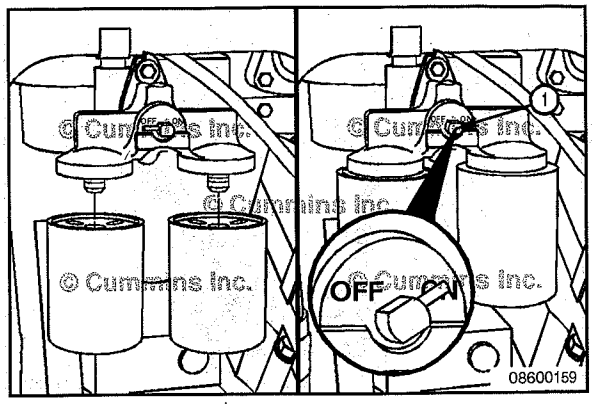
Lubricate the seal on the coolant filter with clean engine oil.

Install the coolant filter.

Turn the coolant filter **clockwise** until the seal touches the coolant filter head.

Turn the coolant filter an additional ½ to ¾ of a turn after contact.

Turn the valve (1) on the coolant filter head to the ON position.

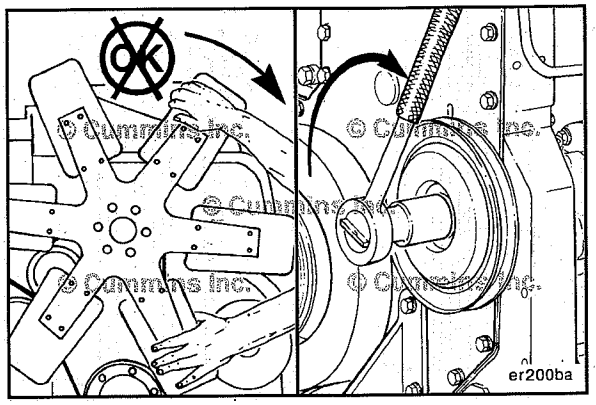


Fan, Cooling

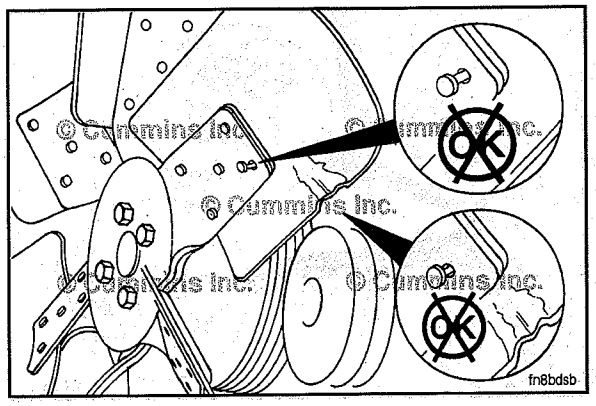
Inspect for Reuse

⚠WARNING⚠

Do not rotate the engine by pulling or prying on the fan. The fan blade(s) can be damaged and cause the fan to fail and cause personal injury or property damage. Use the accessory drive shaft or the crankshaft barring tool to rotate the crankshaft.

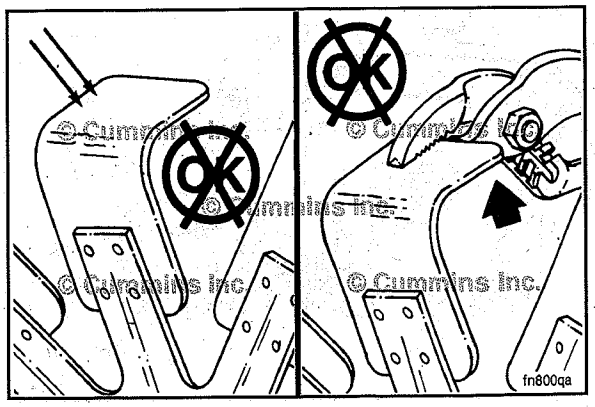


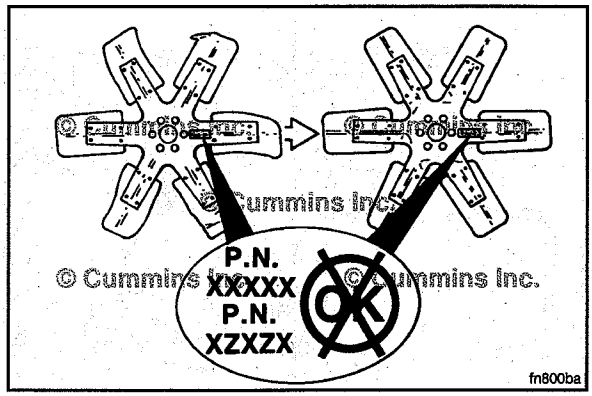
A visual inspection of the cooling fan is required daily. Check for cracks, loose rivets, and bent or loose blades. Check the fan to make sure it is securely mounted. Tighten the capscrews, if necessary.



⚠WARNING⚠

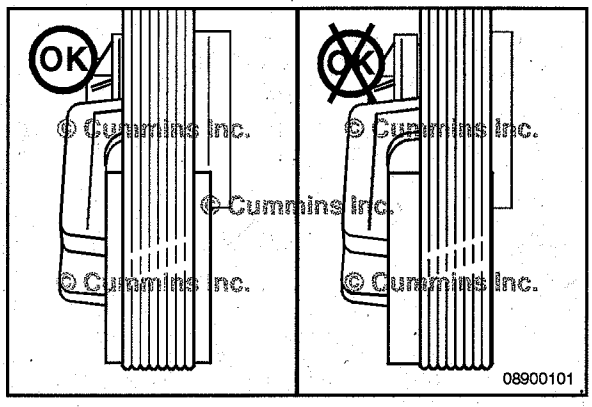
Do not straighten a bent fan blade or continue to use a damaged fan. A bent or damaged fan blade can fail during operation and cause personal injury or property damage.





Replace original equipment fan that is damaged with a fan of the identical part number. Cummins Inc. **must** approve any other fan changes to be covered under warranty.

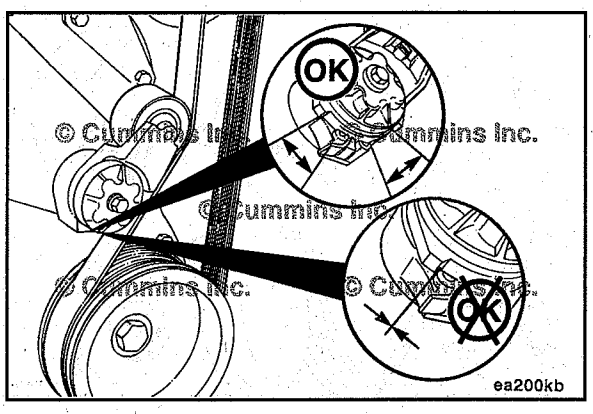
Refer to the vehicle or equipment manufacturer's specifications for capscrew torque.



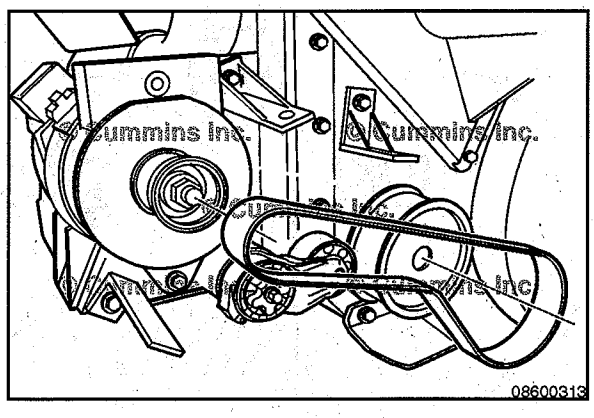
Belt Tensioner, Automatic (Alternator)

Maintenance Check

Check the location of the drive belt on the belt tensioner pulley. The belt should be centered on , or centered close to the middle of the pulley. Unaligned belts, either too far forward or backward, can cause belt wear, belt roll-off failures, or increase uneven tensioner bushing wear.



With the belt on, check that neither tensioner arm stops are in contact with the spring casing stop. If either stop is touching, the drive belt **must** be replaced. After replacing the belt, if the tensioner are stops are still in contact with the spring casing stop, replace the tensioner.



Remove the belt.

⚠CAUTION⚠

Do not increase the torque on engines that have grade 9.8 capscrews installed. Increasing torque can cause damage to the belt tensioner.

Engines that use grade 9.8 alternator tensioner mounting capscrews, must be tightened to the correct torque value.

If the alternator belt tensioner is removed and the mounting capscrew is grade 9.8, it must be replaced with a 10.9 capscrew.

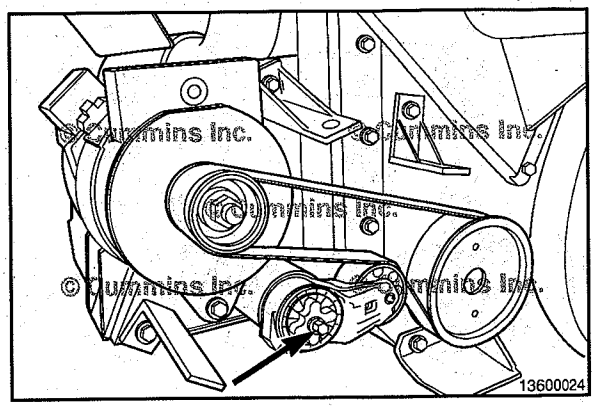
Check the torque of the tensioner capscrew.

The torque for a grade 9.8 capscrew is:

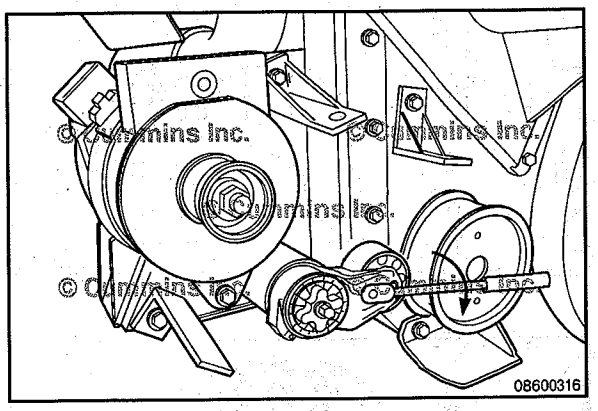
Torque Value: 45 N•m [33 ft-lb]

The torque for a grade 10.9 capscrew is:

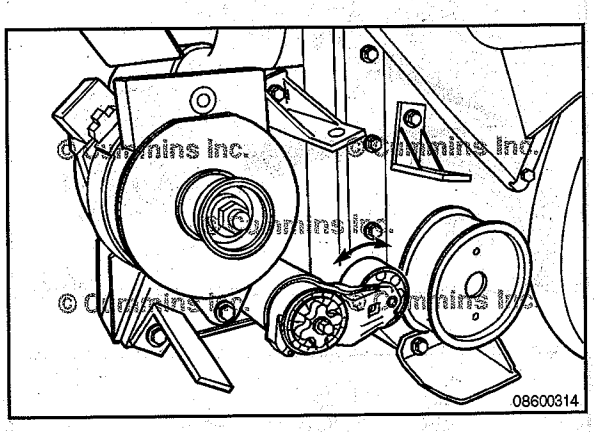
Torque Value: 65 N•m [48 ft-lb]

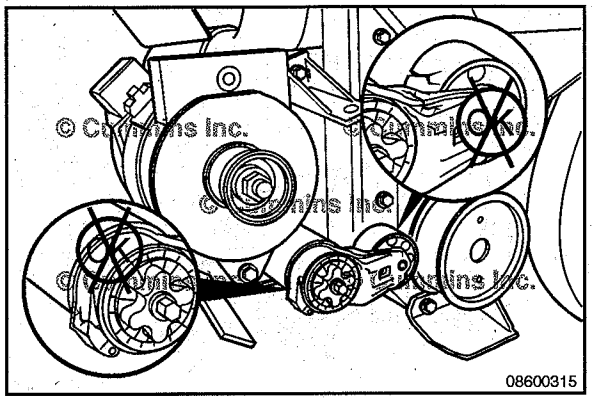


After checking the torque, use a breaker bar with a 1/2-inch ratchet to rotate the tensioner slowly away from the area of belt contact. If the arm rotates with any roughness or hesitancy, replace the tensioner.

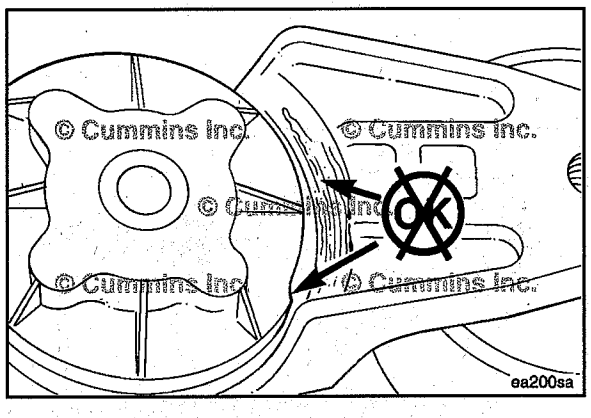


With the belt removed, check to be sure that the tensioner pulley rotates freely.

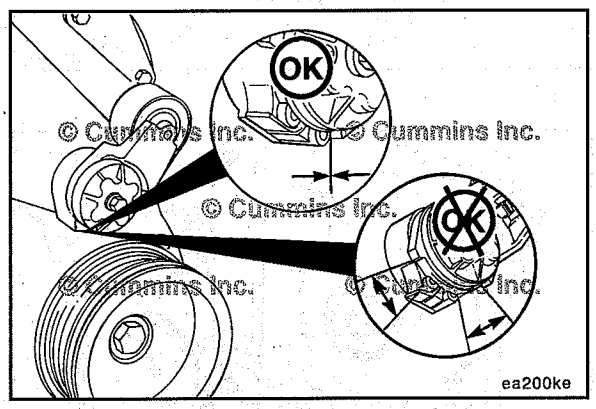




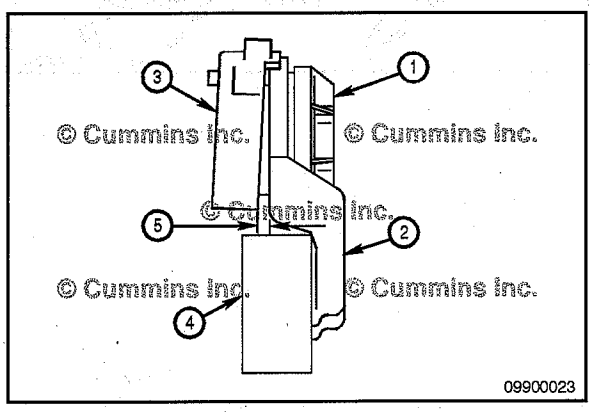
Check the tensioner arm, pulley, and stops for cracks. If any cracks are noticed, the tensioner **must** be replaced.



Inspect the tensioner for evidence of the tensioner arm contacting the tensioner cap. If there is evidence of the two areas making contact, the pivot tube bushing has failed and the tensioner **must** be replaced.



With the belt removed, check that the tensioner arm stop is in contact with the spring case stop. If these two are **not** touching, the tensioner **must** be replaced.



Measure the clearance between the tensioner spring case and the tensioner arm to verify tensioner wear-out and uneven bearing wear. If the clearance exceeds 3 mm [0.12 in] at any point, the tensioner has failed and **must** be replaced as a complete assembly. Experience has revealed that tensioners generally will show a larger clearance gap near the lower portion of the spring case, resulting in the upper portion rubbing against the tensioner arm. **Always** replace the belt when a tensioner is replaced. The belt tensioner assembly contains the following.

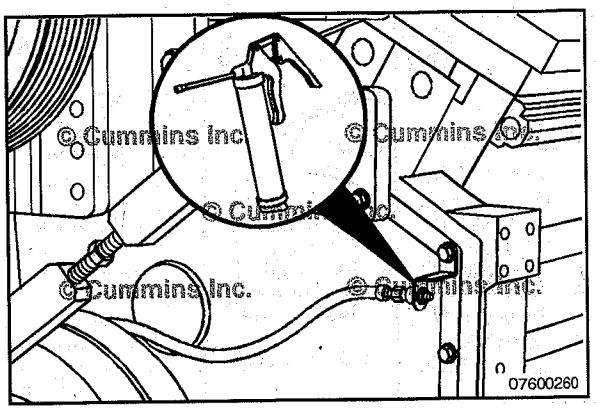
1. Tensioner cap
2. Tensioner arm
3. Spring case
4. Tensioner pulley
5. Clearance gap

Engine Support Bracket, Front

Maintenance Check

Use water pump type grease, Chevron SRI grease, or its equivalent, to lubricate the front engine support.

Lubricate the support until grease appears on the outside of the support.



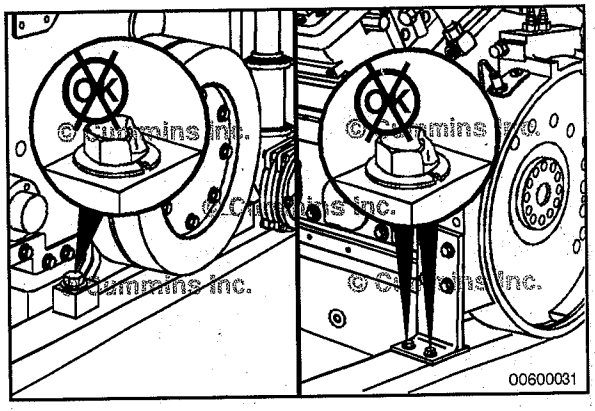
Engine Mounts

Maintenance Check

NOTE: Engine mounts that act as isolators are **not** supplied by Cummins Inc. Refer to the OEM service manual.

Check the torque on the nuts and bolts. Tighten any that are loose. Inspect the rubber for deterioration and age hardening. Replace any broken or lost bolts, capscrews, or damaged rubber.

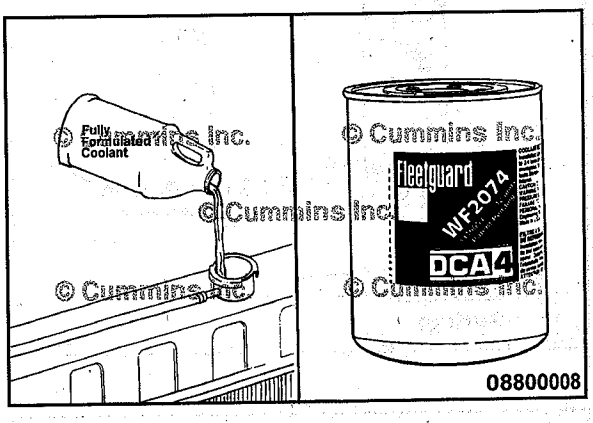
Capscrew size and grade vary with the flywheel housing and mounting arrangement. Determine the size and grade of the mounting bolts. Refer to Procedure 018-006 (Engine Component Torque Values) in Section V for capscrew torque specification.

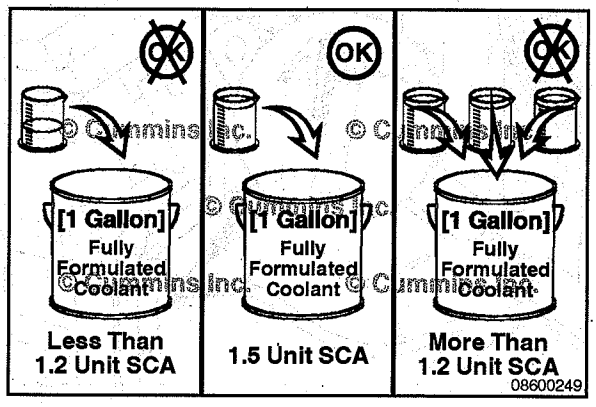


Supplemental Coolant Additive (SCA)

Maintenance Check

Supplemental coolant additives, or equivalent, are used to prevent the buildup of corrosion and scale deposits in the cooling system.





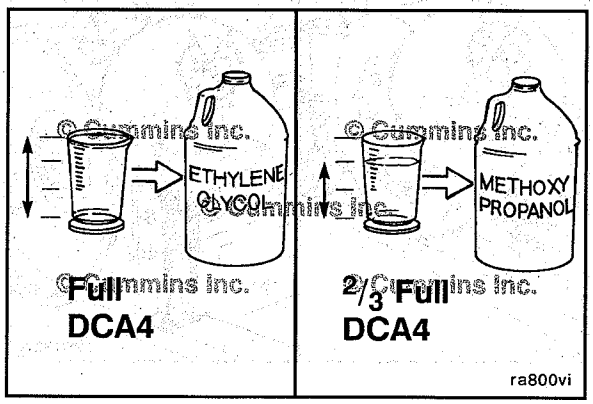
⚠CAUTION⚠

Inadequate concentration of coolant additives can result in major corrosive damage to cooling system components. Over-concentration can cause the formation of gelatin (gel) that can cause restrictions and plugging.

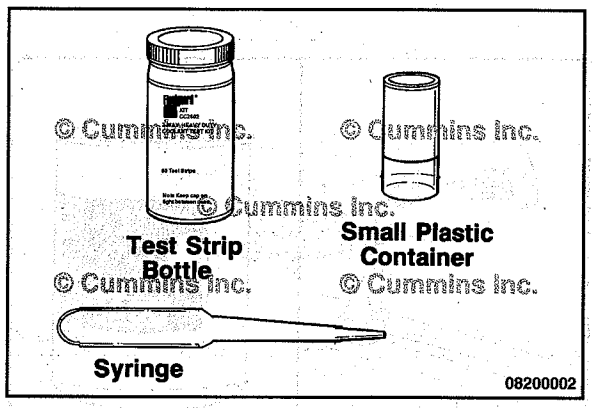
The SCA concentration **must not** fall below 1.2 units per 3.8 liters [1 gal] or exceed 3 units per 3.8 liters [1 gal].

When changing the coolant, the initial SCA, or equivalent concentration, **must** be between 1.2 and 3 units per 3.8 liters [1 gal] of coolant (initial charge).

The cooling system **must** be clean before adding SCA, or equivalent. Refer to Procedure 008-018.



DCA4 is compatible with all permanent-type antifreeze except methoxy propanol. If methoxy propanol antifreeze is used, reduce the amount of DCA4 by one-third. This will prevent inhibitor loss due to precipitation caused by chemical incompatibility.



If coolant is added between drain intervals, additional SCA, or equivalent, will be required.

Check the coolant just before changing the coolant filter.

Use **only** coolant test kit, Fleetguard® Part Number CC2602, to check the coolant additive concentration when SCA is used.



Use the correct Fleetguard® coolant filter to maintain the correct SCA concentration in the system.

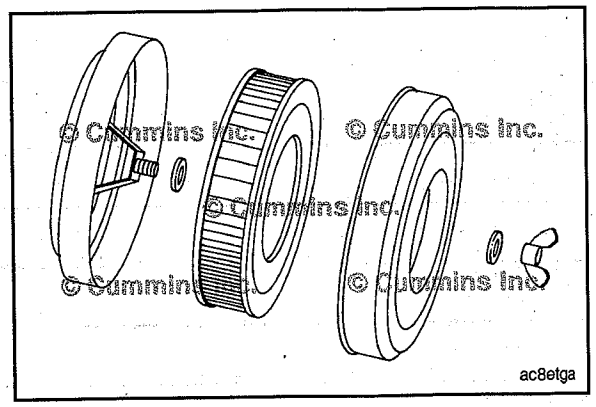
Maintain the correct concentration by changing the maintenance coolant filter at each oil drain interval.

Air Compressor Air Cleaner Element

Maintenance Check

If the air compressor inlet is plumbed to the engine intake air system downstream of the engine intake air filter, an air compressor air cleaner element will **not** be present.

If the air compressor is equipped with an air filter, replace the filter at 250 hours or 6 months.

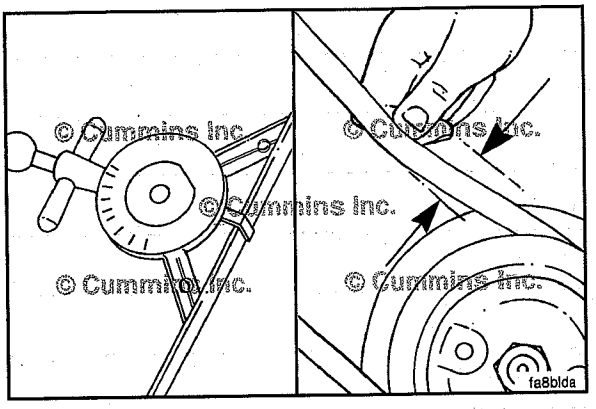


Drive Belt, Alternator

Measure

Measure the belt tension in the center span of the pulleys.

Refer to the Drive Belt Tension chart in Section V, for the correct gauge and tension value for the belt width used.



CENSE™ Datalogger

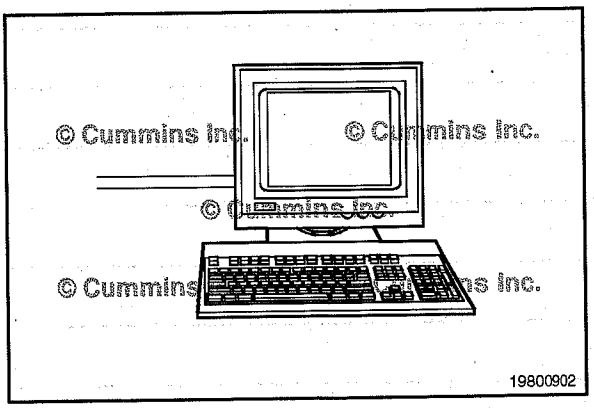
Reset

with Mechanically Actuated Injector

CENSE™ data **must** be reset every 250 hours in order to maintain maximum memory capacity.

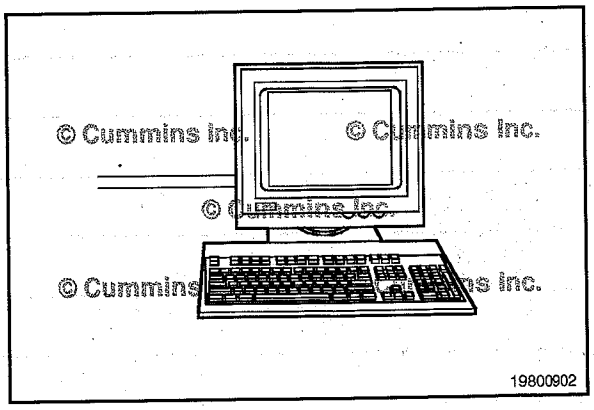
1. First retrieve the CENSE™ data that has been saved.
2. Select the fault codes and trend data options for resetting.

Refer to the local Authorized Cummins Repair Facility for detailed instructions.



with Electronically Actuated Injector

These engines do **not** use CENSE™. Instead, they have advanced engine monitoring built into the ECMs. This data does **not** need to be reset because it will automatically write over the oldest data, if the memory capacity becomes full. However, this memory can be cleared manually using the INSITE™ electronic service tool. Fault logs **must** be viewed every 250 hours even if they are **not** going to be reset.



Notes

Section 5 - Maintenance Procedures at 250 Hours or 1 Year

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Preparatory Steps 5-5
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Maintenance Procedures - Overview

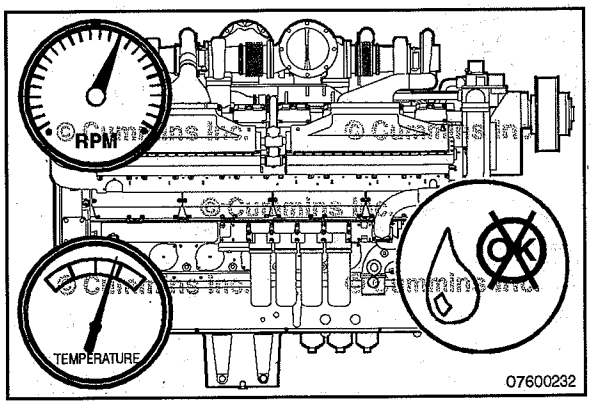
General Information

All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

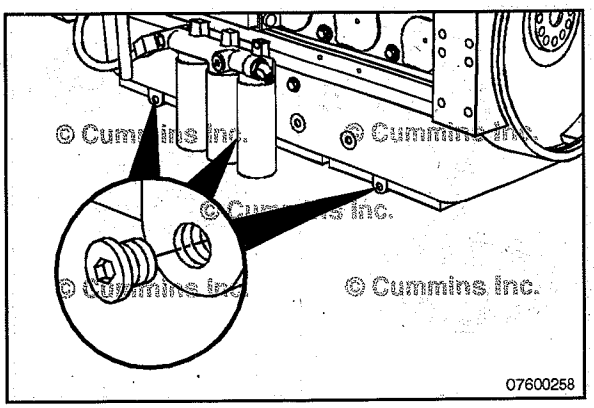
Lubricating Oil and Filters

Drain

Operate the engine until the water temperature reaches 60°C [140°F].



The QSK45 and QSK60 engines have various lubricating oil pan configurations. Remove all drain plugs when draining the oil pan.



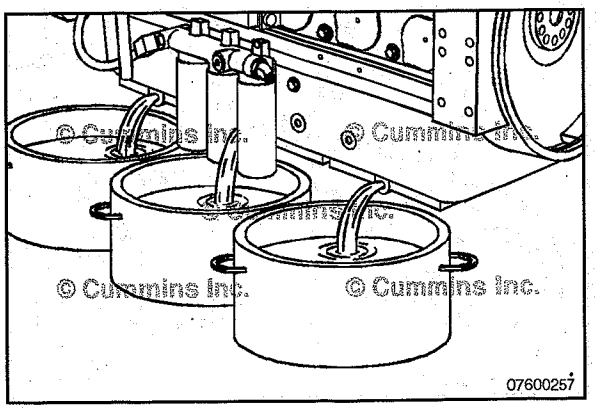
⚠WARNING⚠

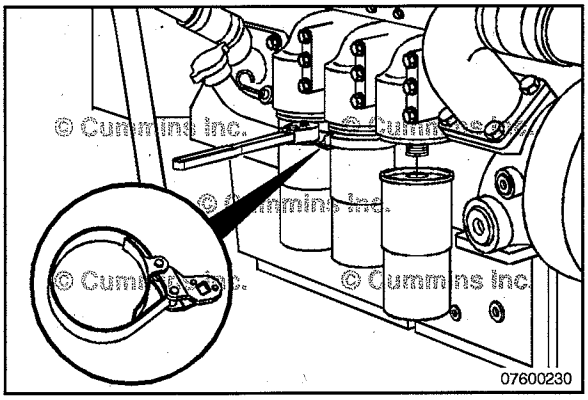
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠WARNING⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

Remove the oil drain plugs and drain the oil immediately to make sure all of the suspended contaminates are removed from the engine.





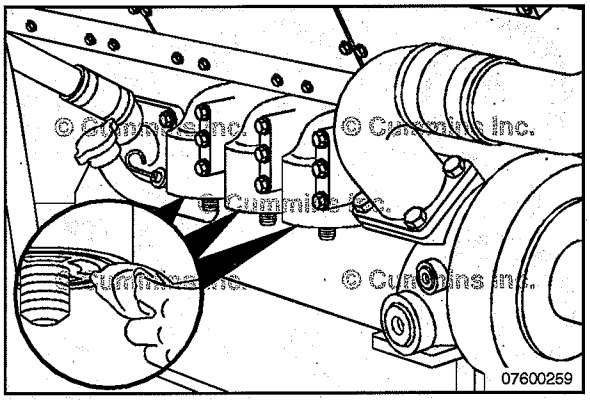
Remove

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

The QSK45 engine has three combination oil filters and the QSK60 has four combination oil filters.

Use an oil filter wrench, Part Number 3375049, or equivalent to remove the oil filters.

Discard the filter if **not** required for failure analysis.

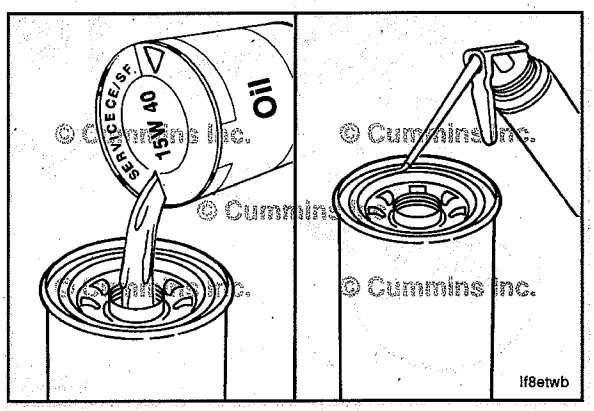


Clean

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

NOTE: The oil filter o-ring can stick on the filter head. Make sure it is removed.

Clean the oil filter head sealing surface with a lint free cloth.

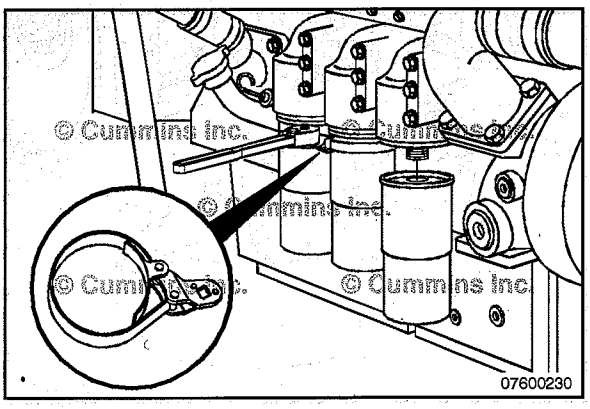


Install

The QSK45 engine has three combination oil filters and the QSK60 engine has four combination oil filters.

Use engine oil to lubricate the oil filter's rubber seal.

Fill the oil filters with clean engine oil.



⚠CAUTION⚠

Mechanical overtightening can distort the threads or damage the filter element seal. If the threads appear damaged, replace the oil filter head adapter.

⚠CAUTION⚠

Locate the oil filter wrench, Part Number 3375049, near the top of the oil filter canister. This will reduce the possibility of damaging the oil filter.

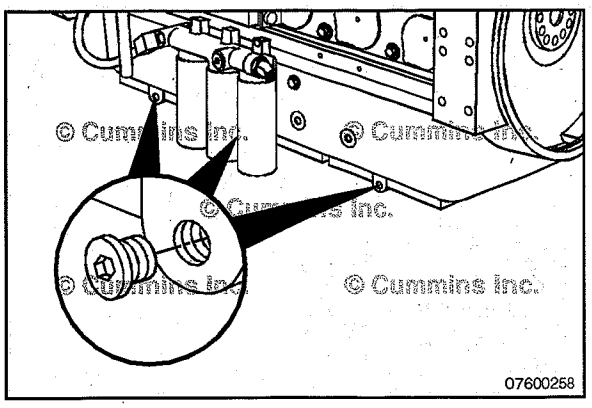
Install the oil filter, turning it until the seal contacts the filter head's sealing surface.

Turn the oil filter an additional 3/4 to 1 turn.

Fill

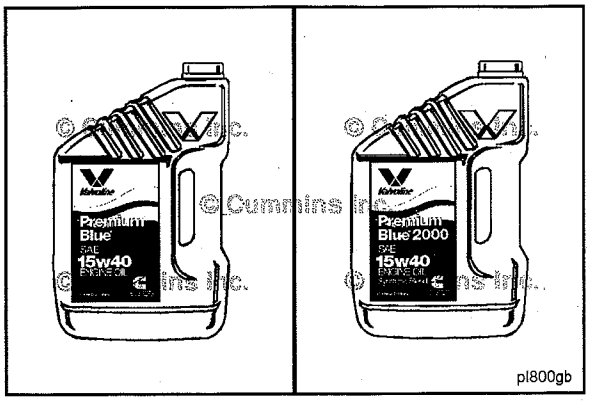
Install and tighten the drain plug(s).

Torque Value: 47 N•m [35 ft-lb]



Use a high quality 15W-40 multiviscosity oil that meets the American Petroleum Institute (API) performance classification CE or CF4 or better.

Choose the correct oil for the operating climate as outlined in Procedure 018-017.

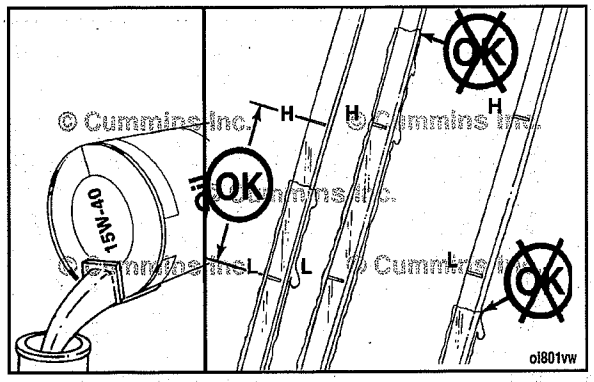


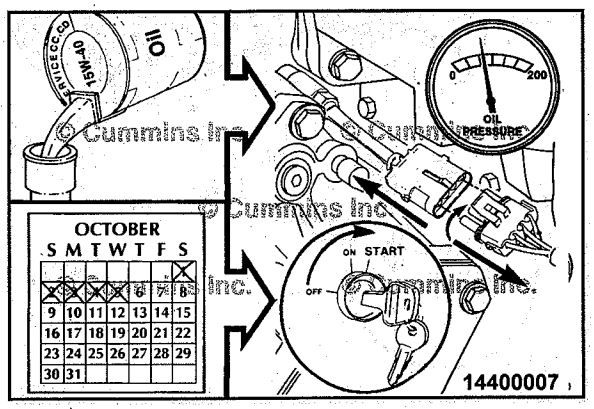
Fill the engine to the correct level with clean engine oil.

Refer to Procedure 018-017 for engine oil capacity.

Check the oil level on the dipstick. The level **must** be to the high (H) mark on the dipstick.

Do **not** overfill. Drain off excess oil in a pan.





⚠CAUTION⚠

Before starting engines not equipped with a PRELUB™ system, complete the following steps. Engine damage will occur, because of inadequate lubrication at startup, if these steps are not followed.

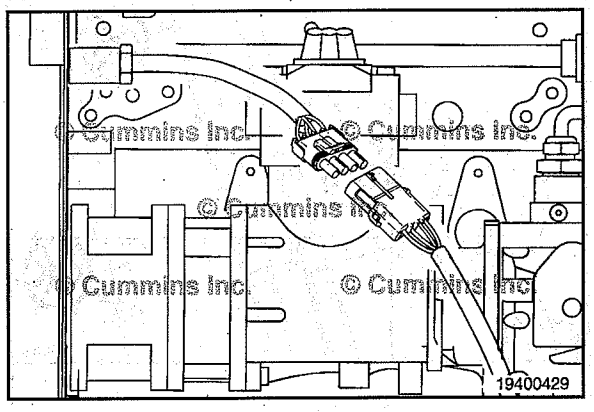
NOTE: This procedure will cause fault codes for the unplugged sensors to be logged. They will go inactive and have no effect on engine operation after the sensors are connected.

NOTE: Engines that are equipped with a PRELUB™ system are self priming and do **not** require completion of this and the next step.

The following steps **must** be completed after each oil change or after the engine has been shut down for more than five days to make sure the engine receives the correct oil flow through the lubricating system.

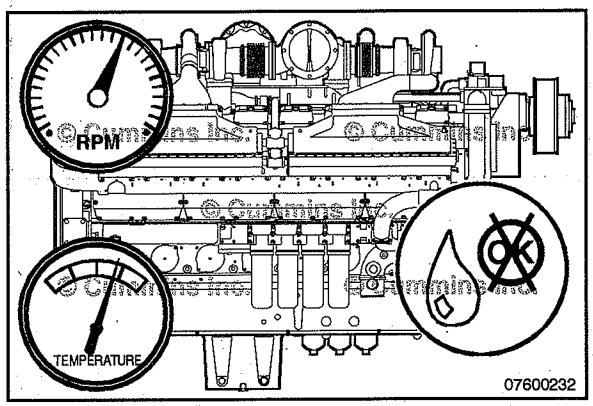
1. On engines using mechanically actuated injectors, disconnect the engine position sensor.
2. On engines using electronically actuated injectors, the following 2 sensors need to be disconnected for priming:
   - Engine speed sensor located in the flywheel housing
   - Camshaft position sensor located above the fuel pump on the left bank side.

Use the starter motor to rotate the engine crankshaft until oil pressure is indicated on the gauge or the warning light goes out.



Connect the engine position sensor on engines with mechanically actuated injectors.

Connect the engine speed and camshaft position sensors on engines with electronically actuated injectors.



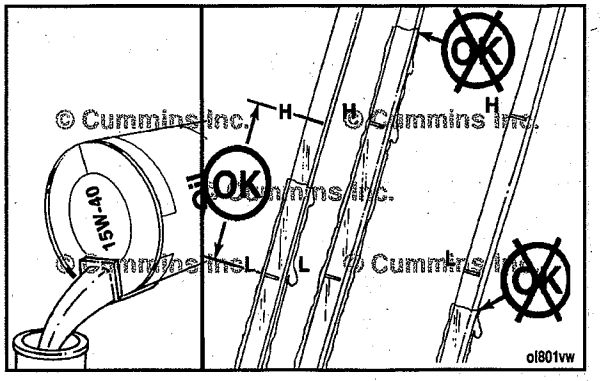
Operate the engine at idle speed to inspect for leaks at the filters and drain plug(s).

Shut off the engine.

Wait approximately 5 minutes to allow the oil to drain from the upper parts of the engine.

Check the oil level.

Add oil as necessary to bring the oil level to the high (H) mark on the dipstick.



Lubricating Oil Level Sensor

Preparatory Steps

⚠WARNING⚠

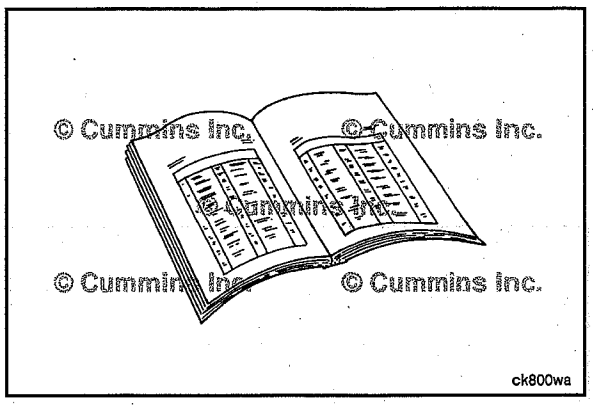
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠WARNING⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

NOTE: QSK60 engines with electronically actuated injectors, do **not** use oil level sensors in the oil sump.

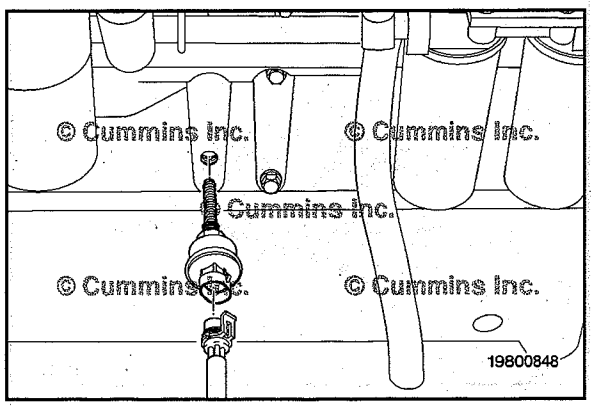
- Partially drain the engine lubricating oil sump or the makeup tank, depending on sensor location. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.

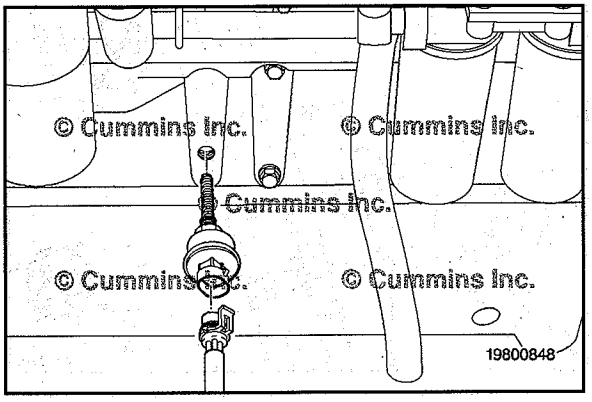


Remove

Lift up on the locking tab and pull the electrical connectors apart.

Remove the sensor.





Clean and Inspect for Reuse

⚠WARNING⚠

To reduce the possibility of personal injury and property damage, never use starting fluid if the grid heater option is used. Starting fluid, which contains ether, can cause an explosion.

⚠WARNING⚠

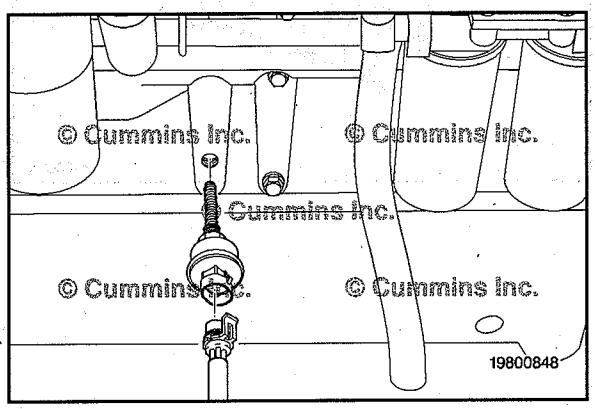
Because of the potential for an explosion, do not use volatile cold starting aids in underground mine or tunnel operations. Ask the local U.S. Bureau of Mines Inspector for instructions.

⚠WARNING⚠

Starting fluid is highly flammable and explosive. Keep flames, sparks, and arcing switches away from starting fluid.

Clean the sensor with ether.

Check the sensor for damaged threads.



Install

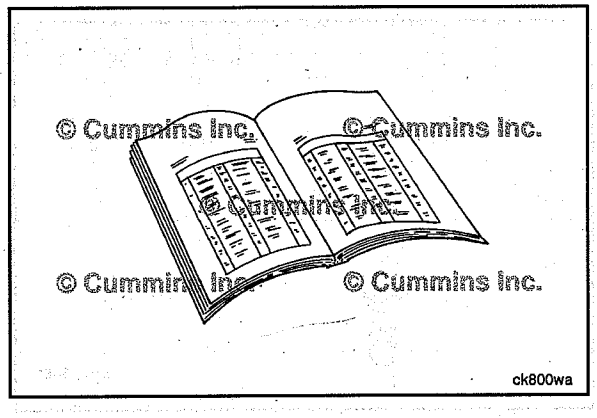
Lubricate the sensor o-ring.

Install the new sensor into the engine.

Tighten the sensor.

Torque Value: 14 N•m [124 in-lb]

Push the electrical connectors together until they lock.



Finishing Steps

- Fill the engine and makeup tank to the proper level with lubricating oil. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.
- Operate the engine and check for leaks.

Section 6 - Maintenance Procedures at 1000 Hours or 1 Year

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Maintenance Procedures - Overview

General Information

All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

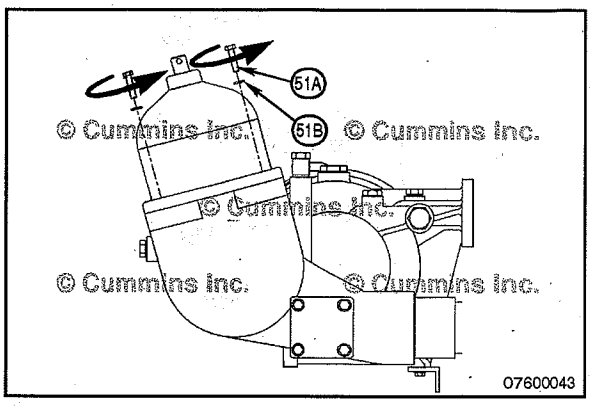
Eliminator Filter Centrifuge

Disassemble

⚠WARNING⚠

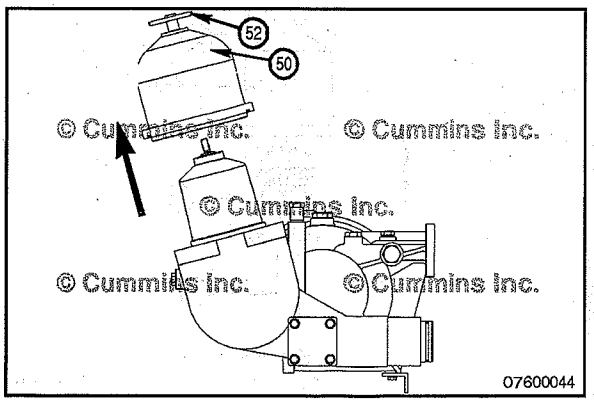
To reduce the possibility of personal injury, make sure the engine and bowl are completely stopped before disassembling the centrifuge. Wait at least 10 minutes after stopping the engine before disassembling.

Remove the four screws (51A) and washers (51B).



Turn the hollow screw handle (52) **counterclockwise**, and remove the cover (50).

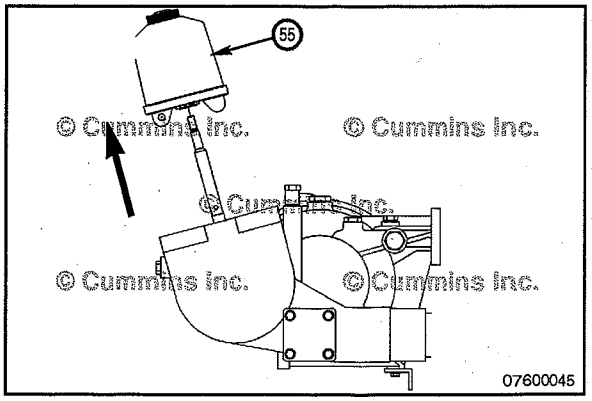
The hollow screw handle (52) will stay on the cover.

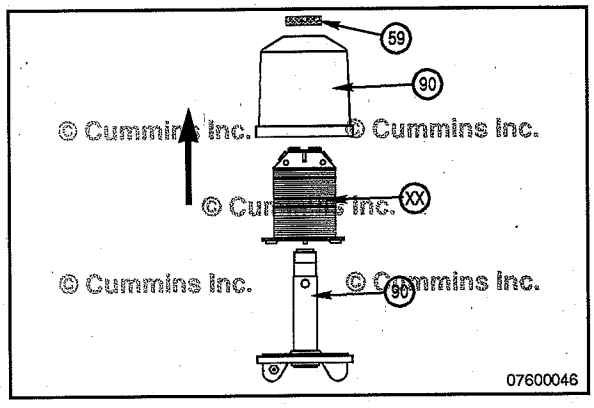


⚠WARNING⚠

The rotating bowl can be hot. To reduce the possibility of personal injury, wear gloves when removing the bowl.

Remove the rotating bowl (55).





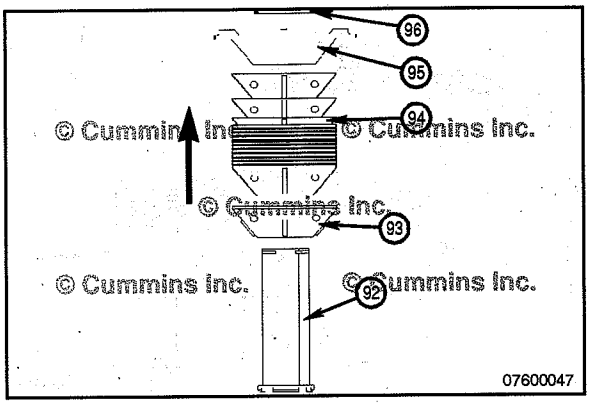
WARNING

The bowl discs can have sharp edges. To reduce the possibility of personal injury wear gloves when removing the bowl discs.

Remove the rotor cover nut (59) and rotor cover (90).

Remove the disc stack (XX) from the top of the rotor (90).

Place the disc stack on a work bench.



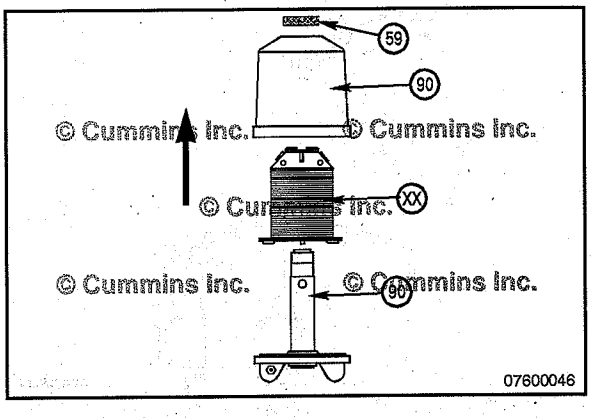
WARNING

The bowl discs can have sharp edges. To reduce the possibility of personal injury wear gloves when removing the bowl discs.

Remove the snap ring (96) and distributing cone (95).

Remove the disc (94) from the distributor.

Remove the top disc (93) from the distributor.



Measure

CAUTION

To avoid damage to the Eliminator filter, reduce the centrifuge service interval by 250 hours if the sludge cake is greater than 14 mm [0.551 in] thick.

To measure the sludge cake, place a wooden stick through the sludge. Measure the mark on the stick.

Measure the sludge cake thickness at two points 90 degrees apart (2), 10 mm, [0.394 in] up from the bottom of the sludge cake (1).

Eliminator Rotor Cover Sludge Cake Thickness		
mm		in
14	MAX	0.551

If the sludge cake thickness is greater than 14 mm [0.551 in], reduce the service interval by 250 hours.

If the sludge cake thickness in less than 7 mm [0.276 in], extend the service interval by 250 hours. It is **not** recommended to extend the centrifuge service interval beyond 2000 hours.

Clean and Inspect for Reuse

WARNING

The bowl discs can have sharp edges. To reduce the possibility of personal injury wear gloves when removing the bowl discs.

WARNING

When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

WARNING

Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

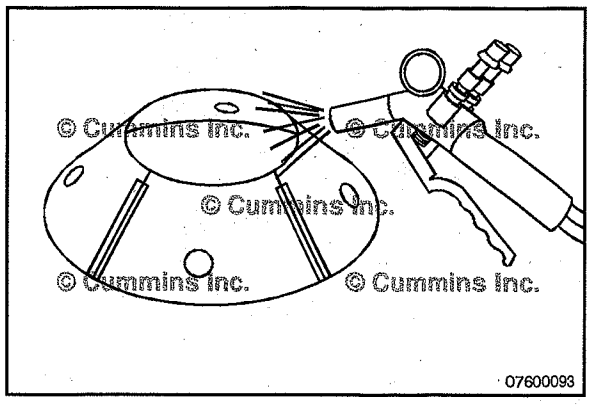
CAUTION

Sludge left on the disc, distributor, or rotor cover can damage the filter when the filter is started.

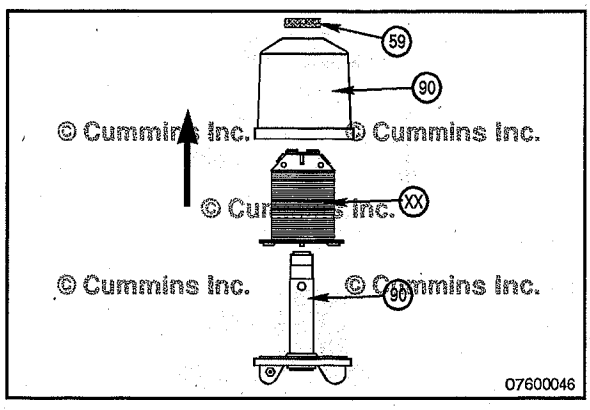
If a paper insert is used in the rotor cover, the sludge is removed by removing the paper insert. Make sure all of the sludge is removed from the rotor cover after the paper insert is removed.

Using diesel fuel or mineral spirits, clean the disc, rotor cover, and distributor.

Dry all components with compressed air.



Inspect all components for cracks or other damage. If any of the components are cracked or damaged, they **must** be replaced.



Assemble

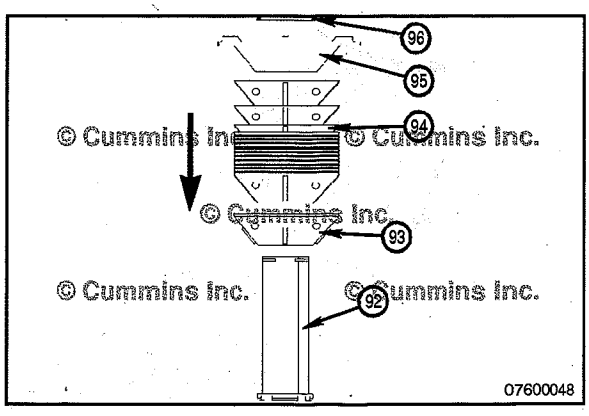
WARNING

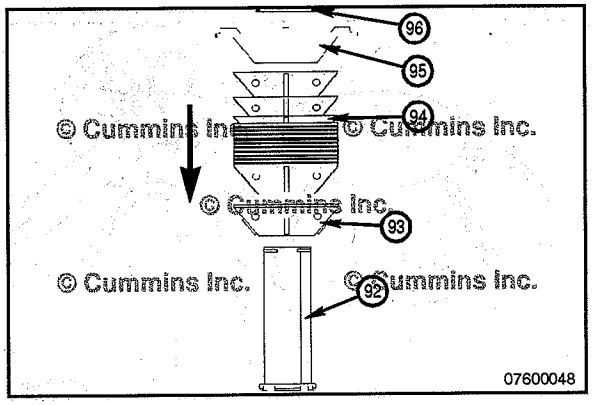
The bowl discs can have sharp edges. To reduce the possibility of personal injury wear gloves when removing the bowl discs.

Place the distributor (92) on a workbench.

Install the top disc (93) on the distributor.

Install the discs (94) on the distributor.





WARNING

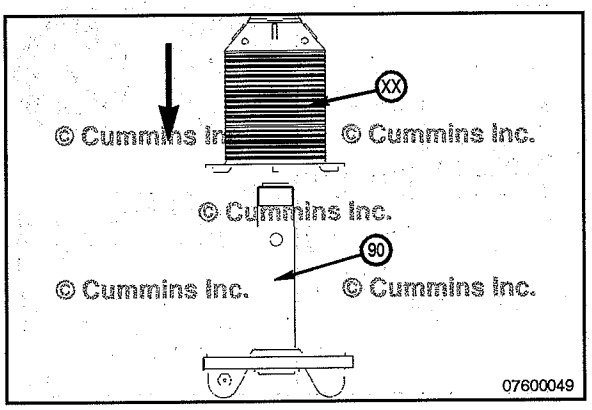
The bowl discs can have sharp edges. To reduce the possibility of personal injury wear gloves when removing the bowl discs.

Install the distributing cone (95).

The correct number of discs can vary. the correct number of discs is achieved when the distributing cone is positioned with the circlip groove on the distributor completely open.

Add or remove bowl discs to achieve the correct disc stack height.

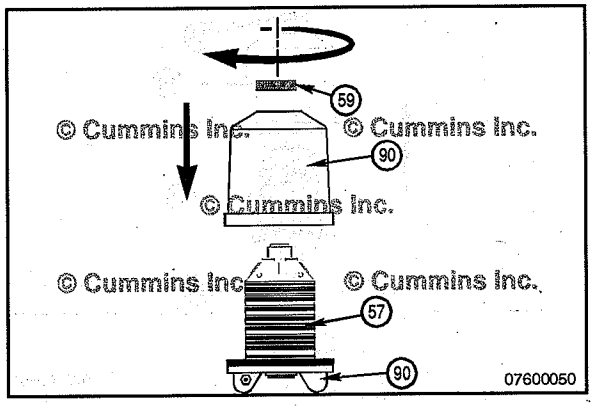
Install the circlip (96).



WARNING

The bowl discs can have sharp edges. To reduce the possibility of personal injury wear gloves when removing the bowl discs.

Install the disc stack (XX) onto the rotor shaft (90).



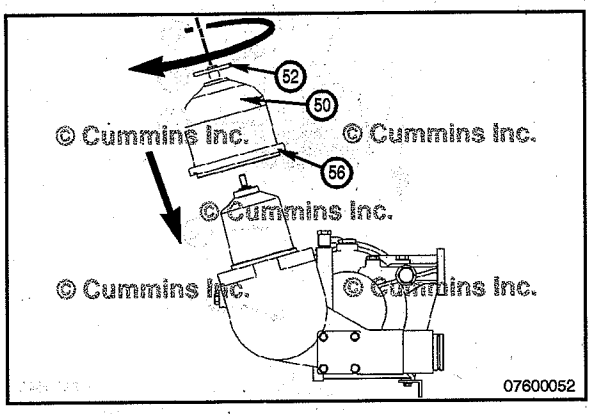
Lubricate the o-ring (57) with vegetable oil.

Install the o-ring (57) on the rotor (90).

Install a new sludge collecting paper insert into the rotor cover (90).

Install the rotor cover (90).

Hand-tighten the rotor cover nut (59).



Lubricate o-ring (56) with vegetable oil.

Install the o-ring (56) onto the cover (50).

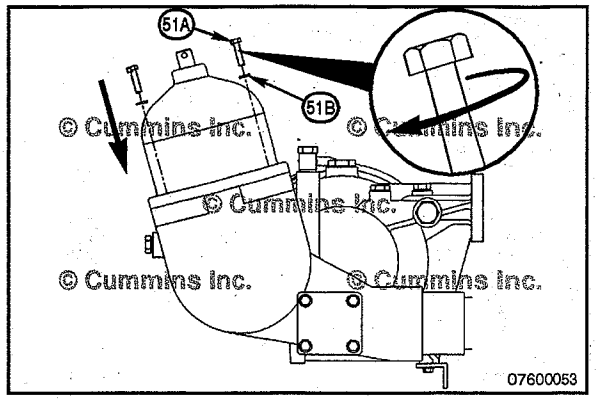
Install the cover (50) onto the filter.

Turn the hollow screw handle (52) **clockwise**.

Install the four capscrews (51A) and washers (51B).

Tighten the capscrews.

Torque Value: 25 N•m [18 ft-lb]



Eliminator Filter

Pressure Test

Perform the following steps to measure the pressure drop across the Eliminator Filter.

Remove one plug from each side at the top of the filter housing.

Install the pressure gauges in the ports.

Operate the engine to normal operating temperature.

Record the readings from both gauges.

The difference between the two measurements is the pressure drop across the filter.

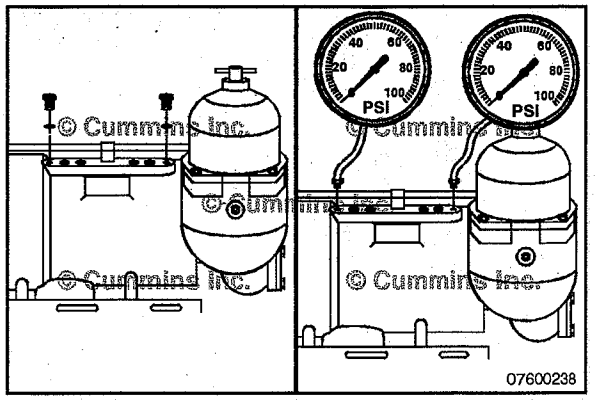
The maximum operating pressure drop **must not** exceed 39.9 kPa [5.8 psi]. If the pressure drop is greater, refer to Section TS.

Remove the pressure gauges.

Install the plugs.

Tighten the plugs.

Torque Value: 10 N•m [96 in-lb]



Rotation Check

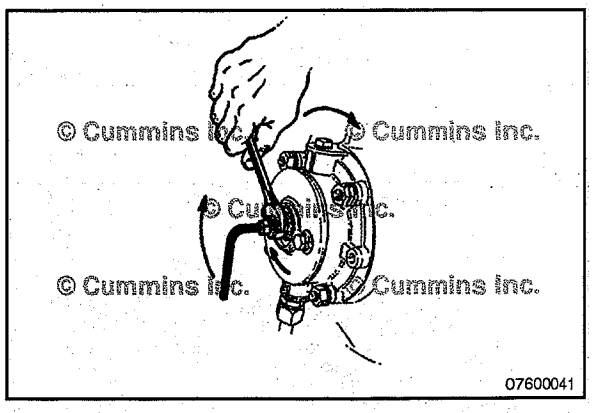
⚠CAUTION⚠

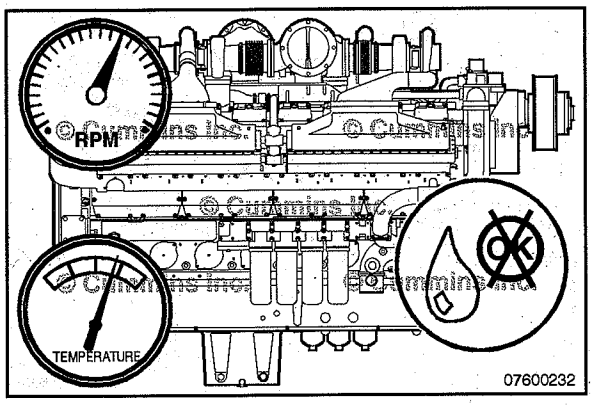
To reduce the possibility of damage to the operating indicator, do not use a pipe on the end of the operating indicator.

The rotation check is performed by manually turning the pump.

Only perform the rotation test when directed by the Troubleshooting Symptom Charts in Section TS.

Manually turn the operating indicator two revolutions within 30 seconds.

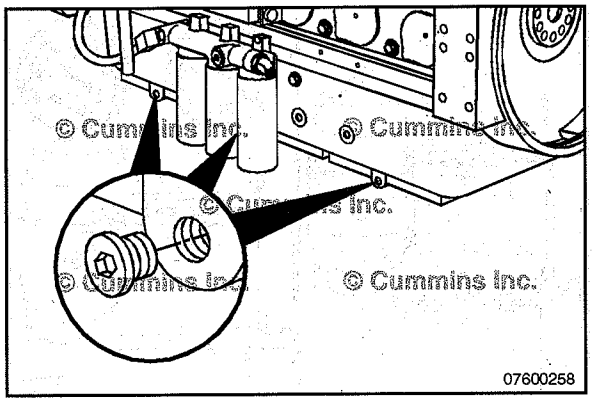




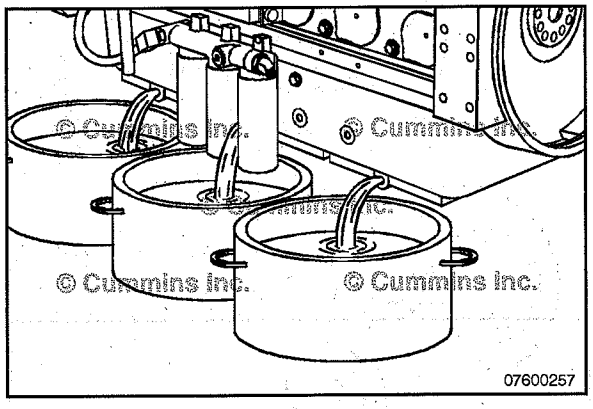
Lubricating Oil and Filters

Drain

Operate the engine until the water temperature reaches 60°C [140°F].



The QSK45 and QSK60 engines have various lubricating oil pan configurations. Remove all drain plugs when draining the oil pan.



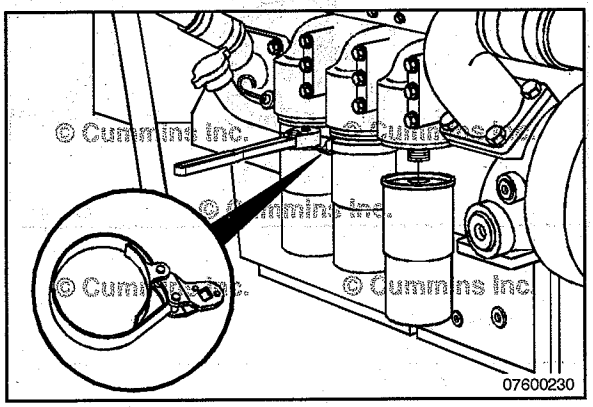
⚠WARNING⚠

Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠WARNING⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

Remove the oil drain plugs and drain the oil immediately to make sure all of the suspended contaminates are removed from the engine.



Remove

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

The QSK45 engine has three combination oil filters and the QSK60 has four combination oil filters.

Use an oil filter wrench, Part Number 3375049, or equivalent to remove the oil filters.

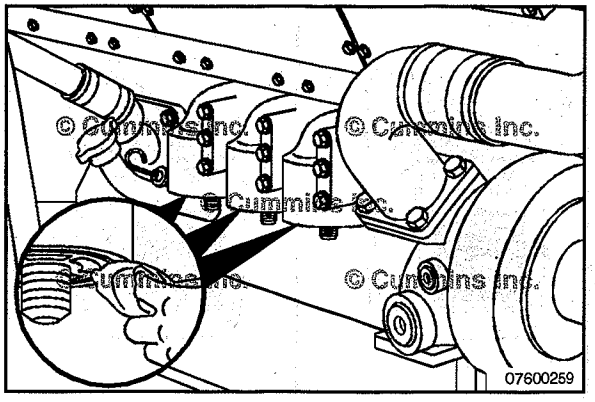
Discard the filter if **not** required for failure analysis.

Clean

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

NOTE: The oil filter o-ring can stick on the filter head. Make sure it is removed.

Clean the oil filter head sealing surface with a lint free cloth.

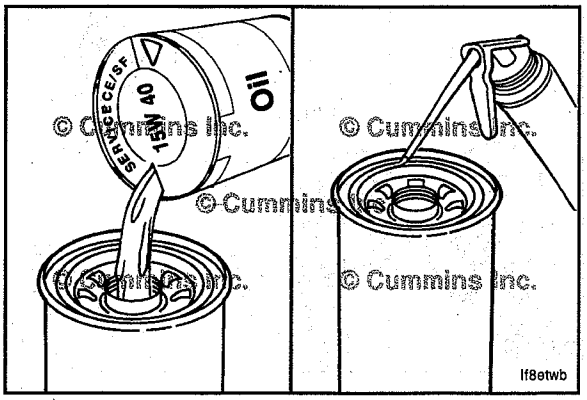


Install

The QSK45 engine has three combination oil filters and the QSK60 engine has four combination oil filters.

Use engine oil to lubricate the oil filter's rubber seal.

Fill the oil filters with clean engine oil.



⚠CAUTION⚠

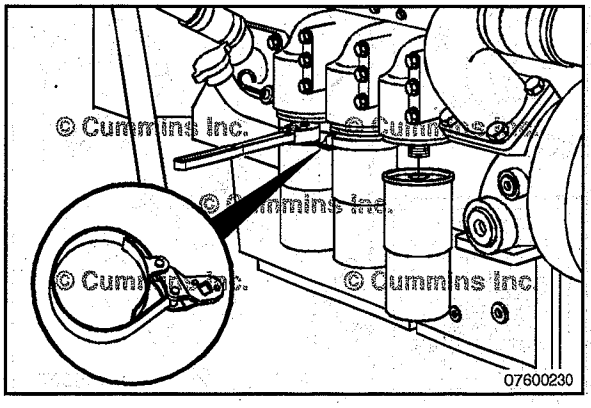
Mechanical overtightening can distort the threads or damage the filter element seal. If the threads appear damaged, replace the oil filter head adapter.

⚠CAUTION⚠

Locate the oil filter wrench, Part Number 3375049, near the top of the oil filter canister. This will reduce the possibility of damaging the oil filter.

Install the oil filter, turning it until the seal contacts the filter head's sealing surface.

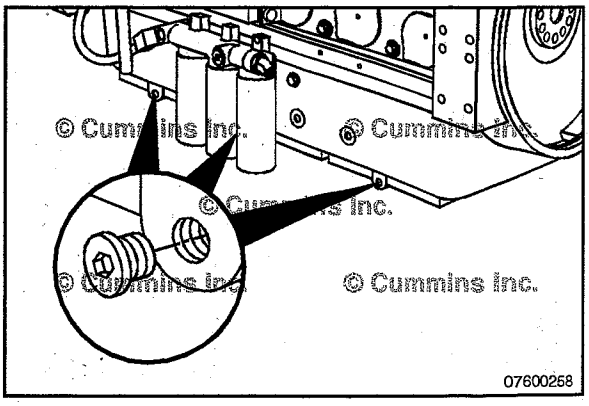
Turn the oil filter an additional 3/4 to 1 turn.

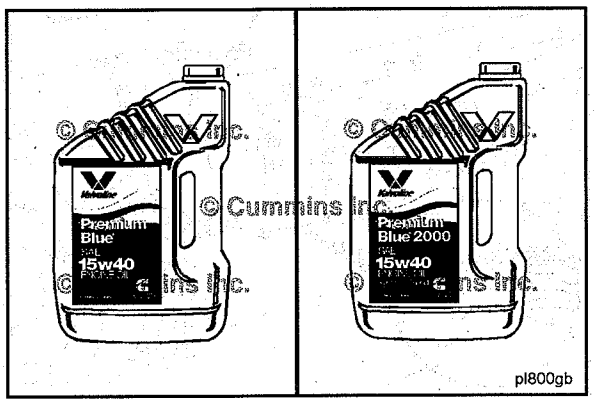


Fill

Install and tighten the drain plug(s).

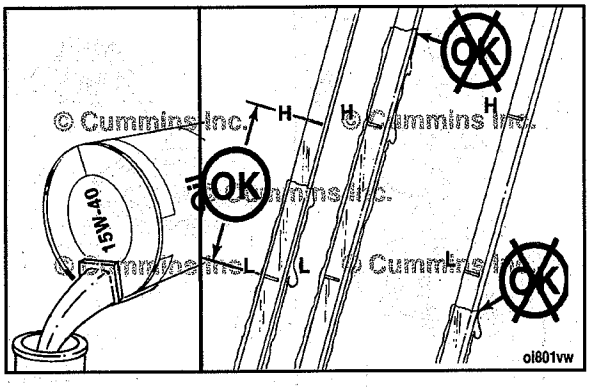
Torque Value: 47 N•m [35 ft-lb]





Use a high quality 15W-40 multiviscosity oil that meets the American Petroleum Institute (API) performance classification CE or CF4 or better.

Choose the correct oil for the operating climate as outlined in Procedure 018-017.

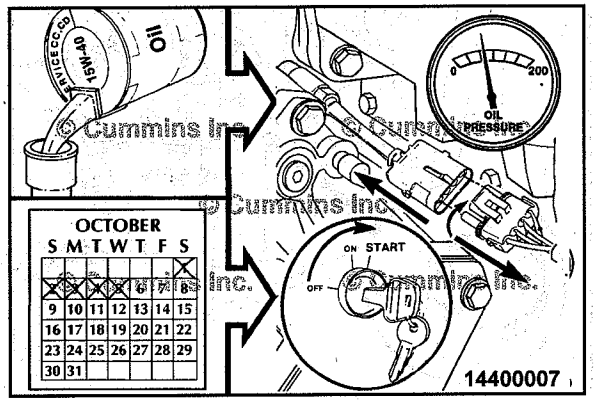


Fill the engine to the correct level with clean engine oil.

Refer to Procedure 018-017 for engine oil capacity.

Check the oil level on the dipstick. The level **must** be to the high (H) mark on the dipstick.

Do **not** overfill. Drain off excess oil in a pan.



⚠CAUTION⚠

Before starting engines not equipped with a PRELUB™ system, complete the following steps. Engine damage will occur, because of inadequate lubrication at startup, if these steps are not followed.

NOTE: This procedure will cause fault codes for the unplugged sensors to be logged. They will go inactive and have no effect on engine operation after the sensors are connected.

NOTE: Engines that are equipped with a PRELUB™ system are self priming and do **not** require completion of this and the next step.

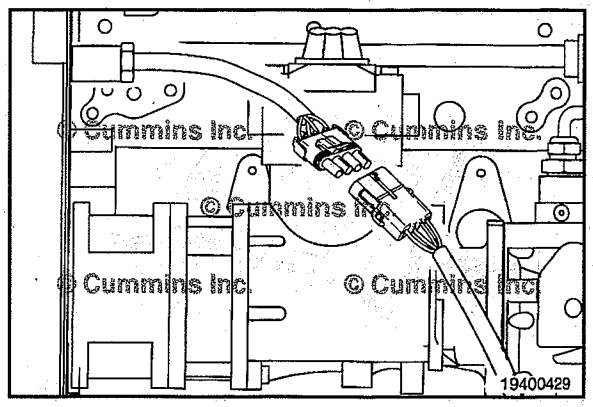
The following steps **must** be completed after each oil change or after the engine has been shut down for more than five days to make sure the engine receives the correct oil flow through the lubricating system.

1. On engines using mechanically actuated injectors, disconnect the engine position sensor.
2. On engines using electronically actuated injectors, the following 2 sensors need to be disconnected for priming:
   - Engine speed sensor located in the flywheel housing
   - Camshaft position sensor located above the fuel pump on the left bank side.

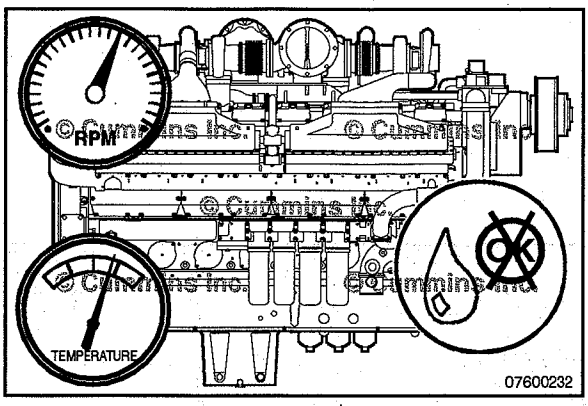
Use the starter motor to rotate the engine crankshaft until oil pressure is indicated on the gauge or the warning light goes out.

Connect the engine position sensor on engines with mechanically actuated injectors.

Connect the engine speed and camshaft position sensors on engines with electronically actuated injectors.



Operate the engine at idle speed to inspect for leaks at the filters and drain plug(s).

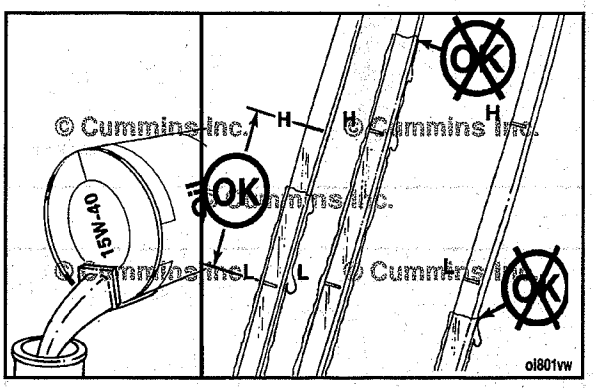


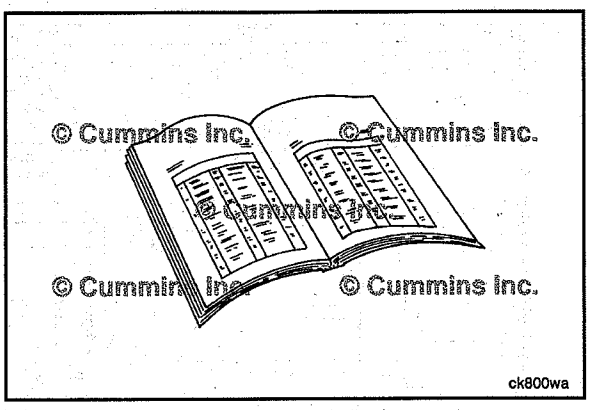
Shut off the engine.

Wait approximately 5 minutes to allow the oil to drain from the upper parts of the engine.

Check the oil level.

Add oil as necessary to bring the oil level to the high (H) mark on the dipstick.





Lubricating Oil Level Sensor

Preparatory Steps

⚠WARNING⚠

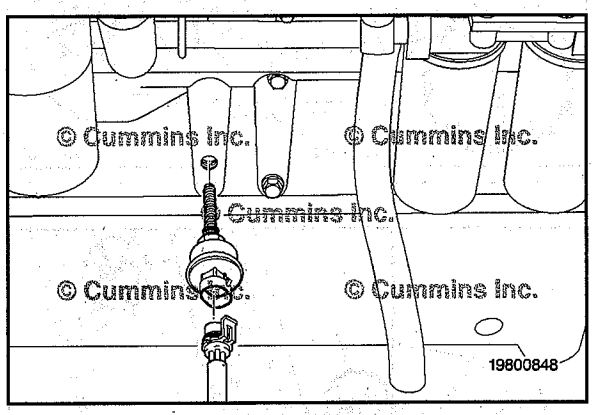
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠WARNING⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

NOTE: QSK60 engines with electronically actuated injectors, do **not** use oil level sensors in the oil sump.

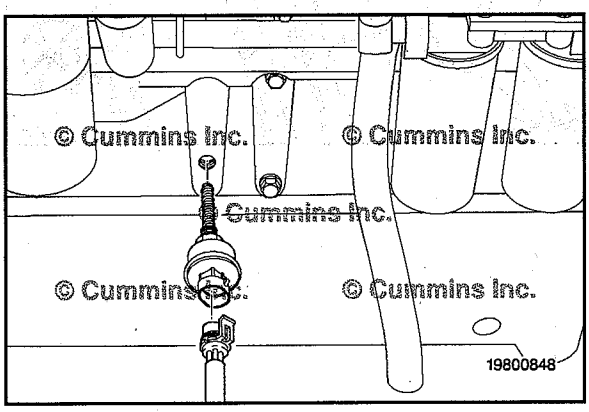
- Partially drain the engine lubricating oil sump or the makeup tank, depending on sensor location: Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.



Remove

Lift up on the locking tab and pull the electrical connectors apart.

Remove the sensor.



Clean and Inspect for Reuse

⚠WARNING⚠

To reduce the possibility of personal injury and property damage, never use starting fluid if the grid heater option is used. Starting fluid, which contains ether, can cause an explosion.

⚠WARNING⚠

Because of the potential for an explosion, do not use volatile cold starting aids in underground mine or tunnel operations. Ask the local U.S. Bureau of Mines Inspector for instructions.

⚠WARNING⚠

Starting fluid is highly flammable and explosive. Keep flames, sparks, and arcing switches away from starting fluid.

Clean the sensor with ether.

Check the sensor for damaged threads.

Install



Lubricate the sensor o-ring.



Install the new sensor into the engine.

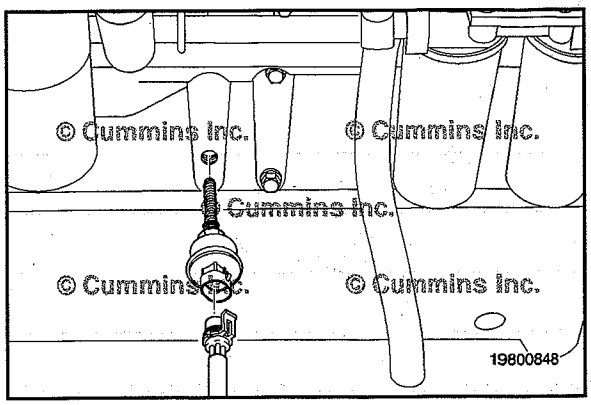
Tighten the sensor.

Torque Value: 14 N•m [124 in-lb]



Push the electrical connectors together until they lock.





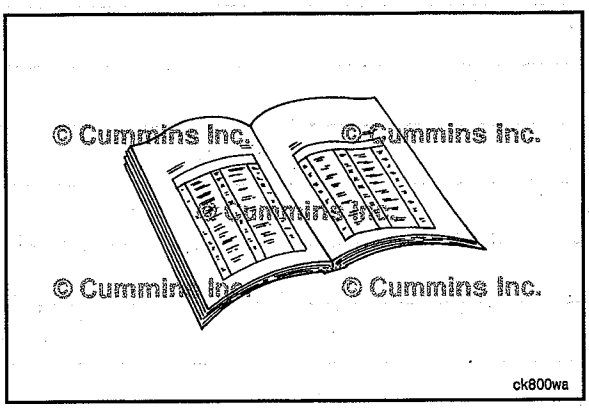
Finishing Steps



- Fill the engine and makeup tank to the proper level with lubricating oil. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.



- Operate the engine and check for leaks.



Notes

Section 7 - Maintenance Procedures at 1500 Hours or 1 Year

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Maintenance Procedures - Overview

General Information

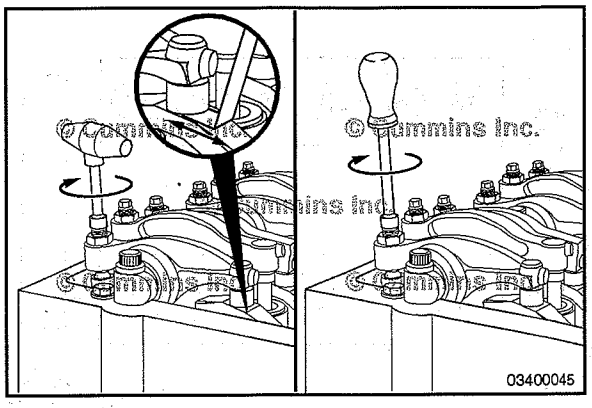
All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Overhead Set (OBC)

General Information

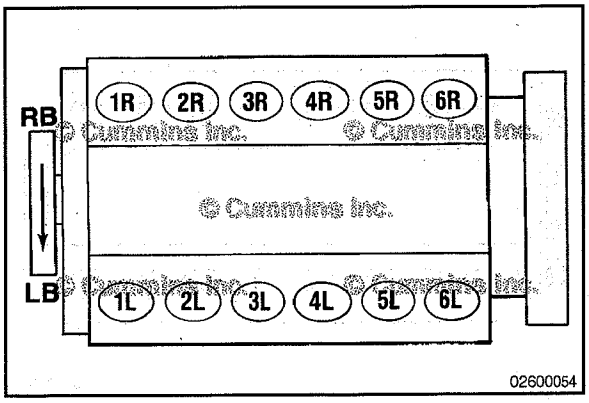
with Mechanically Actuated Injector

Cummins Inc. has found that engines in most applications will **not** experience significant valve/injector train wear after an initial adjustment is performed at 1500 hours. If valve and injector adjustment is checked during troubleshooting or before the recommended maintenance interval, adjustment is **not** required if measurements are within the recheck limits.

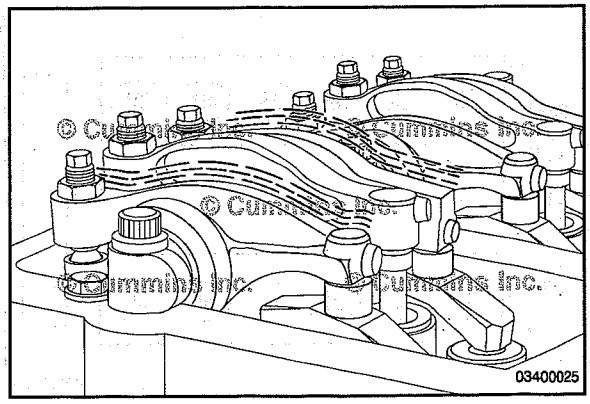


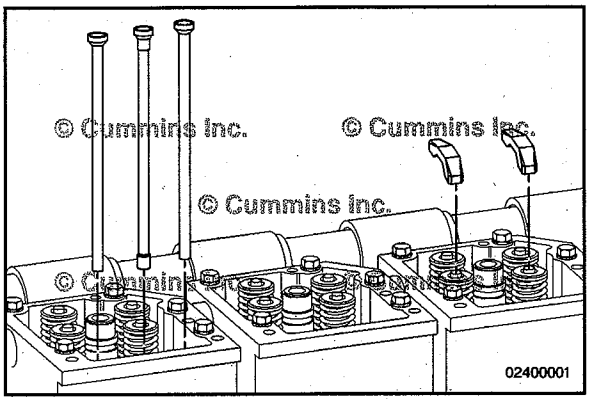
The cylinders are numbered from the front gear cover end of the engine.

To determine the right and left banks on a QSK45 or a QSK60 engine, stand at the rear of the engine and face the front.

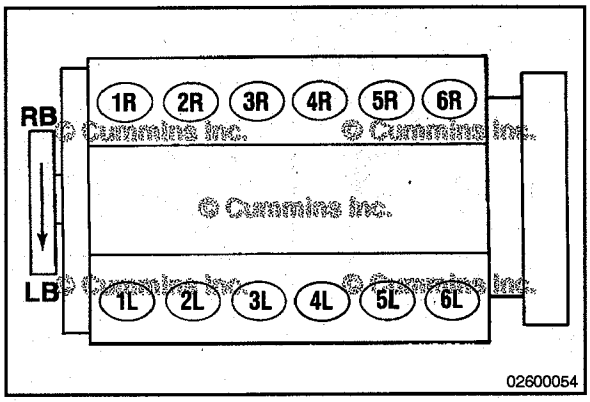


Each cylinder has three rocker levers. When facing the cylinder head, the rocker lever on the left is the exhaust rocker lever. The rocker lever on the right is the intake rocker lever. The center rocker lever is for the injector.





The valve and injector pushrods are different. If removed, make sure the pushrods are installed in the same location as they were removed from.

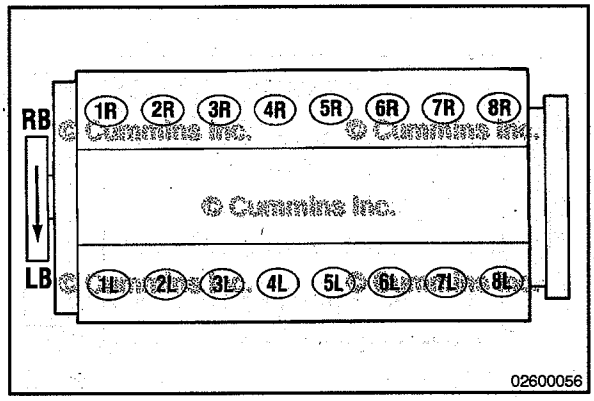


QSK45 Firing Order:

1R-6L-5R-2L-3R-4L-6R-1L-2R-5L-4R-3L

RB = Right Bank of Cylinders

LB = Left Bank of Cylinders.

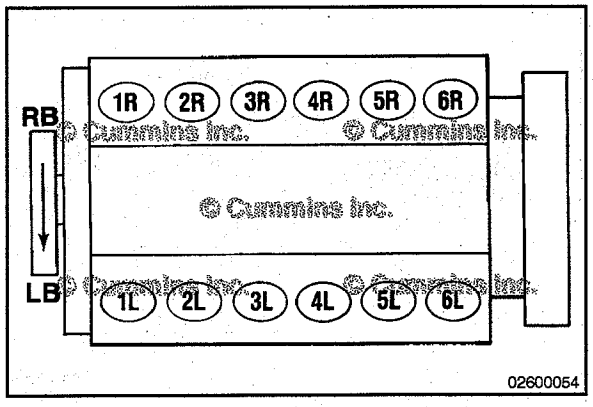


QSK60 Firing Order:

1R-1L-3R-3L-2R-2L-5R-4L-8R-8L-6R-6L-7R-7L-4R-5L

RB = Right Bank of Cylinders

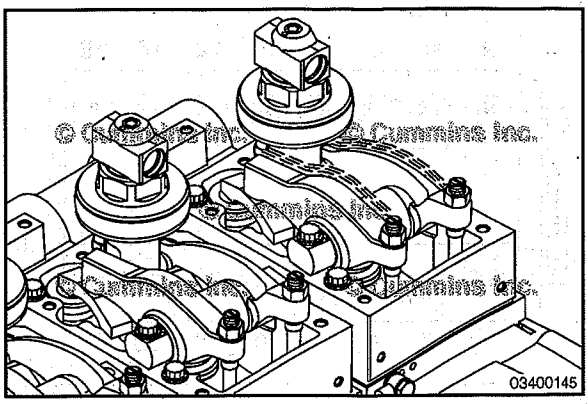
LB = Left Bank of Cylinders.



Direction of normal rotation for QSK45 and QSK60 engines is **clockwise** when viewing the front of the engine.

with Electronically Actuated Injector

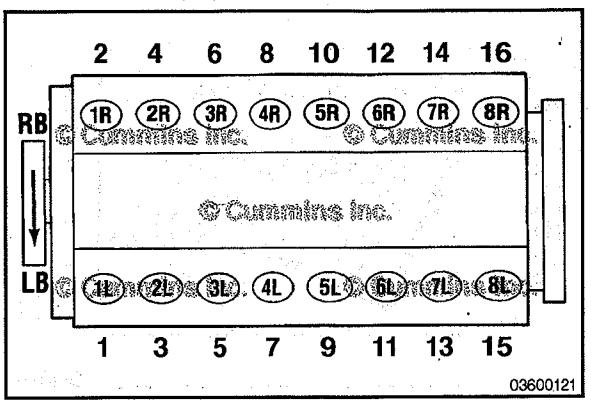
Cummins Inc. has found that engines in most applications will **not** experience significant valve train wear after an initial adjustment is performed at 1500 hours. If the valve adjustment is checked during troubleshooting or before the recommended maintenance interval, adjustment is **not** required if measurements are within the recheck limits.



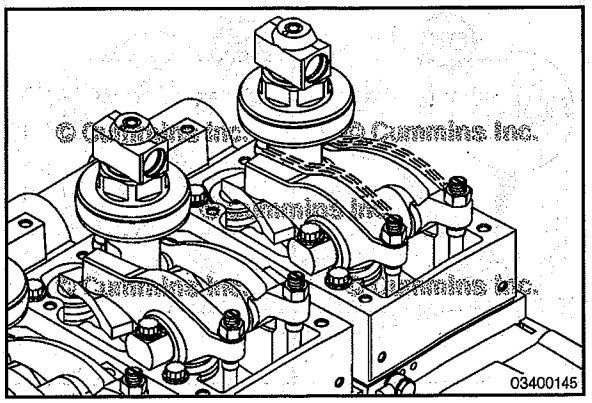
The cylinders are numbered from the front gear cover end of the engine.

To determine the right and left banks on the QSK60 engine, stand at the rear of the engine and face the front.

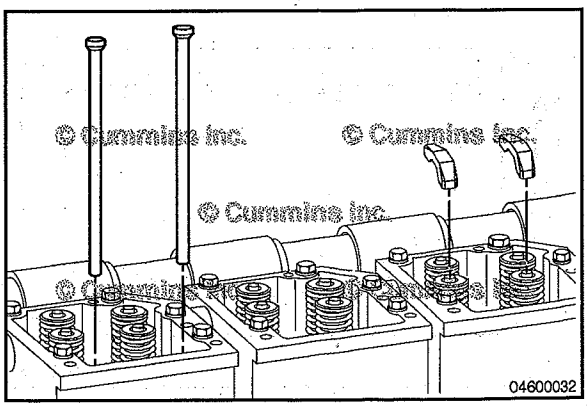
When referring to system electronics, a standard cylinder numbering has been adopted. This is **only** used for the electronic system components on engines with electronically actuated injectors.

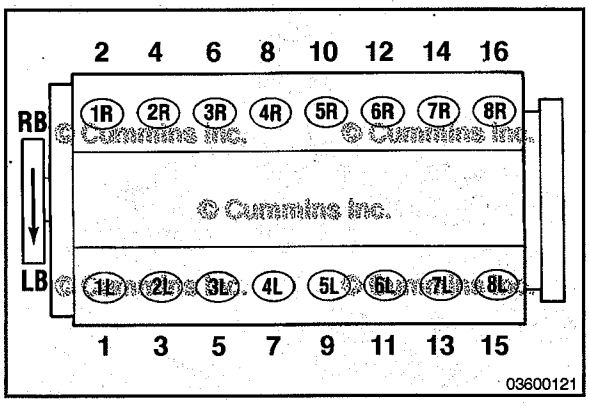


Each cylinder has two rocker levers. When facing the cylinder head, the rocker lever on the left is the exhaust rocker lever. The rocker lever on the right is the intake rocker lever.



If the push rods were removed for service, make sure they are installed in the same location as they were removed from.





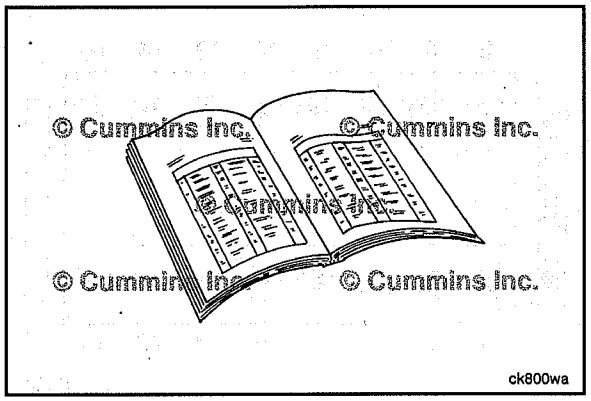
QSK60 Firing Order:

1R-1L-3R-3L-2R-2L-5R-4L-8R-8L-6R-6L-7R-7L-4R-5L or 2-1-6-5-4-3-10-7-16-15-12-11-14-13-8-9.

RB = Right Bank of Cylinders

LB = Left Bank of Cylinders.

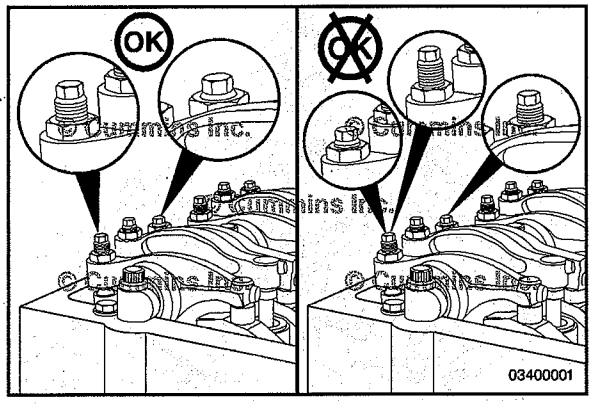
Direction of normal rotation for the QSK60 engine is **clockwise** when viewing from the front of the engine.



Adjust

with Mechanically Actuated Injector

Remove the rocker lever cover and all related parts. Refer to Procedure 003-011 (Rocker Lever Cover) in Section A.



If the rocker lever assemblies have been removed complete the following on all cylinders:

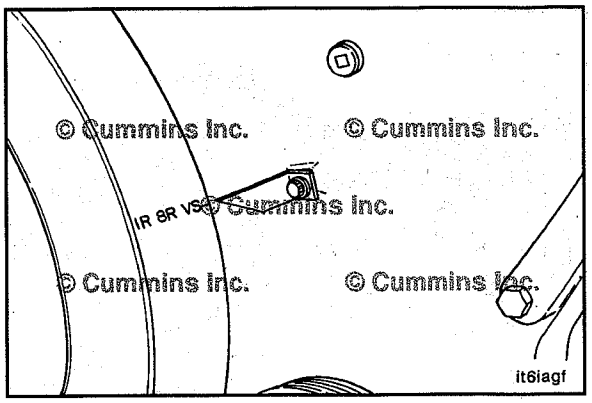
- Lubricate the adjusting screw threads with clean engine oil prior to making valve and injector adjustments.
- All adjusting screws **must** be loose on all cylinders, and the pushrods **must** remain in alignment.
- Hold both rocker levers against the crossheads. Turn the adjusting screws until they touch the pushrods. Turn the locknuts until they touch the levers.
- The pushrods will be close to the same height above the top of the rocker lever housing on the cylinder that is ready for adjustment.
- The number of threads visible above the adjusting nut will **not** be the same. There will be more threads visible on the intake adjusting screw than on the exhaust.

QSK45 and QSK60 engines have valve and injector adjustment marks on the vibration damper and on both sides of the flywheel housing.

Valve and injector adjustment marks **must** be aligned with the pointer or a false adjustment can occur.

One pair of valves and one injector are adjusted at each pulley index mark, before rotating the engine to the next index mark.

Two crankshaft revolutions are required to adjust all of the valves and injectors.



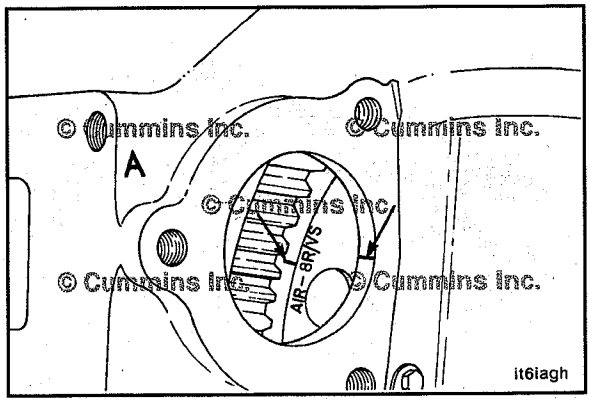
CAUTION

When using the starter covers on the right bank, the marks on the flywheel that begin with an A must be used or the valves and injectors will not be adjusted correctly, causing damage to the engine.

When using the valve and injector adjustment marks on the flywheel, the upper starter bore cover **must** be removed to see the marks.

The A marks **must** be used if the marks are viewed on the right banks.

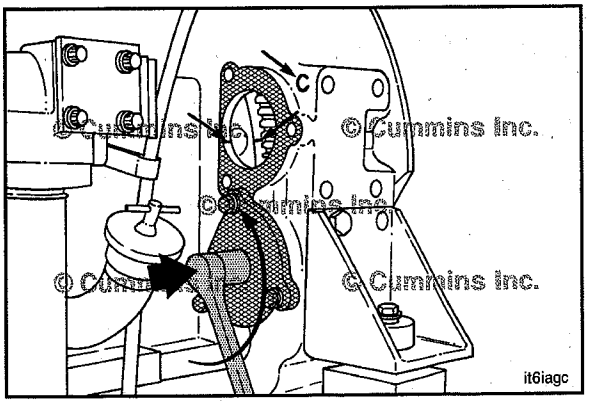
The C marks **must** be used if the marks are viewed on the left bank.



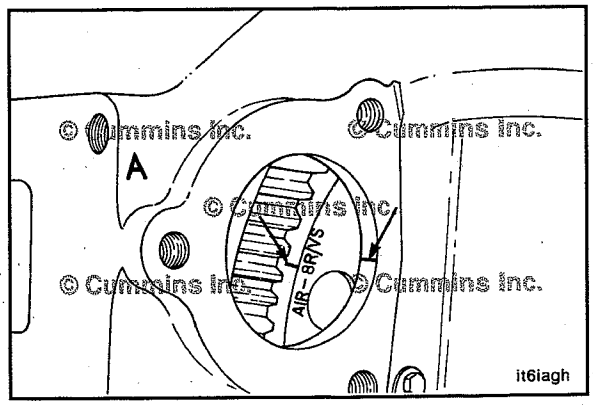
CAUTION

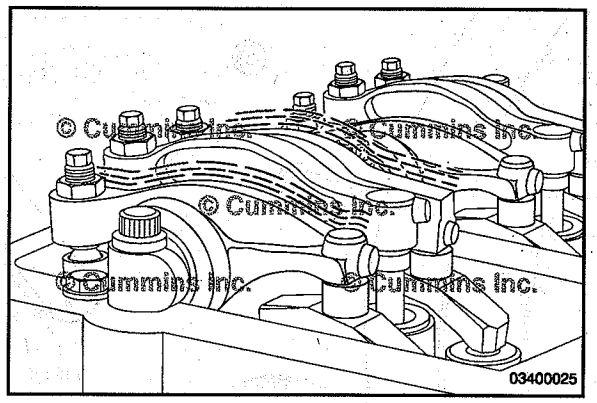
When using the starter covers on the left bank, the marks on the flywheel that begin with a C must be used or the valves and injectors will not be adjusted correctly, causing damage to the engine.

This illustration shows the engine barring device. To use the device, remove the clip and push the device shaft toward the flywheel. The barring device **must** be rotated **counterclockwise** to turn the flywheel and crankshaft in the direction of normal rotation.



VS represents the valve set. Ignore any TC (top center) marks while setting the valves and injectors.



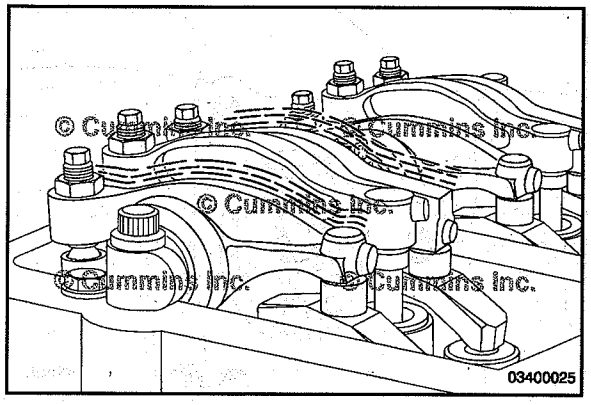


Determine the cylinder in position for valve set:

The valves are ready to be adjusted on the cylinder that has all of the valves closed.

NOTE: When all of the valves are closed, there is some movement in the rocker levers.

Check the two cylinders shown on the VS mark.



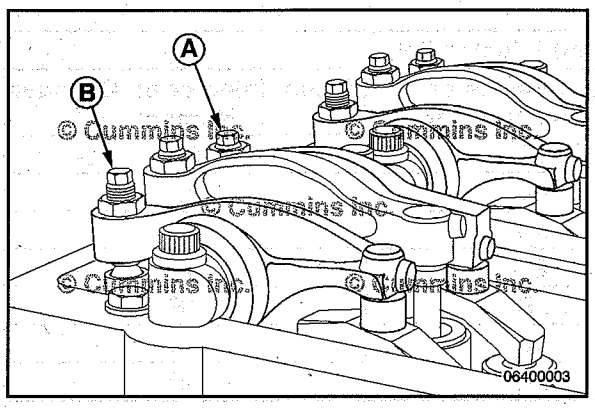
If the rocker levers have **not** been removed, wiggle the valve rocker levers on the two cylinders in question. Set the valves on the cylinder where both levers feel loose.

Adjustment can begin on any valve set mark.

Use the following chart to determine the injector that is ready to adjust.

QSK45 Outer Base Circle Valve and Injector Set			
VS Mark	Valves Closed on Cylinder Number	Adjust Valves on Cylinder Number	Adjust Injector on Cylinder Number
1R-6R VS	1R	1R	2R
6L-1L VS	6L	6L	5L
5R-2R VS	5R	5R	4R
2L-5L VS	2L	2L	3L
3R-4R VS	3R	3R	1R
4L-3L VS	4L	4L	6L
1R-6R VS	6R	6R	5R
6L-1L VS	1L	1L	2L
5R-2R VS	2R	2R	3R
2L-5L VS	5L	5L	4L
3R-4R VS	4R	4R	6R
4L-3L VS	3L	3L	1L

QSK60 Outer Base Circle Valve and Injector Set			
VS Mark	Valves Closed on Cylinder Number	Adjust Valves on Cylinder Number	Adjust Injector on Cylinder Number
1R-8R VS	1R	1R	6R
1L-8L VS	1L	1L	6L
3R-6R VS	3R	3R	7R
3L-6L VS	3L	3L	7L
2R-7R VS	2R	2R	4R
2L-7L VS	2L	2L	5L
4R-5R VS	5R	5R	1R
4L-5L VS	4L	4L	1L
1R-8R VS	8R	8R	3R
1L-8L VS	8L	8L	3L
3R-6R VS	6R	6R	2R
3L-6L VS	6L	6L	2L
2R-7R VS	7R	7R	5R
2L-7L VS	7L	7L	4L
4R-5R VS	4R	4R	8R
4L-5L VS	5L	5L	8L

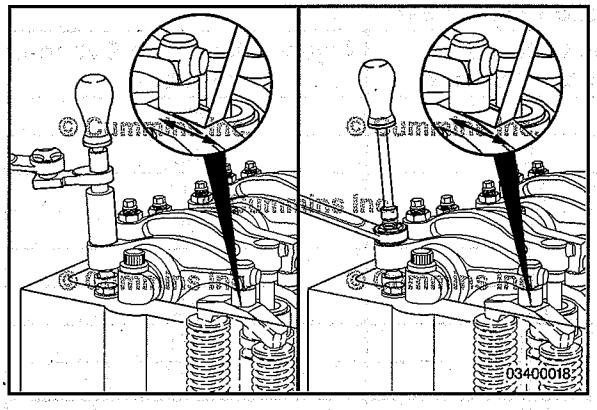


Valves

Valve Clearances - Initial Set			
	mm		in
Exhaust Valves (A)	0.81	MAX	0.032
Intake Valves (B)	0.36	MAX	0.014

Valve Clearances - Recheck			
	mm		in
Exhaust Valves (A)	0.74	MIN	0.029
	0.89	MAX	0.035
Intake Valves (B)	0.28	MIN	0.011
	0.43	MAX	0.017

There are two different methods use to set valve lash clearance: Torque wrench method and feeler gauge method; both are described below. Either method can be used; however, the torque wrench method has proven to be the most consistent.

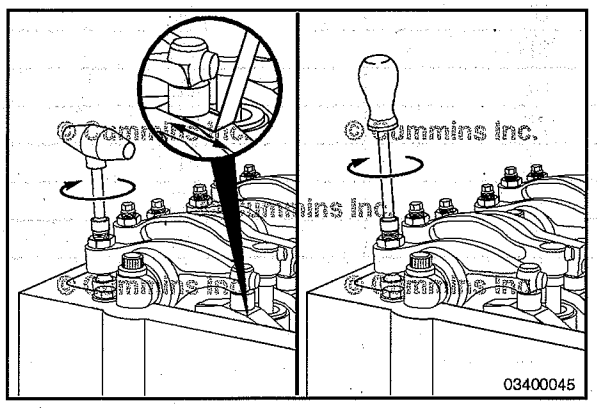


Make sure the crossheads are firmly in place on the valve stems.

Select the proper feeler gauge for the valves being set. Use service tool, Part Number 3824901, or equivalent.

Make sure the feeler gauge is under the center of the ball-and-socket, or the socket can rock or tip, resulting in an incorrect adjustment. Hold the swivel foot flat when checking the lash to avoid false readings.

The adjustment screws **must** turn freely, or a false reading or setting can occur.



Valve Adjustment - Torque Wrench Method

Make sure the parts are aligned, and squeeze the oil out of the valve and the injector train by tightening the adjusting screw.

Loosen the adjusting screw at least one revolution.

Insert the feeler gauge between the rocker lever socket and the crosshead.

Use torque wrench, Part Number 3376592, and tighten the adjusting screw.

Torque Value: 0.7 N•m [6 in-lb]

Remove the feeler gauge.

The adjusting screw **must not** turn when the locknut is tightened. Locknut torque can be applied with or without torque wrench adapter, Part Number 3163196.

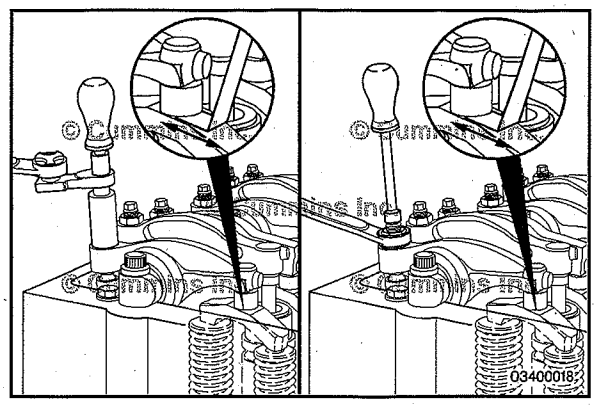
Tighten the locknut.

Torque Value:

With Adapter	48 N•m	[35 ft-lb]
Without Adapter	60 N•m	[44 ft-lb]

Attempt to insert a feeler gauge that is 0.03-mm [0.001-in] thicker. The valve lash is **not** correct if the thicker feeler gauge will fit.

Repeat the adjustment process until the proper lash is obtained.



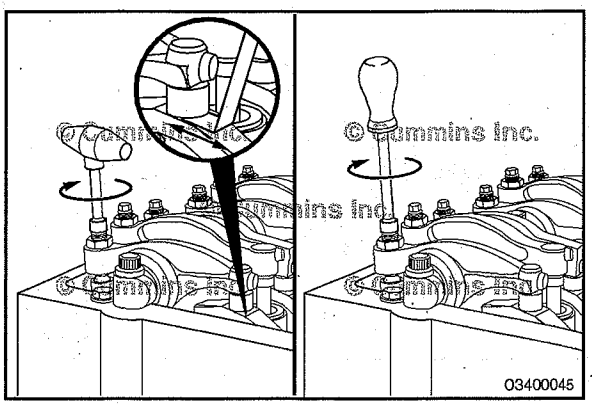
Valve Adjustment - Feeler Gauge Method

Make sure parts are aligned, and squeeze the oil out of the valve and injector train by tightening the adjusting screw.

Loosen the adjusting screw at least one revolution.

Insert the feeler gauge between the rocker lever socket and the crosshead.

Tighten the adjusting screw until the rocker lever touches the feeler gauge.



The adjusting screw **must not** turn when the locknut is tightened. Locknut torque can be applied with or without a torque wrench adapter, Part Number 3163196.

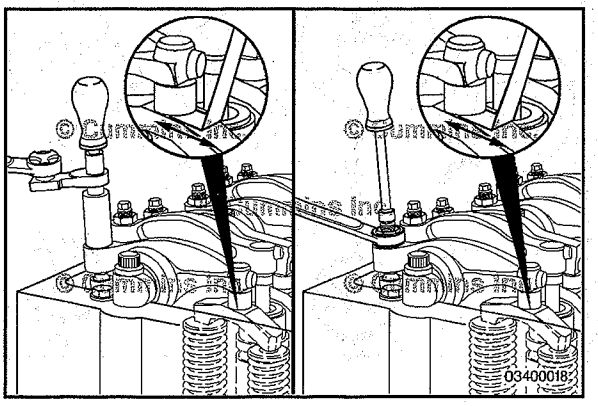
Tighten the locknut.

Torque Value:

With Adapter	48 N•m	[35 ft-lb]
Without Adapter	60 N•m	[44 ft-lb]

Attempt to insert a feeler gauge that is 0.03-mm [0.001-in] thicker. The valve lash is **not** correct if the thicker feeler gauge will fit.

Repeat the adjustment process until the proper lash is obtained.



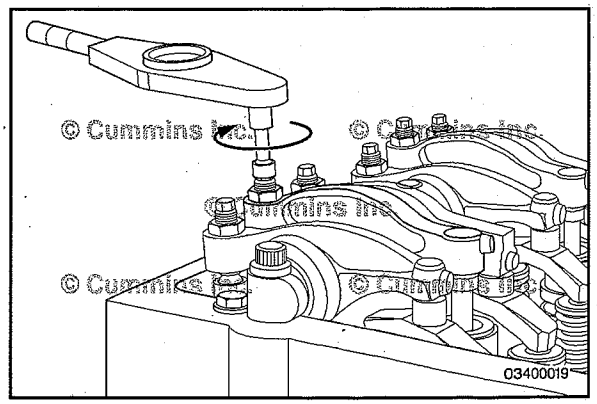
Injectors

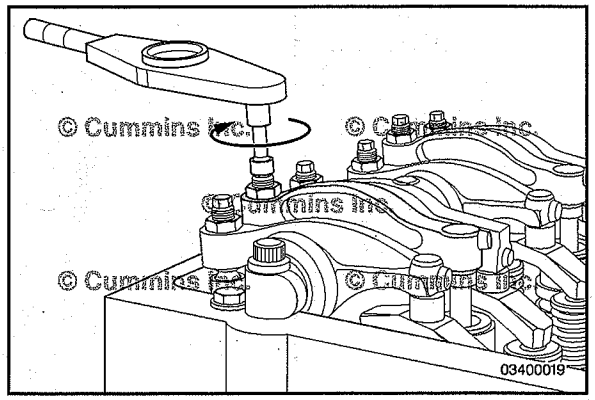
Do **not** use a click-type torque wrench.

Use a dial-type torque wrench, Part Number 3164795, with a range up to 34 N•m [25 ft-lb] to tighten the injector rocker lever adjusting screw. If the screw chatters during setting, repair the screw and lever as required.

Hold the torque wrench in a position that allows you to look in a direct line at the dial. This is to make sure the dial will be read accurately.

Make sure the parts are aligned, and squeeze the oil out of the valve and injector train by tightening the adjusting screw.





Use this initial adjustment to preload the valve train and injector.

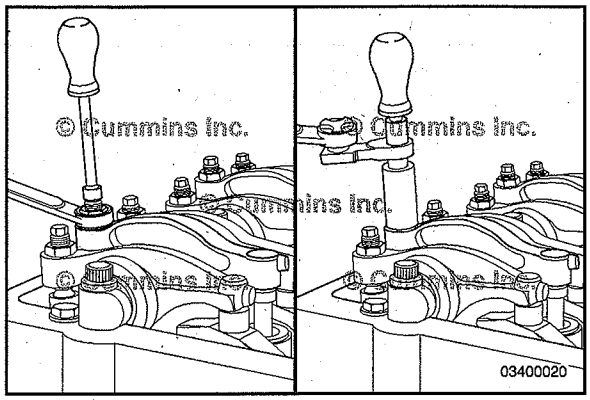
Tighten the injector adjusting screw.

Torque Value: 28 N•m [248 in-lb]

Loosen the adjusting screw at least one revolution.

Tighten the adjusting screw.

Torque Value: 19 N•m [168 in-lb]

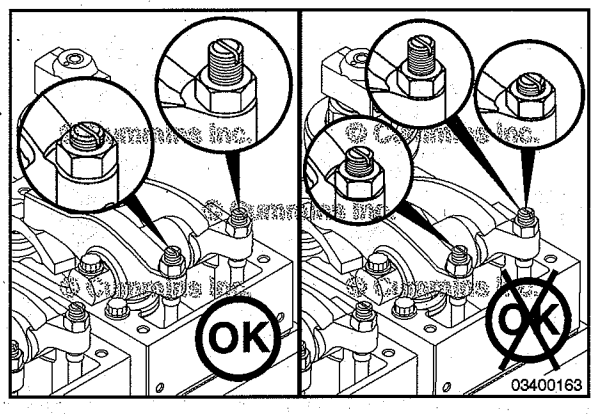


The adjusting screw **must not** turn when the locknut is tightened.

Tighten the injector adjusting screw locknut:

Torque Value:

With Adapter	48 N•m	[35 ft-lb]
Without Adapter	60 N•m	[44 ft-lb]



with Electronically Actuated Injector

If the rocker lever assemblies have been removed complete the following on both cylinders:

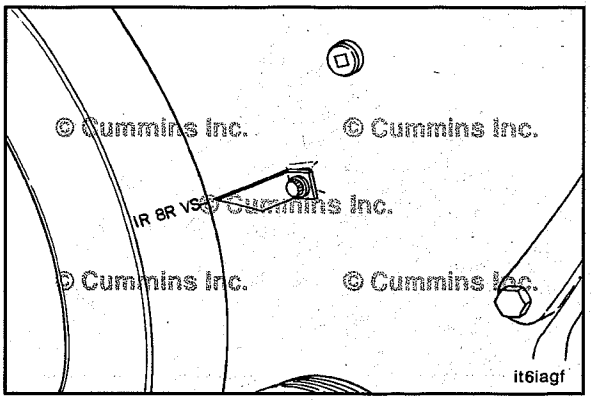
- Lubricate the adjusting screw threads with clean engine oil prior to making valve and injector adjustments.
- All adjusting screws **must** be loose on all cylinders, and the pushrods **must** remain in alignment.
- Hold both rocker levers against the crossheads. Turn the adjusting screws until they touch the pushrods. Turn the locknuts until they touch the levers.
- The pushrods will be close to the same height above the top of the rocker lever housing on the cylinder that is ready for adjustment.
- The number of threads visible above the adjusting nut will **not** be the same. There will be more threads visible on the intake adjusting screw than on the exhaust.

QSK60 engines have valve adjustment marks on the vibration damper and on both sides of the flywheel housing.

Valve adjustment marks **must** be aligned with the pointer or a false adjustment can occur.

One pair of valves are adjusted at each pulley index mark, before rotating the engine to the next index mark.

Two crankshaft revolutions are required to adjust all of the valves.



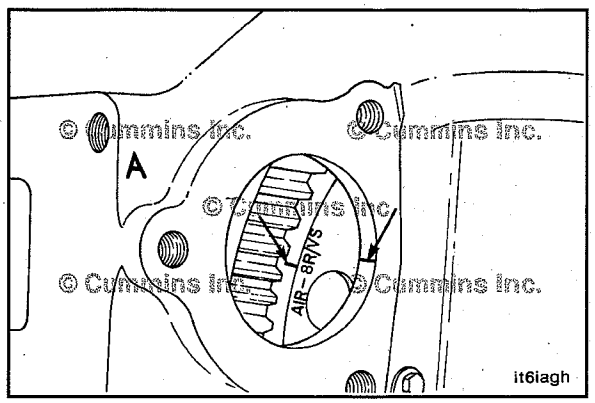
⚠CAUTION⚠

When using the starter covers on the right bank, the marks on the flywheel that begin with an A must be used or the valves will not be adjusted correctly, causing damage to the engine.

When using the valve adjustment marks on the flywheel, the upper starter bore cover **must** be removed to see the marks.

The A marks **must** be used if the marks are viewed on the right banks.

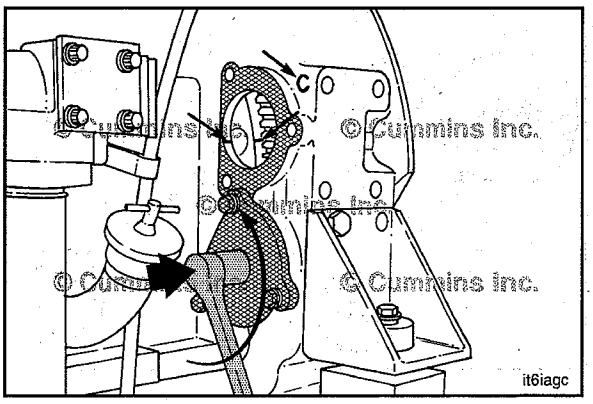
The C marks **must** be used if the marks are viewed on the left bank.



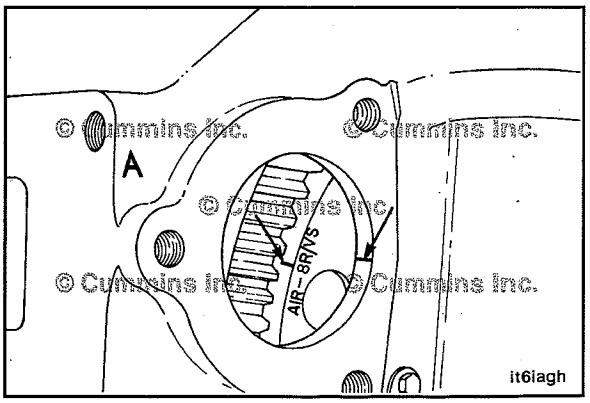
⚠CAUTION⚠

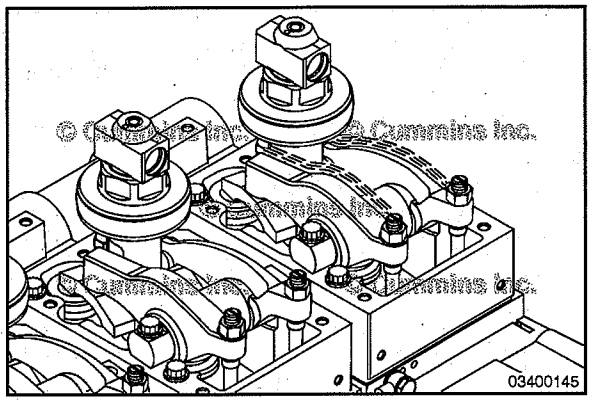
When using the starter covers on the left bank, the marks on the flywheel that begin with a C must be used or the valves will not be adjusted correctly, causing damage to the engine.

This illustration shows the engine barring device. To use the device, remove the clip and push the device shaft toward the flywheel. The barring device **must** be rotated **counterclockwise** to turn the flywheel and crankshaft in the direction of normal rotation.



VS represents the valve set. Ignore any TC (top center) marks while setting the valves.





Determine the cylinder in position for valve set:

The valves are ready to be adjusted on the cylinder that has all of the valves closed.

NOTE: When all of the valves are closed, there is some movement in the rocker levers.

Check the two cylinders shown on the VS mark.

If the rocker levers have **not** been removed, wiggle the valve rocker levers on the two cylinders in question. Set the valves on the cylinder where both levers feel loose.

Adjustment can begin on any valve set mark.

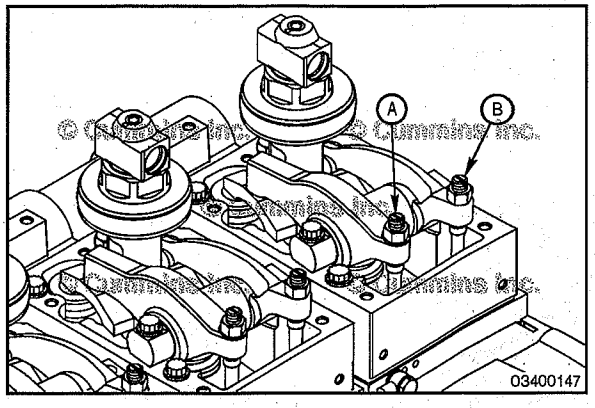
Use the following chart to determine the cylinder that is ready to adjust.

QSK60 Outer Base Circle Valve Set		
VS Mark	Valves Closed on Cylinder Number	Adjust Valves on Cylinder Number
1R-8R VS	1R	1R
1L-8L VS	1L	1L
3R-6R VS	3R	3R
3L-6L VS	3L	3L
2R-7R VS	2R	2R
2L-7L VS	2L	2L
4R-5R VS	5R	5R
4L-5L VS	4L	4L
1R-8R VS	8R	8R
1L-8L VS	8L	8L
3R-6R VS	6R	6R
3L-6L VS	6L	6L
2R-7R VS	7R	7R
2L-7L VS	7L	7L
4R-5R VS	4R	4R
4L-5L VS	5L	5L

Valves

Valve Clearances - Initial Set			
	mm		in
Exhaust Valves (A)	0.81	MAX	0.032
Intake Valves (B)	0.36	MAX	0.014

Valve Clearances - Recheck			
	mm		in
Exhaust Valves (A)	0.74	MIN	0.029
	0.89	MAX	0.035
Intake Valves (B)	0.28	MIN	0.011
	0.43	MAX	0.017



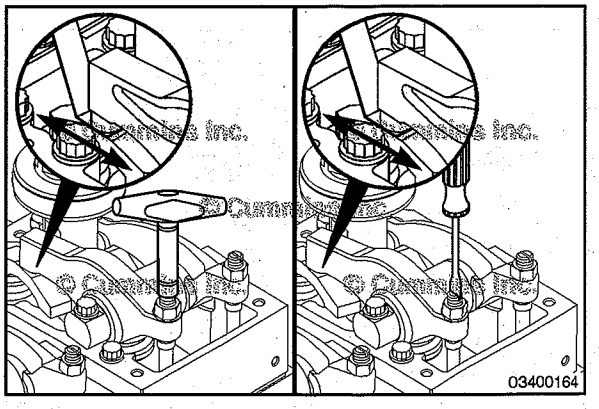
There are two different methods use to set valve lash clearance: Torque wrench method and feeler gauge method; both are described below. Either method can be used; however, the torque wrench method has proven to be the most consistent.

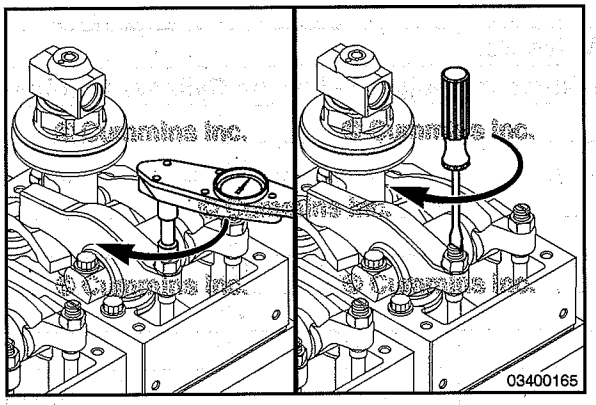
Make sure the crossheads are firmly in place on the valve stems.

Select the proper feeler gauge for the valves being set. Use service tool, Part Number 3824901, or equivalent.

Make sure the feeler gauge is under the center of the ball-and-socket, or the socket can rock or tip, resulting in an incorrect adjustment. Hold the swivel foot flat when checking the lash to avoid false readings.

The adjustment screws **must** turn freely, or a false reading or setting can occur.





Valve Adjustment - Torque Wrench Method

Make sure the parts are aligned, and squeeze the oil out of the valve train by tightening the adjusting screw.

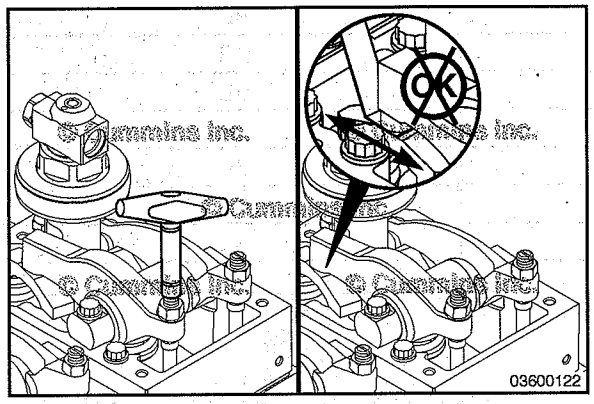
Loosen the adjusting screw at least one revolution.

Insert the feeler gauge between the rocker lever socket and the crosshead.

Use torque wrench, Part Number 3376592, and tighten the adjusting screw.

Torque Value: 0.7 N•m [6 in-lb]

Remove the feeler gauge.



The adjusting screw **must not** turn when the locknut is tightened. Locknut torque can be applied with or without torque wrench adapter, Part Number 3163196.

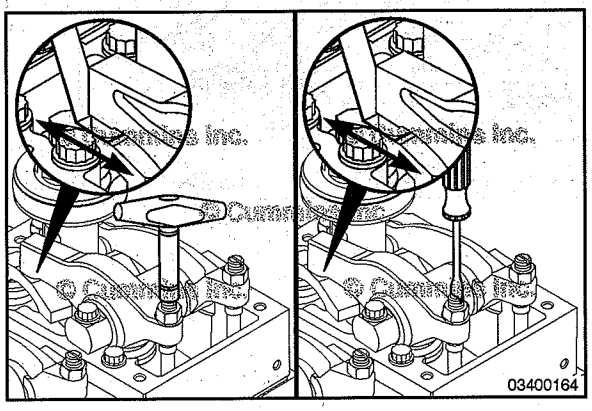
Tighten the locknut.

Torque Value:

With Adapter	48 N•m	[35 ft-lb]
Without Adapter	60 N•m	[44 ft-lb]

Attempt to insert a feeler gauge that is 0.03-mm [0.001-in] thicker. The valve lash is **not** correct if the thicker feeler gauge will fit.

Repeat the adjustment process until the proper lash is obtained.



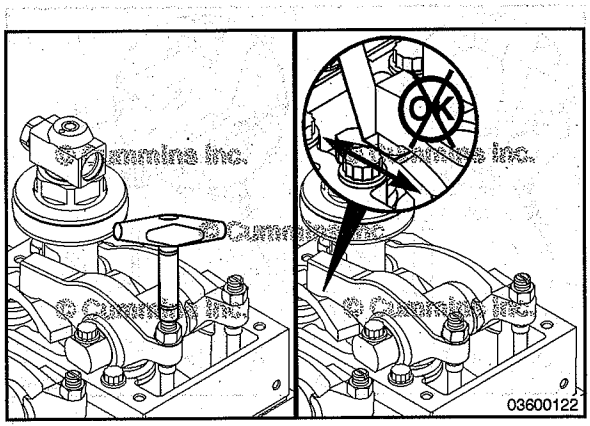
Valve Adjustment - Feeler Gauge Method

Make sure parts are aligned, and squeeze the oil out of the valve and injector train by tightening the adjusting screw.

Loosen the adjusting screw at least one revolution.

Insert the feeler gauge between the rocker lever socket and the crosshead.

Tighten the adjusting screw until the rocker lever touches the feeler gauge.



The adjusting screw **must not** turn when the locknut is tightened. Locknut torque can be applied with or without a torque wrench adapter, Part Number 3163196.

Tighten the locknut.

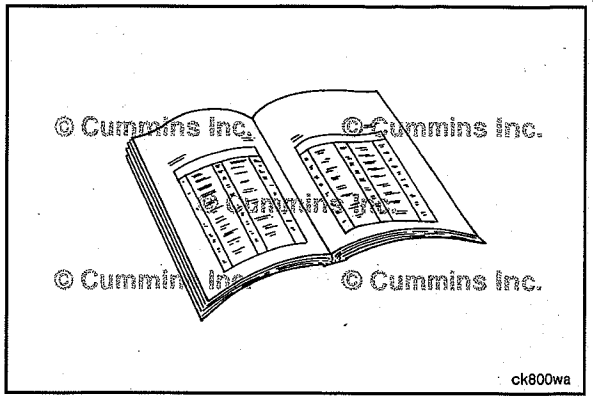
Torque Value:

With Adapter	48 N•m	[35 ft-lb]
Without Adapter	60 N•m	[44 ft-lb]

Attempt to insert a feeler gauge that is 0.03-mm [0.001-in] thicker. The valve lash is **not** correct if the thicker feeler gauge will fit.

Repeat the adjustment process until the proper lash is obtained.

Install the rocker lever cover and all related parts. Refer to Procedure 003-011 (Rocker Lever Cover) in Section A.



Fleetguard® Centrifuge

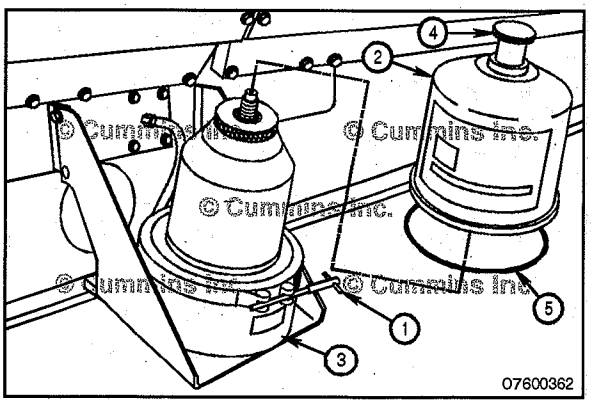
Disassemble

NOTE: Although the illustrations in this procedure show the Fleetguard® Centrifuge mounted on engine, the procedure remains the same for on and off the engine.

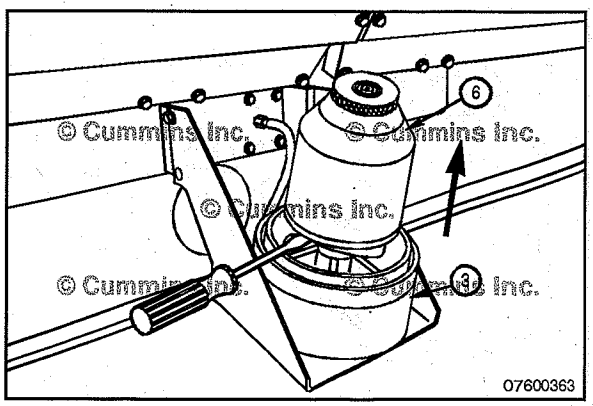
Remove the band clamp (1) from the centrifuge bell housing (2) and base (3).

Loose the bell knob (4), and remove the centrifuge bell housing (2) and o-ring (5).

Discard the o-ring.

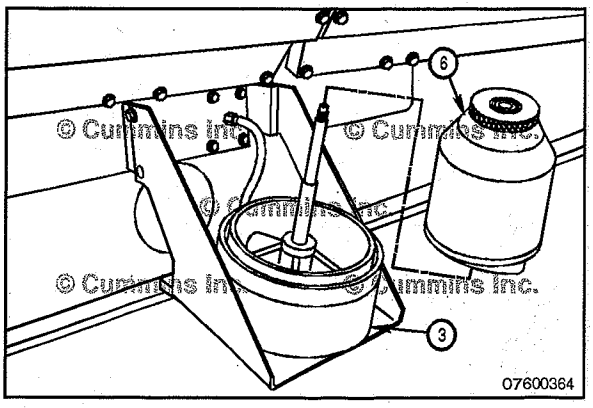


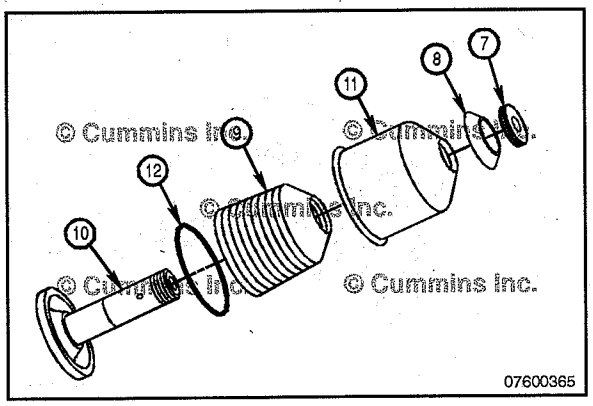
Using a flat screwdriver or prying tool to raise the turbine assembly (6) approximately 25 mm [1 in] above the base (3), and allow any remaining oil to drain from the turbine assembly.



Remove the turbine assembly (6) from the base (3).

Set the turbine assembly to one side of the work area.

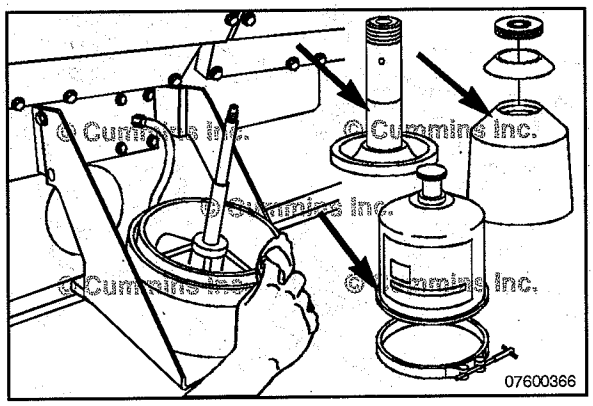




Using a 3 inch spanner wrench, loosen the cam nut (7) and invert the assembly to loosen the cone washer (8) and the turbine can (11).

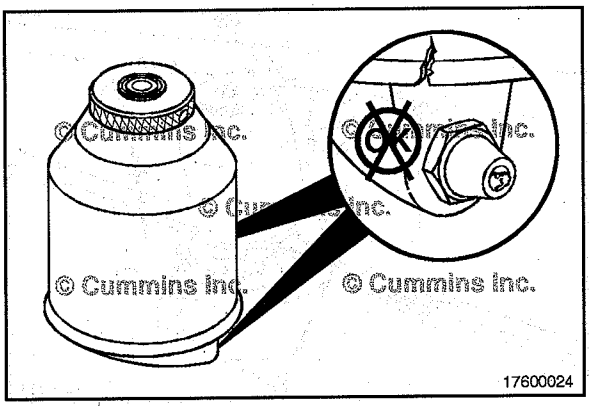
Carefully separate the cam nut (7), cone washer (8), turbine can (11), Conestac filter (9), and o-ring (12) from the rotor turbine (10).

Discard the o-ring and Conestac filter.



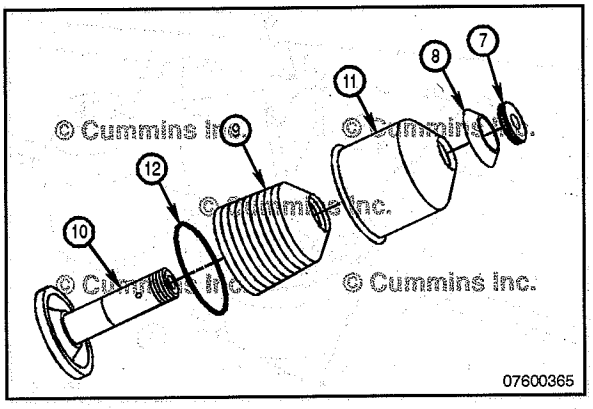
Clean and Inspect for Reuse

Using a clean rag, clean all gasket surfaces, bell housing, can, and shafts.



Make sure the nozzles are free from debris and dirt.

Inspect all parts for cracks or other damage. If any of the parts are damaged they **must** be replaced.



Assemble

Install the o-ring (12), a new Conestac filter (9), turbine can (11), cone washer (8), and can nut (7) onto the rotor turbine (10).

Make sure the Conestac filter and o-ring are fully seated in the groove of the rotor turbine.

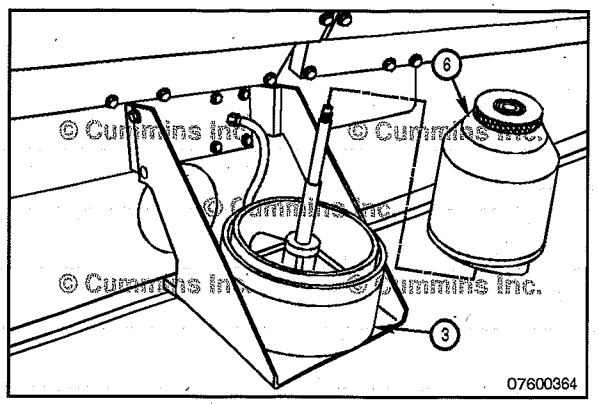
Tighten the cam nut (7) **only** finger tight.

⚠CAUTION⚠

Use caution when assembling the turbine assembly to prevent damage to the bushings. Damage to the bushings will cause premature equipment failure.

Install the turbine assembly (6) onto the base (3).

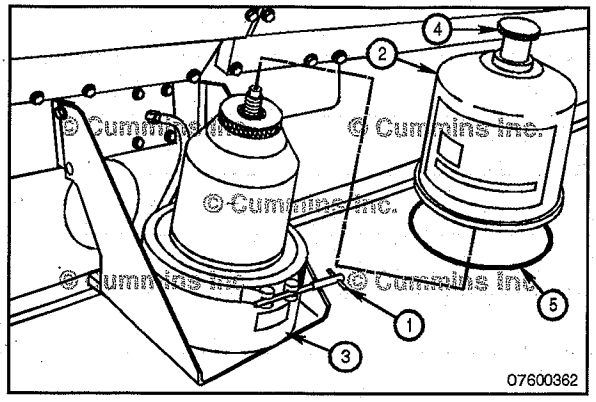
The turbine assembly **must** spin freely on the base when installed.



Install the o-ring (5), and the centrifuge bell housing (2), onto the base (3) hand tightening the bell knob (4).

Install the band clamp (1) around the centrifuge bell housing (2) and base (3).

Tighten the band clamp (1).



Notes

Section 8 - Maintenance Procedures at 4000 Hours or 2 Years

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Maintenance Procedures - Overview

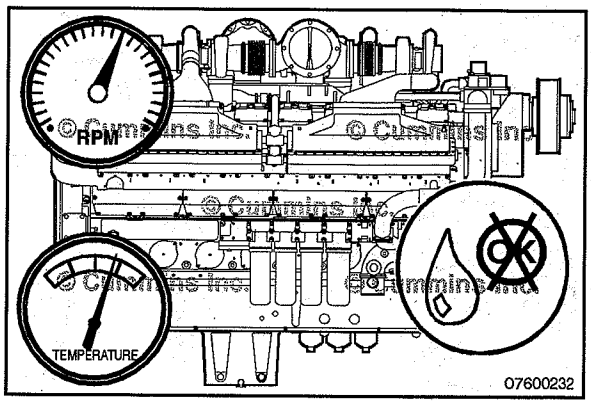
General Information

All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

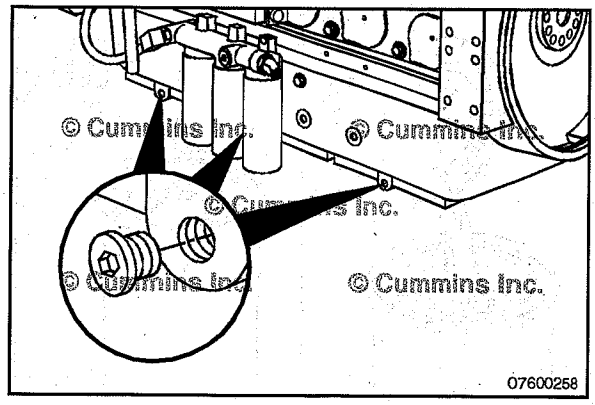
Lubricating Oil and Filters

Drain

Operate the engine until the water temperature reaches 60°C [140°F].



The QSK45 and QSK60 engines have various lubricating oil pan configurations. Remove all drain plugs when draining the oil pan.



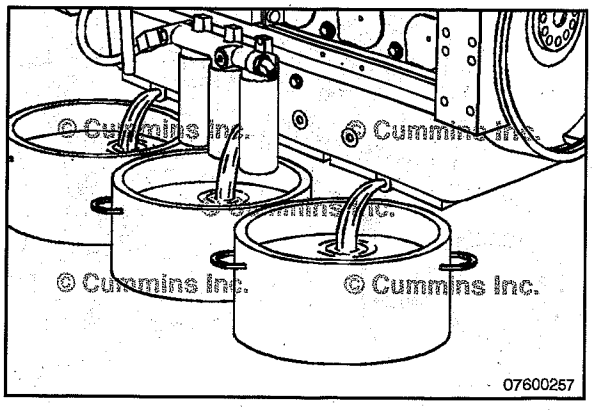
⚠WARNING⚠

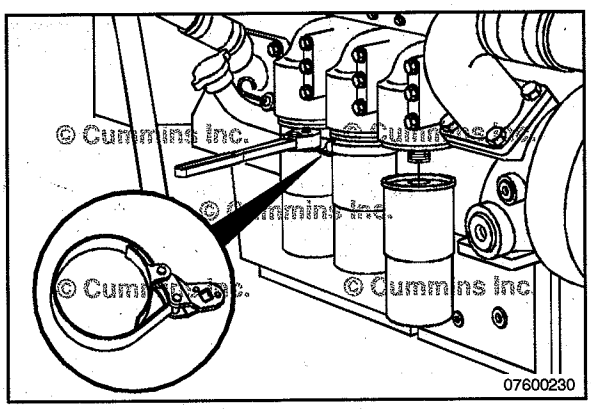
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠WARNING⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

Remove the oil drain plugs and drain the oil immediately to make sure all of the suspended contaminates are removed from the engine.





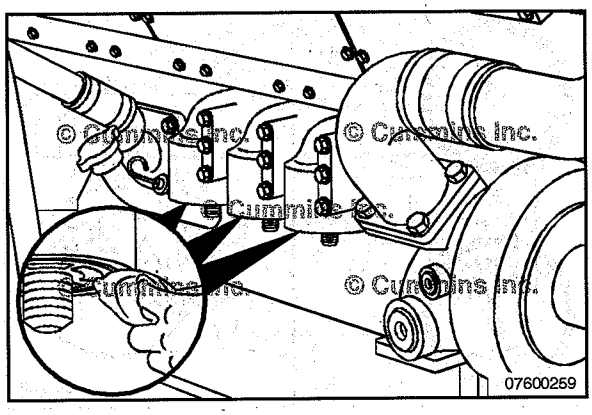
Remove

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

The QSK45 engine has three combination oil filters and the QSK60 has four combination oil filters.

Use an oil filter wrench, Part Number 3375049, or equivalent to remove the oil filters.

Discard the filter if **not** required for failure analysis.

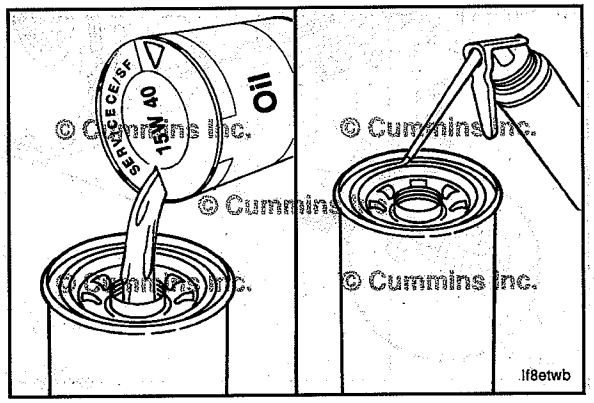


Clean

NOTE: The Eliminator sludge collecting paper does **not** have to be replaced on QSK45 and QSK60 engine applications that use the Eliminator option. If combination oil filters are **not** used, do **not** perform this step.

NOTE: The oil filter o-ring can stick on the filter head. Make sure it is removed.

Clean the oil filter head sealing surface with a lint free cloth.

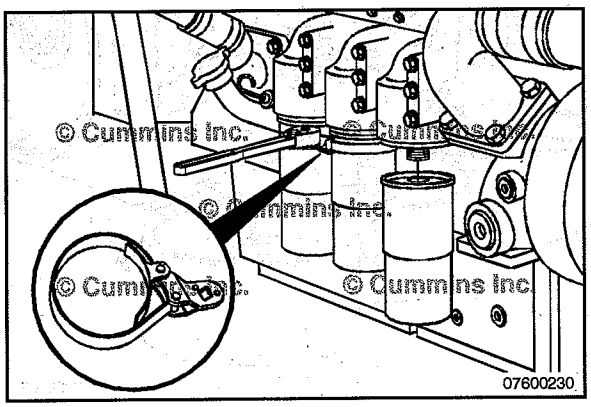


Install

The QSK45 engine has three combination oil filters and the QSK60 engine has four combination oil filters.

Use engine oil to lubricate the oil filter's rubber seal.

Fill the oil filters with clean engine oil.



⚠CAUTION⚠

Mechanical overtightening can distort the threads or damage the filter element seal. If the threads appear damaged, replace the oil filter head adapter.

⚠CAUTION⚠

Locate the oil filter wrench, Part Number 3375049, near the top of the oil filter canister. This will reduce the possibility of damaging the oil filter.

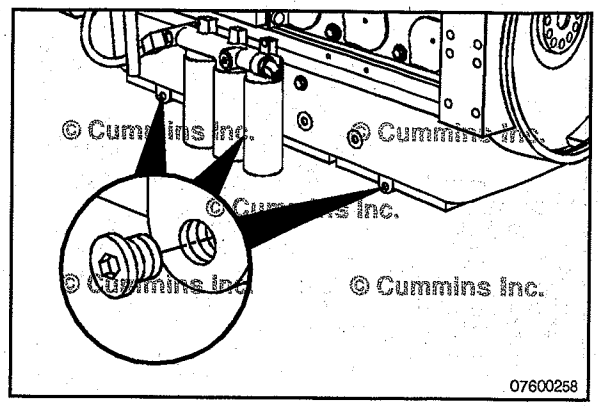
Install the oil filter, turning it until the seal contacts the filter head's sealing surface.

Turn the oil filter an additional 3/4 to 1 turn.

Fill

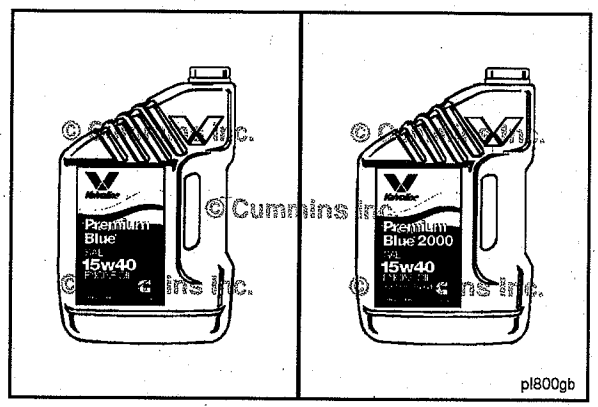
Install and tighten the drain plug(s).

Torque Value: 47 N•m [35 ft-lb]



Use a high quality 15W-40 multiviscosity oil that meets the American Petroleum Institute (API) performance classification CE or CF4 or better.

Choose the correct oil for the operating climate as outlined in Procedure 018-017.

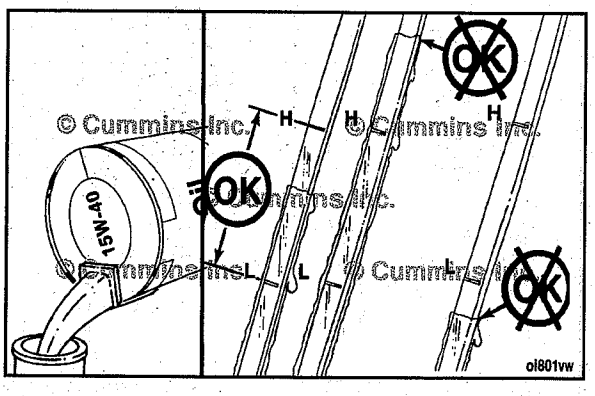


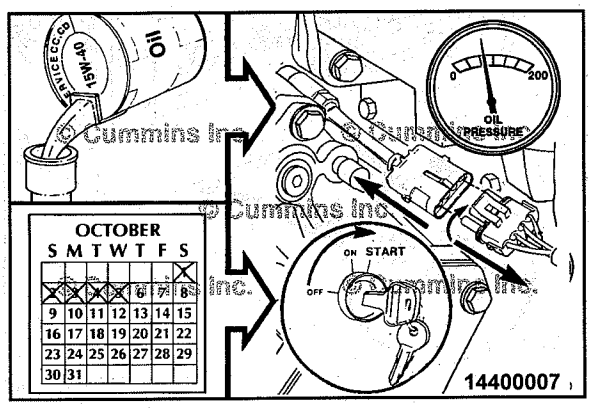
Fill the engine to the correct level with clean engine oil.

Refer to Procedure 018-017 for engine oil capacity.

Check the oil level on the dipstick. The level **must** be to the high (H) mark on the dipstick.

Do **not** overfill. Drain off excess oil in a pan.





⚠CAUTION⚠

Before starting engines not equipped with a PRELUB™ system, complete the following steps. Engine damage will occur, because of inadequate lubrication at startup, if these steps are not followed.

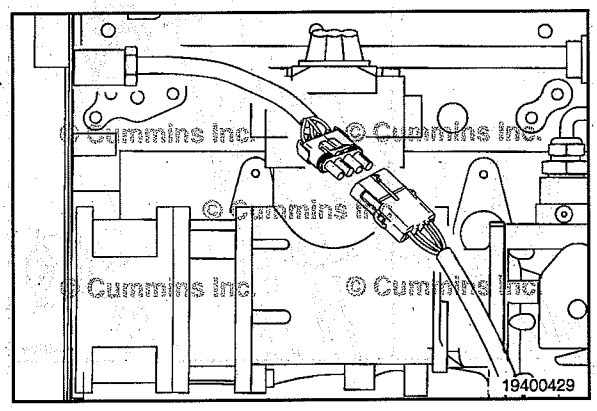
NOTE: This procedure will cause fault codes for the unplugged sensors to be logged. They will go inactive and have no effect on engine operation after the sensors are connected.

NOTE: Engines that are equipped with a PRELUB™ system are self priming and do **not** require completion of this and the next step.

The following steps **must** be completed after each oil change or after the engine has been shut down for more than five days to make sure the engine receives the correct oil flow through the lubricating system.

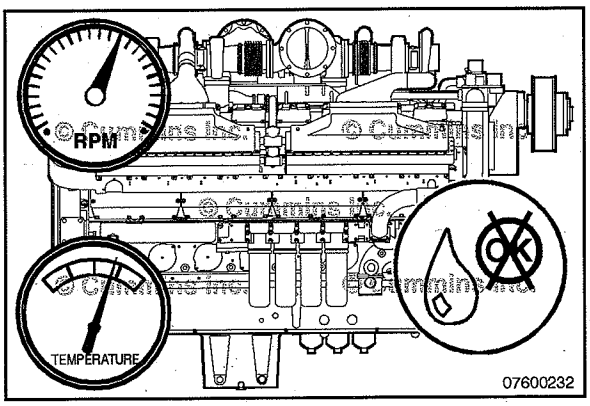
1. On engines using mechanically actuated injectors, disconnect the engine position sensor.
2. On engines using electronically actuated injectors, the following 2 sensors need to be disconnected for priming:
   - Engine speed sensor located in the flywheel housing
   - Camshaft position sensor located above the fuel pump on the left bank side.

Use the starter motor to rotate the engine crankshaft until oil pressure is indicated on the gauge or the warning light goes out.



Connect the engine position sensor on engines with mechanically actuated injectors.

Connect the engine speed and camshaft position sensors on engines with electronically actuated injectors.



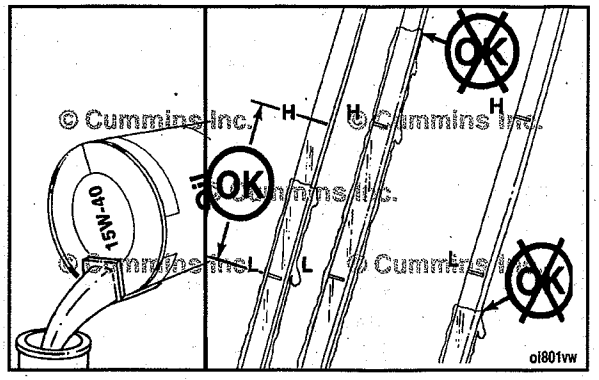
Operate the engine at idle speed to inspect for leaks at the filters and drain plug(s).

Shut off the engine.

Wait approximately 5 minutes to allow the oil to drain from the upper parts of the engine.

Check the oil level.

Add oil as necessary to bring the oil level to the high (H) mark on the dipstick.



Lubricating Oil Level Sensor

Preparatory Steps

⚠WARNING⚠

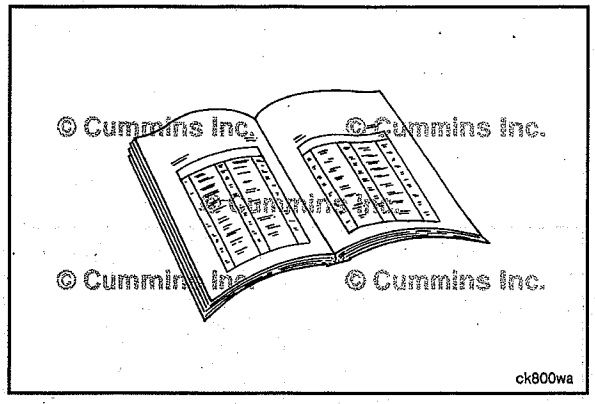
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠WARNING⚠

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin.

NOTE: QSK60 engines with electronically actuated injectors, do **not** use oil level sensors in the oil sump.

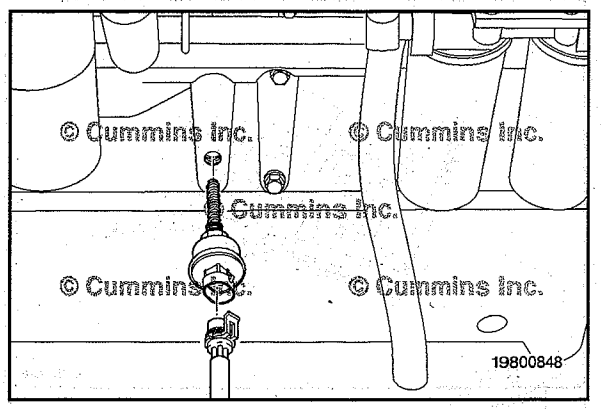
- Partially drain the engine lubricating oil sump or the makeup tank, depending on sensor location. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.

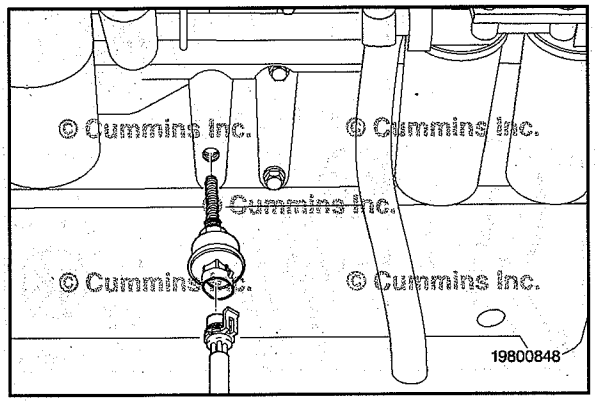


Remove

Lift up on the locking tab and pull the electrical connectors apart.

Remove the sensor.





Clean and Inspect for Reuse

⚠WARNING⚠

To reduce the possibility of personal injury and property damage, never use starting fluid if the grid heater option is used. Starting fluid, which contains ether, can cause an explosion.

⚠WARNING⚠

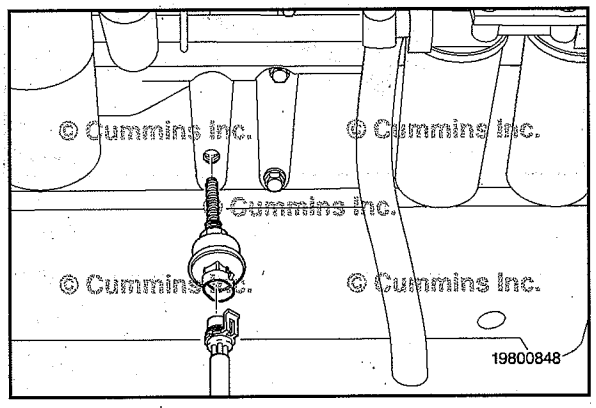
Because of the potential for an explosion, do not use volatile cold starting aids in underground mine or tunnel operations. Ask the local U.S. Bureau of Mines Inspector for instructions.

⚠WARNING⚠

Starting fluid is highly flammable and explosive. Keep flames, sparks, and arcing switches away from starting fluid.

Clean the sensor with ether.

Check the sensor for damaged threads.



Install

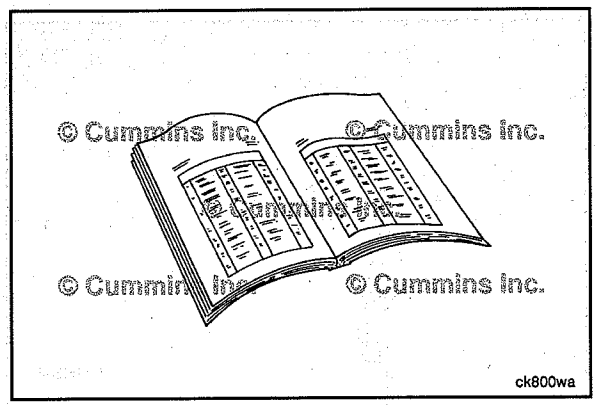
Lubricate the sensor o-ring.

Install the new sensor into the engine.

Tighten the sensor.

Torque Value: 14 N•m [124 in-lb]

Push the electrical connectors together until they lock.



Finishing Steps

- Fill the engine and makeup tank to the proper level with lubricating oil. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.
- Operate the engine and check for leaks.

Section 9 - Maintenance Procedures at 10,000 Hours or 2 Years

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Maintenance Procedures - Overview

General Information

All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Engine Steam Cleaning

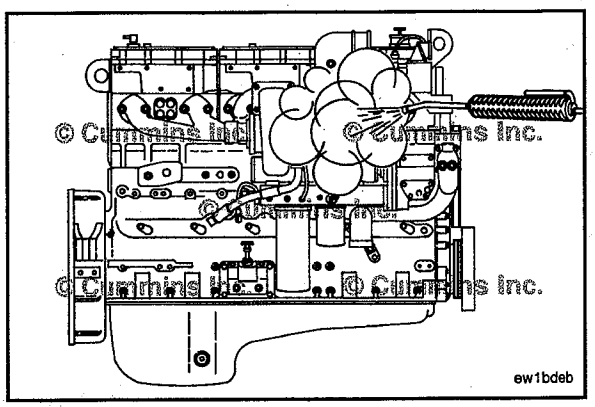
Clean

⚠WARNING⚠

When using a steam cleaner, wear safety glasses or a face shield, as well as protective clothing. Hot steam can cause serious personal injury.

Steam is the best method of cleaning a dirty engine or a piece of equipment. If steam is **not** available, use a solvent to wash the engine.

Protect all electrical components, openings, and wiring from the full force of the cleaner spray nozzle.



Vibration Damper, Viscous

Inspect for Reuse

⚠WARNING⚠

When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

Vibration dampers have a limited service life. The vibration dampers **must** be inspected at 10,000 hours of service and replaced at 24,000 hours of service.

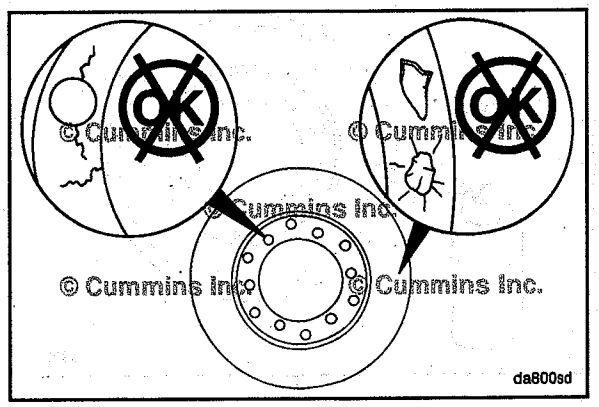
Do **not** attempt to repair or balance a viscous vibration damper in the field.

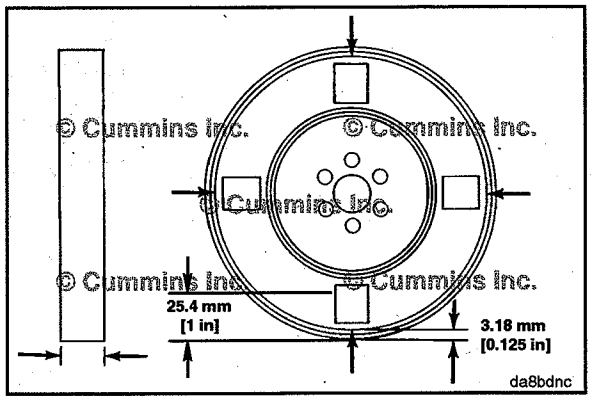
Using solvent, clean the exterior of the vibration damper.

Inspect the mounting flange for cracks.

Inspect the housing for dents or bulges.

If the vibration damper is damaged, it **must** be replaced.





Measure

⚠WARNING⚠

When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

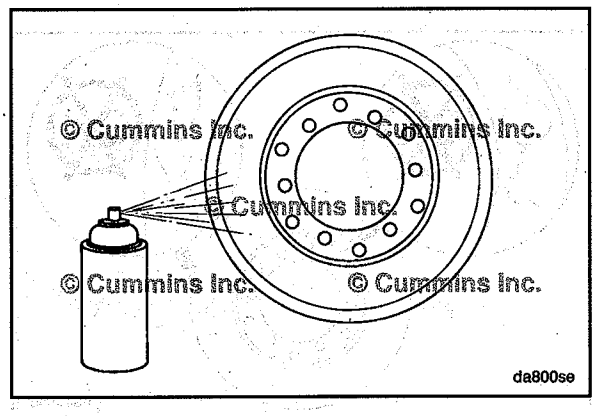
Use a paint solvent and fine emery cloth. Remove paint from the front and back of the housing at the four locations as shown in the drawing.

If the vibration damper has been in service for 24,000 hours or more, it **must** be replaced, regardless of the thickness measurement.

Measure the vibration damper thickness no less than 3 mm [0.125 in] and 25.4 mm [1 in] from the outside circumference to be sure readings are taken on a flat surface.

Measure the thickness at two points in four locations around the vibration damper, 90-degrees apart. The readings **must not** vary more than 0.25 mm [0.010 in]. If the thickness exceeds these specifications, the vibration damper **must** be replaced.

Maximum Vibration Damper Thickness		
mm		in
65.66	MAX	2.585



Leak Test

If inspection found signs of leakage, a thorough leakage detection is required.

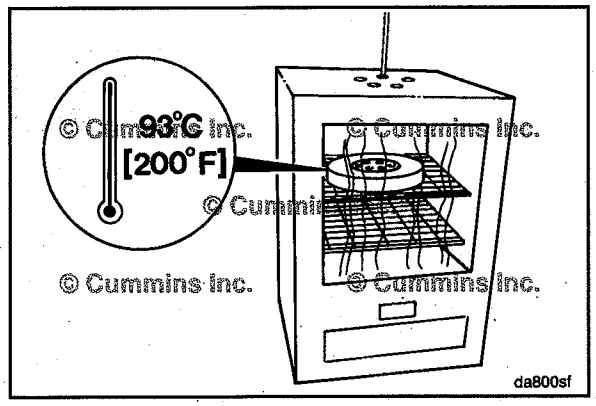
The crack detection kit, Part Number 3375432, contains the necessary cleaner, penetrate and developer to check for cracks using the dye penetrant method.

Use detection developer, Part Number 3375434, or equivalent.

Spray the rolled lip of the vibration damper and inspect for cracks.

If cracks are found, the vibration damper **must** be replaced.

If cracks are **not** found, perform the oven test.



⚠WARNING⚠

Wear protective clothing to reduce the possibility of personal injury from burns.

Place the vibration damper in an oven with the rolled lip toward the bottom.

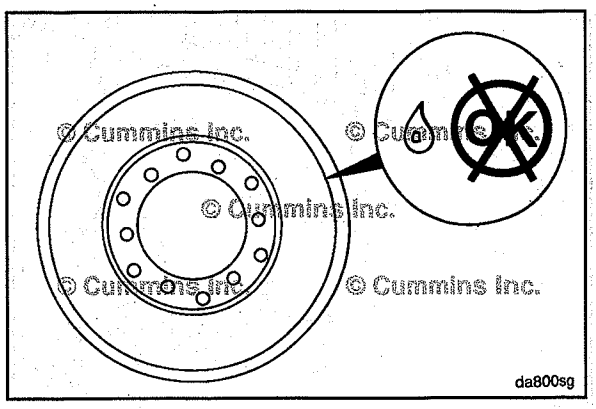
Adjust the temperature of the oven to 93°C [200°F] and allow the vibration damper to remain in the oven for two hours.

⚠WARNING⚠

Wear protective clothing to reduce the possibility of personal injury from burns.

Remove the vibration damper from the oven and look for fluid leakage around the rolled lip.

The vibration damper **must** be replaced if there is any fluid leakage.



Cooling System

Drain

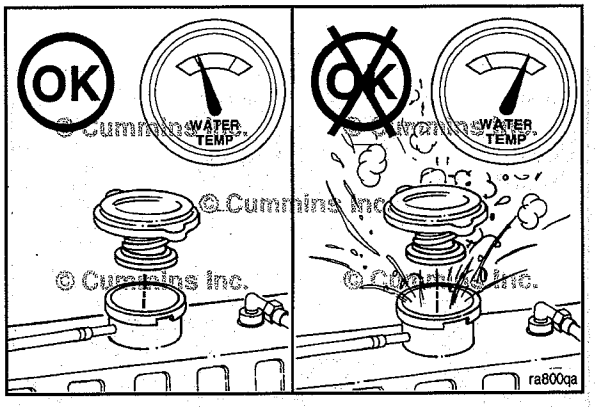
⚠WARNING⚠

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

The QSK45 and QSK60 industrial engines use a two-pump/two-loop cooling system. The primary radiator provides cooling for the engine using the water pump mounted on the right-bank side of the engine. An LTA water pump is mounted on the left-bank side of the engine on the front gear cover. The LTA water pump circulates coolant through the two-pass core of the LTA radiator and back through the aftercoolers. The two center thermostats control temperature as the coolant passes through the thermostat housing.

Remove the radiator cap after the engine is cool.

Open the petcocks on each turbocharger.



Aftercooled Engines

⚠WARNING⚠

Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

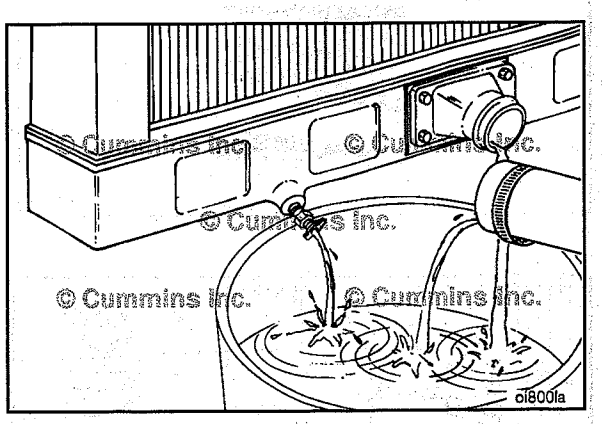
This cooling system uses the same radiator to cool the aftercoolers as is used to cool the engine. Refer to Procedure 200-003.

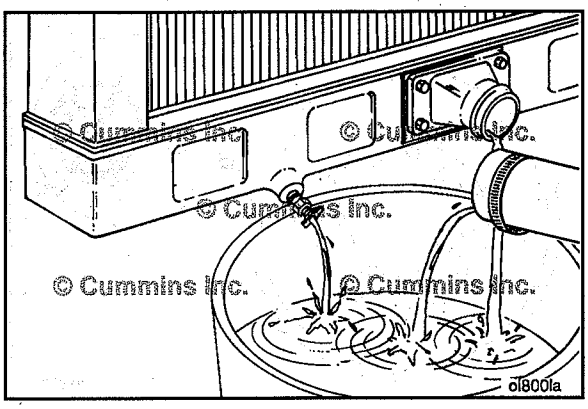
Open the draincock at the bottom of the radiator.

Remove the lower radiator hose.

Drain the cooling system.

Do **not** allow the cooling system to dry out.





LTA

⚠WARNING⚠

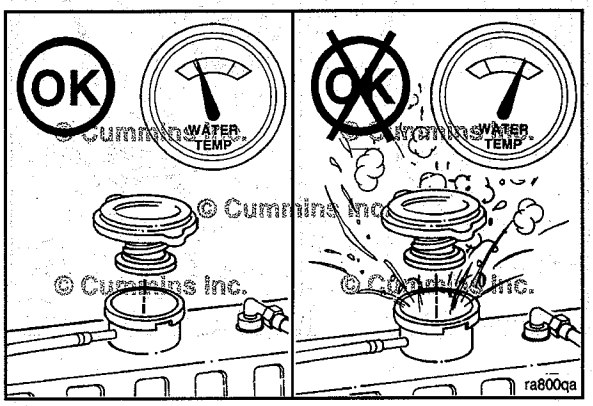
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

This system cools the aftercoolers using a radiator separate from that used to cool the engine. Refer to Procedure 200-003.

Drain the coolant.

The low-temperature aftercooling (LTA) cooling system is drained by opening the draincock in the LTA radiator or disconnecting the piping.

Do **not** allow the cooling system to dry out.

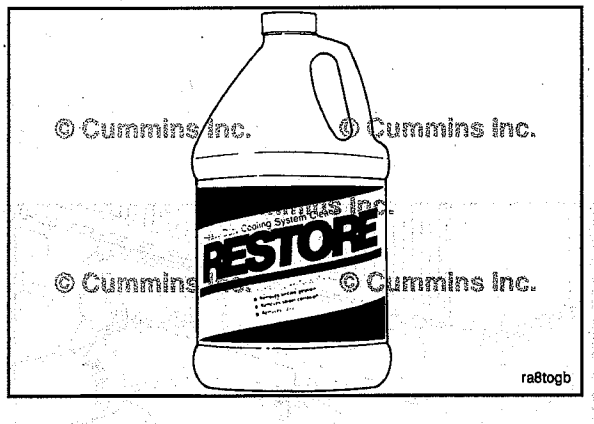


Flush

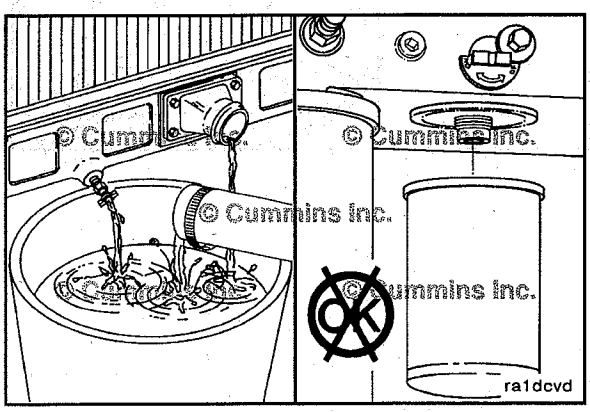
⚠WARNING⚠

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Drain the cooling system.



The performance of Restore™ depends on time, temperature, and concentration levels. An extremely scaled or flow-restricted system, for example, can require higher concentrations of cleaners, higher temperatures, or longer cleaning time. Restore™ can be safely used up to twice the recommended concentration levels. Extremely scaled or fouled systems can require more than one cleaning.



Do **not** remove the coolant filters.

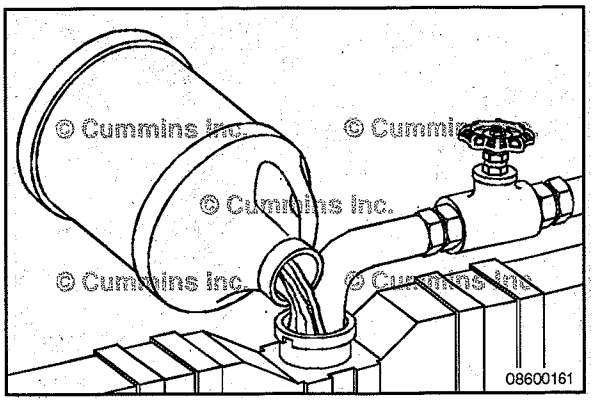
⚠CAUTION⚠

Fleetguard® Restore™ contains no antifreeze. Do not allow the cooling system to freeze during the cleaning operation.

Close all petcocks to avoid air entrapment in the cooling system.

Immediately add 3.8 liters [1 gal] of Fleetguard® Restore™, or equivalent, for each 38 to 57 liters [10 to 15 gal] of cooling system capacity, and fill the system with plain water.

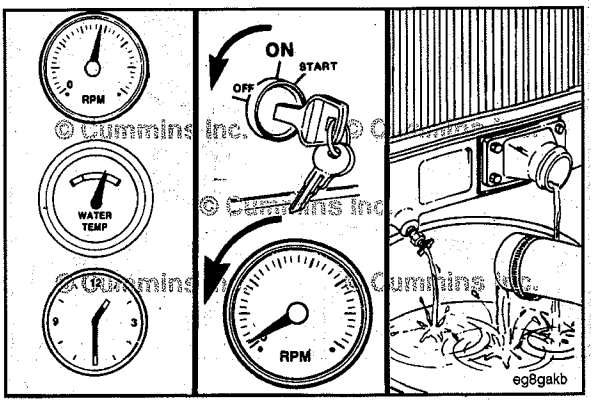
Turn the heater temperature switch to HIGH to allow maximum coolant flow through the heater core. The blower does **not** have to be on.



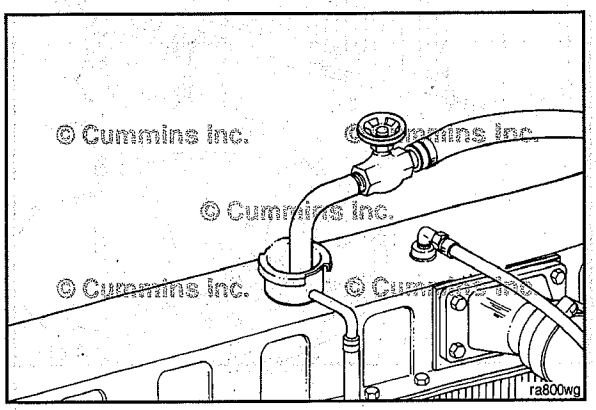
Operate the engine at a coolant temperature of at least 85°C [185°F] for 1 to 1-½ hours.

Shut the engine off.

Drain the cooling system.



Fill the cooling system with clean water.

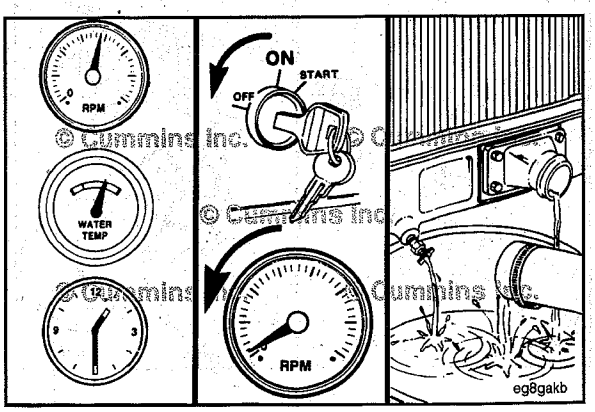


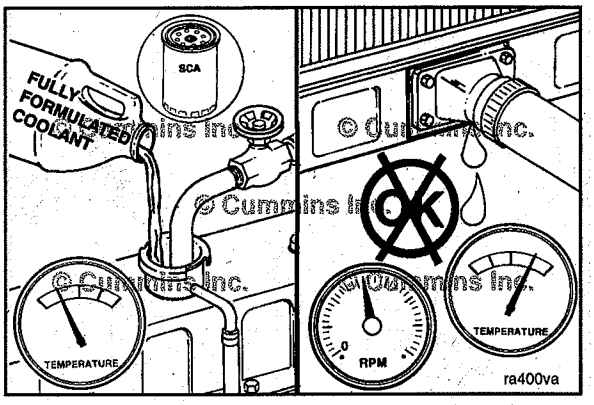
Operate the engine at high idle for 5 minutes with the coolant temperature above 85°C [185°F].

Shut the engine off.

Drain the cooling system.

If the water drained is still dirty, the system **must** be flushed again until the water is clean.

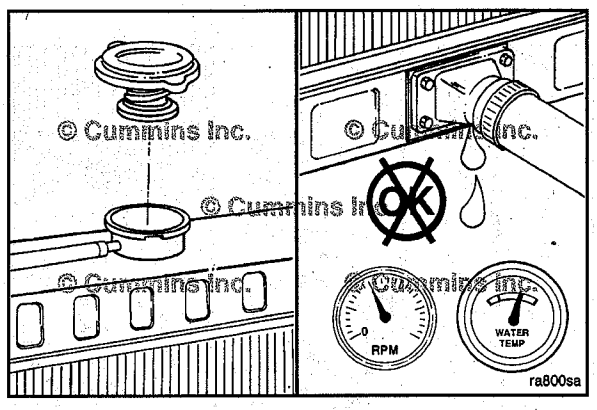




Install a new coolant filter.

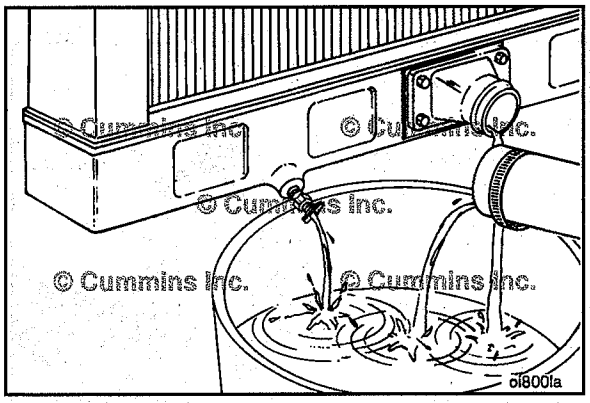
Fill the cooling system with fully formulated coolant.

Use additional SCA to bring the coolant to the correct SCA concentration level. Refer to Procedure 018-018.



Install the pressure cap. Operate the engine until the coolant reaches a temperature of 70°C [158°F] and check for coolant leaks.

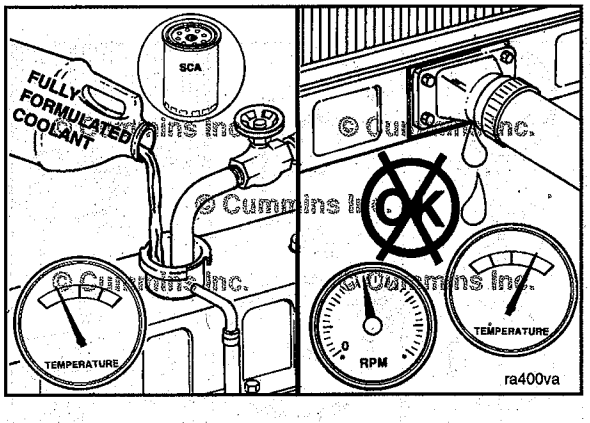
Minimum Cooling System Pressure Cap Capacity 76 kPa [11 psi]



Fill

Make sure the radiator draincocks are closed.

Open the cooling system venting petcocks.



Use fully formulated coolant to fill the cooling system.

Use the correct units of SCA to obtain the correct cooling system protection. Refer to Section V.

⚠CAUTION⚠

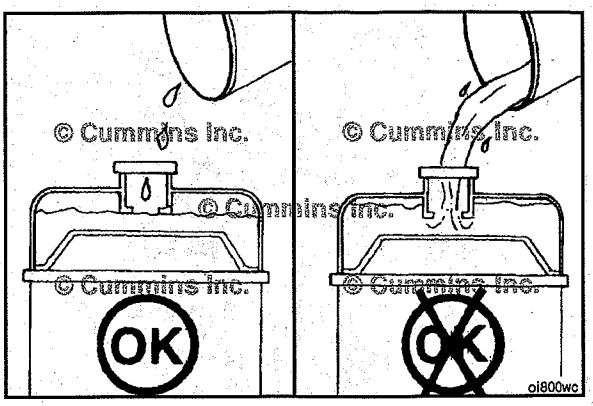
Fill the cooling system slowly to avoid trapping air in the cooling system. Air trapped in the system can cause water pump cavitation and inadequate coolant level.

Begin filling the cooling system with coolant.

Fill until a continuous stream of coolant begins to flow from each opened petcock in the coolant system.

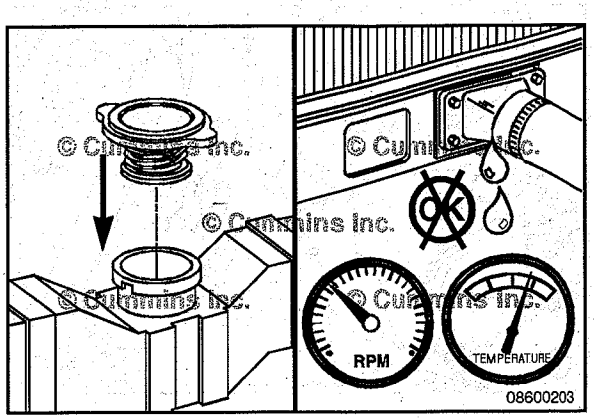
Close each petcock as the continuous stream of coolant begins to flow from that petcock.

Fill the system with the coolant to the bottom of the radiator fill neck.



Install the cooling system pressure cap.

Operate the engine until the coolant reaches a temperature of 85°C [185°F]. Check for leaks.

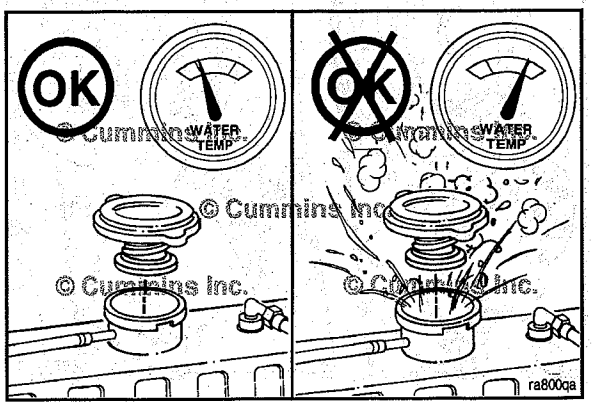


⚠WARNING⚠

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Shut the engine off, and allow it to cool.

Check the coolant level.



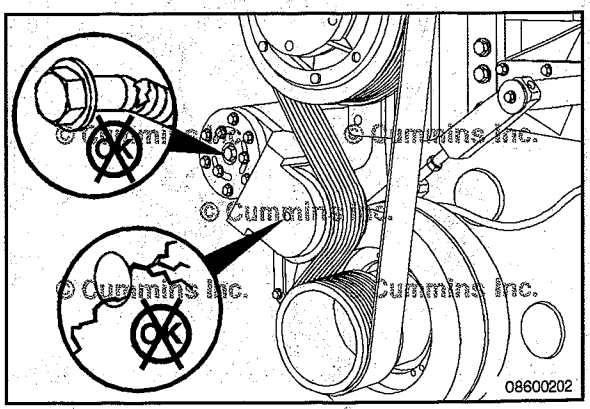
Fan Drive Idler Arm Assembly

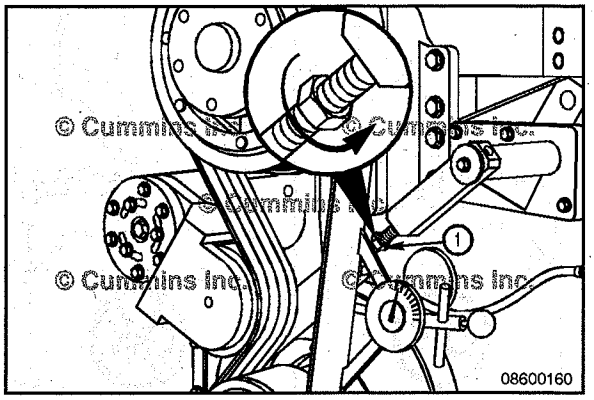
Maintenance Check

Inspect the fan drive idler arm assembly for the following:

- Deterioration
- Cracks
- Broken capscrews.

Replace any damaged parts.



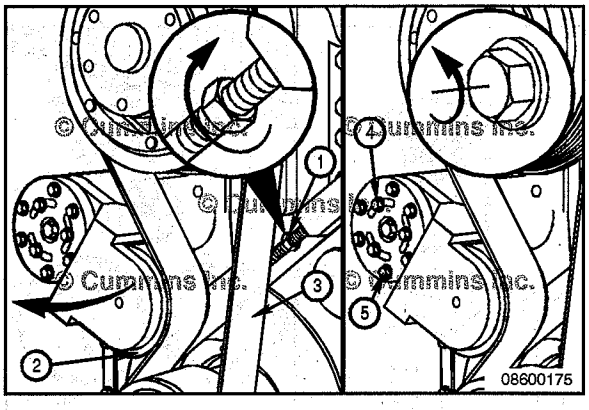


Fan Drive Idler Pulley Assembly

Adjust

The fan belt **must** be installed and under the tension of the fan idler arm to adjust the control rod. The fan belt and a portion of the flat washer is **not** shown for clarity.

Turn the control rod **clockwise** into the upper rod end to increase the belt tension.

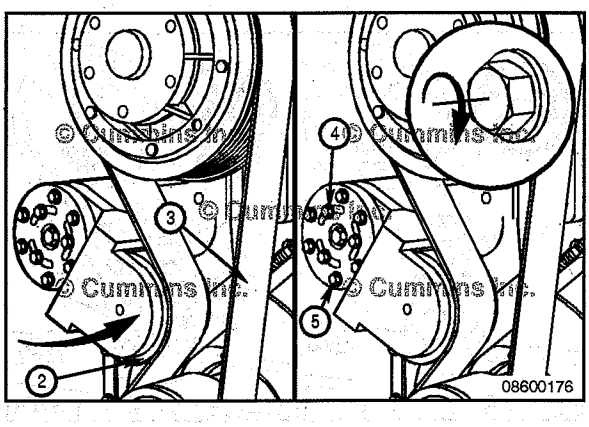


The idler lever screws are adjusted **only** if correct tension can **not** be obtained using the control rod.

Turn the control rod (1) **counterclockwise** out from the upper rod end until the idler lever pulley (2) is off the belt (3) completely.

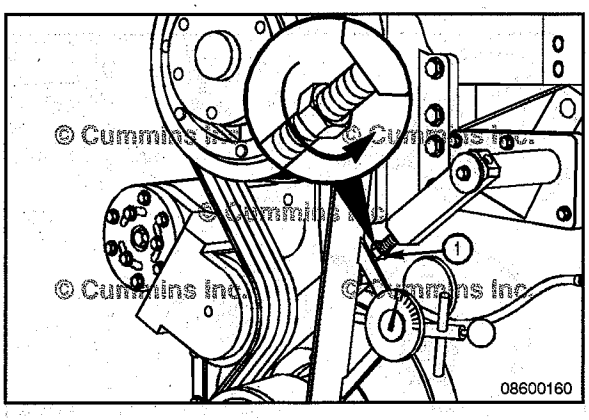
Loosen three screws (4) on the belt tensioner.

Loosen six screws (5) on the belt tensioner.



Position the idler lever pulley (2) against the belt (3).

Tighten the three screws (4) and the six screws (5) on the belt tensioner.

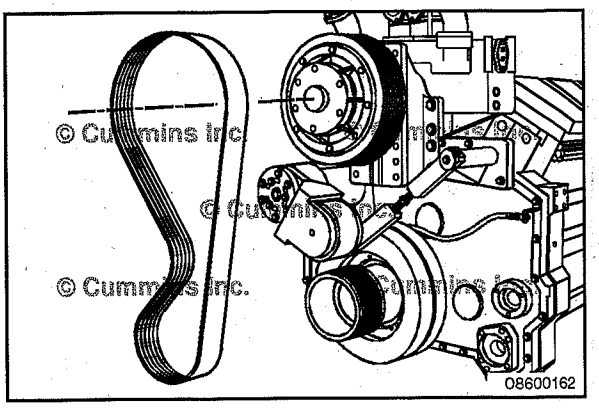


Turn the control rod **clockwise** into the upper rod end to tighten the belt tension.

Fan Hub, Belt Driven

Maintenance Check

Remove the fan belt. Refer to Section A.



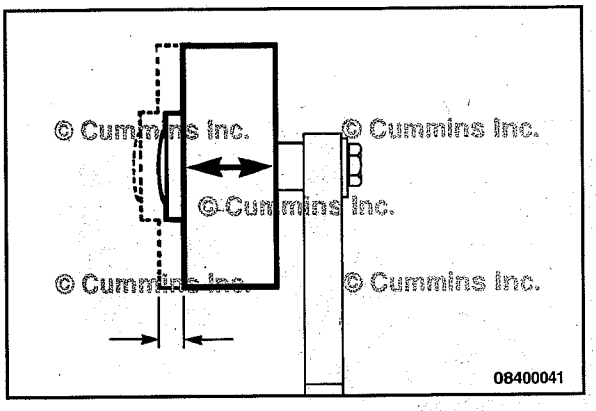
Rotate the fan hub pulley to check for rough or damaged bearings.

Inspect the pulley grooves for excessive wear.

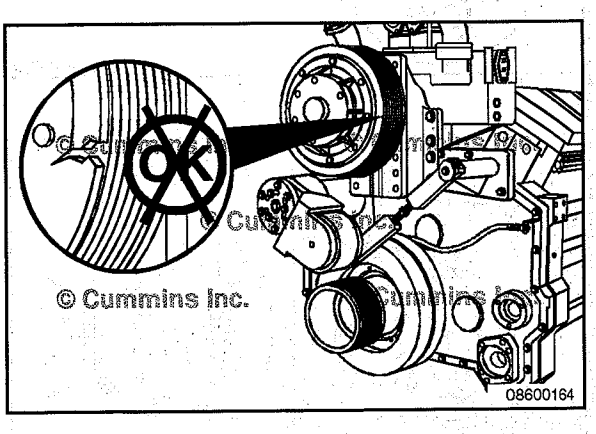
Inspect the fan hub for grease leakage and fan clutch for oil leakage.

Use a dial indicator to check the bearing end clearance.

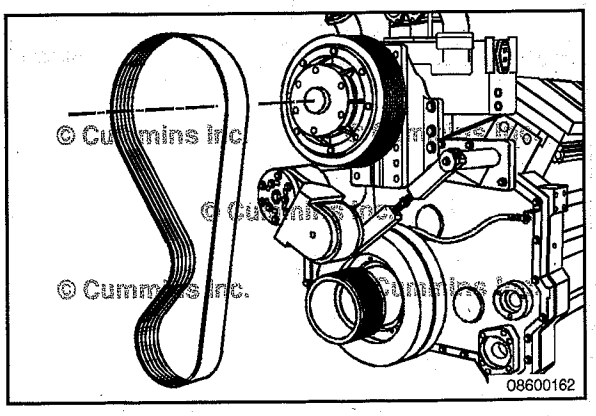
Fan Hub End Clearance		
mm		in
0.03	MIN	0.001
0.15	MAX	0.006

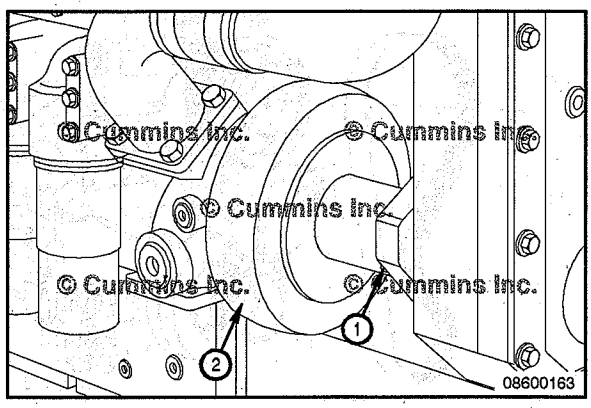


If the inspections result in a faulty condition, replace the fan hub with a new or rebuilt unit as necessary. Contact a Cummins Authorized Repair Facility.



Install the fan belt. Refer to Section A.





Water Pump

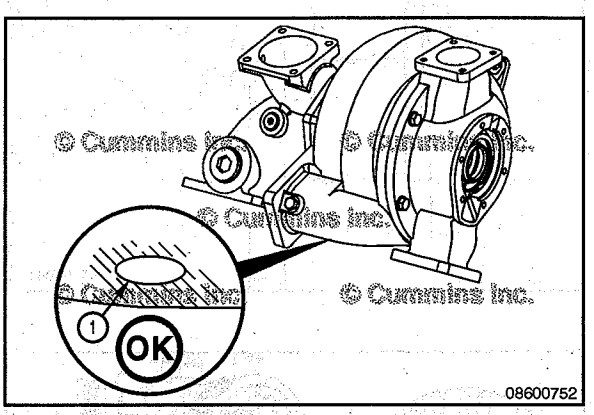
Maintenance Service

with Mechanically Actuated Injector

A minor buildup or streaking at the water pump weep hole (1) is normal. Do **not** repair or replace the water pump (2) unless an actual leak is confirmed. If a leak is confirmed, contact a Cummins Authorized Repair Facility for replacement.

These engines can have a two pump, two loop, cooling system. The LTA pump will be located near the front gear train on the left bank, if equipped. Check both pumps. The procedure for both pumps is similar.

Inspect the water pump and bypass for coolant or oil leakage. Check the water pump weep hole for excessive leakage.

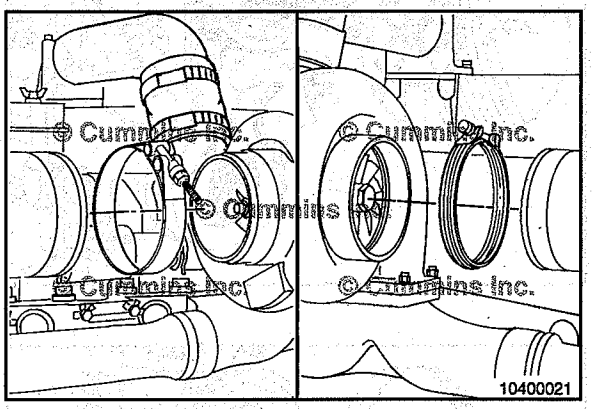


with Electronically Actuated Injector

A minor buildup or streaking at the water pump weep hole (1) is normal. Do **not** repair or replace the water pump (2) unless an actual leak is confirmed. If a leak is confirmed, contact a Cummins Authorized Repair Facility for replacement.

These engines have two pumping elements on a common shaft. There is **only** one weep hole.

Inspect the water pump and bypass for coolant or oil leakage. Check the water pump weep hole for excessive leakage.



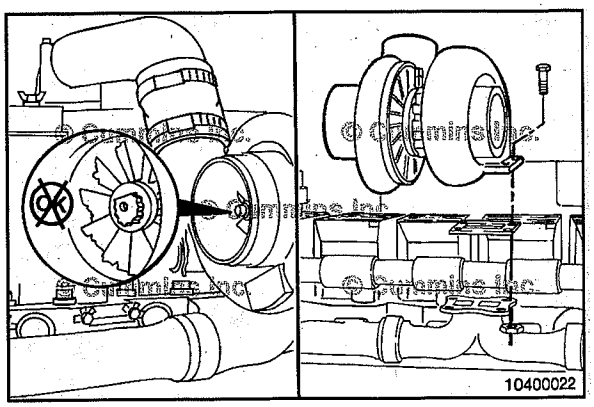
Turbocharger

Maintenance Check

Remove the air intake and exhaust piping.

Inspect the turbocharger compressor impeller blades for damage.

Contact a Cummins Authorized Repair Facility if damage is found. Refer to the model number on the turbocharger dataplate.

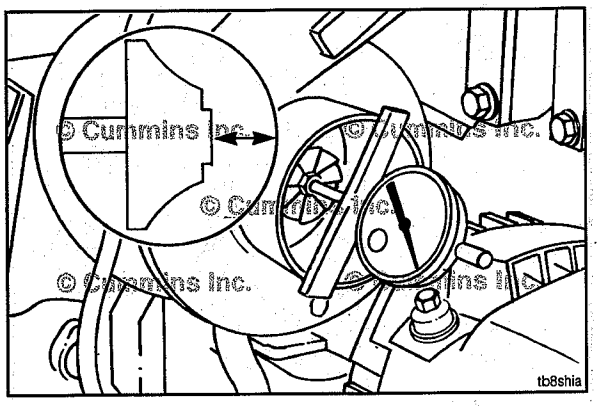


Measure

Measure the turbocharger shaft end clearance with depth gauge, Part Number ST-537, or a dial indicator.

Turbocharger Shaft End Clearance

	mm		in
HX60 Turbocharger	0.051	MIN	0.002
	0.152	MAX	0.006
HX82 and HX83 Turbochargers	0.051	MIN	0.002
	0.125	MAX	0.005

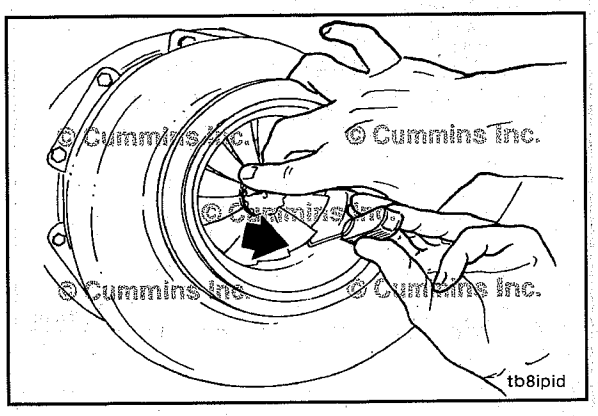


If the turbocharger is **not** within specifications, contact a Cummins Authorized Repair Facility. Refer to the model number on the turbocharger dataplate.

Push the compressor impeller end of the shaft toward the housing.

Using a feeler gauge that is **not** more than 13 mm [0.5 in] wide, measure the clearance between the impeller and the housing at the minimum clearance point.

Perform the same measurement for the turbine wheel.



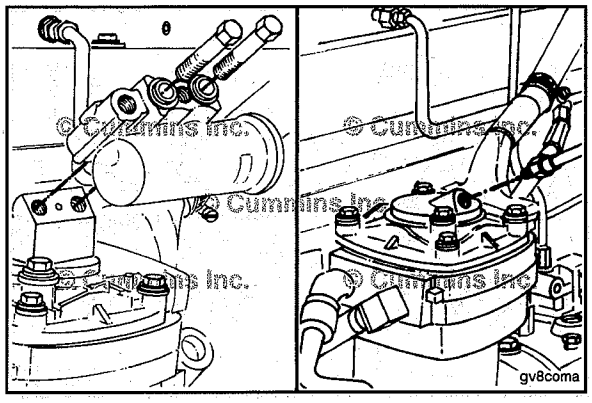
HX60 and HX82 Turbocharger Radial Bearing Clearance

	mm		in
Compressor Impeller	0.15	MIN	0.006
	0.45	MAX	0.018
Turbine Wheel	0.20	MIN	0.008
	0.55	MAX	0.022

HX83 Turbocharger Radial Bearing Clearance

	mm		in
Compressor Impeller	0.15	MIN	0.006
	0.70	MAX	0.028
Turbine Wheel	0.20	MIN	0.008
	0.77	MAX	0.031

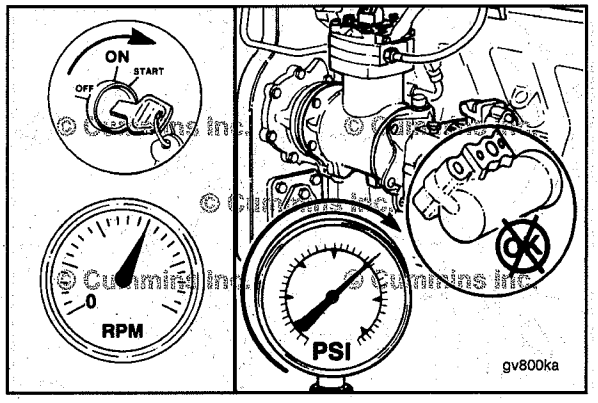
If the turbocharger is **not** within specifications, contact a Cummins Authorized Repair Facility. Refer to the model number on the turbocharger dataplate.



Air Compressor Unloader and Valve Assembly

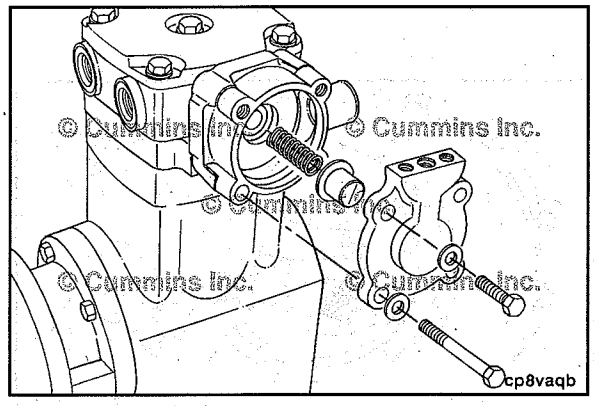
Maintenance Check

Remove the air governor or air governor signal line from the air compressor body.



Operate the engine to activate the air compressor.

If the air compressor is **not** pumping, the unloader valve is malfunctioning and **must** be repaired or repalced.



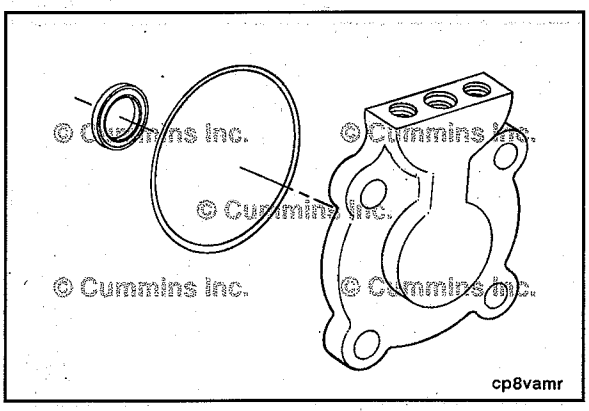
⚠WARNING⚠

The unloader valve body is installed with spring tension. To reduce the possibility of personal injury, hold the unloader body down while removing the capscrews.

Hold the unloader body down and remove the four capscrews.

Remove the unloader valve spring.

Remove the unloader valve cap.



Remove the unloader body gasket and unloader valve cap rectangular ring seal.

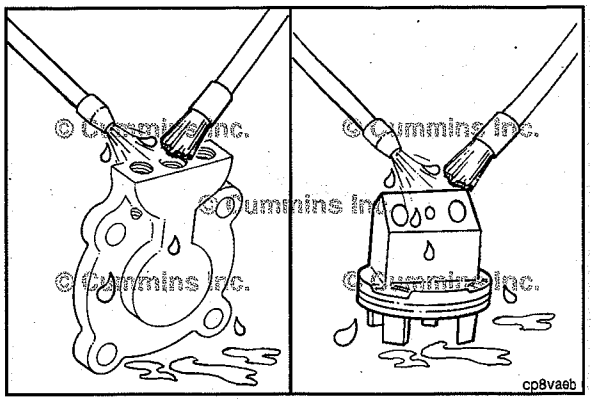
⚠WARNING⚠

When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

⚠WARNING⚠

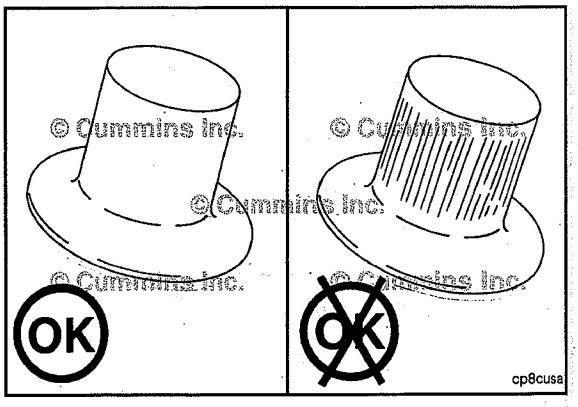
Do not use caustic cleaners. Caustic cleaners can cause personal injury and damage component parts.

Clean the unloader valve body with solvent and a nonmetallic brush to remove carbon and varnish. Do **not** use a sharp object. The sealing surface can be damaged.



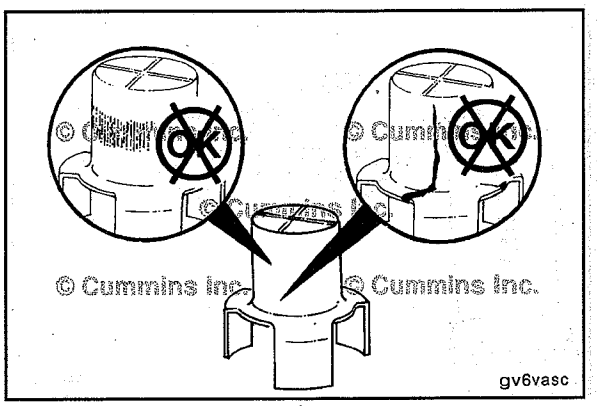
Inspect the upper part of the center unloader valve cap where the rectangular ring seal seats for scoring.

Replace the unloader valve cap if scored.



Inspect the unloader valve for deep scratches or cracks.

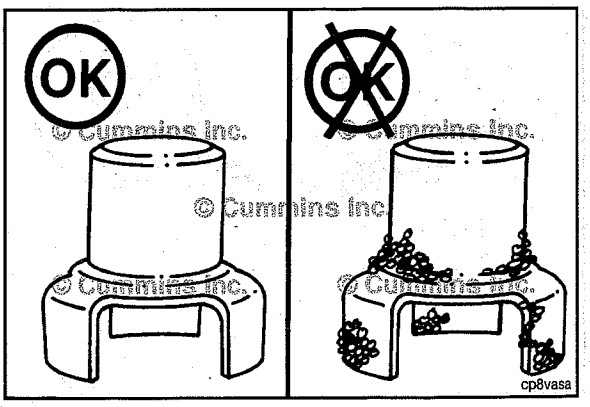
Replace the unloader valve if scratched or cracked.

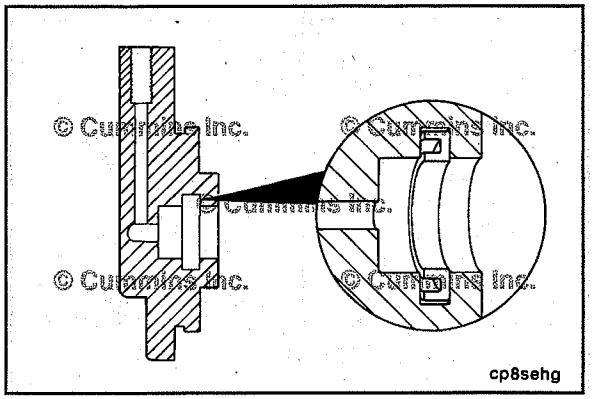


Inspect the unloader valve for carbon buildup.

If carbon or heavy varnish is present, remove, clean, and inspect the compressor head and valve assembly.

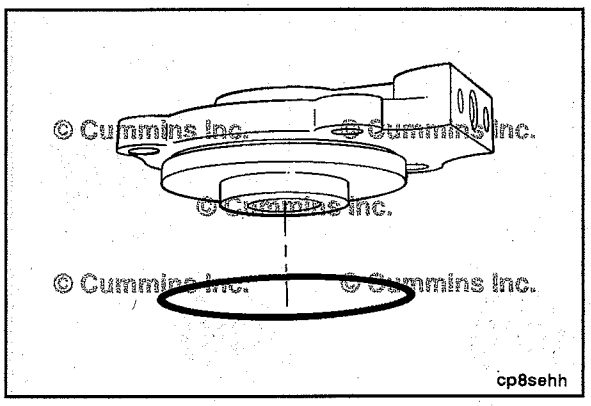
Replace the parts as necessary. Contact a Cummins Authorized Repair Facility as needed.



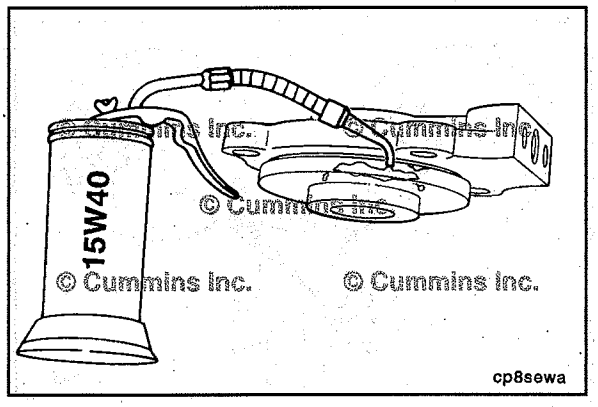


Install the new rectangular V-seal into the unloader body with the grooved side up.

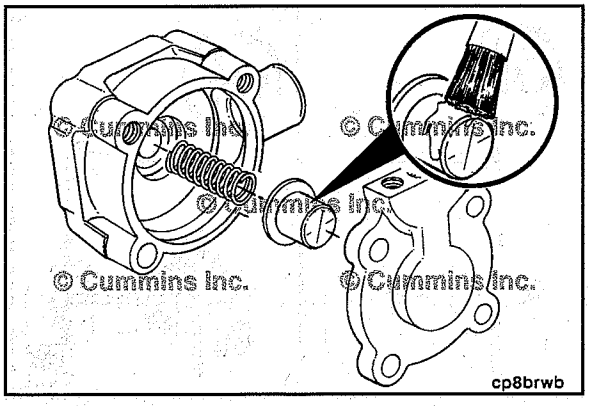
Liberally lubricate the unloader valve bore above and beyond the rectangular ring seal with high-temperature grease (Accrolube lubrication Teflon grease, or equivalent).



Install a new o-ring seal on the unloader valve body.



Use clean 15W-40 oil to lubricate the valve body seal.



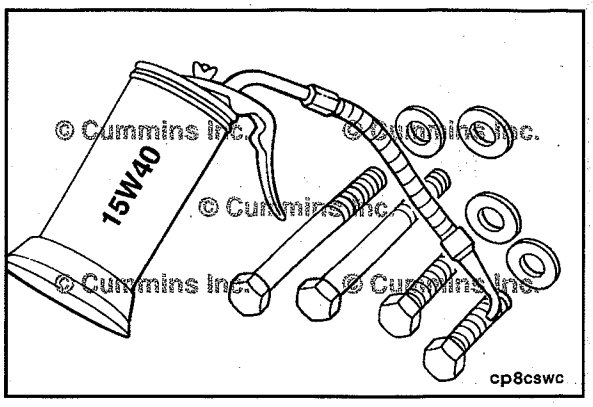
Liberally lubricate the unloader valve body bore and unloader cap with high-temperature grease (Accrolube lubrication Teflon grease, or the equivalent).

Install the unloader cap.

Install the unloader spring.

Lubricate the unloader capscrew threads and under head with clean engine oil (SAE 15W-40).

The two unloader body capscrews **must not** be used to attach any brackets.



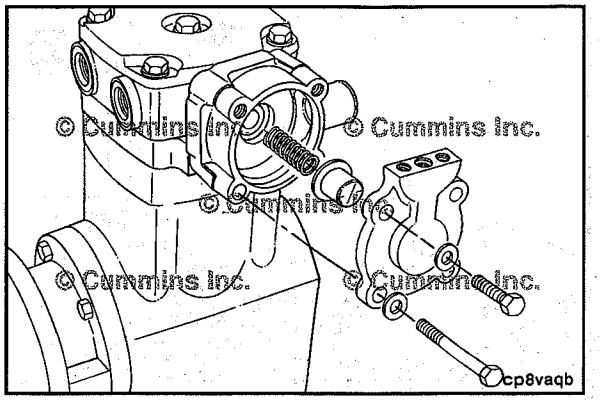
The longer capscrews are used to mount the manifold to the compressor.

Assemble the unloader components and attach the unloader assembly to the valve plate with the four capscrews and washers

Tighten the capscrews.

Torque Value: 27 N•m [20 ft-lb]

Operate the engine and check the air compressor for air leaks.

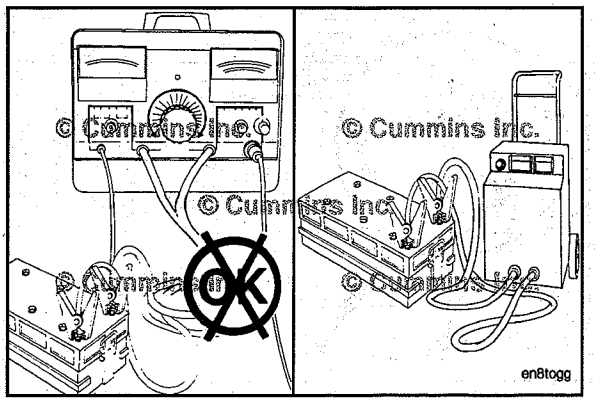


Batteries

Inspect

Use an inductive charging and cranking system analyzer to load-test the state of charge of maintenance-free batteries. If the state of charge is low, use a battery charger to charge the battery. Refer to the manufacturer's instructions.

Replace the battery if it will **not** charge to the manufacturer's specifications or the battery will **not** maintain a charge.



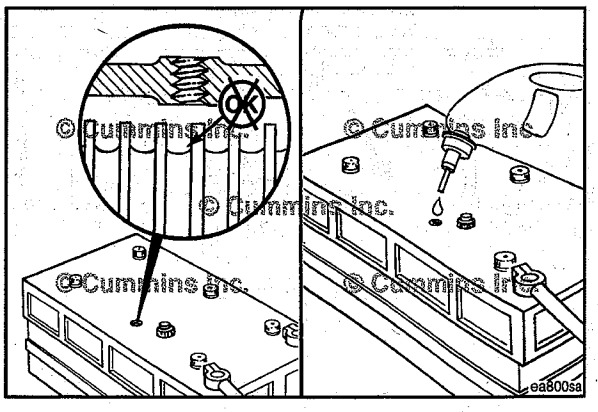
If conventional batteries are used, remove the cell caps or covers and check the electrolyte (water and sulfuric acid solution) level.

⚠WARNING⚠

Batteries can emit explosive gas. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the battery (-) negative cable first and attach the battery negative cable last.

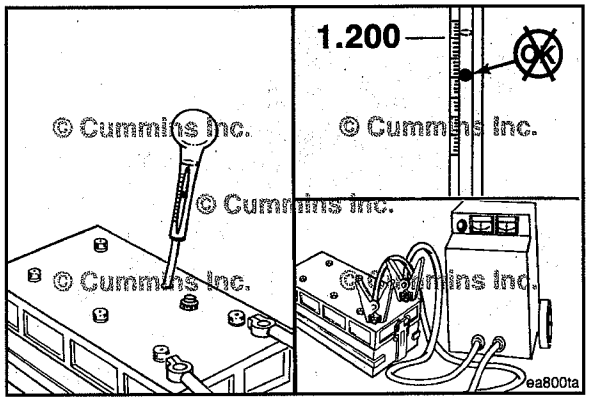
NOTE: Maintenance-free batteries are sealed and do **not** require the addition of water.

Fill each battery cell with water. Refer to the manufacturer's specifications.



Refer to the accompanying table to determine the battery state of charge based on the specific-gravity readings.

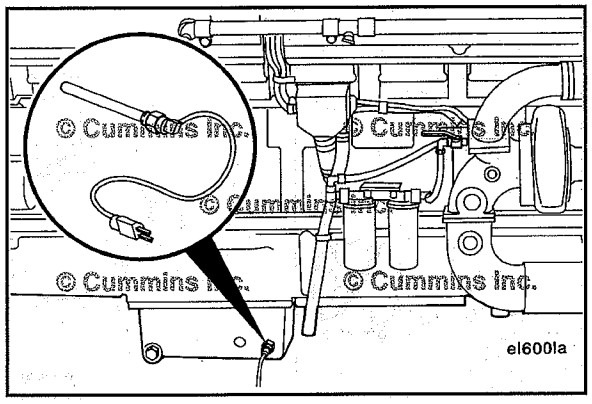
Battery State of Charge	Specific Gravity @ 27°C [80°F]
100%	1.260 to 1.280
75%	1.230 to 1.250
50%	1.200 to 1.220
25%	1.170 to 1.190
Discharged	1.110 to 1.130



Use a hydrometer to measure the specific gravity of each cell.

NOTE: If the specific gravity of any cell is below 1.200, the battery **must** be charged.

NOTE: Do **not** attempt to check the specific gravity of a battery immediately after adding water. If it is necessary to add water to allow use of the hydrometer, charge the battery several minutes at a high rate to mix the electrolyte.

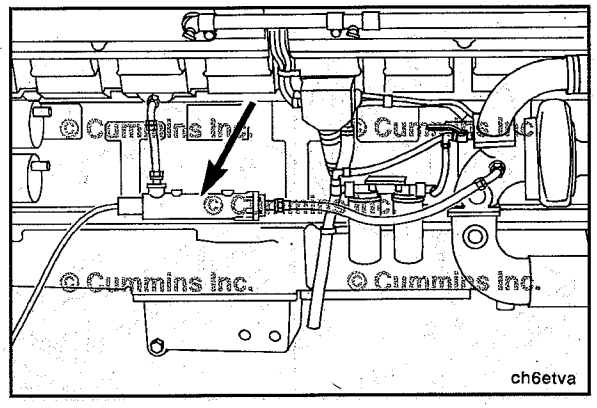


Cold Weather Starting Aids

Maintenance Check

Check the lubricating oil heater for proper operation. If operating properly, the oil pan will be warm.

Inspect for loose connections, frayed wires, and oil leaks. Repair or replace as needed.



Check the coolant preheater for proper operation.

Check for loose connections, frayed wires, and coolant leaks.

Clean all alkali and sludge from the unit. Clean the scale from the copper heating element with a wire brush.

The outlet connection from the coolant heater will experience a large number of thermal cycles and, therefore, **must** be of high quality with specific operating capabilities.

Replacement hose material for the coolant heater to the block hose connection **must** be a polyester-reinforced silicone rubber material, capable of 120°C [248°F] temperatures and a minimum working pressure rating of 689 kPa [100 psi].

Section 10 - Other Maintenance

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Maintenance Procedures - Overview

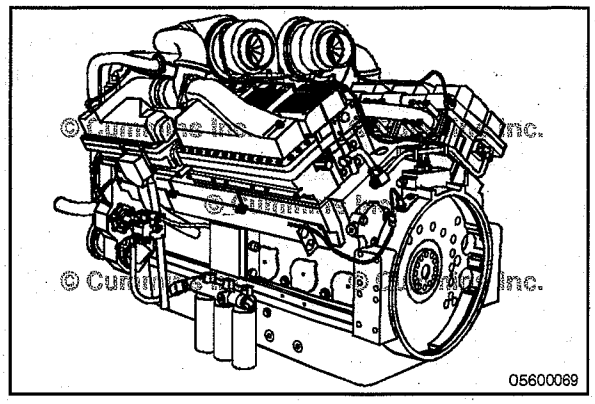
General Information

All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Seasonal Storage

General Information

The following recommendations are to prepare the engine for winter storage. **Not** all recommendations will apply to all applications. **Always** follow the manufacturer's recommendation on components **not** manufactured by Cummins Inc.



Marine Applications

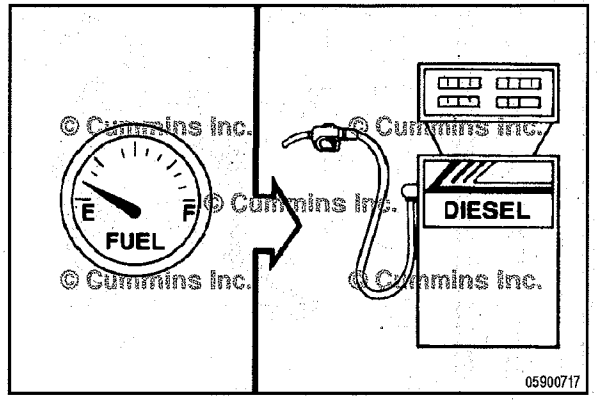
Fill the tank with good quality ASTM number 2D climatized diesel fuel.

Change the fuel filter. Refer to Section 4.

Change the boat fuel-water separator element. Refer to Section 3.

Change the engine lubricating oil and filters. Refer to Section 4.

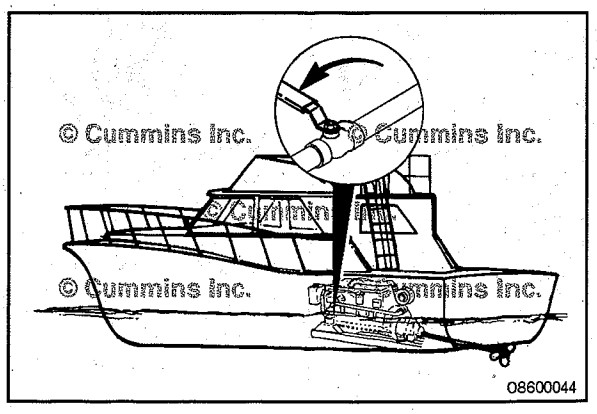
Treat the fuel with diesel conditioner or algaecide to prevent the growth of algae in the fuel tank.

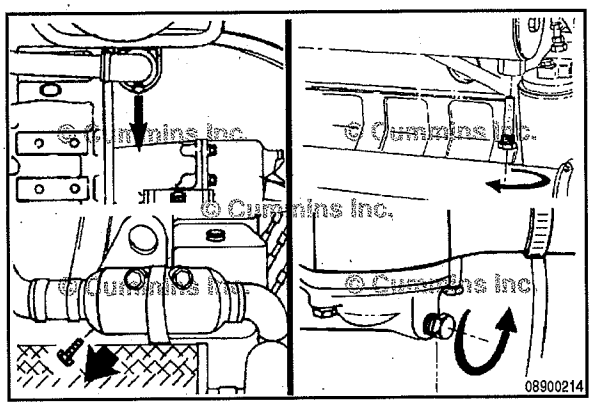


⚠CAUTION⚠

Do not run the engine with the sea water valve closed. This can damage the sea water pump and the engine. It is good practice to disable the engine or to place a tag at the helm(s) when the sea water valve is closed.

If the vessel is stored in the water, close the sea water valve on the vessel hull.





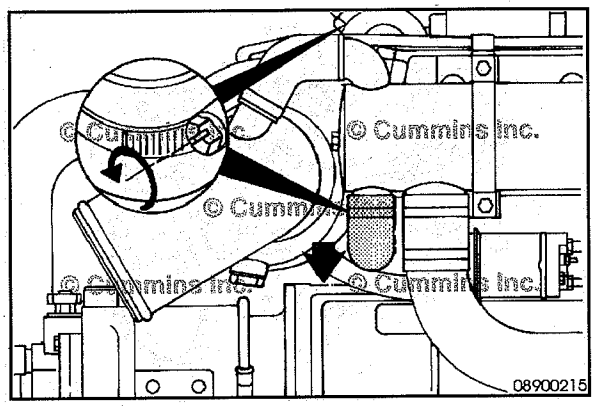
Drain the sea water system.

Remove the drain plug on the marine gear cooler.

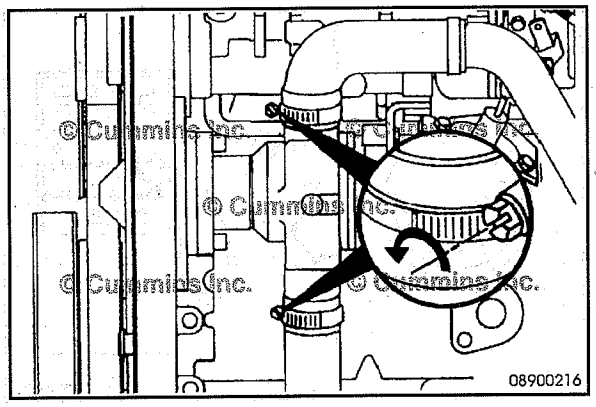
Remove the zinc anodes from the heat exchanger and the aftercooler. Refer to Section 4.

Remove the drain plug from the air box side of the sea water aftercooler, if equipped.

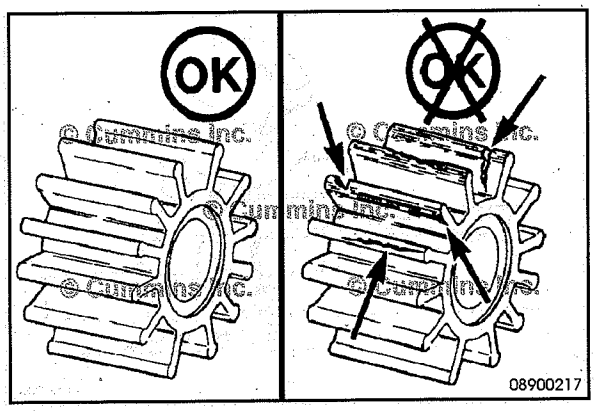
Remove the engine sea water hoses to drain sea water from the engine.



Remove the inlet and outlet hoses from the heat exchanger.



Remove the inlet and outlet hoses from the sea water pump.



There are two different types of pumps. Use the appropriate procedure for the type of pump used.

Remove and inspect the sea water pump impeller. Refer to the manufacturer's instructions.

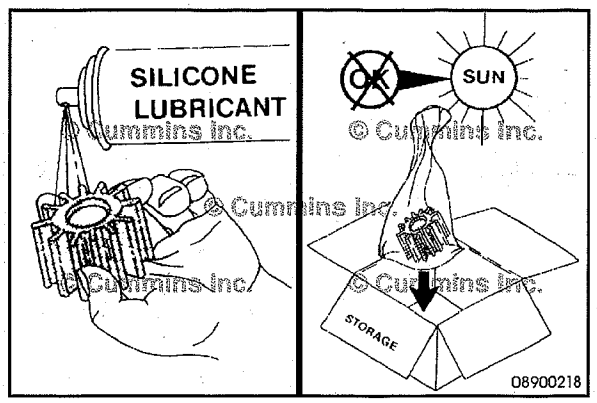
If the sea water pump impeller is damaged or **not** reusable, do **not** install a new sea water pump impeller until the vessel is ready to be used.

⚠CAUTION⚠

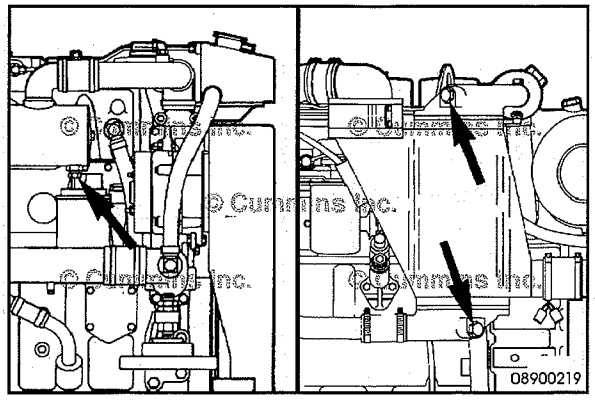
Do not expose the sea water pump impeller to sunlight, fluorescent lighting, or any source of ultra-violet light for an extended period of time. This will cause damage the sea water pump impeller.

The sea water pump impeller **must** be lubricated with glycerin or a nonpetroleum-based lubricant such as silicon spray.

Store the sea water pump impeller for the season in a polyethylene bag in a location void of sunlight, fluorescent light, or any other source of ultraviolet light.

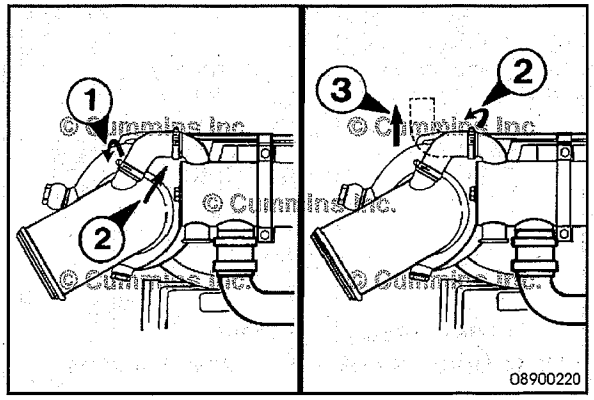


Install the zinc anodes in the heat exchanger and aftercooler. Refer to Section 4.



Loosen the heat exchanger sea water outlet clamps (1 and 2).

Rotate the sea water outlet connection to a vertical position (3).



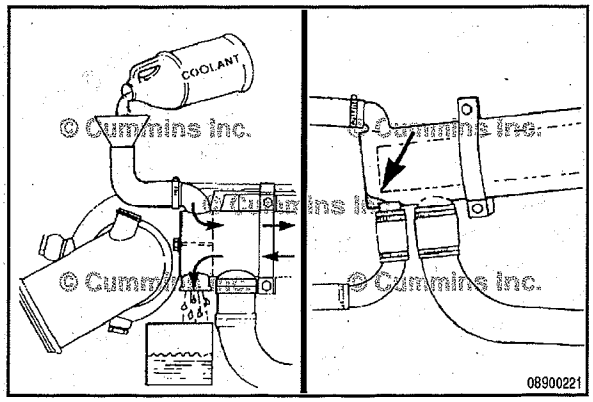
⚠WARNING⚠

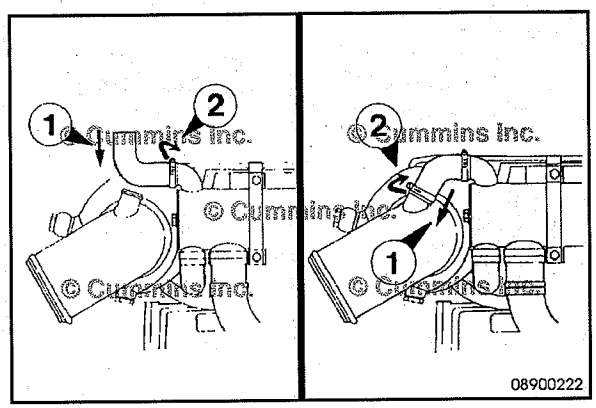
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

Place a container under the heat exchanger sea water inlet.

Pour the coolant, a 50/50 mixture of antifreeze and water, through the heat exchanger.

Do **not** allow excess coolant to drain into the bilge.

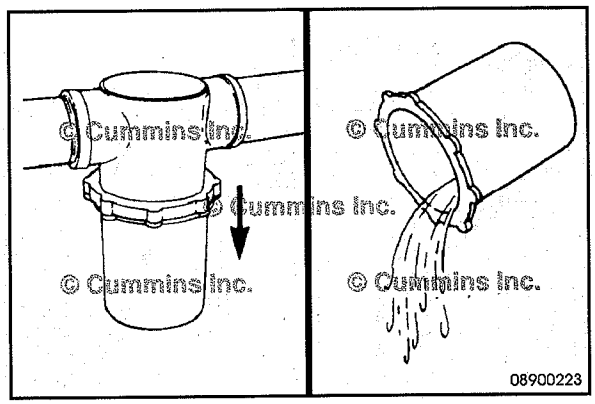




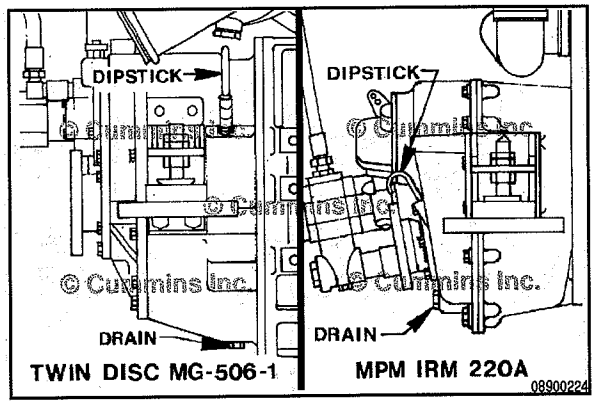
Rotate and connect the sea water outlet connection to the exhaust elbow (1).

Tighten the hose clamps (2).

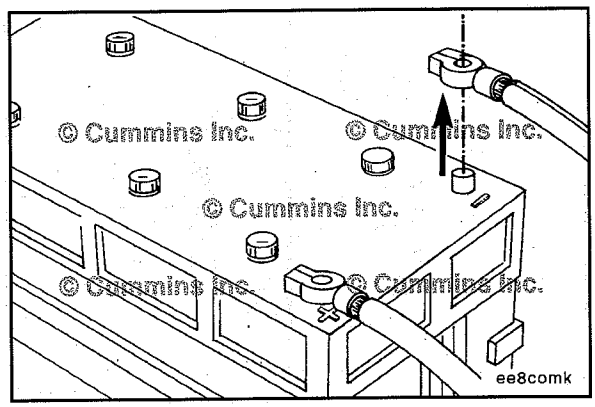
Torque Value: 5 N•m [44 in-lb]



Empty the sea water stainer. Refer to Section 3.



Perform the recommended maintenance procedures on the marine gear. Refer to the manufacturer's recommendations and specifications.



⚠ WARNING ⚠

Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

Disconnect and remove the battery. Refer to the manufacturer's instructions.

Engine Storage - Long Term

General Information

If the engine will be out of service longer than 6 months, take special precautions to prevent rust. Contact the nearest Cummins Authorized Repair Location for information concerning engine storage procedures.

Notes

Section A - Adjustment, Repair, and Replacement

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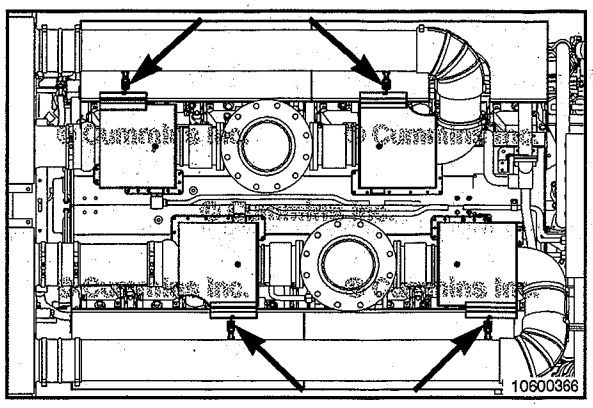
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Aftercooler Heat Shield

Remove

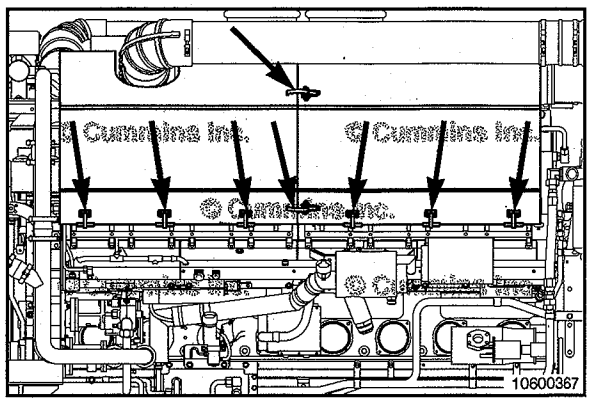
Disconnect the latch on the front and rear turbocharger heat shields supporting the top of the aftercooler heat shield.



NOTE: There are two alignment pins. The two shields **must** be separated from each other before removal.

Disconnect the latch connecting the front and rear aftercooler heat shields.

Disconnect the latches on the bottom rail.

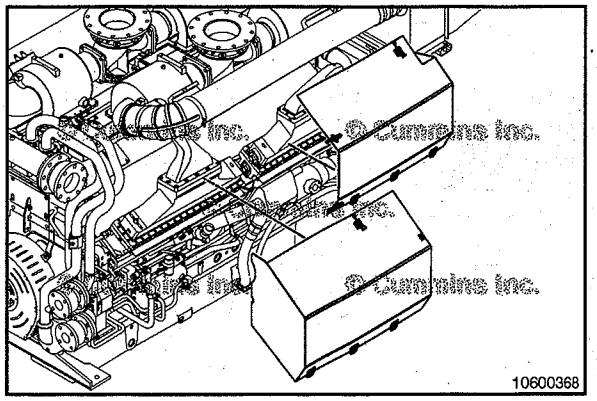


Install

Position the rear aftercooler heat shield on the bottom rail first and latch to the rear turbocharger heat shield.

Then position front aftercooler heat shield on bottom rail and latch to the front turbocharger heat shield using the alignment pins.

Latch the bottom of both aftercooler heat shields to the bottom rail.



Rocker Lever Cover

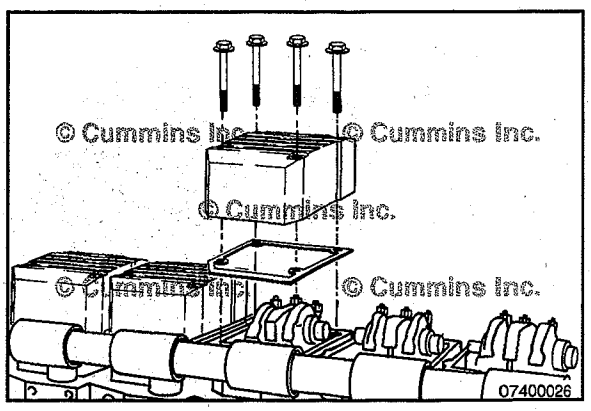
Remove

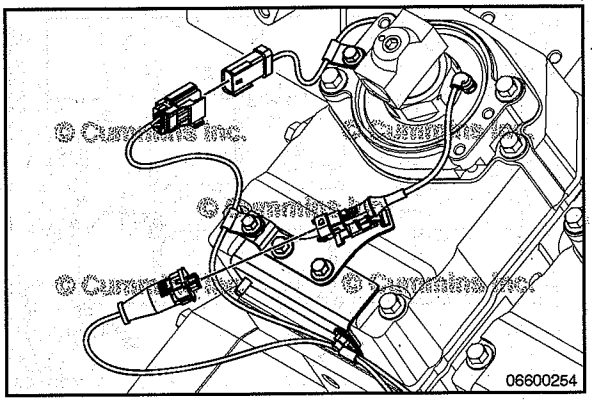
with Mechanically Actuated Injector

Remove the mounting capscrews from the rocker lever cover.

Remove the rocker lever cover and gasket.

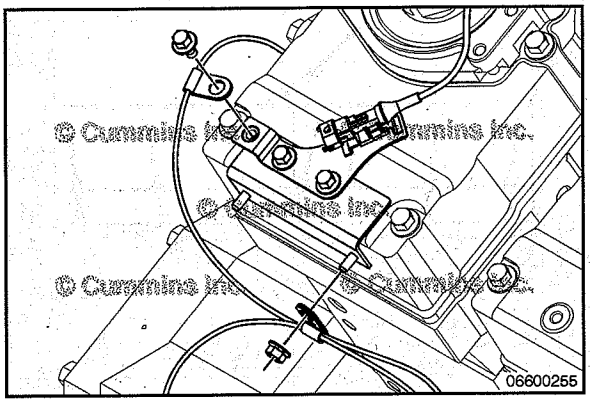
Discard the gasket.



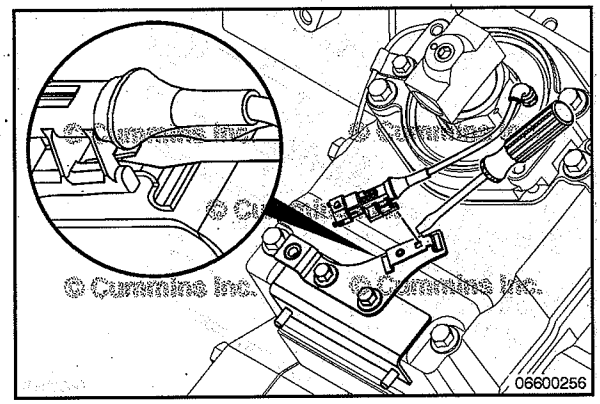


with Electronically Actuated Injector

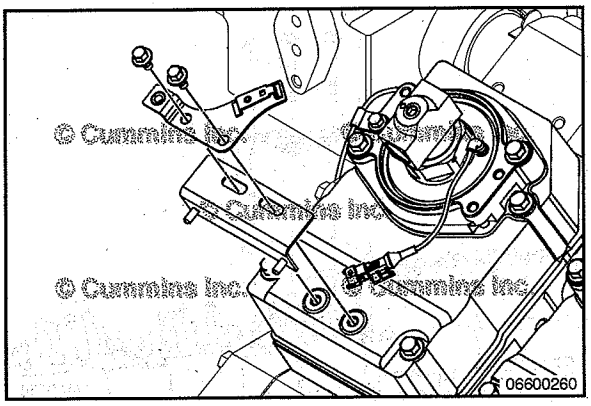
Disconnect the electrical connectors for the injector and exhaust gas temperature sensor.



Remove the two p-clips securing the wiring harness to the rocker lever cover.

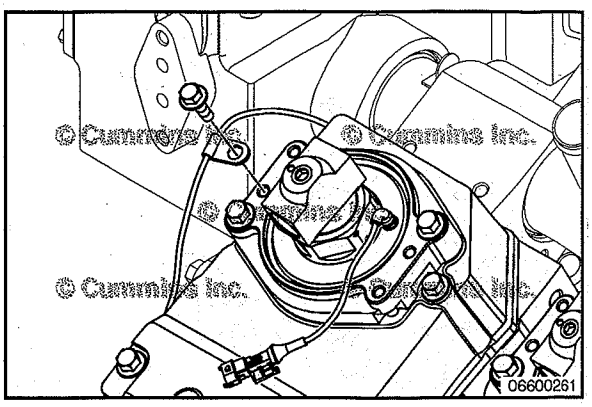


Remove the injector wiring harness from the rocker cover bracket by using a small flat tip screwdriver to release the locking mechanism.

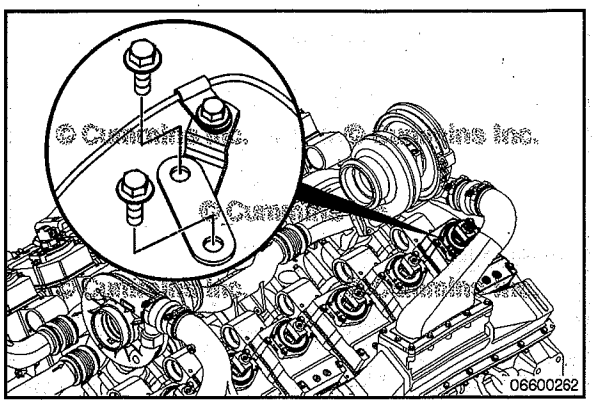


Remove the two capscrews securing the two brackets to the rocker lever cover and remove the brackets.

Remove the p-clip securing the exhaust gas temperature sensor wire to the injector cover plate.

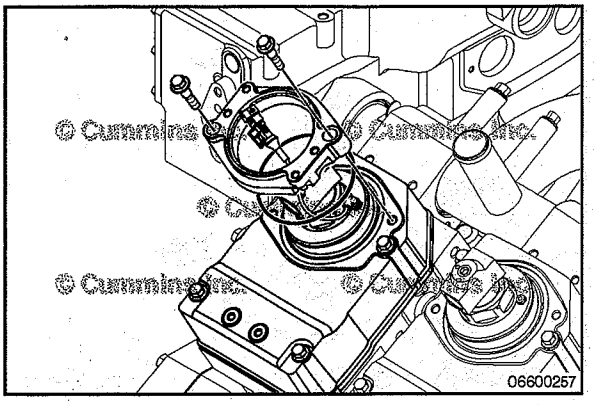


If equipped with a turbocharger speed sensor, remove the four capscrews securing the brackets to the rocker lever cover plate (left bank rear most cylinder).



Remove the two capscrews securing the injector cover plate to the rocker lever cover and remove the injector cover plate.

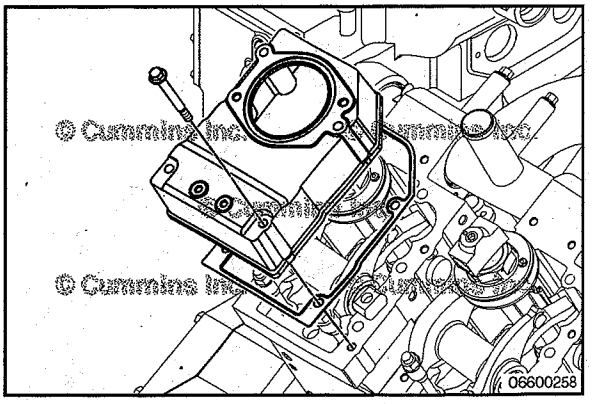
Remove the o-ring seal from the rocker lever cover plate.

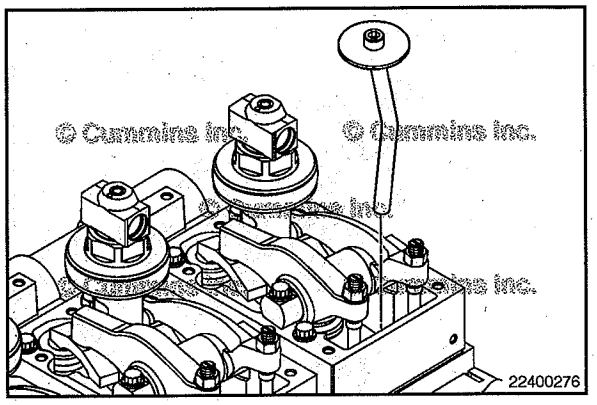


Remove the four capscrews securing the rocker lever cover.

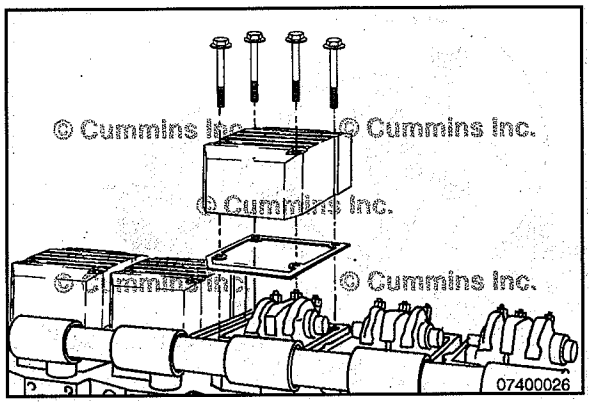
Remove the rocker lever cover and gasket.

Discard the old gasket.





Install the cylinder head protective cover, Part Number 4918282, in the hole located between the push tubes to prevent debris from entering the engine while the rocker lever cover is removed.



Install

with Mechanically Actuated Injector

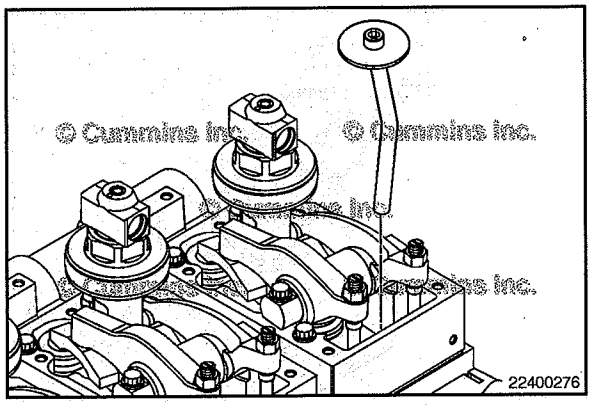
⚠CAUTION⚠

Do not use gasket cement. Gasket cement will prevent the gasket from sealing properly.

Install a new gasket, rocker lever cover and mounting capscrews.

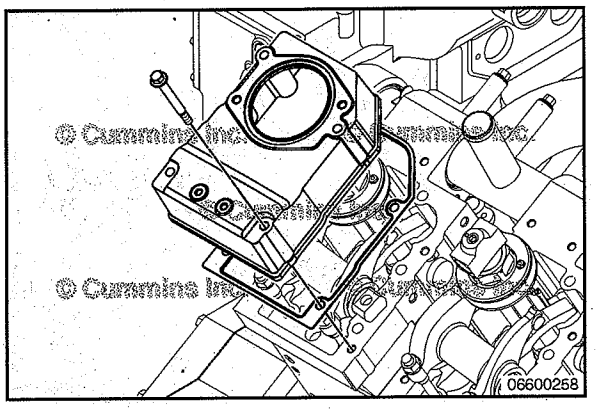
Tighten the capscrews.

Torque Value: 45 N•m [33 ft-lb]



with Electronically Actuated Injector

Remove the cylinder head protective cover from the push tube hole.



⚠CAUTION⚠

Do not use gasket cement. Gasket cement will prevent the gasket from sealing properly.

Install the new rocker lever cover gasket and rocker lever cover.

Install the rocker lever cover capscrews and tighten.

Torque Value:

Rocker Lever Cover Capscrews	40 N•m	[30 ft-lb]

Lubricate the large o-ring and damper on the injector with clean engine oil. Engine oil will protect the o-ring and damper during the installation of the rocker lever cover plate.

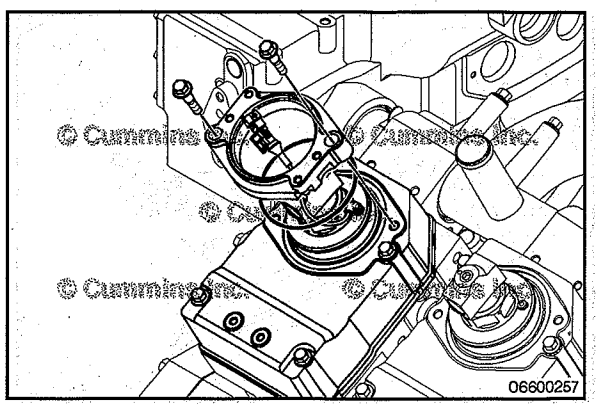
Install the new o-ring on the rocker lever cover plate.

Install the rocker lever cover plate on the injector and tap it into place with a soft face mallet.

Install the rocker lever cover plate capscrews and tighten.

Torque Value:

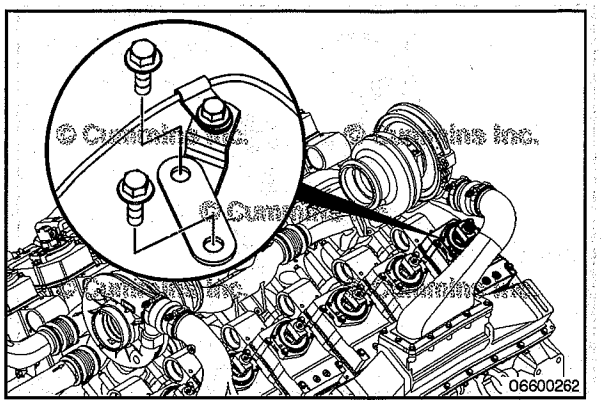
Rocker Lever Cover Plate Capscrews	40 N•m	[30 ft-lb]



If equipped with a turbocharger speed sensor, install the four capscrews securing the brackets to the rocker lever cover plate (left bank rear most cylinder).

Torque Value:

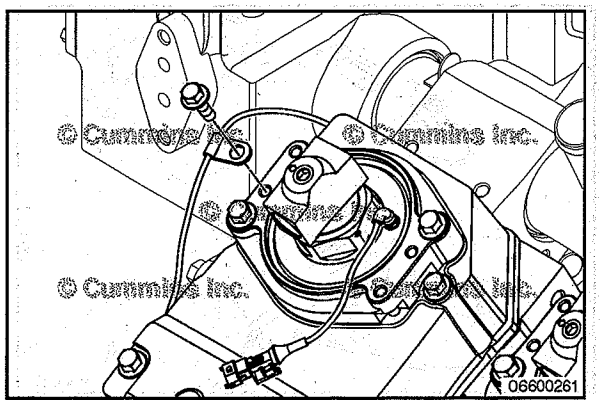
Turbocharger Speed Sensor Bracket Capscrews	20 N•m	[180 in-lb]



Install the p-clip securing the exhaust gas temperature sensor wire to the injector cover plate.

Torque Value:

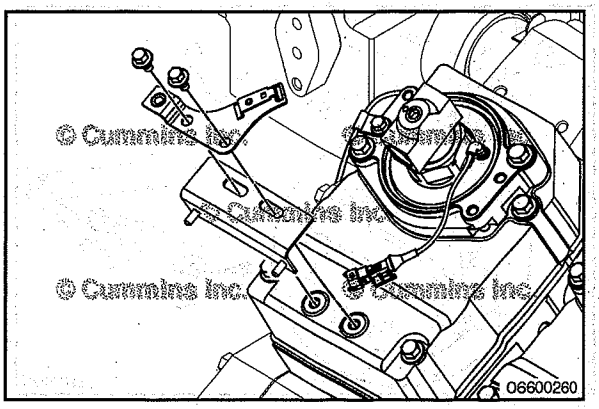
Exhaust Gas Temperature Sensor P-clip Capscrews	20 N•m	[180 in-lb]

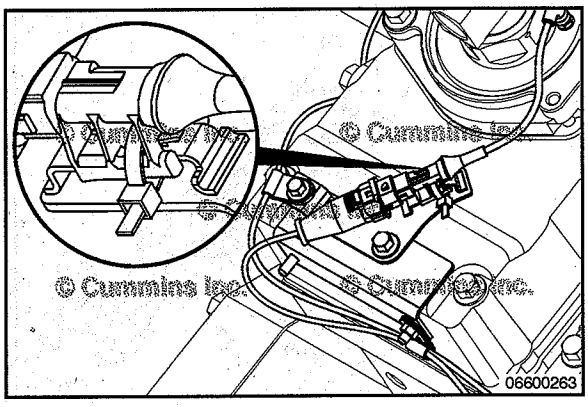


Install the two brackets and capscrews that retain the injector and exhaust gas temperature sensor connectors.

Torque Value:

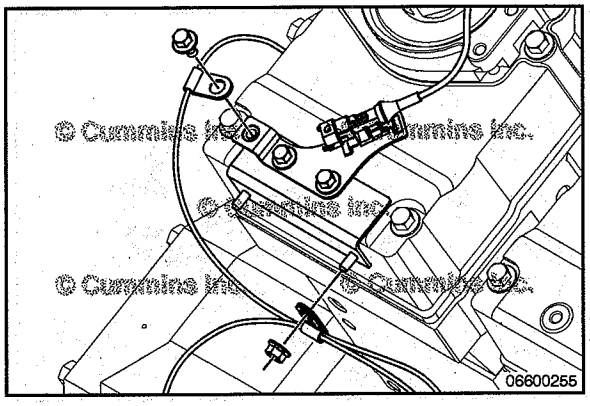
Sensor Bracket Capscrews	20 N•m	[180 in-lb]





Install the injector wiring harness connector to the bracket by sliding it onto the bracket until the connector locks into position.

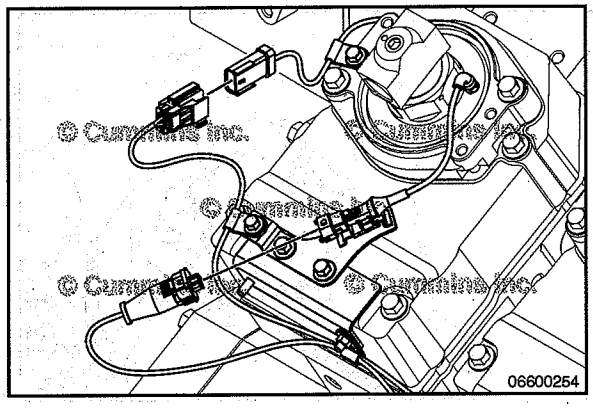
If the locking fixture on the connector is missing, use a cable tie, Part Number 3822924 or equivalent, to secure the wiring harness to the bracket.



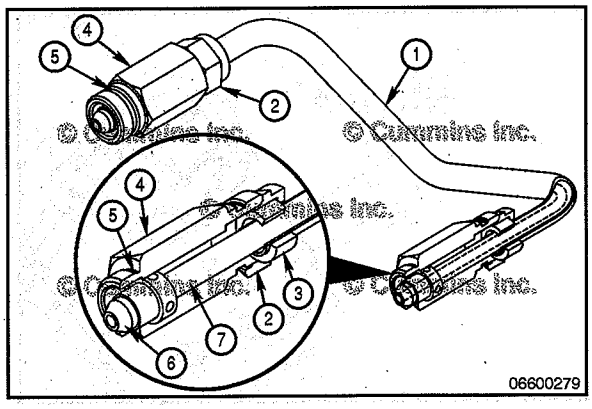
Install the two p-clips securing the wiring harness to the rocker lever cover brackets.

Torque Value:

P-clip Capscrews	20 N•m	[180 in-lb]



Connect the electrical connectors for the injector and exhaust gas temperature sensor.



Injector Supply Lines (High Pressure)

General Information

with Electronically Actuated Injector

The high-pressure injector supply lines consist of the following components:

1. Outerwall pipe
2. Rectangular grommet nut
3. Grommet
4. Connector fitting
5. O-ring Groove
6. Sealing cone
7. Innerwall pipe.

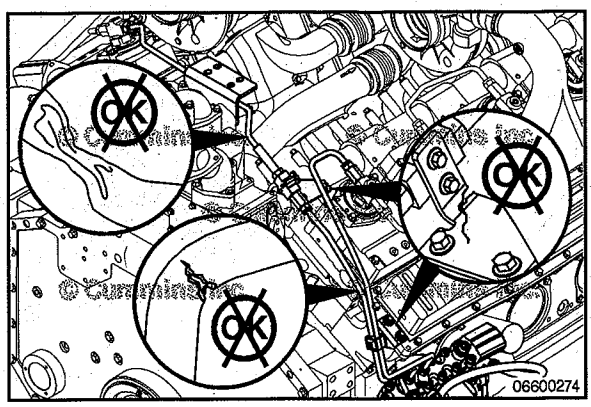
Initial Check

with Electronically Actuated Injector

⚠WARNING⚠

The fuel pump, high-pressure fuel lines, and injector supply lines contain very high-pressure fuel. To reduce the possibility of injury and property damage, do not loosen any fittings while the engine is running. Wait at least 10 minutes after shutting down the engine before loosening any fittings in the high-pressure fuel system to allow the pressure to decrease to a lower level.

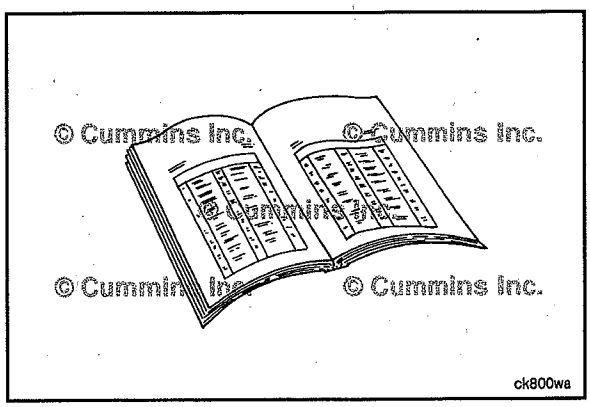
Inspect the injector high-pressure supply lines for cracks, chafe, leaks, and loose or broken clamps.

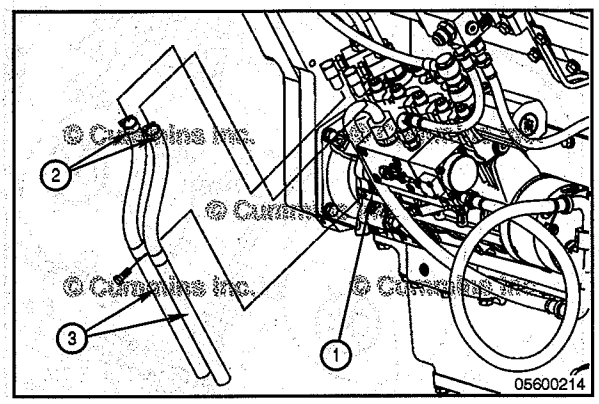


Preparatory Steps

with Electronically Actuated Injector

- Thoroughly clean all fittings and components before removal from the engine.
- Make sure that debris, water steam, or cleaning solution does **not** get inside the fuel system.





Remove

with Electronically Actuated Injector

⚠WARNING⚠

Fuel is flammable. Keep all cigarettes, flames, pilot lights, arcing equipment, and switches out of the work area and areas sharing ventilation to reduce the possibility of severe personal injury or death when working on the fuel system.

⚠WARNING⚠

The pressure of the fuel in the line can penetrate the skin and cause serious personal injury. Wear gloves and protective clothing when working on the fuel system.

⚠WARNING⚠

Pressure within the high-pressure fuel system must never be measured using a mechanical gauge. Fuel pressure values of over 1724 bar [25,000 psi] are possible. Under high pressure, a mechanical gauge can fail causing a high-pressure fuel leak resulting in personal injury and property damage.

⚠CAUTION⚠

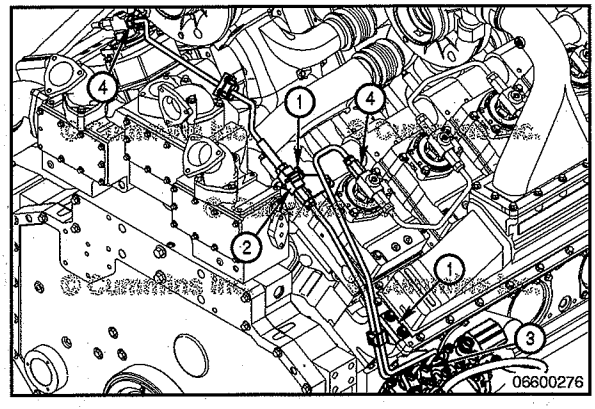
A very small amount of dirt and debris can be very harmful to the injectors and the cone seats on the injector high-pressure supply connections. Extra care is required to keep the fuel connections clean during removal and installation. The injector supply line must be placed in a plastic bag or the connections be covered immediately to keep them clean when they are removed from the engine.

Remove the vent hose bracket (1).

Loosen the two clamps securing the fuel vent hoses (2).

Remove the hoses (3).

Connect the INSITE™ electronic service tool and verify that the fuel pressure has bled down by monitoring the fuel pressure.



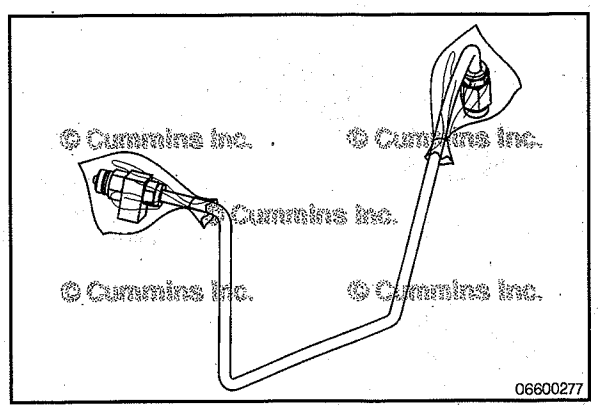
Disconnect the clamps (1) securing the injector supply line the to engine.

Back off the rectangular grommet nut and grommets.

NOTE: Supply line from the connection block (2) to the right bank cylinder 1, does **not** have a rectangular grommet nut or grommet at the connection block end.

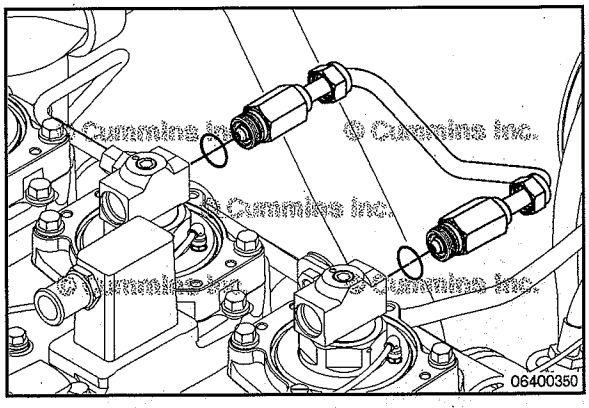
Disconnect the injector supply line from the fuel pump (3), connection block (2), and the injectors (4). Remove and discard the o-ring.

Cover both ends of the injector supply line with plastic bags. Do **not** use tape, or any products on the injector supply line connections which can cause contamination such as adhesive residue, plastic shavings, or dirt from protective caps. A small piece of dirt or debris can cause injector failure.



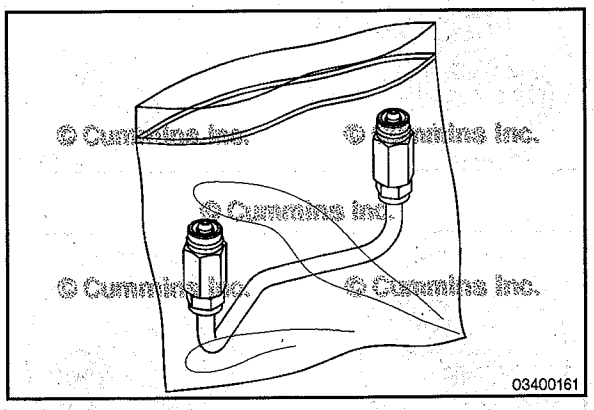
Back off the rectangular grommet nuts and grommets.

Disconnect the injector supply line between the injectors and discard the o-rings.



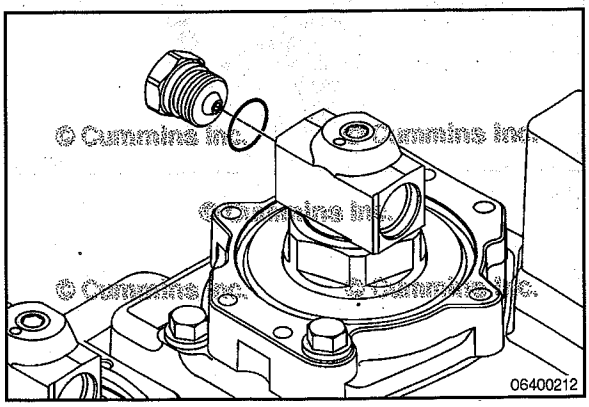
Place the injector supply line in a plastic bag. Do **not** use tape or any products on the injector supply line connections which can cause contamination such as adhesive residue, plastic shavings or dirt from protective caps. A small piece of dirt or debris can cause injector failure.

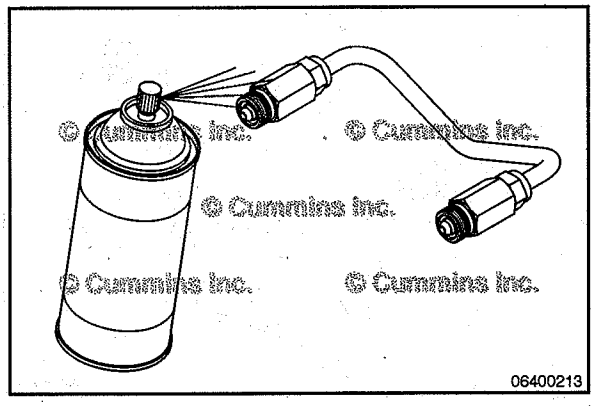
Note the location of the injector supply line on the bag so it can be installed in the same location.



Remove the plug on the last injector of each bank and discard the o-ring.

Place the plug in a plastic bag.





Clean and Inspect for Reuse

with Electronically Actuated Injector

⚠WARNING⚠

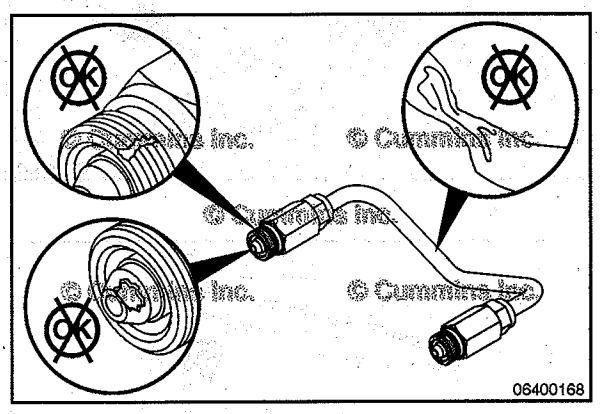
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

⚠WARNING⚠

Some solvents are flammable and toxic. Read the manufacturer's instructions before using.

If the injector supply lines have been properly protected to prevent dirt from entering then there is no need to clean the line.

If the line has been inadvertently dropped and became dirty then clean with Cummins® aerosol cleaner, Part Number 3824510, or equivalent. Do **not** dry with compressed air, allow the cleaner to evaporate completely before installing the injector supply line.



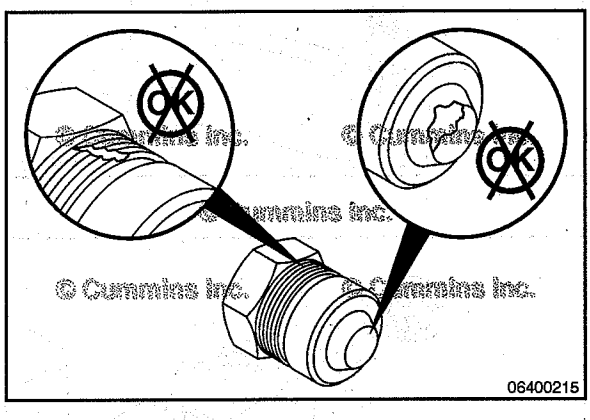
Inspect the injector supply lines for obvious damage, such as lines that have been bent, to facilitate injector removal.

Bent fuel lines **must** be replaced.

Inspect the injector supply line fittings for cracks, damage, stripped threads. Inspect the sealing surface on the cone for damage, scratches, and severe deformation which can cause leakage.

Inspect the grommet for signs of damage, cracks, or tears.

Replace damaged injector supply lines.



Inspect the plug for cracks, damage, or stripped threads. Inspect the sealing surface on the cone for damage, scratches, and severe deformation which can cause leakage.

A damaged plug **must** be replaced.

Install

with Electronically Actuated Injector

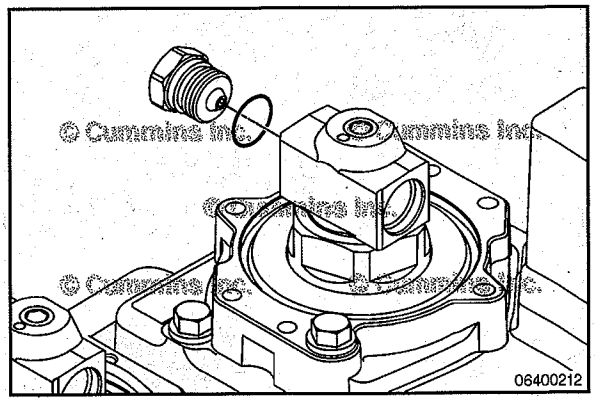
⚠CAUTION⚠

Do not overtighten or undertighten the injector supply line fittings. A fuel leak can occur.

Assemble the new o-rings onto the plugs.

Install the plugs into the injector connections.

Torque Value: 45 N•m [34 ft-lb]



Lubricate the grommet with clean engine oil on the outside and inside diameters. The inside diameter can be lubricated by placing a few drops of clean engine oil on the injector outerwall pipe.

The vee-shaped bends in the injector supply lines **must** all be oriented in the downward direction.

It is important to install both ends of the injector supply line simultaneously to each pair of injectors. If one end of the fuel line is installed and tightened before the other then the fuel line will have to bend in order to install and tighten the second end.

Install the new o-rings on each cone end of the injector supply line.

Insert the cone seat tips of both ends of the injector supply line into the injectors. Be careful to reduce the possibility of damaging the cone seats during installation.

Start the first thread of the connector nut on both ends of the injector supply line by hand. **Only** start the first thread for one connector then start the first thread for the second connector. Be careful to properly engage the first thread to reduce the possibility of cross-threading. If the thread can **not** be started by hand, then the injector clamp needs to be loosened and the injectors rotated until the injector supply line can be started by hand.

Thread the connector nuts into the injectors until finger tight. Both nuts **must** be snug before tightening either end.

Check for alignment or installation issues before final tightening.

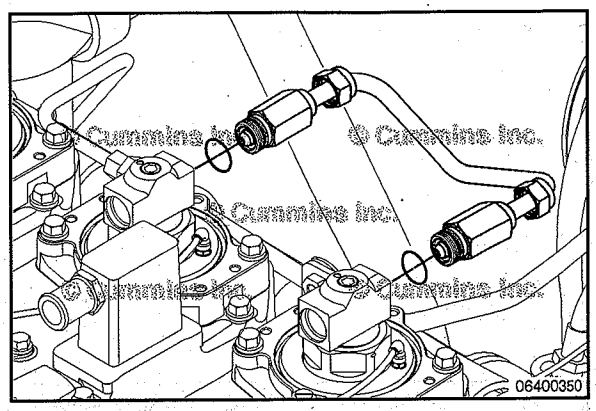
Tighten both connector nuts with a suitable M27 [1-1/16 in] crow's foot and torque wrench.

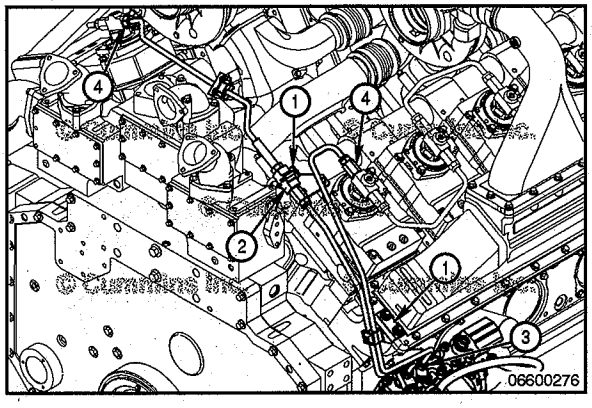
Torque Value: 45 N•m [34 ft-lb]

Install the rectangular grommet nuts with a suitable M27 [1-1/16 in] crow's foot and torque wrench.

Support the connector nut with a wrench while tightening the rectangular grommet nut.

Torque Value: 45 N•m [34 ft-lb]





Install the new o-rings on the injector supply line which connects the fuel pump to the first injector of each bank.

Carefully insert the cone seat tips of both ends of the injector supply lines to reduce the possibility of damaging the cone seats during installation.

Start the first thread of the connector nut on both ends of the injector supply line by hand. **Only** start the first thread for one connector. Be careful to properly engage the first thread to reduce the possibility of cross-threading.

Thread the connector nuts into the injectors until finger tight. Both nuts **must** be snug before tightening either end.

Check for alignment or installation issues before final tightening.

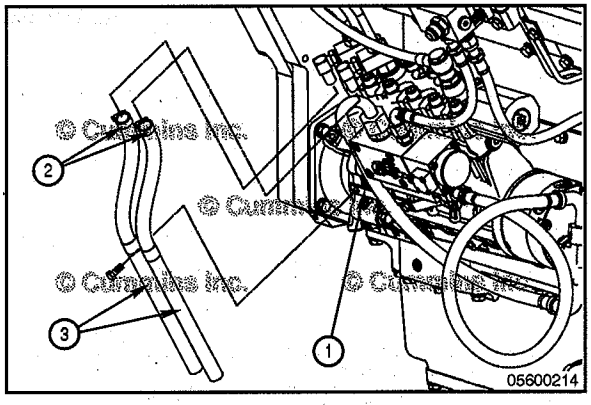
Tighten both connector nuts with a suitable M27 [1-1/16 in] crow's foot and torque wrench.

Torque Value: 45 N•m [34 ft-lb]

Install the rectangular grommet nuts with a suitable M27 [1-1/16 in] crow's foot and torque wrench.

Support the connector nut with a wrench while tightening the rectangular grommet nut.

Torque Value: 45 N•m [34 ft-lb]



Attach the two clamps (2) that secure the fuel vent hoses.

Install the vent hoses (3) and mounting bracket (1).

Finishing Steps

with Electronically Actuated Injector

- It is **not** necessary to vent air from the high-pressure fuel system before starting the engine. Cranking the engine will prime the fuel system.
- Perform a leak test.

Leak Test

with Electronically Actuated Injector

⚠WARNING⚠

The fuel pump, high-pressure fuel lines, and injector supply lines contain very high-pressure fuel. To reduce the possibility of injury and property damage, do not loosen any fittings while the engine is running. Wait at least 10 minutes after shutting down the engine before loosening any fittings in the high-pressure fuel system to allow the pressure to decrease to a lower level.

⚠WARNING⚠

Fuel is flammable. Keep all cigarettes, flames, pilot lights, arcing equipment, and switches out of the work area and areas sharing ventilation to reduce the possibility of severe personal injury or death when working on the fuel system.

⚠WARNING⚠

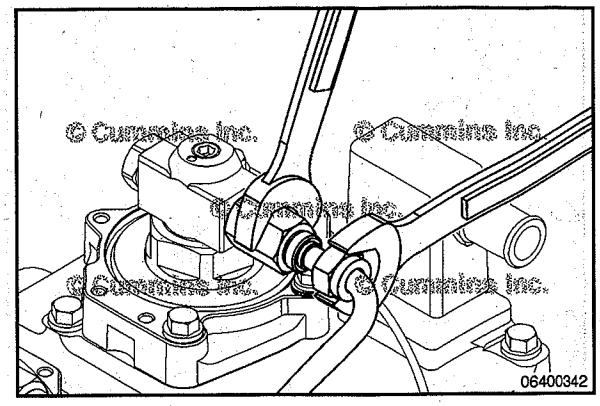
The pressure of the fuel in the line can penetrate the skin and cause serious personal injury. Wear gloves and protective clothing when working on the fuel system.

⚠WARNING⚠

Pressure within the high-pressure fuel system must never be measured using a mechanical gauge. Fuel pressure values of over 1724 bar [25,000 psi] are possible. Under high pressure, a mechanical gauge can fail causing a high-pressure fuel leak resulting in personal injury and property damage.

Back off the rectangular grommet nut on the injector nearest the rear of the engine for each bank.

Support the connector nut with a wrench while backing off the rectangular grommet nut.

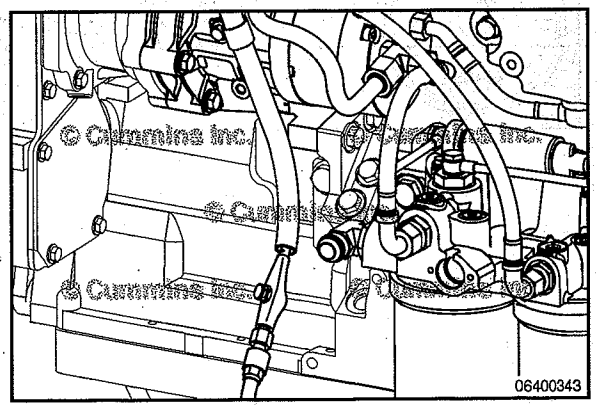


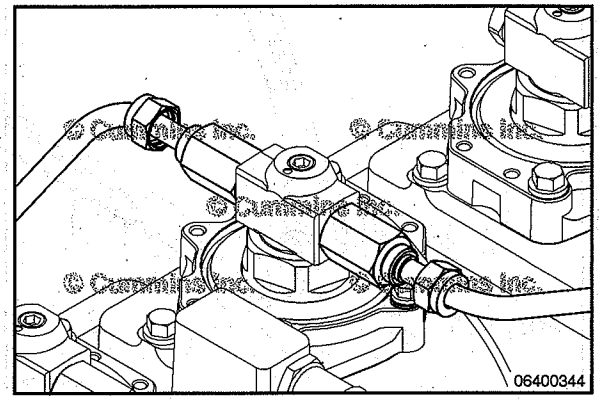
⚠WARNING⚠

Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

Place a rag over the injectors that have the rectangular grommet nuts backed off to prevent accidental spraying of fuel on the engine.

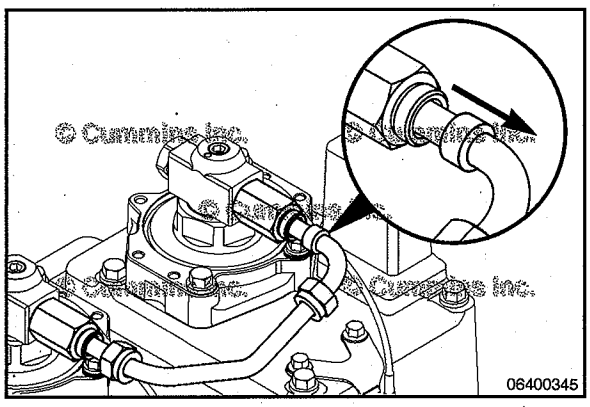
Blow compressed air into the vent hoses located on the side of the fuel pump to remove any fuel and debris from the outer wall of the injector supply lines.



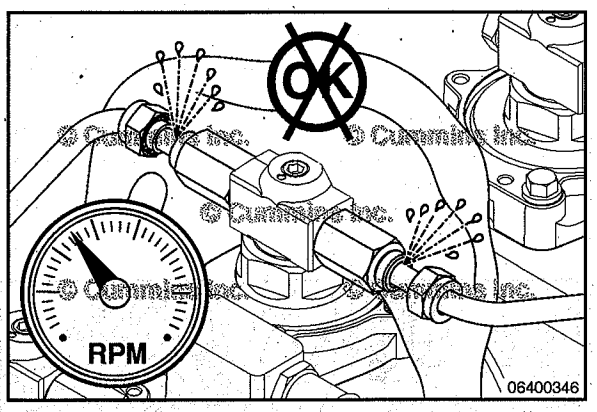


Back off the rectangular grommet nuts from each side of the injectors.

Support the connector nut with a wrench while backing off the rectangular grommet nut.



Slide the grommets away from the connecting fittings.



Operate the engine at idle and check for leaks at each fuel supply line to injector fitting.

If leakage occurs, note which connection(s) are leaking then shut off the engine.

Check to make sure the connecting nut(s) are properly torqued by backing off a half turn, then torque again.

Operate the engine at idle again and see if the leak has stopped. If the leak has stopped, install the grommet and the rectangular grommet nut on each fitting to complete the repair.

If leakage still occurs, remove the injector supply line and check for damage to the injector supply and injector fitting mating surfaces. Replace damaged components as necessary.

If no signs of damage are located, the leakage is most likely caused by misalignment during installation. Install the injector supply line again, making sure to seat the sealing cone, and torque each fitting to the proper torque.

Operate the engine at idle and check for leaks. If leakage still occurs, replace the leaking injector supply line.

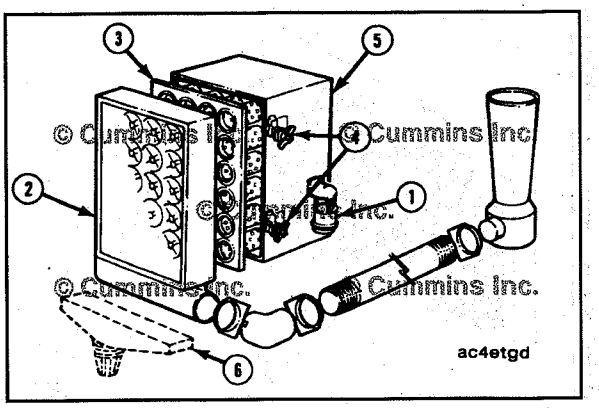
If no leakage is detected, connect the rectangular grommet nut and tighten.

Torque Value: 45 N•m [34 ft-lb]

Air Cleaner Element, Cartridge Type

Remove

Industrial and Power Generation

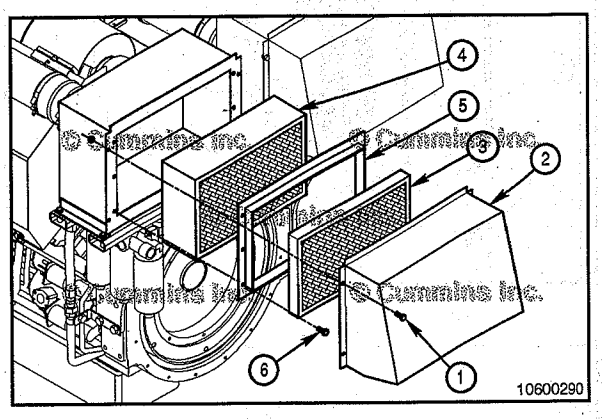


Loosen the wing nuts (4) on the air cleaner housing (5) to remove the precleaner panel with the dust bin (6). To remove the precleaner panel (2) equipped with an exhaust aspirator, loosen the U-bolt clamp securing the precleaner to the aspirator tubing.

Remove the dirty cartridge (3) by inserting fingers into the cartridge opening (loosen all four corners of the cartridge one at a time) and pull it straight out.

With the larger cartridge, break the seal along the edges. After the seal has been broken, pull the cartridge straight out and slightly up so the cartridge will clear the sealing frame and edges of the air cleaner housing.

Marine Applications



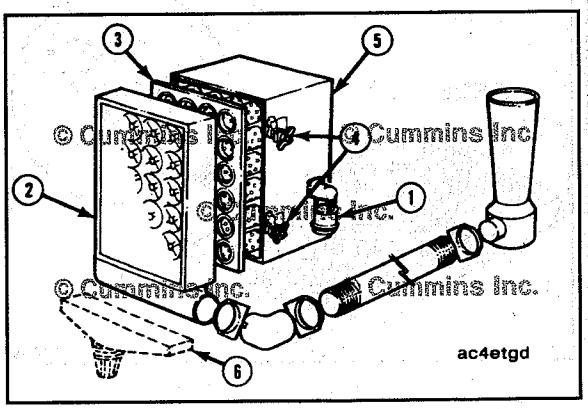
Remove the air inlet capscrews (1) to remove the air inlet hood (2) and moisture separator (3).

Remove the sealing angle mounting capscrews (6) and sealing angle (5).

Remove the air cleaner element (4).

Clean

Industrial and Power Generation



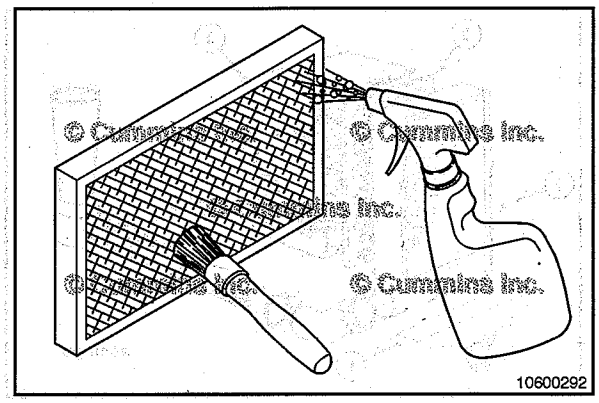
Cummins Inc. does **not** recommend cleaning and reusing the cartridge. When returned to service, the life expectancy of a cleaned cartridge will be **only** a fraction of the original service life.

The precleaner dust bin (6) is self-cleaning.

Clean the precleaner openings (2). Remove all soot, oil film, and any other objects that can become lodged in the opening.

Remove any dust or dirt in the lower portion of the precleaner and aspirator tubing.

Remove all foreign material from the inside of the air cleaner housing.



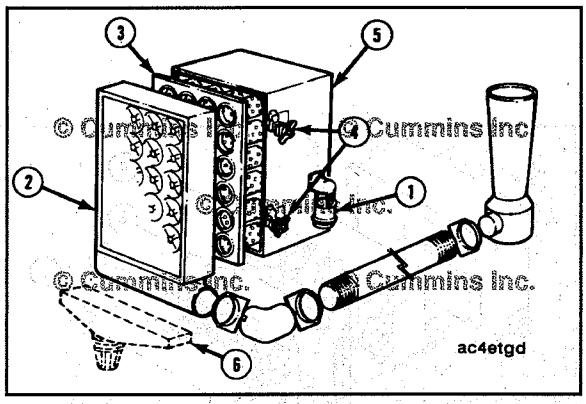
Marine Applications

⚠CAUTION⚠

It is not recommended to clean and reuse the cartridge. When returned to service the life expectancy of a cleaned cartridge will be only a fraction of the original service life.

The moisture separator can be sprayed with light water pressure and brushed with a soft bristle brush.

Remove all foreign material from the inside of the air cleaner housing.



Inspect

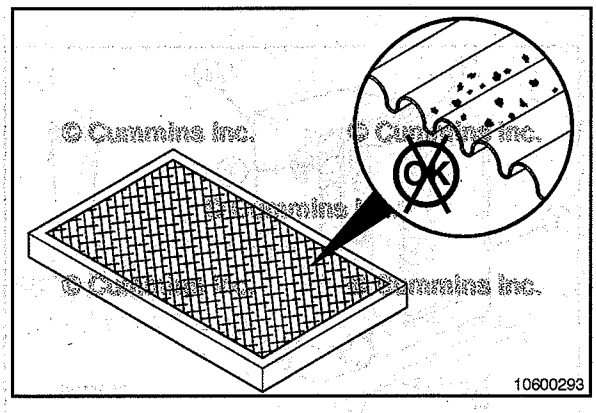
Industrial and Power Generation

Excessive oil mist shortens the life of any dry-type cartridge. Troubleshooting at this point can appreciably lengthen new cartridge life.

Inspect the dirty cartridge for soot or oil. If there is soot inside the tubes, check for leaks in the engine exhaust system, and exhaust blow-back into the air intake and exhaust from other equipment.

If the cartridge appears oily, check for fumes escaping from the crankcase breather.

Inspect clamps and flexible hose or tubing to make sure all fittings are airtight on the cleaners with exhaust aspirators.



Marine Applications

Excessive oil mist shortens the life expectancy of any dry-type cartridge. Troubleshooting at this point can appreciably lengthen new cartridge life.

Inspect the dirty cartridge and moisture separator for soot or oil. If there is soot inside the pleats, check for leaks in the engine exhaust system, and exhaust blow-back into the air intake system from exhaust of other equipment.

If the cartridge or moisture separator appears oily, check for fumes escaping from the crankcase breather.

Inspect clamps and flexible hoses or tubing to make sure all fittings are airtight on the cleaners with exhaust aspirators.

Install

Industrial and Power Generation

Inspect the new filter cartridge for shipping damage before installing.

Install a new cartridge by inserting fingers in the cartridge opening and pushing the cartridge straight into the housing. Do **not** hit the cartridge tubes against the sealing flange on the edges of the air cleaner housing.

As the cleaner requires no separate gaskets for seals, care **must** be taken when inserting the cartridge to create a proper seat within the cleaner housing.

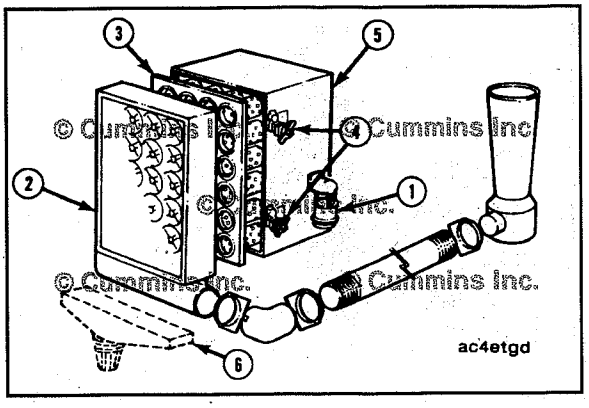
Firmly press all edges and corners of the cartridge with fingers to effect a positive air seal against the sealing flange of the housing. The cartridge **must not** be pounded or pressed in the center to seal the cartridge.

Care **must** be taken to keep the cleaner's face unobstructed.

Replace the precleaner panel (2), and tighten the wing nut (4) by hand.

Turn the wing nuts 1 to 1-1/2 turns with a small adjustable wrench. Do **not** overtighten.

A precleaner equipped with an exhaust aspirator, assemble the aspirator tube to the precleaner panel, and tighten the U-bolt.



Marine Applications

NOTE: Inspect the new filter cartridge for shipping damage before installing.

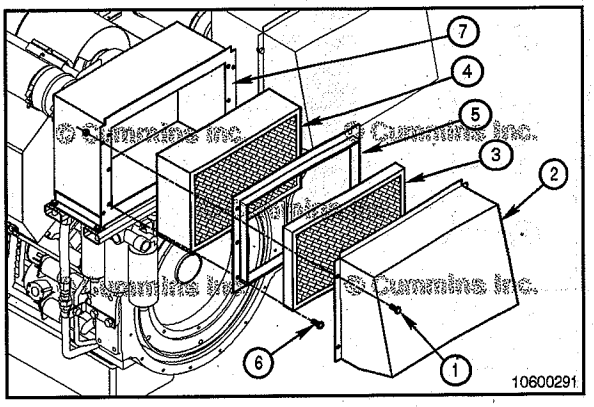
Install a new cartridge (4) into the rear housing (7).

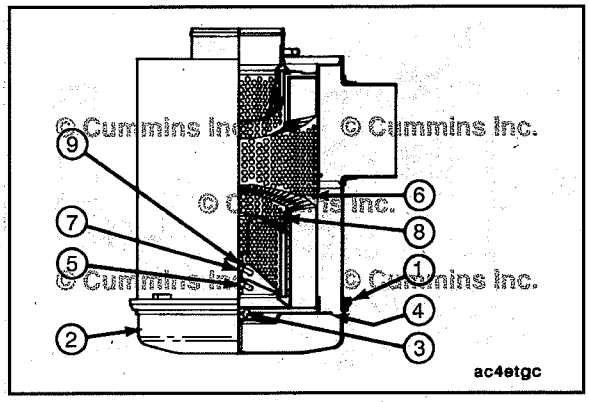
Install the sealing angle (5) and tighten the capscrews (6).

Torque Value: 40 N•m [30 ft-lb]

Install the air inlet hood (2), moisture separator (3), and tighten the capscrews (1).

Torque Value: 40 N•m [30 ft-lb]





Air Cleaner Element, Dual Heavy Duty Dry Type

Remove

Heavy-duty air cleaners combine centrifuge cleaning with element filtering before air enters the engine.

Before disassembly, wipe dirt from the cover and the upper portion of the air cleaner.

Loosen wing bolt (1), and remove the band clamp securing the dust pan (2).

Loosen the wing nut (3).

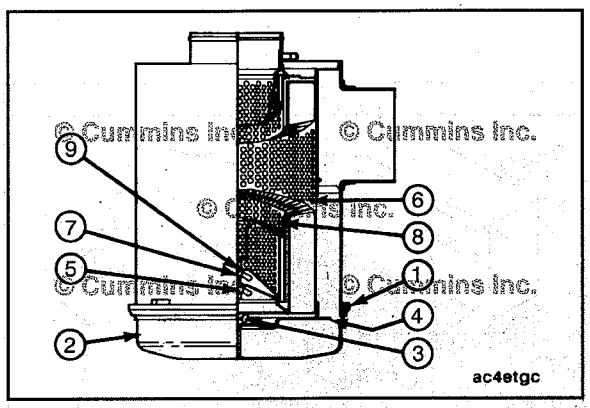
Remove the dust shield (4) from the dust pan (2).

Clean the dust pan and shield.

Remove the wing nut (5) that secures the air cleaner primary element (6) in the air cleaner housing.

Inspect the rubber sealing washer on the wing nut.

Remove the dirty cleaner element (6). If the inner safety element (8) is being replaced based on high intake restriction, remove the wing nut (7), and replace the inner safety element.



Install

If the inner safety element (8) is being replaced based on high intake restriction, install the safety element and secure with the wing nut (7).

Check the seals.

Install the air cleaner primary element (6) in the air cleaner housing.

Inspect the rubber sealing washer on the wing nut (5).

Tighten the wing nut to secure the primary element in the air cleaner housing.

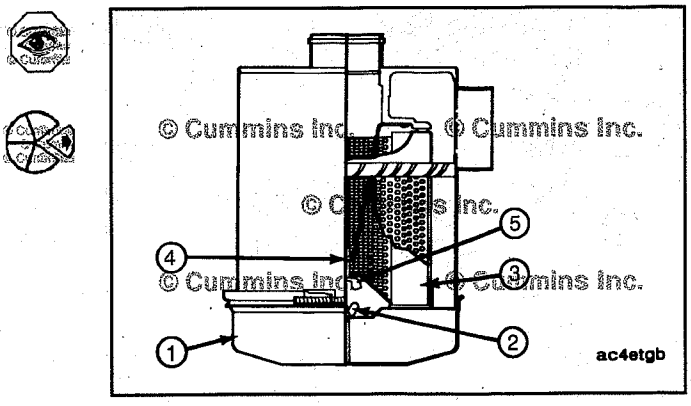
Install the dust shield (4) into the dust pan (2).

Install the dust pan and band clamp (1) and secure with the wing nut.

Operate the engine at rated speed and power, and record the intake restriction. Refer to Procedure 018-019 (Air Intake System) in Section V for intake restriction specifications with new filters.

Air Cleaner Element, Single Heavy Duty Dry Type

Remove



⚠CAUTION⚠

Holes, loose-end seals, dented sealing surfaces, corrosion of pipes, and other forms of damage render the cleaner inoperative and require immediate element replacement or engine damage can occur.

Cummins Inc. does **not** recommend cleaning paper-type air cleaner elements. Elements that have been cleaned will clog, and airflow to the engine will be restricted.

Heavy-duty air cleaners combine centrifuge cleaning with element filtering before air enters the engine.

Loosen wing bolt (2), and remove the band clamp securing the dust pan (1).

Remove the dust shield (3) from the dust pan (1).

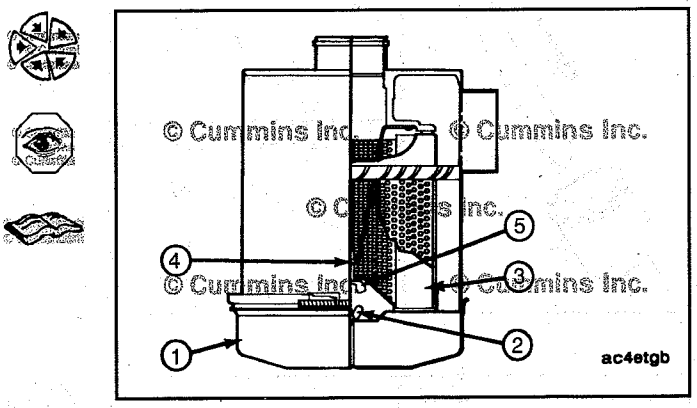
Clean the dust pan and dust shield.

Remove the wing nut (5) that secures the air cleaner primary element (4) in the air cleaner housing.

Inspect the rubber sealing washer on the wing nut.

Remove the dirty cleaner element (4).

Install



Install the air cleaner primary element (4) in the air cleaner housing.

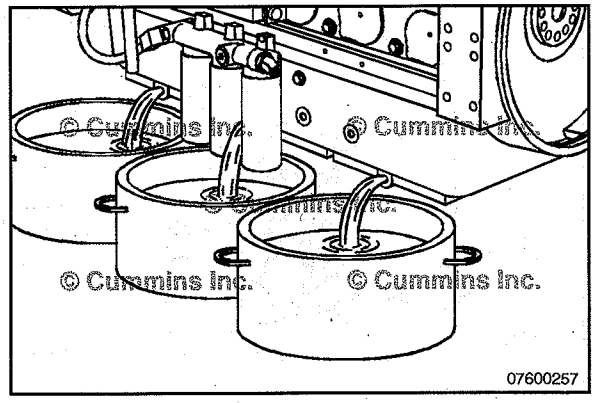
Inspect the rubber sealing washer, and make sure it is in place under the wing nut (5).

Tighten the wing nut (5) that secures the primary element (4) in the air cleaner housing.

Assemble the dust shield (3) and the dust pan (4).

Position the dust shield (3) and dust pan (1) to the air cleaner housing, and secure them with band clamp wing bolt (5).

Operate the engine at rated speed and power, and record intake restriction. Refer to Procedure 018-019 (Air Intake System) in Section V for intake restriction specifications.



Lubricating Oil Dipstick

Calibrate

Standard

⚠WARNING⚠

To reduce the possibility of personal injury, avoid contact of hot oil with your skin.

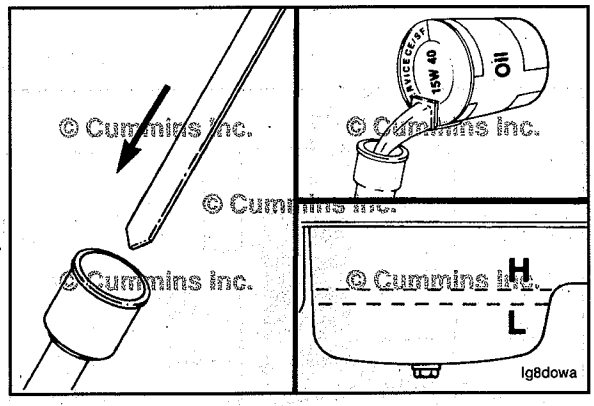
⚠WARNING⚠

Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

NOTE: For marine applications **only**, the lubricating oil dipstick can **not** be calibrated until the engine is in the vessel and the vessel is in the water.

Drain the lubricating oil. Refer to Procedure 007-037.

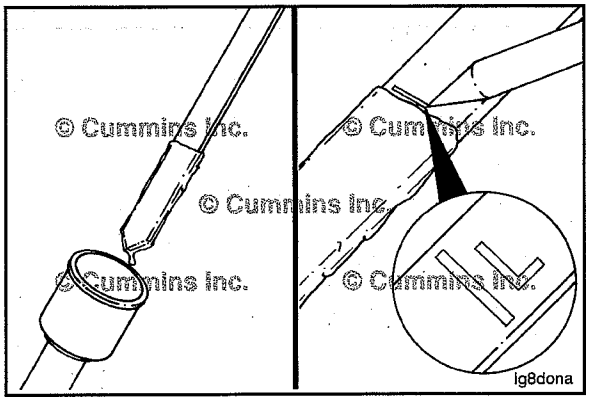
Allow five minutes for the oil to drain into the oil pan. If the engine and/or oil temperature is below 4°C [39°F], a longer period of time will be required for full drain.



The engine **must** be level to perform this procedure.

Install the dipstick in the dipstick tube housing.

Use the correct volume of clean 15W-40 oil. Fill the oil pan to the specified low or L oil level. Refer to Lubricating Oil System - Specifications, in Procedure 018-017 for the correct engine oil capacity for the application.



⚠CAUTION⚠

Exercise care when marking the dipstick, or the dipstick will break if the scribe mark is too deep.

Remove the dipstick, and scribe a mark across the stick at the oil level. Label the mark with an L to indicate the low oil level.

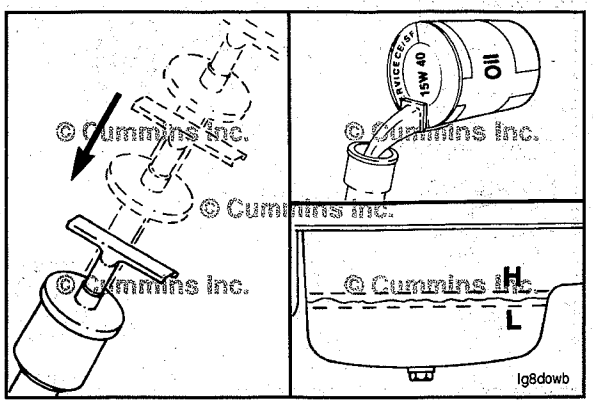
If a new, blank dipstick is being used, cut the dipstick approximately 38 mm [1.5 in] below the low or L oil level mark.

⚠CAUTION⚠

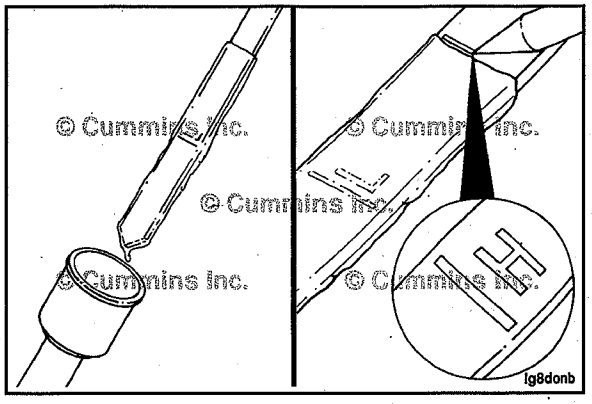
Only add the difference between low volume and high volume when adding oil to the specified high or low level. Excessive oil in the crankcase can cause premature engine failure.

Wipe the excess oil from the dipstick, and install it in the dipstick tube housing.

Use the correct volume of oil to fill the oil pan to the specified high or H oil level. Refer to the Lubricating System Specification, in Procedure 018-017, for engine oil capacity.



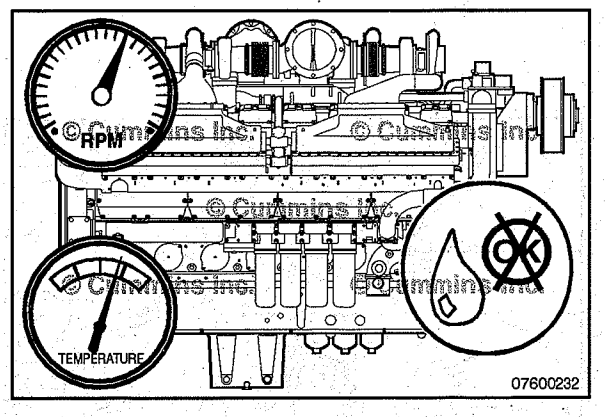
Remove the dipstick, and scribe a mark across the stick at the oil level. Label the mark with an H to indicate the high oil level.

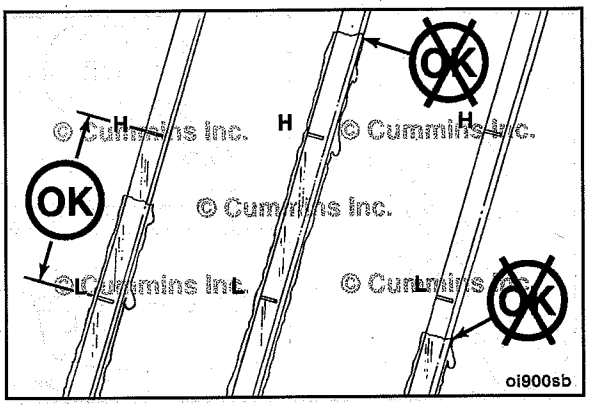


Running Level Dipstick

To calibrate the running level dipstick, the following procedure **must** be followed:

1. With the oil level to the static high mark on the dipstick and confirmed by using the weep hole, operate the engine to bring the pan temperature up to approximately 99°C [210°F].
2. Return the engine to the low idle condition, disengage any engine driven accessories and put the transmission in neutral.
3. Allow to idle for 5 minutes.
4. Remove the oil filler cap.
5. Remove the dipstick from the tube and wipe clean.
6. Insert the dipstick fully and immediately withdraw.
7. Check the oil level marking on the engine idling side of the dipstick.
8. The running level readings **must** be between the high and low level range and produce a clearly readable line. If not, repeat steps 4 and 5. The oil level indicated can be near to the HIGH level mark.





9. Take further readings to confirm that readings are repeatable. However, it is **not** unusual for the level in the sump to vary slightly while the engine is idling. It can however remain near to the HIGH level mark. Total idling time can **not** exceed 10 minutes.
10. Install the oil filler cap.

When satisfied that the dipstick registers the high running level correctly, it is suggested that the same test be run with the oil pan drained to the static low level mark.

At all times during the low level test, monitor the low oil pressure and temperature warning lamps and gauges.

Repeat the procedure used for the high level testing. The run level readings **must** be between the run high and low level range indicated on the dipstick. Total idling time **must not** exceed 10 minutes.

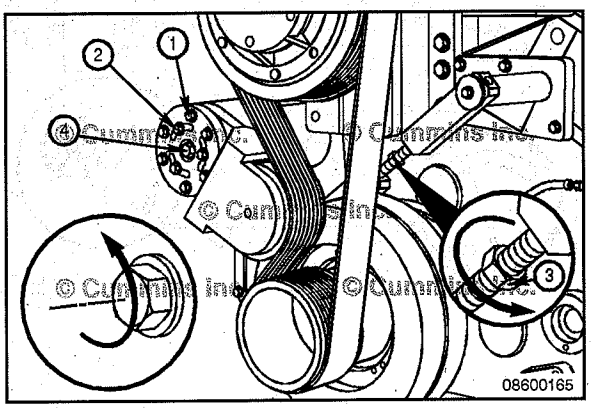
When satisfied that the dipstick markings are reflective of the behavior of the oil in the oil pan at low levels, add oil to the oil pan in equal steps until the high level is reached.

Each time an amount of oil is added check that the dipstick registers a change in the oil level. Each quantity of oil added can register a change in the level on the dipstick.

If it is practical and safe while the engine is idling use the engine running dipstick procedure. If it is **not** possible use the static level checking method.

As a guide, 10 mm [0.394 in] on the dipstick equates to approximately 30.3 liters [8 gal] of oil on a QSK60 engine.

When the above tests have been completed and the operator is confident with the results, the vehicle can be returned to normal operations.



Drive Belt, Cooling Fan

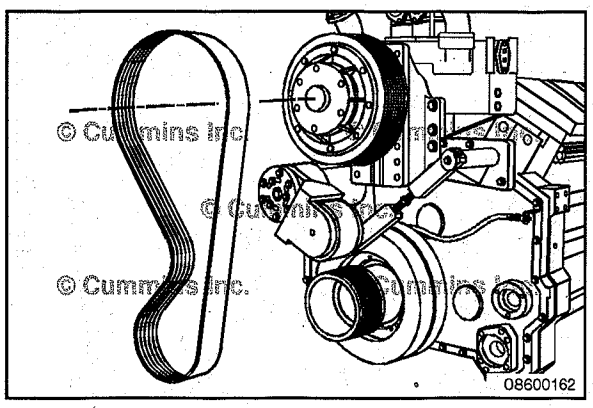
Remove

⚠WARNING⚠

The fan belt idler is under tension. Do not allow your hands to get between the idler and the belt or the fan hub. Personal injury can result.

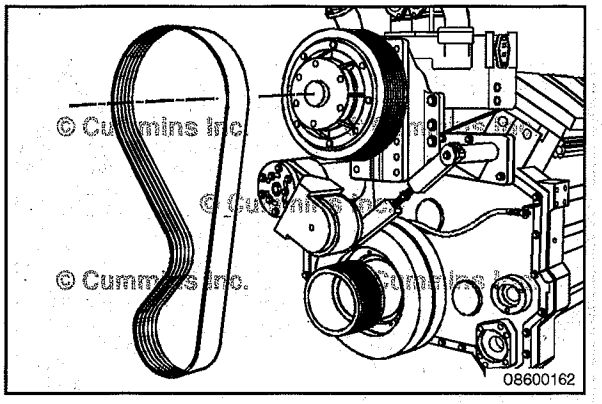
Loosen the six capscrews (1) and the three capscrews (2) and the center capscrew (4). Turn the hexagon nut (3) **counterclockwise** to relieve tension on the belt.

Remove the fan belt.



Install

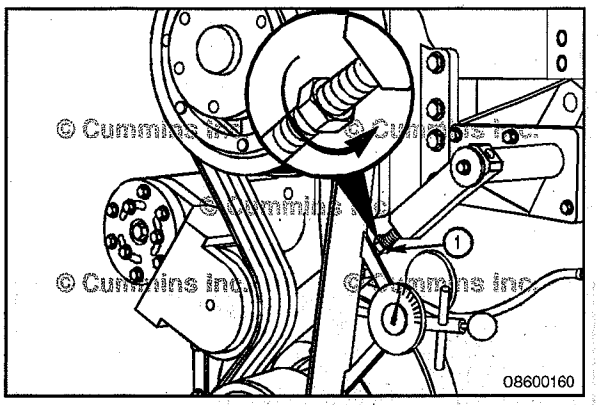
Install the belt.



Adjust

Install the belt tension gauge, Part Number 3163569.

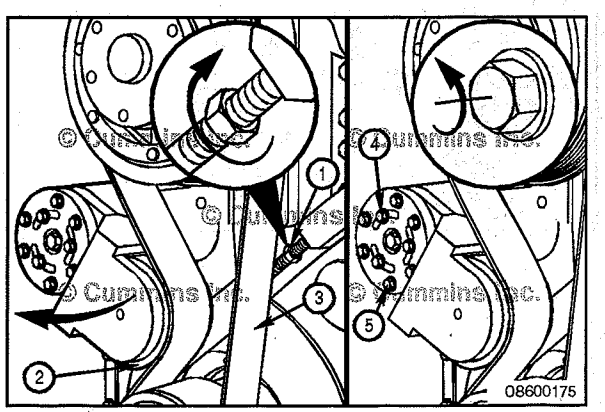
Turn the control rod (1) **clockwise** to tighten the belt tension.

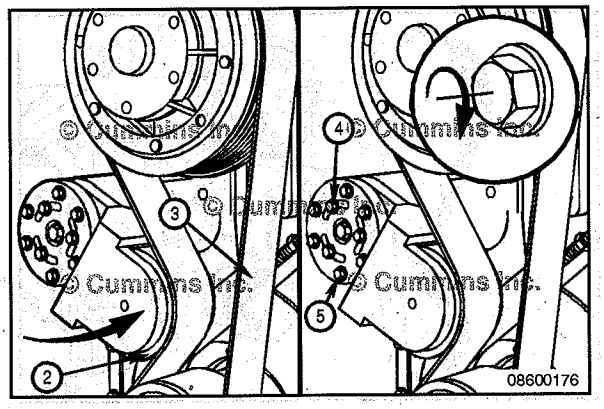


Reposition the idler lever clamping screws **only** if correct tension can **not** be obtained using the control rod.

Loosen the three capscrews (4), the six capscrews (5), and the center capscrew on the belt tensioner.

Turn the control rod (1) **counterclockwise** until the idler lever pulley (2) is off the belt (3) completely.





Position the idler lever pulley (2) against the belt (3). Reposition clamping capscrews if necessary.

Turn the control rod (1) **clockwise** to increase the belt tension.

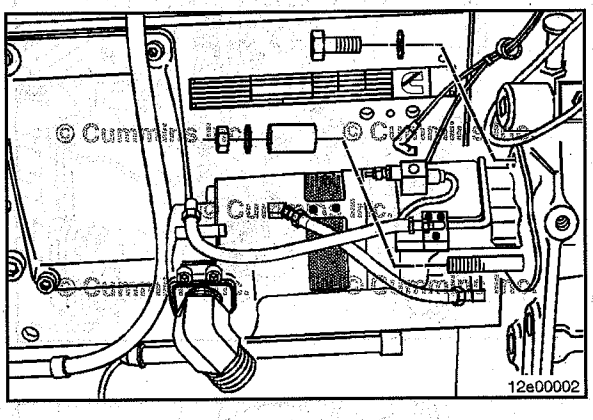
Set the belt initially to 4893 N [1100 lbf].

Run the engine for a minimum of 1 hour and a maximum of 24 hours. Check and reset, if necessary, to 4893 N [1100 lbf].

After the belt tension has relaxed to a minimum of 3559 N [800 lbf], reset it to 4893 N [1100 lbf].

Tighten the three capscrews (4), six capscrews (5), and the center capscrew on belt tensioner.

Torque Value: 200 N•m [148 ft-lb]



Air Starting Motor

General Information

An engine air starting motor is shown in the illustration.

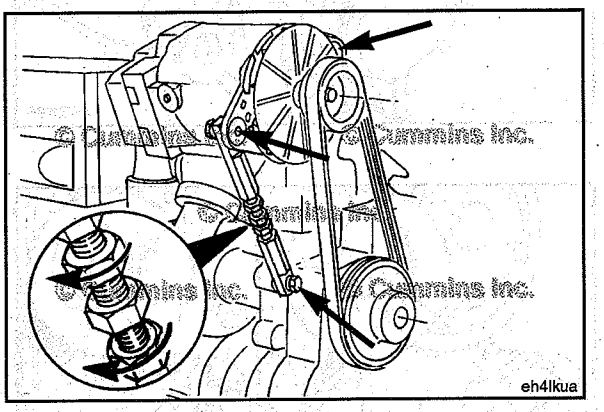
The air starting motor system (tanks, line sizes, and valves) is designed and installed by the OEM and the starting motor suppliers. Refer any questions about the air starting systems to the manufacturer.

Do **not** operate the air starting motor with air pressure lower than 480 kPa [70 psi].

Maintain the air compressor according to the recommendations outlined in the component manufacturer's manual.

For maximum efficiency, the hoses, tubes, and lines **must not** leak.

Refer to the OEM and starting motor manufacturer's manuals for specific information regarding the starting motors, valves, and systems.



Drive Belt, Alternator

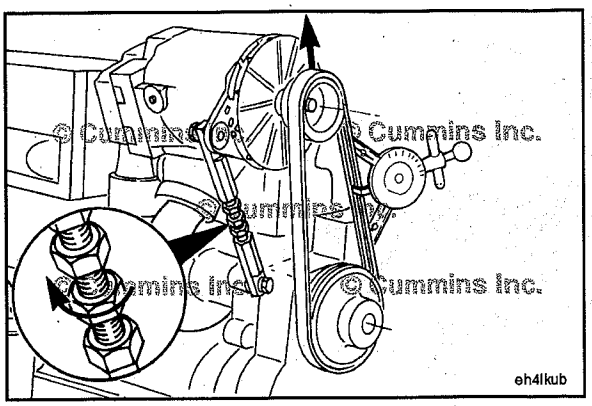
Adjust

NOTE: The lower jam nut has left-hand threads.

Loosen the alternator and adjusting link mounting capscrews.

Loosen the jam nuts on the adjusting screw.

Turn the adjusting screw **clockwise** to increase the belt tension.



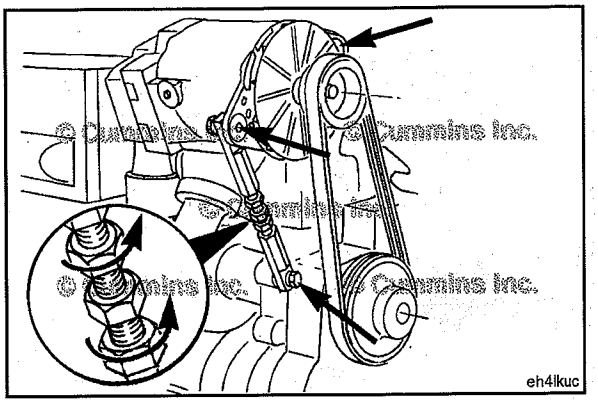
NOTE: The lower jam nut has left-hand threads.

Tighten the jam nuts on the adjusting screw.

Tighten the adjusting link and alternator mounting capscrews.

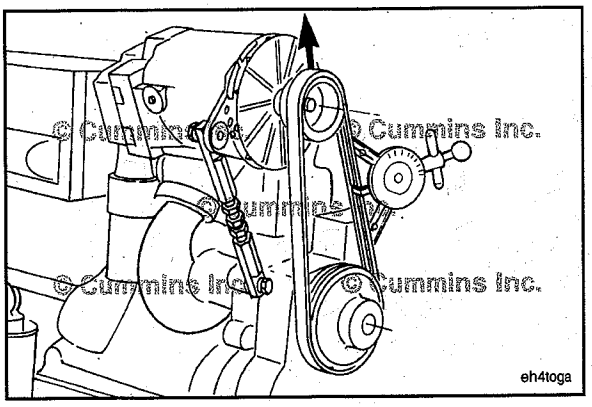
Torque Value:

Jam Nuts	80 N•m	[59 ft-lb]
Alternator Mounting Capscrews	115 N•m	[85 ft-lb]



Check the belt tension again to be sure it is correct.

Refer to Section V for the proper belt tension.

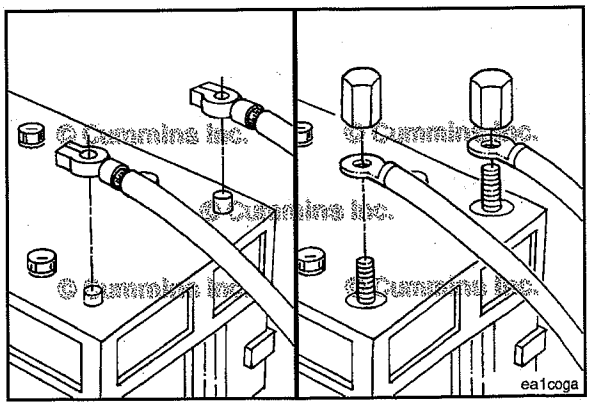


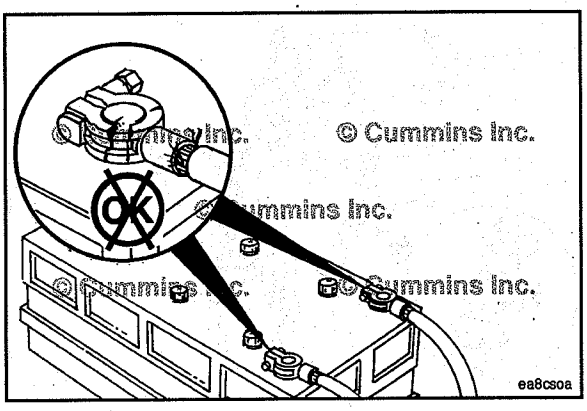
Battery Cables and Connections

Initial Check

There are two possible heavy-duty battery connections:

- Battery terminal and clamp (1)
- Threaded battery terminal and nut (2).



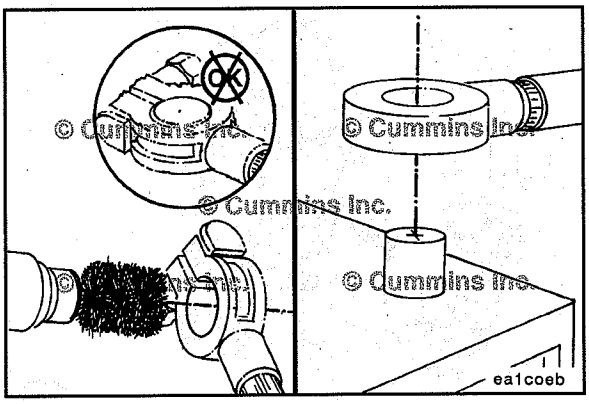


WARNING

Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

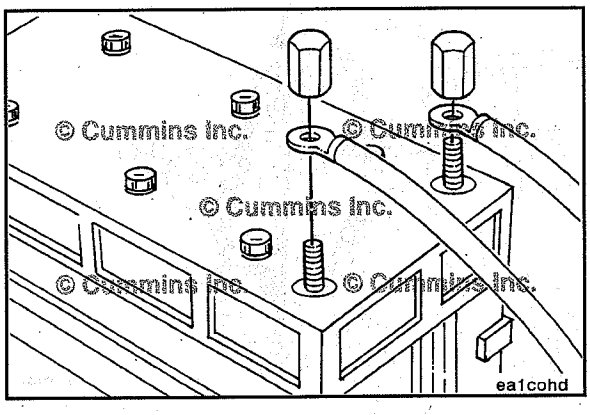
Remove and inspect the battery cables and connections for cracks or corrosion.

Replace broken terminals, connectors, or cables.



If the connections are corroded, use a battery brush or wire brush to clean the connections until shiny.

Make sure all debris is removed from the connecting surfaces.



WARNING

Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

Install the cables and tighten the battery connections.

Coat the terminals with grease to prevent corrosion.

Cold Weather Starting Aids

Ether Starting Aids

⚠WARNING⚠

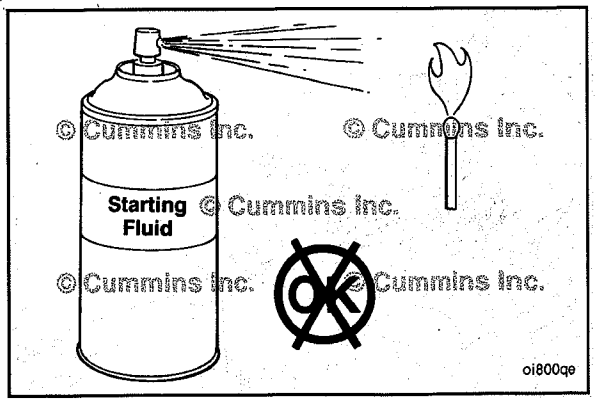
Because of the potential for an explosion, do not use volatile cold starting aids in underground mine or tunnel operations. Ask the local U.S. Bureau of Mines inspector for instructions.

⚠WARNING⚠

Do not use volatile cold starting aids in marine applications due to the potential of an explosion.

⚠WARNING⚠

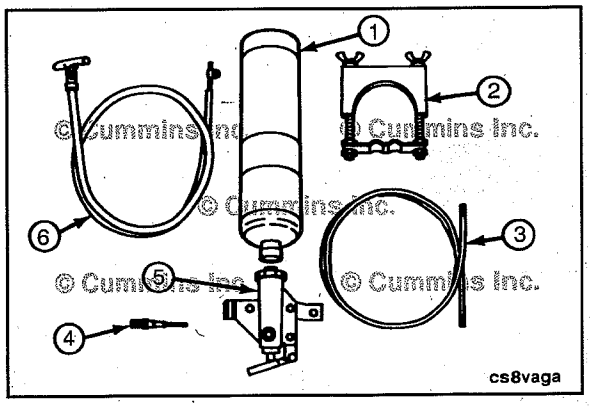
Starting fluid is high flammable and explosive. Keep flames, sparks, and arcing switches away from starting fluid.



Ether Valve, Manual

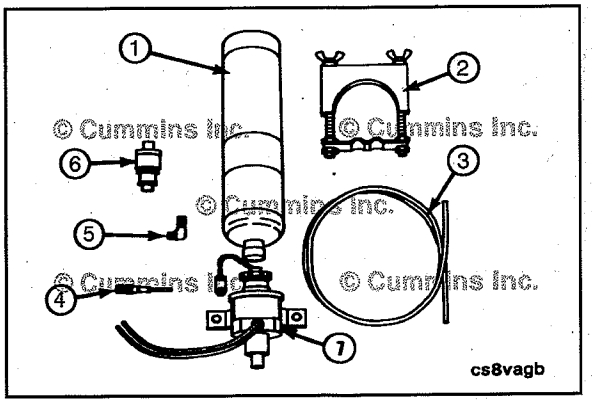
The manually operated ether valve includes the valve body assembly (5), clamp (2), and nylon tube (3). The fuel cylinder (1), atomizer fitting (4), and pull control (6) **must** be ordered separately.

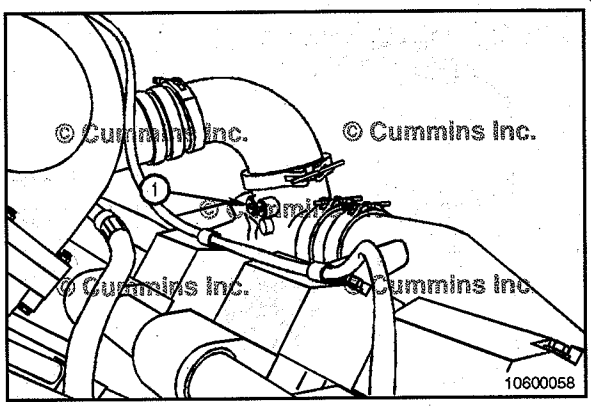
Standard pull or throttle control cables can be used to actuate the manual valve, if desired.



Ether Valve, Electric

The electrically operated ether valve includes the valve body (7), 90-degree elbow (5), clamp (2), push button switch (6), and nylon tube (3). A thermostat is mounted to the cylinder block or coolant passage and stops electrical power to the atomizer solenoid when the engine is warm. Contact a Cummins Authorized Repair Facility for fuel cylinder (1) and fuel atomizer fittings (4). These fittings **must** be ordered separately, as required.





Install

General Information

The atomizer fittings **must** be mounted in the engine air intake crossover tube (1) to provide an equal distribution of starting fuel to each cylinder.

Section D - System Diagrams

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System Diagrams - Overview

General Information

The following drawings display the flow through the engine systems. Although parts can change between different application and installations, the flow remains the same. The system shown are:

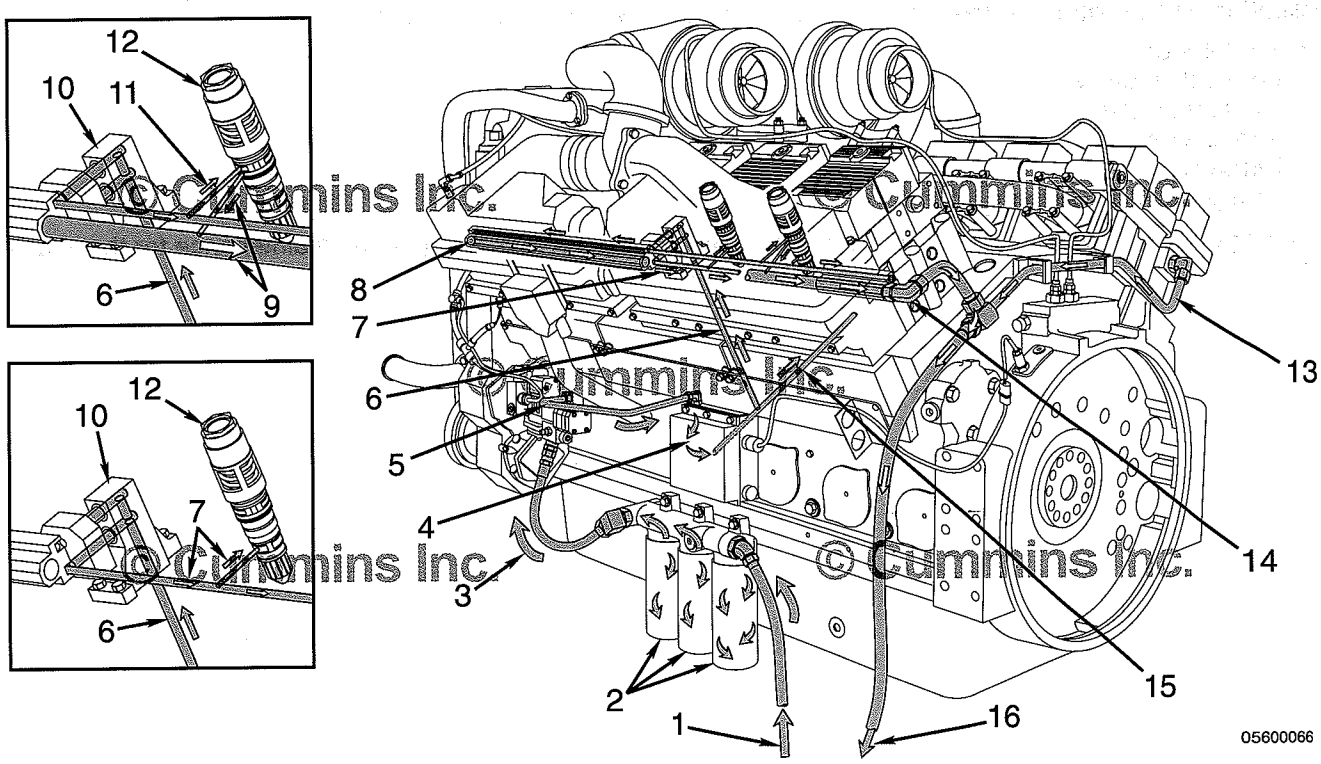
- Fuel system
- Lubricating oil system
- Coolant system
- Intake air system
- Exhaust system
- Compressed air system.

Knowledge of the engine systems can help in troubleshooting, service, and general maintenance for the engine.

Flow Diagram, Fuel System

Flow Diagram

with Mechanically Actuated Injector



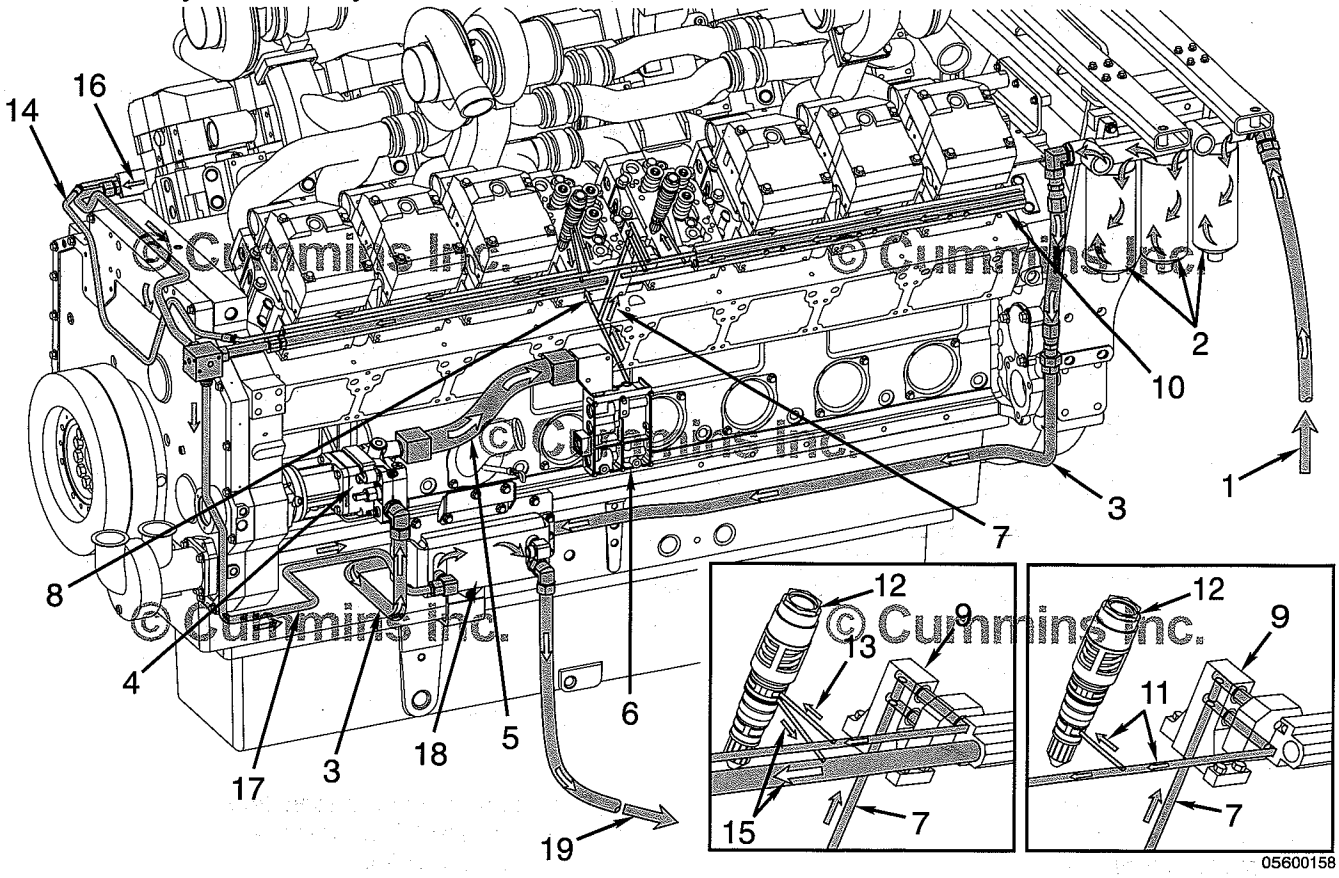
Fuel System - Industrial and Power Generation

1. Fuel inlet from tank
2. Fuel filters
3. Fuel supply to fuel pump
4. Fuel flow through fuel shutoff valve to engine
5. Fuel supply from fuel pump to fuel shutoff valve
6. Fuel supply to left bank fuel block
7. Fuel rail supply to injectors
8. Fuel manifold
9. Fuel drain
10. Fuel block
11. Fuel timing supply to injectors
12. Injector
13. Right bank fuel drain
14. Left bank fuel drain
15. Fuel supply to right bank fuel block
16. Fuel drain to fuel tank.

Flow Diagram, Fuel System

Flow Diagram

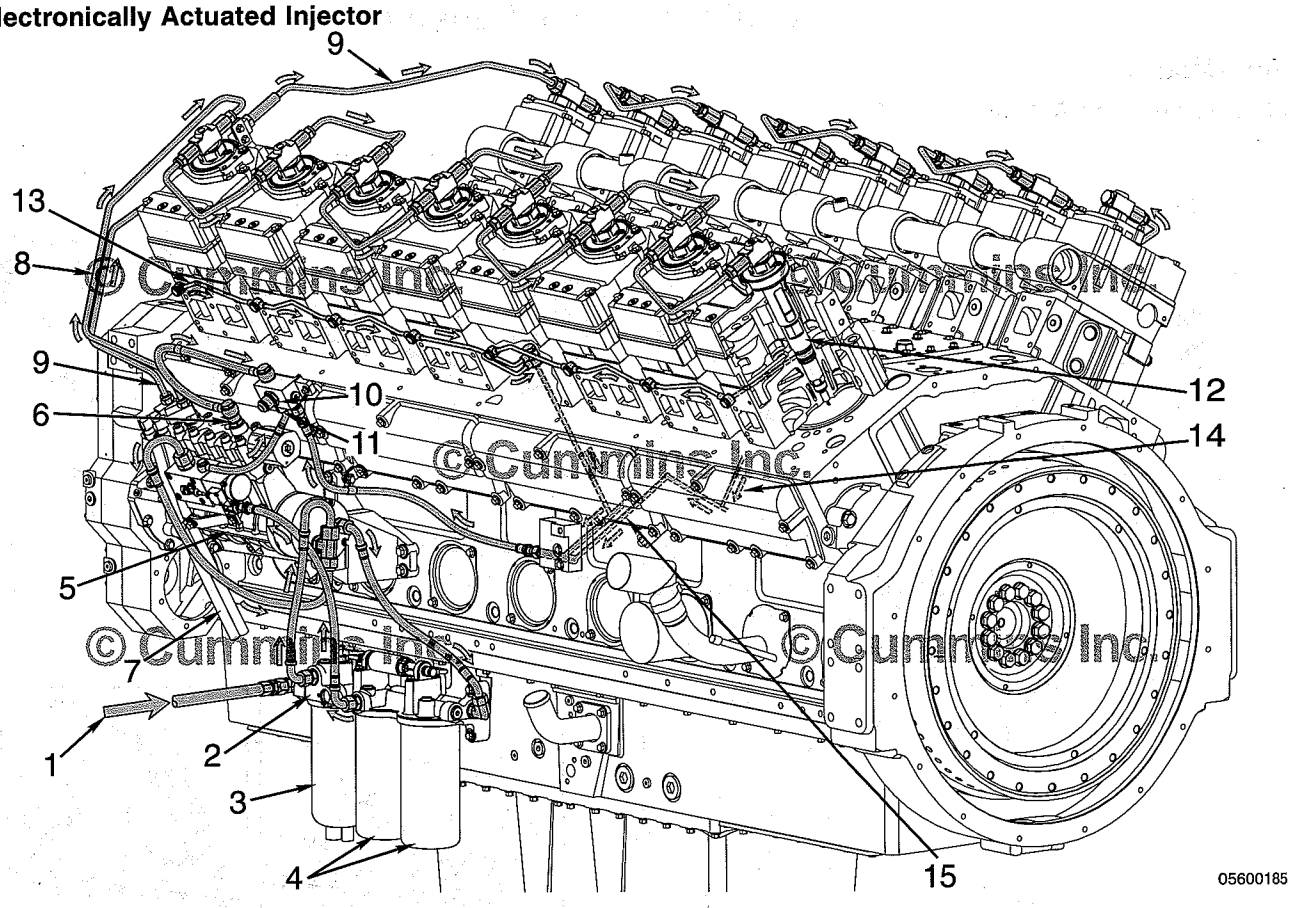
with Mechanically Actuated Injector



QSK60 Fuel System - Marine

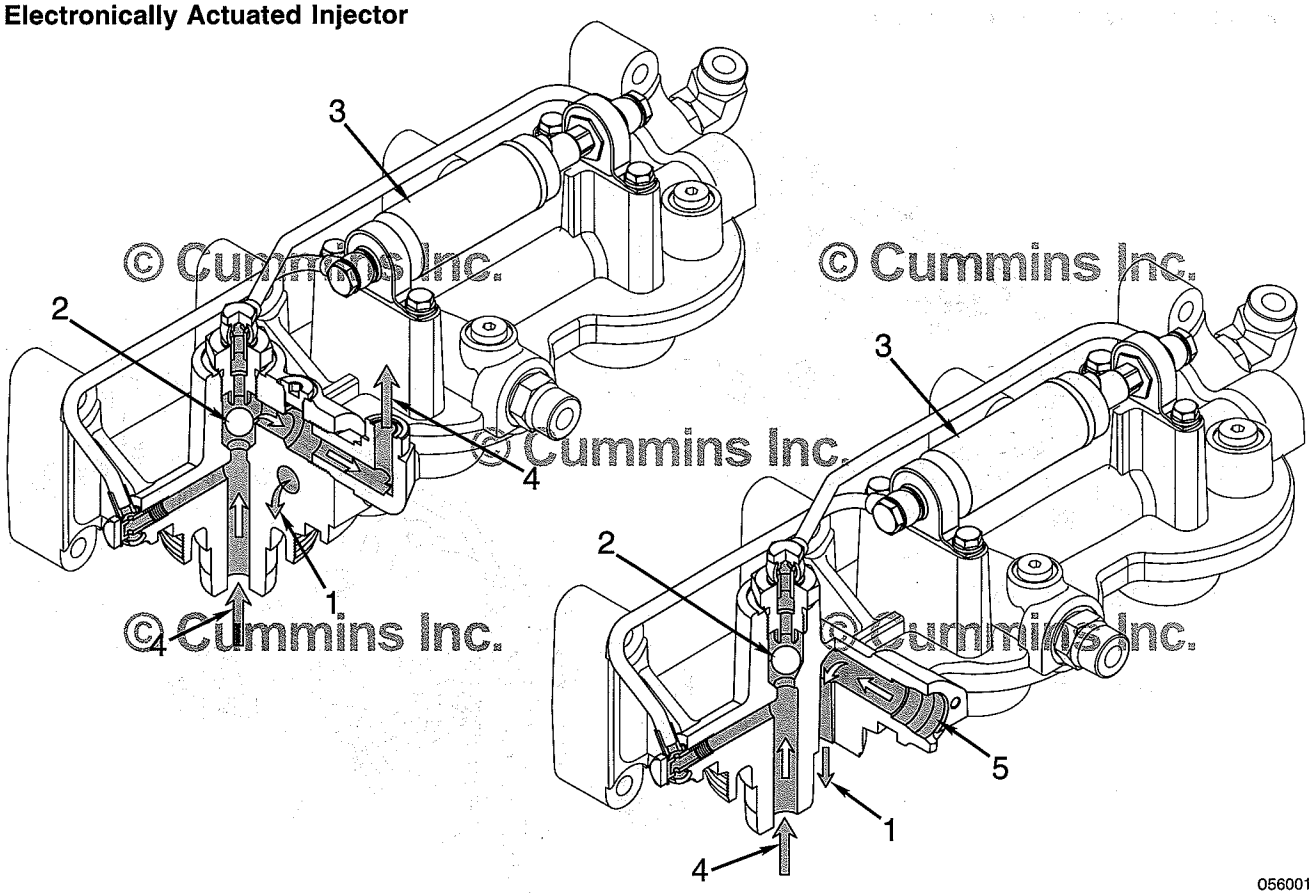
1. Fuel inlet from fuel tank
2. Fuel filters
3. Fuel supply to fuel pump
4. Fuel pump
5. Fuel supply to electronic control valve assembly
6. Electronic control valve assembly
7. Fuel supply to left bank fuel block
8. Fuel supply to right bank fuel block (internal)
9. Fuel block
10. Fuel manifold
11. Fuel rail supply to injector
12. Injector
13. Fuel timing supply to injector
14. Balancing tube
15. Left bank fuel drain
16. Right bank fuel drain
17. Fuel drain to fuel cooler
18. Fuel cooler (optional)
19. Fuel drain to fuel tank.

with Electronically Actuated Injector



1. Fuel supply from tank
2. Fuel filter head assembly
3. First stage fuel filter
4. Second stage fuel filter
5. Fuel pump
6. Mechanical dump valve
7. Vents for injector supply lines
8. Left bank injector supply line
9. Right bank injector supply line
10. Fuel return to OEM fuel tank
11. Air bleed check valve
12. Injector
13. Fuel return line
14. Fuel return flow from right bank
15. Fuel return flow from left bank.

with Electronically Actuated Injector



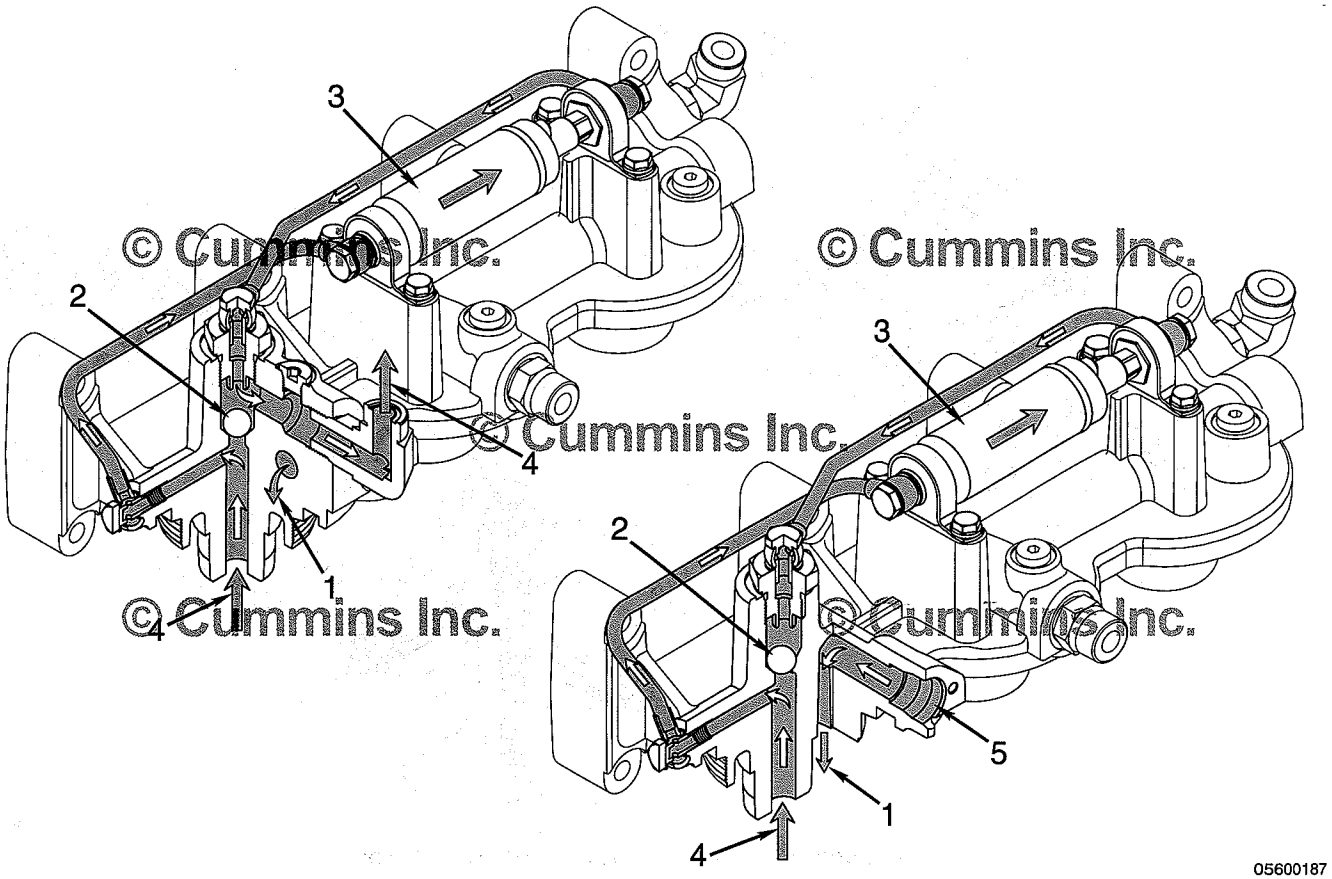
© Cummins Inc.

05600186

First Stage Fuel Filter Head - Check Valve Open

1. Fuel inlet from OEM fuel supply line
2. Check ball
3. Lift pump
4. First stage filtered fuel flow
5. Port for optional fuel heater.

with Electronically Actuated Injector

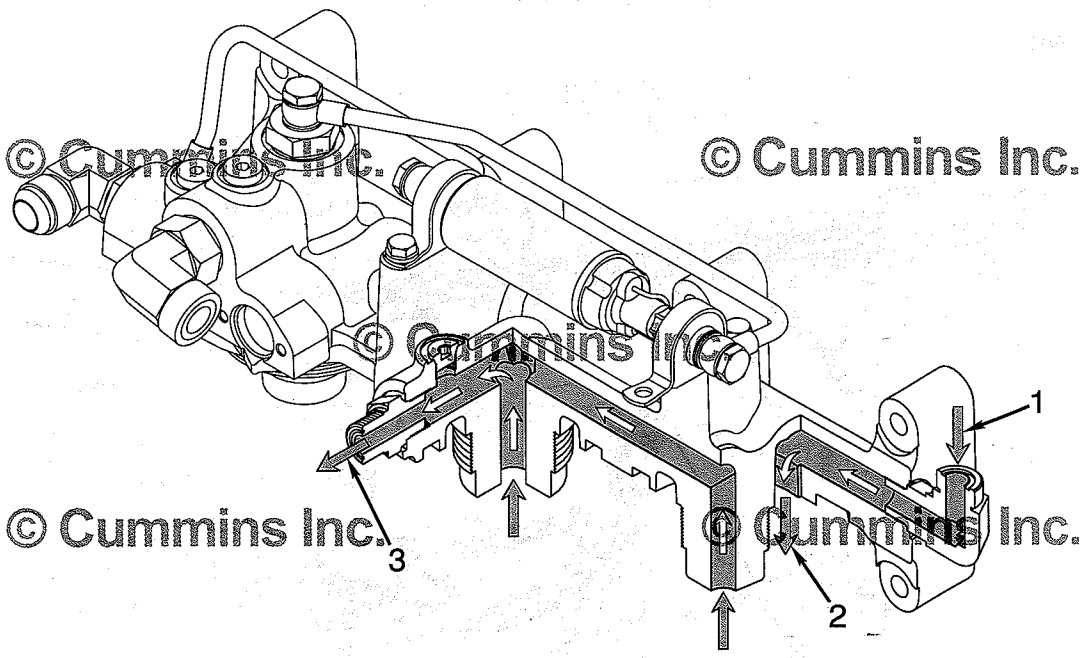


© Cummins Inc.

First Stage Fuel Filter Head - Check Valve Closed (Cranking)

1. Fuel inlet from OEM fuel supply line
2. Check ball
3. Lift pump
4. First stage filtered fuel flow
5. Port for optional fuel heater.

with Electronically Actuated Injector



© Cummins Inc.

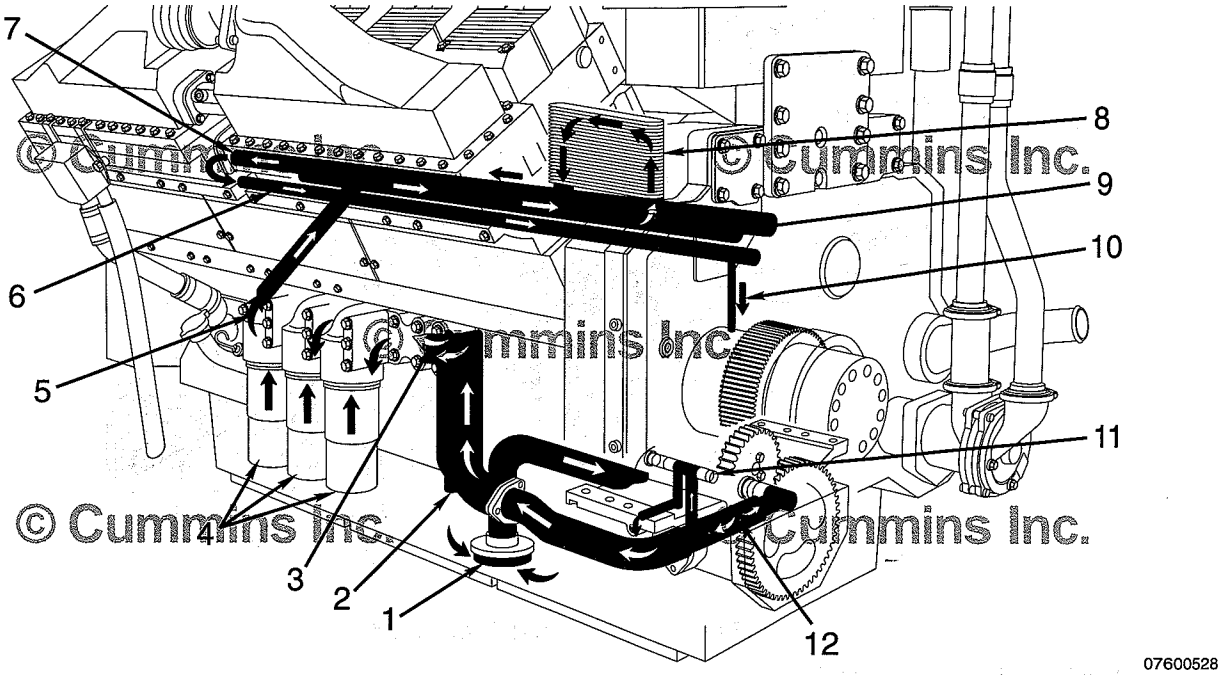
05600188

Second Stage Fuel Filter Head

1. Fuel flow from first stage fuel filter
2. Fuel into second stage fuel filter
3. Filtered second stage fuel to fuel pump.

Flow Diagram, Lubricating Oil System

Flow Diagram

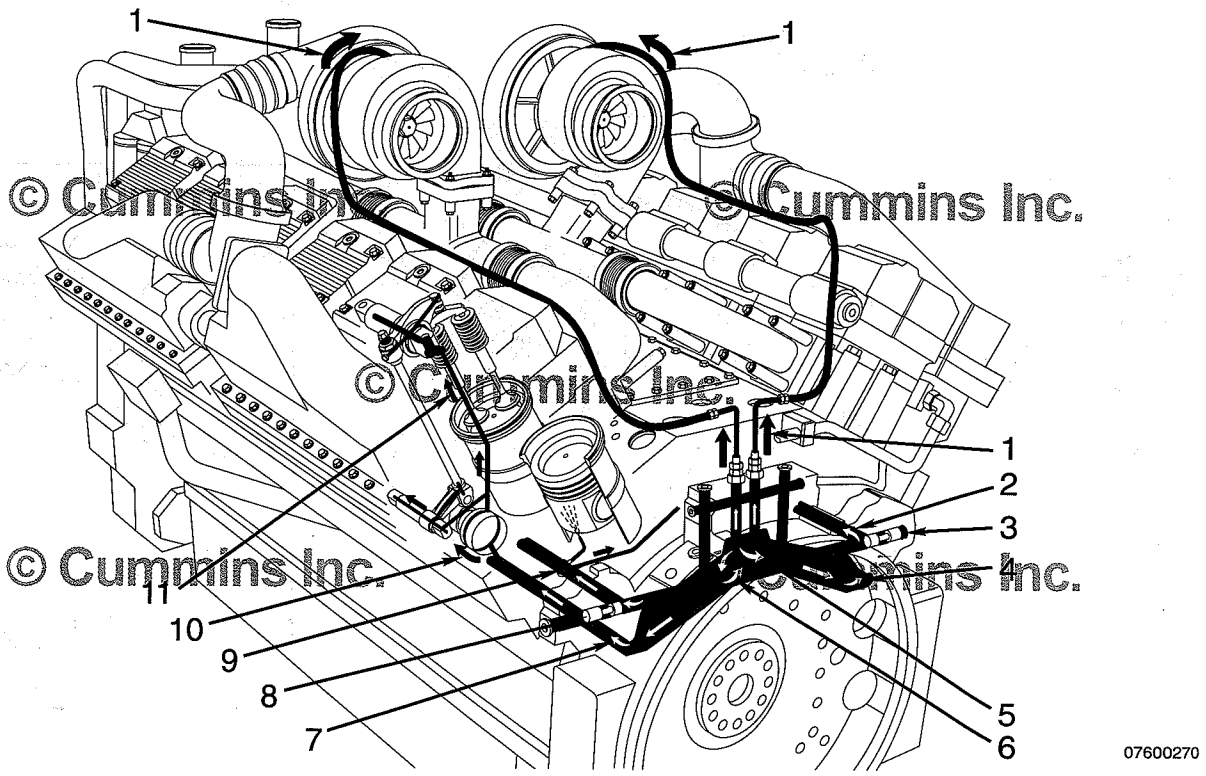


Lubricating Oil System

1. Lubricating oil suction tube
2. Block connection
3. Lubricating oil flow to filter head
4. Lubricating oil filters
5. Lubricating oil flow out of filters
6. Main lubricating oil rifle
7. Cooled lubricating oil to flywheel housing
8. Lubricating oil cooler
9. Lubricating oil rifle/supply to oil coolers
10. Lubricating oil supply to main bearings
11. Pressure regulator valve
12. Lubricating oil flow from rotor to discharge port

Flow Diagram, Lubricating Oil System

Flow Diagram

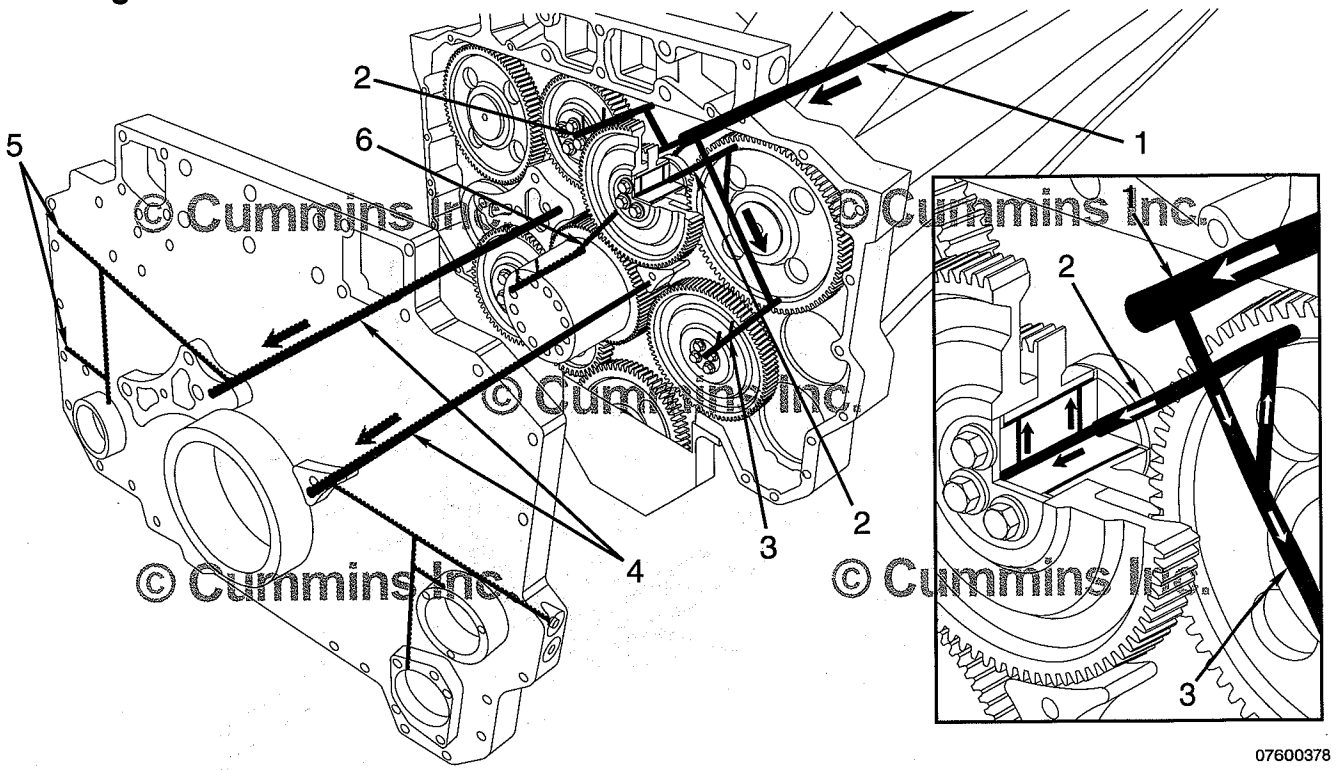


Piston Cooling, Connecting Rod, Overhead

1. Lubricating oil supply to turbochargers
2. Lubricating oil supply to right-bank piston cooling nozzle
3. Right-bank piston cooling nozzle regulator
4. Lubricating oil supply rifles to right-bank camshaft
5. Lubricating oil supply from lubricating oil coolers
6. Lubricating oil supply to main lubricating oil rifle
7. Lubricating oil supply rifles to left-bank camshaft
8. Left-bank piston cooling nozzle regulator
9. Piston cooling nozzle
10. Lubricating oil supply to camshaft and cam followers
11. Lubricating oil supply to rocker levers.

Flow Diagram, Lubricating Oil System

Flow Diagram

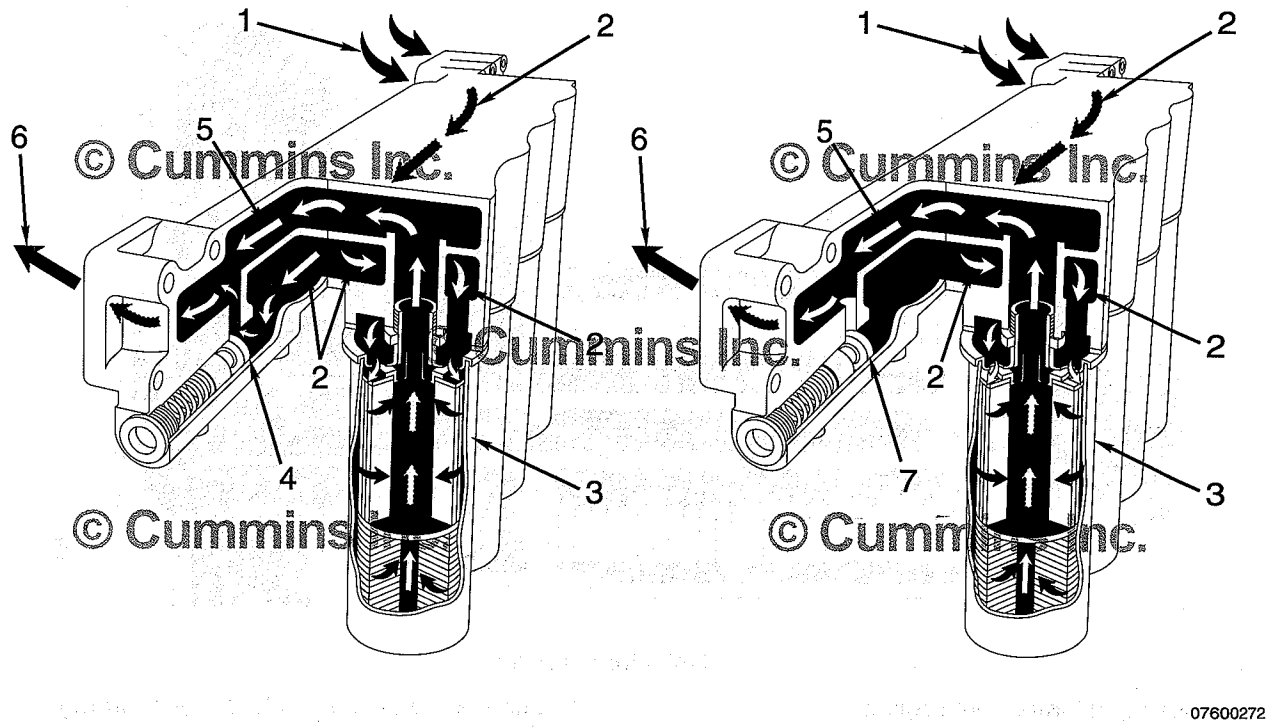


Front Gear Train

1. Main Lubricating oil rifle
2. Lubricating oil supply to idler gear
3. Lubricating oil supply to accessory drive
4. Lubricating oil supply to gear cover
5. Lubricating oil supply to rockford fan clutch (either passage)
6. Lubricating oil supply to water pump drive.

Flow Diagram, Lubricating Oil System

Flow Diagram



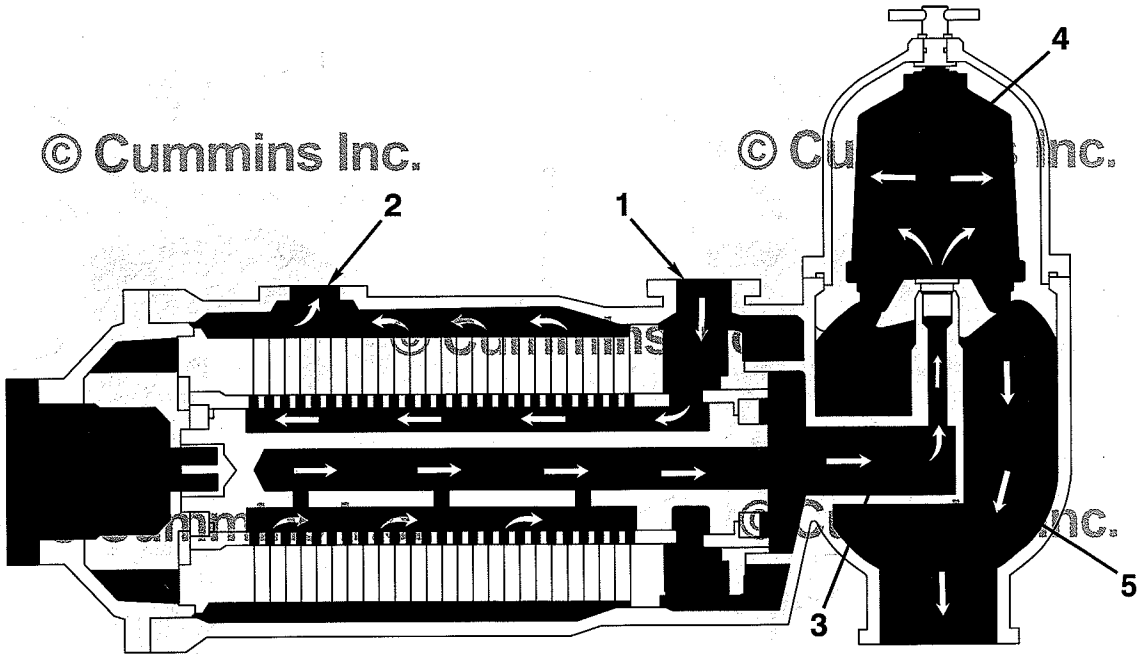
07600272

Full-Flow Lubricating Oil Filter Head

1. Lubricating oil supply from lubricating oil pump
2. Oil supply through filter head to oil filters
3. Lubricating oil filter
4. Bypass valve - open position
5. Lubricating oil supply from lubricating oil filter
6. Lubricating oil supply lubricating oil coolers
7. Bypass valve - closed position.

Flow Diagram, Lubricating Oil System

Flow Diagram

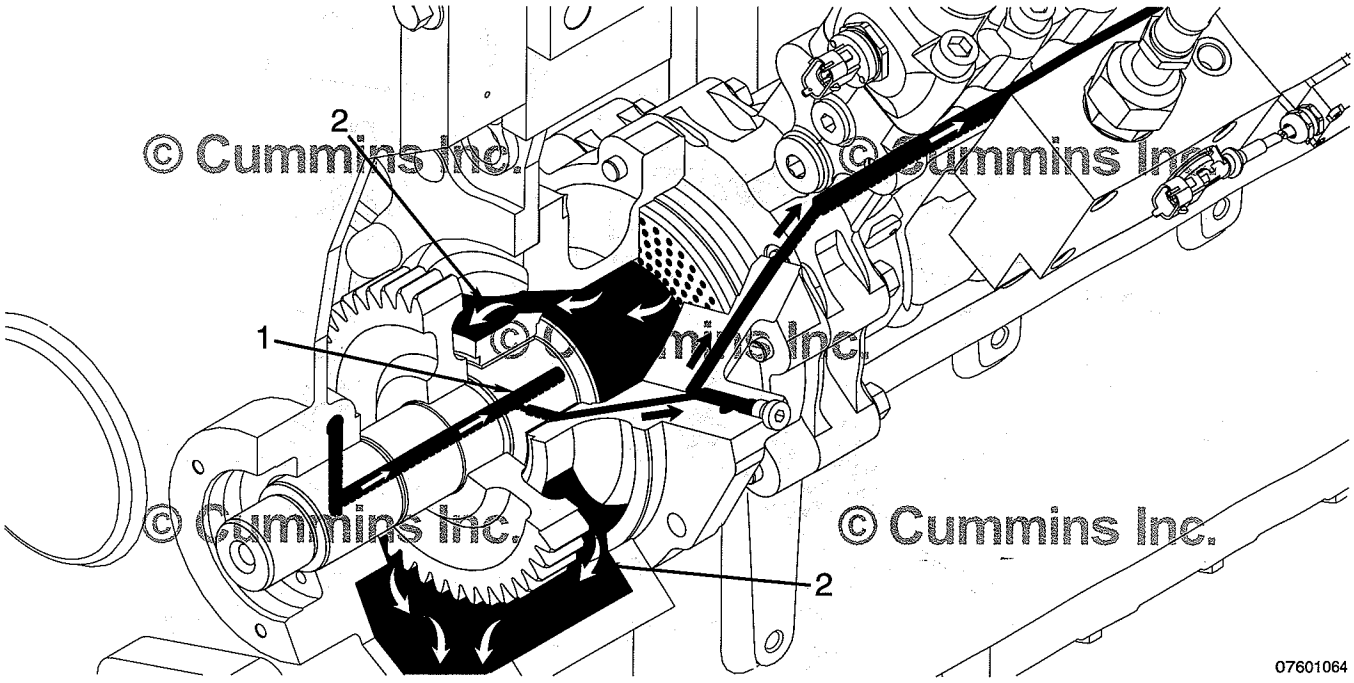


Eliminator Oil Filter

1. Lubricating oil inlet from engine
2. Filtered lubricating oil returned to engine block
3. Back flushed lubricating oil
4. Lubricating oil being filtered by centrifuge
5. Clean lubricating oil returned to sump.

Flow Diagram, Lubricating Oil System

Flow Diagram



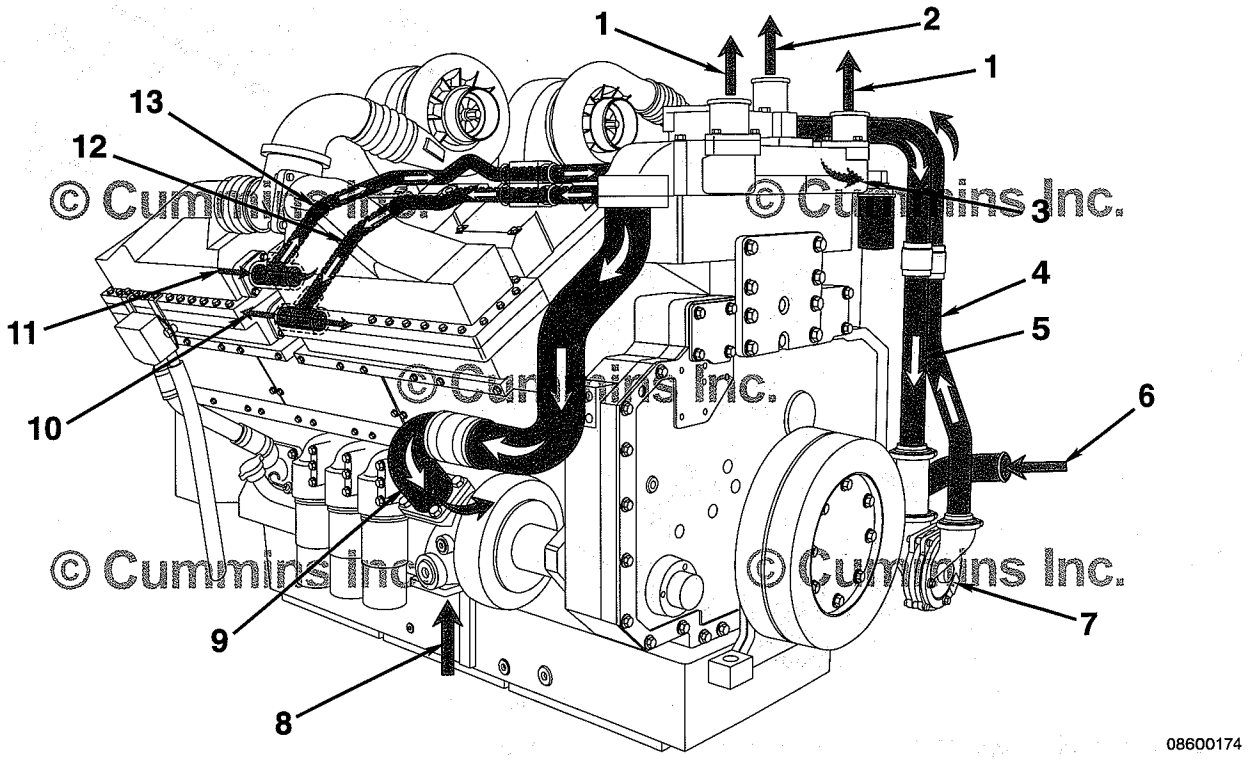
© Cummins Inc.

Fuel Pump Lubrication

1. Lubricating oil supply to accessory drive bushing and fuel pump
2. Lubricating oil return.

Flow Diagram, Cooling System

Flow Diagram

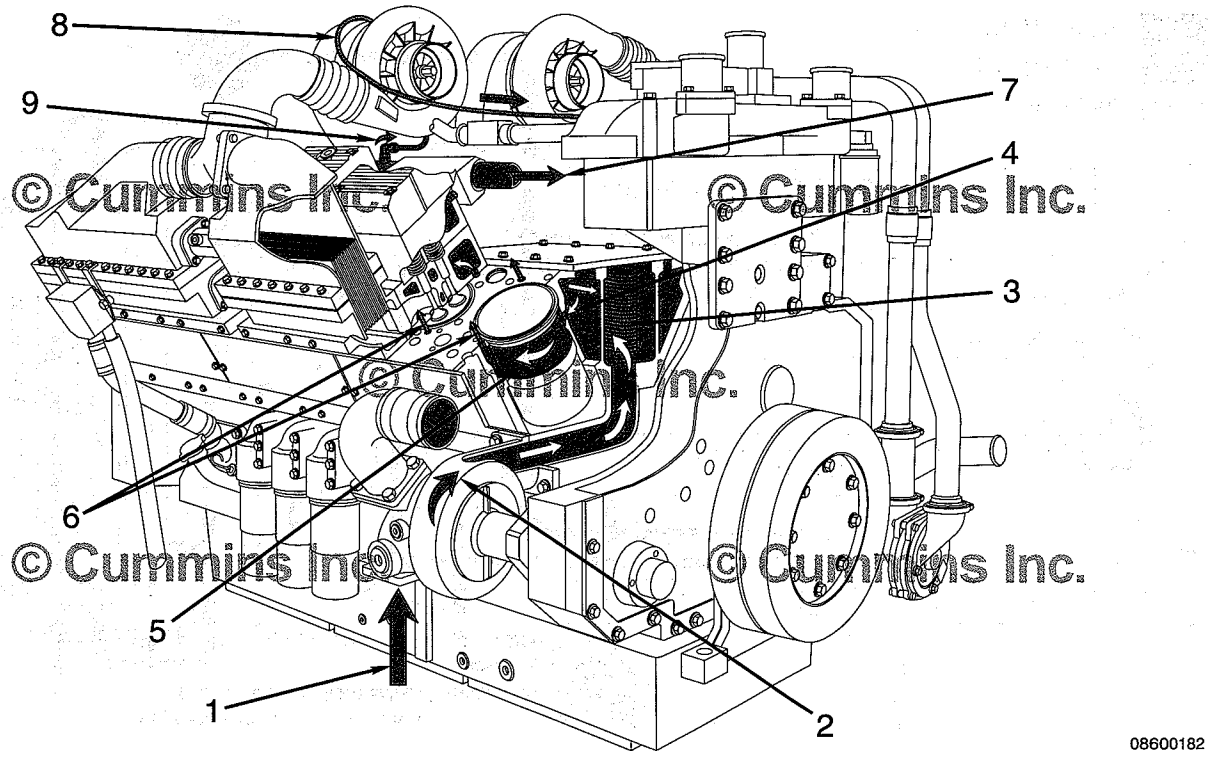


Cooling System (QSK45 engine shown), with Mechanically Actuated Injectors

1. Coolant flow to engine radiator
2. Coolant flow to low temperature aftercooler radiator
3. Coolant flow to coolant filters
4. Coolant flow from low temperature aftercooler pump
5. Coolant bypass to low temperature aftercooler radiator
6. Coolant flow from low temperature aftercooler radiator
7. Low temperature aftercooler water pump
8. Coolant inlet to water pump
9. Coolant bypass return to pump
10. Coolant flow to aftercooler core
11. Coolant flow from aftercooler core
12. Coolant flow to aftercooler from thermostat housing
13. Coolant flow from aftercooler to thermostat housing.

Flow Diagram, Cooling System

Flow Diagram

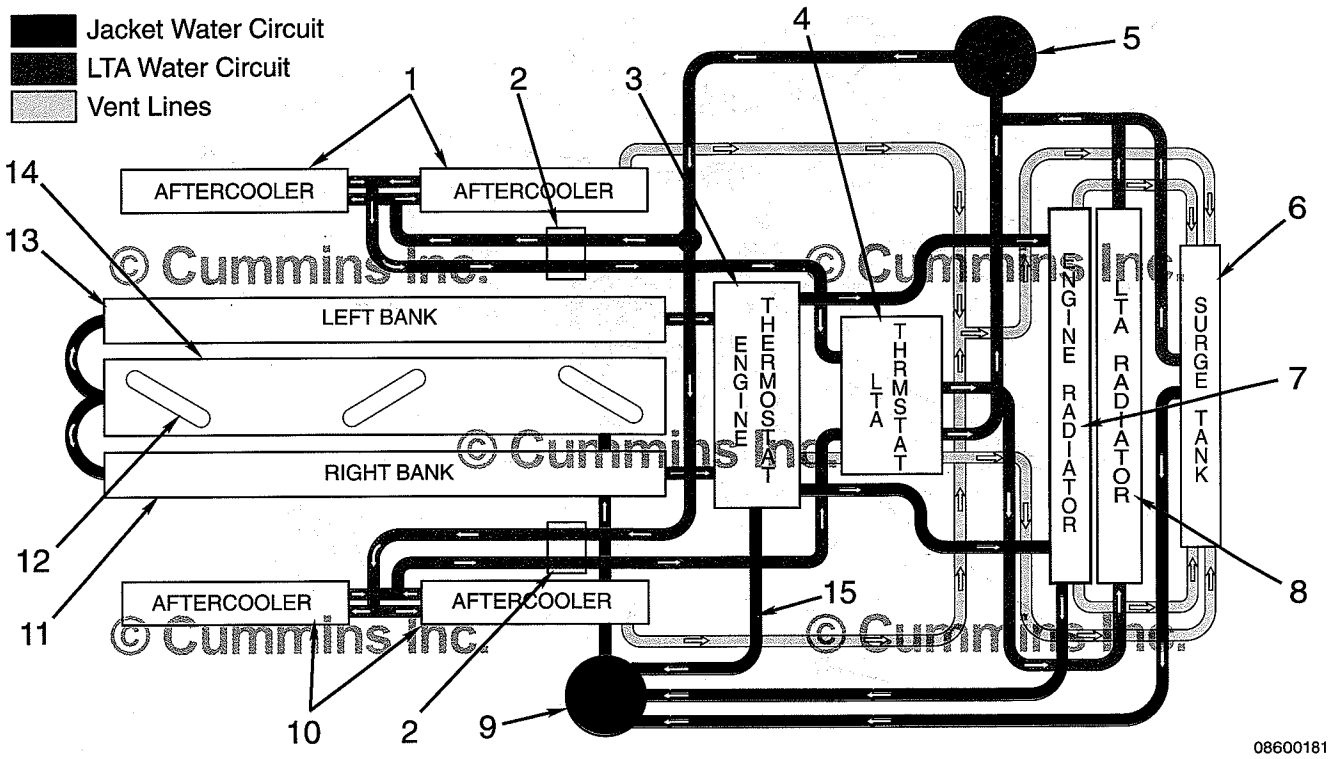


Cooling System (Continued) (QSK45 engine shown), with Mechanically Actuated Injectors

1. Coolant inlet
2. Water pump
3. Coolant flow around oil coolers
4. Coolant flow to cylinder liners
5. Coolant flow around cylinder liners
6. Coolant flow to cylinder head
7. Coolant flow through water manifold to thermostat housing
8. Coolant return from turbocharger
9. Coolant supply to turbocharger.

Flow Diagram, Cooling System

Flow Diagram

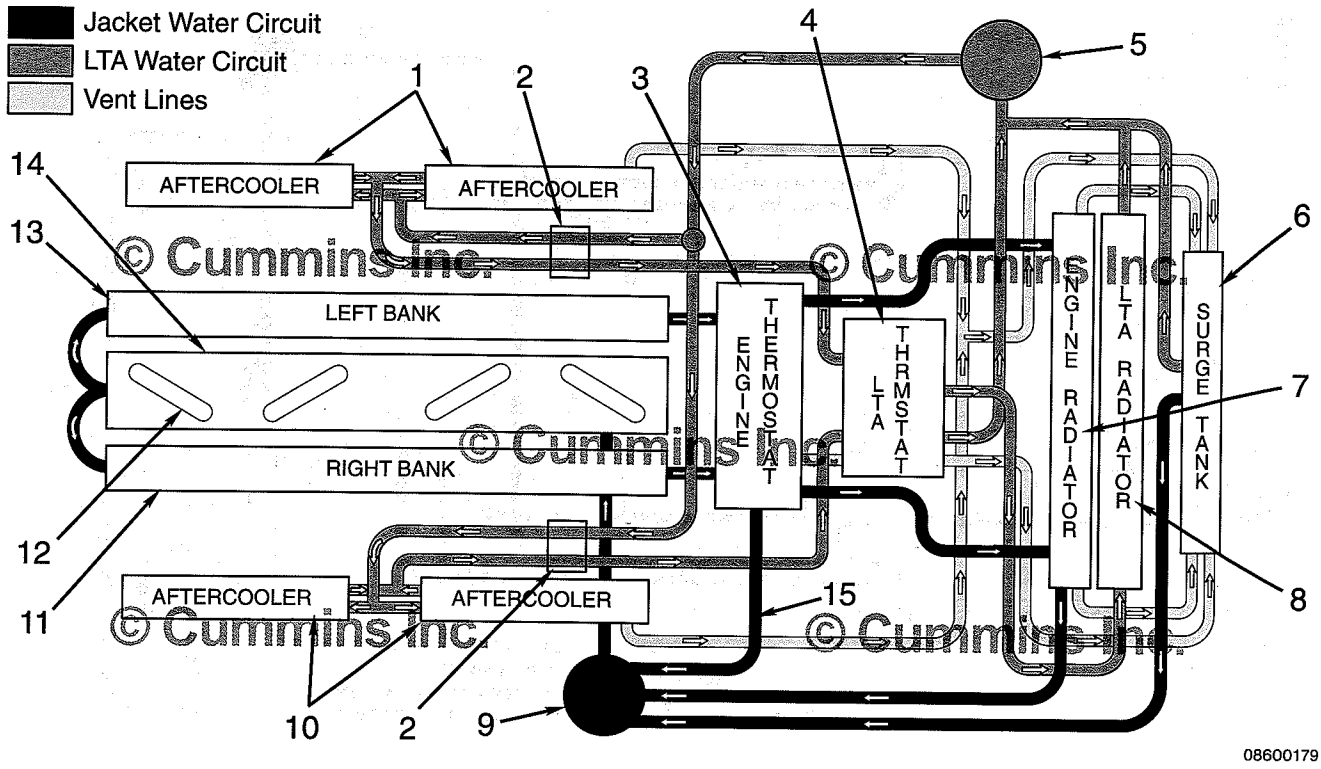


QSK45 Cooling System Schematic

1. Left-rear and left-front aftercoolers
2. Water connection
3. Engine thermostat housing
4. Low temperature aftercooler thermostat housing
5. Low temperature aftercooler water pump
6. Surge/fill tank
7. Engine radiator
8. Low temperature aftercooler radiator
9. Engine water pump
10. Right-rear and right-front aftercoolers
11. Right-bank liners and heads
12. Oil coolers
13. Left-bank liners and heads
14. Engine vee-cavity
15. Bypass tube.

Flow Diagram, Cooling System

Flow Diagram

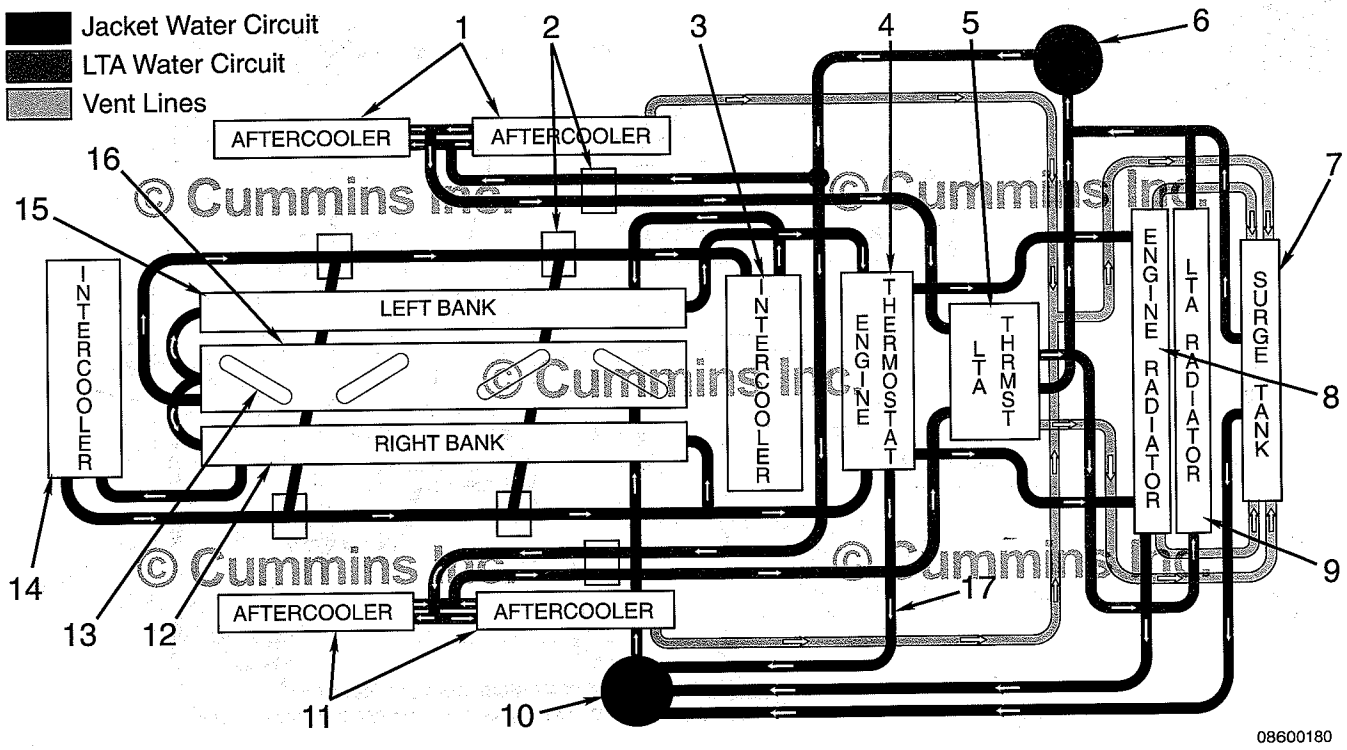


QSK60 Cooling System Schematic - Single-Stage Turbocharged, Aftercooled

1. Left-rear and left-front aftercoolers
2. Water connection
3. Engine thermostat housing
4. Low temperature aftercooler thermostat housing
5. Low temperature aftercooler water pump
6. Surge/fill tank
7. Engine radiator
8. Low temperature aftercooler radiator
9. Engine water pump
10. Right-rear and right-front aftercoolers
11. Right-bank liners and heads
12. Oil coolers
13. Left-bank liners and heads
14. Engine vee-cavity
15. Bypass tube.

Flow Diagram, Cooling System

Flow Diagram

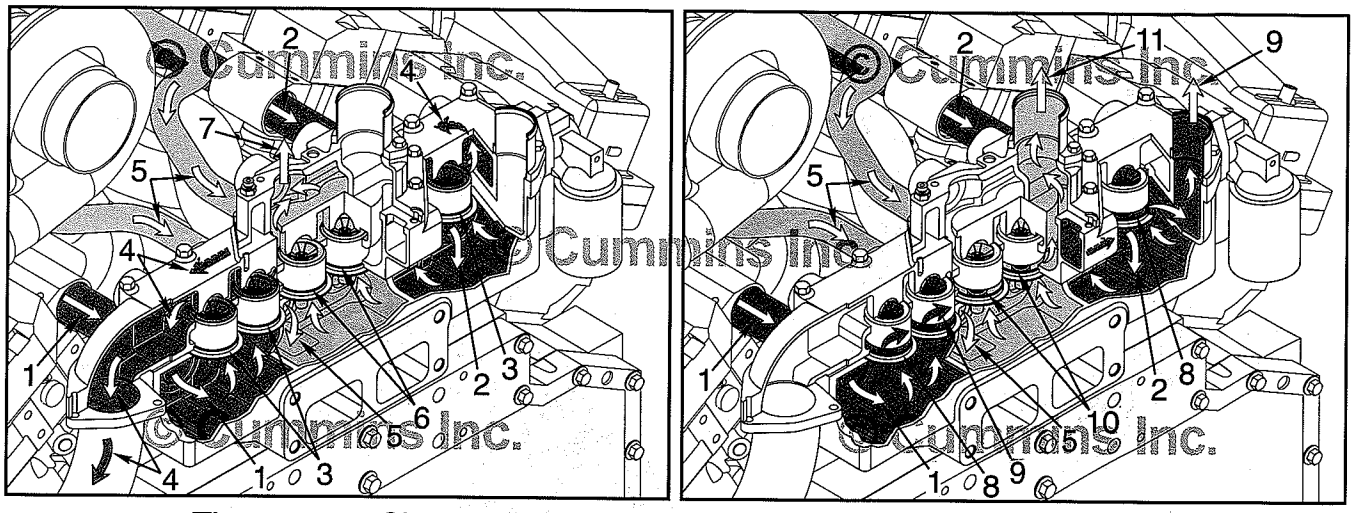


QSK60 Cooling System Schematic - Two-Stage Turbocharged, Aftercooled

1. Left-rear and left-front aftercoolers
2. Water connection
3. Front intercooler
4. Engine thermostat housing
5. Low temperature aftercooler thermostat housing
6. Low temperature aftercooler water pump
7. Surge/fill tank
8. Engine radiator
9. Low temperature aftercooler radiator
10. Engine water pump
11. Right-rear and right-front aftercoolers
12. Right bank liners and heads
13. Oil coolers
14. Rear intercoolers
15. Left-bank liners and heads
16. Engine vee-cavity
17. Bypass tube.

Flow Diagram, Cooling System

Flow Diagram



Thermostats Closed

Thermostats Open

08e00102

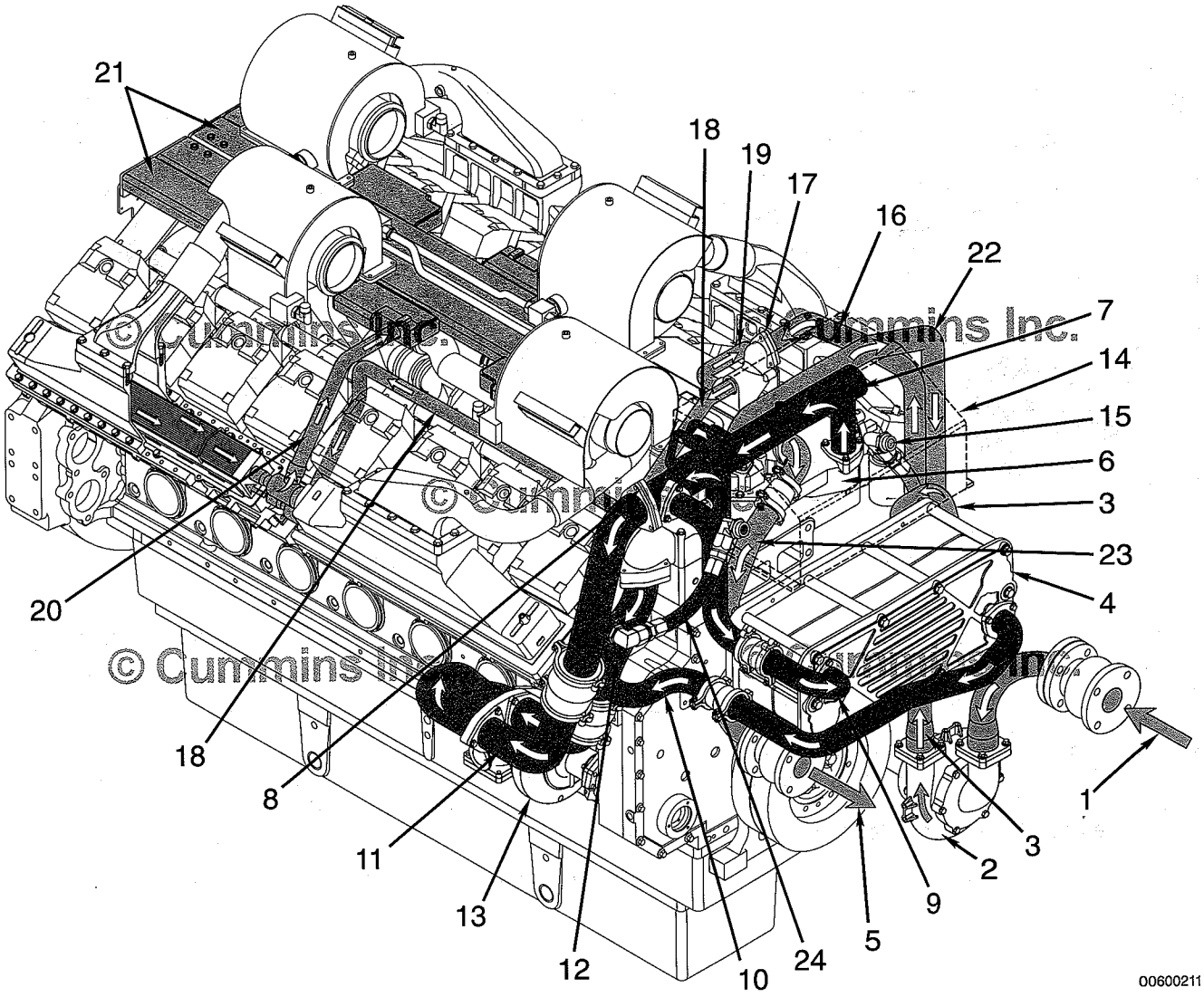
Thermostat Housing Flow - Low temperature aftercooler (two pump/two loop), with Mechanically Actuated Injectors

1. Right-bank engine coolant to thermostat housing
2. Left-bank engine coolant to thermostat housing
3. Engine thermostats (closed)
4. Engine coolant bypass to engine water pump
5. Low temperature aftercooler coolant supply to thermostat housing
6. Low temperature aftercooler thermostats (closed)
7. Low temperature aftercooler coolant bypass to low temperature aftercooler water pump
8. Engine thermostats (open)
9. Engine coolant to engine radiator
10. Low temperature aftercooler thermostats (open)
11. Low temperature aftercooler coolant return to low temperature aftercooler radiator.

NOTE: If the thermostats are partially open, coolant is flowing through both the radiator and the bypass.

Flow Diagram, Cooling System

Flow Diagram

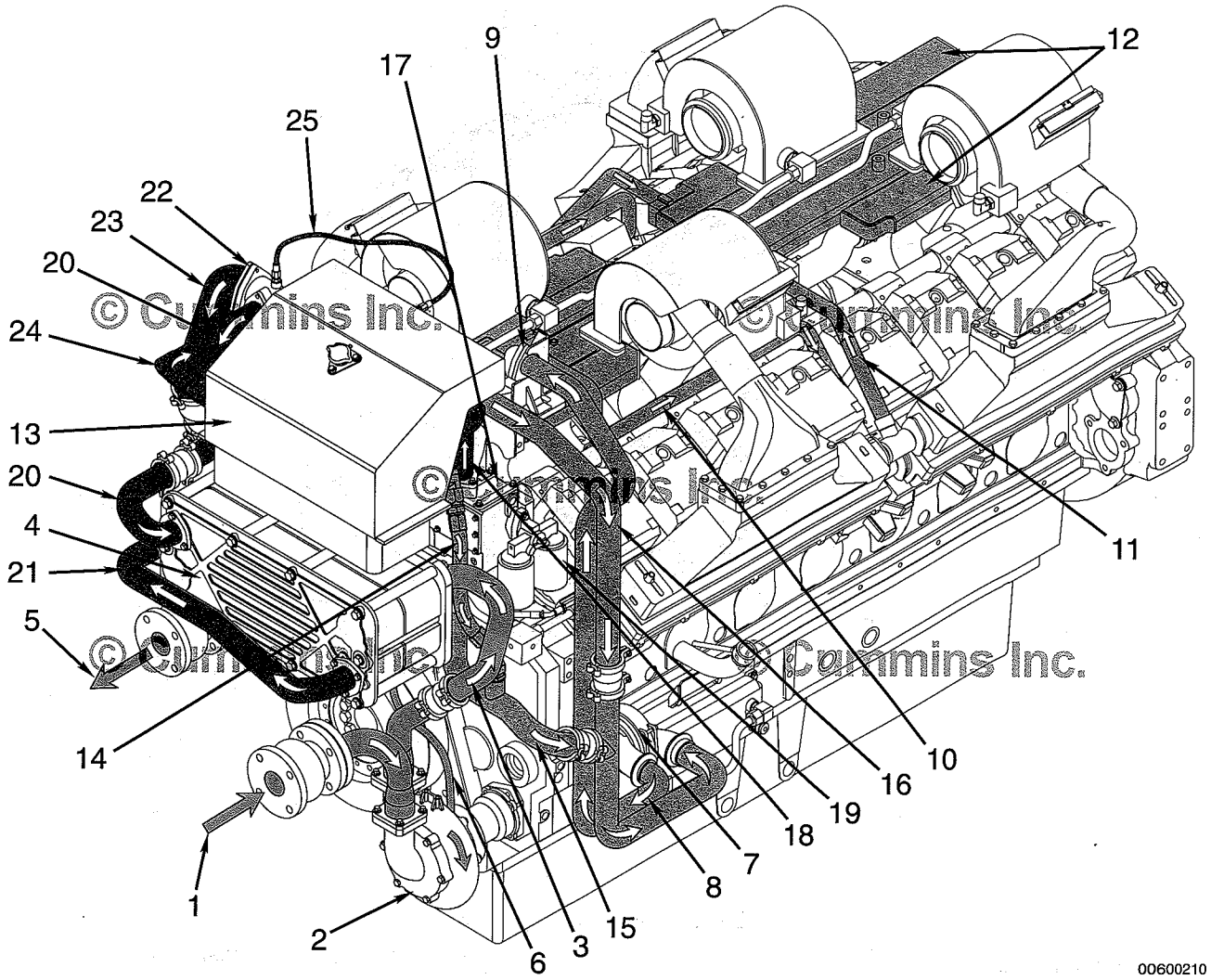


QSK60 with Heat Exchanger - Marine

1. Seawater inlet
2. Seawater pump
3. Seawater pump outlet
4. Heat exchanger
5. Seawater outlet from heat exchanger
6. Thermostat housing
7. Engine coolant outlet manifold
8. Engine coolant bypass orifice plate
9. Engine coolant supply to heat exchanger
10. Heat exchanger engine coolant return to engine water pump
11. Engine coolant heat exchanger bypass to engine water pump
12. Engine coolant thermostat bypass to engine water pump
13. Engine water pump
14. Expansion tank
15. Low temperature aftercooler coolant make-up from expansion tank
16. Low temperature aftercooler water pump outlet
17. "J" block
18. Low temperature aftercooler coolant supply to right-bank aftercoolers
19. Low temperature aftercooler coolant supply to left-bank aftercoolers.
20. Low temperature aftercooler coolant supply to right-bank exhaust manifold heat shields
21. Exhaust manifold heat shields
22. Low temperature aftercooler thermostat bypass to low temperature aftercooler water pump
23. Low temperature aftercooler coolant supply to heat exchanger
24. Engine coolant make-up from expansion tank

Flow Diagram, Cooling System

Flow Diagram

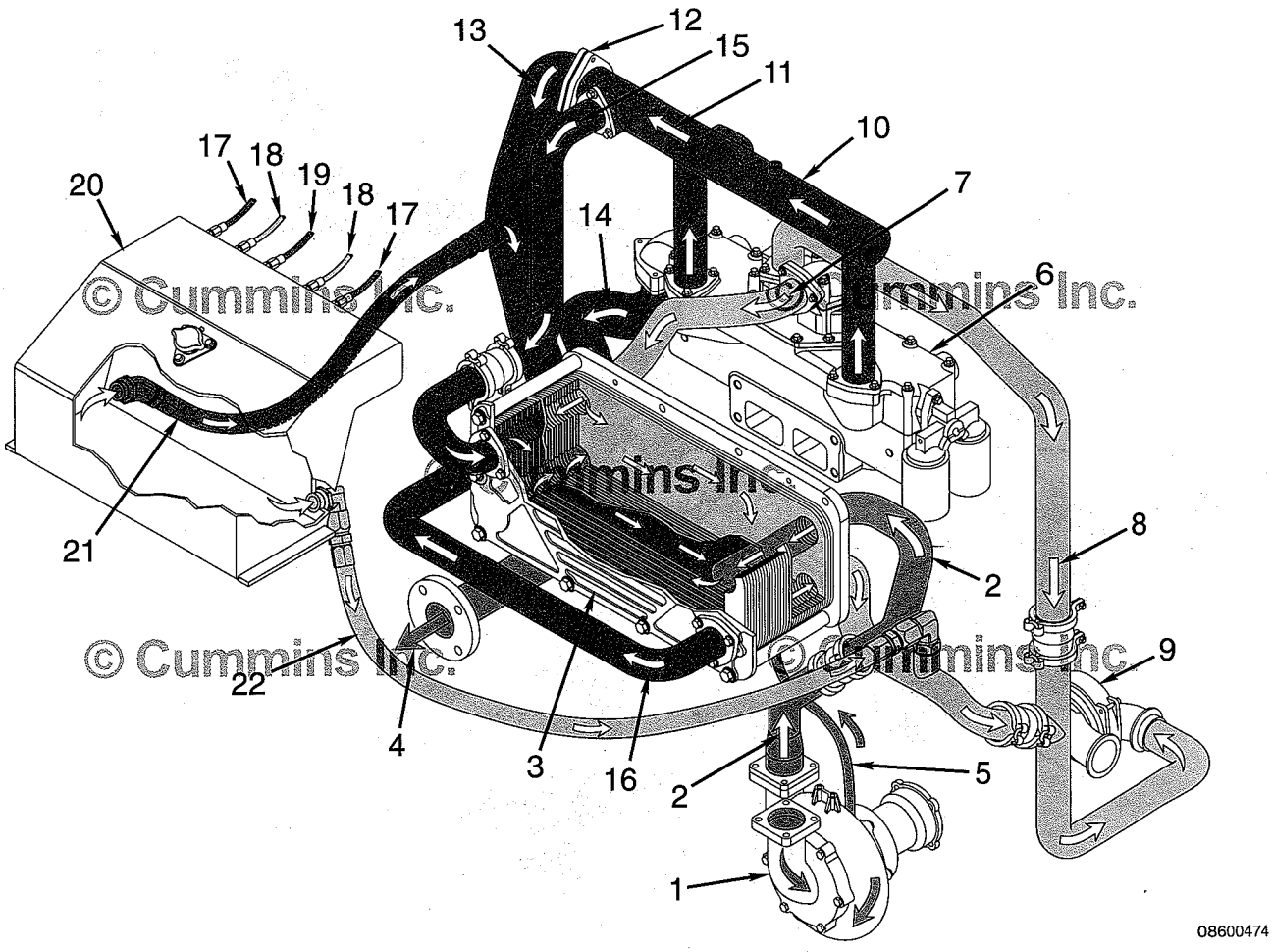


QSK60 with Heat Exchanger - Marine

1. Seawater inlet
2. Seawater pump
3. Seawater pump outlet to heat exchanger
4. Heat exchanger
5. Seawater outlet from heat exchanger
6. Seawater pump priming impeller discharge line
7. Low temperature aftercooler water pump
8. Low temperature aftercooler water pump outlet
9. "J" block
10. Low temperature aftercooler coolant supply to left-bank aftercoolers
11. Low temperature aftercooler coolant supply to left-bank exhaust manifold heat shields
12. Exhaust manifold heat shields
13. Expansion tank
14. Low temperature aftercooler coolant make-up from expansion tank
15. Heat exchanger low temperature aftercooler coolant outlet to low temperature aftercooler water pump
16. Low temperature aftercooler thermostat bypass to low temperature aftercooler water pump
17. Thermostat housing
18. Engine coolant outlet manifold
19. Engine coolant filters
20. Engine coolant supply to heat exchanger
21. Engine coolant return to engine water pump
22. Engine coolant bypass orifice plate
23. Engine coolant heat exchanger bypass to engine water pump
24. Engine coolant make-up from expansion tank
25. Engine coolant manifold vent line.

Flow Diagram, Cooling System

Flow Diagram

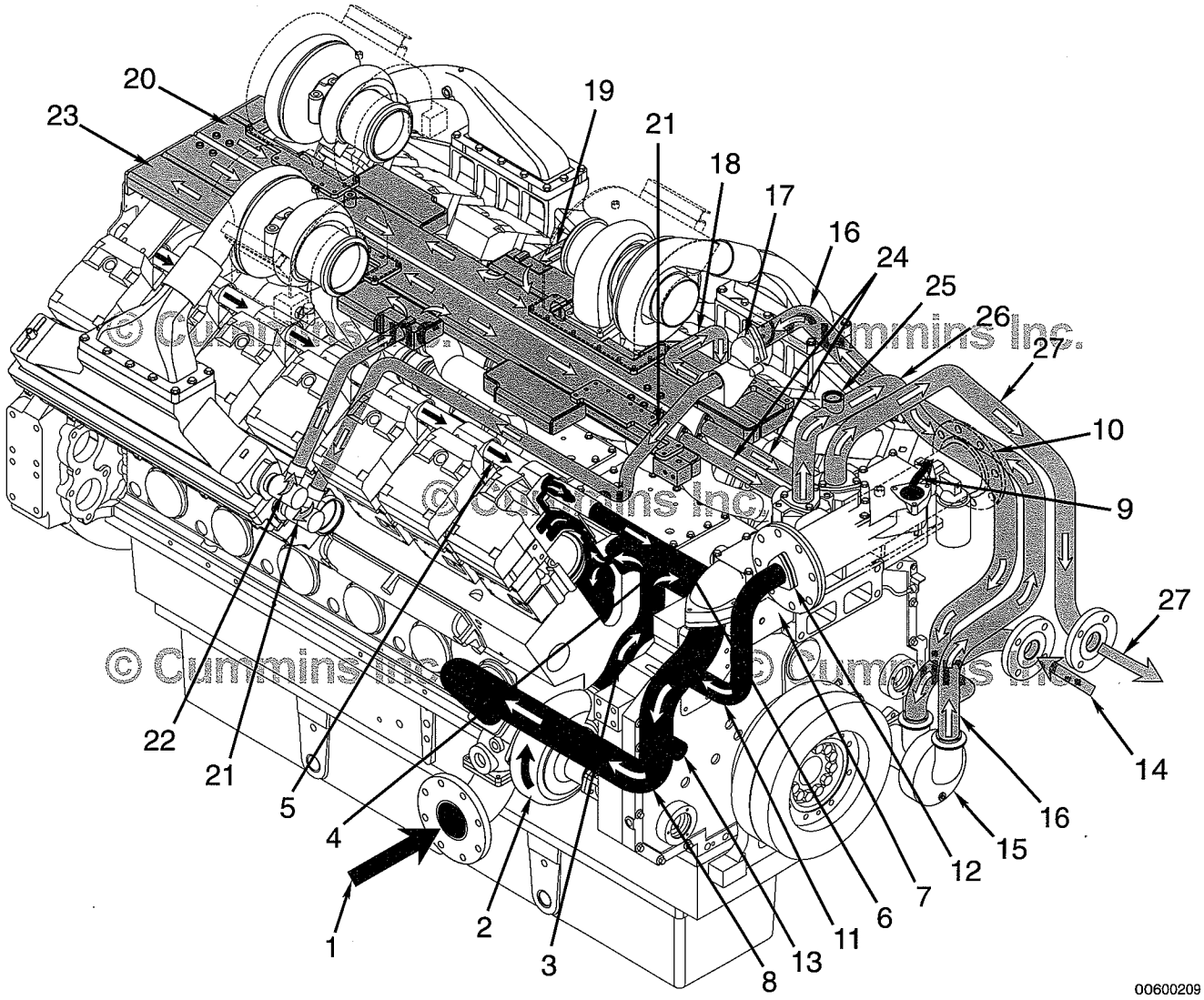


QSK60 Heat Exchanger - Marine

1. Seawater pump
2. Seawater pump outlet to heat exchanger
3. Heat exchanger
4. Seawater outlet from heat exchanger
5. Seawater pump priming impeller discharge line
6. Thermostat housing
7. Low temperature aftercooler coolant supply to heat exchanger
8. Low temperature aftercooler bypass to low temperature aftercooler water pump
9. Low temperature aftercooler water pump
10. Engine coolant outlet manifold
11. Engine coolant outlet from thermostat housing
12. Engine coolant bypass orifice plate
13. Engine coolant heat exchanger bypass to engine water pump
14. Engine coolant thermostat bypass to engine water pump
15. Engine coolant supply to heat exchanger
16. Heat exchanger engine coolant return to engine water pump
17. Turbocharger heat shield vent line
18. Exhaust manifold heat shield vent line
19. Engine coolant manifold vent line
20. Expansion tank
21. Engine coolant make-up from expansion tank
22. Low temperature aftercooler coolant make-up from expansion tank.

Flow Diagram, Cooling System

Flow Diagram



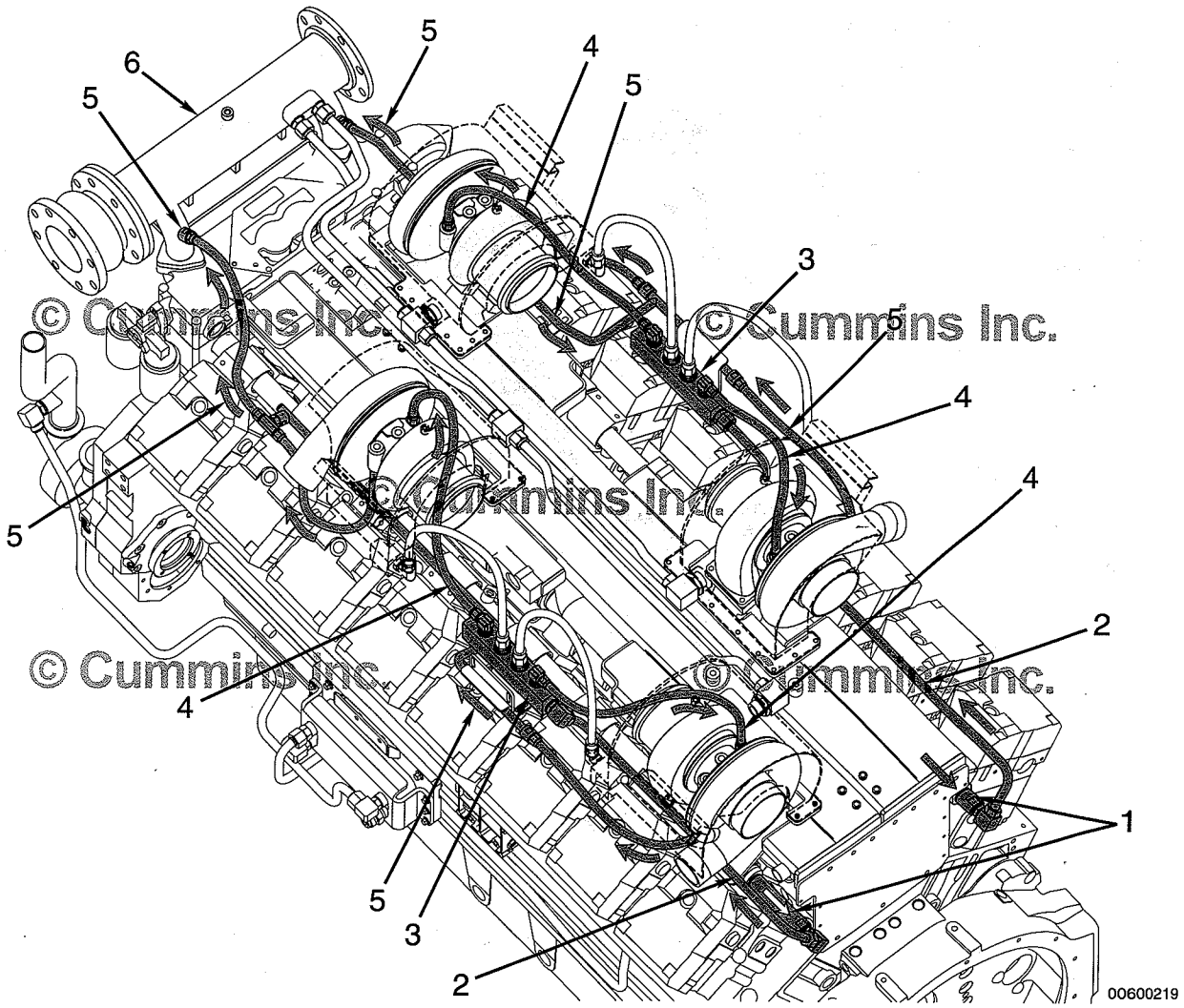
QSK60 Keeled Cooled - Marine

1. Engine coolant inlet from main engine cooler
2. Engine water pump
3. Engine coolant supply to block
4. Lubricating oil cooler
5. Engine coolant manifold
6. Engine coolant to thermostat housing
7. Thermostat housing
8. Engine coolant thermostat bypass to engine water pump
9. Engine coolant to engine coolant outlet manifold
10. Engine coolant outlet to main engine cooler
11. Main engine cooler bypass to engine water pump
12. Engine coolant bypass orifice plate
13. Engine coolant make-up from expansion tank
14. Low temperature aftercooler coolant inlet from Low temperature aftercooler cooler
15. Low temperature aftercooler water pump
16. Low temperature aftercooler water pump outlet to “J” block
17. “J” block
18. Low temperature aftercooler coolant from “J” block to left-bank aftercoolers
19. Low temperature aftercooler coolant from left-bank aftercoolers to left-bank exhaust manifold heat shields
20. Left-bank exhaust manifold heat shields
21. Low temperature aftercooler coolant from “J” block to right-bank aftercoolers
22. Low temperature aftercooler coolant from right-bank aftercoolers to right-bank exhaust manifold heat shields
23. Right-bank exhaust manifold heat shield
24. Low temperature aftercooler coolant from exhaust manifold heat shields to thermostat housing
25. Low temperature aftercooler coolant make-up from expansion tank

26. Low temperature aftercooler coolant thermostat bypass to low temperature aftercooler water pump
27. Low temperature aftercooler coolant outlet to low temperature aftercooler cooler.

Flow Diagram, Cooling System

Flow Diagram



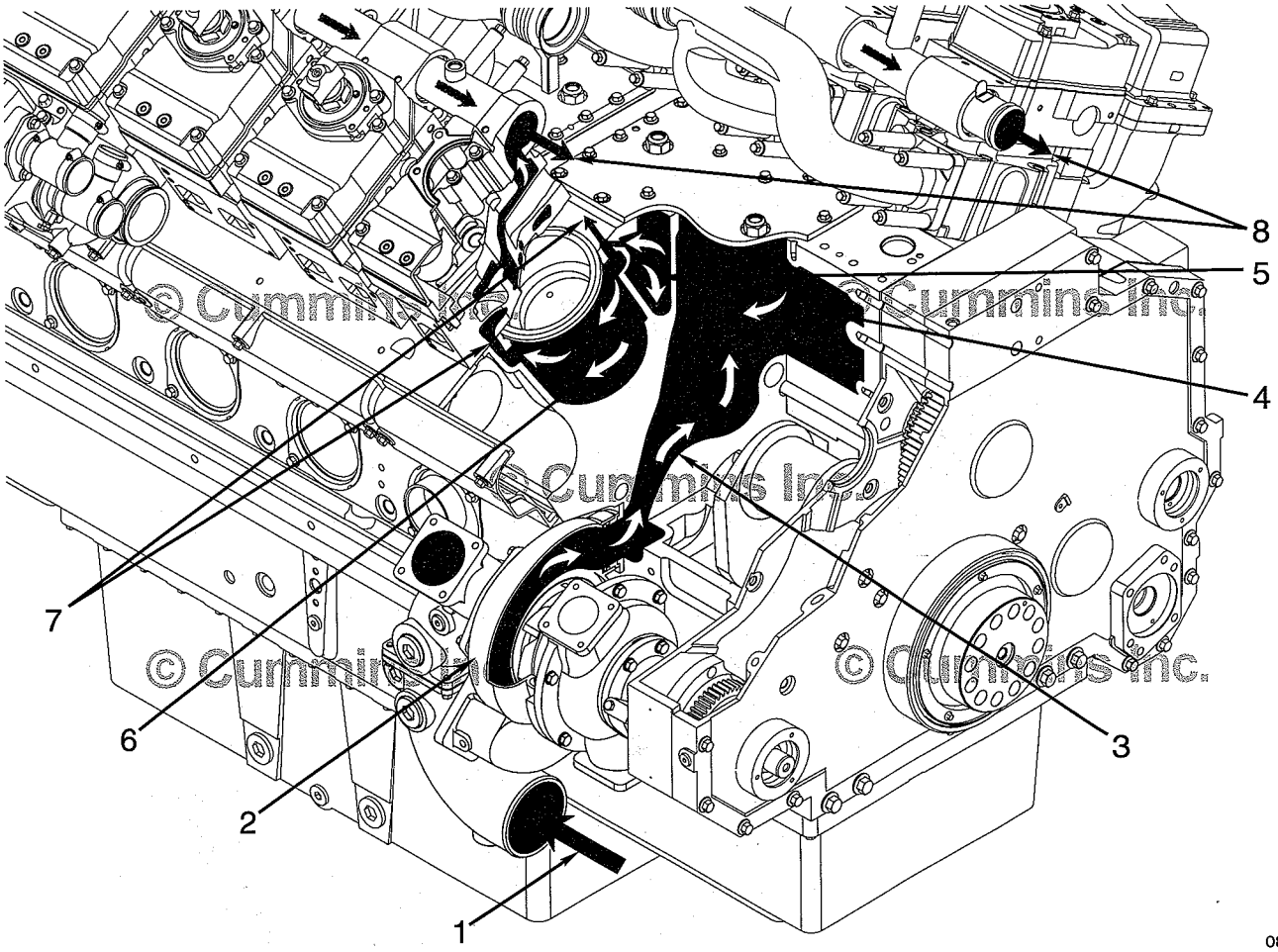
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QSK60 Turbocharger Bearing Housing Cooling - Marine

1. Engine coolant from engine coolant manifold
2. Engine coolant to engine coolant distribution block
3. Engine coolant distribution block
4. Engine coolant supply to turbocharger bearing housing
5. Engine coolant return from turbocharger bearing housing
6. Engine coolant outlet manifold.

Flow Diagram, Cooling System

Flow Diagram

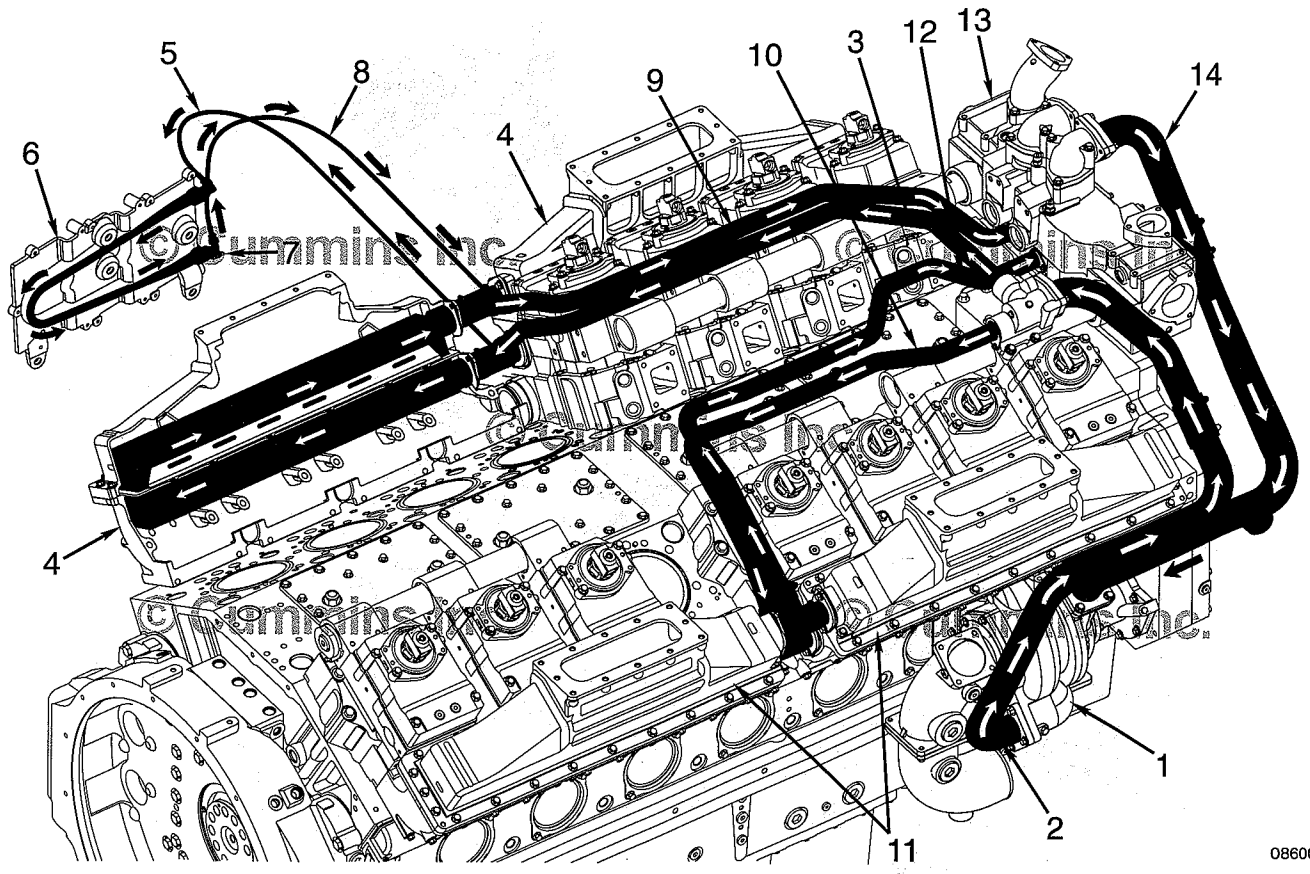


QSK60 Jacket Water Coolant Flow - with Electronically Actuated Injectors

1. Coolant inlet
2. Water pump
3. Coolant flow to oil cooler cavity
4. Coolant around oil coolers
5. Water jacket coolant
6. Coolant flow around cylinder liner
7. Coolant flow around cylinder head
8. Coolant flow to thermostat housing.

Flow Diagram, Cooling System

Flow Diagram

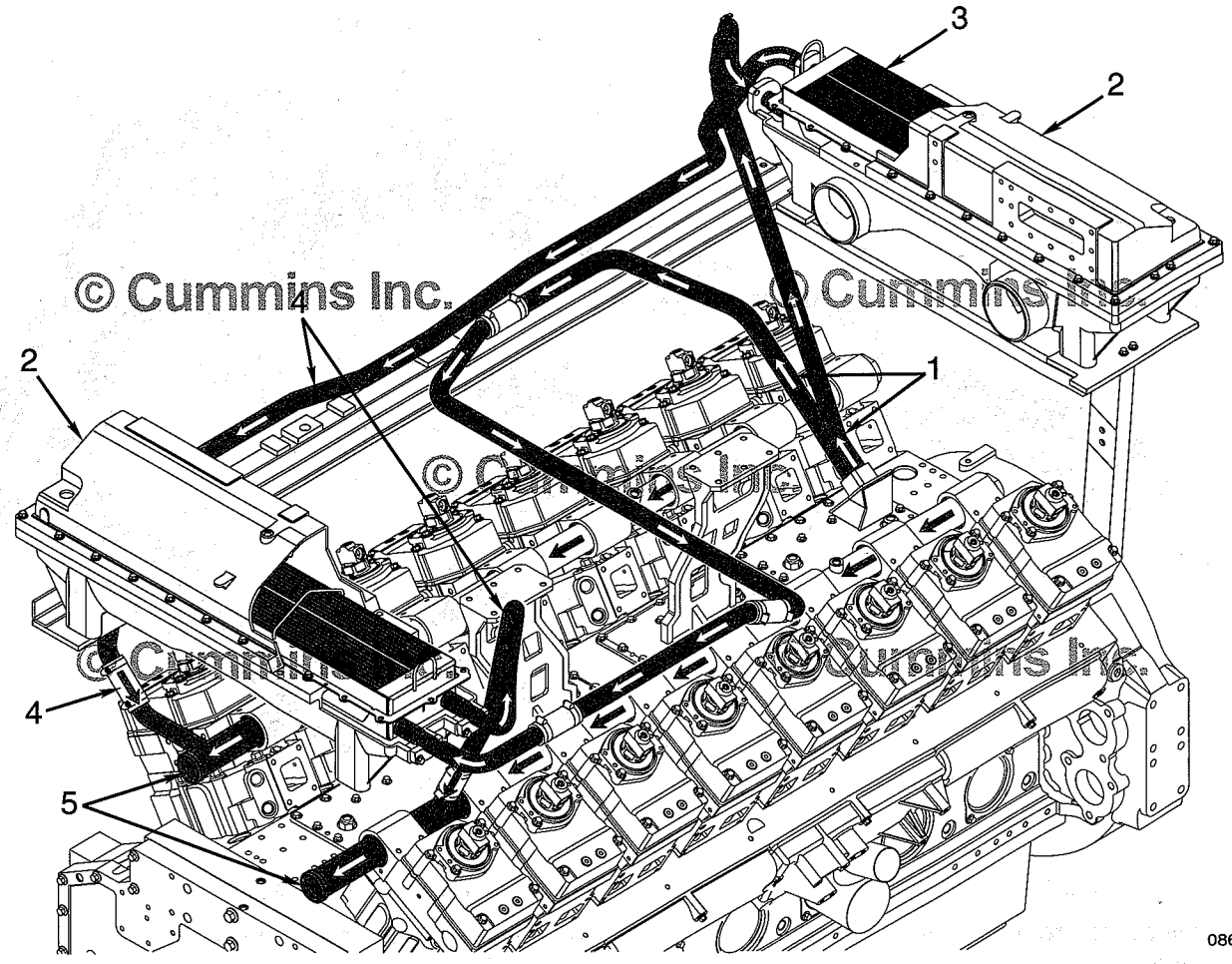


QSK60 Low Temperature Aftercooler Flow - with Electronically Actuated Injectors

1. Low temperature aftercooler coolant pump
2. Coolant supply
3. Left bank aftercooler coolant supply
4. Left bank aftercooler
5. Coolant supply to electronic control module (ECM) coolant plate
6. Electronic control module (ECM) coolant plate
7. Coolant drain valve
8. Electronic control module (ECM) coolant plate coolant return
9. Left bank aftercooler coolant return
10. Right bank aftercooler coolant supply
11. Right bank aftercooler
12. Right bank aftercooler coolant return
13. Thermostat housing
14. Low temperature aftercooler coolant bypass.

Flow Diagram, Cooling System

Flow Diagram

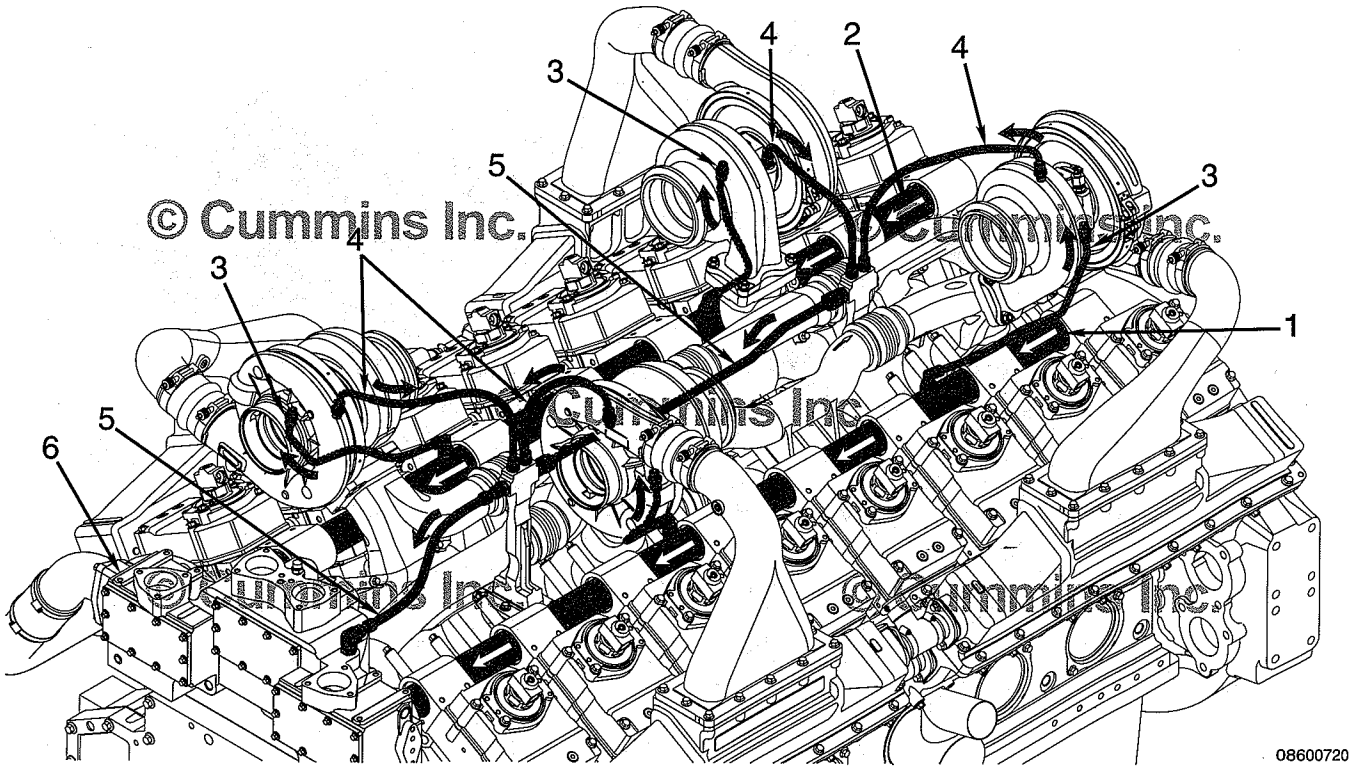


QSK60 Intercooler Coolant Flow - with Electronically Actuated Injectors

1. Coolant supply from oil coolers
2. Intercooler
3. Intercooler core
4. Coolant return to water manifold
5. Coolant return to thermostat housing.

Flow Diagram, Cooling System

Flow Diagram



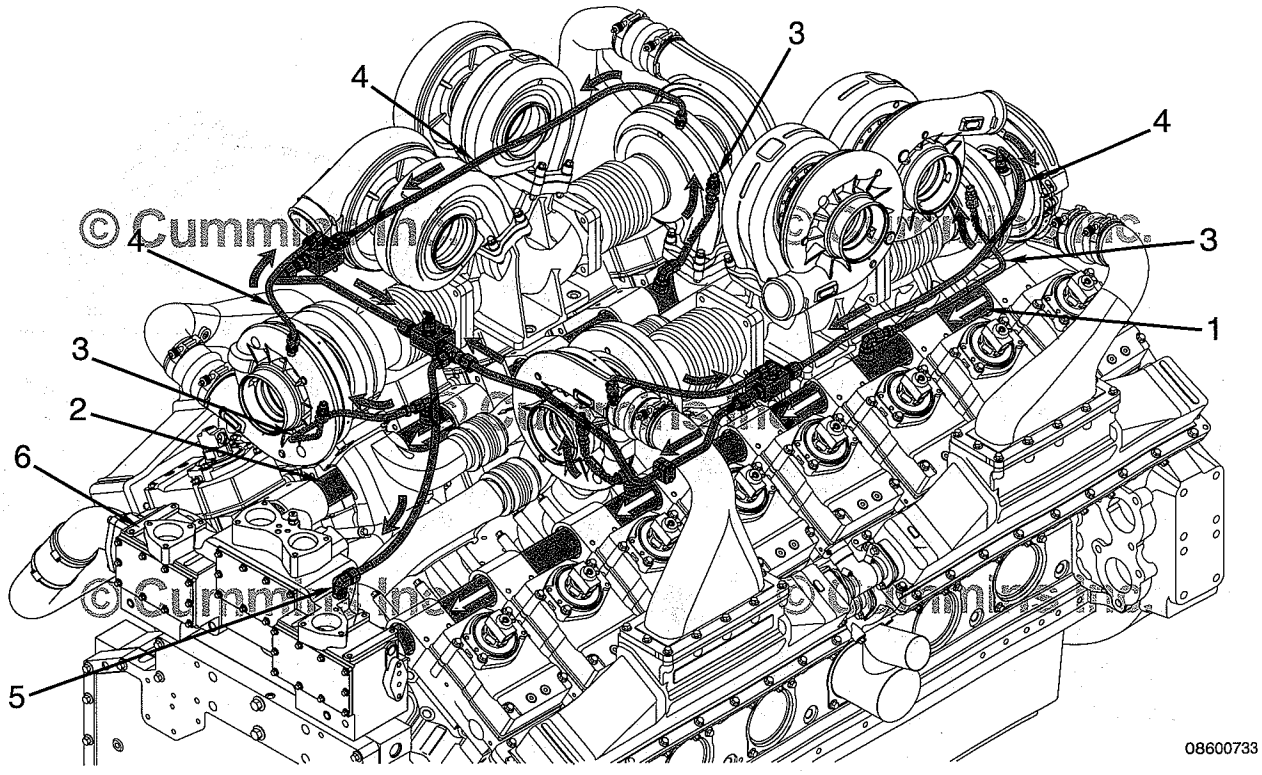
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QSK60 Single-Stage Turbocharger Coolant Flow - with Electronically Actuated Injectors

1. Left bank water manifold
2. Right bank water manifold
3. Turbocharger coolant supply
4. Turbocharger coolant return
5. Turbocharger coolant return to thermostat housing
6. Thermostat housing.

Flow Diagram, Cooling System

Flow Diagram

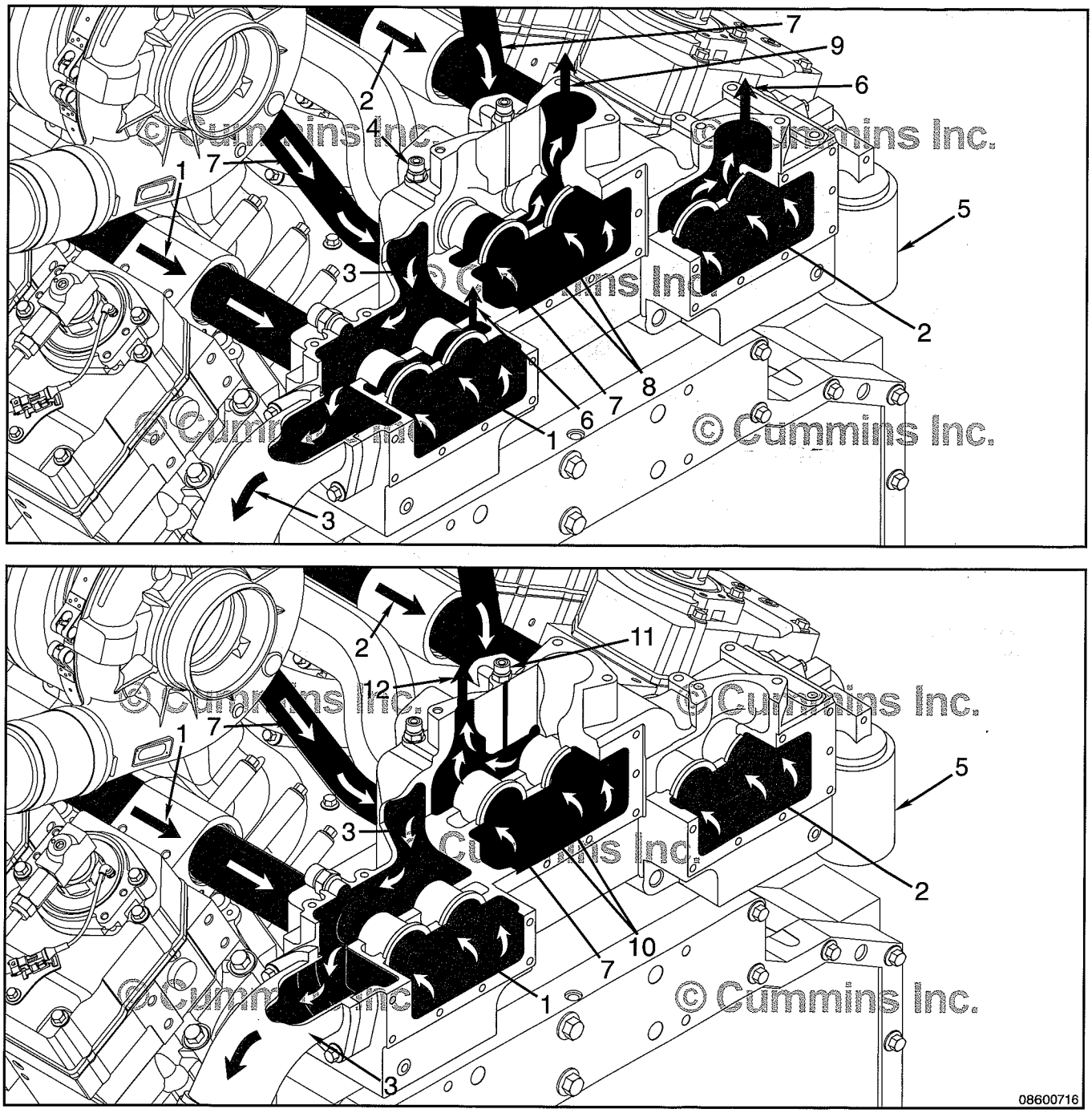


QSK60 Two-Stage Turbocharger Coolant Flow - with Electronically Actuated Injectors

1. Left bank water manifold
2. Right bank water manifold
3. Turbocharger coolant supply
4. Turbocharger coolant return
5. Turbocharger coolant return to thermostat housing
6. Thermostat housing.

Flow Diagram, Cooling System

Flow Diagram



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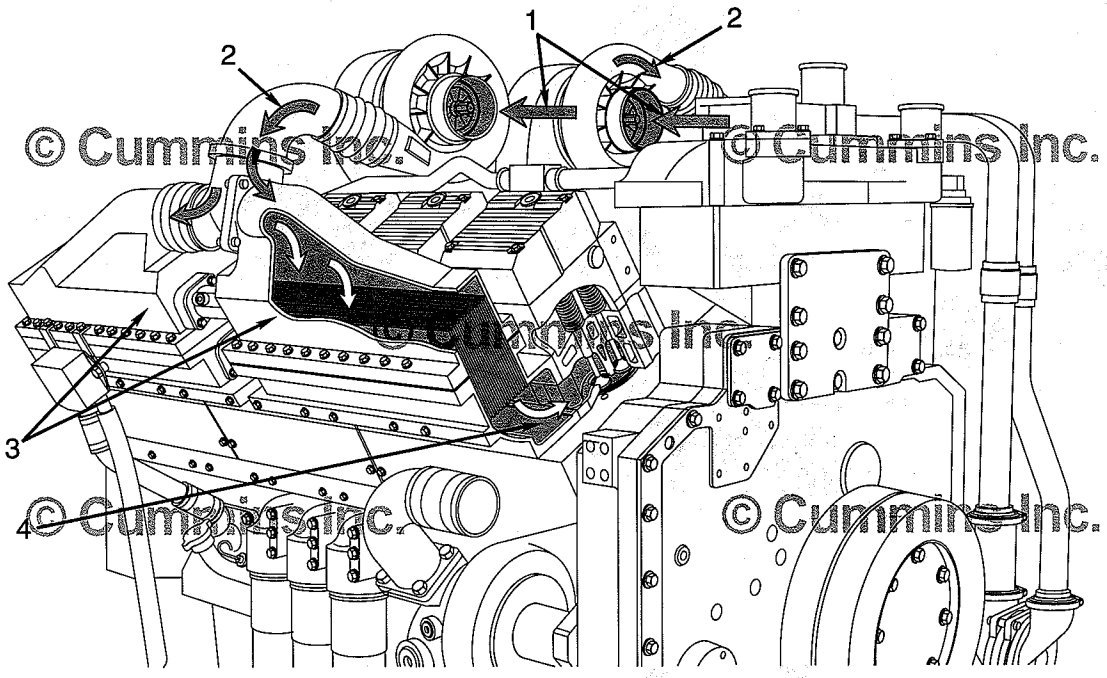
QSK60 Thermostat Housing Coolant Flow (top view open, bottom view closed) - with Electronically Actuated Injectors

1. Right bank coolant to thermostat housing
2. Left bank coolant to thermostat housing
3. Coolant bypass to water jacket pump
4. Coolant vent port
5. Coolant filters
6. Coolant return to radiators
7. Low temperature aftercooler coolant from aftercooler
8. Low temperature aftercooler thermostats open
9. Low temperature aftercooler coolant supply to low temperature aftercooler radiator
10. Low temperature aftercooler thermostats closed
11. Low temperature aftercooler vent
12. Low temperature aftercooler coolant bypass to low temperature aftercooler pump.

Flow Diagram, Air Intake System

Flow Diagram

with Mechanically Actuated Injector



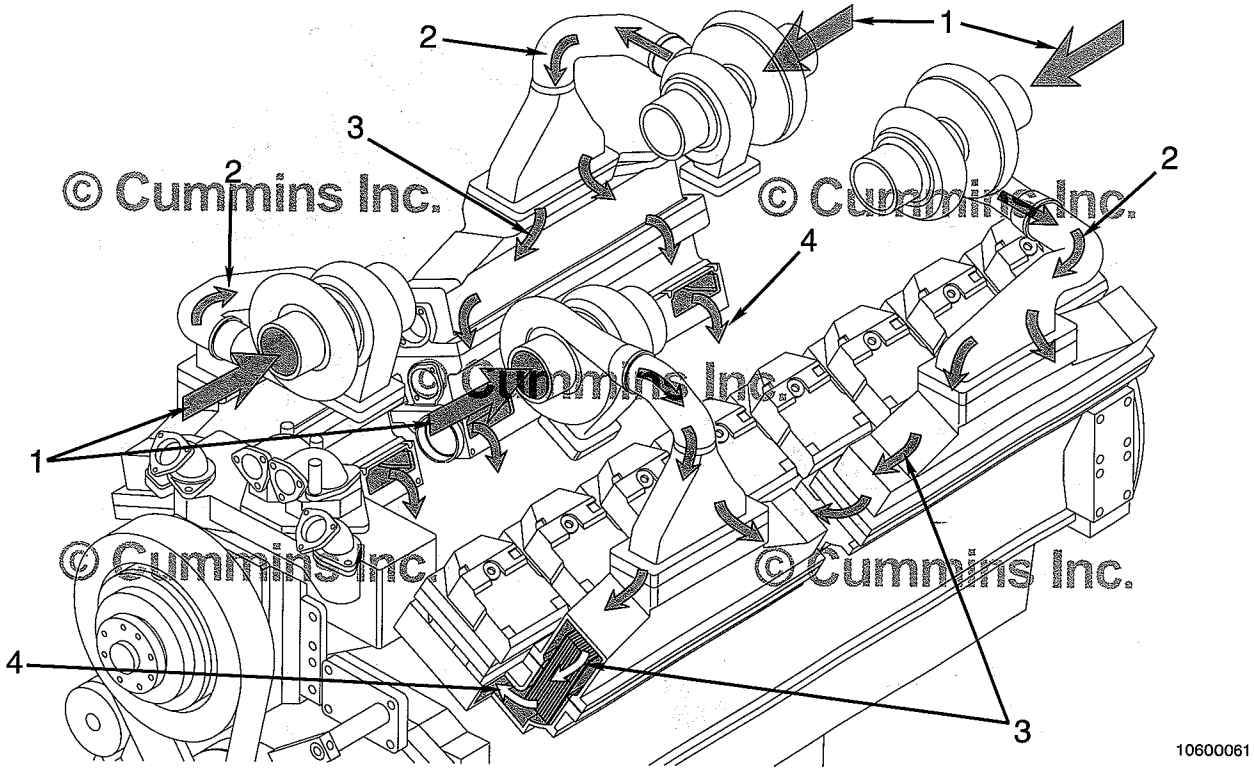
QSK45 Intake System - Single Stage

1. Intake air inlet to turbocharger
2. Turbocharged air to aftercooler
3. Aftercooler assemblies
4. Aftercooled air to intake ports.

Flow Diagram, Air Intake System

Flow Diagram

with Mechanically Actuated Injector



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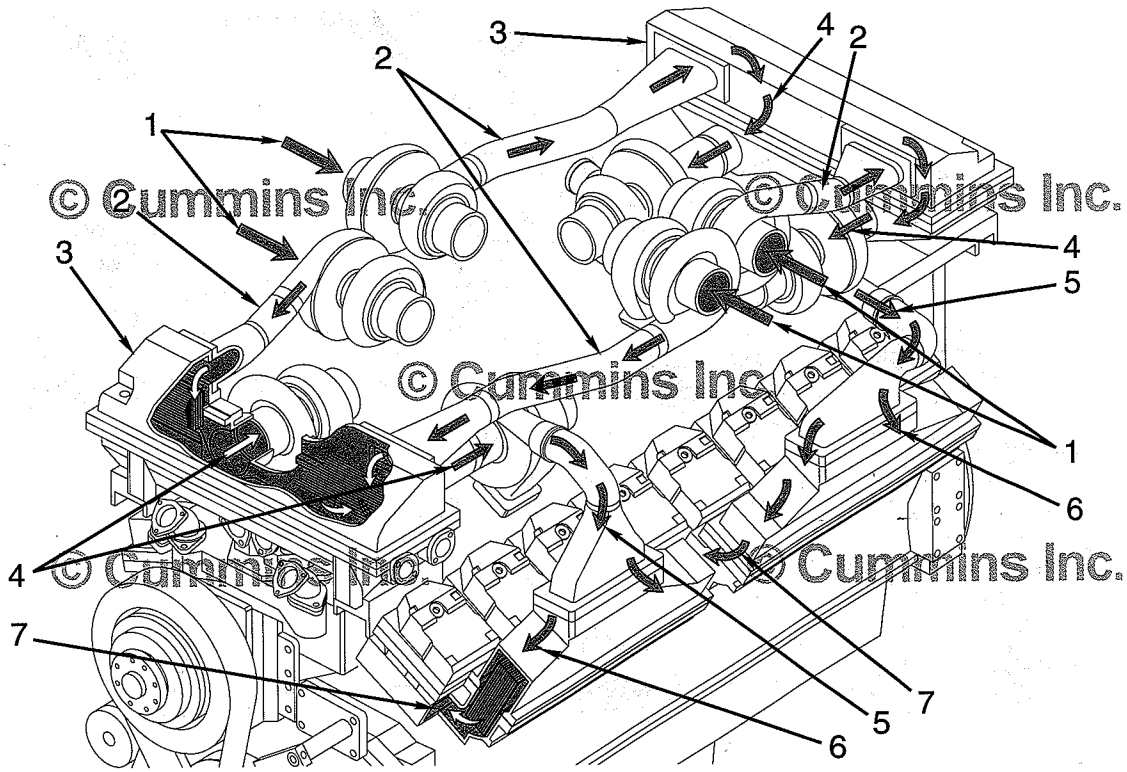
QSK60 Intake System- Single Stage

1. Intake air inlet to turbochargers
2. Turbocharged air to aftercooler
3. Turbocharged air travels through aftercoolers
4. Aftercooled air to intake ports.

Flow Diagram, Air Intake System

Flow Diagram

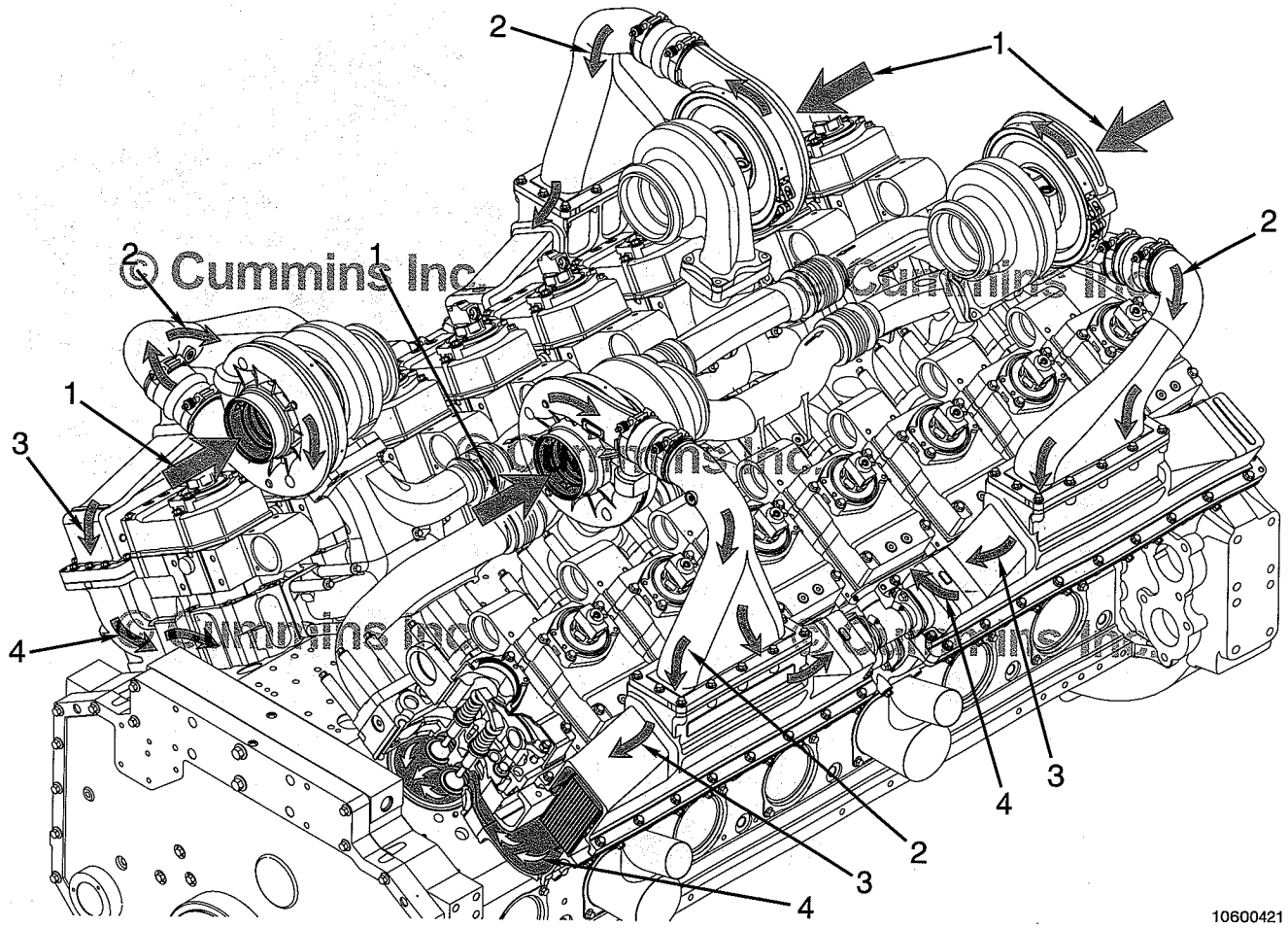
with Mechanically Actuated Injector



QSK60 Intake System- Two Stage

1. Intake air inlet to low-pressure turbochargers
2. Low-pressure turbocharger to intercooler air crossover
3. Intercooler assemblies
4. Intake air inlet to high-pressure turbochargers
5. High-pressure turbocharger to aftercooler air crossover
6. Aftercooler inlet
7. Aftercooled air to intake ports.

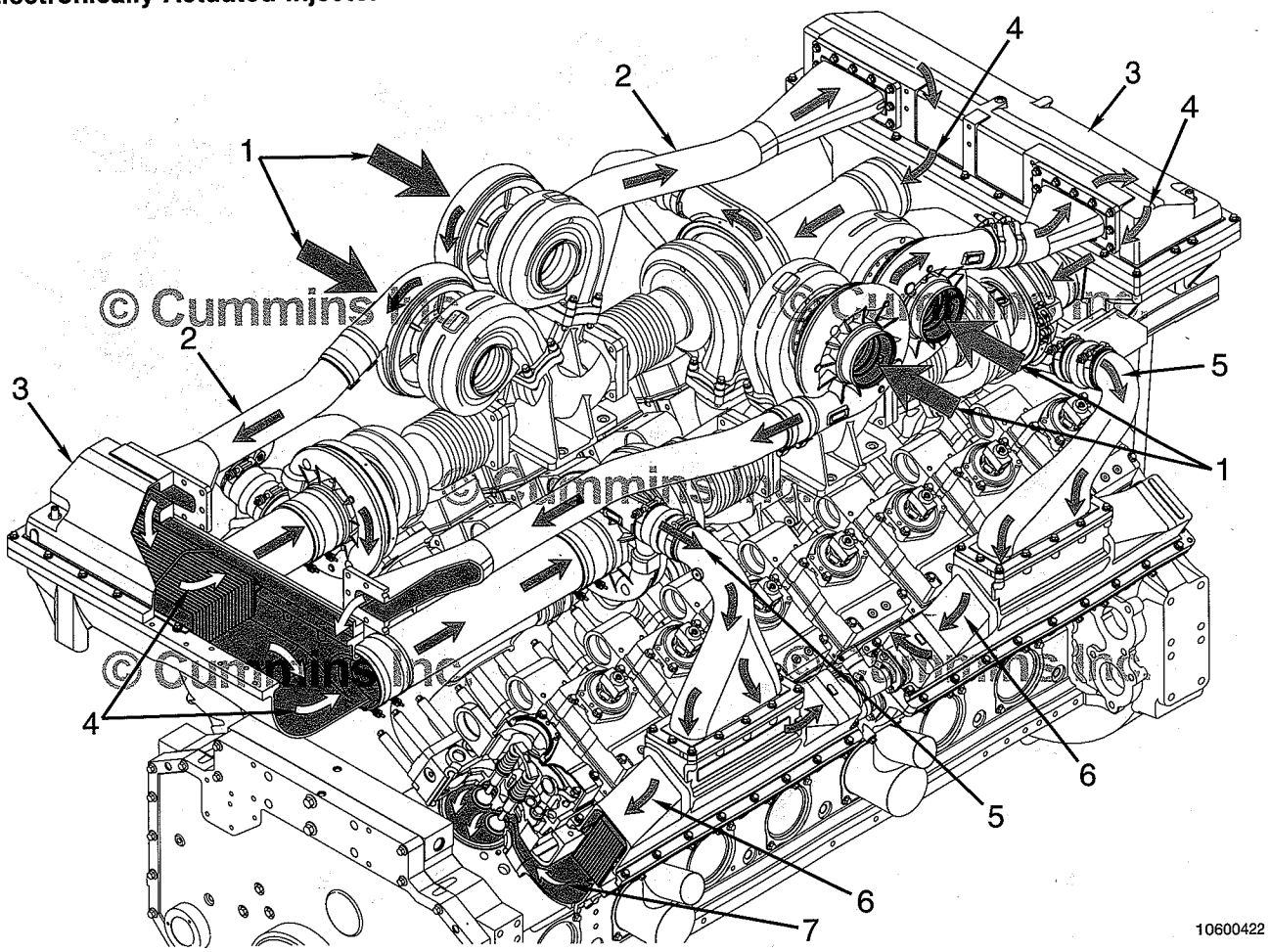
with Electronically Actuated Injector



QSK60 Intake System- Single Stage

1. Intake air inlet to turbochargers
2. Turbocharged air to aftercooler
3. Turbocharged air travels through aftercoolers
4. Aftercooled air to intake ports.

with Electronically Actuated Injector



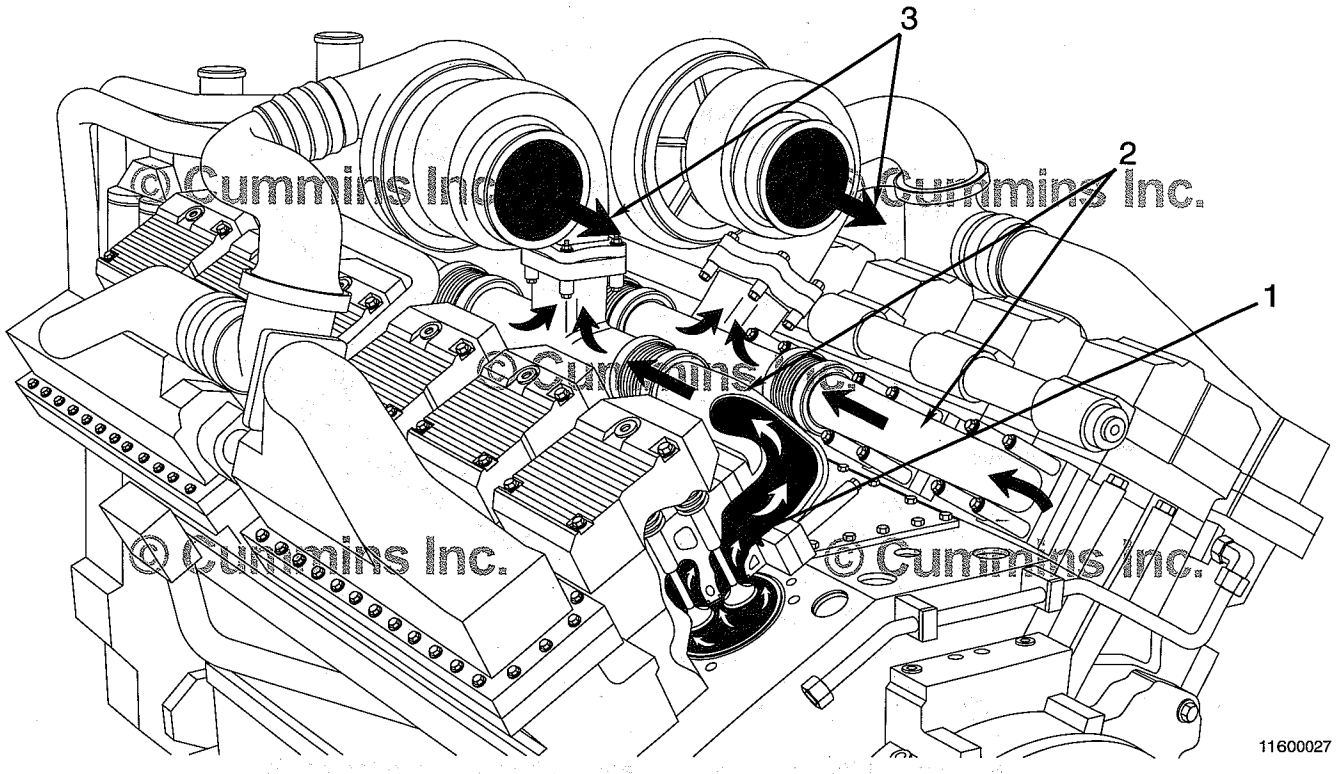
QSK60 Intake System- Two Stage

1. Intake air inlet to low-pressure turbochargers
2. Low-pressure turbocharger to intercooler air crossover
3. Intercooler assemblies
4. Intake air inlet to high-pressure turbochargers
5. High-pressure turbocharger to aftercooler air crossover
6. Aftercooler inlet
7. Aftercooled air to intake ports.

Flow Diagram, Exhaust System

Flow Diagram

with Mechanically Actuated Injector



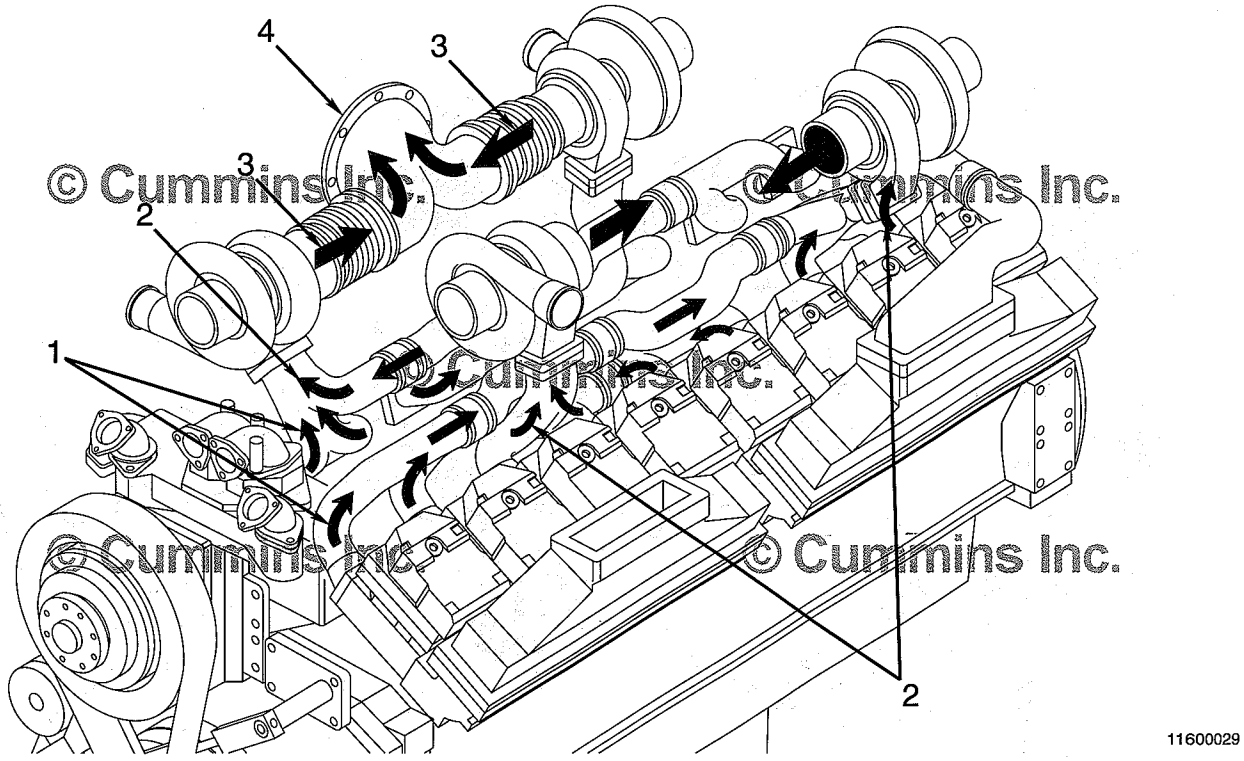
QSK45 Exhaust System - Single-Stage Turbocharger, Aftercooled

1. Exhaust port
2. Exhaust manifolds
3. Turbocharger exhaust outlet.

Flow Diagram, Exhaust System

Flow Diagram

with Mechanically Actuated Injector



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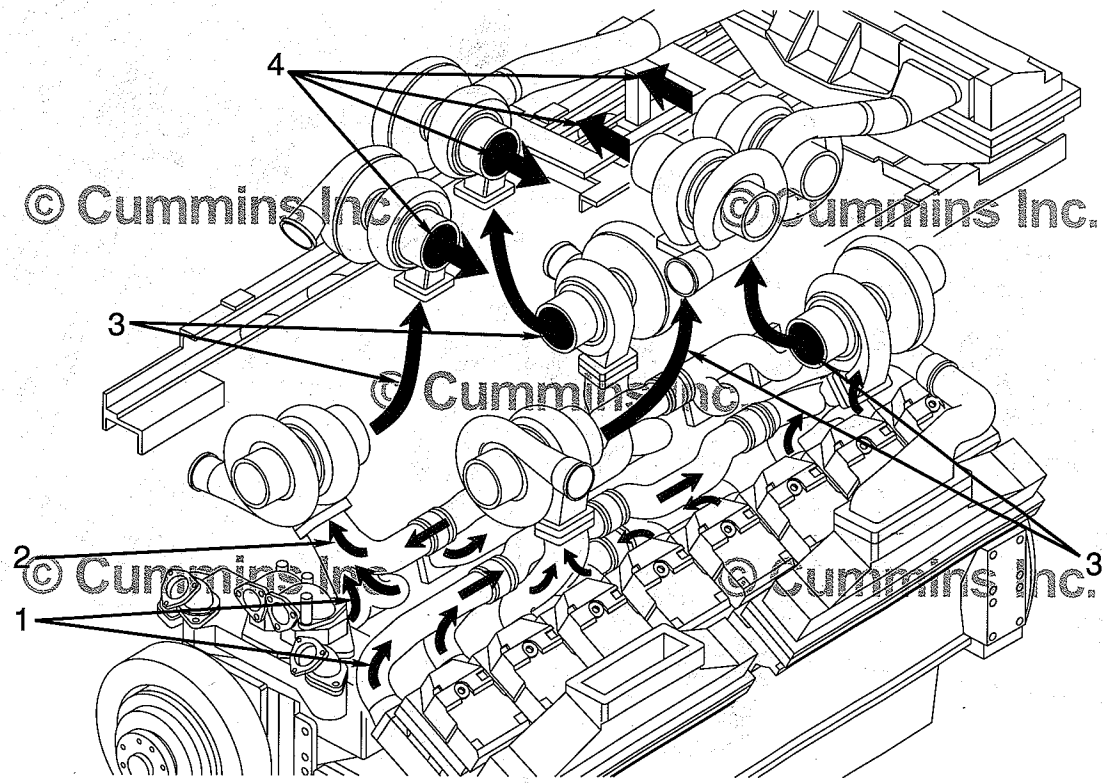
QSK60 Exhaust System - Single-Stage Turbocharger, Aftercooled

1. Exhaust manifold
2. Turbocharger exhaust inlet
3. Turbocharger exhaust outlet
4. Exhaust flange outlet (left side **not** shown).

Flow Diagram, Exhaust System

Flow Diagram

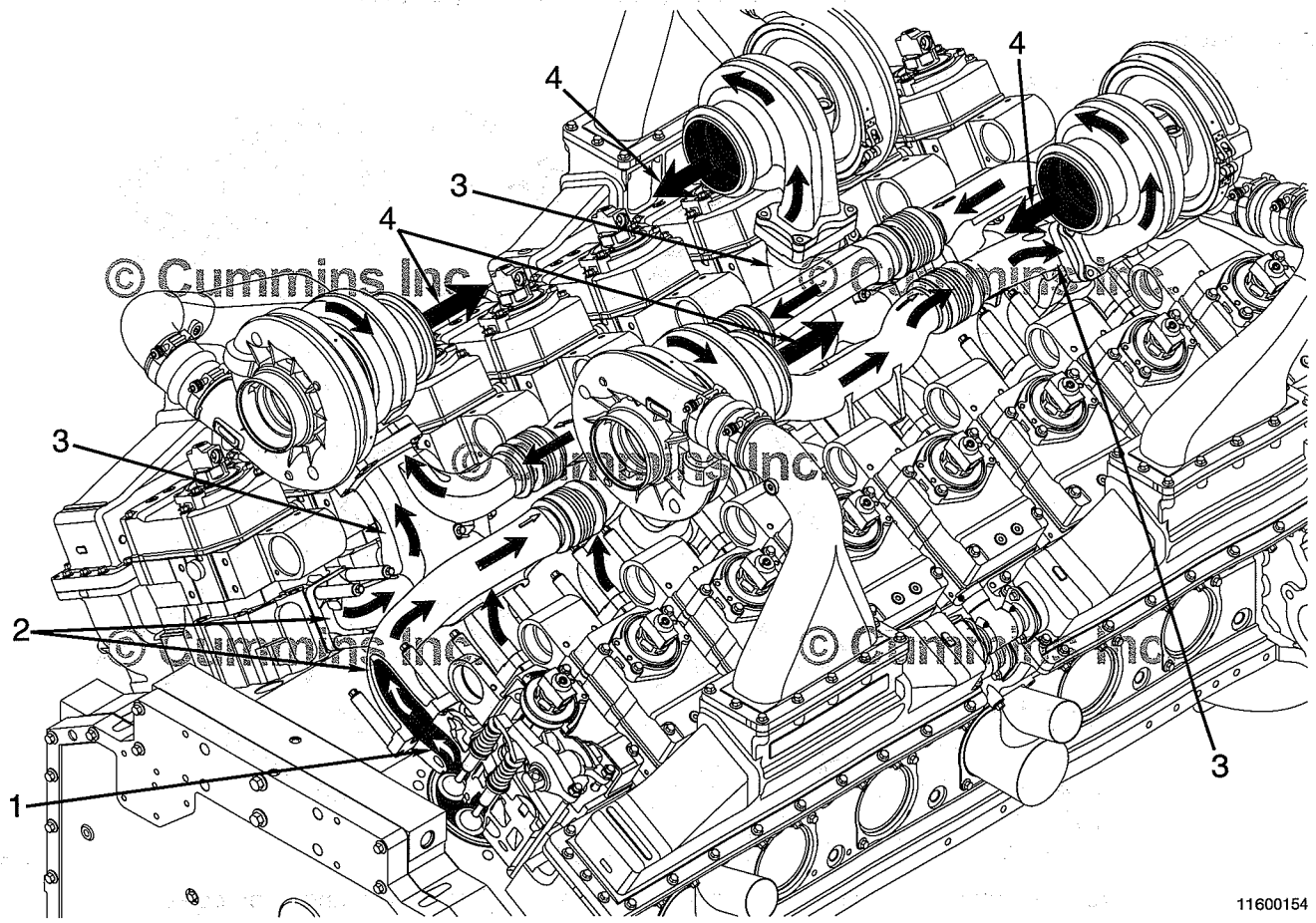
with Mechanically Actuated Injector



QSK60 Exhaust System - Two-Stage Turbocharger, Aftercooled and Intercooled

1. Exhaust manifolds
2. High-pressure turbocharger exhaust inlet
3. High-pressure turbocharger exhaust outlet to low-pressure turbocharger exhaust inlet
4. Low-pressure turbocharger exhaust outlet.

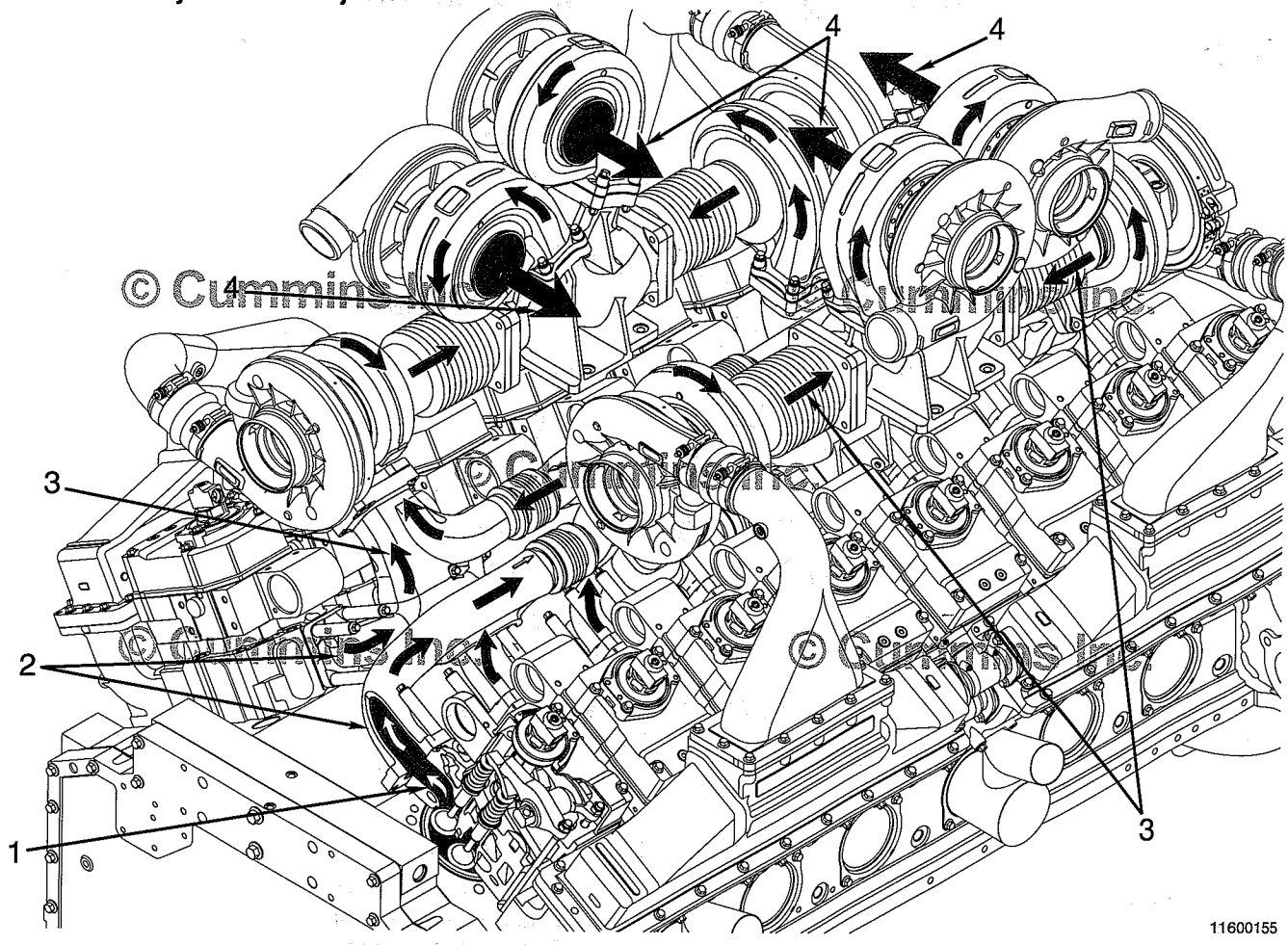
with Electronically Actuated Injector



QSK60 Exhaust System - Single-Stage Turbocharger, Aftercooled

1. Exhaust manifold
2. Turbocharger exhaust inlet
3. Turbocharger exhaust outlet
4. Exhaust flange outlet (left side **not** shown).

with Electronically Actuated Injector

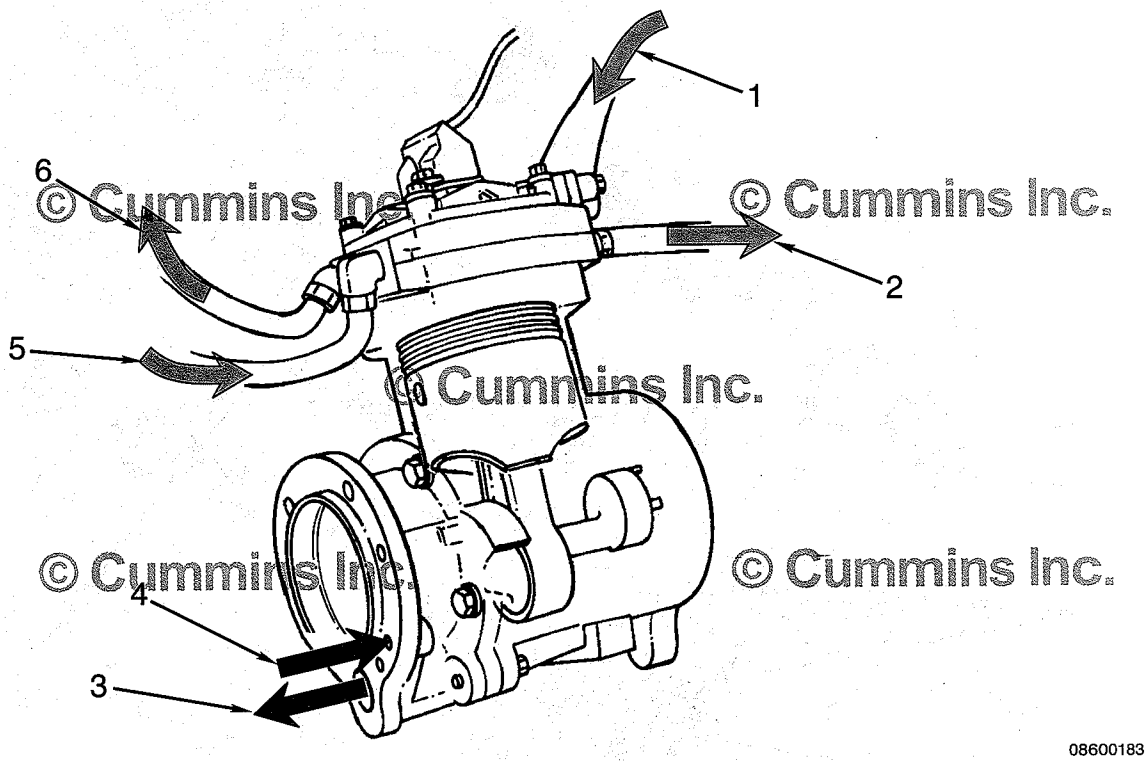


QSK60 Exhaust System - Two-Stage Turbocharger, Aftercooled and Intercooled

1. Exhaust manifolds
2. High-pressure turbocharger exhaust inlet
3. High-pressure turbocharger exhaust outlet to low-pressure turbocharger exhaust inlet
4. Low-pressure turbocharger exhaust outlet.

Flow Diagram, Compressed Air System

Flow Diagram



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08600183

Compressor Coolant, Lubricant and Airflow

1. Air intake
2. Air outlet
3. Lubricating oil drain to lubricating oil pan
4. Lubricating oil supply
5. Engine coolant inlet
6. Engine coolant outlet.

Section L - Service Literature

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Additional Service Literature

General Information

The following publications can be purchased by contacting a Cummins Inc. Distributor:

Bulletin	Title of Publication
3669001	Fuel for Cummins Engines
3810340	Cummins Engine Oil Recommendations
3666132	Cummins Coolant Requirements and Maintenance
3379000	Air For Your Engine
3387266	Cold Weather Operation
3666121	Holset® Air Compressor Master Repair Manual
3666261	Troubleshooting and Repair Manual, QSK45 and QSK60 Series Engines
3666393	Troubleshooting and Repair Manual, QSX15/QSK45/60 Generator-Drive Control System
3666394	Troubleshooting and Repair Manual, QSX15/QSK45/60 Generator Set Power Command Control Version 3200
3666347	QSK45/60 Generator-Drive Control System Wiring Diagram
3666351	QSK45/60 Wiring Diagram
3666357	QSK45/60 CENSE™ Phase 1.0 Wiring Diagram
3666465	QSK45/60 PowerCommand® Control Version 3200 with Control Housing 1 Wiring Diagram
4021349	QSK60 Wiring Diagram
4021373	Shop Manual, QSK45 and QSK60 Series Engines
4021380	QSK45, QSK60, and QSK78 Generator-Drive Control System Wiring Diagram
4021406	QSK45 and QSK60 PowerCommand® Control 3200 with Control Housing 1 and Centinel™ Wiring Diagram
4021407	QSK45 and QSK60 PowerCommand® Control 3200 with Control Housing 2 Wiring Diagram
4021408	QSK45 and QSK60 PowerCommand® Control 3200 with Control Housing 2 and Centinel™ Wiring Diagram
4021410	QSK45 and QSK60 Phase 2.0 Industrial without CENSE™ Wiring Diagram
4021412	QSK60 Phase 2.0 Industrial with CENSE™ Wiring Diagram
4021413	QSK45 Phase 2.0 Industrial with CENSE™ Wiring Diagram
4021414	QSK60 CENSE™ Phase 1.5 Wiring Diagram
4021534	QSK60 Industrial Modular Common Rail System Wiring Diagram
4021542	QSK60 Power Generation Modular Common Rail System Wiring Diagram
4021533	Troubleshooting and Repair Manual Electronic Control System, QSK50 and QSK60 Modular Common Rail System Series Engines
4021530	Service Manual, QSK45 and QSK60 Series Engines

Service Literature Ordering Location
Contact Information

Region	Ordering Location
United States and Canada	Cummins Distributors or Credit Cards at 1-800-646-5609 or Order online at www.powerstore.cummins.com
U.K., Europe, Mid-East, Africa, and Eastern European Countries	Cummins Engine Co., Ltd. Royal Oak Way South Daventry Northants, NN11 5NU, England
South and Central America (excluding Brazil and Mexico)	Cummins Americas, Inc. 16085 N.W. 52nd Avenue Hialeah, FL 33104
Brazil and Mexico	Cummins Inc. International Parts Order Dept., MC 40931 Box 3005 Columbus, IN 47202-3005
Far East (excluding Australia and New Zealand)	Cummins Diesel Sales Corp. Literature Center 8 Tanjong Penjuru Jurong Industrial Estate Singapore
Australia and New Zealand	Cummins Diesel Australia Maroondah Highway, P.O.B. 139 Ringwood 3134 Victoria, Australia

Cummins Customized Parts Catalog

General Information

Cummins is pleased to announce the availability of a parts catalog compiled specifically for you. Unlike the generic versions of parts catalogs that support general high volume parts content; Cummins Customized catalogs contains only the new factory parts that were used to build your engine.

The catalog cover, as well as the content, is customized with you in mind. You can use it in your shop, at your worksite, or as a coffee table book in your RV or boat. The cover contains your name, company name, address, and telephone number. Your name and engine model identification even appears on the catalog spine. Everybody will know that Cummins created a catalog specifically for you.

This new catalog was designed to provide you with the exact information you need to order parts for your engine. This will be valuable for customers that do not have easy access to the Cummins Electronic Parts Catalog or the Cummins Parts Microfilm System.

Additional Features of the Customized Catalog include:

- Engine Configuration Data
- Table of Contents
- Separate Option and Parts Indexes
- Service Kits (when applicable)
- ReCon Part Numbers (when applicable)

Ordering the Customized Parts Catalog

Ordering by Telephone

North American customers can contact their Cummins Distributor or call Gannett Direct Marketing Services at 1-800-646-5609 and order by credit card. Outside North America order on-line or make an International call to Gannett at (+ +)502-454-6660.

Ordering On-Line

The Customized Parts Catalog can be ordered On-Line from the Cummins Powerstore by credit card. Contact the Powerstore at WWW.POWERSTORE.CUMMINS.COM

Contact GDMS or the CUMMINS POWERSTORE for the current price; Freight may be an additional expense.

Information we need to take your Customized Parts Catalog Order. This information drives the cover content of the CPC.

- Customer Name
- Street Address
- Company Name (optional)
- Telephone no.
- Credit Card No.
- Cummins Engine Serial Number (located on the engine data plate)
- Please identify the required media: Printed Catalog, CD-ROM, or PDF File

Unfortunately not all Cummins Engines can be supported by this parts catalog. Engines older than 1984 or newer than 3 months may not have the necessary parts information to compile a catalog. We will contact you if this occurs and explain why we are unable to fill your order.

Customized Parts Catalogs are produced specifically for a single customer. This means they are not returnable for a refund. If we make an error and your catalog is not useable, we will correct that error by sending you a new catalog.

Notes

Section M - Component Manufacturers

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Component Manufacturers' Addresses

NOTE: The following list contains addresses and telephone numbers of suppliers of accessories used on Cummins engines. Suppliers can be contacted directly for any specifications **not** covered in this manual.

Air Compressors

Bendix Heavy Vehicles Systems
Div. of Allied Automotive
901 Cleveland Street
Elyria, OH 44036
Telephone: (216) 329-9000

Holset Engineering Co., Inc.
1320 Kemper Meadow Drive
Suite 500
Cincinnati, OH 45240
Telephone: (513) 825-9600

Midland-Grau
Heavy Duty Systems
Heavy Duty Group Headquarters
10930 N. Pamona Avenue
Kansas City, MO 64153
Telephone: (816) 891-2470

Air Cylinders

Bendix Ltd.
Douglas Road
Kingswood
Bristol
England
Telephone: 0117-671881

Catching Engineering
1733 North 25th Avenue
Melrose Park, IL 60160
Telephone: (708) 344-2334

TEC - Hackett Inc.
8909 Rawles Avenue
Indianapolis, IN 46219
Telephone: (317) 895-3670

Air Heaters

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Kim Hotstart Co.
P.O. Box 11245
Spokane, WA 99211-0245
Telephone: (509) 534-6171

Air Starting Motors

Ingersoll Rand
Chorley New Road
Horwich
Bolton
Lancashire
England
BL6 6JN
Telephone: 01204-65544

Ingersoll-Rand Engine
Starting Systems
888 Industrial Drive
Elmhurst, IL 60126
Telephone: (708) 530-3875

StartMaster
Air Starting Systems
A Division of Sycon Corporation
9595 Cheney Avenue
P. O. Box 491
Marion, OH 43302
Telephone: (614) 382-5771

Alternators

Robert Bosch Ltd.
P.O. Box 98
Broadwater Park
North Orbital Road
Denham
Uxbridge
Middlesex UD9 5HG
England
Telephone: (0)1895-838383

Prestolite Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: (0)1772-421663

C. E. Niehoff & Co.
2021 Lee Street
Evanston, IL 60202
Telephone: (708) 866-6030

Delco-Remy America
2401 Columbus Avenue
P.O. Box 2439
Anderson, IN 46018
Telephone: (317) 646-3528

Leece-Neville Corp.
400 Main Street
Arcade, NY 14009
Telephone: (716) 492-1700

Auxiliary Brakes

The Jacobs Manufacturing Company
Vehicle Equipment Division
22 East Dudley Town Road
Bloomfield, CT 06002
Telephone: (203) 243-1441

Belts

T.B.A. Belting Ltd.
P.O. Box 77
Wigan
Lancashire
WN2 4XQ
England
Telephone: (0)1942-259221

Dayco Mfg.
Belt Technical Center
1955 Enterprize
Rochester Hills, MI 48309
Telephone: (810) 853-8300

Gates Rubber Company
900 S. Broadway
Denver, CO 80217

Goodyear Tire and
Rubber Company
Industrial Products Div.
2601 Fortune Circle East
Indianapolis, IN 46241
Telephone: (317) 898-4170

Catalytic Converters

Donaldson Company, Inc.
1400 West 94th Street
P.O. Box 1299
Minneapolis, MN 55440
Telephone: (612) 887-3835

Nelson Division
Exhaust and Filtration Systems
1801 U.S. Highway 51 P.O. Box 428
Stoughton, WI 53589
Telephone: (608) 873-4200

Walker Manufacturing
3901 Willis Road
P.O. Box 157
Grass Lake, MI 49240
Telephone: (517) 522-5500

Coolant Level Switches

Robertshaw Controls Company
P.O. Box 400
Knoxville, TN 37901
Telephone: (216) 885-1773

Clutches

Twin Disc International S.A.
Chaussee de Namur
Nivelles
Belguim
Telephone: 067-224941

Twin Disc Incorporated
1328 Racine Street
Racine, WI 53403
Telephone: (414) 634-1981

Coolant Heaters

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Drive Plates

Detroit Diesel Allison
Division of General Motors
Corporation
P.O. Box 894
Indianapolis, IN 46206-0894
Telephone: (317) 242-5000

Electric Starting Motors

Prestolite Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: 01772-421663

Delco-Remy America
2401 Columbus Avenue
P.O. Box 2439
Anderson, IN 46018
Telephone: (317) 646-3528

Leece-Neville Corp.
400 Main Street
Arcade, NY 14009
Telephone: (716) 492-1700

Nippondenso Inc.
2477 Denso Drive
P.O. Box 5133
Southfield, MI 48086
Telephone: (313) 350-7500

Electronic Switches

Cutler-Hammer Products
Eaton Corporation
4201 N. 27th Street
Milwaukee, WI 53216
Telephone: (414) 449-6600

Engine Protection Controls

Flight Systems Headquarters
Hempt Road
P.O. Box 25
Mechanicsburg, PA 17055
Telephone: (717) 697-0333

The Nason Company
2810 Blue Ridge Blvd.
West Union, SC 29696
Telephone: (803) 638-9521

Teddington Industrial
Equipment
Windmill Road
Sunbury on Thames
Middlesex
TW16 7HF
England
Telephone: (0)9327-85500

Fan Clutches

Kysor Cooling Systems N.A.
6040 West 62nd Street
Indianapolis, IN 46278
Telephone: (317) 328-3330

Holset Engineering Co. Ltd.
ST Andrews Road
Huddersfield, West Yorkshire
England HD1 6RA
Telephone: (0)1484-22244

Horton Industries, Inc.
P.O. Box 9455
Minneapolis, MN 55440
Telephone: (612) 378-6410

Rockford Clutch Company
1200 Windsor Road
P.O. Box 2908
Rockford, IL 61132-2908
Telephone: (815) 633-7460

Fans

Truflo Ltd.
Westwood Road
Birmingham
B6 7JF
England
Telephone: (0)121-3283041

Hayes-Albion Corporation
Jackson Manufacturing Plant
1999 Wildwood Avenue
Jackson, MI 49202
Telephone: (517) 782-9421

Engineered Cooling Systems, Inc.
201 W. Carmel Drive
Carmel, IN 46032
Telephone: (317) 846-3438

Brookside Corporation
P.O. Box 30
McCordsville, IN 46055
Telephone: (317) 335-2014

TCF Aerovent Company
9100 Purdue Rd., Suite 101
Indianapolis, IN 46268-1190
Telephone: (317) 872-0030

Kysor-Cadillac
1100 Wright Street
Cadillac, MI 49601
Telephone: (616) 775-4681

Schwitzer
6040 West 62nd Street
P.O. Box 80-B
Indianapolis, IN 46206
Telephone: (317) 328-3010

Fault Lamps

Cutler-Hammer Products
Eaton Corporation
4201 N. 27th Street
Milwaukee, WI 53216
Telephone: (414) 449-6600

Filters

Fleetguard International Corp.
Cavalry Hill Industrial Park
Weedon
Northampton NN7 4TD
England
Telephone: 01327-341313

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: 1-800-22-Filters
(1-800-223-4583)

Flexplates

Corrugated Packing and
Sheet Metal
Hamsterley
Newcastle Upon Tyne
England
Telephone: (0)1207-560-505

Allison Transmission
Division of General Motors
Corporation
P.O. Box 894
Indianapolis, IN 46206-0894
Telephone: (317) 242-5000

Midwest Mfg. Co.
29500 Southfield Road, Suite 122
Southfield, MI 48076
Telephone: (313) 642-5355

Wohlert Corporation
708 East Grand River Avenue
P.O. Box 20217
Lansing, MI 48901
Telephone: (517) 485-3750

Fuel Coolers

Hayden, Inc.
1531 Pomona Road
P.O. Box 848
Corona, CA 91718-0848
Telephone: (909) 736-2665

Fuel Pumps

Robert Bosch Corp.
Automotive Group
2800 South 25th Ave.
Broadview, IL 60153

Fuel Warmers

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Gauges

Grasslin U.K. Ltd.
Vale Rise
Tonbridge
Kent
TN9 1TB
England
Telephone: (0)1732-359888

Datcon Instruments
P.O. Box 128
East Petersburg, PA 17520
Telephone: (717) 569-5713

Rochester Gauges, Inc.
11616 Harry Hines Blvd.
P.O. Box 29242
Dallas, TX 75229
Telephone: (214) 241-2161

Governors

Woodward Governor Co.
P.O. Box 1519
Fort Collins, CO 80522
Telephone: (303) 482-5811
(800) 523-2831

Barber Colman Co.
1354 Clifford Avenue
Loves Park, IL 61132
Telephone: (815) 637-3000

United Technologies
Diesel Systems
1000 Jorie Blvd.
Suite 111
Oak Brook, IL 69521
Telephone: (312) 325-2020

Heat Sleeves

Bentley Harris Manufacturing Co.
100 Bentley Harris Way
Gordonville, TN 38563
Telephone: (313) 348-5779

Hydraulic and Power Steering Pumps

Honeywell Control Systems Ltd.
Honeywell House
Arlington Business Place
Bracknell
Berks RG12 1EB
Telephone: (0)1344-656000

Sperry Vickers
P.O. Box 302
Troy, MI 48084
Telephone: (313) 280-3000

Z.F.
P.O. Box 1340
Grafvonsoden Strasse
5-9 D7070
Schwaebisch Gmuend
Germany
Telephone: 7070-7171-31510

In-Line Connectors

Pioneer-Standard Electronics, Inc.
5440 Neiman Parkway
Solon, OH 44139
Telephone: (216) 349-1300

Deutsch
Industrial Products Division
37140 Industrial Avenue
Hemet, CA 92343
Telephone: (714) 929-1200

Oil Heaters

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Kim Hotstart Co.
P.O. Box 11245
Spokane, WA 99211-0245
Telephone: (509) 534-6171

Prelubrication Systems

RPM Industries, Inc.
Suite 109
55 Hickory Street
Washington, PA 15301
Telephone: (412) 228-5130

Radiators

JB Radiator Specialties, Inc.
P.O. Box 292087
Sacramento, CA 95829-2087
Telephone: (916) 381-4791

The G&O Manufacturing Company
100 Gando Drive
P.O. Box 1204
New Haven, CT 06505-1204
Telephone: (203) 562-5121

Young Radiator Company
2825 Four Mile Road
Racine, WI 53404
Telephone: (910) 271-2397

L and M Radiator, Inc.
1414 East 37th Street
Hibbing, MN 55746
Telephone: (218) 263-8993

Throttle Assemblies

Williams Controls, Inc.
14100 SW 72nd Avenue
Portland, OR 97224
Telephone: (503) 684-8600

Torque Converters

Twin Disc International S.A.
Chaussee de Namur
Nivelles
Belgium
Telephone: 067-224941

Twin Disc Incorporated
1328 Racine Street
Racine, WI 53403-1758
Telephone: (414) 634-1981

Rockford Powertrain, Inc.
Off-Highway Systems
1200 Windsor Road
P.O. Box 2908
Rockford, IL 61132-2908
Telephone: (815) 633-7460

Modine Mfg. Co.
1500 DeKoven Avenue
Racine, WI 53401
Telephone: (414) 636-1640

Notes

Section S - Service Assistance

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Routine Service and Parts

General Information

Personnel at Cummins Authorized Repair Locations can assist you with the correct operation and service of your engine. Cummins has a worldwide service network of more than 5,000 Distributors and Dealers who have been trained to provide sound advice, expert service, and complete parts support. Check the telephone directory yellow pages or refer to the directory in this section for the nearest Cummins Authorized Repair Location.

Emergency and Technical Service

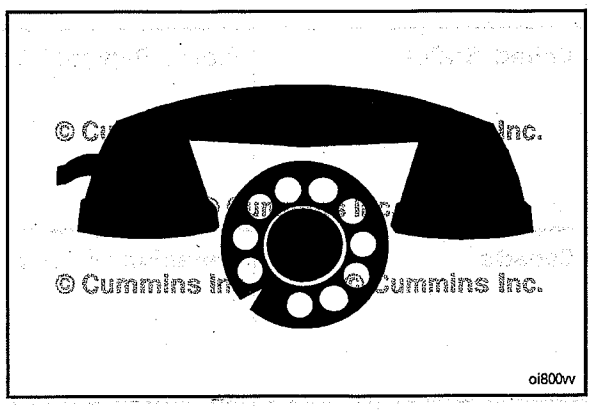
General Information

The Cummins Customer Assistance Center provides a 24-hour, toll free telephone number to aid in technical and emergency service when a Cummins Authorized Repair Location can **not** be reached or is unable to resolve an issue with a Cummins product.

If additional assistance is required, call Toll-Free:

1-800-DIESELS
(1-800-343-7357)

- Includes all 50 states, Bermuda, Puerto Rico, Virgin Islands, and the Bahamas.
- Outside of North America contact your Regional Office. Telephone numbers and addresses are listed in the International Directory.



Problem Solving

General Information

Normally, any problem that arises with the sale, service, or repair of your engine can be handled by a Cummins Authorized Repair Location in your area. Refer to the telephone directory yellow pages for the one nearest you. If the problem has **not** been handled satisfactorily, follow the steps outlined below:

1. If the disagreement is with a Dealer, talk to the Cummins Distributor with whom he has his service agreement.
2. If the disagreement is with a Distributor, call the nearest Cummins Division or Regional Office; however, most problems are solved below the Division or Regional office level. Telephone numbers and addresses are listed in this section. Before calling, write down the following information:

a. Engine model and serial number
b. Type and make of equipment
c. Total kilometers [miles] or hours of operation
d. Warranty start date
e. Nature of problem
f. Summary of the current problem arranged in the order of occurrence
g. Name and location of the Cummins Distributor or Dealer

12. If a problem can **not** be resolved satisfactorily through your Cummins Authorized Repair Location or Division Office, write to:

Cummins Customer Assistance Center - 41403, Cummins Inc., Box 3005, Columbus, IN 47202-3005

Division and Regional Offices - Locations

NOTE: The following list contains offices in U.S., Canada, Australia, New Zealand, and Puerto Rico.

United States	**Southern Division Office**	Cummins Engine Company, Inc. 425 Franklin Road S.W. Suite 500 Marietta, GA 30067 Telephone: (770) 423-1108 FAX: (770) 499-8240
United States	**Plains Regional Office**	Cummins Engine Company, Inc. 1901 Central Drive Suite 356 Bedford, TX 76021 Telephone: (817) 267-3172 FAX: N/A
Canada	**Canadian Division Office**	Cummins Diesel of Canada, Ltd. 5575 North Service Road Burlington, Ontario L726M1 Telephone: (905) 331-5944 FAX: (905) 331-0276
Canada	**Western Canada Regional Office**	Cummins Diesel of Canada, Ltd. 18452 - 96th Avenue Surrey, B.C. V3T 4W2 Telephone: (604) 882-5727 FAX: (604) 882-9110
Canada	**Eastern Canada Regional Office**	Cummins Diesel of Canada Ltd. 7200 Trans Canada Hwy. Pt. Cuaire, Quebec H9R 1C0 Telephone: (514) 695-2402 FAX: (514) 695-8917
Canada	**Central Canada Regional Office**	Cummins Diesel of Canada Ltd. 4887 - 35th Street SE Calgary, Alberta T2B 3C6 FAX: (403) 569-9974
Australia Regional Office	**Cummins Engine Company Pty. Ltd.**	2 Caribbean Drive Scoresby, Victoria 3179 Australia Telephone: (61-3) 9765-3222 FAX: (61-3) 9763-0079 **NOTE:** This office also serves New Zealand.
Cummins Americas Regional Office	**Cummins Latin America**	3088 N. Commerce Parkway MPC #14, Building A Miramar, FL 33025 Telephone: (305) 621-1300 **NOTE:** This office serves Puerto Rico and South America excluding Brazil.

Distributors and Branches - United States

Alabama	**Birmingham Distributor**	Cummins Alabama, Inc. 2200 Pinson Highway P.O. Box 1147 Birmingham, AL 35201 Telephone: (205) 841-0421 FAX: (205) 849-5926
Alabama	**Mobile Branch**	Cummins Alabama, Inc. 1924 N. Beltline Hwy. Mobile, AL 36601-1598 Telephone: (334) 456-2236 FAX: (334) 452-6419
Alabama	**Mobile Onan/Marine Branch**	Cummins Alabama, Inc. 3422 Georgia Pacific Avenue Mobile, AL 36617 Telephone: (334) 452-6426 FAX: (334) 473-6657
Alabama	**Montgomery Branch**	Cummins Alabama, Inc. 2325 West Fairview Avenue Montgomery, AL 36108 Telephone: (205) 263-2594 FAX: (205) 263-2594
Alaska	**Anchorage - (Branch of Seattle)**	Cummins Northwest, Inc. 2618 Commercial Drive Anchorage, AK 99501-3095 Telephone: (907) 279-7594 FAX: (907) 276-6340
Arizona	**Phoenix Distributor and Branch**	Cummins Southwest, Inc. 2239 N. Black Canyon Hgwy Phoenix, AZ 85009 Telephone: (602) 252-8021 FAX: (602) 253-6725
Arizona	**Tucson Branch**	Cummins Southwest, Inc. 1912 West Prince Road Tucson, AZ 85705 Telephone: (520) 887-7440 FAX: (520) 887-4173
Arkansas	**Little Rock - (Branch of Memphis)**	Cummins Mid-South, Inc. 6600 Interstate 30 Little Rock, AR 72209 Telephone: Sales: (501) 569-5600 Service: (501) 569-5656 Parts: (501) 569-5613 FAX: (501) 565-2199
California	**San Leandro Distributor**	Cummins West, Inc. 14775 Wicks Blvd. San Leandro, CA 94577-6779 Telephone: (510) 351-6101 FAX: (510) 352-3925

California	**Arcata Branch**	Cummins West, Inc. 4801 West End Road Arcata, CA 95521 Telephone: (707) 822-7392 FAX: (707) 822-7585
California	**Bakersfield Branch**	Cummins West, Inc. 4601 East Brundage Lane Bakersfield, CA 93307 Telephone: (805) 325-9404 FAX: (805) 861-8719
California	**Fresno Branch**	Cummins West, Inc. 2740 Church Avenue Fresno, CA 93706 Telephone: (209) 495-4745 FAX: (209) 486-7402
California	**Redding Branch**	Cummins West, Inc. 20247 Charlanne Drive Redding, CA 96001 Telephone: (916) 222-4070 FAX: (916) 224-4075
California	**Stockton Branch**	Cummins West, Inc. 41 West Yokuts Avenue Suite 131 Stockton, CA 95207 Telephone: (209) 473-0386 FAX: (209) 478-2454
California	**West Sacramento Branch**	Cummins West, Inc. 2661 Evergreen Avenue West Sacramento, CA 95691 Telephone: (916) 371-0630 FAX: (916) 371-2849
California	**Los Angeles Distributor**	Cummins Cal Pacific Inc. 1939 Deere Avenue (Irvine) Irvine, CA 92606 Telephone: (949) 253-6000 FAX: (949) 253-6080
California	**Montebello Branch**	Cummins Cal Pacific Inc. 1105 South Greenwood Avenue Montebello, CA 90640 Telephone: (323) 728-8111 FAX: (323) 889-7422
California	**Bloomington Branch**	Cummins Cal Pacific Inc. 3061 S. Riverside Avenue Bloomington, CA 92377 Telephone: (909) 877-0433 FAX: (909) 877-3787
California	**San Diego Branch**	Cummins Cal Pacific Inc. 310 N. Johnson Avenue El Cajon, CA 92020 Telephone: (619) 593-3093 FAX: (619) 593-0600

California	**Ventura Branch**	Cummins Cal-Pacific Inc. 3958 Transport St. Ventura, CA 93003 Telephone: (805) 644-7281 FAX: (805) 644-7284
Colorado	**Denver Distributor**	Cummins Rocky Mountain, Inc. 5100 East 58th Avenue Commerce City, CO 80022 Telephone: (303) 287-0201 FAX: (303) 288-7080
Colorado	**Denver Onan/Industrial Branch**	Cummins Rocky Mountain, Inc. 5100 East 58th Ave. Commerce City, CO 80022 Telephone: (303) 286-7697 FAX: (303) 287-4837
Colorado	**Durango Branch**	Cummins Rocky Mountain, Inc. 13595 County Road 213 Durango, CO 81301 Telephone: (970) 259-7470 FAX: (970) 259-7482
Colorado	**Grand Junction Branch**	Cummins Rocky Mountain, Inc. 2380 U.S. Highway 6 & 50 P.O. Box 339 Grand Junction, CO 81501 Telephone: (303) 242-5776 FAX: (303) 243-5495
Connecticut	**Rocky Hill - (Branch of Bronx)**	Cummins Metropower, Inc. 914 Cromwell Ave. Rocky Hill, CT 06067 Telephone: (860) 529-7474 FAX: (860) 529-7524
Florida	**Tampa Distributor**	Cummins Southeastern Power, Inc. Corporate Office 5421 N. 59th Street Tampa, FL 33610 Telephone: (813) 621-7202 FAX: (813) 621-8250
Florida	**Ft. Myers Branch**	Cummins Southeastern Power, Inc. 2671 Edison Avenue Ft. Myers, FL 33902 Telephone: (941) 337-1211 FAX: (941) 337-5374
Florida	**Jacksonville Branch**	Cummins Southeastern Power, Inc. 755 Pickettville Rd. Jacksonville, FL 32220 Telephone: (904) 378-1902 FAX: (904) 378-1904
Florida	**Hialeah (Miami) Branch**	Cummins Southeastern Power, Inc. 9900 N.W. 77th Avenue Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 FAX: (305) 557-2992

Florida	**Ocala Branch**	Cummins Southeastern Power 321 Southwest 52nd Ave. Ocala, FL 34474-1892 Telephone: (352) 861-1122 FAX: (352) 861-1130
Florida	**Orlando Branch**	Cummins Southeastern Power, Inc. 4020 North Orange Blossom Trail Orlando, FL 32810 Telephone: (407) 298-2080 FAX: (407) 290-8727
Florida	**Tampa Branch**	Cummins Southeastern Power, Inc. 5912 E. Hillsborough Avenue Tampa, FL 33610 Telephone: (813) 626-1101 FAX: (813) 628-4183
Georgia	**Atlanta Distributor**	Cummins South, Inc. 5125 Georgia Highway 85 College Park, GA 30349 Telephone: (404) 763-0151 FAX: (404) 766-2132
Georgia	**Albany Branch**	Cummins South, Inc. 1915 W. Oakridge Drive Albany, GA 31707-4938 Telephone: (912) 888-6210 FAX: (912) 883-1670
Georgia	**Atlanta Branch**	Cummins South, Inc. 100 University Avenue, S.W. Atlanta, GA 30315-2202 Telephone: (404) 527-7800 FAX: (404) 527-7832
Georgia	**Augusta Branch**	Cummins South, Inc. 1255 New Savannah Road Augusta, GA 30901-3891 Telephone: (706) 722-8825 FAX: (706) 722-7553
Georgia	**Savannah Branch**	Cummins South, Inc. 8 Interchange Court Savannah, GA 31401-1627 Telephone: (912) 232-5565 FAX: (912) 232-5145
Hawaii	**Kapolei Distributor**	Cummins Hawaii Diesel Power, Inc. 91-230 Kalaeloa Blvd. Kapolei, HI 96707 Telephone: (808) 682-8110 FAX: (808) 682-8477
Idaho	**Boise - (Branch of Salt Lake City)**	Cummins Intermountain, Inc. 2851 Federal Way City Boise, ID 83705 Telephone: (208) 336-5000 FAX: (208) 338-5436

Idaho	**Pocatello - (Branch of Salt Lake City)**	Cummins Intermountain, Inc. 14299 Highway 30 West Pocatello, ID 83201 Telephone: (208) 234-1661 FAX: (208) 234-1662
Illinois	**Chicago Distributor**	Cummins Northern Illinois, Inc. 7145 Santa Fe Drive Hodgkins, IL 60525 Telephone: (708) 579-9222 FAX: (708) 352-7547
Illinois	**Bloomington-Normal - (Branch of Indianapolis)**	Cummins Mid-States Power, Inc. (at U.S. 51 N and I-55) 414 W. Northtown Road Bloomington-Normal, IL 61761 Telephone: (309) 452-4454 FAX: (309) 452-1642
Illinois	**Onan Branch**	Cummins/Onan Northern Illinois 8745 W. 82nd Place Justin, IL 60458 Telephone: (708) 563-7070 FAX: (708) 563-7095
Illinois	**Harrisburg (Branch of St. Louis)**	Cummins Gateway, Inc. Highway 45 North Harrisburg, IL 62946 Telephone: (618) 273-4138 FAX: (618) 273-4531
Illinois	**Rock Island - (Branch of Omaha)**	Cummins Great Plains Diesel, Inc. 7820 - 42nd Street West Rock Island, IL 61204 Telephone: (309) 787-4300 FAX: (309) 787-4397
Illinois	**Onan Branch**	Cummins Gateway, Inc. #1 Extra Mile Drive Collinsville, IL 62234 Telephone: (618) 345-0123 FAX: (314) 531-6604
Indiana	**Indianapolis Distributor**	Cummins Mid-States Power, Inc. P.O. Box 42917 3762 West Morris Street Indianapolis, IN 46242-0917 Telephone: (317) 243-7979 FAX: (317) 240-1925
Indiana	**Evansville - (Branch of Louisville)**	Cummins Cumberland, Inc. 7901 Highway 41 North Evansville, IN 47711 Telephone: (812) 867-4400 FAX: (812) 421-3282
Indiana	**Ft. Wayne Branch**	Cummins Mid-States Power, Inc. 3415 Coliseum Blvd. West (At Jct. I-69 & 30/33) Ft. Wayne, IN 46808 Telephone: (219) 482-3691 FAX: (219) 484-8930

Indiana	**Gary - (Branch of Chicago)**	Cummins Northern Illinois, Inc. 1440 Texas Street Gary, IN 46402 Telephone: (219) 885-5591 FAX: (219) 883-4817
Indiana	**Indianapolis Branch**	Cummins Mid-States Power, Inc. P. O. Box 42917 3621 West Morris Street Indianapolis, IN 46242-0917 Telephone: (317) 244-7251 FAX: (317) 240-1215
Indiana	**Onan Branch**	Mid-States Power, Inc. 4301 W. Morris Street P.O. Box 42917 Indianapolis, IN 46240-0917 Telephone: (317) 240-1967 FAX: (317) 240-1975
Iowa	**Cedar Rapids - (Branch of Omaha)**	Cummins Great Plains Diesel, Inc. 625 - 33rd Avenue SW Cedar Rapids, IA 52406 Telephone: (319) 366-7537 (24 hours) FAX: (319) 366-7562
Iowa	**Des Moines - (Branch of Omaha)**	Cummins Great Plains Diesel, Inc. 1680 N.E. 51st Avenue P.O. Box B Des Moines, IA 50313 Telephone: (515) 262-9591 Parts: (515) 262-9744 FAX: (515) 262-0626
Iowa	**Des Moines - (Branch of Omaha)**	Midwestern Power Products Division of Cummins Great Plains Diesel, Inc. 5194 N.E. 17th Street Des Moines, IA 50313 Telephone: (515) 264-1650 FAX: (515) 264-1651
Kansas	**Colby - (Branch of Kansas City, Missouri)**	Cummins Mid-America, LLC. 1880 South Range Colby, KS 67701 Telephone: (785) 462-3945 FAX: (785) 462-3970
Kansas	**Garden City - (Branch of Kansas City, Missouri)**	Cummins Mid-America, Inc. 1285 Acraway Garden City, KS 67846 Telephone: (316) 275-2277 FAX: (316) 275-2533
Kansas	**Wichita - (Branch of Kansas City, Missouri)**	Cummins Mid-America, Inc. 5101 North Broadway Wichita, KS 67201 Telephone: (316) 838-0875 FAX: (316) 838-0704

Kentucky	**Louisville Distributor**	Cummins Cumberland, Inc. (Corporate Office) 2301 Nelsonville Parkway Louisville, KY 40223 Telephone: (502) 254-3363 FAX: (502) 254-9272
Kentucky	**Hazard Branch**	Cummins Cumberland, Inc. Highway 15 South P.O. Box 510 Hazard, KY 41701 Telephone: (606) 436-5718 FAX: (606) 436-5038
Kentucky	**Louisville Branch**	Cummins Cumberland, Inc. 9820 Bluegrass Parkway Louisville, KY 40299 Telephone: (502) 491-4263 FAX: (502) 499-0896
Louisiana	**Morgan City - (Branch of Memphis)**	Cummins Mid-South, Inc. Hwy. 90 East P.O. Box 1229 Amelia, LA 70340 Telephone: (504) 631-0576 FAX: (504) 631-0081
Louisiana	**New Orleans - (Branch of Memphis)**	Cummins Mid-South, Inc. 110 E. Airline Highway Kenner, LA 70062 Telephone: (504) 468-3535 FAX: (504) 465-3408
Maine	**Bangor (Branch of Boston)**	Cummins Northeast, Inc. 221 Hammond Street Bangor, ME 04401 Telephone: (207) 941-1061 FAX: (207) 945-3170
Maine	**Scarborough - (Branch of Boston)**	Cummins Northeast, Inc. 10 Gibson Road Scarborough, ME 04074 Telephone: (207) 883-8155 FAX: (207) 883-5526
Maryland	**Baltimore Distributor**	Cummins Power Systems, Inc. 1907 Parkwood Drive MD 21061 Telephone: (410) 590-8700 FAX: (410) 590-8723
Massachusetts	**Boston Distributor**	Cummins Northeast, Inc. 100 Allied Drive Dedham, MA 02026 Telephone: (781) 329-1750 FAX: (781) 329-4428
Massachusetts	**Springfield Branch**	Cummins Northeast, Inc. 177 Rocus Street Springfield, MA 01104 Telephone: (413) 737-2659 FAX: (413) 731-1082

Mexico	**Tijuana - (Branch of Los Angeles)**	Distribuidora Cummins De Baja Blvd. 3ra. Oeste No. 17523 Fracc. Industrial Garita de Otay C.P. 22400 Tijuana, Baja California Mexico Telephone: 011-52-66-238433 FAX: 011-52-66-238649
Michigan	**Detroit (Novi) Distributor**	Cummins Michigan, Inc. 41216 Vincenti Court Novi, MI 48375 Telephone: (248) 478-9700 FAX: (248) 478-1570
Michigan	**Blissfield, Michigan**	Diesel Fuel Systems, Inc. Subsidiary of Cummins Michigan Inc. 211 N. Jipson Street Blissfield, MI 49228 Telephone: (517) 486-4324 FAX: (517) 486-3614
Michigan	**Dearborn Branch**	Cummins Michigan, Inc. 3760 Wyoming Avenue Dearborn, MI 48120 Telephone: (313) 843-6200 FAX: (313) 843-6070
Michigan	**Grand Rapids Branch**	Cummins Michigan, Inc. 3715 Clay Avenue, S.W. Grand Rapids, MI 49508 Telephone: (616) 538-2250 FAX: (616) 538-3830
Michigan	**Grand Rapids Branch**	Standby Power, Inc. 7580 Expressway Drive S.W. Grand Rapids, MI 49548 Telephone: (616) 281-2211 FAX: (616) 281-3177
Michigan	**Iron Mountain - (Branch of De Pere)**	Cummins Great Lakes, Inc. 1901 Stevenson Avenue Iron Mountain, MI 49801 Telephone: (906) 774-2424 (800) 236-2424 FAX: (906) 774-1190
Michigan	**Novi Branch**	Cummins Michigan, Inc. 25100 Novi Road Novi, MI 48375 Telephone: (248) 380-4300 FAX: (248) 380-0910
Michigan	**Power Products (Branch of Detroit)**	Cummins Michigan, Inc. 41326 Vincenti Ct. Novi, MI 48375 Telephone: (248) 426-9300 FAX: (248) 473-8560
Michigan	**Saginaw Branch**	Cummins Michigan, Inc. 722 N. Outer Drive Saginaw, MI 48605 Telephone: (517) 752-5200 FAX: (517) 752-4194

Michigan	**Standby Power - (Branch of Detroit)**	Cummins Michigan, Inc. 12130 Dixie Redford, MI 48239 Telephone: (313) 538-0200 FAX: (313) 538-3966
Minnesota	**St. Paul Distributor**	Cummins North Central, Inc. 3030 Centre Pointe Drive Suite 500 Roseville, MN 55113 Telephone: (651) 636-1000 FAX: (651) 638-2442
Minnesota	**Duluth Branch**	Cummins Diesel Sales, Inc. 3115 Truck Center Drive Duluth, MN 55806-1786 Telephone: (218) 628-3641 FAX: (218) 628-0488
Minnesota	**St. Paul Branch**	Cummins North Central, Inc. 2690 Cleveland Ave. North St. Paul, MN 55113 Telephone: (651) 636-1000 FAX: (651) 638-2497
Mississippi	**Jackson - (Branch of Memphis)**	Cummins Mid-South, Inc. 325 New Highway 49 South Jackson, MS 39288-4224 Telephone: Admin.: (601) 932-7016 Parts: (601) 932-2720 Service: (601) 939-1800 FAX: (601) 932-7399
Missouri	**Kansas City Distributor and Branch**	Cummins Mid-America, Inc. 8201 NE Parvin Road Kansas City, MO 64161 Telephone: (816) 414-8200 FAX: (816) 414-8299
Missouri	**Joplin Branch**	Cummins Mid-America, Inc. 3507 East 20th Street Joplin, MO 64801 Telephone: (417) 623-1661 FAX: (417) 623-1817
Missouri	**Springfield Branch**	Cummins Mid-America, Inc. 3637 East Kearney Springfield, MO 65803 Telephone: (417) 862-0777 FAX: (417) 862-4429
Missouri	**St. Louis Distributor**	Cummins Gateway, Inc. 7210 Hall Street St. Louis, MO 63147 Telephone: (314) 389-5400 FAX: (314) 389-9671
Missouri	**Columbia Branch**	Cummins Gateway, Inc. 5221 Highway 763 North Columbia, MO 65202 Telephone: (314) 449-3711 FAX: (314) 449-3712

Missouri	**Sikeston Branch**	Cummins Gateway, Inc. 101 Keystone Drive Sikeston, MO 63801 Telephone: (314) 472-0303 FAX: (314) 472-0306
Missouri	**Industrial Power Branch**	Cummins Gateway, Inc. 3256 E. Outer Road Scott City, MO 63788 Telephone: (573) 335-9399 FAX: (573) 335-7062
Montana	**Billings - (Branch of Denver)**	Cummins Rocky Mountain, Inc. 5151 Midland Road Billings, MT 59101 Telephone: (406) 245-4194 FAX: (406) 245-7923
Montana	**Great Falls - (Branch of Denver)**	Cummins Rocky Mountain, Inc. 415 Vaughn Road Great Falls, MT 59404 Telephone: (406) 452-8561 FAX: (406) 452-9911
Montana	**Missoula - (Branch of Seattle)**	Cummins Northwest, Inc. 4950 North Reserve Street Missoula, MT 59802-1498 Telephone: (406) 728-1300 FAX: (406) 728-8523
Nebraska	**Omaha Distributor and Branch**	Cummins Great Plains Diesel, Inc. 5515 Center Street P.O. Box 6068 Omaha, NE 68106 Telephone: (402) 551-7678 (24 Hours) FAX: (402) 551-1952
Nebraska	**Kearney Branch**	Cummins Great Plains Diesel, Inc. 515 Central Avenue Kearney, NE 68847 Telephone: (308) 234-1994 FAX: (308) 234-5776
Nevada	**Elko - (Branch of Salt Lake City)**	Cummins Intermountain, Inc. 5370 East Idaho Street Elko, NV 89801 Telephone: (775) 738-6405 FAX: (775) 738-1719
Nevada	**Las Vegas - (Branch of Salt Lake City)**	Cummins Intermountain, Inc. 2750 Losee Road North Las Vegas, NV 89030 Telephone: (702) 399-2339 FAX: (702) 399-7457
Nevada	**Sparks - (Branch of Salt Lake City)**	Cummins Intermountain, Inc. 150 Glendale Avenue Sparks, NV 89431 Telephone: (775) 331-4983 FAX: (775) 331-7429

New Jersey	**Newark - (Branch of Bronx)**	Cummins Metropower, Inc. 41-85 Doremus Ave. Newark, NJ 07105 Telephone: (973) 491-0100 FAX: (973) 578-8873
New Mexico	**Albuquerque - (Branch of Phoenix)**	Cummins Southwest, Inc. 1921 Broadway N.E. Albuquerque, NM 87102 Telephone: (505) 247-2441 FAX: (505) 842-0436
New Mexico	**Farmington - (Branch of Phoenix)**	Cummins Southwest, Inc. 1101 North Troy King Road Farmington, NM 87401 Telephone: (505) 327-7331 FAX: (505) 326-2948
New York	**Bronx Distributor**	Cummins Metropower, Inc. 890 Zerega Avenue Bronx, NY 10473 Telephone: (718) 892-2400 FAX: (718) 892-0055
New York	**Albany - (Branch of Boston)**	Cummins Northeast, Inc. 101 Railroad Avenue Albany, NY 12205 Telephone: (518) 459-1710 FAX: (518) 459-7815
New York	**Buffalo - (Branch of Boston)**	Cummins Northeast, Inc. 480 Lawrence Bell Dr. Williamsville, NY 14221-7090 Telephone: (716) 631-3211 FAX: (716) 626-0799
New York	**Syracuse - (Branch of Boston)**	Cummins Northeast, Inc. 29 Eastern Avenue Syracuse, NY 13211 Telephone: (315) 437-2751 FAX: (315) 437-8141
North Carolina	**Charlotte Distributor**	Cummins Atlantic, Inc. 11101 Nations Ford Road (28273) P.O. Box 240729 Charlotte, NC 28224-0729 Telephone: (704) 588-1240 FAX: (704) 587-4870
North Carolina	**Charlotte Branch**	Cummins Atlantic, Inc. 3700 North Interstate 85 Charlotte, NC 28206 Telephone: (704) 596-7690 FAX: (704) 596-3038
North Carolina	**Greensboro Branch**	Cummins Atlantic, Inc. 513 Preddy Boulevard (27406) P.O. Box 22066 Greensboro, NC 27420-2066 Telephone: (336) 275-4531 FAX: (336) 275-8304

North Carolina	**Wilson Branch**	Cummins Atlantic, Inc. 1514 Cargill Avenue (27893) P.O. Box 1177 Wilson, NC 27894-1117 Telephone: (252) 237-9111 FAX: (252) 237-9132
North Dakota	**Fargo - (Branch of St. Paul)**	Cummins North Central, Inc. 3801 - 34th Ave. SW Fargo, ND 58104 Telephone: (701) 282-2466 FAX: (701) 277-5399
North Dakota	**Grand Forks - (Branch of St. Paul)**	Cummins North Central, Inc. 4728 Gateway Drive Grand Forks, ND 58201 Telephone: (701) 775-8197 FAX: (701) 775-4833
North Dakota	**Minot - (Branch of St. Paul)**	Cummins North Central, Inc. 1501 - 20th Avenue, S.E. Minot, ND 58702 Telephone: (701) 852-3585 FAX: (701) 852-3588
Ohio	**Columbus Distributor and Branch**	Cummins Interstate Power, Inc. 4000 Lyman Drive Hilliard (Columbus), OH 43026 Telephone: (614) 771-1000 FAX: (614) 771-0769
Ohio	**Columbus Distributor**	Cummins Interstate Power, Inc. 2297 Southwest Bldv., Suite K Grove City, OH 43123 Telephone: (614) 771-1000 FAX: (614) 527-2576
Ohio	**Cincinnati Branch**	Cummins Interstate Power, Inc. 10470 Evendale Drive Cincinnati, OH 45241 Telephone: (513) 563-6670 FAX: (513) 563-0594
Ohio	**Cleveland Branch**	Cummins Interstate Power, Inc. 7585 Northfield Road Cleveland, OH 44146 Telephone: (440) 439-6800 FAX: (440) 439-7390
Ohio	**Strasburg Branch**	Cummins Interstate Power, Inc. 777 South Wooster Avenue Strasburg, OH 44680 Telephone: (216) 878-5511 FAX: (216) 878-7666
Ohio	**Toledo Branch**	Cummins Interstate Power, Inc. 801 Illinois Avenue Maumee (Toledo), OH 43537 Telephone: (419) 893-8711 FAX: (419) 893-5362

Ohio	**Youngstown Branch**	Cummins Interstate Power, Inc. 7145 Masury Road Hubbard (Youngstown), OH 44425 Telephone: (216) 534-1935 FAX: (216) 534-5606
Oklahoma	**Oklahoma City - (Branch of Arlington)**	Cummins Southern Plains, Inc. 5800 West Reno Oklahoma City, OK 73127 Telephone: (405) 946-4481 (24 hours) FAX: (405) 946-3336
Oklahoma	**Tulsa - (Branch of Arlington)**	Cummins Southern Plains, Inc. 16525 East Skelly Drive Tulsa, OK 74116 Telephone: (918) 234-3240 FAX: (918) 234-2342
Oregon	**Bend - (Branch of Seattle)**	Cummins Northwest, Inc. 3500 N. Highway 97 (97701-5729) P.O. Box 309 Bend, OR 97709-0309 Telephone: (541) 389-1900 FAX: (541) 389-1909
Oregon	**Coburg/Eugene - (Branch of Seattle)**	Cummins Northwest, Inc. 91201 Industrial Parkway Coburg, OR 97401 (Mailing Address) P.O. Box 10877 Eugene, OR 97440-2887 Telephone: (541) 687-0000 FAX: (541) 687-1977
Oregon	**Medford - (Branch of Seattle)**	Cummins Northwest, Inc. 4045 Crater Lake Highway Medford, OR 97504-9796 Telephone: (541) 779-0151 FAX: (541) 772-2395
Oregon	**Pendleton - (Branch of Seattle)**	Cummins Northwest, Inc. 223 S.W. 23rd Street Pendleton, OR 97801-1810 Telephone: (541) 276-2561 FAX: (541) 276-2564
Oregon	**Portland - (Branch of Seattle)**	Cummins Northwest, Inc. 4711 N. Basin Avenue P. O. Box 2710 (97208-2710) Portland, OR 97217-3557 Telephone: (503) 289-0900 FAX: (503) 286-5938
Pennsylvania	**Philadelphia Distributor**	Cummins Power Systems, Inc. 2727 Ford Road Bristol, PA 19007 Telephone: (215) 785-6005 and (609) 563-0005 FAX: (215) 785-4085

Pennsylvania	**Bristol Branch**	Cummins Power Systems, Inc. 2727 Ford Road Bristol, PA 19007 Telephone: (215) 785-6005 and (609) 563-0005 FAX: (215) 785-4728
Pennsylvania	**Pittsburgh Branch**	Cummins Power Systems, Inc. 3 Alpha Drive Pittsburgh, PA 15238-2901 Telephone: (412) 820-8300 FAX: (412) 820-8308
Pennsylvania	**Harrisburg Branch**	Cummins Power Systems, Inc. 4499 Lewis Road Harrisburg, PA 17111-2541 Telephone: (717) 564-1344 FAX: (717) 558-8217
Puerto Rico	**Puerto Nuevo - (Branch of Tampa)**	Cummins Diesel Power, Inc. #31 Calle "C" El Matadero Puerto Nuevo, Puerto Rico 00920 Telephone: (787) 793-0300 FAX: (787) 793-1072
South Carolina	**Charleston - (Branch of Charlotte)**	Cummins Atlantic, Inc. 3028 West Montague Avenue Charleston, SC 29418-5593 Telephone: (843) 554-5112 FAX: (843) 745-0745
South Carolina	**Charleston - (Branch of Charlotte)**	Cummins Atlantic Inc. 231 Farmington Road Charleston, SC 29483 Telephone: (843) 851-9819 FAX: (843) 875-4338
South Carolina	**Columbia - (Branch of Charlotte)**	Cummins Atlantic, Inc. 1233 Bluff Road (29201) P.O. Box 13543 Columbia, SC 29201-3543 Telephone: (803) 799-2410 FAX: (803) 779-3427
South Dakota	**Sioux Falls - (Branch of Omaha)**	Cummins Great Plains Diesel, Inc. 701 East 54th Street North Sioux Falls, SD 57104 Telephone: (605) 336-1715 FAX: (605) 336-1748
Tennessee	**Memphis Distributor & Distribution Center**	Cummins Mid-South, Inc. 666 Riverside Drive Memphis, TN 38703 Telephone: (901) 577-0666 FAX: (901) 522-8758
Tennessee	**Chattanooga - (Branch of Atlanta)**	Cummins South, Inc. 1509 East 26th Street Chattanooga, TN 37407-1095 Telephone: (615) 629-1447 FAX: (615) 629-1494

Tennessee	**Knoxville - (Branch of Louisville)**	Cummins Cumberland, Inc. 1211 Ault Road Knoxville, TN 37914 Telephone: (423) 523-0446 FAX: (423) 523-0343
Tennessee	**Memphis Branch**	Cummins Mid-South, Inc. 1784 E. Brooks Road Memphis, TN 38116 Telephone: Sales/Admin.: (901) 345-7424 Parts: (901) 345-1784 Service: (901) 345-6185 FAX: (901) 346-4735
Tennessee	**Nashville - (Branch of Louisville)**	Cummins Cumberland, Inc. 706 Spence Lane Nashville, TN 37217 Telephone: (615) 366-4341 FAX: (615) 366-5693
Texas	**Arlington Distributor**	Cummins Southern Plains, Inc. 600 N Watson Road Arlington, TX 76004-3027 Telephone: (817) 640-6801 FAX: (817) 640-6852
Texas	**Amarillo Branch**	Cummins Southern Plains, Inc. 5224 Interstate 40 - Expressway East P.O. Box 31570 Amarillo, TX 79120-1570 Telephone: (806) 373-3793 (24 hours) FAX: (806) 372-8547
Texas	**Dallas Branch**	Cummins Southern Plains, Inc. 3707 Irving Boulevard Dallas, TX 75247 Telephone: (214) 631-6400 (24 hours) FAX: (214) 631-2322
Texas	**El Paso - (Branch of Phoenix)**	Cummins Southwest, Inc. 14333 Gateway West El Paso, TX 79927 Telephone: (915) 852-4200 FAX: (915) 852-3295
Texas	**Fort Worth Branch**	Cummins Southern Plains, Inc. 3250 North Freeway Fort Worth, TX 76111 Telephone: (817) 624-2107 (24 hours) FAX: (817) 624-3296
Texas	**Houston Branch**	Cummins Southern Plains, Inc. 4750 Homestead Road P.O. Box 1367 Houston, TX 77251-1367 Telephone: (713) 675-7421 (24 hours) FAX: (713) 675-1515

Texas	**Mesquite Branch**	Cummins Southern Plains, Inc. 2615 Big Town Blvd. Mesquite, TX 75150 Telephone: (214) 321-5555 (24 hours) FAX: (214) 328-2732
Texas	**Odessa Branch**	Cummins Southern Plains, Inc. 1210 South Grandview P.O. Box 633 Odessa, TX 79760-0633 Telephone: (915) 332-9121 (24 hours) FAX: (915) 333-4655
Texas	**San Antonio Branch**	Cummins Southern Plains, Inc. 6226 Pan Am Expressway North P.O. Box 18385 San Antonio, TX 78218-0385 Telephone: (512) 655-5420 (24 hours) FAX: (512) 655-3865
Texas	**Houston Onan Branch**	Southern Plains Power A Division of Cummins Southern Plains 1155 West Loop North Houston, TX 77055 Telephone: (713) 956-0020 FAX: (713) 956-0266
Utah	**Salt Lake City Distributor**	Cummins Intermountain, Inc. 1030 South 300 West Salt Lake City, UT 84101 Telephone: (801) 355-6500 FAX: (801) 524-1351
Utah	**Vernal Branch**	Cummins Intermountain, Inc. 1435 East 335 South Vernal, UT 84078 Telephone: (435) 789-5732 FAX: (435) 789-2853
Virginia	**Cloverdale - (Branch of Charlotte)**	Cummins Atlantic, Inc. 263 Simmons Drive Cloverdale, VA 24077 Telephone: (540) 966-3169 FAX: (540) 966-3749
Virginia	**Richmond - (Branch of Charlotte)**	Cummins Atlantic, Inc. 3900 Deepwater Terminal Road Richmond, VA 23234 Telephone: (804) 232-7891 FAX: (804) 232-7428
Virginia	**Tidewater - (Branch of Charlotte)**	Cummins Atlantic, Inc. Atlantic Power Generation 3729 Holland Blvd. Chesapeake, VA 23323 Telephone: (757) 485-4848 FAX: (757) 485-5085
Washington	**Seattle Distributor**	Cummins Northwest, Inc. 811 S.W. Grady Way (98055-2944) P.O. Box 9811 Renton, WA 98057-9811 Telephone: (425) 235-3400 FAX: (425) 235-8202

Washington	**Chehalis Branch**	Cummins Northwest, Inc. 926 N.W. Maryland Chehalis, WA 98532-0339 Telephone: (360) 748-8841 FAX: (360) 748-8843
Washington	**Spokane Branch**	Cummins Northwest, Inc. 11134 W. Westbow Blvd. Spokane, WA 99204 Telephone: (509) 455-4411 FAX: (509) 624-4681
Washington	**Tacoma Branch**	Cummins Northwest, Inc. 3701 Pacific Highway East Tacoma, WA 98424-1135 Telephone: (253) 922-2191 FAX: (253) 922-2379
Washington	**Yakima Branch**	Cummins Northwest, Inc. 1905 East Central Avenue (98901-3609) P.O. Box 9129 Yakima, WA 98909-0129 Telephone: (509) 248-9033 FAX: (509) 248-9035
West Virginia	**Charleston - (Branch of Louisville)**	Cummins Cumberland, Inc. 3100 MacCorkle Ave. SW P.O. Box 8456 South Charleston, WV 25303 Telephone: (304) 744-6373 FAX: (304) 744-8605
West Virginia	**Fairmont - (Branch of Louisville)**	Cummins Cumberland, Inc. South Fairmount Exit, I-79 145 Middletown Road Fairmont, WV 26554 Telephone: (304) 367-0196 FAX: (304) 367-1077
Wisconsin	**DePere Distributor**	Cummins Great Lakes, Inc. Corporate Office 875 Lawrence Drive P.O. Box 5070 DePere, WI 54115-5070 Telephone: (920) 337-1991 FAX: (920) 337-9746
Wisconsin	**Chippewa Falls Branch**	Cummins Great Lakes, Inc. 2030 St. Highway 53 Chippewa Falls, WI 54729 Telephone: (715) 720-0680 FAX: (715) 720-0685
Wisconsin	**DePere Branch**	Cummins Great Lakes, Inc. 939 Lawrence Drive P. O. Box 5070 DePere, WI 54115-5070 Telephone: (920) 336-9631 (800) 236-1191 FAX: (920) 336-8984

Wisconsin	**Milwaukee Branch**	Cummins Great Lakes, Inc. 9401 South 13th Street P.O. Box D Oak Creek, WI 53154 Telephone: (414) 768-7400 (800) 472-8283 FAX: (414) 768-9441
Wisconsin	**Wausau Branch**	Cummins Great Lakes, Inc. 4703 Rib Mountain Drive Wausau, WI 54401 Telephone: (715) 359-6888 (800) 236-3744 FAX: (715) 359-3744
Wyoming	**Gillette - (Branch of Denver)**	Cummins Rocky Mountain, Inc. 2700 Hwy. 14 & 16 North P.O. Box 1207 (82717) Gillette, WY 82716 Telephone: (307) 682-9611 FAX: (307) 682-8242
Wyoming	**Rock Springs - (Branch of Salt Lake City)**	Cummins Intermountain, Inc. 2000 Foothill Blvd. P.O. Box 1634 Rock Springs, WY 82901 Telephone: (307) 362-5168 FAX: (307) 362-5171

Distributors and Branches - Canada

Alberta	**Edmonton Distributor and Branch**	Cummins Alberta 11751 - 181 Street Edmonton, AB T5S 2K5 Telephone: (780) 455-2151 FAX: (780) 454-9512
Alberta	**Calgary Branch**	Cummins Alberta 4887 - 35th Street S.E. Calgary, Alberta T2B 3H6, Canada Telephone: (403) 569-1122 FAX: (403) 569-0027
Alberta	**Grande Prairie**	Cummins Alberta - Grande Praire RR2, Site 9, Box 22 Sexsmith, AB CN T0H 3C0 Telephone: (780) 568-3359 FAX: (780) 568-2263
Alberta	**Hinton Branch**	Cummins Alberta 135 Veats Avenue Hinton, Alberta T7V 1S8, Canada Telephone: (780) 865-5111 FAX: (780) 865-5714
Alberta	**Lethbridge Branch**	Cummins Alberta 240 - 24th Street North Lethbridge, Alberta T1H 3T8, Canada Telephone: (403) 329-6144 FAX: (403) 320-5383
British Columbia	**Vancouver Distributor**	Cummins British Columbia 18452 - 96th Avenue Surrey, B.C., Canada V4N 3P8 Telephone: (604) 882-5000 FAX: (604) 882-5080
British Columbia	**Kamloops Branch**	Cummins British Columbia 976 Laval Crescent Kamloops, B.C. Canada V2C 5P5 Telephone: (250) 828-2388 FAX: (250) 828-6713
British Columbia	**Prince George Branch**	Cummins British Columbia 102- 3851- 18th Avenue Prince George, B.C. V2N 1B1 Telephone: (250) 564-9111 FAX: (250) 564-5853
British Columbia	**Sparwood Branch**	Cummins British Columbia 731 Douglas Fir Road Sparwood, B.C. VOB 2GO, Canada Telephone: (250) 425-0522 FAX: (250) 425-0323
British Columbia	**Tumbler Ridge Branch**	Cummins British Columbia Industrial Site, Box 226 Tumbler Ridge, B.C. Canada VOC 2WO Telephone: (250) 242-4217 FAX: (250) 242-4906

Manitoba	**Winnipeg Distributor**	Cummins Mid-Canada Ltd. 489 Oak Point Road P.O. Box 1860 Winnipeg, MB R3C 3R1, Canada Telephone: (204) 632-5470 FAX: (204) 697-0267
New Brunswick	**Fredericton - (Branch of Montreal)**	Cummins Eastern Canada, Inc. R.R.#1 Doak Road P.O. Box 1178, Station 'A' Fredericton, New Brunswick E3B 4X2, Canada Telephone: (506) 451-1929 FAX: (506) 451-1921
Newfoundland	**St. John's - (Branch of Montreal)**	Cummins Eastern Canada, Inc. 122 Clyde Avenue Donovans Industrial Park Mount Pearl, Newfoundland A1N 2C2 Canada Telephone: (709) 747-0176 FAX: (709) 747-2283
Newfoundland	**Wabush - (Branch of Montreal)**	Cummins Eastern Canada, Inc. Wabush Industrial Park Wabush, Newfoundland A0R 1B0 Telephone: (709) 282-3626 FAX: (709) 282-3108
Nova Scotia	**Halifax - (Branch of Montreal)**	Cummins Eastern Canada, Inc. 50 Simmonds Drive Dartmouth, Nova Scotia B3B 1R3 Telephone: (902) 468-7938 FAX: (902) 468-5177 Parts: (902) 468-6560
Ontario	**Toronto Distributor**	Cummins Ontario, Inc. 7175 Pacific Circle Mississauga, ON L5T 2A5 Telephone: (905) 795-0050 FAX: (905) 795-0021
Ontario	**Kenora - (Branch of Winnipeg)**	Cummins Mid-Canada Ltd. Highway 17 East P.O. Box 8 Kenora, Ontario P9N 3X1 Telephone: (807) 548-1941 FAX: (807) 548-8302
Ontario	**Ottawa Branch**	Cummins Ontario Inc. 3189 Swansea Crescent Ottawa, Ontario K1G 3W5, Telephone: (613) 736-1146 FAX: (613) 736-1202
Ontario	**Thunder Bay Branch**	Cummins Ontario Inc. 1400 W. Walsh Street Thunder Bay Ontario P7E 4X4 Telephone: (807) 577-7561 FAX: (807) 577-1727

Ontario	**Whitby Branch**	Cummins Ontario Inc. 1311 Hopkins Street Whitby, Ontario L1N 2C2, Canada Telephone: (905) 668-6886 FAX: (905) 668-1375
Quebec	**Montreal Distributor**	Cummins Eastern Canada, Inc. 7200 Trans Canada Highway Pointe Claire, Quebec H9R 1C2, Telephone: (514) 695-8410 FAX: (514) 695-8917
Quebec	**Montreal Branch**	Cummins Eastern Canada, Inc. 7200 Trans Canada Highway Pointe Claire, Quebec H9R 1C2, Canada Telephone: (514) 695-8410 Sales: (514) 695-4555 Parts: (514) 694-5880 FAX: (514) 695-8917
Quebec	**Dorval Onan Branch**	Cummins, Eastern Canada, Inc. 580 Lepihe Dorval, Quebec H9H 1G2 Telephone: (514) 631-5000 FAX: (514) 631-0104
Quebec	**Quebec City Branch**	Cummins Diesel Branch of Cummins Americas, Inc. 2575 Dalton Street Ste. Foy, Quebec G1P 3S7 Telephone: (418) 653-6411 FAX: (418) 653-5844
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Distributors and Branches - Australia

Branches:	**Gepps Cross**	Cummins Engine Company, Pty. Ltd. P.O. Box 108 Blair Athol, 5084 South Australia, Australia Location: 45-49 Cavan Road Gepps Cross, 5094 Telephone: (61-8) 8262-5211
Branches:	**Dosra**	Cummins Engine Company, Pty. Ltd. P.O. Box 124 Darra, 4076 Queensland, Australia Location: 33 Kimberley Street Darra, 4076, Australia Telephone: (61-7) 3375-3277
Branches:	**Bunbury**	Cummins Engine Company, Pty. Ltd. P.O. Box 1751 Bunbury, WA 6230 Australia Location: 11 Dryanda Court Picton, WA 6230 Telephone: (61-8) 9725-6777 FAX: (61-8) 9725-6444
Branches:	**Cairns**	Cummins Engine Company, Pty. Ltd. P.O. Box 7189 Cairns Mail Centre, 4870 Queensland, Australia Location: Liberty Street Cairns, 4870 Telephone: (61-7) 935-2999
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Branches:	**Darwin**	Cummins Engine Company, Pty. Ltd. P.O. Box 37587 Winnellie, 0821 Northern Territory, Australia Location: Lot 1758 Graffin Crescent Winnellie, 0821 Telephone: (61-8) 8947-0766

Branches:	**Devonport**	Cummins Engine Company, Pty. Ltd. P.O. Box 72E Tasmania, Australia Location: 2 Matthews Way Devonport, 7310 Telephone: (61-3) 6424-8800
Branches:	**Emerald**	Cummins Engine Company, Pty. Ltd. P.O. Box 668 Emerald, 4720 Queensland, Australia Location: Capricorn Highway Emerald, 4720 Telephone: (61-7) 4982-4022
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Branches:	**Kalgoorlie**	Cummins Engine Company, Pty. Ltd. P.O. Box 706 Kalgoorlie, 6430 Western Australia, Australia Location: 16 Atbara Street Kalgoorlie, 6430 Telephone: (61-8) 9021-2588
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Branches:	**Queanbeyan**	Cummins Engine Company, Pty. Ltd. P.O. Box 527 Queanbeyan, 2620 New South Wales, Australia Location: 15-27 Bayldon Road Queanbeyan, 2620 Telephone: (61-2) 6297-3433 FAX: (61-2) 6297-6709
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Branches:	**Townsville**	Cummins Engine Company, Pty. Ltd. P.O. Box 7339 Garbutt Business Centre, QLD4814 Australia Location: 704-710 Ingham Road Townsville, QLD 4814 Telephone: (61-7) 4774-7733 FAX: (61-7) 4774-7640
Branches:	**Welshpool**	Cummins Engine Company, Pty. Ltd. P. O. Box 52 Welshpool, 6986 Western Australia, Australia Location: 50 Kewdale Road Welshpool, 6106 Telephone: (61-8) 9458-5911
Branches:	**Wetherill Park**	Cummins Engine Company, Pty. Ltd. Private Bag 150 Wetherill Park, NSW 2164 Australia Location: 492-494 Victoria Street Wetherill Park, NSW 2164 Australia Telephone: (61-2) 9616-5300 FAX: (61-2) 9616-5399
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Branches:	**Christchurch**	Cummins Engine Company, Pty. Ltd. P.O. Box 16-149 Hornby, Christchurch, New Zealand Location: 35 Parkhouse Road Sockburn, Christchurch Telephone: (64-3) 348-8170
Branches:	**Dunedin**	Cummins Engine Company, Pty. Ltd. P.O. Box 2333 South Dunedin, New Zealand Location: 8 Devon Street Dunedin Telephone: (643) 477-8818
Branches:	**Palmerston North**	Cummins Engine Company, Pty. Ltd. P.O. Box 9024 Palmerston North, New Zealand Location: 852-860 Tremaine Avenue Telephone: (64-6) 356-2209
Branches:	**Rotorua**	Cummins Engine Company, Pty. Ltd. P.O. Box 934 Rotorua, New Zealand Location: 328 Te Ngae Road Rotorua Telephone: (647) 345-6699

Regional Offices - International - Locations

European Regional Office - Mechelen

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Countries Covered:

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- Czech Republic
- Denmark
- Finland
- Greece
- Hungary
- Iceland
- Israel
- Luxembourg
- Netherlands
- Norway
- Portugal
- Slovakia
- Spain
- Sweden
- Switzerland

Cumbrasa Regional Office - Brazil

Cummins Brasil S.A.
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07180-900 Guarulhos
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Sao Paulo, Brazil
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Country Covered:

- Brazil

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Countries Covered:

- China
- Mongolia

Bogota Regional Office - Columbia	
Cummins Engine Co. de Colombia S.A. Carrera 11A No. 90-15 Of. 601/602 Bogota, D.E., Colombia Telephone: (57-1) 610-4849	Mailing Address: Apartado Aereo 90988 Bogota D.E., Colombia

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Hong Kong Regional Office - Hong Kong	
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Country Covered:	
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Country Covered: South Korea	

Cummsa Regional Office - Mexico	
Cummins, S.A. de C.V. Arquimedes No. 209 Col. Polanco 11560 Mexico, D.F. Mexico Telephone: (52-5) 254-3822/3783/3622	Mailing/Shipping Address: Gonzalez de Castilla Inc. P.O. Box 1391 4605 Modern Lane Modern Industrial Park Laredo, TX 78040 Telephone: (512) 722-5207
Country Covered: Mexico	

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Countries Covered:

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- Belarus
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South And East Asia Area Office - Singapore

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Jurong Industrial Estate
Singapore 2260
Telephone: (65) 265-0155

Countries Covered:

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- Brunei
- Burma/Mynamar
- Cambodia
- Indonesia
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- Malaysia
- Mongolia
- Philippines
- Singapore
- Sri Lanka
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- Vietnam

Taipei Regional Office - Taiwan

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Country Covered: Taiwan

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Iran	Turkey	

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NORTH/WEST/EAST AND CENTRAL AFRICA

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Central African Republic	Guinea-Bissau	Sao Tome & Principe
	Ivory Coast	
Chad	Liberia	Senegal
Congo (D.R.)		Seychelles
Congo (P.R.)		
	Libya	Siera Leone
Djibouti		Somalia
Equatorial Guinea	Mali	Togo
	Malta	Tunisia
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Latin America Regional Office - Miramar (U.S.A.)	
Cummins Americas, Inc. Miramar Park of Commerce 3450 Executive Way Miramar, FL 33025 Telephone: (305) 431-5511	

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- Bolivia
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- Colombia
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- Peru
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Counties Covered:

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- Dominican Republic
- El Salvador
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- Nicaragua
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- Comoros Island
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- Malawi
- Mauritius
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- Swaziland
- South Africa
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Distributors - International - Locations

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AFGHANISTAN		- See Middle East Regional Office
ALBANIA		- See Germany Regional Office - Gross-Gerau
ALGERIA		- See Cummins Diesel S.A. - Lyon
AMERICAN SAMOA		- See South Pacific Regional Office
ANDORRA		- See European Regional Office - Mechelen
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BOTSWANA		- See Southern Africa Regional Office - Kelvin
BRAZIL	**Ananindeua**	Marcos Marcelino & Companhia Ltda. Rodovia BR-316, Km 9 67020-010 Ananindeua, Para, Brazil Telephone: (55-91) 235-4100/4132/ 4143/4012

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BRAZIL	**Fortaleza**	Distribuidora Cummins Diesel Do Nordeste Ltda. Av. da Abolicao, 3882, Mucuripe 60165-081 Fortaleza, Ceara Brazil Telephone: (55-85) 263-1212
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BRUNEI		- See Malaysia
BURKINA - FASO		- See North/West/East and Central Africa Regional Office - Daventry
BULGARIA		-See Germany Regional Office - Gross-Gerau
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CAPE VERDE		- See ECV Portugal
CENTRAL AFRICAN REPUBLIC		- See North/West Africa Regional Office - Daventry
CEYLON		- See Sri Lanka
CHAD		- See North/West/East and Central Africa Regional Office - Daventry
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COLOMBIA	**Bucaramanga**	Cummins API, Ltda. Apartado Aereo 352 Bucaramanga, Colombia Location: Autopista a Giron, Km 7 Telephone: (57-76) 468060
COLOMBIA	**Cali**	Distribuidora Cummins del Valle, Ltda. Apartado Aereo No. 6398 Cali, Colombia Location: Av. 3a. # 39-35 - Vipasa Telephone: (57-3) 65-4343
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CORSICA		- See France
COSTA RICA	**San Jose**	Servicios Unidos, S.A. P.O. Box 559 San Jose, Costa Rica Location: 100 metros al este de Excelsior Antiguo Curridabat, San Jose Telephone Office: (506) 53-93-93 Telephone Service Shop: (506) 26-00-76
CUBA	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200

CYPRUS	**Nicosia**	Alexander Dimitriou & Sons Ltd. P.O. Box 21932 Nicosia, Cyprus CY-1515 Location: 4 Salamis Avenue Telephone: (357-2) 349450
CZECH REPUBLIC		- See Austrian Distributor
DENMARK	**Glostrup**	Cummins Diesel Salg & Service A/S Hovedvejen 233B Osted DK-4000 Roskilde Denmark Telephone: (45-46) 423 552
DJIBOUTI		- See North/West/East and Central Africa
DOMINICA	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
DOMINICAN REPUBLIC	**Santo Domingo**	Argico C. Por A. P.O. Box 292-2 Feria Santo Domingo Dominican Republic, ZP-6 Location: Calle Jose A. Soler No. 3, ESQ. Avenida Lope de Vega Telephone: (809) 562-6281
DUBAI		- See United Arab Emirates
ECUADOR	**Guayaquil**	Motores Cummins (MOTCUM) S.A. P.O. Box 1062 Guayaquil, Ecuador Location: Avenida Carlos Julio Arosemena Km. 4 Telephone: (593-4) 203995/201177
ECUADOR	**Quito**	Rectificadora Botar S.A. P.O. Box 17-01-3344 Quito, Ecuador Location: Av. 10 de Agosto No. 5980 Telephone: (593-2) 465-176/177/ 178/195/197
EGYPT	**Cairo**	ADAT P.O. Box 1572 Cairo, Egypt Sales and Service Location: 25, Pyramid Road Giza, Cairo, Egypt Telephone: (20-2) 385-4001/2/4/5/6/8/9

EL SALVADOR	**San Salvador**	Salvador Machinery Company, S.A. de C.V. P.O. Box 125 San Salvador, El Salvador Location: Blvd. Ejercito Nacional Telephone: (503) 711022, 228388
ENGLAND		- See United Kingdom
EQUATORIAL GUINEA		- See North/West/East and Central Africa Regional Office - Daventry
ESTONIA		- See Gross Gerau Regional Office - Germany
FAROE ISLANDS	**Wellingborough (Office in United Kingdom)**	Cummins Diesel Rutherford Drive Park Farm South Wellingborough Northants NN8 2QH, England Telephone: (44-1933) 334200
FERNANDO PO		- See Spain
FIJI		- See Cummins Diesel Sales & Service New Zealand Ltd.
FINLAND	**Helsinki**	Machinery OY P.O. Box 560 FIN 01741 Varta Finland Telephone: Int: (358-9) 8955 2215
FRANCE	**Lyon**	Cummins Diesel S.A. Sales Corporation 39, rue Ampere Z.I. 69680 Chassieu, France Telephone: (33) 72-22-92-72 Parts and Service Telephone: (33) 72-22-92-69
GABON		- See North/West/East and Central Africa Regional Office - Daventry
GAMBIA		- See Matforce Senegal
GEORGIA		- See Moscow Regional Office - Moscow
GERMANY	**Gross-Gerau**	Cummins Diesel Deutschland GmbH P.O. Box 1134 D-6080 Gross-Gerau, Germany Location: Odenwaldstr. 23 Telephone: (49-6152) 174-0
GHANA	**Accra**	J&D Diesels and Systems P.O. Box c2381 Cantonments Accra, Ghana Telephone: (233-21) 30-14-51

GREECE	**Athens**	Ergotrak Box 51528 14 Km. National Rd. Athens-Lamia 14510 Kifissia, Greece Telephone: (30-1) 6293400/41
GREENLAND		- See Denmark
GRENADA	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
GUADELOUPE	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
GUAM	**Barrigada**	Mid-Pac Far East, Inc. Airport Industrial Park 825 Tiyan Parkway Barrigada, Guam 96921 Telephone: (671) 632-5160
GUATEMALA	**Guatemala City**	Maquinaria y Equipos, S.A. P.O. Box 2304 Guatemala City, Guatemala Location: Carretera Amatitlan Km 12 zona 12 Telephone: (502-2) 773334/7/9
GUINEA	**Brussels (Office in Belgium)**	BIA s.a. Rameistraat, 123 B-3090 - Overijse, Belgium Telephone: (32-2) 6892811
GUINEA BISSAU		- See North/West/East and Central Africa Regional Office - Daventry
GUYANA	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
GUYANA, FRENCH	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
HAITI	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
HOLLAND		- See Netherlands

HONDURAS	**Tegucigalpa**	Comercial Laeisz Honduras, S.A. P.O. Box 1022 Tegucigalpa, D.C., Honduras Location: Zona La Burrera, Blvd. Toncontin Frente a Gasolinera Esso. Telephone: (504) 333570/335615
HONG KONG	**Kowloon**	Cummins Engine H. K. Ltd. P.O. Box 840 Shatin N.T., Hong Kong Location: Unison Industrial Centre 15th Floor, Units C & D 27-31 Au Pui Wan Street Fo Tan, Shatin, Hong Kong Telephone: (852) 2606-5678 Fax: (852) 2691-1641, 2687-3552
ICELAND	**Velasalan H.F.**	Ananaustrum 1 121 Reykjavik Iceland Telephone: (354) 5526122
INDIA	**Pune**	Cummins Diesel Sales & Service (India) Ltd. 35A/1/2, Erandawana Pune - 411 038, (State of Maharashtra) India Telephone: (91-212) 331234, 331554, 331635, 330066, 330166, 330356, 331703
INDIA	**Bombay**	Cummins Diesel Sales & Service (I) Ltd. 298, Perin Nariman Street, Fort, Bombay 400001, India Telephone: (91-22) 2863566/2862247
INDIA	**Calcutta**	Cummins Diesel Sales & Service (I) Ltd. 94, Tivoli Court, I/C Ballygunge Circular Road Calcutta 700 019 (West Bengal), India Telephone: (91-33) 2478065/2470481/ 2470774
INDIA	**New Delhi**	Cummins Diesel Sales & Service (I) Ltd. Flat No. 307, Meghdoot Building 94 Nehru Place New Delhi 110 019, India Telephone: (91-11) 6431051/6445756/ 6452817
INDIA	**Raipur**	Cummins Diesel Sales & Service (I) Ltd. Plot No. 15, Jalashay Marg Choube Colony Raipur 492 001 (Madhya Pradesh), India Telephone: (91-771) 24994/23157/29498

INDIA	**Ranchi**	Cummins Diesel Sales & Service (I) Ltd. `Shanti Kunj' C-202, Vidyalaya Marg Road No. 1, Ashoknagar Ranchi 834 002 (Bihar) India Telephone: (91-651) 301948/303623
INDONESIA	**Jakarta**	P.T. Alltrak 1978 P.O. Box 64/KBYL Jakarta Selatan 12330, Indonesia Location: J1. R.S.C. Veteran No. 4 Bintaro, Rempoa Telephone: (62-21) 736-1978/736-3302
IRAN		- See Middle East Regional Office - United Arab Emirates
IRAQ		- See Middle East Regional Office or United Arab Emirates
IRELAND	**Wellingborough (Office in England)**	Cummins Diesel Denington Estate Wellingborough Northants NN8 2QH, England Telephone: (44-1933) 334200
ISRAEL	**Tel Aviv**	Israel Engines & Trailers Co. Ltd. Levinson Brothers Engineers P. O. Box 390 33 Hahashmal Street Tel Aviv, Israel 61003 Telephone: (972-3) 7106222
ITALY	**Milan**	Cummins Diesel Italia S.p.A. Piazza Locatelli, 8 Zona Industriale Sesto Ulteriano 20098 S. Giuliano Milanese (Milan), Italy Telephone: (39-2) 9828-1235/6/7
IVORY COAST		- See Cote d' Ivoire
JAMAICA	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
JAPAN	**Tokyo**	Cummins Diesel (Japan) Ltd. 1-12-10-Shintomi Chuo-ku, Tokyo 104 Japan Telephone: (81-3) 3555-8511
JORDAN	**Amman**	S.E.T.I. Jordan Limited P.O. Box 8053 Amman, Jordan Telephone: (962-6) 621867/621884

KENYA	**Nairobi**	Werrot & Company Limited P.O. Box 41216 Nairobi, Kenya Location: Lusaka Road Telephone: (254-150) 20316
KOREA, SOUTH	**Seoul**	Hwa Chang Trading Co., Ltd. Central P.O. Box No. 216 Seoul, South Korea Location: 143-11 Doksan-dong, Kuro-ku Telephone: (82-2) 854-0071/2/3/4/5, 869-1411/2/3
KUWAIT	**Kuwait**	General Transportation & Equipment Co. (Sales Department) P.O. Box 1096 13011 Safat, Kuwait Location: Shuwaikh Behind Canada Dry Factory Telephone: (965) 4833380/1/2
KUWAIT	**Kuwait**	General Transportation & Equipment Co. (Service Department) East Ahmadi Area 13011 Safat, Kuwait Telephone: (965) 3981577
LAOS		- See South and East Asia Regional Office - Singapore
LATVIA		- See Moscow Regional Office - Moscow
LEBANON	**Beirut**	S.E.T.I. Charles Keller S.A.L. B.P. 16-6726 Beirut, Lebanon Location: Corniche du Fleuve Telephone: (961-1) 425040/41
LESOTHO		- See South Africa
LIBYA		- See North/West Africa Regional Office - Daventry
LIECHTENSTEIN		- See Switzerland
LUXEMBOURG	**Gross-Gerau (Office in Germany)**	Cummins Diesel Deutschland GmbH P.O. Box 11 34 Odenwaldstrasse 23 D-6080 Gross-Gerau, Germany Telephone: (49-6152) 174-0
MACAU		- See Hong Kong
MADAGASCAR		- See East and Southern Africa Regional Office - Harare
MADEIRA ISLANDS		- See Portugal

MALAYSIA	**Kuala Lumpur**	Cummins Diesel Sales & Service Div. of Scott & English (M) Sdn. Bhd. P.O. Box 10324 50710 Kuala Lumpur, West Malaysia Location: 16 Jalan Chan Sow Lin 55200 Kuala Lumpur Telephone: (60-3) 2211033
MALI		- See Senegal (Matforce)
MALTA	**Valletta**	Plant & Equipment Ltd. Regency House 254, Republic Street Valletta, Malta Telephone: (356) 23-26-20, 23-33-43, 23-16-23, 24-75-17
MARTINIQUE	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
MEXICO	**Guadalajara**	Cummins Del Occidente, S.A. Lazaro Cardenas No. 2950 Fracc. Alamo Industrial 45560 Guadalajara, Jal. Mexico Telephone: (52-3) 670-93-06, 670-53-38, 670-63-61, 670-62-33
MEXICO	**Monterrey**	Tecnica Automotriz, S.A. Av. Alfonso Royes No. 3637 Nte. Monterrey, Nuevo Leon, Mexico Telephone: (52-83) 51-41-51, 51-46-56
MEXICO	**Merida**	Cummins Del Sureste, S.A. de C.V. Av. Aviacion Civil No. 647 Esquina Calle 100 Col. Sambula 97259 Merida, Yucatan, Mexico Telephone: (52-99) 24-11-55, 24-00-15
MEXICO	**Puebla**	Cummins de Oriente, S.A. de C.V. Av. Reforma No. 2112, Puebla, Pue. Mexico Telephone: (52-22) 48-76-74, 48-76-75
MEXICO	**Queretaro**	Distribuidor Cummins Del Centro, S.A. de C.V. Blvd. Bernardo Quintana No. 518 Col. Arboledas C.P. 76140 Queretaro, Qro., Mexico Telephone: (52-42) 12-41-90, 12-58-90, 12-62-94, 14-04-16, 14-08-81, 14-15-91
MEXICO	**Tlalnepantla**	Distribuidor Cummins Metropolitana, S.A. DE C.V. Sor Juana Ines de la Cruz No. 555 54000 Tlalnepantla, Edo. de Mexico, Mexico Telephone: (52-5) 327-38-00, 390-64-37, 390-12-27

MOROCCO	**Casablanca**	Soberma (Groupe Auto Hall) Société Soberma Chamin Ain Borja Quartier Beausite Ain Sebaâ Casablanca, Morocco Telephone: (212-22) 66 66 40-43 Fax: (212-22) 66 66 45-46
MOZAMBIQUE		- See Southern Africa Regional Office - Kelvin
NAMIBIA (Southwest Africa)	**Walvis Bay**	Namib Diesel P.O. Box 2449, Walvis Bay, Namibia Location: 210, 2nd Street Walvis Bay, Namibia Telephone: 064-203971
NEPAL	**Pune (Office in India)**	Cummins Diesel Sales & Service (India) Ltd. 35A/1/2, Erandawana Pune, - 411 038, (State of Maharashtra) India Telephone: (91-212) 331234, 331554, 331635, 330066, 330166, 330356, 331703
NETHERLANDS	**Dordrecht**	Cummins Diesel Sales & Service, B.C. Galvanistraat 35 3316 GH Dordrecht Netherlands Telephone: (31-78) 618-12-00
NETHERLANDS ANTILLES	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
NEW CALEDONIA		- See South Pacific Regional Office - Melbourne
NEW GUINEA		- See Papua New Guinea
NICARAGUA	**Managua**	F. Alf. Pellas & Cia. Apartado Postal No. 46 Managua, Nicaragua Location: 6a. Calle 30 y 31 Avs. N.O., Zona 5 Telephone: (505-2) 660616
NIGERIA	**Lagos**	SCOA TRAC P.M.B. 21108 Ikeja, Lagos Nigeria Location: Apapa-Oshodi Expressway Isolo Industrial Estate, Isolo Telephone: (234-1) 45-21-539/45-21-803

NIGERIA	**Paris (Office in France)**	SCOA INTER Immeuble Marie-Joseph Rue du Maréchal de Lattre de Tassigny 78990 Elancourt France Telephone: (33-1) 30-68-82-68
NORTHERN IRELAND		- See United Kingdom
NORWAY	**Oslo**	Cummins Diesel Salg & Service A/S Hestehagen 3 Postboks 151 N-1441 DR0BAK Norway Telephone: (47) 64 90 70 80
OMAN	**Ruwi**	Universal Engineering Services L.L.C. P.O. Box 2688 Ruwi Sultanate of Oman Telephone: (968) 590830, 591304
PAKISTAN	**Karachi**	Diesel Power Systems 2 Bangalore Town Main Shahrah-e-Faisal Karachi 75350 Pakistan Telephone: (92) 21-453 9603/4/5
PANAMA	**Panama City**	Grupo Tiesa, S.A. Apartado Postal #55-0549 Partillo, Panama Telephone: (507) 67-3866
PAPUA NEW GUINEA	**Sydney (Office in Australia)**	Cummins Diesel Sales & Service P.O. Box 150 Cabramatta, 2166 New South Wales, Australia
PARAGUAY	**Asuncion**	Automotores y Maquinaria, S.R.L. Yegros y Fulgencio R. Moreno P.O. Box 1160 Asuncion, Paraguay Telephone: (595-21) 493111, 493115
PERU	**Lima**	Comercial Diesel del Peru S.A. P.O. Box 14-0234 Lima, Peru Location: Ave. V.R. Haya de la Torre 2648 Lima 3, Peru Telephone: (51-14) 74-3173/4374/ 3144/2281

PHILIPPINES	**EDSA**	Power Systems, Inc. EDSA P.O. Box 3241 Manila Philippines 1501 Location: 79E. Delos Santos Ave. Mandaluyong, Metro Manila Telephone: (63-2) 791769, 791771, 5311945, 5315448, 5311934, 5312531, 53414513
POLAND		Polremaco 30-709 Krakow Ul. Stoczniowcow 3 Poland Telephone: (48-12) 6561917
PORTUGAL	**Lisbon**	Electro Central Vulcanizadora, Lda. P.O. Box 3077 1302 Lisbon, Portugal Location: Rua Conselheiro Martins de Carvalho Lote 1480 1400 Lisboa (Restelo) Telephone: (351-2) 303 4800
QATAR	**Doha**	Jaidah Motors & Trading Co. P.O. Box 150 Doha, Qatar (Arabian Gulf) Telephone: (974) 442-6161
REUNION		- See Lyon Regional Office - Lyon
RIO DE ORO		- See Spain
ROMANIA		- See Germany Regional Office - Gross-Gerau
RUSSIA		- See Moscow Regional Office - Moscow
RWANDA	**Brussels (Office in Belgium)**	Bia, S.A. Rameistraat, 123 B-3090 - Overijse, Belgium Telephone: (32-2) 6892811
ST. LUCIA	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
ST. VINCENT	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
SAN MARINO		- See Italy
SAO TOME AND PRINCIPE		- See North/West/East and Central Africa Regional Office - Daventry

SAUDI ARABIA	**Al-Khobar**	GCC Olayan P.O. Box 356 Al-Khobar 31952 Saudi Arabia Telephone: (966-3) 882-0888
SCOTLAND		- See United Kingdom
SENEGAL	**Dakar**	Matforce B.P. 397 Dakar, Senegal Location: 10 Avenue Faidherbe Telephone: (221-8) 399500 Fax: (221-8) 399531/399550 Equipements et Services (Mining Only) BP 15372-Fann Dakar Senegal Contacts: Mr. Jean Smets Tel: (221-8) 60 77 76 & 24 73 62 Fax: (221-8) 60 95 98
SEYCHELLES		- See North/West/East & Central Regional Office - Daventry
SIERRA LEONE		- See North/West/East and Central Africa Regional Office - Daventry
SINGAPORE	**Singapore**	Applied Diesel Sales & Service Pte Ltd 8 Tanjong Penjuru Jurong Industrial Estate Singapore 2260 Telephone: (65) 261-3555
SLOVAKIA		- See European Regional Office - Gross-Gerau
SOLOMON ISLANDS		- See South Pacific Regional Office - Melbourne
SOMALIA		- See East and Southern Africa Regional Office - Harare
SOUTH AFRICA	**Johannesburg**	Cummins Diesel South Africa Pty. Ltd. Private Bag X7 Wendywood 2144 South Africa Location: 13 Eastern Service Road Kelvin View 2054 Telephone: (27-11) 321 8700
SOUTHWEST AFRICA		- See Namibia
SPAIN	**Madrid**	Cummins Ventas y Servicio S.A. Torrelaguna, 56 28027 Madrid, Spain Telephone: (34-91) 367-2000/3672404
SPANISH GUINEA		- See Spain

SRI LANKA	**Colombo**	Trade Promoters Ltd P.O. Box 321 69, Walukarama Road Colombo 3 Sri Lanka Telephone: (94-1) 573927, 574651, 575005
SUDAN		- See Middle East Regional Office - United Arab Emirates
SURINAM	**Miami (Office in U.S.A.)**	Cummins Southeastern Power, Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
SWAZILAND		- See South Africa
SWEDEN	**Stockholm**	SMA Maskin AB Aggelundavagen 7 S-17562 Jarfalla Sweden Telephone: (46-8) 56-222-500
SWITZERLAND	**Regensdorf**	Robert Aebi S.A. Riedhofstrasse 100 8105 Regensdorf Switzerland Telephone: (41-1) 842-5111
SYRIA	**Damascus**	Puzant Yacoubian & Sons P.O. Box 3617 Damascus, Syria Location: Abou Baker El Saddik Street Kafar Sousse Square Telephone: (963-11) 212-8600
TAHITI, ISLAND OF		- See French Polynesia
TAIWAN	**Taipei (JV)**	Cummins Power Service & Parts Corp. No. 115, Wu Ko 1st Rd., Wu Ku, Industrial District Taipei, Taiwan, R.O.C. Telephone: (886-2) 2290-0331 Fax: (886-2) 2290-0393
TANZANIA		- See South African Regional Office - Kelvin
THAILAND	**Bangkok**	Diethelm & Company Ltd. 1696 New Petchburi Road Bangkok 10310, Thailand Telephone: (66-2) 254-4900
TOGO (and BENIN)	**Lome**	Togomat B.P. 1641 Lome, Togo Location: Zone Industrielle CNPPME Telephone: (228) 27-23-95
TONGA, ISLAND OF		- See South Pacific Regional Office - Melbourne

TRINIDAD and TOBAGO	**Miami (Office in U.S.A.)**	Cummins Southeastern Power Inc. 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200
TURKEY	**Istanbul**	Hamamcioglu Muesseseleri Okul Cad. No. 9 81474 Orhanli - Tuzia Istanbul, Turkey Telephone: (90) 216-394-3210
UKRAINE		- See Moscow Regional Office - Moscow
UNITED ARAB EMIRATES	**Dhabi**	Cummins Diesel FZE P.O. Box 17636 Units ZF516, Jebel Ali Free Zone Dhabi, United Arab Emirates Telephone: (971) 4-883-8998
UNITED KINGDOM	**Wellingborough**	Cummins Diesel Rutherford Drive Park Farm South Wellingborough Northants NN8 2QH, England Telephone: (44-1933) 334200
URUGUAY	**Montevideo**	Santaro S.A. P.O. Box 379 Montevideo Uruguay Location: Avenida Millan No. 2441 Telephone:(598-2) 293908
VATICAN CITY		- See Italy
VENEZUELA	**Caracas**	Sudimat Apartado Postal 1322 Carmelitas Caracas 1010 Venezuela Location: Final Avenida San Martin Urb. la Quebradita Caracas 1061 Telephone: (58-2) 442-6161/2647
VIETNAM	**Hanoi**	Diethelm & Co. Ltd. Engineering Room No. 1, 2nd Floor 8 Trang Thi Street Hanoi, Vietnam Telephone: (84-4) 260-332, 244-394
VIETNAM	**Ho Chi Minh City**	Diethelm & Co. Ltd. Engineering 3rd Floor, IBC Building 1 Me Linh Square District 1 Ho Chi Minh City, Vietnam Telephone: (84-8) 294-102, 294-103
WESTERN SAMOA		- See South Pacific Regional Office - Melbourne

YEMEN	**Sana'a**	Zubieri Trading Co. P.O. Box 535 Sana'a, Yemen Arab Republic Telephone: (967) 1-223943/224051
YUGOSLAVIA		Cummins Dizel Motori Doo Prodaja I Servis Autoput 22 11080 Zemun Beograd F.R. Yugoslavia Telephone: (381-11) 314 9071
ZAMBIA	**Ndola**	Cummins Diesel Services (Zambia) Ltd. P.O. Box 71501 Ndola, Zambia Telephone: (260-2) 610729
ZIMBABWE	**Harare**	Cummins Zimbabwe (Pvt) Ltd. P.O. Box ST363 Southerton Harare, Zimbabwe Location: 72 Birmingham Road Southerton, Harare Telephones: (263-4) 621871/2/3/4/5

Section TS - Troubleshooting Symptoms

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Troubleshooting Procedures and Techniques

General Information

This guide describes some typical engine operating problems, their causes, and some acceptable corrections to those problems. Unless noted otherwise, the problems listed are those which an operator can diagnose and repair.

WARNING

Performing troubleshooting procedures NOT outlined in this section can result in equipment damage or personal injury or death. Troubleshooting must be performed by trained, experienced technicians. Consult a Cummins Authorized Repair Location for diagnosis and repair beyond that which is outlined, and for symptoms not listed in this section. Before beginning any troubleshooting, refer to General Safety Instructions in Section i of this manual.

Follow the suggestions below for troubleshooting:

- Study the complaint thoroughly before acting
- Refer to the engine system diagrams
- Do the easiest and most logical things first
- Find and correct the cause of the complaint

Troubleshooting Symptoms Charts

General Information

Use the charts on the following pages of this section to aid in diagnosing specific engine symptoms. Read each row of blocks from top to bottom. Follow through the chart to identify the corrective action.

⚠ WARNING ⚠

Troubleshooting presents the risk of equipment damage, personal injury or death. Troubleshooting must be performed by trained, experienced technicians.

Coolant Temperature Below Normal

Cause	Correction
STEP 1 Radiator shutters are stuck open or opening early	Check the shutter operation. Repair or replace the shutters if necessary. Refer to the OEM service manual.

OK
Go To Next Step

STEP 2 Coolant temperature gauge or sensor is malfunctioning	Test the gauge and the sensor. Repair or replace, if necessary. Refer to the OEM service manual.

OK
Go To Next Step

STEP 3 Contact a Cummins Authorized Repair Facility

Coolant Temperature Above Normal

Cause	Correction
STEP 1 Coolant level is below specification	Inspect the engine and cooling system for external coolant leaks. Repair if necessary. Add coolant. Refer to Procedure 018-018 (Cooling System) in Section V.
OK Go To Next Step	
STEP 2 Radiator fins are damaged or obstructed with debris	Inspect the radiator fins. Clean and repair the fins as necessary. Refer to the manufacturer's instructions.
OK Go To Next Step	
STEP 3 Cooling system hose is collapsed, restricted, or leaking	Inspect the hoses. Refer to Procedure 104-001 (Engine Hoses) in Section 4.
OK Go To Next Step	
STEP 4 Fan drive belt is broken	Check the fan drive belt. Replace the belt, if necessary. Refer to Procedure 008-002 (Adjustment, Repair and Replacement) in Section A.
OK Go To Next Step	
STEP 5 Lubricating oil level is above or below specification	Check the oil level. Add or drain oil, if necessary. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.
OK Go To Next Step	
STEP 6 Fan shroud is damaged or missing or the air recirculation baffles are damaged or missing	Inspect the shroud and the recirculation baffles. Repair, replace, or install, if necessary. Refer to the OEM service manual.
OK Go To Next Step	
STEP 7 Pressure cap is **not** correct or is malfunctioning	Replace pressure cap with the correct rating for the cooling system. Refer to 018-018 (Cooling System) in Section V for proper pressure ratings for Marine applications.
OK Go To Next Step	
STEP 8 Coolant temperature gauge or sensor is malfunctioning	Test the gauge and the sensor. Repair or replace, if necessary. Refer to the OEM service manual.
OK Go To Next Step	

Coolant Temperature Above Normal

Cause	Correction
STEP 9 Radiator shutters are **not** opening completely, or the shutterstat setting is wrong	Inspect the radiator shutters. Repair or replace if necessary. Check the shutterstat setting. Refer to the manufacturer's instructions.
OK Go To Next Step	
STEP 10 Cold weather radiator cover or winterfront is closed	Open the cold weather radiator cover or the winterfront. Maintain a minimum of 784 cm^2 [122 in^2] or approximately 28 x 28 cm [11 x 11 in] of opening at all times. Refer to the OEM service manual.
OK Go To Next Step	
STEP 11 Sea water cooling system is malfunctioning	Troubleshoot the sea water system. Refer to Procedure 018-018 (Cooling System) in Section V for operating parameters.
OK Go To Next Step	
STEP 12 Contact a Cummins Authorized Repair Facility	

Engine Difficult to Start or Will Not Start (Exhaust Smoke)

Cause	Correction
STEP 1 Engine cranking speed is too slow	If the cranking speed is slower than 150 rpm, refer to Procedure 018-021 (Electrical System) in Section V.
OK Go To Next Step	
STEP 2 Engine-driven units are engaged	Disengage engine-driven units.
OK Go To Next Step	
STEP 3 Starting aid is necessary for cold weather or starting aid is malfunctioning	Check for the correct operation of the starting aid. Refer to the manufacturer's instructions. Refer to Procedure 018-021 (Electrical System) in Section V Section 1.
OK Go To Next Step	
STEP 4 Fuel filter or fuel suction line is restricted	Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 (Fuel Filter) in Section 4 and Procedure 018-016 (Fuel System) in Section V.
OK Go To Next Step	
STEP 5 Air in the fuel system	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.
OK Go To Next Step	
STEP 6 Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Procedure 010-058 (Air Intake Piping) in Section 3.
OK Go To Next Step	
STEP 7 Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of high-quality fuel. Refer to Procedure 018-002 (Fuel Recommendations and Specifications) in Section V.
OK Go To Next Step	
STEP 8 Contact a Cummins Authorized Repair Facility	

Engine Difficult to Start or Will Not Start (No Exhaust Smoke)

Cause	Correction
STEP 1 Fuel level is low in the tank	Fill the supply tank. Refer to the OEM service manual.
OK Go To Next Step	
STEP 2 Fuel shutoff valve(s) closed (electronically controlled injection)	Check the fuel shutoff valve and circuit. Contact a Cummins Authorized Repair Facility.
OK Go To Next Step	
STEP 3 Fuel supply line restriction between the fuel pump and the injectors	Check the fuel supply line from the fuel pump to the cylinder head for sharp bends that can cause restrictions. Refer to Procedure 018-016 (Fuel System) in Section V.
OK Go To Next Step	
STEP 4 Fuel connections on the suction side of the pump are loose	Tighten all the fuel fittings and connections between the fuel tanks and fuel pump.
OK Go To Next Step	
STEP 5 Fuel filter or fuel suction line is restricted	Replace the fuel filter. Refer to Procedure 006-015 (Fuel Filter) in Section 4 and Procedure 018-016 (Fuel System) in Section V. Check the fuel suction line for restrictionProcedure 006-015 (Fuel Filter) in Section 4 and Procedure 018-016 (Fuel System) in Section V.
OK Go To Next Step	
STEP 6 Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Procedure 010-058 (Air Intake Piping) in Section 3.
OK Go To Next Step	
STEP 7 Exhaust system restriction	Check the exhaust system for any restrictions. Refer to Procedure 018-020 (Exhaust System) in Section V.
OK Go To Next Step	
STEP 8 Contact a Cummins Authorized Repair Facility	

Engine Power Output Low

Cause	Correction
STEP 1 Load is excessive for engine horsepower rating	Reduce the load on the engine. Refer to the OEM specifications.
OK Go To Next Step	
STEP 2 Engine is operating above recommended altitude	Engine power decreases above recommended altitude. Refer to the Engine Data Sheet for specifications.
OK Go To Next Step	
STEP 3 Fuel filter or fuel suction line is restricted	Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 (Fuel Filter) in Section 4 and Procedure 018-016 (Fuel System) in Section V.
OK Go To Next Step	
STEP 4 Lubricating oil level is above specification	Check the oil level. Verify the dipstick calibration and oil pan capacity. Fill the system to the specified level. Refer to Procedure 018-003 (Lubricating Oil Recommendations and Specifications) in Section V.
OK Go To Next Step	
STEP 5 Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Procedure 018-019 (Air Intake System) in Section V.
OK Go To Next Step	
STEP 6 Exhaust system restriction is **not** within specification	Check the exhaust system for restrictions. Contact a Cummins Authorized Repair Facility.
OK Go To Next Step	
STEP 7 Air in the fuel system	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.
OK Go To Next Step	
STEP 8 Fuel drain line is restricted	Inspect the fuel drain lines for restrictions. Remove any restrictions found. Refer to Procedure 018-016 (Fuel System) in Section V.
OK Go To Next Step	

Engine Power Output Low

Cause	Correction
STEP 9 Fuel tank vents are plugged or damaged	Remove and clean the tank vents. Replace the vents if necessary. Refer to the OEM service manual.
OK Go To Next Step	
STEP 10 Overhead adjustments are **not** correct	Measure and adjust the overhead settings. Refer to Procedure 003-006 (Overhead Set) in Section 7.
OK Go To Next Step	
STEP 11 Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of high-quality fuel. Refer to Procedure 018-002 (Fuel Recommendations and Specifications) in Section V.
OK Go To Next Step	
STEP 12 Intake manifold air temperature is above specification	Refer to a Cummins Authorized Repair Facility.
OK Go To Next Step	
STEP 13 Intake manifold air temperature is below specification	Refer to the Coolant Temperature Below Normal symptom tree in Section TS.
OK Go To Next Step	
STEP 14 Fuel temperature is above specification	Fill the fuel tanks. Turn off or bypass the fuel heater, if equipped. Refer to the OEM service manual.
OK Go To Next Step	
STEP 15 Contact a Cummins Authorized Repair Facility	

Engine Runs Rough at Idle, Warm Engine

Cause	Correction
STEP 1 Coolant temperature is below specification	Refer to the Coolant Temperature Below Normal symptom tree.
OK Go To Next Step	
STEP 2 Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of high-quality fuel. Refer to Procedure 018-002 (Fuel Recommendations and Specifications) in Section V.
OK Go To Next Step	
STEP 3 Contact a Cummins Authorized Repair Facility	

Engine Starts But Will Not Keep Running

Cause	Correction
STEP 1 Air in the fuel system	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.
OK Go To Next Step	
STEP 2 Engine-driven units are engaged	Disengage engine-driven units.
OK Go To Next Step	
STEP 3 Fuel supply line restriction between the fuel pump and the injectors	Check the fuel supply line from the fuel pump to the cylinder head for sharp bends that can cause restrictions. Refer to Procedure 018-016 (Fuel System) in Section V for specifications.
OK Go To Next Step	
STEP 4 Fuel filter or fuel suction line is restricted	Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 (Fuel Filter, Spin-On Type)) in Section 4 and Procedure 018-016 (Fuel System) in Section V for specifications.
OK Go To Next Step	
STEP 5 Fuel is waxing due to cold weather	Check the fuel heater, if installed. Weather conditions sometimes require a fuel heater.
OK Go To Next Step	
STEP 6 Fuel connections on the suction side of the pump are loose	Tighten all the fuel fittings and connections between the fuel tanks and fuel pump.
OK Go To Next Step	
STEP 7 Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of high-quality fuel. Refer to Procedure 018-002 (Fuel Recommendations and Specifications) in in Section V.
OK Go To Next Step	
STEP 8 Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Procedure 010-058 (Air Intake Piping) in Section 3.
OK Go To Next Step	

Engine Starts But Will Not Keep Running

Cause	Correction
STEP 9 Exhaust system restriction is above specification	Check the exhaust system for restrictions. Refer to the OEM service manual.

OK
Go To Next Step

STEP 10
Contact a Cummins Authorized Repair Facility

Engine Will Not Crank or Cranks Slowly (Air Starter)

Cause	Correction
STEP 1 Lubricating oil does **not** meet specifications for operating conditions	Change the oil and filters. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4 and Procedure 018-003 (Lubricating Oil Recommendations and Specifications) in Section V. Use the oil recommended in Section V.

OK
Go To Next Step

STEP 2 Air pressure is low in the air tanks	Increase air pressure with an external air source. Refer to Procedure 012-021 (Air Tanks and Reservoirs) in Section 3.

OK
Go To Next Step

STEP 3 Starting motor is malfunctioning or starting motor is **not** correct	Check the starting motor operation. Compare the starting motor with the engine and vehicle specifications. Refer to the manufacturer's instructions.

OK
Go To Next Step

STEP 4 Crankshaft rotation is impaired	Check the crankshaft for ease of rotation. Refer to a Cummins Authorized Repair Facility.

OK
Go To Next Step

STEP 5
Contact a Cummins Authorized Repair Facility

Engine Will Not Reach Rated Speed (RPM)

Cause	Correction
STEP 1 Load is excessive for engine horsepower rating	Reduce the load on the engine. Refer to Procedure 018-015 (General Engine) in Section V for general engine specifications.
OK Go To Next Step	
STEP 2 Tachometer is **not** calibrated or is malfunctioning	Compare the tachometer reading with a handheld tachometer or an electronic service tool reading. Calibrate or replace the tachometer as necessary. Refer to the OEM service manual.
OK Go To Next Step	
STEP 3 Fuel filter or fuel suction line is restricted	Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 (Fuel Filter, Spin-On Type) in Section 4 and Procedure 018-016 (Fuel System) in Section V.
OK Go To Next Step	
STEP 4 Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Procedure 018-019 (Air Intake System) in Section V.
OK Go To Next Step	
STEP 5 Exhaust system restriction	Check the exhaust system for any restrictions. Refer to Procedure 018-020 (Exhaust System) in Section V.
OK Go To Next Step	
STEP 6 Drivetrain or propeller is damaged or is **not** correctly matched to the engine	Check for the correct gearing, drivetrain components, or propeller. Refer to the OEM service manual.
OK Go To Next Step	
STEP 7 Contact a Cummins Authorized Repair Facility	

Engine Will Not Shut Off

Cause	Correction
STEP 1 Fuel tank vents are plugged or damaged	Remove and clean the tank vents. Replace the vents if necessary. Refer to the OEM service manual.
OK Go To Next Step	
STEP 2 Fuel drain line is restricted	Inspect the fuel drain lines for restrictions. Remove any restrictions found. Refer to Procedure 018-016 (Fuel System) in Section V for specifications.
OK Go To Next Step	
STEP 3 Engine is running on fumes drawn into the air intake	Check the air intake ducts. Locate and isolate the source of the fumes. Repair as necessary. Refer to the OEM service manual.
OK Go To Next Step	
STEP 4 Contact a Cummins Authorized Repair Facility	

Excessive Noise

This symptom tree corresponds to the Eliminator system only.

Cause

STEP 1
Rotating parts touching stationary parts in the centrifuge

.....

Correction

Dismantle the centrifuge. Change the damaged parts as necessary. Refer to Procedure 007-066 (Eliminator Filter Centrifuge) in Section 6.

OK
Go To Next Step

STEP 2
Contact a Cummins Authorized Repair Facility

Exhaust Black Smoke - Excessive Under Load

Cause	Correction
STEP 1 Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Procedure 010-058 (Air Intake Piping) and Procedure 010-059 (Air Cleaner Restriction) in Section 3.
OK Go To Next Step	
STEP 2 Air intake or exhaust leaks	Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to Procedure 010-058 (Air Intake Piping) and Procedure 010-059 (Air Cleaner Restriction) in Section 3.
OK Go To Next Step	
STEP 3 Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of high-quality fuel. Refer to Procedure 018-002 (Fuel Recommendations and Specifications) in Section V.
OK Go To Next Step	
STEP 4 Overhead adjustments are **not** correct	Measure and adjust the overhead settings. Refer to Procedure 003-006 (Overhead Set) in Section 7.
OK Go To Next Step	
STEP 5 Fuel drain line is restricted	Inspect the fuel drain lines for restrictions. Remove any restrictions found. Refer to a Cummins Authorized Repair Facility.
OK Go To Next Step	
STEP 6 Contact a Cummins Authorized Repair Facility	

Lubricating Oil Pressure Low

Cause	Correction
STEP 1 Lubricating oil level is above or below specification	Check the oil level. Add or drain oil, if necessary. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4.
OK Go To Next Step	
STEP 2 Lubricating oil pressure switch, gauge, or sensor is malfunctioning or is **not** in the correct location	Check the oil pressure switch, gauge, or sensor for correct operation and location. Refer to the OEM service manual.
OK Go To Next Step	
STEP 3 Lubricating oil is diluted with fuel	Change the oil. Refer to a Cummins Authorized Repair Facility. If the oil becomes diluted again, contact an Authorized Cummins Repair Facility.
OK Go To Next Step	
STEP 4 Lubricating oil does **not** meet specifications for operating conditions	Change the oil and filters. Refer to Procedure 007-002 (Lubricating Oil and Filters) in Section 4 and Procedure 018-003 (Lubricating Oil Recommendations and Specifications) in Section V. Use the oil recommended in Section V.
OK Go To Next Step	
STEP 5 Lubricating oil temperature is above specification	Contact a Cummins Authorized Repair Facility.
OK Go To Next Step	
STEP 6 Contact a Cummins Authorized Repair Facility	

Section V - Maintenance Specifications

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General Engine

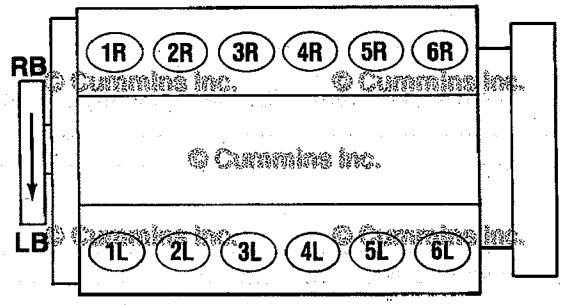
General Specifications

Listed below are general specifications for the engine. See each system section for additional specifications.

No injector adjustments are required for engines with electronic injectors.

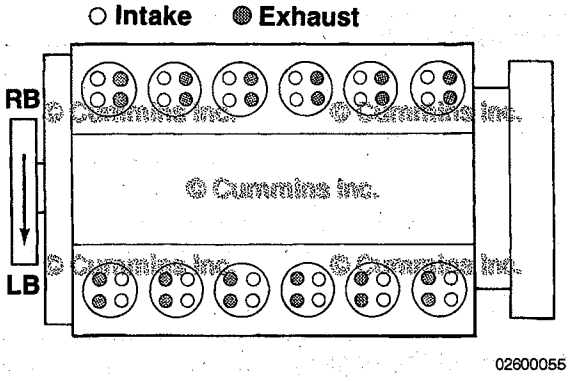
QSK45 Engines

Horsepower.....See the engine dataplate
Engine Speed.....See the fuel system calibration data for speed rating
Aspiration.....Turbocharged and Aftercooled
Bore and Stroke.....159 mm [6.25 in] x 190 mm [7.48 in]
Compression Ratio:
  Industrial.....Application-Dependent
Two-Pump and Two-Loop Cooling System:
  at 1800 rpm.....14.5:1
  at 1900 rpm.....16.5:1
  Power-Generation.....Application-dependent
Jacket Water Aftercooled, Two-Pump and Two-Loop Cooling System, TA Luft:
  at 1800 rpm/60 Hz.....14.5:1
  at 1900 rpm/50 Hz.....16.2:1
Displacement.....45 liters [2746 C.I.D.]
Firing Order.....1R-6L-5R-2L-3R-4L-6R-1L-2R-5L-4R-3L
Type.....4 cycle, 60-degree vee, 12 cylinder
Engine Weight (estimates **only**):
  Wet.....6123 kg [13.499 lb]
  Dry.....5813 kg [12,815 lb]
Crankshaft Rotation (viewed from the front of the engine)..... **Clockwise**
Valve and Injector Settings:
  Intake Valve Adjustment.....0.36 mm [0.014 in]
  Intake Valve Limits.....0.28 to 0.43 mm [0.011 to 0.017 in]
  Exhaust Valve Adjustment.....0.81 mm [0.032 in]
  Exhaust Valve Limits.....0.74 to 0.89 mm [0.029 to 0.035 in]
  Injector Outer Base Circle Method Adjustment (in engine).....19 N•m [168 in-lb]



02600054

Cylinder Numbering Sequence: RB = Right-bank of cylinders and LB = Left-bank of cylinders.



02600055

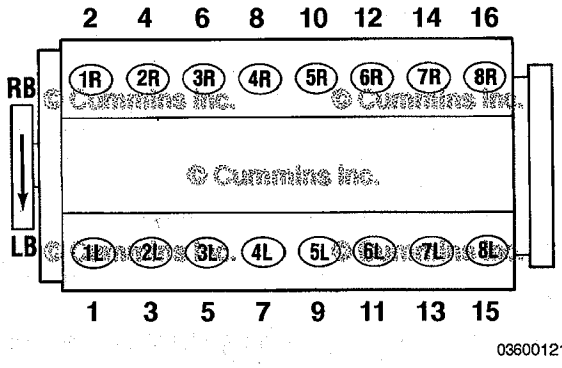
The intake and exhaust valve locations as shown in the illustration.

QSK60 Engines

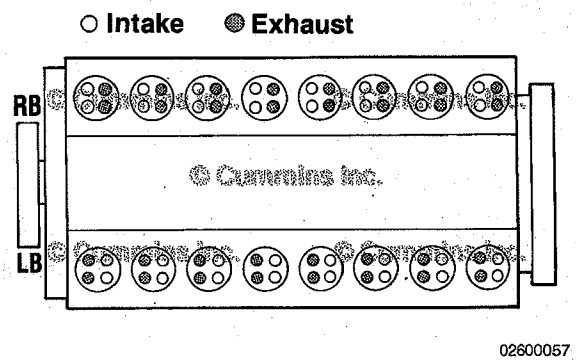
Horsepower.....See the engine dataplate
Engine Speed.....See the fuel system calibration data for speed rating
Aspiration:
  Single-Stage.....Turbocharged and aftercooled
  Two-Stage.....Turbocharged, aftercooled, and intercooled
Bore and Stroke.....159 mm [6.25 in] x 190 mm [7.48 in]
Compression Ratio with mechanically actuated injectors:
  Marine.....14.5:1
  Industrial.....Application-Dependent
Two-Pump and Two-Loop Cooling System:
  at 1800 rpm.....14.5:1
  at 1900 rpm.....16.5:1
  Power-Generation.....Application-dependent
Jacket Water Aftercooled, Two-Pump and Two-Loop Cooling System, TA Luft:
  at 1800 rpm/60 Hz.....14.5:1
  at 1900 rpm/50 Hz.....16.2:1
Compression Ratio with electronically actuated injectors:
  All Applications.....14.5:1
Displacement.....60 liters [3660 C.I.D.]
Firing Order.....1R-1L-3R-3L-2R-2L-5R-4L-8R-8L-6R-6L-7R-7L-4R-5L
Type.....4 cycle, 60-degree vee, 16 cylinder
Industrial and Power-Generation Single-Stage Engine Weight with mechanically actuated injectors (estimates **only**):
  Wet.....7956 kg [17,540 lb]
  Dry.....7535 kg [16,612 lb]
Industrial and Power-Generation Single-Stage Engine Weight with electronically actuated injectors (estimates **only**):
  Wet.....8570 kg [18,893 lb]
  Dry.....6759 kg [14,900 lb]
Industrial and Power-Generation Two-Stage Engine Weight with mechanically actuated injectors (estimates **only**):
  Wet.....9305 kg [20,514 lb]
  Dry.....8852 kg [15,515 lb]
Industrial and Power-Generation Two-Stage Engine Weight with electronically actuated injectors (estimates **only**):
  Wet.....9616 kg [21,207 lb]
  Dry.....7790 kg [17,175 lb]
Marine Engine Weight with mechanically actuated injectors (estimates **only**):
Engine **only** (estimate)*
  Wet.....8671 kg [19,117 lb]
  Dry.....8448 kg [18,625 lb]
Marine Engine with heat exchanger and expansion tank with mechanically actuated injectors (estimate)*
  Wet.....8980 kg [19,797 lb]
  Dry.....8675 kg [19,125 lb]
Marine Engine Dimensions *
Height
  Engine **only** .....2420 mm [95.3 in]
  Engine with heat exchanger and expansion tank.....2420 mm [95.3 in]
Width
  Engine **only** .....1730 mm [68.1 in]
  Engine with heat exchanger and expansion tank.....1730 mm [68.1 in]
Length
  Engine **only** .....3357 mm [132.2 in]
  Engine with heat exchanger and expansion tank.....3602 mm [141.8 in]
Marine Ratings
Continuous
  2000 hp.....1800 rpm
  2200 hp.....1800 rpm
Heavy Duty
  2300 hp.....1900 rpm
  2500 hp.....1900 rpm
Prime power
  At 50 Hz.....1563 kW at 1500 rpm
  At 60 Hz.....1900 kW at 1800 rpm
Crankshaft Rotation (viewed from the front of the engine)..... **Clockwise**
Valve and Injector Settings:

Intake Valve Adjustment.....0.36 mm [0.014 in]
Intake Valve Limits.....0.28 to 0.43 mm [0.011 to 0.017 in]
Exhaust Valve Adjustment.....0.81 mm [0.032 in]
Exhaust Valve Limits.....0.74 to 0.89 mm [0.029 to 0.035 in]
Injector Outer Base Circle Method Adjustment (in engine)(No adjustment required for engines with electronically actuated injectors).....19 N•m [168 in-lb]

* QSK60M-specific



Cylinder Numbering Sequence: RB = Right-bank of cylinders and LB = Left-bank of cylinders.



The intake and exhaust valve locations as shown in the illustration.

Fuel System

Specifications

with Electronically Actuated Injector

For performance and fuel rate values, refer to the engine data sheet or the fuel pump code for the specific rating involved.

Engine Idle Speed.....See Engine Data Sheet
Fuel Inlet Maximum Restriction:
  Clean Fuel Filter.....102 mm Hg [4.0 in Hg]
  Dirty Fuel Filter.....229 mm Hg [9.0 in Hg]
Fuel Drain Line Restriction:
  With Check Valves.....127 mm Hg [5.0 in Hg]
  With Check Valves Removed.....254 mm Hg [10.0 in Hg]
Water Removal:
  Free.....95 percent
  Emulsified.....95 percent
Engine Minimum Cranking Speed.....150 rpm

with Mechanically Actuated Injector

For performance and fuel rate values, refer to the engine data sheet or the fuel pump code for the specific rating involved.

Engine Idle Speed.....700 ± 25 rpm
Maximum Fuel Inlet Restriction (at rated power):
  Clean Fuel Filter.....100 mm Hg [4.0 in Hg]
  Dirty Fuel Filter.....203 mm Hg [8.0 in Hg]
Maximum Fuel Drain Line Restriction (Industrial and Power-Generation **only**):
  Before Check Valves.....254 mm Hg [10 in Hg]
  After Check Valves.....228 mm Hg [9.0 in Hg]
Maximum Fuel Drain Line Restriction (Marine **only**):
  Before Check Valves.....304 mm Hg [12 in Hg]
  After Check Valves and Before Fuel Cooler.....279 mm Hg [11 in Hg]
Fuel Check Valve Between Fuel Pump and Electronic Fuel Control Valve Assembly (integral to fuel pump):
  Opening Pressure.....14 to 21 kPa [2 to 3 psi]
Engine Minimum Cranking Speed.....175 rpm
Fuel Check Valve in Fuel Drain Line:
  Opening Pressure.....13 to 25 mm Hg [0.512 to 0.984 in Hg]
Derate Engine Fuel Rate for High Altitude.....Refer to the engine performance curves and data sheets
Shutoff Valve Solenoid Coil Resistance in Ohms at 24VDC.....28 to 32 ohms
Fuel Pump Cranking Pressure.....241 kPa [35 psi] at 175 rpm
Fuel Pump Pressure:
  1500 rpm (50 Hz).....1572 kPa [228 psi]
  1800 rpm (60 Hz).....1820 kPa [264 psi]
  1900 rpm.....1896 kPa [275 psi]
  2070 rpm.....1896 kPa [275 psi]
  2470 rpm.....1896 kPa [275 psi]
Fuel Filter Specifications:
Efficiency:
  at 10 microns.....98.7 percent
  at 8 microns.....96 percent
  at 5 microns.....86 percent
Water Removal:
  Free.....95 percent
  Emulsified.....95 percent

Lubricating Oil System

Specifications

Lubricating Oil Pressure, Main Oil Rifle (15W-40 oil at 107°C [225°F]):
- Minimum at rated rpm....310 kPa [45 psi]
- Maximum at rated rpm....483 kPa [70 psi]
- Minimum at idle rpm....138 kPa [20 psi]

Lubricating Oil Pressure Spike on Cold Engine....1724 kPa [250 psi]
Lubricating Oil Temperature - Maximum....120°C [248°F]
Lubricating Oil Pan Sump Capacity....See below
Eliminator Oil Capacity - Engine Operation:
- QSK45....18 liters [4.8 gal]
- QSK60....20 liters [5.2 gal]

Fleetguard® Centrifuge - Engine Operation:
- Centrifuge capacity....1 liter [0.26 gal]

Lubricating Oil Filter Capacity (each filter)(model LF9024):
- Combination Filter (three required on QSK45, four required on QSK60)....2.65 liters [0.70 gal]

Sump Configuration	System Capacity
QSK45 Engine	
No Sump	132.5 liters [35 gal]
Middle Sump	174.1 liters [46 gal]
Rear Sump	174.1 liters [46 gal]
Front and Middle Sump	215.7 liters [57 gal]
Middle and Rear Sump	215.7 liters [57 gal]
Full Length Sump	284 liters [75 gal]
QSK60 Engine	
No Sump	176 liters [46.5 gal]
Middle Front Sump	174.1 liters [46 gal]
Middle Rear Sump	174.1 liters [46 gal]
Front and Middle Front Sump	261.18 liters [69 gal]
Middle Front and Middle Rear Sump	261.18 liters [69 gal]
Middle Rear and Rear Sump	261.18 liters [69 gal]
Full Length Sump	378.5 liters [100 gal]

Cooling System

Specifications

QSK45 Engines

Coolant Capacity (engine **only**).....105 liters [28 gal]
Standard Modulating Thermostat Range.....85 to 97°C [185 to 207°F]
Standard LTA Thermostat Range.....46 to 57°C [115 to 135°F]
Maximum Allowable Top Tank Temperature (Industrial and Non-Prime Power-Generation **only**).....100°C [212°F]
Maximum Allowable Top Tank Temperature (Prime Power-Generation **only**).....104°C [220°F]
Minimum Recommended Top Tank Temperature.....71°C [160°F]
Maximum Allowable Deaeration Time.....25 minutes
Minimum Allowable Drawdown or 20 Percent of System Capacity (whichever is greater).....26 liters [7 gal]
Minimum Allowable Pressure Cap.....76 kPa [11 psi]

QSK60 Engines

Coolant Capacity (Industrial and Power-Generation **only**):
Single-Stage.....140 liters [37 gal]
Two-Stage.....170 liters [45 gal]
Coolant Capacity (Marine **only**):
Engine **only**.....233 liters [62 gal]
Engine with heat exchanger and expansion tank.....318 liters [84 gal]
Standard Modulating Thermostat Range (with Mechanically Actuated Injectors).....85 to 97°C [185 to 207°F]
Standard Modulating Thermostat Range (with Electronically Actuated Injectors).....82 to 94°C [180 to 202°F]
Standard LTA Thermostat Range.....46 to 57°C [115 to 135°F]
Maximum Allowable Top Tank Temperature (Industrial, Marine, and Non-Prime Power-Generation **only**)....100°C [212°F]
Maximum Allowable Top Tank Temperature (Prime Power-Generation **only**).....104°C [220°F]
Minimum Recommended Top Tank Temperature.....71°C [160°F]
Maximum Allowable Deaeration Time.....25 minutes
Minimum Allowable Drawdown or 20 Percent of System Capacity (whichever is greater).....28 liters [7.4 gal]
Allowable Pressure Cap Relief Range at Sea Level.....76 to 103 kPa [11 to 15 psi]
Maximum Seawater Pump Outlet Pressure.....206 kPa [30 psi]
Maximum Seawater Pressure Drop Across Heat Exchanger.....138 kPa [20 psi]
Maximum Seawater Pump Inlet Restriction.....255 mm Hg [8 in Hg]
Maximum Seawater Outlet Temperature.....54°C [130°F]
Maximum Seawater Temperature Rise Across Heat Exchanger.....22°C [40°F]
Minimum Seawater Temperature Rise Across Heat Exchanger.....3°C [5°F]

Air Intake System

Specifications

Maximum Allowable Intake Restriction:
With Clean Filter Element.....380 mm H_20 [15 in H_20]
With Dirty Filter Element.....635 mm H_20 [25 in H_20]

Exhaust System

Specifications

Maximum Back Pressure (at rated speed and load):
- QSK45 (1500 hp and less)....75 mm Hg [3 in Hg]
- QSK45 (greater than 1500 hp)....51 mm Hg [2 in Hg]
- QSK60 Single-Stage (up to an including 2000 hp)....75 mm Hg [3 in Hg]
- QSK60 Single-Stage (greater than 2000 hp)....50 mm Hg [2 in Hg]
- QSK Two-Stage (greater than 2000 hp)....50 mm Hg [2 in Hg]

Exhaust Pipe Size (normally acceptable inside diameter):
- QSK45....139.5 mm [5.5 in]
- QSK60, Single-Stage....230 mm [9 in]
- QSK60, Two-Stage....254 mm [10 in]

Electrical System

Specifications

Minimum recommended battery capacity:

Engine Model	System Voltage	Temperature Range	Cold Cranking Amperes	Reserve Capacity	Maximum Allowable Starting Circuit Resistance
QSK45	24	-18 to 0°C [0 to 32°F]	1800	640 A	0.0020 ohms
QSK60	24	Above 0°C [32°F]	1800	640 A	0.0020 ohms
QSK60 Two-Stage	24	All	1800	640 A	0.0020 ohms

Battery Cable Sizes - American Wire Gauge (maximum length in cranking motor circuit):
24 to 32 VDC
Number 00.....6.1 m [20 ft]
Number 000.....8.2 m [27 ft]
Number 0000 or two Number 0 (see note).....6.1 m [20 ft]
Two Number 00.....13.7 m [45 ft]

NOTE: Two strands of number 0 cable can be used instead of on number 0000 cable, provided all connections are carefully made to maintain equal current flow in each parallel cable.

Minimum Cranking Speed Without Starting Aid.....150 rpm

Starting aids, such as block heaters, lubricating oil pan heaters, and so forth, are available to aid in cold weather starting.

The number of plates within a given battery size determines reserve capacity. Reserve capacity is the length of time sustained cranking can occur.

CCA ratings are based on two 12 VDC batteries in series.

Batteries (Specific Gravity)

Battery State of Charge	Specific Gravity (at 27°C [80°F])
100 %	1.260 to 1.280
75%	1.230 to 1.250
50%	1.200 to 1.220
25%	1.170 to 1.190
DISCHARGED	1.110 to 1.130

Compressed Air System

Specifications

The following specifications are for a upright two-cylinder air compressor (Holset® ST676 Air Compressor Model)

Cylinders	2
Compressor Capacity (at 1250 rpm)	14.2 liter [30.00 cfm] per second
Piston Displacement	676 cc [41.3 C.I.D.]
Bore	92.08 mm [3.625 in]
Stroke	50.8 mm [2 in]
Speed	Engine speed
Cooling	Engine coolant
Lubrication	Engine lubricating oil
Plumbing Line Sizes:	
Coolant Inlet and Outlet (pipe fitting)	12.7 mm NPTF [0.50 in NPTF]
Air Inlet (inside diameter)	22.22 mm [0.875 in]
Air Outlet (minimum inside diameter)	15.88 mm [0.625 in]
Height, Overall (approximate)	34.3 cm [13.5 in]
Width, Overall (approximate)	17.8 cm [7 in]
Length, Overall (approximate)	28.7 cm [11.30 in]
Weight (approximate)	33.5 kg [74.5 lb]

NOTE: In applications where duty cycles average 10 percent or more or air pressures are above 862 kPa [125 psi], use a discharge line with a minimum inside diameter of 15.9 mm [0.625 in] for single-cylinder compressors and 25.4 mm [1 in] for twin-cylinder compressors to prevent carbon buildup. Examples of these applications are as follows:

- Refuse trucks
- Pickup and delivery trucks
- Transit buses
- Equipment with high accessory air usage.

The following specifications are for a upright single-cylinder air compressor (Holset® HD850 Air Compressor Models)

Cylinders	1
Compressor Capacity (at 1250 rpm)	7.1 liter [15.00 cfm] per second
Piston Displacement	338 cc [20.63 C.I.D.]
Bore	98.4 mm [3.875 in]
Stroke	44.5 mm [1.75 in]
Speed	Engine speed
Cooling	Engine coolant
Lubrication	Engine lubricating oil
Plumbing Line Sizes:	
Coolant Inlet and Outlet (pipe fitting)	9.53 mm NPTF [0.375 in NPTF]
Air Inlet (inside diameter)	22.22 mm [0.875 in]
Air Outlet (minimum inside diameter)	15.88 mm [0.625 in]
Height, Overall (approximate)	31.1 cm [12.25 in]
Width, Overall (approximate)	14.6 cm [5.75 in]
Length, Overall (approximate)	22.9 cm [9 in]
Weight (approximate)	18 kg [40 lb]

Cummins/Fleetguard® Filter Specifications

Specifications

Fleetguard® is a subsidiary of Cummins Inc. Fleetguard® filters are developed through joint testing at Cummins Inc. and Fleetguard®. Fleetguard® filters are standard on new Cummins Inc. engines. Cummins Inc. recommends their use.

Fleetguard® products meet all Cummins Inc. Source Approval Test standards to provide the quality filtration necessary to achieve the engine's design life. If other brands are substituted, the purchaser **must** insist on products the supplier has tested to meet Cummins Inc. high-quality standards.

Cummins Inc. can **not** be responsible for problems caused by non-genuine filters that do **not** meet Cummins Inc. performance or durability requirements.

QSK45 and QSK60 engines are now using Fleetguard® LF9024 filters, or LF 9034 filters, Cummins® Part Numbers 3101870 and 4197219. These filters are venturi combo style filters (full flow and bypass components are used in the same filter), and mount to the existing filter head on all QSK45 and QSK60 engines. There are two different part numbers because the LF 9034 is able to resist the additional additive package seen by the filter when Centinel™ is used.

When using a lubricating oil filter (full flow) a lubricating oil filter (bypass) **must** also be used.

Lubricating Oil Filter (full flow)
- Cummins Inc., Part Number 3889310
- Fleetguard®, Part Number LF670.

Lubricating Oil Filter (bypass)
- Cummins Inc., Part Number 3889311
- Fleetguard®, Part Number LF777.

Lubricating Oil Filter (venturi combination for use with Centinel™.
- Cummins Inc., Part Number 4197219
- Fleetguard®, Part Number LF9034.

Lubricating Oil Filter (venturi combination for use without Centinel™)
- Cummins Inc., Part Number 3101870
- Fleetguard®, Part Number LF9024.

Fuel Filter (20 micron, no water separation, engines with mechanically actuated injectors)
- Cummins Inc., Part Number 3313306
- Fleetguard®, Part Number FF202.

Fuel Filter (10 micron, with water separation, engines with mechanically actuated injectors))
- Cummins Inc., Part Number 3089916
- Fleetguard®, Part Number FS1006.

Fuel Filter (marine applications) (10 micron, water separation with metal drain valve)
- Cummins Inc., Part Number 3959569
- Fleetguard®, Part Number FS1013.

Coolant Filter
- Cummins Inc., Part Number 3100308
- Fleetguard®, Part Number WF2075.

Air Filter (Marine Applications)
- Cummins Inc., Part Number 4916129

Fuel Filter (15 micron, with water separation, engines with electronically actuated injectors)
- Cummins Inc., Part Number 4924640
- Fleetguard® Part Number FS1062

Fuel Filter (two required, 5 micron, no water separation, engines with electronically actuated injectors)
- Cummins Inc., Part Number 4924300
- Fleetguard® Part Number FF5607

Fleetguard® DCA4 Service Filters and Liquid Precharge

Install service filter(s) and/or liquid containing the number of SCA units below:

DCA4 Service Filters		DCA (Fleetcool) Service Filters	
Part Number	**SCA Units**	**Part Number**	**SCA Units**
WF2070	2	WF2050	2
WF2071	4	WF2051	4
WF2072	6	WF2052	6
WF2073	8	WF2053	8

DCA4 Service Filters		DCA (Fleetcool) Service Filters	
WF2074	12	**Not** available	12
WF2075	15	WF2054	15
WF2076	23	WF2055	23
WF2077	(blank filter without SCAs)	WF2077	(blank filter without SCAs)

DCA4 Liquid			DCA (Fleetcool) Liquid		
Part Number	**Size**	**SCA Units**	**Part Number**	**Size**	**SCA Units**
DCA60L	0.47 liter [1 pt]	5	DCA30L	0.47 liter [1 pt]	5
DCA65L	1.89 liter [2 qt]	20	DCA35L	1.89 liter [2 qt]	20
DCA70L	3.78 liter [1 gal]	40	DCA40L	3.78 liter [1 gal]	40
DCA75L	18.9 liter [5 gal]	200	DCA45L	18.9 liter [5 gal]	200
DCA80L	208 liter [55 gal]	2200	DCA50L	208 liter [55 gal]	2200

Fuel Recommendations and Specifications

General Information

WARNING

Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can cause an explosion.

Cummins Inc. recommends the use of ASTM number 2 diesel fuel. The use of number 2 diesel fuel will result in optimum engine performance. At operating temperatures below 0°C [32°F], acceptable performance can be obtained by using blends of number 2D and number 1D. The use of lighter fuels can reduce fuel economy.

The viscosity of the fuel **must** be kept above 1.3 cSt to provide adequate fuel system lubrication.

For a more detailed description of fuel properties, refer to Fuel for Cummins Engines, Bulletin 3379001. Refer to Procedure 205-001 (Additional Service Literature) in Section L for ordering information.

Lubricating Oil Recommendations and Specifications

General Information

The use of quality engine lubricating oils and appropriate oil drain and filter change intervals are critical factors in maintaining engine performance and durability.

Cummins Inc. recommends the use of oil that meets the American Petroleum Institute (API) performance categories of CF-4, CG-4, CF-4/SG, or CG-4/SH. Oil with an older API classification of CD or CE can be used in areas of the world outside North America where oils meeting the current API categories are **not** available. However, if using CD or CE classification oil, the oil **must** be changed at the standard service interval and **only** extended if scheduled oil sampling is used for close monitoring of oil condition. Oil with an API classification of CC can be used in areas of the world outside North America where oils meeting the current API categories are **not** available. If used, they **must** be changed at one half the normal recommended service intervals. Oil with an API classification of CA or CB **must not** be used.

The oil supplier is responsible for the quality and performance of their product.

Cummins Inc. recommends engine oil with a nominal ash content of 1 to 1.5 percent mass. Oils with higher ash content, up to 1.85 percent ash, can be used in areas where the sulfur content of the fuel is normally 1 to 1.5 percent mass. Limiting ash content is critical to the prevention of valve and piston deposit formation.

For further details and discussion of engine lubricating oils for Cummins Inc. engines, refer to service bulletin Cummins Engine Oil Recommendations, Bulletin 3810340.

New Engine Break-in Oils

Special break-in engine lubricating oils are **not** recommended for new or rebuilt Cummins Inc. engines. Use the same type of oil during the break-in as is used in normal operation.

Synthetic or partially synthetic engine oils, however, can **not** be used in a new or rebuilt engine during break-in. Use a standard petroleum-based oil for the first drain interval.

Additional information regarding lubricating oil availability throughout the world is available in the Engine Manufacturer's Association Lubricating Oils Data Book for Heavy-Duty Automotive and Industrial Engines. The data book can be ordered from the address below:

Engine Manufacturer's Association

One Illinois Center

2 N Lasalle Street

Chicago, IL U.S.A. 60601

Phone: (312) 644-6610

The oil performance classifications represented in the following chart as standard or premium have been determined through field experience and engine testing. Engine component wear and deposits are limiting factors in evaluating useful oil life. Contact a Cummins Inc. representative or oil supplier representative(s) for further assistance, if needed.

Cummins Inc. recommends the use of a high-quality 15W-40 multiviscosity, heavy-duty engine oil that meets the requirements of Cummins Engineering Standard (CES) 20071, 22072, 20075, 20076, and 20077. The oil categories CC, CD, and CE have been obsoleted by API and are **not** to be used as their specifications are no longer controlled. Engine oils that meet CES 20076 and 20077 are also considered premium oils when using the Chart Method. ACEA and API designations have **not** been assigned to CES 20076 and 20077 as of yet.

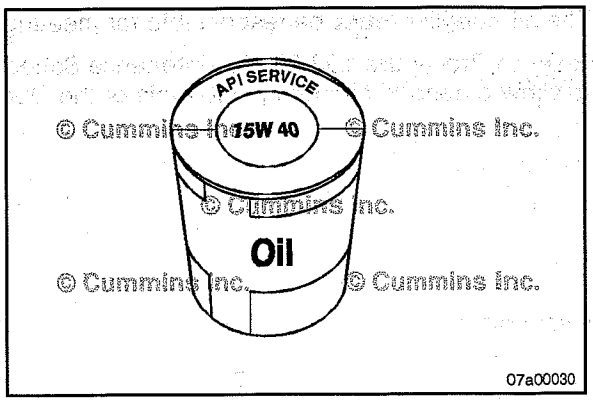
Oil Performance Classification			
API Category	**Cummins Engine Standard (CES)**	**ACEA**	**Classification of Oil Charts**
CC, CD, CE	N/A	N/A	N/A
CF-4/SG, CG-4SH	20075	E2, E3	Standard
CH-4	20072, 20071	E5	Premium
N/A	20076, 20077	N/A	Premium

ACEA = European Automobile Manufacturers Association

Viscosity Recommendations

The viscosity of an oil is a measure of its resistance to flow. The Society of Automotive Engineers has classified engine oils into viscosity grades. Oils that meet the low temperature (-18°C [0°F]) requirement carry a grade designation with a W suffix. Oils that meet both the low and high temperature requirements are referred to as multigrade or multiviscosity grade oils.

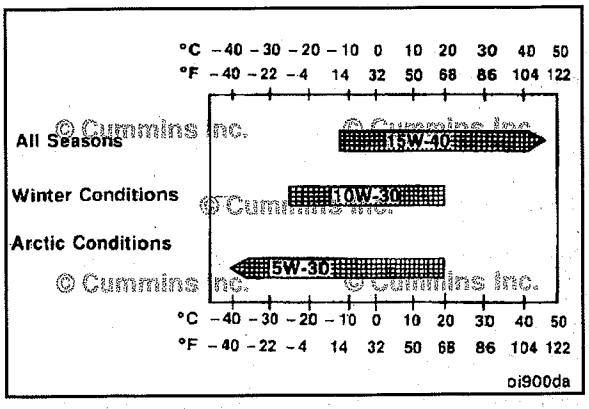
Cummins Inc. has found that the use of multigrade lubricating oil improves oil consumption control and engine cranking in cold conditions while maintaining lubrication at high operating temperatures and can contribute to improved fuel consumption.



⚠CAUTION⚠

When single-grade oil is used, make sure the oil will be operating within the temperature ranges, as shown.

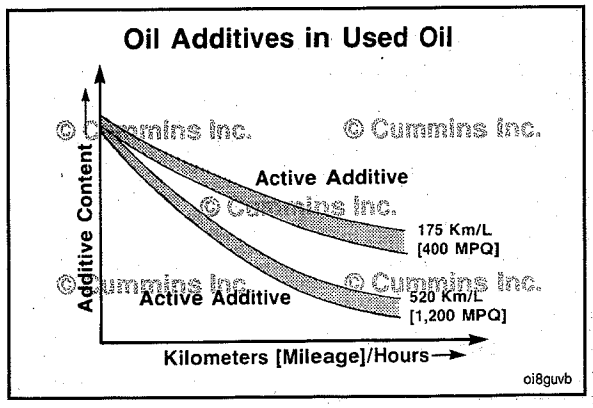
Cummins Inc. recommends the use of multigrade lubricating oils with the viscosity grades for the ambient temperatures indicated. This picture shows **only** the preferred oil grades.



Single-grade oils can be substituted for short durations until the recommended multigrade is procured. Arctic condition oils are available commercially with better low temperature properties. Consult your supplier.

The primary criterion for selecting an oil viscosity grade is the lowest temperature the oil will experience while in the engine oil sump. Bearing problems can be caused by the lack of lubrication during the cranking and start up of a cold engine when the oil being used is too viscous to flow properly. Change to a lower viscosity grade of oil as the temperature of the oil in the engine oil sump reaches the lower end of the ranges shown in the picture.

As the engine oil becomes contaminated, essential oil additives are depleted. Lubricating oils protect the engine as long as these additives are functioning properly. Progressive contamination of the oil between oil and filter change intervals is normal. The amount of contamination will vary depending on the operation of the engine, hours or miles on the oil, fuel consumed, and new oil added.



Arctic Operation

⚠CAUTION⚠

The use of a synthetic base oil does not justify extended oil change intervals. Extended oil change intervals can cause engine damage.

If an engine is operated in ambient temperatures consistently below -23°C [-10°F] and there are no provisions to keep the engine warm when it is **not** in operation, use a synthetic engine oil with adequate low temperature properties.

The oil supplier **must** be responsible for meeting the performance service specifications.

Refer to Procedure 102-002 (Maintenance Schedule - Oil Drain Intervals) in Section 2 for the use of the Chart Method to allow extended oil change intervals or the Operation of Diesel Engines in Cold Climate, Bulletin 3379009.

Coolant Recommendations and Specifications

General Information

Cummins Inc. recommends the use of fully formulated antifreeze or coolant containing a precharge of supplemental coolant additive (SCA). The antifreeze or coolant **must** meet the specifications outlined in The Maintenance Council (TMC) Recommended Practice (RP) 329 (ethylene glycol) or RP 330 (propylene glycol). Using fully formulated antifreeze or coolant significantly simplifies cooling system maintenance.

Copies of TMC specifications can be obtained by contacting:

The Maintenance Council
American Trucking Association
2200 Mill Road
Alexandria, VA 22314-5388
Phone: (703) 838-1763
Fax: (703) 836-6070

Fully formulated antifreeze contains balanced amounts of antifreeze, SCA, and buffering compounds, but does **not** contain 50-percent water. Fully formulated coolant contains balanced amounts of antifreeze, SCA, and buffering compounds already premixed 50/50 with deionized water.

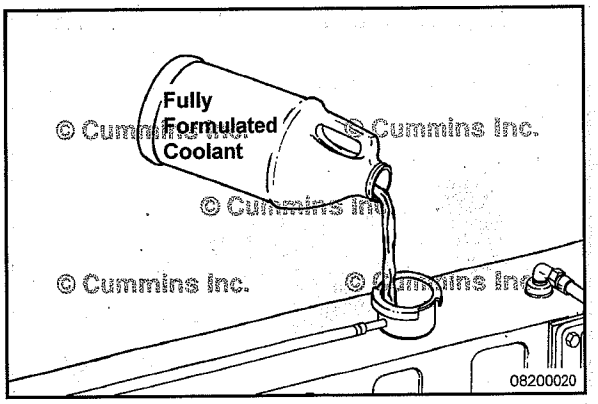
The following pages will give an explanation of water, antifreeze, and SCAs. They will also explain how to test antifreeze and SCA levels.

This section also contains information on cooling system maintenance and a coolant treatment chart that is used to determine the correct SCA service filter.

Alternative maintenance practices for cooling systems can be found in Cummins Inc. Coolant Requirements and Maintenance, Bulletin 3666132.

Fully Formulated Coolant/Antifreeze

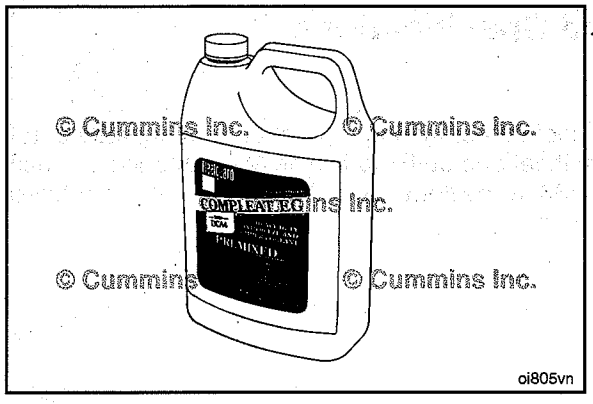
Cummins Inc. recommends using either a 50/50 mixture of good-quality water and fully formulated antifreeze, or fully formulated coolant when filling the cooling system. The fully formulated antifreeze or coolant **must** meet TMC RP 329 or TMC RP 330 specifications.



Good-quality water is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

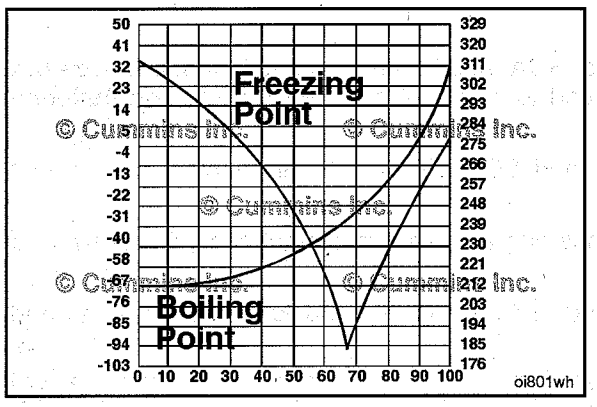
Water Quality	
Calcium Magnesium (Hardness)	Maximum 170 ppm as ($CaCO_3$ + $MgCO_3$)
Chloride	40 ppm as(Cl)
Sulfur	100 ppm as (SO_4)

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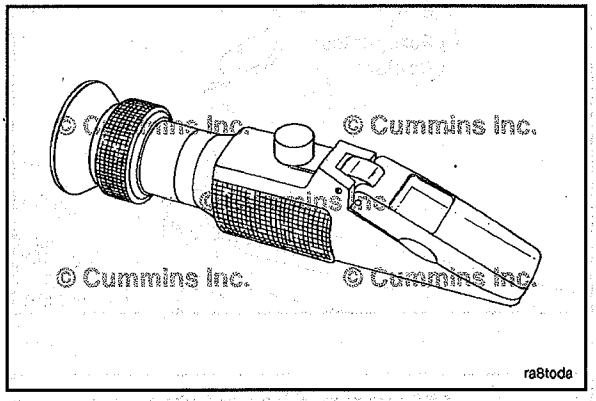
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Cummins Inc. recommends using Fleetguard® Compleat. It is available in both glycol forms (ethylene and propylene) and complies with TMC standards.

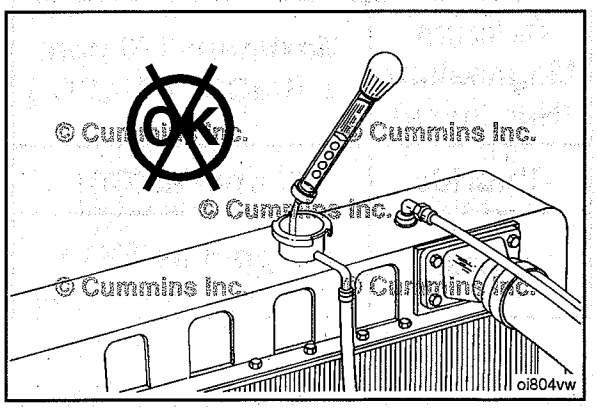


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Fully formulated antifreeze **must** be mixed with quality water at a 50/50 ratio (40-percent to 60-percent working range). A 50/50 mixture of antifreeze and water gives a -36°C [-34°F] freezing point and a 110°C [228°F] boiling point, which is adequate for locations in North America. The lowest freezing point of ethylene glycol antifreeze (-173°C [-94°F]) is obtained at 68 percent. Using higher concentrations of antifreeze will raise the freezing point of the solution and increase the possibility of a silicate gel problem.


ra8toda

A refractometer, part number CC-2800, **must** be used to measure the freezing point of the coolant accurately.

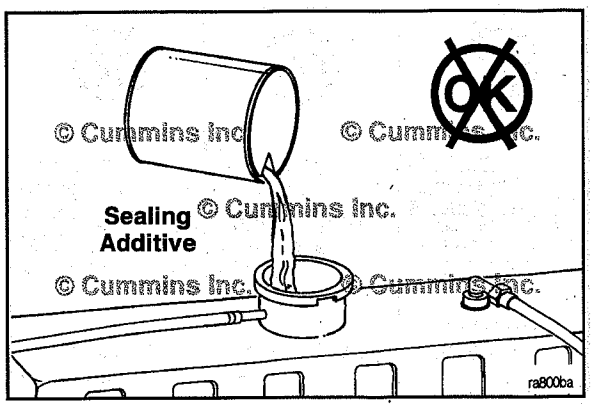

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Do **not** use a floating ball hydrometer. Using a floating ball hydrometer can give an incorrect reading.

Cooling System Sealing Additives

Do **not** use sealing additives in the cooling systems. The use of sealing additives will:

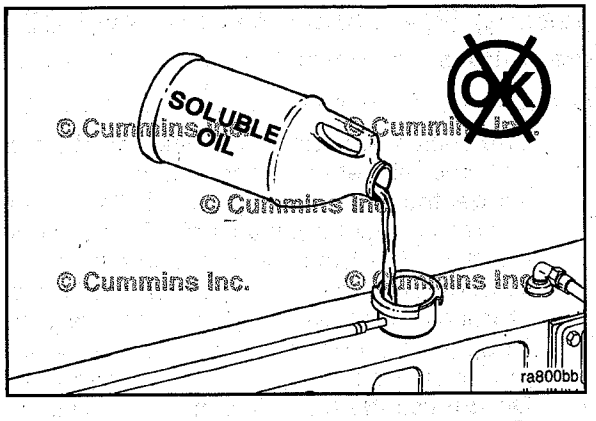
- Build up in coolant low-flow areas
- Clog coolant filters
- Plug radiator and oil coolers
- Plug fuel coolers.



Cooling System Soluble Oils

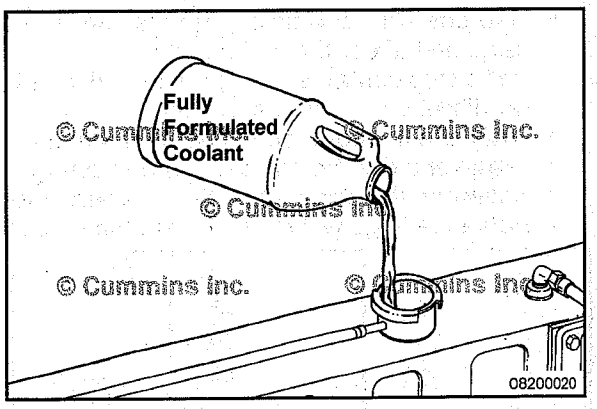
Do **not** use soluble oils in the cooling system. The use of soluble oils will:

- Allow cylinder liner pitting
- Corrode brass and copper
- Damage heat transfer surfaces
- Damage seals and hoses.



Supplemental Coolant Additive (SCA)

Fully formulated products contain SCAs and are required to protect the cooling system from fouling, solder blooming, and general corrosion. The coolant filter is required to protect the cooling system from abrasive materials, debris, and precipitated coolant additives.

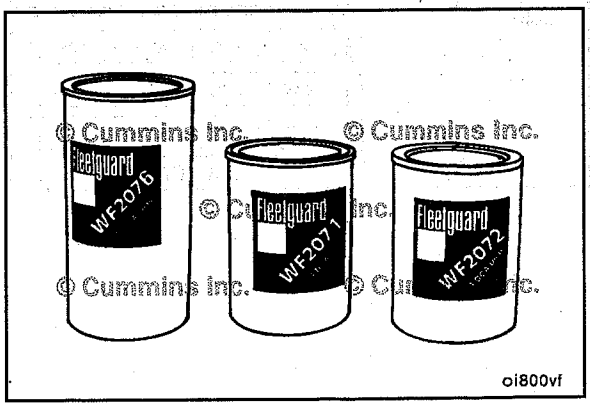


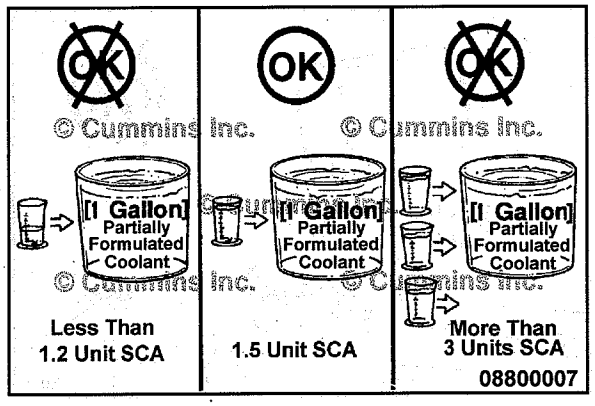
Supplemental coolant additives, or equivalent, are used to prevent liner pitting, corrosion, and scale deposits in the cooling system.

Use the correct Fleetguard® coolant filter to maintain the recommended SCA concentration in the system.

Maintain the correct concentration by changing the service filter at each oil drain interval.

NOTE: The correct filter is determined by the total cooling system capacity and oil drain interval. Refer to the Coolant Capacity charts.





⚠CAUTION⚠

Insufficient concentration of the coolant additives will result in liner pitting and engine failure.

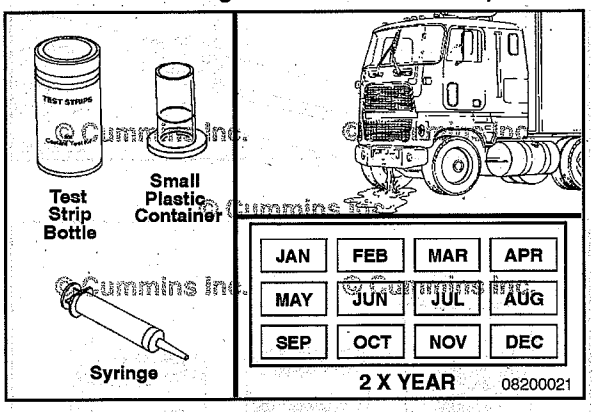
The SCA concentration **must not** fall below 1.2 units or exceed 3 units per 3.8 liters [1 gal] of cooling system capacity.

Testing SCA Concentration Level CC-2602 Test Kit

Precautions and Instructions for Proper Kit Use

Carefully follow the instructions to test the coolant and take the appropriate action recommended by the kit.

- The coolant sample to be tested **must** be between 10 and 54°C [50 and 130°F]. If the sample is too cold or too hot, you will get incorrect results.
- To get the best color match results, compare test strip pads to the color chart in daylight or under cool white fluorescent lighting. If unsure about a specific color match when a test does fall between two colors on the color chart, choose the lower numbered block. It is safer to underestimate your results than to overestimate.
- The test strips do have a limited shelf life and are sensitive to humidity and extreme heat. Proper handling and storage is necessary to protect the life of the strips.
- Keep the cap tightly sealed on the test strip bottle except when removing a strip. Store away from direct sunlight and in an area where the temperature will generally stay below 32°C [90°F].
- Do **not** use the test strips after the expiration date stamped on the bottle.
- Discard the kit if any of the pads on the unused strips have turned light brown or pink.
- Use one strip at a time and take care **not** to touch any of the pads on the strip. Doing so will contaminate the pads and affect the test results.
- If the strip container is left uncapped for 24 hours, moisture in the air will render the strips useless, even though no discoloration will be evident.
- **Only** use the color chart supplied with the kit.
- Clean and dry the sample cup and syringe after each use. This will prevent contaminating future samples.
- Following the correct test times is very important. Use a clock or stopwatch.
- False readings will result if test strip is read too early or too late.

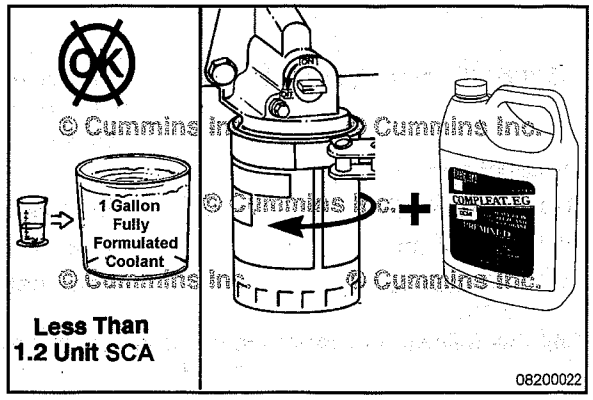


Test Intervals

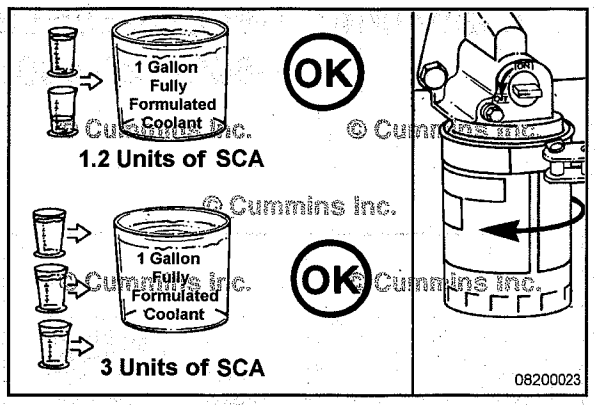
Testing is recommended if the operator is **not** sure of his cooling system condition due to leaks, uncontrolled topping off of the system, or major coolant loss.

Testing is also recommended twice a year to monitor the SCA level. If the SCA level is above 3 units, test at subsequent oil drain intervals until the concentration is back under 3 units. When the concentration is back under 3 units, start installing the correct service filters according to the maintenance schedule used.

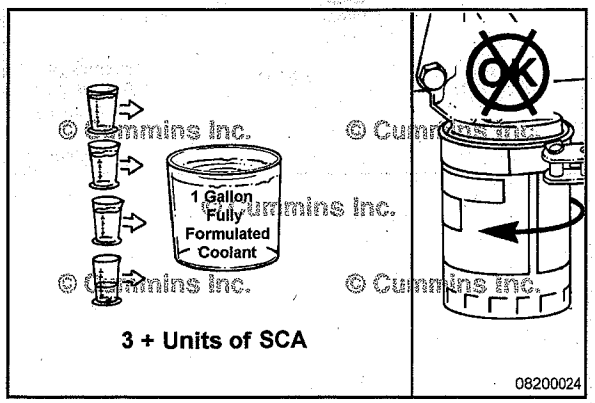
If the concentration is below 1.2 units per 3.78 liter [1gal], replace the filter and precharge with liquid.



If the concentration is 1.2 to 3 units per 3.78 liter [1gal], replace the filter.

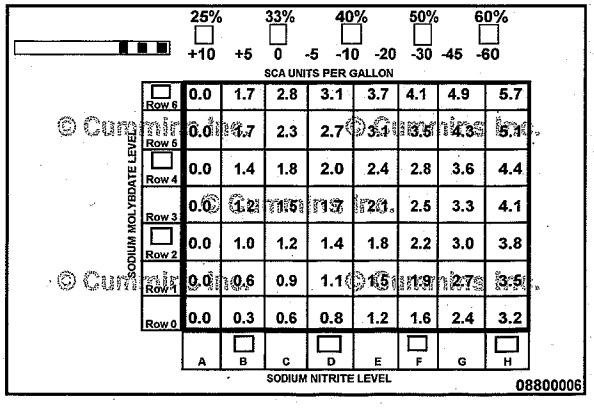


If the concentration is above 3 units per 3.78 l[1gal], do **not** replace the service filter. Test the coolant at subsequent oil drain intervals until the concentration is back under 3 units. When the concentration is back under 3 units, start installing service filters at each oil change interval.



NOTE: Do **not** utilize the test kit to maintain minimum SCA concentration levels (i.e., 1.5 units).

NOTE: In some instances the nitrate or molybdate reading will be high. However, it is the combined reading that is important. Therefore, **always** follow the chart.



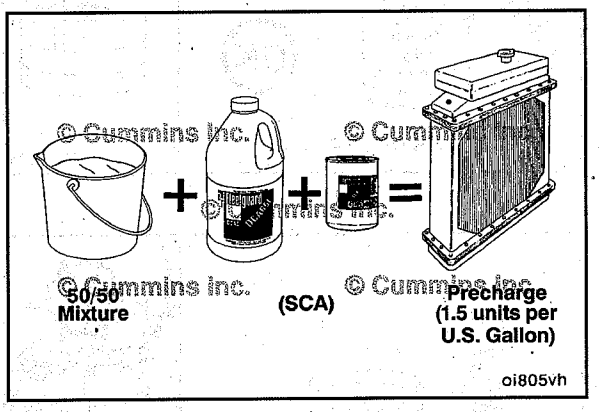
CC2602 Coolant Test Kit	- Works with any SCA formulation. Call 1-800-DIESELS if you have this test kit and the color chart does **not** show the number of units of SCA per gallon of coolant.
Probablizer:	
3318169S Plug	- Installs on the engine for easy coolant sampling
3318168S Cap	- Use with Monitor C™ bottle to sample coolant
CC2700 Monitor C	- Lab analysis of coolant samples

Call the following numbers to get answers to any questions you may have about cooling system maintenance.

Cummins 1-800-DIESELS 1-800-22-FILTERS
1-800-521-4005 1-800 - 223 - 4583

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Coolant Replacement Requirements

Drain and flush the cooling system after 9000 hours or 2 years of service. Fill with either new fully formulated coolant or a 50/50 mixture of good quality water and fully formulated antifreeze, and install the correct service coolant filter.

If the coolant is **not** going to be reused, dispose of it in accordance with federal, state, and local laws and regulations.

Drive Belt Tension

Tension Chart

SAE Belt Size	Belt Tension Gauge Part No.		Belt Tension New		Belt Tension Range Used*	
	Click-type	Burroughs	N	lbf	N	lbf
0.380 in	3822524		620	140	270 to 490	60 to 110
0.440 in	3822524		620	140	270 to 490	60 to 110
1/2 in	3822524	ST-1138	620	140	270 to 490	60 to 110
11/16 in	3822524	ST-1138	620	140	270 to 490	60 to 110
3/4 in	3822524	ST-1138	620	140	270 to 490	60 to 110
7/8 in	3822524	ST-1138	620	140	270 to 490	60 to 110
4 rib	3822524	ST-1138	620	140	270 to 490	60 to 110
5 rib	3822524	ST-1138	670	150	270 to 530	60 to 120
6 rib	3822525	ST-1293	710	160	290 to 580	65 to 130
8 rib	3822525	ST-1293	890	200	360 to 710	80 to 160
10 rib	3822525	3823138	1110	250	440 to 890	100 to 200
12 rib	3822525	3823138	1330	300	530 to 1070	120 to 240
12 rib K section	3822525	3823138	1330	300	890 to 1070	200 to 240

NOTE: This chart does not apply to automatic belt tensioners.

* A belt is considered used if it has been in service for ten minutes or longer.

* If used belt tension is less than the minimum value, tighten the belt to the maximum used belt value.

Engine Component Torque Values

General Information

Component	Wrench Size	Torque Value (N•m)	Torque Value [ft-lb]
Oil pan drain plug	12 mm	27	20
Turbocharger mounting nuts	13 mm	45	33
Vibration damper	18 mm	165	122
Fan hub mounting capscrews	5/8 in	290	215
Fuel pump mounting capscrews (mechanically actuated injector **only**)	13 mm	95	70
Fuel pump mounting capscrews (electronically actuated injector **only**)	15 mm	112	83
Rocker cover capscrews	13 mm	95	70
Injector hold-down capscrews (mechanically actuated injector **only**)	13 mm	100	75
Injector hold-down capscrews (electronically actuated injector **only**)	13 mm	30 (+60 degrees)	22 (+60 degrees)
Rocker lever shaft capscrews	14 mm (12 point)	280	207
Rocker adjust screw locknut (with adapter)	24 mm	47.5	35
Rocker adjust screw locknut (without adapter)	24 mm	60	44
Injector adjust screw locknut (with adapter)	24 mm	47.5	35
Injector adjust screw locknut (without adapter)	24 mm	60	44
Radiator hose clamp	8 mm	5	4 in-lb
Air compressor unloader valve plate	1/2 in	27	20

Capscrew Markings and Torque Values

General Information

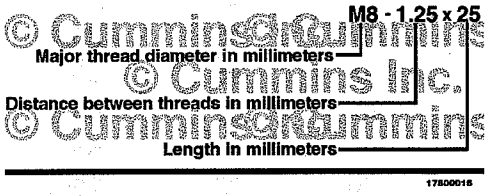
⚠CAUTION⚠

When replacing capscrews, always use a capscrew of the same measurement and strength as the capscrew being replaced. Using the wrong capscrews can result in engine damage.

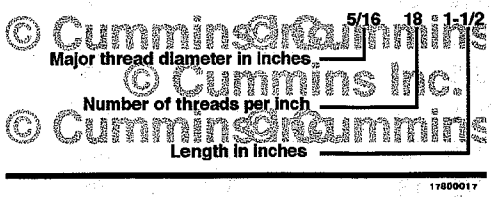
Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts. U.S. Customary capscrews are identified by radial lines stamped on the head of the capscrew.

The following examples indicate how capscrews are identified:

Metric - M8-1.25 X 25



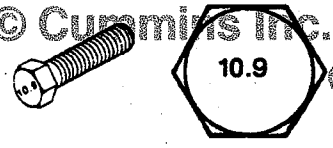
U.S. Customary [5/16 X 18 X 1-1/2]



NOTES:

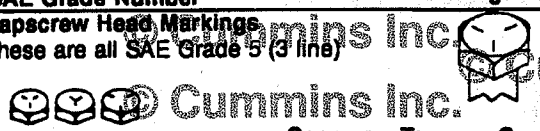
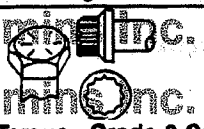
1. **Always** use the torque values listed in the following tables when specific torque values are **not** available.
2. Do **not** use the torque values in place of those specified in other sections of this manual.
3. The torque values in the table are based on the use of lubricated threads.
4. When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

Capscrew Markings and Torque Values - Metric

Commercial Steel Class	8.8	10.9	12.9
Capscrew Head Markings			

Body Size	Torque				Torque				Torque			
Diameter	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	13	10	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	23	17	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	65	50	30	25	70	50	30	25
12	80	60	55	40	115	85	55	40	125	95	55	40
14	125	90	90	65	180	133	90	65	195	145	90	65
16	195	140	140	100	280	200	140	100	290	210	140	100
18	280	200	180	135	390	285	180	135	400	290	180	135
20	400	290	—	—	550	400	—	—	—	—	—	—

Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5	8
Capscrew Head Markings These are all SAE Grade 5 (3 line)		

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Capscrew Body Size	Capscrew Torque - Grade 5 Capscrew				Capscrew Torque - Grade 8 Capscrew			
	Cast Iron		Aluminum		Cast Iron		Aluminum	
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4 - 20	9	7	8	6	15	11	8	6
1/4 - 28	12	9	9	7	18	13	9	7
5/16 - 18	20	15	16	12	30	22	16	12
5/16 - 24	23	17	19	14	33	24	19	14
3/8 - 16	40	30	25	20	55	40	25	20
3/8 - 24	40	30	35	25	60	45	35	25
7/16 - 14	60	45	45	35	90	65	45	35
7/16 - 20	65	50	55	40	95	70	55	40
1/2 - 13	95	70	75	55	130	95	75	55
1/2 - 20	100	75	80	60	150	110	80	60
9/16 - 12	135	100	110	80	190	140	110	80
9/16 - 18	150	110	115	85	210	155	115	85
5/8 - 11	180	135	150	110	255	190	150	110
5/8 - 18	210	155	160	120	290	215	160	120
3/4 - 10	325	240	255	190	460	340	255	190
3/4 - 16	365	270	285	210	515	380	285	210
7/8 - 9	490	360	380	280	745	550	380	280
7/8 - 14	530	390	420	310	825	610	420	310
1 - 8	720	530	570	420	1100	820	570	420
1 - 14	800	590	650	480	1200	890	650	480

Section W - Warranty

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All Diesel EnginesWorldwideGenerator Drive

Engines Warranted

This warranty applies to new Engines sold by Cummins and delivered to the first user on or after April 1, 1999 that are used in generator drive application anywhere in the world where Cummins approved service is available. These Engines will have the following rating designations:

Standby Power Rating

Engines of this rating are applicable for supplying emergency power for the duration of the utility power outage. No overload capability is available for this rating. Under no condition is an Engine allowed to operate in parallel with the public utility at the Standby Power rating. This rating should be applied where reliable utility power is available. A standby rated engine is to be sized for a maximum of an 80 percent average load factor and 200 hours of operation per year. This includes less than 25 hours per year at the Standby Power rating. Standby rating should never be applied except in true emergency power outages. Negotiated power outages contracted with a utility company are not considered an emergency.

Unlimited Time Running Prime Power Rating

Engines with this rating are available for an unlimited number of hours per year in a variable load application. Variable load is not to exceed a 70 percent average of the Prime Power Rating during any operating period of 250 hours. Total operating time at 100 percent Prime Power shall not exceed 500 hours per year.

A 10 percent overload capability is available for a period of one hour within a twelve hour period of operation. Total operating time at the 10 percent overload power shall not exceed 25 hours per year.

Limited Time Running Prime Power Rating

Engines of this rating are available for a limited number of hours in a non-variable load application. It is intended for use in situations where power outages are contracted, such as in utility power curtailment. Engines may be operated in parallel to the public utility up to 750 hours per year at power levels never to exceed the Prime Power rating.

Limited Time Running Prime Power ratings differ from Unlimited Time Running in that even though the maximum power output of the engines are the same, the Limited Time Running allows the Engine to be parallel to Public Utility and run at the full Prime Power rating and must never exceed the Prime Power rating.

Continuous/Base Power Rating

Engines with this rating are available for supplying utility power at a constant 100 percent load for an unlimited number of hours per year. No overload capability is available for this rating.

Continuous/Base Power ratings differ from Unlimited Time Running Prime Power ratings in that the Continuous/Base Load ratings are significantly reduced from the Prime Power ratings. Continuous/Base Load ratings have no load factor or application restrictions.

Coverage

Base Engine Warranty

This warranty covers any failures of the Engine, under normal use and service, which result from a defect in material or factory workmanship (Warrantable Failure).

Coverage begins with the sale of the Engine by Cummins and continues for the Duration stated below. The Duration commences either on the date of delivery of the Engine to the first user, or on the date the Engine is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first.

Base Engine Warranty

	Duration Whichever Occurs First	
Rating	**Months**	**Hours**
Standby Power	24	400
Unlimited Prime Power	12	Unlimited
Limited Prime Power	12	750
Continuous/Base Power	12	Unlimited

Extended Major Components Warranty

The Extended Major Components Warranty applies to Engines other than B and C series and covers Warrantable Failures of the Engine cylinder block, camshaft, crankshaft and connecting rods (Covered Parts). Bushing and bearing

failures are not covered. This coverage begins with the expiration of the Base Engine Warranty and continues for the following stated Duration. The Duration commences either on the date of delivery of the Engine to the first user, or on the date the Engine is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first.

Extended Major Components Warranty

	Duration Whichever Occurs First	
Rating	**Months**	**Hours**
Standby Power	36	600
Unlimited Prime Power	36	10,000
Limited Prime Power	36	2,250
Continuous/Base Power	36	10,000

Consumer Products

This warranty on Consumer Products in the United States is a LIMITED warranty. **CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.** Any implied warranties applicable to Consumer Products terminate concurrently with the expiration of the express warranties applicable to the product. In the United States, some states do not allow the exclusion of incidental or consequential damages, or limitations on how long an implied warranty lasts, so the limitations or exclusions herein may not apply to you.

These warranties are made to all Owners in the chain of distribution, and Coverage continues to all subsequent Owners until the end of the periods of Coverage.

Cummins Responsibilities

During Base Engine Warranty

Cummins will pay for all parts and labor needed to repair the damage to the Engine resulting from a Warrantable Failure when performed during normal business hours. All labor costs will be paid in accordance with Cummins published Standard Repair Time guidelines.

Cummins will pay for the lubricating oil, antifreeze, filter elements, and other maintenance items that are not reusable due to the Warrantable Failure.

Cummins will pay reasonable travel expenses for mechanics to travel to and from the Engine site, including meals, mileage, and lodging when the repair is performed at the site of the failure.

Cummins will pay reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

During the Extended Major Components Warranty

Cummins will pay for the repair or, at its option, replacement of the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner's Responsibilities

During the Base Engine Warranty

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during warranty repairs unless such items are not reusable due to the Warrantable Failure.

During the Extended Major Components Warranty

Owner is responsible for the cost of all labor needed to repair the Engine, including the labor cost for Engine removal and reinstallation. When Cummins elects to repair a part instead of replacing it, the Owner is not responsible for the labor needed to repair the part.

Owner is responsible for the cost of all parts required for the repair except for the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during repair of a Warrantable Failure.

During the Base Engine and Extended Major Components Warranties

Owner is responsible for the operation and maintenance of the Engine as specified in the applicable Cummins Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed.

Before the expiration of the applicable warranty, Owner must notify a Cummins distributor, authorized dealer or other repair location approved by Cummins of any Warrantable Failure and make the Engine available for repair by such facility. Locations in the United States* and Canada are listed in the Cummins United States and Canada Sales and Service Directory; other locations are listed in the Cummins International Sales and Service Directory.

Owner is responsible for communication expenses, meals, lodging and similar costs incurred as a result of a Warrantable Failure.

Owner is responsible for non-Engine repairs, "downtime" expenses, fines, all applicable taxes, all business costs and other losses resulting from a Warrantable Failure.

Owner is responsible for providing sufficient access to and reasonable ability to remove the Engine from the installation in the event of a Warrantable Failure.

Owner is responsible for maintaining an operating Engine hourmeter. If the hourmeter is not operational, engine usage will be estimated at 400 hours per month.

Limitations

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications to the Engine. Cummins is also not responsible for Engine performance problems or failures caused by incorrect oil or fuel, or by water, dirt or other contaminants in the fuel or oil.

This warranty does not apply to accessories supplied by Cummins which bear the name of another company. Such non-warranted accessories include, but are not limited to: alternators, starters, fans**, air conditioning compressors, clutches, filters, transmissions, air cleaners and safety shutdown switches.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that consumption exceeds Cummins published standards.

Failure of belts and hoses supplied by Cummins are not covered beyond the first 500 hours or one year of operation, whichever occurs first after the warranty start date.

Parts used to repair a Warrantable Failure may be new Cummins parts, Cummins approved rebuilt parts, or repaired parts. Cummins is not responsible for failures resulting from the use of parts not approved by Cummins.

A new Cummins or Cummins-approved rebuilt part used to repair a Warrantable Failure assumes the identity of the part it replaced and is entitled to the remaining coverage hereunder.

Cummins is not responsible for Engine performance problems or failures resulting from:

1. Use or application of the Engine inconsistent with its rating designation as set forth above.
2. Inadequate or incorrect installations deviating from Cummins Generator Drive Installation Guidelines.

CUMMINS IS NOT RESPONSIBLE FOR WEAR OR WEAROUT OF COVERED PARTS.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

THE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS IN REGARD TO THESE ENGINES. CUMMINS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

In the United States* and Canada, this warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Outside the United States* and Canada, in case of consumer sales, in some countries, the Owner has statutory rights which cannot be affected or limited by the terms of this warranty.

Nothing in this warranty excludes or restricts any contractual rights the owner may have against third parties.

* Includes American Samoa, the Commonwealth of Northern Mariana Islands, Guam, Puerto Rico, and the U.S. Virgin Islands.

** Alternators, starters, and fans ARE covered for the duration of the base engine warranty on B3.3 engines.

All Engines United States and Canada Industrial (Off-Highway)

Coverage

Products Warranted

This warranty applies to new Engines sold by Cummins and delivered to the first user on or after April 1, 1999, that are used in industrial (off-highway) applications in the United States* and Canada, except for Engines used in marine, generator drive and certain defense applications, for which different warranty coverage is provided.

Base Engine Warranty

This warranty covers any failures of the Engine, under normal use and service, which result from a defect in material or factory workmanship (Warrantable Failures).

Coverage begins with the sale of the Engine by Cummins. Coverage continues for two years or 2,000 hours of operation, whichever occurs first, from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first. If the 2,000 hour limit is exceeded during the first year, Coverage continues until the end of the first year.

Extended Major Components Warranty

The Extended Major Components Warranty covers Warrantable Failures of the Engine cylinder block, camshaft, crankshaft and connecting rods (Covered Parts).

Bushing and bearing failures are not covered.

This Coverage begins with the expiration of the Base Engine Warranty and ends three years or 10,000* hours of operation from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or from when the Engine has been operated for 50 hours, whichever occurs first.

*3,000 hours for A series engines.

Consumer Products

The warranty on Consumer Products in the United States is a LIMITED warranty. **CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.** Any implied warranties applicable to Consumer Products in the United States terminate concurrently with the expiration of the express warranties applicable to the product. In the United States, some states do not allow the exclusion of incidental or consequential damages, or limitations on how long an implied warranty lasts, so the limitations or exclusions herein may not apply to you.

These warranties are made to all Owners in the chain of distribution, and Coverage continues to all subsequent Owners until the end of the periods of Coverage.

Cummins' Responsibilities

During The Base Engine Warranty

Cummins will pay for all parts and labor needed to repair the damage to the Engine resulting from a Warrantable Failure.

Cummins will pay for the lubricating oil, antifreeze, filter elements, and other maintenance items that are not reusable due to the Warrantable Failure.

Cummins will pay reasonable costs for mechanics to travel to and from the equipment site, including meals, mileage and lodging, when the repair is performed at the site of the failure.

Cummins will pay reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

During The Extended Major Components Warranty

Cummins will pay for the repair or, at its option, replacement of the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered part.

Owner's Responsibilities

During The Base Engine Warranty

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items provided during warranty repairs unless such items are not reusable due to the Warrantable Failure.

During The Extended Major Components Warranty

Owner is responsible for the cost of all labor needed to repair the Engine, including the labor to remove and reinstall the Engine. When Cummins elects to repair a part instead of replacing it, Owner is not responsible for the labor needed to repair the part.

Owner is responsible for the cost of all parts required for the repair except for the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during repair of a Warrantable Failure.

During The Base Engine and Extended Major Components Warranties

Owner is responsible for the operation and maintenance of the Engine as specified in the applicable Cummins Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed.

Before the expiration of the applicable warranty, Owner must notify a Cummins distributor, authorized dealer or other repair location approved by Cummins of any Warrantable Failure and make the Engine available for repair by such facility. Locations in the United States and Canada are listed in the Cummins Off Highway Authorized Dealer Directory.

Owner is responsible for communication expenses, meals, lodging and similar costs incurred as a result of a Warrantable Failure.

Owner is responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs and other losses resulting from a Warrantable Failure.

Limitations

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications of the Engine. Cummins is also not responsible for failures caused by incorrect oil or fuel or by water, dirt or other contaminants in the fuel or oil.

For power units and fire pumps (package units), this warranty applies to accessories, except for clutches and filters, supplied by Cummins which bear the name of another company.

Except for power units and fire pumps, this warranty does not apply to accessories which bear the name of another company. Such non-warranted accessories include, but are not limited to: alternators, starters, fans**, air conditioning compressors, clutches, filters, transmissions, torque converters, steering pumps, and non-Cummins fan drives, engine compression brakes and air compressors.

Cummins Compusave units are covered by a separate warranty.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that consumption exceeds Cummins published standards.

Failures of belts and hoses supplied by Cummins are not covered beyond the first 500 hours or one year of operation, whichever occurs first.

Parts used to repair a Warrantable Failure may be new Cummins parts, Cummins-approved rebuilt parts, or repaired parts. Cummins is not responsible for failures resulting from the use of parts not approved by Cummins.

A new Cummins or Cummins-approved rebuilt part used to repair a Warrantable Failure assumes the identity of the part it replaced and is entitled to the remaining coverage hereunder.

CUMMINS DOES NOT COVER WEAR OR WEAROUT OF COVERED PARTS.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

THESE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS IN REGARD TO THESE ENGINES. CUMMINS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Emission Warranty

Products Warranted

This emission warranty applies to new Engines marketed by Cummins that are used in the United States* in vehicles designed for Industrial off-highway use. This warranty applies to Engines delivered to the ultimate purchaser on or after April 1, 1999 for engines up to 750 horsepower, on or after January 1, 2000 for engines 751 horsepower and over.

Coverage

Cummins warrants to the ultimate purchaser and each subsequent purchaser that the Engine is designed, built and equipped so as to conform at the time of sale by Cummins with all U.S. Federal emission regulations applicable at the time of manufacture and that it is free from defects in workmanship or material which would cause it not to meet these regulations within the longer of the following periods: (A) Five years or 3,000 hours of operation, whichever

occurs first, as measured from the date of delivery of the Engine to the ultimate purchaser, or (B) The Base Engine Warranty.

If the vehicle in which the Engine is installed is registered in the state of California, a separate California Emission Warranty also applies.

Limitations

Failures, other than those resulting from defects in materials, or workmanship, are not covered by this warranty.

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolant or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications of the Engine. Cummins is also not responsible for failures caused by incorrect fuel or by water, dirt or other contaminants in the fuel.

Cummins is not responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all business costs or other losses resulting from a Warrantable Failure.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

* Includes American Samoa, the Commonwealth of Northern Mariana Islands, Guam, Puerto Rico, and the U.S. Virgin Islands.

** Alternators, starters, and fans ARE covered for the duration of the base engine warranty on A series and B3.3 engines.

All Engines Worldwide Marine/Commercial Propulsion and Auxiliary Products

Coverage

Engines Included in this Coverage

Marine Propulsion	Marine Generator Drive
NT855-M	4B3.9-D(M)
NTA855-M	4BT3.9-D(M)
KT19-M	6B5.9-D(M)
KTA19-M	6BT5.9-D(M)
KTA19-M3	6CT8.3-D(M)
KTA19-M4	6CTA8.3-D(M)
QSK19-M	NT855-D(M)
VTA28-M	NTA855-D(M)
KTA38-M0	KTA19-D(M)
KTA38-M1	KTA19-D(M1)
KTA38-M2	VTA28-D(M)
KTA50-M2	KTA38-D(M)
QSK60-M	KTA38-D(M1)
	KTA50-D(M)
	QSK60-D(M)

Products Warranted

This warranty applies to new Engines sold by Cummins Inc., herein after "Cummins", that are branded as Cummins Marine products and used in Marine propulsion and marine auxiliary applications anywhere in the world where Cummins approved service is available and delivered to the first user on or after July 1, 2002. This warranty excludes all engines branded and sold as Cummins Mercruiser Diesel products. The `Product' consists of a new Cummins Engine, as well as accessories, which are approved and supplied by Cummins and which are either installed by Cummins or a Cummins authorized distributor. These Products have the following designation:

MARINE PROPULSION AND MARINE AUXILIARY (EXCLUDING GENERATOR DRIVE ENGINES)

Intermittent Rating

This power rating is intended for intermittent use in variable load applications where full power is limited to two hours out of every eight hours of operation. Also, reduced power operations must be at or below 200 RPM of the maximum rated RPM. This rating is an ISO3046 Fuel Stop Power Rating and is for applications that operate less than 1500 hours per year.

Medium Continuous Rating

This power rating is intended for continuous use in variable load applications where full power is limited to six hours out of every twelve hours of operation. Also, reduced power operations must be at or below 200 RPM of the maximum rated RPM. This rating is an ISO3046 Fuel Stop Power Rating and is for applications that operate less than 3000 hours per year.

Heavy Duty Rating

This power rating is intended for continuous use in variable load applications where full power is limited to eight hours out of every ten hours of operation. Also, reduced power must be at least 200 RPM below the maximum rated RPM. This rating is an ISO3046 Fuel Stop Power Rating and is for applications that operate less than 5,000 hours per year.

Continuous Rating

This power rating is intended for continuous use in applications requiring uninterrupted service at full power. This rating is an ISO3046 Standard Power Rating.

MARINE GENERATOR DRIVE

Prime Power

Engines with this rating are available for an unlimited number of hours per year in variable load applications. Variable load is not to exceed a 70 percent average of the Prime Power rating during any operating period of 250 hours. Total operating time at 100 percent Prime Power shall not exceed 500 hours per year.

A 10 percent overload capability is available for a period of one hour within a twelve hour period of operation. Total operating time at the 10 percent overload power shall not exceed 25 hours per year. This power rating conforms to ISO 8528 guidelines.

Continuous Power

Engines with this rating are available for supplying utility power at a constant 100 percent load for an unlimited number of hours per year. No overload capability is available for this rating.

Continuous Power ratings differ from Prime Power ratings in that the Continuous Load ratings are significantly reduced from the Prime Power ratings. Continuous Load ratings have no load factor or application restrictions. This power rating conforms to ISO 8528 guidelines.

Base Engine Warranty

This warranty covers any failures of the Product, under normal use and service, which result from a defect in Cummins material or factory workmanship (Warrantable Failure). Coverage begins with the sale of the Engine by Cummins and ends at the time and hours stated in the following table. The Duration commences on either the date of delivery of the Product to the first end-user, or the date the unit is first leased, rented or loaned, or when the Product has been operated for 50 hours, whichever occurs first.

	Duration Whichever Occurs First	
Rating	Years	Hours
Intermittent	1	1500
Medium Continuous	1	3000
Heavy Duty	1	5000
Continuous	1	Unlimited
Prime Power	1	Unlimited
Continuous Power	1	Unlimited

Extended Major Components Warranty

The Extended Major Components Warranty applies to engines other than B and C Series. It covers Warrantable Failures of the engine cylinder block, camshaft, crankshaft and connecting rods (Covered Parts). Bushing and bearing failures are not covered. This coverage begins with the expiration of the Base Engine Warranty and ends at three years or 10,800 hours of operation, whichever occurs first, after the date of delivery to the first end-user, or the date the unit is first leased, rented, or loaned, or when the Product has been operated for 50 hours, whichever occurs first.

These warranties are made to all Owners in the chain of distribution and Coverage continues to all subsequent Owners until the end of the periods of Coverage.

Cummins Responsibilities

During Base Engine Warranty

Cummins will pay for all parts and labor needed to repair the damage to the Product resulting from a Warrantable Failure when performed during normal business hours. All labor costs will be paid in accordance with Cummins published Standard Repair Time guidelines.

When it is necessary for mechanics to make on-site warranty repairs, Cummins will pay reasonable travel expenses, including meals, mileage and lodging, for mechanics to travel to and from the repair dock.

Cummins will pay for the lubricating oil, antifreeze, filter elements, and other maintenance items that are not reusable due to the Warrantable Failure.

Cummins will pay for reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

During the Extended Major Components Warranty

Cummins will pay for the repair or, at its option, replacement of the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner Responsibilities

During the Base Engine Warranty

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements, and other maintenance items replaced during warranty repairs unless such items are not reusable due to the Warrantable Failure.

During the Extended Major Components Warranty

Owner is responsible for the cost of all labor needed to repair the Engine, including the labor cost for Engine removal and reinstallation. When Cummins elects to repair a part instead of replacing it, the Owner is not responsible for the labor needed to repair the part.

Owner is responsible for the cost of all parts required for the repair except for the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during repair of a Warrantable Failure.

During the Base Engine and Extended Major Components Warranties

Owner is responsible for the operation and maintenance of the Product as specified in the applicable Cummins Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed.

Before the expiration of the applicable warranty, Owner must notify a Cummins distributor, authorized dealer, or other repair location approved by Cummins of any Warrantable Failure and make the Engine available for repair by such facility. Locations in the United States and Canada are listed in the Cummins U.S. and Canada Sales and Service Directory; other locations are listed in the Cummins International Sales and Service Directory.

In the event of any Product failure, Owner is responsible for the cost of towing the boat to the repair dock and for all associated docking and harbor charges.

Owner is responsible for communication expenses, meals, lodging, and similar costs incurred as a result of a Warrantable Failure.

Owner is responsible for maintaining the Engine hourmeter in good working order at all times and to ensure that the hourmeter accurately reflects the total hours of operation of the Product.

Owner is responsible for the costs to investigate complaints, unless the problem is caused by a defect in Cummins material or factory workmanship.

Owner is responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs, and other losses resulting from a Warrantable Failure.

Limitations

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of cooling, lubricating or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications to the Engine. Cummins is also not responsible for failures caused by incorrect oil or fuel or by water, dirt or other contaminants in the fuel or oil.

Cummins is not responsible for failures resulting from:

1. Use or application of the Product inconsistent with its rating designation set forth above.
2. Incorrect installation.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that oil consumption exceeds Cummins published standards.

Cummins is not responsible for failures of marine maintenance components supplied by Cummins beyond ninety days after the coverage start date. Marine maintenance components include, but are not limited to: sea water pump impellers; zinc plugs; oil filters; fuel filters; air filters; water filters; fuel/water separator filters; expansion tank pressure caps.

Failure of belts and hoses supplied by Cummins are not covered beyond 90 days after the date of delivery of the Product to the first user, or the date the unit is first leased, rented or loaned, or when the Product has been operated for 50 hours, whichever occurs first.

Except for the accessories noted previously, Cummins does not warrant accessories which bear the name of another company.

Parts used in warranty repairs may be new Cummins parts, Cummins approved rebuilt parts, or repaired parts. Cummins is not responsible for failures resulting from the use of parts not supplied by Cummins.

Parts used to repair a Warrantable Failure may be new Cummins parts, Cummins approved rebuilt parts, or repaired parts. Cummins is not responsible for failures resulting from the use of parts not approved by Cummins.

A new Cummins or Cummins-approved rebuilt part used to replace a Warranted Part assumes the identity of the Warranted Part it replaced and is entitled to the remaining coverage hereunder.

Cummins Inc. reserves the right to interrogate Electronic Control Module (ECM) data for purposes of failure analysis.

CUMMINS DOES NOT COVER WEAR OR WEAROUT OF COVERED PARTS.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

THIS WARRANTY AND THE EMISSION WARRANTY SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS IN REGARD TO THESE ENGINES. CUMMINS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

In the United States** and Canada, this warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Outside the United States** and Canada, in case of consumer sales, in some countries the Owner has statutory rights which cannot be affected or limited by the terms of this warranty.

Nothing in this warranty excludes or restricts any contractual rights the Owner may have against third parties.

Emission Warranty

Products Warranted

This Emission Warranty applies to new Engines certified to United States EPA 40 CFR 94 sold by Cummins that are installed on vessels flagged or registered in the United States**.

Coverage

Cummins warrants to the first user and each subsequent purchaser that the Engine is designed, built and equipped so as to conform at the time of sale by Cummins with all United Stated Federal emission regulations applicable at the time of manufacture and that it is free from defects in material or factory workmanship which would cause it not to meet these regulations within the longer of the following periods. (A) Five years or 5,000 hours of operation, whichever occurs first, as measured from the date of delivery of the engine to the first user, or the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first, or (B) The Base Engine Warranty.

Limitations

An owner may elect to have maintenance, replacement or repair of the emission control parts performed by a facility other than a Cummins distributor, an authorized dealer or a repair location approved by Cummins, and may elect to use parts other than new genuine Cummins or Cummins approved rebuilt parts and assemblies for such maintenance, replacement or repair; however, the cost of such service or parts and subsequent failures resulting from such service or parts will not be covered under this emission control system warranty.

Failures, other than those resulting from defects in materials or factory workmanship, are not covered by this warranty.

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding, lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications of the Engine. Cummins is also not responsible for failures caused by incorrect oil or fuel or by water, dirt or other contaminants in the fuel or oil.

Cummins is not responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs or other losses resulting from a Warrantable Failure.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

** United States incudes American Samoa, the Commonwealth of Northern Mariana Islands, Guam, Puerto Rico, and the U.S. Virgin Islands.

All Engines InternationalIndustrial (Off-Highway)

Coverage

PRODUCTS WARRANTED

This warranty applies to new Engines sold by Cummins and delivered to the first user on or after April 1, 1999, that are used in industrial (off-highway) applications anywhere in the world where Cummins-approved service is available, except the United States* and Canada. Different warranty coverage is provided for Engines used in marine, generator drive and certain defense applications.

BASE ENGINE WARRANTY

This warranty covers any failures of the Engine, under normal use and service, which result from a defect in material or factory workmanship (Warrantable Failure).

Coverage begins with the sale of the Engine by Cummins. Coverage continues for two years or 2,000 hours of operation, whichever occurs first, from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first. If the 2,000 hour limit is exceeded during the first year, coverage continues until the end of the first year.

EXTENDED MAJOR COMPONENTS WARRANTY

The Extended Major Components Warranty covers Warrantable Failures of the Engine cylinder block, camshaft, crankshaft and connecting rods (Covered Parts).

Bushing and bearing failures are not covered.

This coverage begins with the expiration of the Base Engine Warranty and ends three years or 10,000* hours of operation, from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first.

*3,000 hours for A series engines.

These warranties are made to all Owners in the chain of distribution, and Coverage continues to all subsequent Owners until the end of the periods of Coverage.

Cummins' Responsibilities

DURING THE BASE ENGINE WARRANTY

Cummins will pay for all parts and labor needed to repair the damage to the Engine resulting from a Warrantable Failure.

Cummins will pay for the lubricating oil, antifreeze, filter elements, and other maintenance items that are not reusable due to a Warrantable Failure.

Cummins will pay reasonable costs for mechanics to travel to and from the equipment site, including meals, mileage and lodging, when the repair is performed at the site of the failure.

Cummins will pay reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

DURING THE EXTENDED MAJOR COMPONENTS WARRANTY

Cummins will pay for the repair or, at its option, replacement of the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered part.

Owner's Responsibilities

DURING THE BASE ENGINE WARRANTY

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during warranty repairs unless such items are not reusable due to the Warrantable Failure.

DURING THE EXTENDED MAJOR COMPONENTS WARRANTY

Owner is responsible for the cost of all labor needed to repair the Engine, including the labor to remove and reinstall the Engine. When Cummins elects to repair a part instead of replacing it, Owner is not responsible for the labor needed to repair the part.

Owner is responsible for the cost of all parts required for the repair except for the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during repair of a Warrantable Failure.

DURING THE BASE ENGINE AND EXTENDED MAJOR COMPONENTS WARRANTIES

Owner is responsible for the operation and maintenance of the Engine as specified in the applicable Cummins Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed.

Before the expiration of the applicable warranty, Owner must notify a Cummins distributor, authorized dealer or other repair location approved by Cummins of any Warrantable Failure and make the product available for repair by such facility. Locations are listed in the Cummins International Sales and Service Directory.

Owner is responsible for communication expenses, meals, lodging and similar costs incurred as a result of a Warrantable Failure.

Owner is responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs and other losses resulting from a Warrantable Failure.

Limitations

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications of the Engine. Cummins is also not responsible for failures caused by incorrect oil or fuel or by water, dirt or other contaminants in the fuel or oil.

For power units and fire pumps (package units) the warranty applies to accessories, except for clutches and filters supplied by Cummins which bear the name of another company.

Non-Cummins starters, alternators, power steering pumps and air compressors supplied by Cummins that are not supplied as part of a package unit are covered for six months from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first. Cummins branded parts noted above supplied by Cummins are covered for the entire Base Warranty period.

Except for the accessories noted previously, Cummins does not warrant accessories which bear the name of another company. Such non-warranted accessories include, but are not limited to: alternators, starters, fans*, air conditioning compressors, clutches, filters, transmissions, torque converters, steering pumps, non-Cummins fan drives, and air cleaners.

Cummins Compusave units are covered by a separate warranty.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that consumption exceeds Cummins published standards.

Failures of belts and hoses supplied by Cummins are not covered beyond the first 500 hours or one year of operation, whichever occurs first.

Parts used to repair a Warrantable Failure may be new Cummins parts, Cummins-approved rebuilt parts, or repaired parts. Cummins is not responsible for failures resulting from the use of parts not approved by Cummins.

A new Cummins or Cummins-approved rebuilt part used to repair a Warrantable Failure assumes the identity of the part it replaced and is entitled to the remaining coverage hereunder.

CUMMINS DOES NOT COVER WEAR OR WEAROUT OF COVERED PARTS.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

THESE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS IN REGARD TO THESE ENGINES. CUMMINS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

In case of consumer sales, in some countries, the Owner has statutory rights which cannot be affected or limited by the terms of this warranty.

Nothing in this warranty excludes or restricts any contractual rights the Owner may have against third parties.

* Alternators, starters, and fans ARE covered for the duration of the base engine warranty on A series and B3.3 engines.

California Emission Control System Warranty, Off-Highway

Products Warranted

This Emission Control System Warranty applies to off-road diesel engines certified with the California Air Resources Board beginning with the year 1996 for engines up to 750 horsepower, beginning with the year 2000 for 751 horsepower and over, marketed by Cummins, and registered in California for use in industrial off-highway applications.

Your Warranty Rights and Obligations

The California Air Resources Board and Cummins Engine Company, Inc., are pleased to explain the emission control system warranty on your engine. In California, new off-road diesel engines must be designed, built and equipped to meet the State's stringent anti-smog standards. Cummins must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, Cummins will repair your off-road diesel engine at no cost to you including diagnosis, parts and labor.

Manufacturer's Warranty Coverage

This warranty coverage is provided for 5 years or 3,000 hours of engine operation, whichever first occurs from the date of delivery of the engine to the first user. If any emission-related part on your engine is defective, the part will be repaired or replaced by Cummins.

Coverage

This emission control system warranty applies to the following QSK emission control parts:

Fuel Pump
Timing and Metering Supply Tubes

Injectors
Cup
Nozzle Flow Calibration
Barrel Flow Calibration
Top Stop Setting

Turbocharger
Compressor Wheel
Turbine Wheel
Oil Seal

Intake Manifold
Aftercooler Core

Exhaust Manifold

Electronic Control System
Control Module
Timing and Rail Pressure Sensor
Boost Pressure Sensor
Ambient Air Pressure Sensor
Coolant Temperature Sensor

Owner's Warranty Responsibilities

As the off-road diesel engine owner, you are responsible for the performance of the required maintenance listed in your Cummins Operation and Maintenance Manual. Cummins recommends that you retain all receipts covering maintenance on your off-road diesel engine, but Cummins cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance.

You are responsible for presenting your off-road diesel engine to a Cummins dealer as soon as a problem exists. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

As the off-road diesel engine owner, you should also be aware that Cummins may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Your engine is designed to operate on diesel fuel only. Use of any other fuel may result in your engine no longer operating in compliance with California's emissions requirements.

If you have any questions regarding your warranty rights and responsibilities, you should contact Cummins Customer Assistance Department at 1-800-343-7357 (1-800-DIESELS) or the California Air Resources Board at 9528 Telstar Avenue, El Monte, CA 91731.

Prior to the expiration of the applicable warranty, Owner must give notice of any warranted emission control failure to a Cummins distributor, authorized dealer or other repair location approved by Cummins and deliver the engine to such facility for repair. Repair locations are listed in Cummins United States and Canada Service Directory.

Owner is responsible for incidental costs such as: communication expenses, meals, lodging incurred by Owner or employees of Owner as a result of a warrantable failure.

Owner is responsible for business costs and losses, "downtime" expenses, and cargo damage resulting from a warrantable failure. CUMMINS IS NOT RESPONSIBLE FOR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDE BUT ARE NOT LIMITED TO FINES, THEFT, VANDALISM OR COLLISIONS.

Replacement Parts

Cummins recommends that any service parts used for maintenance, repair or replacement of emission control systems be new, genuine Cummins or Cummins approved rebuilt parts and assemblies, and that the engine be serviced by a Cummins distributor, authorized dealer or the repair location approved by Cummins. The owner may elect to have maintenance, replacement or repair of the emission control parts performed by a facility other than a Cummins distributor, an authorized dealer or a repair location approved by Cummins, and may elect to use parts other than new genuine Cummins or Cummins approved rebuilt parts and assemblies for such maintenance, replacement or repair; however, the cost of such service or parts will not be covered under this emission control system warranty.

Cummins Responsibilities

Repairs and service will be performed by any Cummins distributor, authorized dealer or other repair location approved by Cummins using new, genuine Cummins or Cummins approved rebuilt parts and assemblies. Cummins will repair any of the emission control parts found by Cummins to be defective without charge for parts or labor (including diagnosis which results in determination that there has been a failure of a warranted emission control part).

Emergency Repairs

In the case of an emergency where a Cummins distributor, authorized dealer, or other repair location approved by Cummins is not available, repairs may be performed by any available repair location using any replacement parts. Cummins will reimburse the Owner for expenses (including diagnosis), not to exceed the manufacturer's suggested retail price for all warranted parts replaced and labor charges based on the manufacturer's recommended time allowance for the warranty repair and the geographically appropriate hourly labor rate. A part not being available within 30 days or a repair not being complete within 30 days constitutes an emergency. Replaced parts and paid invoices must be presented at a Cummins authorized repair facility as a condition of reimbursement for emergency repairs not performed by a Cummins distributor, authorized dealer, or other repair location approved by Cummins.

Warranty Limitations

Cummins is not responsible for failures resulting from Owner or operator abuse or neglect, such as: operation without adequate coolant, fuel or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or air intake systems; improper storage, starting, warm-up, run-in or shutdown practices.

The manufacturer warrants to the ultimate purchaser and each subsequent purchaser that the engine is designed, built, and equipped so as to conform with all applicable regulations adopted by the Air Resources Board, and that it is free from defects in materials and workmanship which cause the failure of a warranted part.

Any warranted part which is not scheduled for replacement as required maintenance, or which is scheduled only for regular inspection to the effect of "repair or replace as necessary" is warranted for the warranty period.

Any warranted part which is scheduled for replacement as required maintenance is warranted for the period of time prior to the first scheduled replacement point for that part.

The owner will not be charged for diagnostic labor which leads to the determination that a warranted part is defective, if the diagnostic work is performed at a warranty station.

The manufacturer is liable for damages to other engine components caused by the failure under warranty of any warranted part.

Cummins is not responsible for failures resulting from improper repair or the use of parts which are not genuine Cummins or Cummins approved parts.

These warranties, together with the express commercial warranties and emission warranty are the sole warranties of Cummins. There are no other warranties, express or implied, or of merchantability or fitness for a particular purpose.

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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.

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