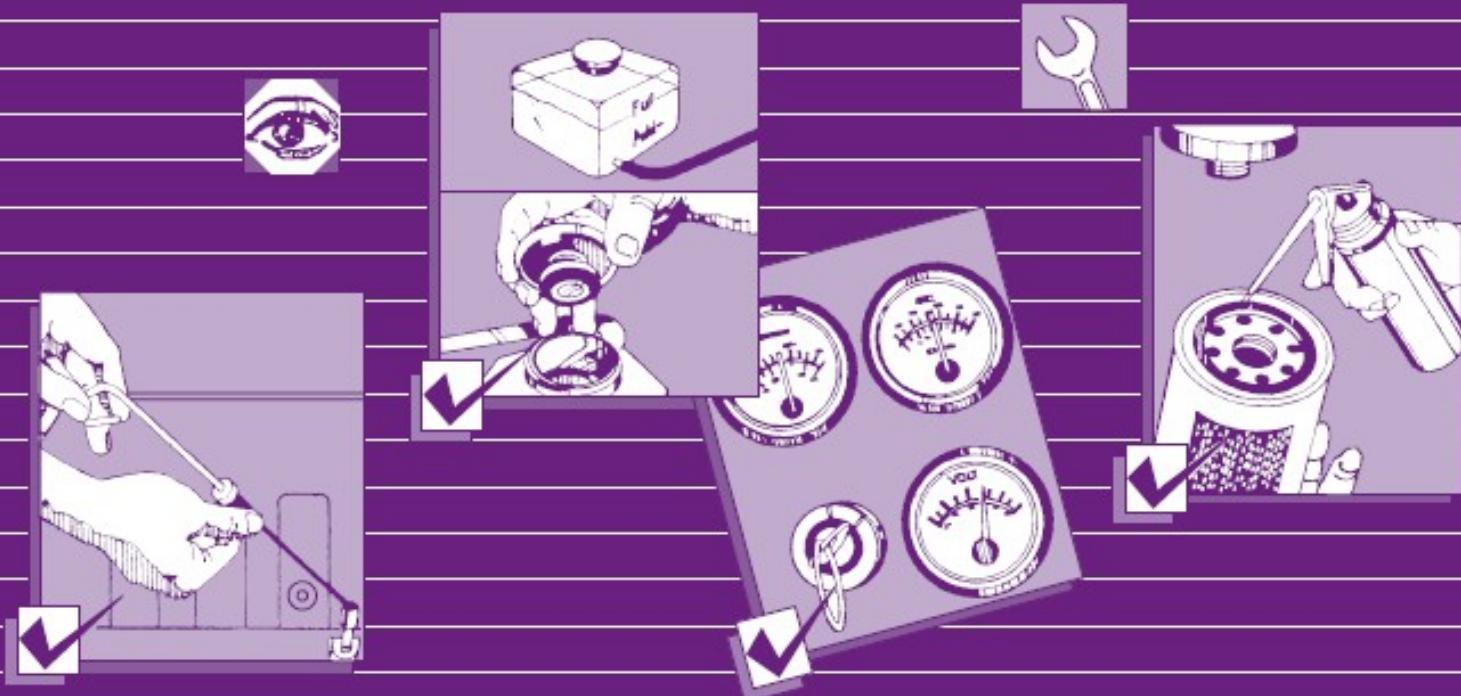




# Operation and Maintenance Manual

## QSM11 Marine



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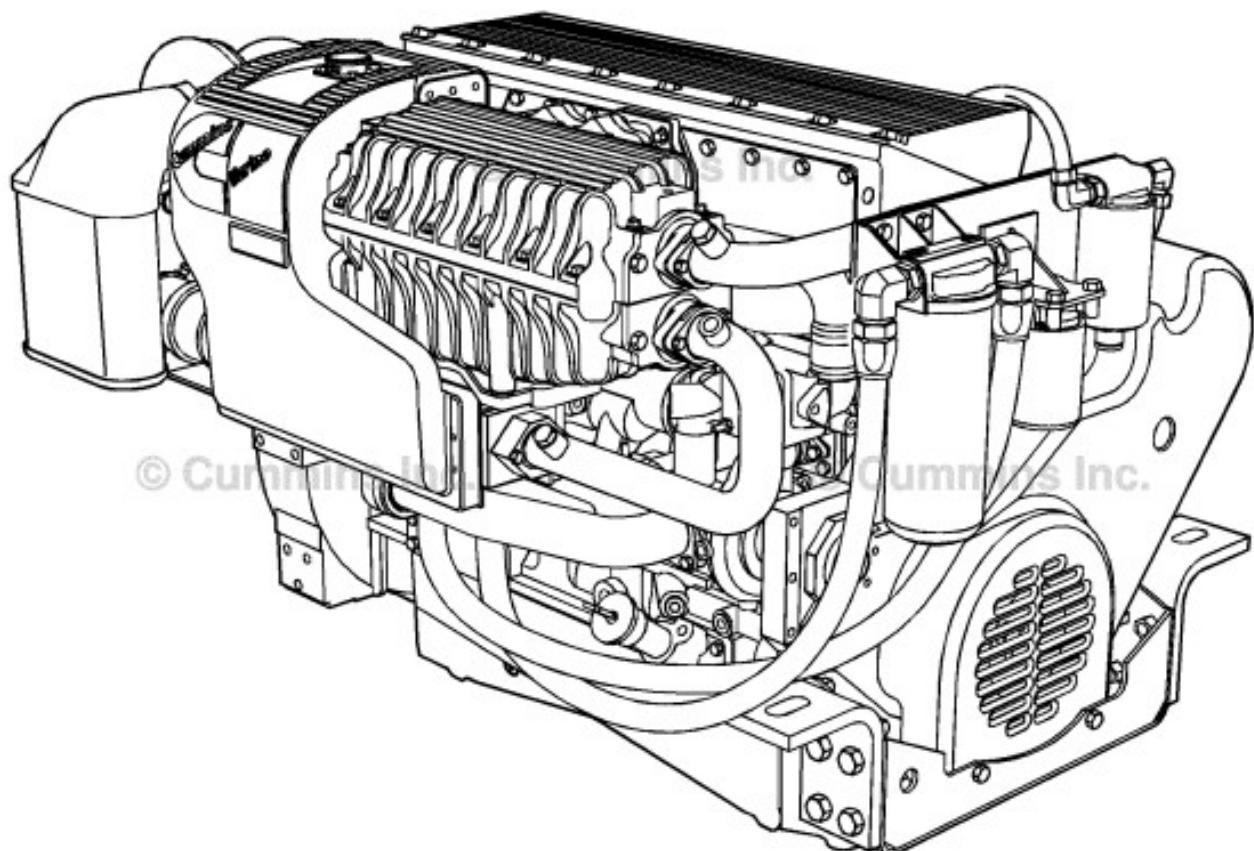


## Operation and Maintenance Manual

### QSM11 Marine

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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.

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

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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.

Name	Number	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		
• Fuel		
• Fuel-Water Separator		
• Coolant		
• Crankcase Ventilation		
• Cummins Particulate Filter		
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

### Section Contents

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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). Blending engine oil with fuel is prohibited for engines with an aftertreatment system.

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 divided into the same group system used for previous manuals and the Cummins' filmcard system. Section 00 is organized into a logical sequence of engine disassemble/assemble, all other sections are in numerical sequence. Refer to the Table of Contents at the front of the book to determine the section that details the desired information.

The disassemble/assemble sections of this manual is divided into the same group system used for previous manuals and the Cummins' filmcard system.

Section 00 is organized into a logical sequence of engine disassemble/assemble, all other sections are in numerical sequence. Refer to the Table of Contents at the front of the book to determine the section that details the desired information.

Each section contains the following in sequence:

- Table of Contents
- Required Service Tool Listings
- General Information containing the basic service, maintenance, design and revision information necessary to assist in the rebuild of an engine or a component
- Procedure instructions for the disassembly, inspection, maintenance, and assembly that can be required to rebuild an engine; additional procedures that are **not** necessary during **every** rebuild, but can be necessary, are included. These procedures depend on the length of time an engine has been in service and the conditions of the parts.

All the procedures are identified with a name and a number. Each digit in the procedure number has a specific meaning.

The first three digits of the number refer to the specific section that the procedure can be found within the manual. In this example, "001" represents Section 01 - Cylinder Block. This number will range from 000 to 022.

The second three digits of the number are unique and refer to a specific subject. In this example, "028" represents Cylinder Liner. This number will range from 001 to 999.

Refer to Section V for specifications recommended by Cummins Engine Company, Inc. for your engine. Specifications and torque values for each engine system are given in that section.

**NOTE:** Discharge of oil or oily water into or upon the water is a direct violation of today's laws. Violators are subject to a penalty of various monetary charges. Dispose of these substances in accordance with standards set by the EPA.

## 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:

	<b>WARNING</b> - Serious personal injury or extensive property damage can result if the warning instructions are not followed.		<b>PERFORM</b> a mechanical or time <b>MEASUREMENT</b> .
	<b>CAUTION</b> - Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are not followed.		<b>LUBRICATE</b> the part or assembly.
	Indicates a <b>REMOVAL</b> or <b>DISASSEMBLY</b> step.		Indicates that a <b>WRENCH</b> or <b>TOOL SIZE</b> will be given.
	Indicates an <b>INSTALLATION</b> or <b>ASSEMBLY</b> step.		<b>TIGHTEN</b> to a specific torque.
	<b>INSPECTION</b> is required.		<b>PERFORM</b> an electrical <b>MEASUREMENT</b> .
	<b>CLEAN</b> the part or assembly.		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.

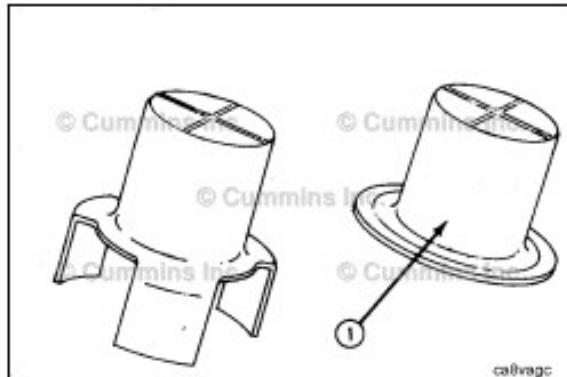
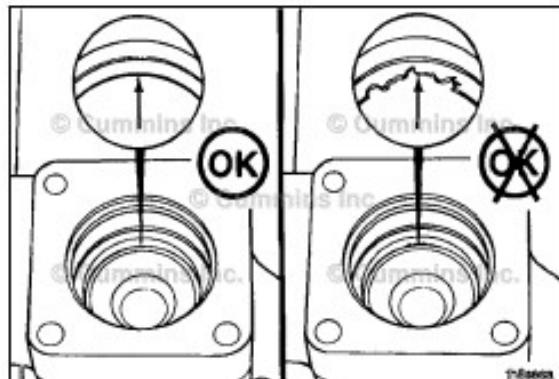
17800009

## 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, exhaust gas flow, 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.
- When necessary, the removal and replacement of any guards covering rotating components, drives, and/or belts should only be carried out by a trained technician. Before removing any guards the engine **must** be turned off and any starting mechanisms **must** be isolated. All fasteners **must** be replaced on re-fitting the guards.
- 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.
- Do not connect the jumper starting or battery charging cables to any ignition or governor control wiring. This can cause electrical damage to the ignition or governor.
- Always torque fasteners and fuel connections to the required specifications. Overtightening or undertightening can allow leakage. This is critical to the natural gas and liquefied petroleum gas fuel and air systems.
- Always test for fuel leaks as instructed, as odorant can fade.
- Close the manual fuel valves prior to performing maintenance and repairs, and when storing the vehicle inside.
- 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.
- 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.

## 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.

#### △ CAUTION △

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 service 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 clamp of the welder to any of the sensors, wiring harness, the ECM or the engine. Direct welding of any electronic engine component or engine mounted component must not be attempted. Sensors, wiring harness, and ECM should be removed if nearby welding will expose these components to temperatures beyond normal operation. Additionally, all ECM connectors must be disconnected..

## 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 particularly 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
- NOx Sensor.

## 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 psi) 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.

## Fuel System

When servicing any fuel system components, which can be exposed to potential contaminants, prior to disassembly, clean the fittings, mounting hardware, and the area around the component to be removed. If the surrounding areas are not cleaned, dirt or contaminants can be introduced into the fuel system.

The internal drillings of some injectors are extremely small and susceptible to plugging from contamination. Some fuel injection systems can operate at very high pressures. High pressure fuel can convert simple particles of dirt and rust into a highly abrasive contaminant that can damage the high pressure pumping components and fuel injectors.

Electrical contact cleaner can be used if steam cleaning tools are not available. Use electrical contact cleaner rather than compressed air, to wash dirt and debris away from fuel system fittings. Diesel fuel on exposed fuel system parts attracts airborne contaminants.

Choose lint free towels for fuel system work.

Cap and plug fuel lines, fittings, and ports whenever the fuel system is opened. Rust, dirt, and paint can enter the fuel system whenever a fuel line or other component is loosened or removed from the engine. In many instances, a good practice is to loosen a line or fitting to break the rust and paint loose, and then clean off the loosened material.

When removing fuel lines or fittings from a new or newly-painted engine, make sure to remove loose paint flakes/chips that can be created when a wrench contacts painted line nuts or fittings, or when quick disconnect fittings are removed.

Fuel filters are rated in microns. The word micron is the abbreviation for a micrometer, or one millionth of a meter. The micron rating is the size of the smallest particles that will be captured by the filter media. As a reference, a human hair is 0.003 mm [3/1000 in] in diameter. One micron measures 0.00004 mm [4/100,000 in]. The contaminants being filtered out are smaller than can be seen with the human eye, a magnifying glass, or a low powered microscope.

The tools used for fuel system troubleshooting and repair are to be cleaned regularly to avoid contamination. Like fuel system parts, tools that are coated with oil or fuel attract airborne contaminants. Remember the following points regarding your fuel system tools:

- Fuel system tools are to be kept as clean as possible.
- Clean and dry the tools before returning them to the tool box.
- If possible, store fuel system tools in sealed containers.
- Make sure fuel system tools are clean before use.

## 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
BTU	British Thermal Unit
BTDC	Before Top Dead Center
°C	Celsius
CO	Carbon Monoxide
CCA	Cold Cranking Amperes
CARB	California Air Resources Board
C.I.B.	Customer Interface Box
C.I.D.	Cubic Inch Displacement
CNG	Compressed Natural Gas
CPL	Control Parts List
cSt	Centistokes
DEF	Diesel Exhaust Fluid
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
ECM	Electronic Control Module
EFC	Electronic Fuel Control
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
°F	Fahrenheit
ft-lb	Foot-Pound Force
FMI	Failure Mode Identifier
GVW	Gross Vehicle Weight
Hg	Mercury
hp	Horsepower
H <sub>2</sub> O	Water
inHg	Inches of Mercury
in H <sub>2</sub> O	Inches of Water
ICM	Ignition Control Module
km/l	Kilometers per Liter
kPa	Kilopascal
LNG	Liquid Natural Gas
LPG	Liquified Petroleum Gas
LTA	Low Temperature Aftercooling
MIL	Malfunction Indicator Lamp
MPa	Megapascal
mph	Miles Per Hour
mpq	Miles Per Quart
N·m	Newton-meter
NOx	Mono-Nitrogen Oxides
NG	Natural Gas
O <sub>2</sub>	Oxygen
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacturer

<b>PID</b>	Parameter Identification Descriptions
<b>ppm</b>	Parts Per Million
<b>psi</b>	Pounds Per Square Inch
<b>PTO</b>	Power Takeoff
<b>REPTO</b>	Rear Power Take Off
<b>RGT</b>	Rear Gear Train
<b>rpm</b>	Revolutions Per Minute
<b>SAE</b>	Society of Automotive Engineers
<b>SCA</b>	Supplemental Coolant Additive
<b>SCR</b>	Selective Catalytic Reduction
<b>STC</b>	Step Timing Control
<b>SID</b>	Subsystem Identification Descriptions
<b>VDC</b>	Volts of Direct Current
<b>VS</b>	Variable Speed
<b>VSS</b>	Vehicle Speed Sensor

## Section E - Engine and System Identification

### Section Contents

	Page
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<b>Engine Diagrams .....</b>	E-3
Engine Views.....	E-3
<b>Engine Identification .....</b>	E-1
Cummins® Engine Nomenclature.....	E-2
ECM Dataplate.....	E-2
Engine Dataplate.....	E-1
Fuel Injection Pump Dataplate.....	E-2

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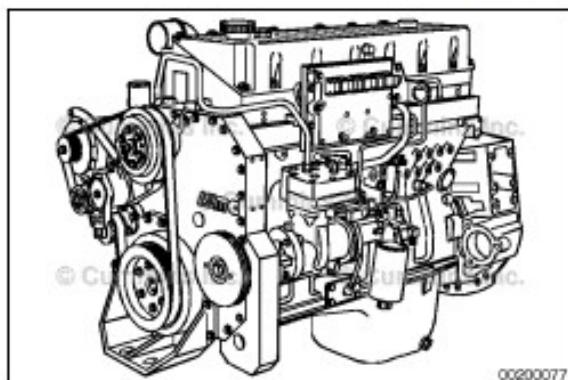
## **Engine Identification**

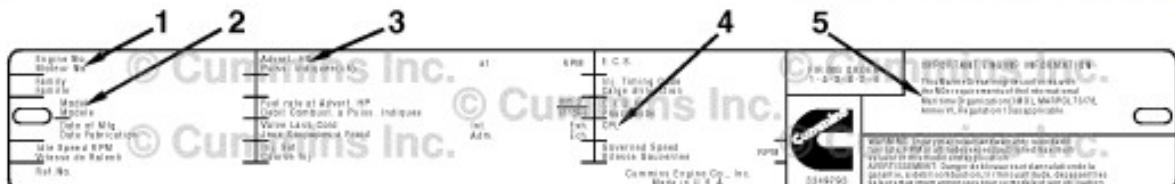
### **Engine Dataplate**

#### **Marine and Industrial Applications**

The engine dataplate shows important facts about your engine. The engine serial number and CPL provide data for ordering parts and service. The engine dataplate **must not be changed unless approved by Cummins Inc.**

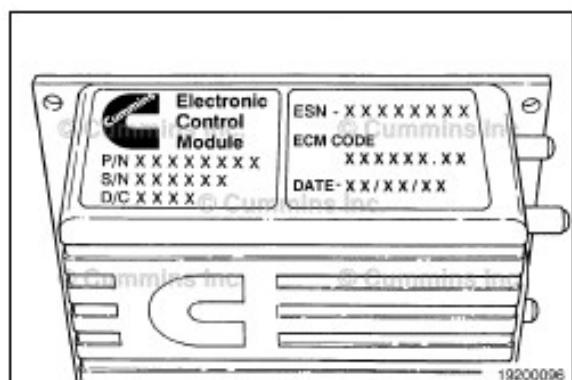
The dataplate is located on the fuel pump side of the engine, on the rocker housing. Have the following engine data available when communicating with a Cummins Authorized Repair Location. The following information on the dataplate is **mandatory** when sourcing service parts:





00200104

- 1 Engine serial number
- 2 Model
- 3 Horsepower and rpm rating
- 4 CPL
- 5 Emission statement (if applicable).



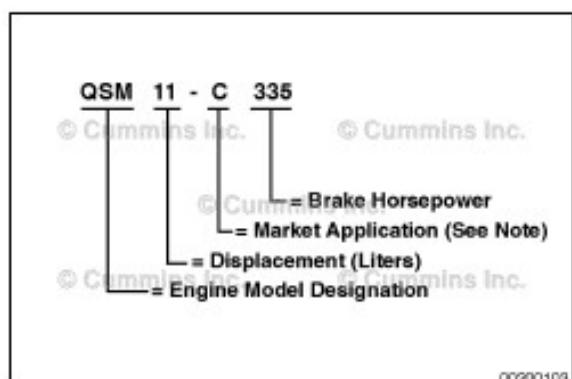
### ECM Dataslate

#### Marine and Industrial Applications

There are two dataspates on top of the ECM.

The dataplate on the left contains the part number (P/N), serial number (S/N), and date code (D/C) of the ECM.

The dataplate on the right contains the engine serial number (ESN), ECM code, and date.



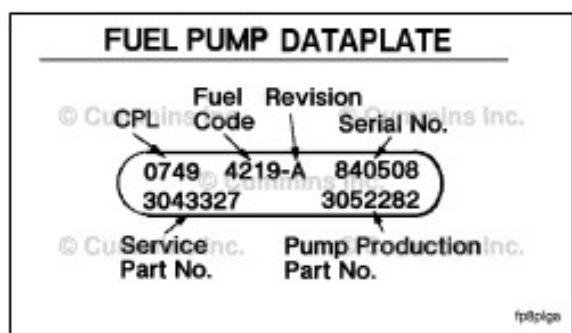
### Cummins® Engine Nomenclature

#### Marine Applications

The Cummins® engine nomenclature provides the data as illustrated in the graphic.

**NOTE:** The following letters designate some of the different market applications for a Cummins® engine.

- A = agriculture
- C = construction
- M = marine
- G = generator drive.



### Fuel Injection Pump Dataplate

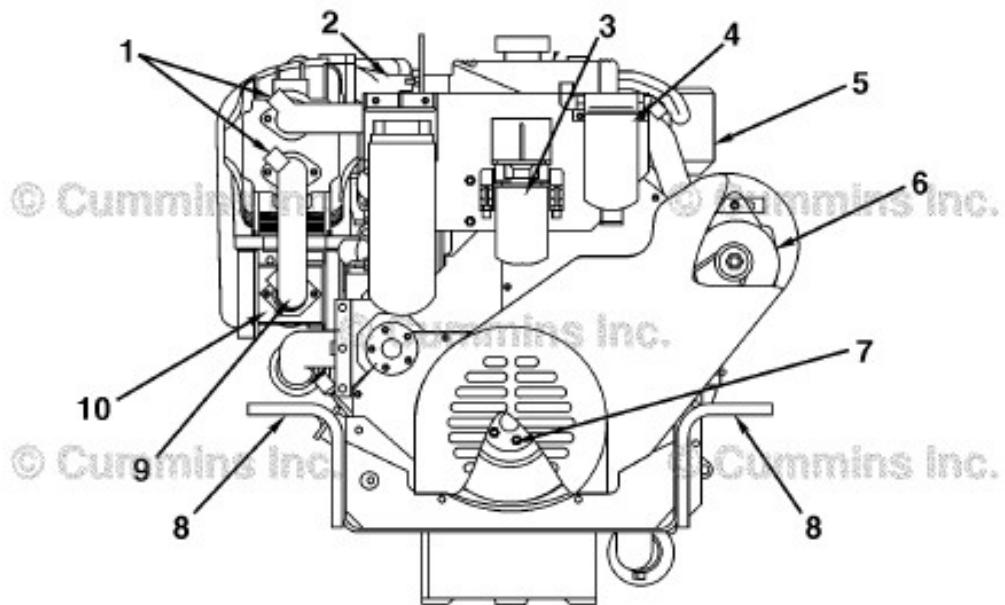
The fuel pump dataplate is located on top of the fuel pump. It provides the data needed to calibrate the fuel pump.

## Engine Diagrams

### Engine Views

The following illustrations contain information about engine components, filter locations, drain points, and access locations for instrumentation and engine controls. The information and configuration of components shown in these illustrations are of a general nature. Some component locations will vary, depending on applications and installations.

Marine Applications

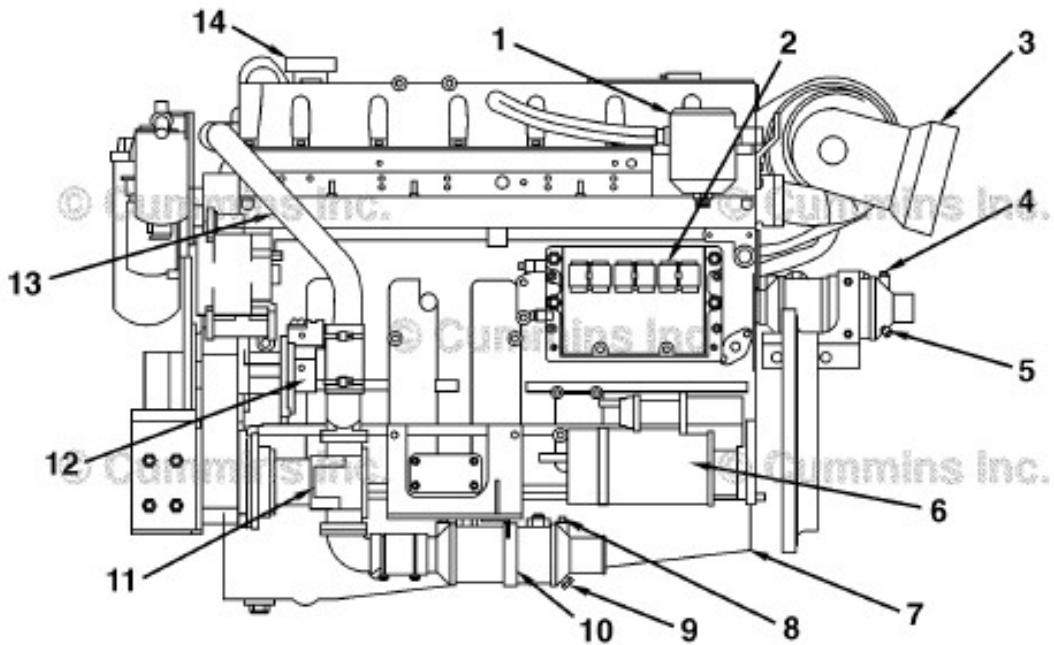


17200016

Front - QSM11 Marine

- |                      |                                      |
|----------------------|--------------------------------------|
| 1 Zinc plugs         | 6 Alternator                         |
| 2 Air crossover      | 7 Vibration damper                   |
| 3 Coolant filter     | 8 Front engine mounts                |
| 4 Fuel Filter        | 9 Aftercooler-to-heat-exchanger pipe |
| 5 Crankcase breather | 10 Heat exchanger.                   |

Marine Applications

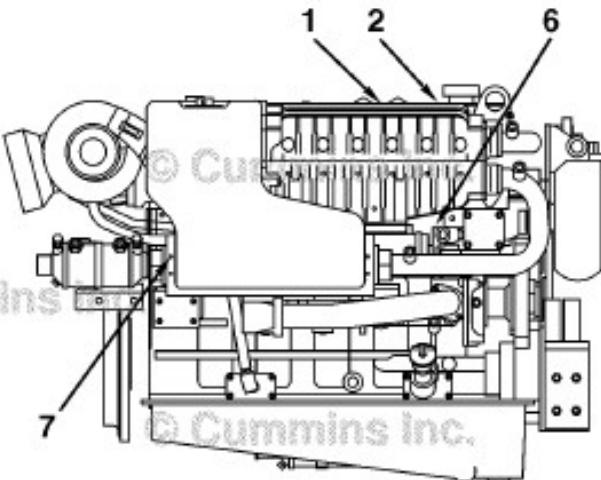
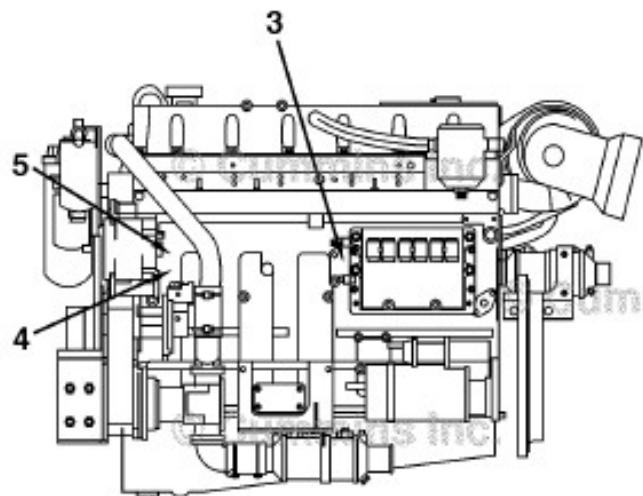


17200013

Left (Port) - QSM11 Marine - Components

- |                          |                                       |
|--------------------------|---------------------------------------|
| 1 Crankcase breather     | 8 Zinc anode (fuel cooler)            |
| 2 ECM                    | 9 Fuel cooler drain plug              |
| 3 Exhaust elbow          | 10 Fuel cooler                        |
| 4 Zinc anode             | 11 Sea water pump                     |
| 5 Gear cooler drain plug | 12 Fuel pump                          |
| 6 Starter                | 13 Sea-water-pump-to-aftercooler pipe |
| 7 Oil pan                | 14 Oil fill.                          |

Marine Applications

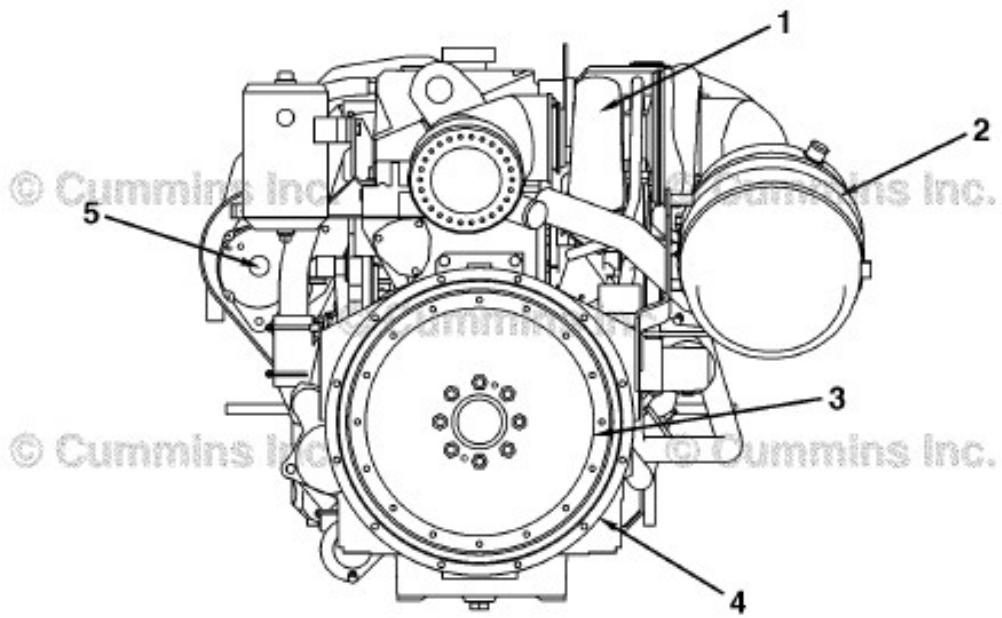


15d00831

Left (Port) - QSM 11 Marine - Sensors

- |  |  |
|--|--|
| 1 Ambient air pressure sensor                        | 3 Engine position sensor (behind fuel pump). |
| 2 Oil pressure/temperature sensor (behind fuel pump) |  |

Marine Applications

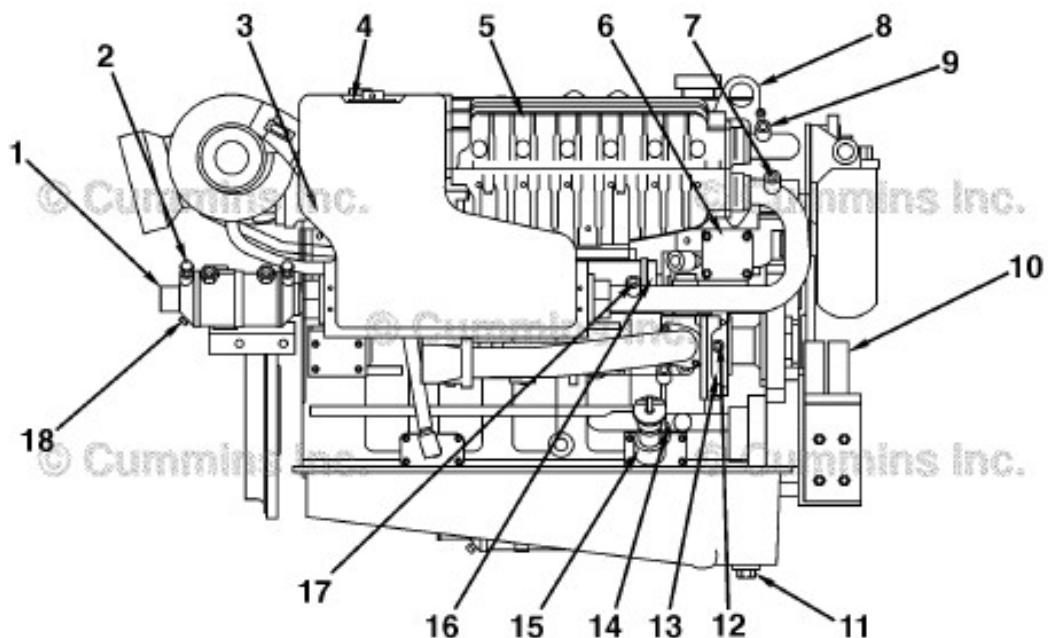


17200017

Back - QSM11 Marine

- |                |                    |
|----------------|--------------------|
| 1 Turbocharger | 4 Flywheel housing |
| 2 Air cleaner  | 5 Alternator.      |
| 3 Flywheel     |                    |

Marine Applications

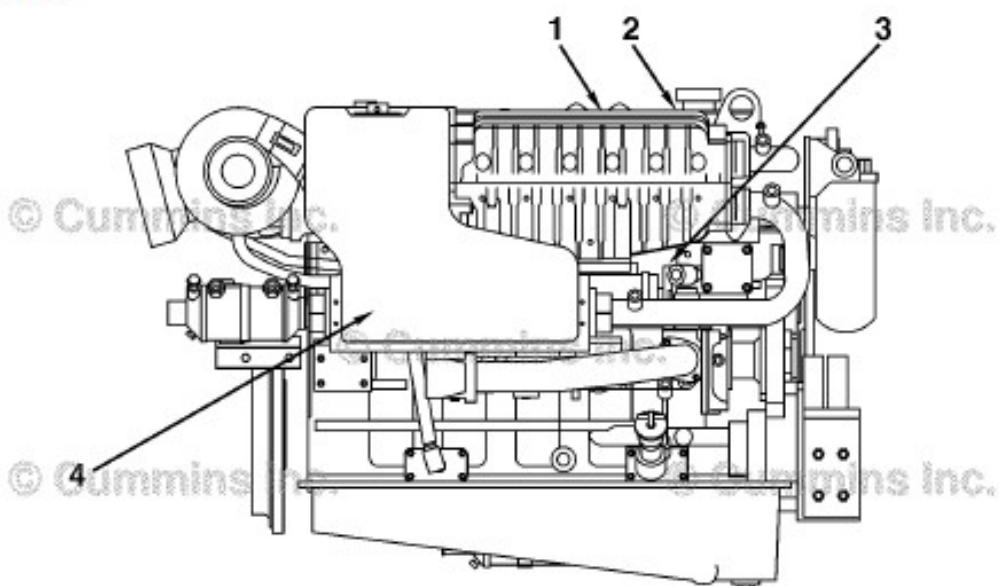


17200014

Right (Starboard) - QSM11 Marine - Components

- |                            |                                |
|----------------------------|--------------------------------|
| 1 Gear oil cooler          | 10 Vibration damper            |
| 2 Zinc anode (gear cooler) | 11 Oil pan drain plug          |
| 3 Heat exchanger           | 12 Coolant drain               |
| 4 Expansion tank           | 13 Water pump                  |
| 5 Aftercooler              | 14 Oil dipstick                |
| 6 Thermostat housing       | 15 Oil fill                    |
| 7 Zinc anode               | 16 Engine oil cooler           |
| 8 Engine lifting bracket   | 17 Zinc anode                  |
| 9 Zinc anode               | 18 Gear oil cooler drain plug. |

Marine Applications

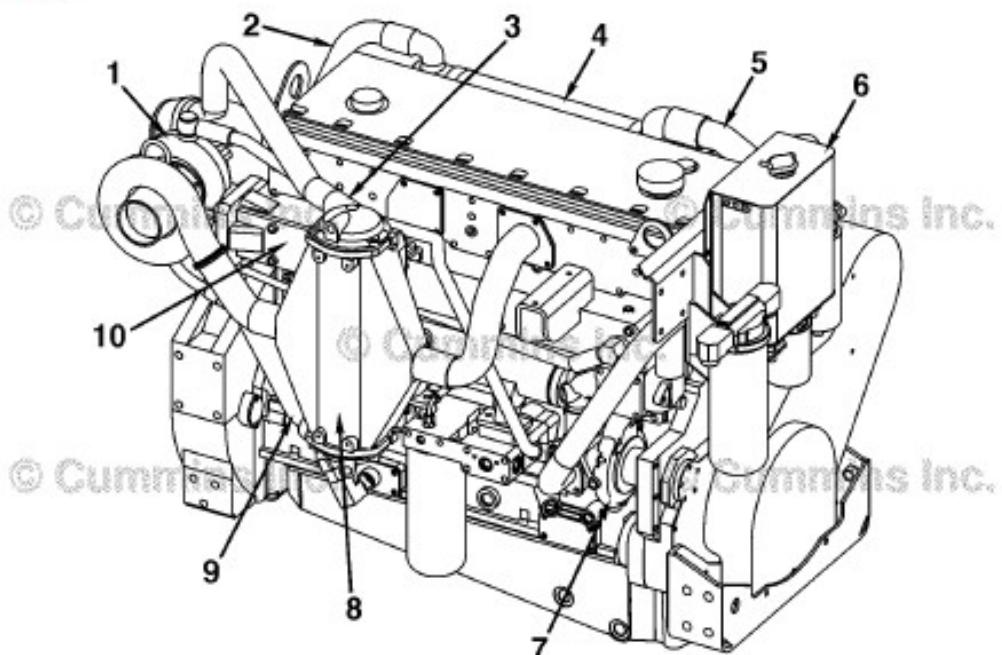


15d00841

Right (Starboard) - QSM11 Marine - Sensors

- 1 Intake manifold temperature sensor
- 2 Intake manifold pressure sensor
- 3 Coolant temperature sensor
- 4 Coolant level sensor.

Marine Applications

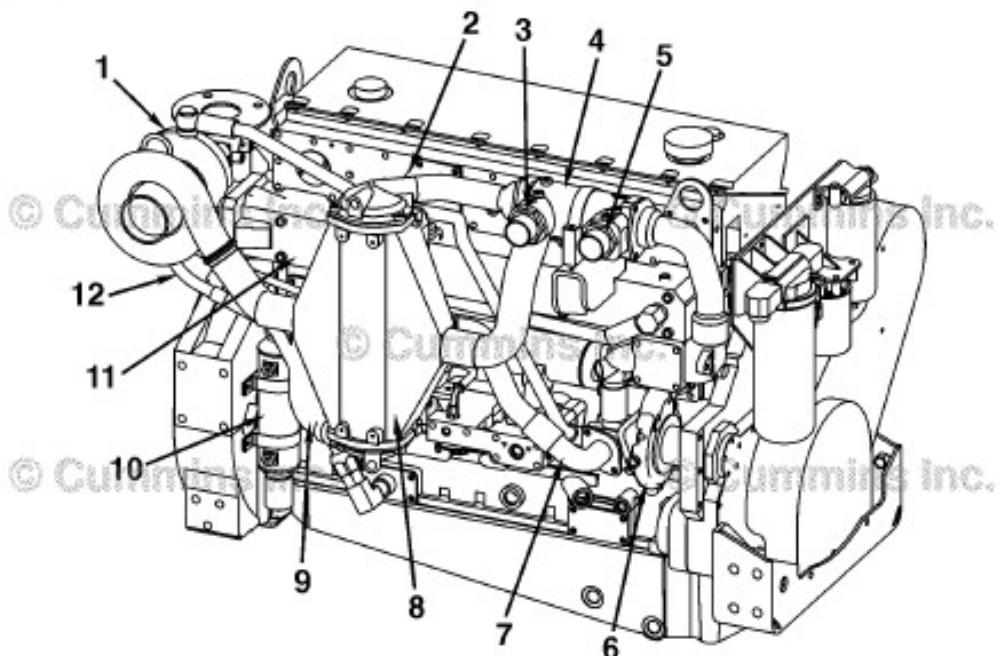


08200244

Right (Starboard) - QSM11 Marine - Heat Exchanger

- 1 Turbocharger with water cooled turbine housing
- 2 Coolant flow from heat exchanger
- 3 Aftercooler sea water outlet
- 4 Heat exchanger
- 5 Coolant flow to heat exchanger
- 6 Expansion tank
- 7 Water pump
- 8 Aftercooler
- 9 Aftercooler sea water inlet
- 10 Water cooled exhaust manifold.

Marine Applications

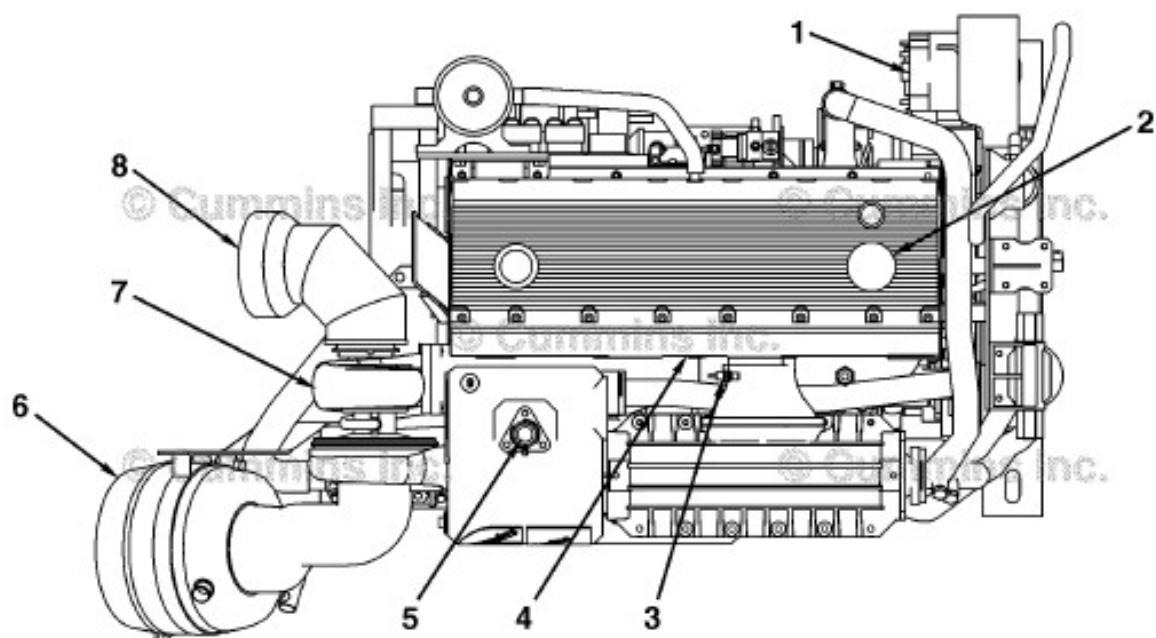


08200245

Right (Starboard) - QSM11 Marine - Keel Cooled

- 1 Turbocharger with water cooled turbine housing
- 2 Coolant inlet (aftercooler)
- 3 Coolant in from Keel Cooler
- 4 LTA thermostat housing
- 5 Coolant out to Keel Cooler
- 6 Water pump
- 7 Coolant to water pump
- 8 Aftercooler
- 9 Coolant outlet (aftercooler) to water pump
- 10 Gear oil cooler (optional)
- 11 Water cooled exhaust manifold
- 12 Coolant out from turbocharger.

Marine Applications



17200016

Top - QSM11 Marine

- |                                      |                  |
|--------------------------------------|------------------|
| 1 Alternator                         | 5 Coolant fill   |
| 2 Oil fill (alternate)               | 6 Air cleaner    |
| 3 Intake manifold temperature sensor | 7 Turbocharger   |
| 4 Intake manifold pressure sensor    | 8 Exhaust elbow. |

## Cummins® Service Engine Model Product Identification

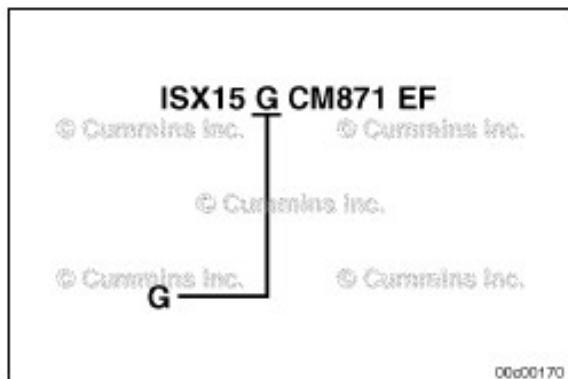
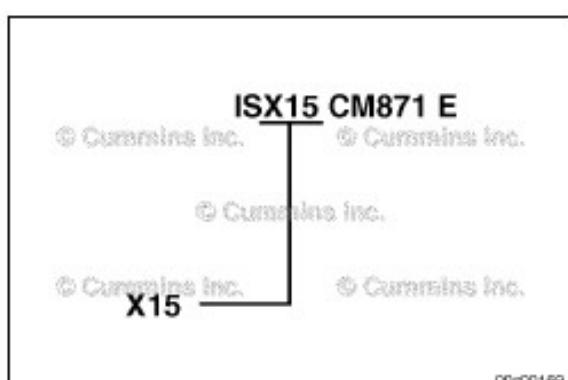
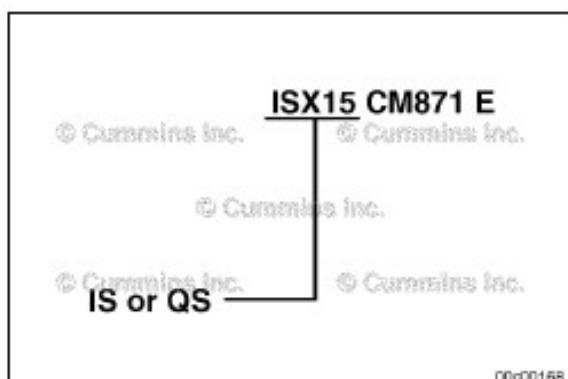
### General Information

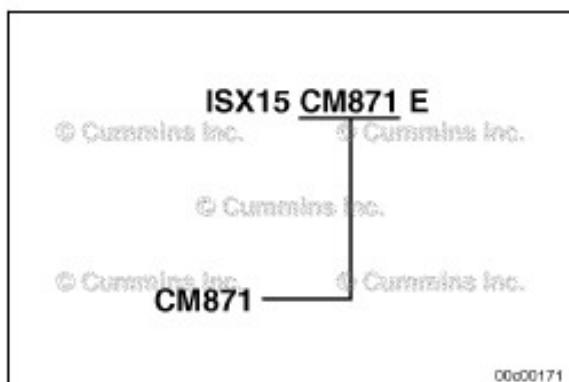
The Cummins® Service Engine Model Nomenclature procedure describes how engines are identified within Cummins service organization. This method was introduced for models after and including manufacture year 2007.

Electronic engines are identified by the first two letters, either an "IS" for On-Highway automotive or "QS" for Off-Highway industrial market applications.

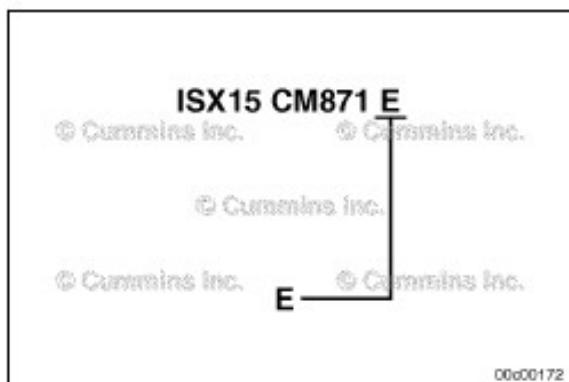
The third letter is the engine platform designation followed by the engine liter size.

If the engine operates on a fuel type other than diesel, the type will be identified after the liter size.

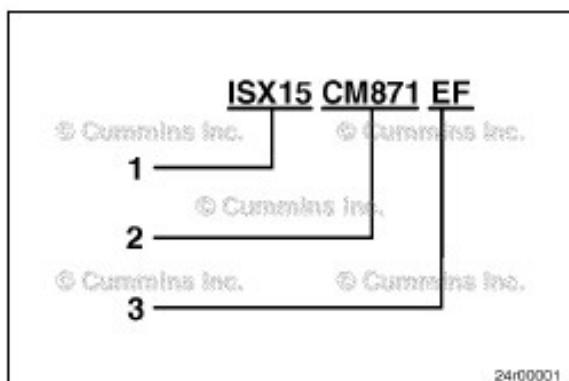




The control system is identified with the letters "CM" followed by the control system model number.



The technology identifier after the control system designates the prevailing technology used with the engine. (See table in this procedure for letter designations.)



**Example:**

- 1 On-Highway automotive "X" 15 liter engine
- 2 Control system number 871
- 3 Technology supported; Electric EGR and Diesel Particulate Filter

<b>Technology</b>	<b>Name</b>	<b>Suffix</b>
Exhaust Gas Recirculation	Not used	None
	Pneumatic	P
	Electric	E
Diesel Particulate Filter	Not used	None
	DPF	F
Diesel Oxidation Catalyst	Not used	None
	DOC	C
3-Way Oxidation Catalytic Converter	Not used	None
	3-Way Catalyst	J
Selective Catalytic Reduction System	Not used	None
	Air Driven	S
	Airless	A
Nox Sensor	Not used	None
	Nox Sensor	N
Modular Common Rail System	Used only on QSK19, 38, 50 , 60 HHP Engines	MCRS
Integrated Dosing Control Unit	Not Used	None
	Intergrated	I

## Notes

## Section 1 - Operating Instructions

### Section Contents

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## Operating Instructions - Overview



### General Information

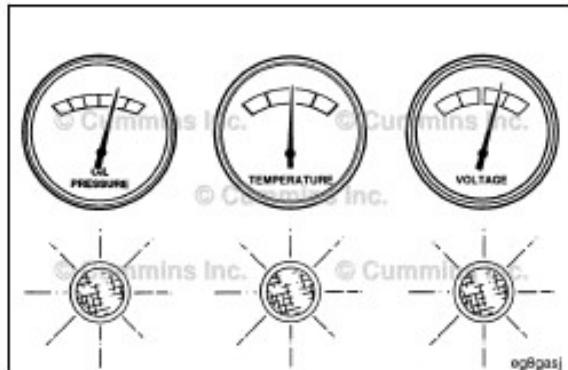
Correct care of your engine will result in longer life, better performance, and more economical operation.

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

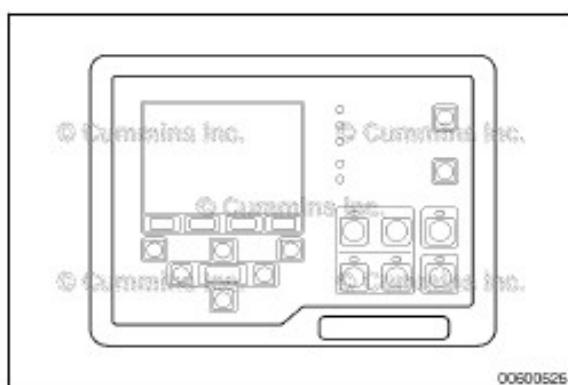
The new Cummins® engine associated with this manual does not require a "break-in" procedure. This section of the manual provides all of the necessary information required for proper engine operation.

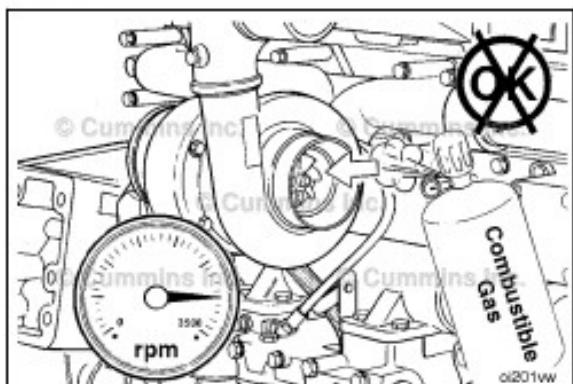
U.S. legislation requires that stationary compression ignition internal combustion engines designated for emergency use are limited to emergency operations and required maintenance and testing.

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



For the PowerCommand Controller 3300 Generator Set Control the automatic and manual modes are selected via push buttons. Cummins® Inc recommends that the Generator Set is operated in automatic mode.





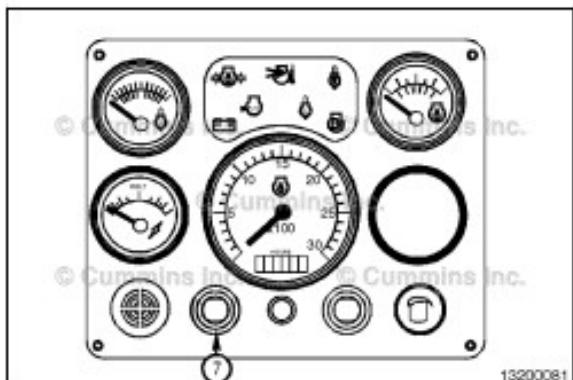
### ⚠️WARNING⚠️

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, might operate in a combustible environment, such as 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 when an engine is operating 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.



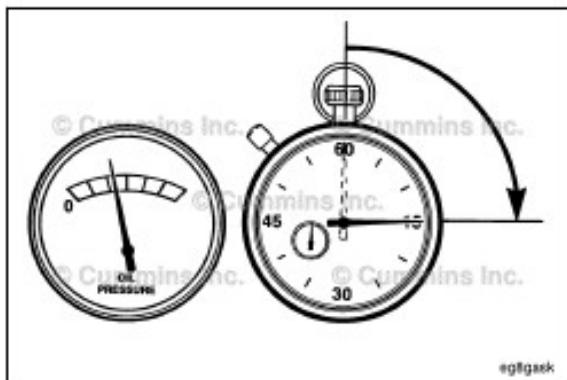
## Normal Starting Procedure General Information

NOTE: There is a separate keyswitch wired to the primary panel. It will be installed in the helm at the boat manufacturer's or installer's desired location. The keyswitch **must** be in the ON position to crank-start the engine.

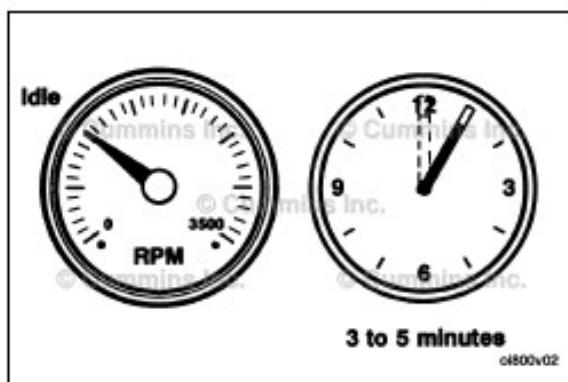
The engine start button (7) is used to engage the starter motor.



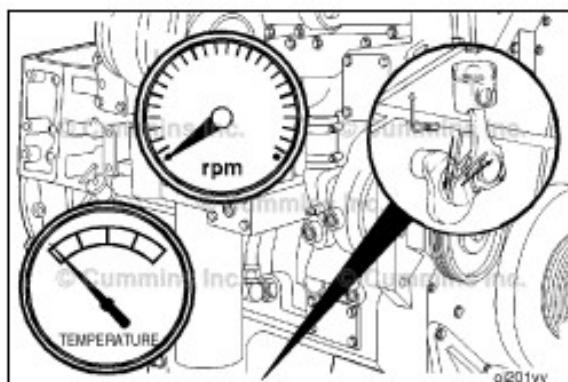
The engine **must** have adequate oil pressure within 15 seconds after starting. If the warning light indicating low oil pressure has not gone out or there is **no** oil pressure indicated on a gauge within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm the correct oil level in the oil pan.



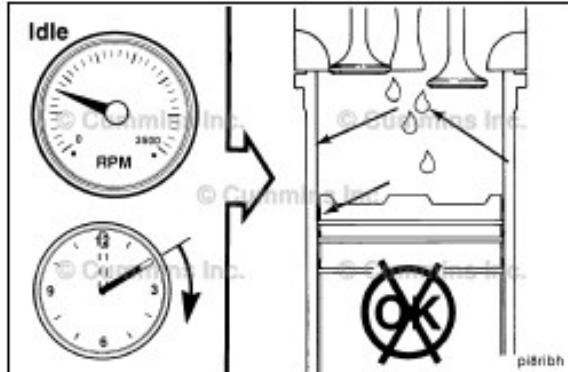
Idle the engine 3 to 5 minutes before operating with a load.



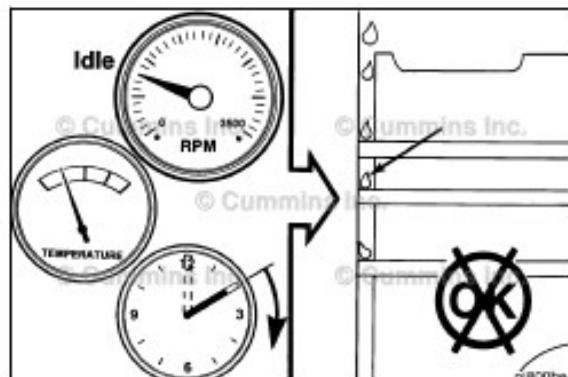
Increase the engine speed (rpm) slowly to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.

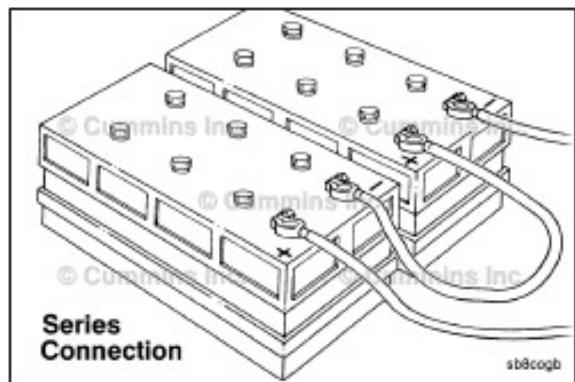
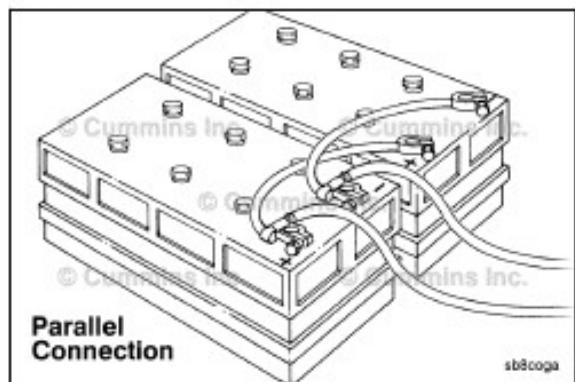


Do not keep the engine at low idle for long periods. Idling for periods longer than 10 minutes can damage an engine, causing combustion chamber temperatures to drop so low the fuel will not burn completely. This will cause carbon to build up around the injector spray holes and piston rings, and can cause the valves to stick.



If the engine coolant temperature becomes too low, below 60° C [140° F], raw fuel will wash the lubrication oil off the cylinder walls and dilute the crankcase oil. Fuel dilution adversely affects lubricating oil properties and can shorten engine life. Utilize the fast idle to prevent these conditions.





### ▲WARNING▲

Batteries can emit explosive gases. To avoid personal injury, always ventilate the compartment before servicing the batteries. To avoid 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 accompanying illustration shows a typical parallel battery connection. This arrangement doubles the cranking amperage.



This illustration shows a typical series battery connection. This arrangement, positive (+) to negative (-), doubles the voltage.

## Cold Weather Starting General Information

Follow the Normal Starting Procedure in this section.

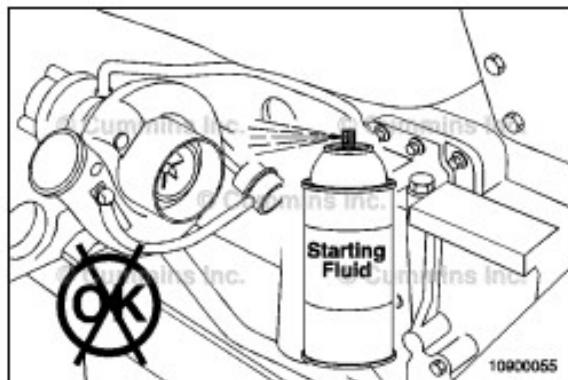
## Using Starting Aids

### ▲WARNING▲

Do not use starting fluids with this engine. Use of starting fluid can cause an explosion, fire, personal injury, severe damage to the engine, and property damage.

The only recommended cold weather starting aids for marine applications are engine coolant preheaters and oil pan immersion heaters.

Cold weather starting aids are available for this engine. Contact a Cummins® Authorized Repair Location for more information.



## Starting Procedure After Extended Shutdown or Oil Change

### General Information

Follow the Normal Starting Procedure in this section. The engine will run at idle only until the minimum specified oil pressure is detected by the electronic control module (ECM).

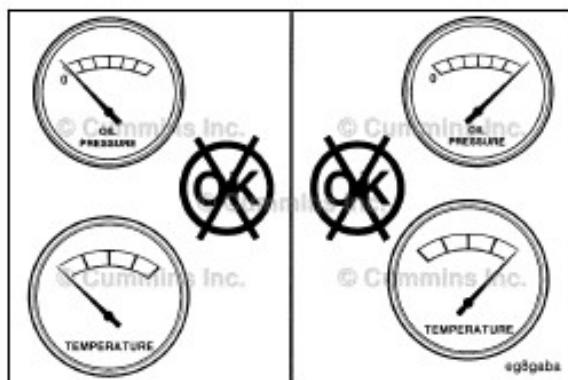
## Operating the Engine

### Normal

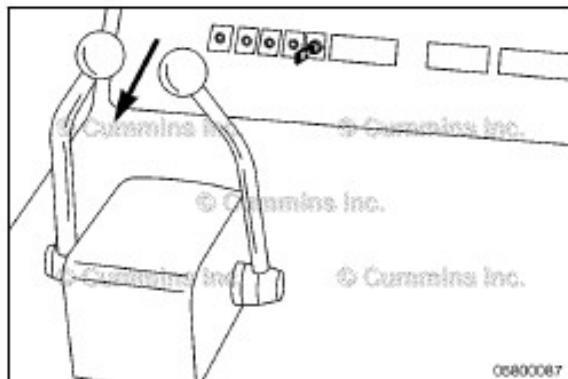


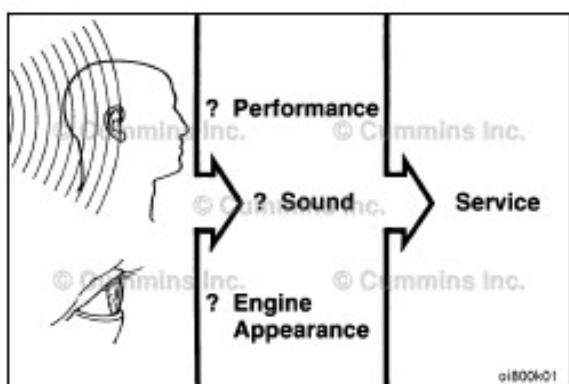
If equipped, monitor the oil pressure and coolant temperature gauges frequently. Refer to Lubricating Oil System specifications and Cooling System specifications, in Maintenance Specifications (Section V) for recommended operating pressures and temperatures. Shut off the engine if any pressure or temperature 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 reducing the throttle setting until the temperature returns to normal operating range. If the engine temperature does not return to normal, further reduce the engine speed and 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 glycol antifreeze and 50-percent water for the engine coolant mixture.

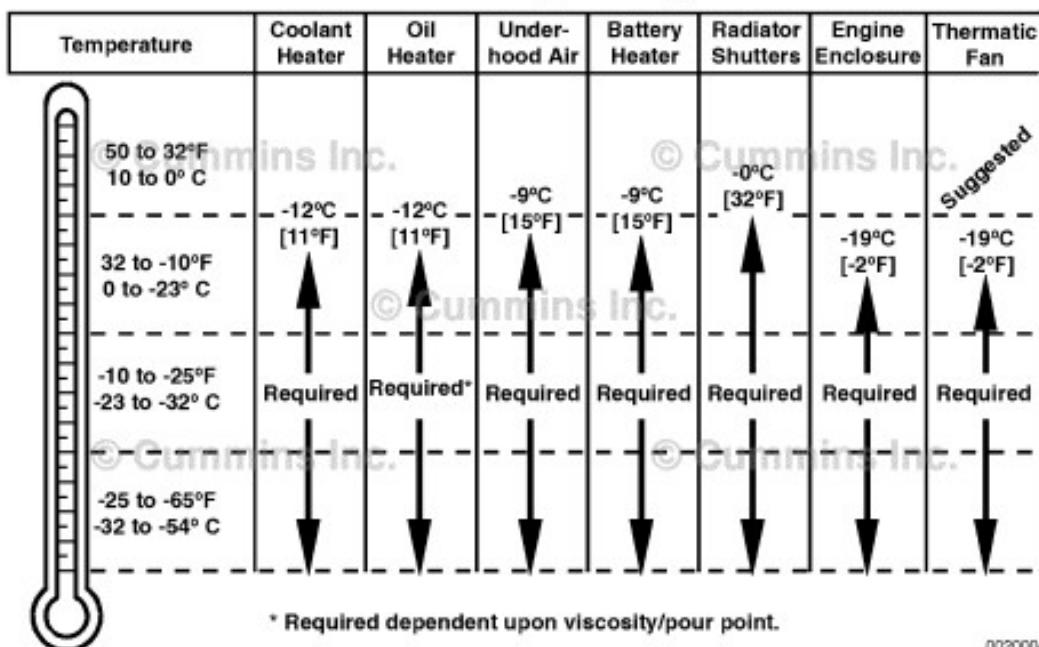
Refer to Lubricating Oil recommendations and Specifications and Coolant Recommendations and Specifications in Section V for the correct specifications.

-32 to -54°C [-25 to -65°F]

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

Refer to Lubricating Oil recommendations and Specifications and Coolant Recommendations and Specifications in Section V for the correct specifications.

## Cold Weather Operating Aids



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The cold weather operating aid is required for cold weather situations.

## Engine Operating Range General Information

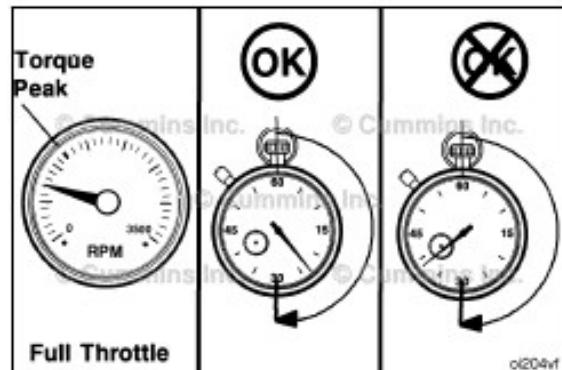
### CAUTION

Do not operate the engine at full throttle 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.

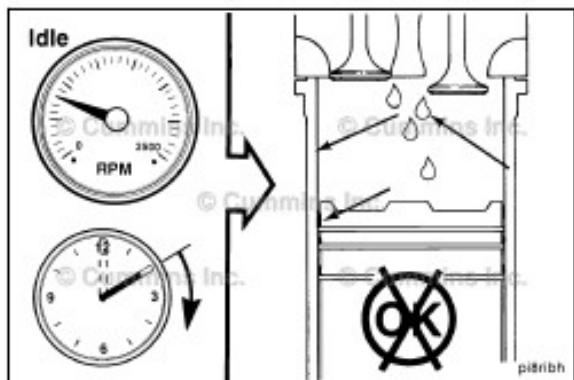
Cummins® engines are designed to operate successfully at full throttle under transient conditions down to peak torque engine speed. This is consistent with recommended operating practices.

### 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).

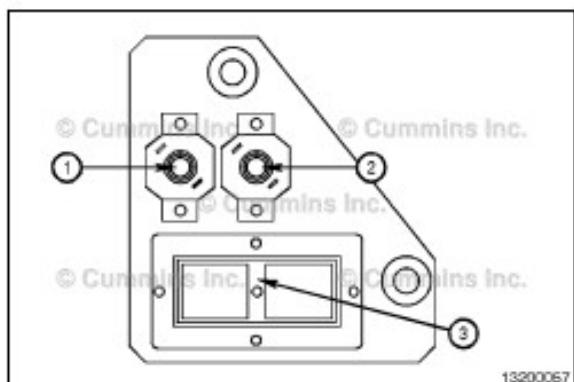


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## CAUTION

Do not idle the engine for excessively long periods. Long periods of idling, more than 10 minutes, can cause poor engine performance.

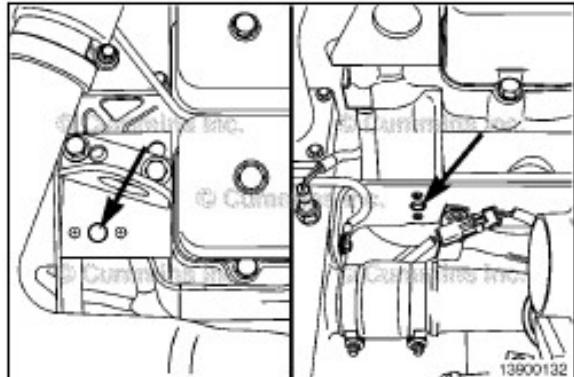


## Circuit Breakers

### Electronic Governor Operation

The electronically controlled marine engine is equipped with two circuit breakers located on the ECM side of the engine.

A 5-amp circuit breaker (1) is used for keyswitched power to the ECM and a 10-amp circuit breaker (2) is used for non-keyswitched power to the panel. The circuit breaker panel also houses a 40-pin OEM connector (3).



### Mechanic Governor Operation

The marine engine is equipped with a 10 amp circuit breaker on the engine wiring system. The breaker is located on the rear of the cylinder head for some models and the rear of the cylinder block on other engine models.

## Engine Shutdown

### General Information

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

Otherwise, 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.

If the engine does **not** shut down, refer to Troubleshooting Symptom (Section TS) in appropriate Operation and Maintenance manual.

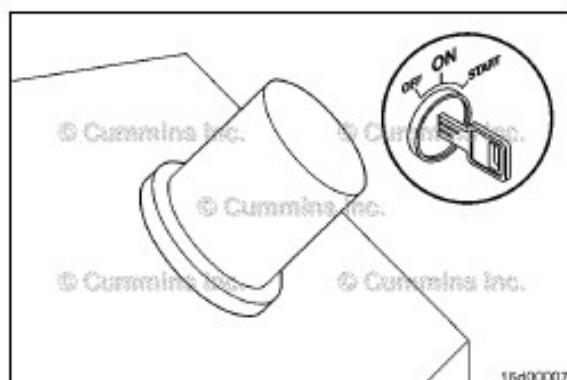
Turn the keyswitch to the OFF position.

Push the STOP button to stop the engine(s), or if equipped with a keyswitch **only**, turn the keyswitch to the OFF position.

**NOTE:** For engines equipped with an electronic control module (ECM) ensure the keyswitch is turned off for a minimum of 60 seconds prior to disconnecting the continuous (unswitched) battery power supply. If the unswitched battery power supply is disconnected in less than 60 seconds after the keyswitch is turned off active fault codes and incorrect ECM information can occur.

**NOTE:** Damage to the engine resulting from freezing is  not covered under the Cummins® warranty.

Procedures **must** be followed to protect the engine from freeze damage during a cold weather storage period. The procedure applies anytime freezing conditions are present or could occur. Refer to Procedure 000-014 (Seasonal Storage) - in Section SS in appropriate Operation and Maintenance manual, for steps to protect the engine during these periods.

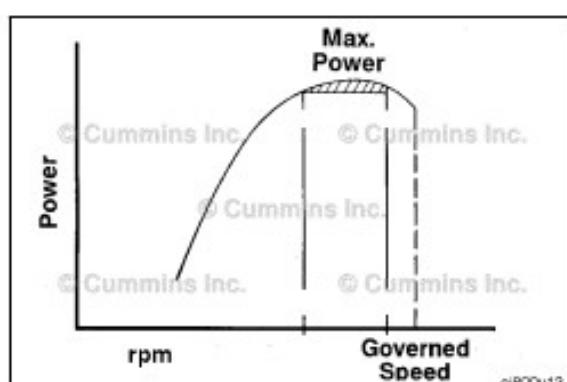


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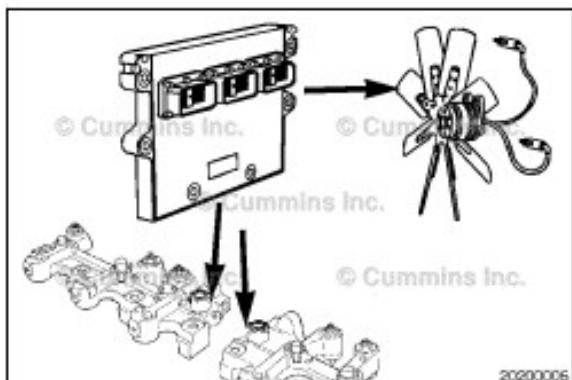
## Electronic Controlled Fuel System

### General Information

The system is an electronically controlled fuel injection system that optimizes fuel economy. It does this by controlling the torque and horsepower curve, air-fuel control (AFC) function, engine high speed, low idle, and road speed.

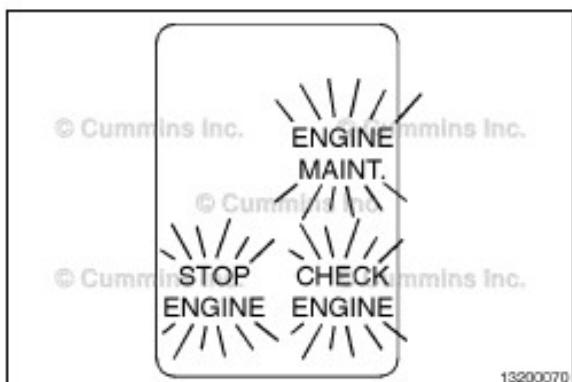


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The engine has the capability of controlling the fan clutch actuator if an electronically controlled fan clutch is used.

The engine also allows the engine brakes to be activated by controlling the engine brake solenoids.



## Diagnostic Fault Codes

### Engine Fault and Maintenance Lamps

The ENGINE FAULT and MAINTENANCE lamps are illuminated for 2 seconds when the keyswitch is turned to the ON position.

After 2 seconds, the red STOP ENGINE lamp will turn off. After an additional 1/2 second, the amber CHECK ENGINE lamp will turn off. After an additional 1/2 second, the amber ENGINE MAINT lamp will turn off.

The lamps will remain off until a fault is detected.

**NOTE:** This is a self-test feature of the lamp wiring and lamps.

**NOTE:** The names and colors of the lamps can vary with vessel manufacturer if non-Cummins panels are used.

The following chart summarizes the different lamps and their operation.

Feature	Operator Message	Lamp Operation		
Check Engine	Stop Engine	Engine Maintenance		
Lamp Display	Power-up lamp test	ON then OFF	ON then OFF	ON then OFF
Diagnostics	Fault code flashout	Flash once/code	Flash code Number	
Engine Protection	System problem		Slow flash	
Maintenance Monitor	Interval expired			3x5 fast flash
Maintenance Monitor	Interval rest			3x5 fast flash
Diagnostics	Nonfatal system error	On steady		
Diagnostics	Fatal system error		On steady	
Diagnostics	Maintenance required			On steady

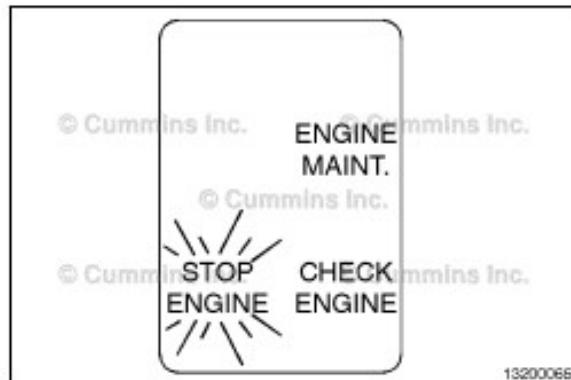
If the STOP or CHECK ENG lamp comes on when the engine is running, it means a fault code has been recorded. The lamp will remain on as long as the fault exists. The severity of the fault will determine the lamp that will come on.

### Stop Engine Lamp

The STOP ENGINE lamp is a red lamp. This lamp indicates that the engine needs to be shut down before permanent damage occurs to the engine.

**NOTE:** The engine should be shut off as soon as it can be shut off safely. The engine should **not** be run until the fault is corrected.

This lamp is also used to flash out the fault code number in the diagnostic mode.

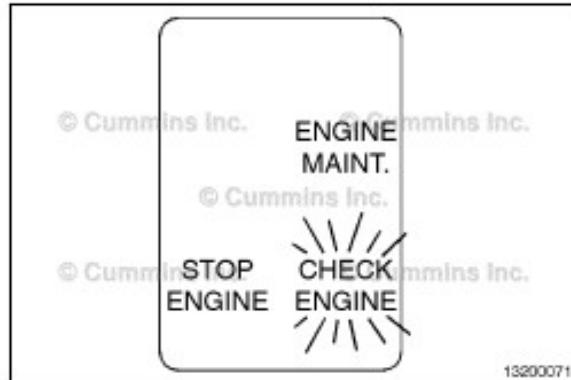


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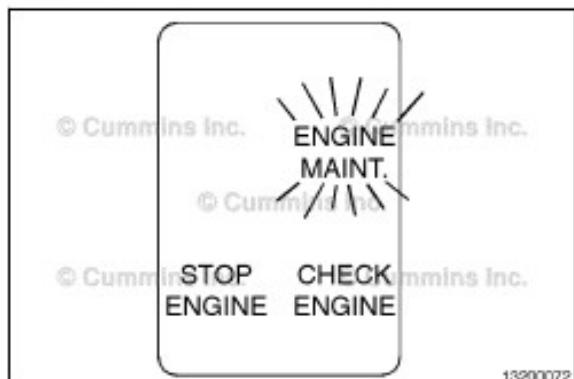
### Check Engine Lamp

The CHECK ENGINE lamp comes on during a nonfatal system error. The engine can still be run, but the fault should be corrected as soon as possible.

**NOTE:** In the diagnostic mode, the check engine lamp will flash after the stop engine lamp completes the three-digit fault code.

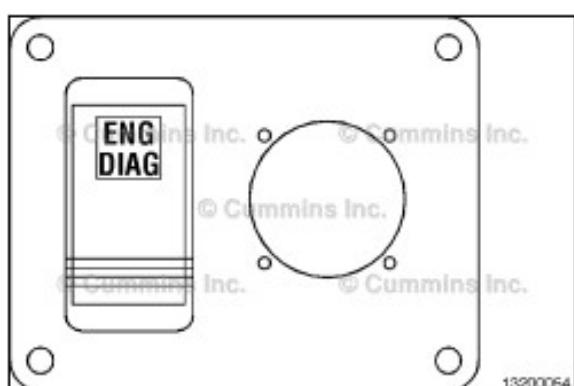


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### Engine Maintenance Lamp

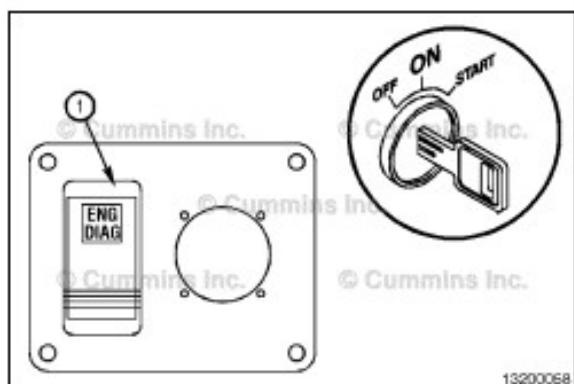
The ENGINE MAINT lamp comes on when engine maintenance is required.



### Engine Diagnostics

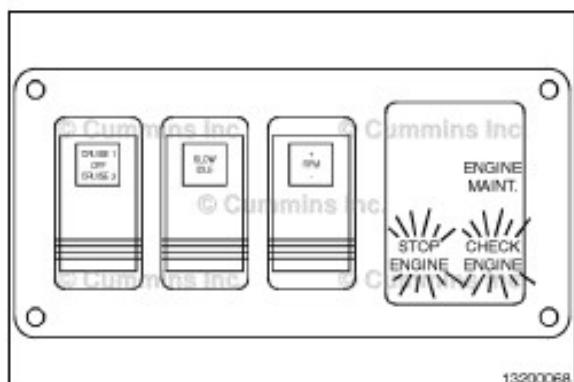
When a fault or maintenance lamp is lit, the engine diagnostics switch allows the operator to view the fault codes. The receptacle to the right of the switch is for the technician's computer connection using INSITE™ electronic service tool or Echek™ service tool.

Active fault codes can be viewed using the stop engine warning lamp as described below.



To view the fault codes:

- 1 The engine **must** be shut off (not running)
- 2 The keyswitch **must** be in the ON position
- 3 The ENG DIAG switch (1) **must** be in the ON position.



The check engine and stop engine lamps flash if there are any fault codes to display.

If there are no fault codes to display, the check engine and stop engine lamps will remain lit.

If there are fault codes to be displayed, the check engine lamp will flash momentarily. Then the stop engine lamp will flash the first, second, and third digits of the fault code.

Example:

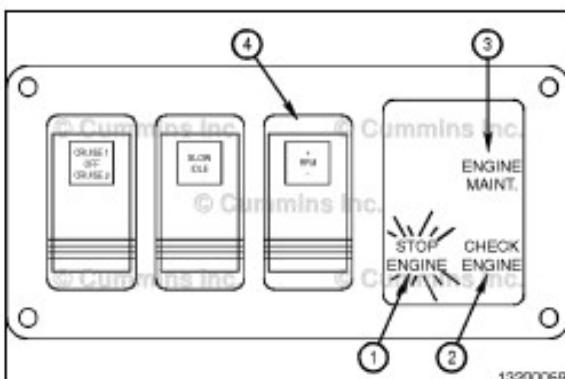
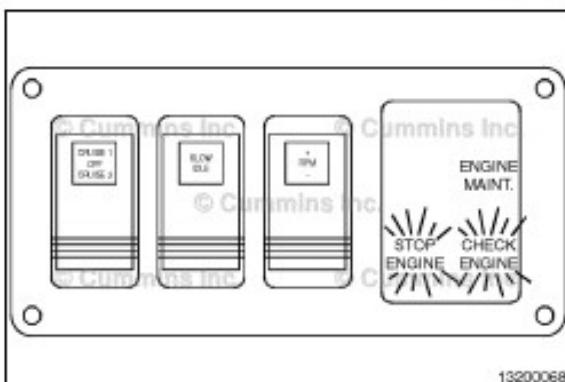
- Fault Code 432
- 4 flashes, pause
- 3 flashes, pause
- 2 flashes.

**NOTE:** The check engine lamp will flash between each fault code.

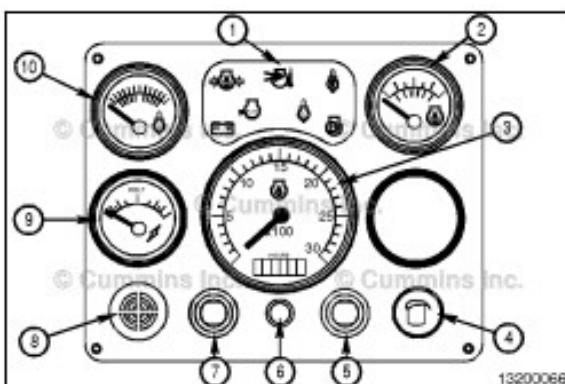
The pattern repeats itself until the fault is cleared or the switch is turned off.

To view the next fault code, press the rpm ± switch (4) in the + direction.

To view the previous fault code, press the rpm ± switch (4) in the - direction.

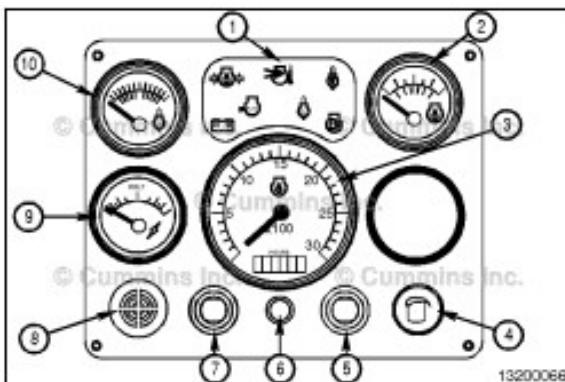


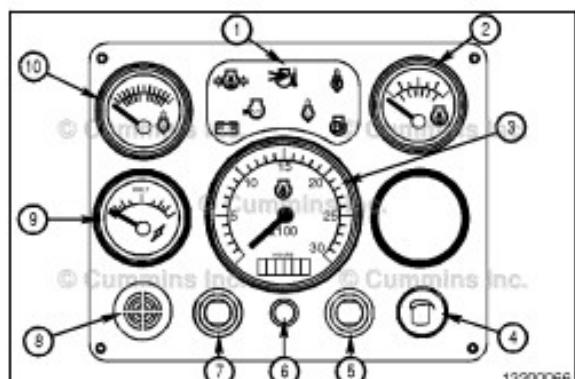
The audible alarm (8) comes on anytime the warning or caution symbols are illuminated.



The alarm silence button (6) will temporarily silence the audible alarm.

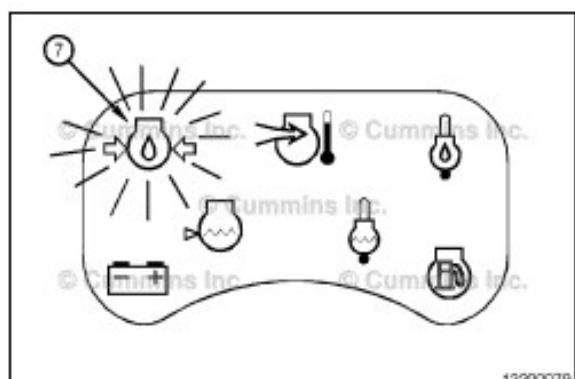
**NOTE:** The alarm will be silenced for up to 2 minutes. As long as the fault condition exists, the alarm will "chirp" every 2 minutes to remind the operator that a fault exists.





The alarm silence button (6) is also used to test the warning and caution symbol lamps (1) and the gauges.

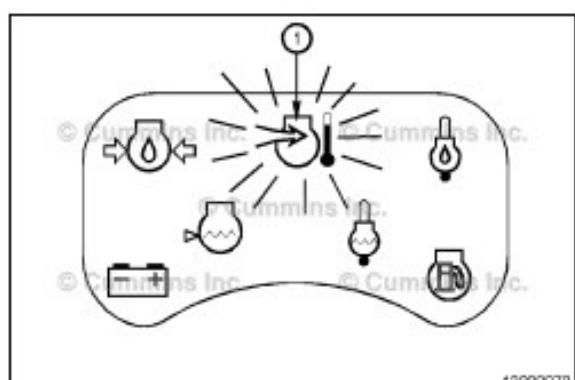
**NOTE:** To test the gauges and symbol lamps, press the alarm silence button (6) while turning ON the keyswitch. The alarm will come on for 5 seconds and for 25 seconds all symbols will illuminate and the gauge needles will move from the lowest position to the highest position and back to the lowest position.



## Engine Protection System

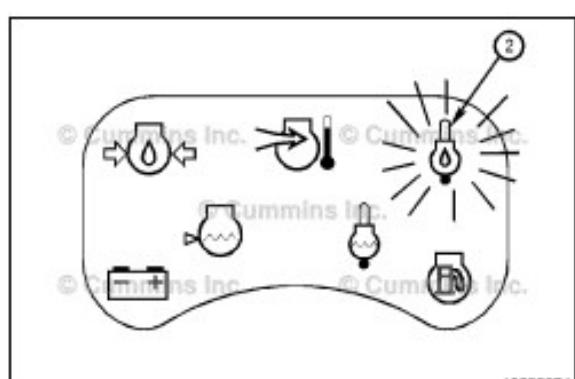
### Low Engine Oil Pressure

The low engine oil pressure lamp (7) comes on when the engine oil pressure is below specification. Refer to Procedure 018-017 (Lubricating Oil System) in Section V.



### High Intake Manifold Temperature

The high intake manifold temperature lamp (1) comes on when the intake manifold temperature is above specification.

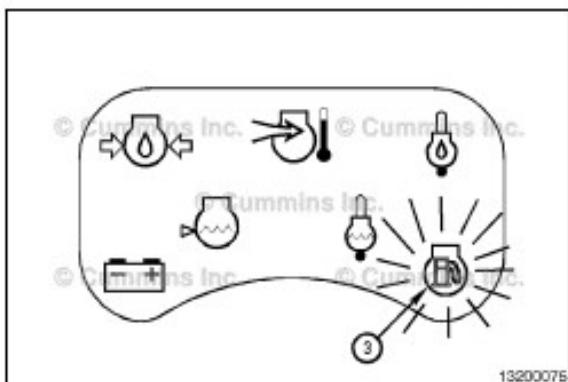


### High Engine Oil Temperature

The high engine oil temperature lamp (2) comes on when the engine oil temperature is above specification.

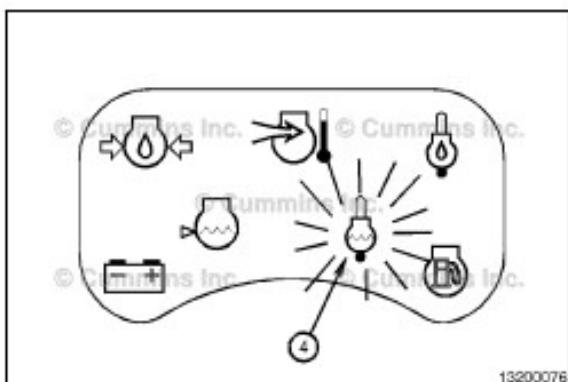
### Water in Fuel

The water-in-fuel lamp (3) interfaces with the optional water-in-fuel sensor in the suction side fuel filter. It comes on when there is water in the fuel filter.



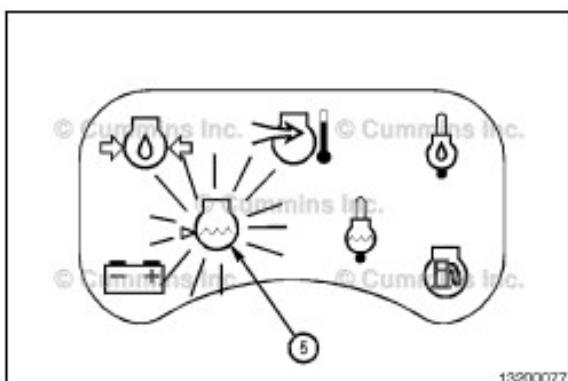
### High Coolant Temperature

The high coolant temperature lamp (4) comes on when the engine coolant temperature is above specification.



### Low Coolant Level

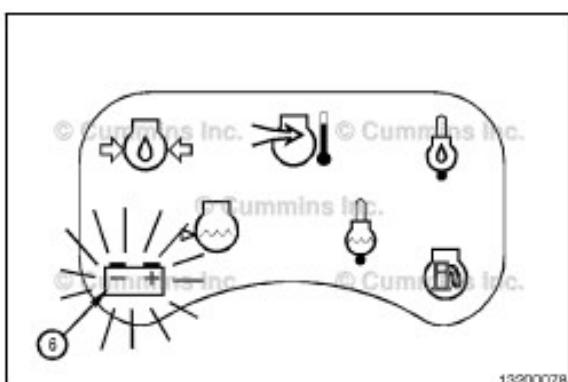
The low coolant level lamp (5) comes on when the coolant level is below specification. Refer to Procedure 018-018 (Cooling System) in Section V.

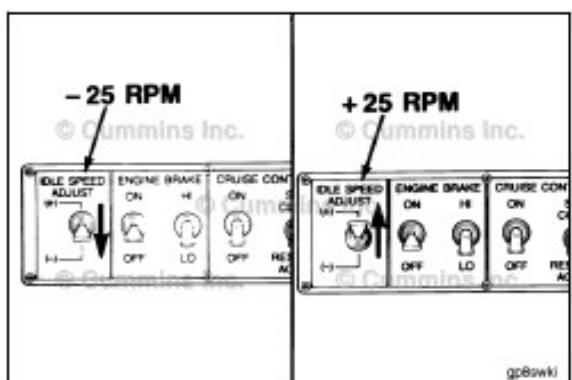
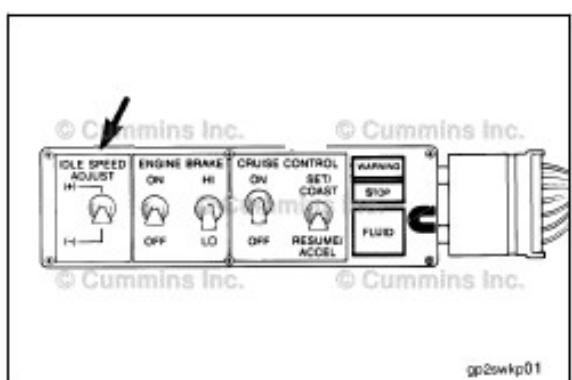
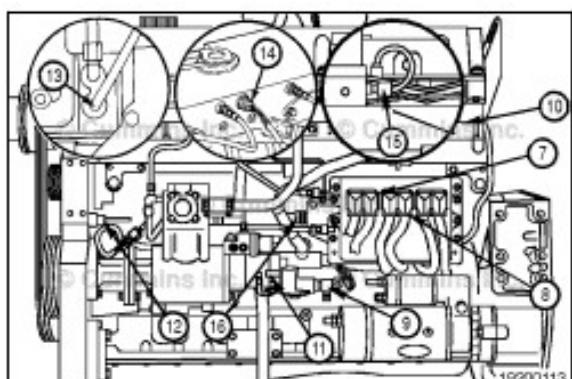
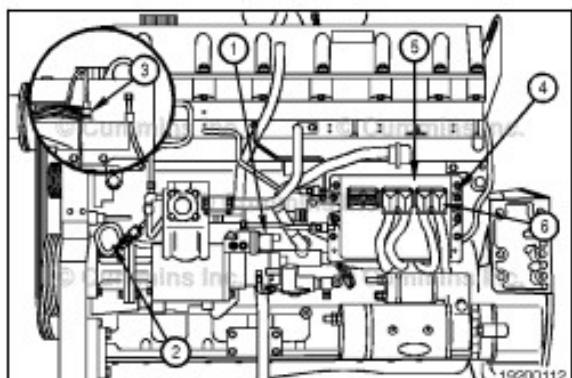


### Low Battery Voltage

NOTE: This voltage lamp only applies to marine applications.

The low battery voltage lamp (6) comes on when the battery voltage is below specification.





## Fuel System Description

### Industrial Applications

The fuel system on a QSM11 engine consists of:

- 1 Fuel shutoff valve
- 2 Oil pressure sensor and temperature sensor
- 3 Intake manifold boost sensor
- 4 Cooling plate
- 5 ECM
- 6 Engine wiring harness Deutsch connector.

- 1 OEM wiring harness
- 2 Engine wiring harness Deutsch connector
- 3 Fuel in
- 4 Fuel out
- 5 Fuel gear pump
- 6 Engine position sensor (EPS)
- 7 Coolant temperature sensor (in thermostat support)
- 8 Coolant level sensor (in overflow tank) - optional
- 9 Intake manifold temperature sensor
- 10 Ambient air pressure sensor.

The idle adjustment is in the cab panel. Use this switch to adjust the engine idle speed in increments of 25 rpm.

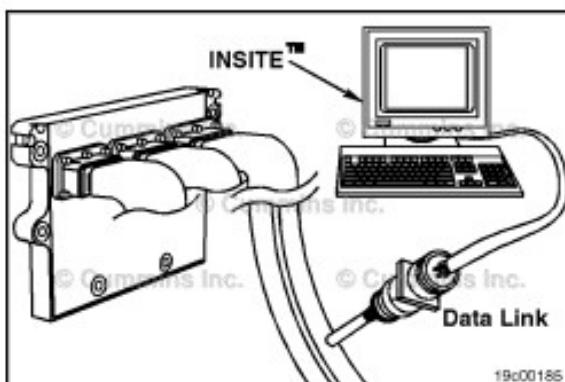
- Industrial - 650 to 800 rpm.

Each time the switch is briefly moved to the minus (-) position, the idle speed is decreased by 25 rpm. When the switch is briefly moved to the plus (+) position, the idle speed is increased by 25 rpm.

## Programmable Features

### General Information

The system provides additional electronic features that enhance engine and vehicle performance and control. These are programmable features in the ECM. For more information on additional features, refer to PROCEDURE NUMBER or contact a Cummins® Authorized Repair Location.



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### Marine Applications

#### Slow Idle

##### WARNING

Deactivate the SLOW-IDLE feature during docking maneuvers. In slow-idle mode, propeller inertia can cause the engine to stall when shifting into forward or reverse, which can cause the user to collide with the dock. Failure to turn off the SLOW-IDLE feature can cause personal injury, damage to the vessel, and/or the dock.

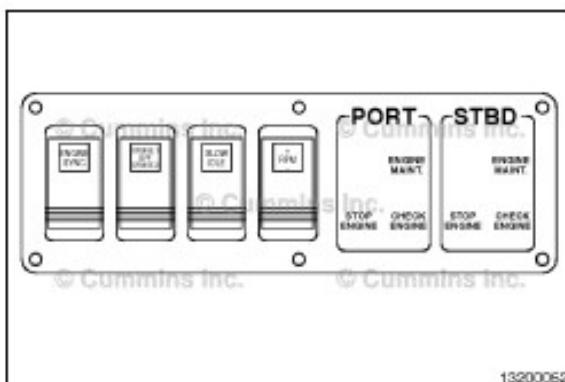
The SLOW-IDLE feature allows for lower idle speed for operation in "No Wake Zones." When activated, the slow-idle feature reduces the engine speed to 550 rpm.

**NOTE:** A single switch controls both engines on twin-engine vessels.

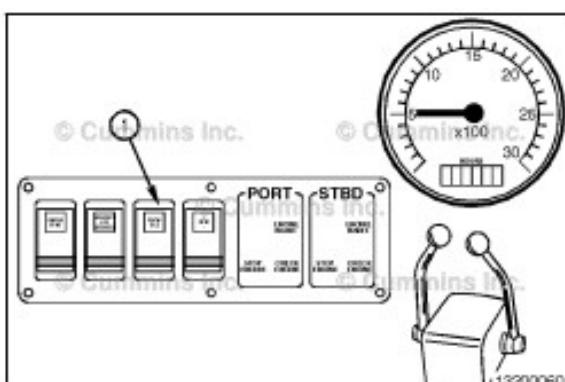
To use the SLOW-IDLE feature:

- 1 The vessel **must** be in gear
- 2 The throttle **must** be in the idle position
- 3 Put the SLOW-IDLE switch in the ON position (1) by depressing the top of the rocker switch.

The engine(s) idle will decrease to 550 rpm.



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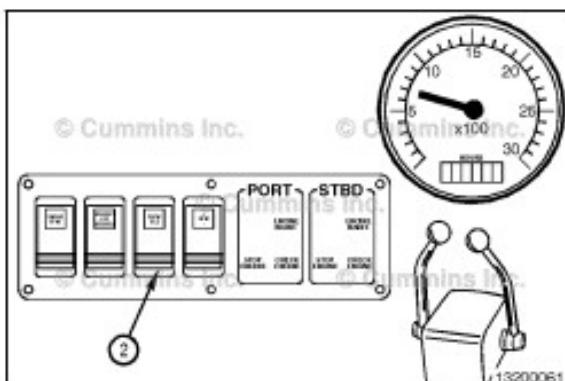


13200060

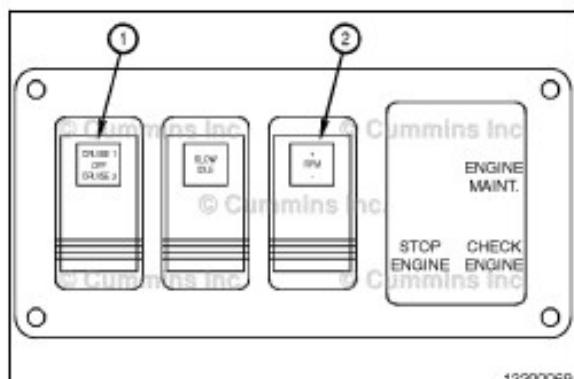
To turn the slow-idle feature off, put the SLOW-IDLE switch in the OFF position (2) by depressing the bottom of the rocker switch.

The engine(s) will adjust to the idle set speed.

**NOTE:** When the slow-idle switch is on, increasing the throttle will **temporarily** turn off the slow-idle feature. When the throttle is moved back into the idle position, the slow-idle feature will automatically turn itself on again.



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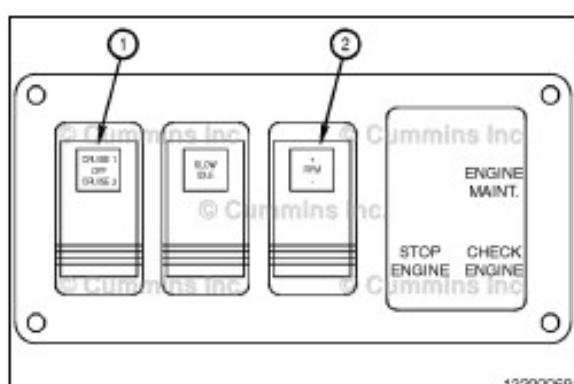


### Engine Speed Control

The engine speed control (rpm ±) switch (2) allows the idle speed to be adjusted in 25-rpm increments by pressing the rocker switch.

Pressing the top of the switch increases (+) engine rpm.

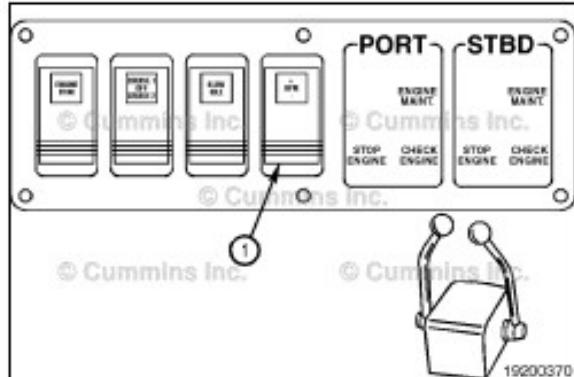
Pressing the bottom of the switch decreases (-) engine rpm.



When the rpm ± switch (2) is used with the engine at idle, the switch will only work from 600 to 1000 rpm.

**NOTE:** The rpm ± switch (2) will not change the idle speed when the engine is in SLOW-IDLE mode.

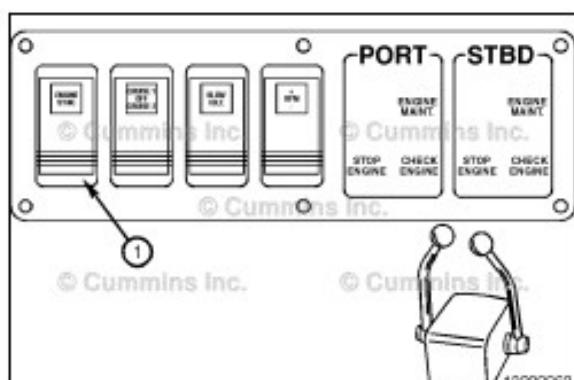
Use of the slow-idle feature will deactivate the rpm ± feature.



### Twin-Engine Vessels

If the engine speed between the two engines is not the same, adjust both engines to the minimum rpm setting, 600 rpm, by depressing the bottom (-) of the switch until both engines are at 600 rpm.

Then using the rpm ± switch (1), adjust the idle to the desired speed, rpm.



### Engine Synchronization Switch

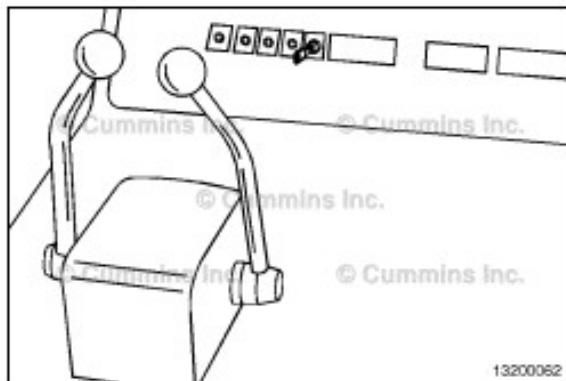
#### ▲ WARNING ▲

The engine synchronization feature must be turned off before docking or low-speed maneuvering; this allows full and separate control of each engine. Failure to turn off the engine synchronization feature can cause personal injury, damage to the vessel, and/or the dock.

**NOTE:** The engine synchronization feature is an option available only on twin-engine vessels.

The engine synchronization feature is used to control the speed of both engines electronically, using one throttle lever.

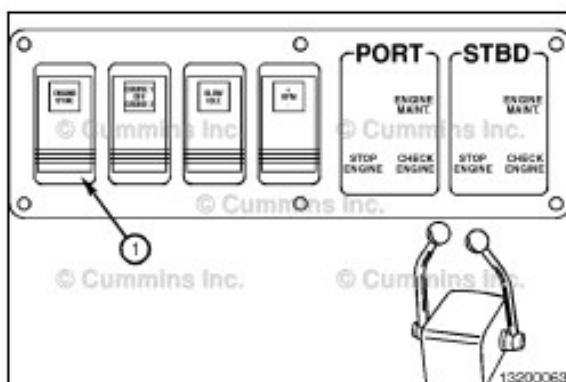
Normally the starboard throttle is used as the master throttle. The distributor or dealer can change it to the port throttle, if desired, by changing the master and slave plugs in the engine wiring. Refer to the OEM service manual.



To use the engine synchronization feature:

- 1 Both engines **must** be in the same throttle position, running at the same rpm.
- 2 Put the ENG SYNC switch (1) in the ON position by depressing the top of the rocker switch.

Both engines will adjust to the same rpm. The master throttle will control both engines.



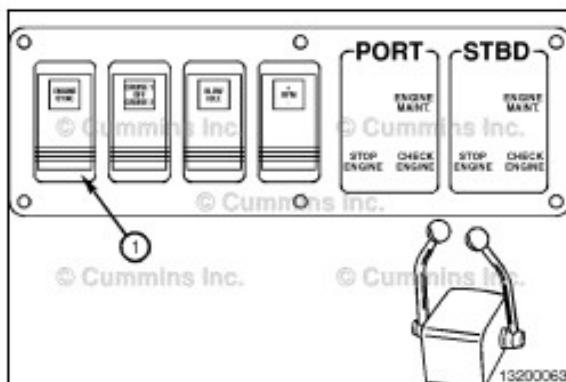
### CAUTION

Adjust both throttles to the same position before turning the engine synchronization feature off. Failure to do so can cause a sudden port or starboard turn.

To turn the engine synchronization feature off:

- 1 Both throttles **must** be in the same position.
- 2 Put the ENG SYNC switch (1) in the OFF position by depressing the bottom of the rocker switch.

The engines speed will slowly ramp to their physical throttle settings.



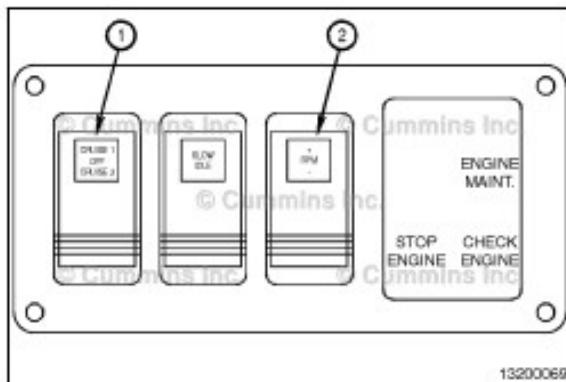
### Marine Cruise Control

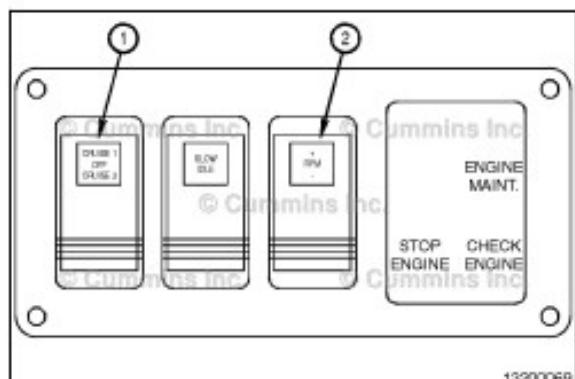
The marine cruise control feature provides two adjustable engine speeds. The cruise control can be used to run the engine(s) at the optimal cruise rpm or trolling rpm.

CRUISE 1 has a default setting of 2100 rpm.

CRUISE 2 has a default setting of 1200 rpm.

**NOTE:** The marine cruise control feature can be used in conjunction with the engine synchronization feature.



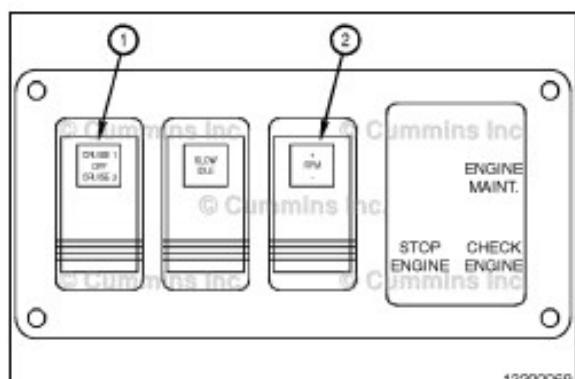


To activate the marine cruise control feature:

- 1 Put the cruise switch (1) in the desired position, CRUISE 1 or CRUISE 2.
- 2 Move the throttle(s) past the desired cruise speed.

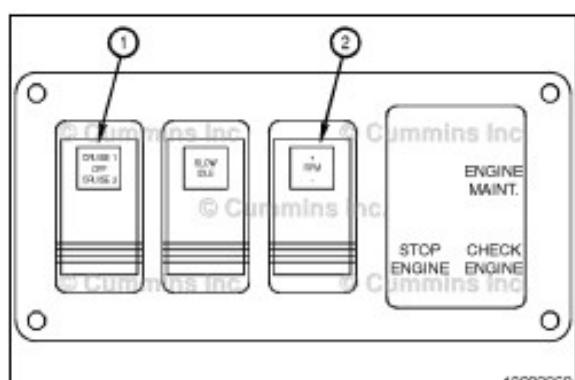
The engine(s) speed will increase to the cruise setting.

**NOTE:** When using the engine synchronization feature, the master throttle is the **only** throttle that **must** be moved past the cruise point.



To turn the marine cruise control off, put the cruise switch (1) in the OFF position (rocker switch in the center position).

The engine(s) rpm will slowly ramp to the throttle lever setting.



To change the CRUISE 1 or CRUISE 2 default setting rpm:

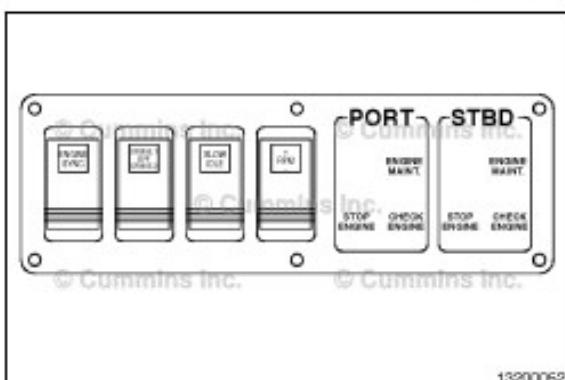
- 1 With the engine running, select the cruise setting that you want by setting the cruise control switch (1) to CRUISE 1 or CRUISE 2.
- 2 Move the throttle to the full-throttle position while underway, or at the dock with the gear in neutral. The engine will **not** exceed the existing cruise setting. For example, if CRUISE 2 is at the factory setting of 1200 rpm, the engine will **only** reach 1200 rpm at full throttle.
- 3 Using the rpm ± switch (2), adjust the cruise rpm to the new desired engine speed.

**NOTE:** The cruise speeds can be set between 600 and 2100 rpm. This new setting will be saved until the cruise is readjusted.

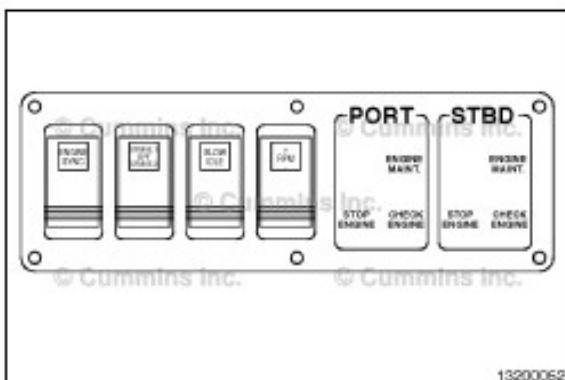
### Twin-Engine Applications

If the engines are running at different speeds:

- Adjust the cruise to the minimum or maximum setting, using the rpm ± switch.
- Adjust the cruise to the desired setting, using the rpm ± switch.



**NOTE:** If an engine will not reach rated rpm, make sure the marine cruise control feature is in the OFF position. If the marine cruise control feature is left in the CRUISE 1 or CRUISE 2 position, maximum engine speed will be limited to the set point of the position of the cruise switch.



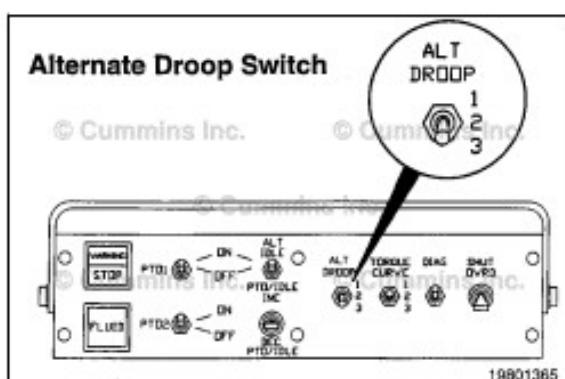
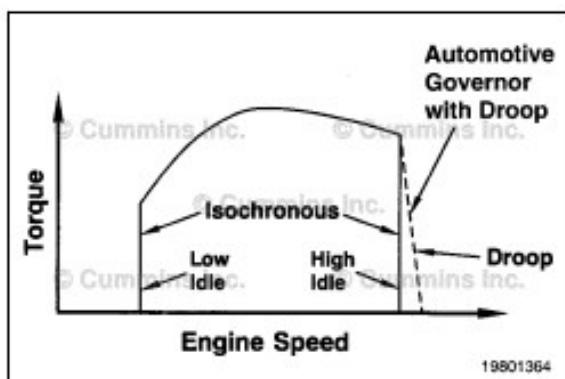
### Industrial Applications

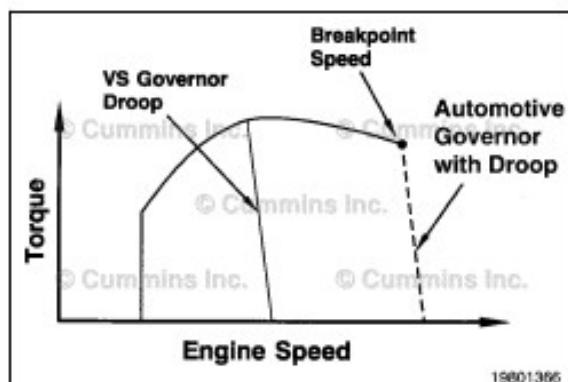
#### Alternate Droop

The alternate droop feature allows characteristics to be changed for the automotive governor and for the variable speed governor. Droop is usually expressed as a percentage. The graph to the right illustrates the isochronous (0-percent droop) and droop (more than 0-percent droop) governor characteristics. Less governor droop provides a more responsive governor for more precise engine control. More governor droop provides smoother shifting and smoother mechanical clutch engagement.

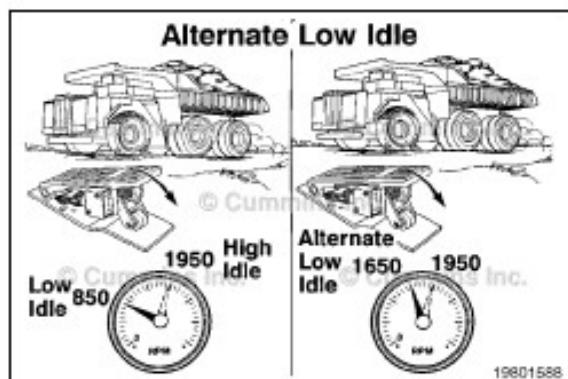
Alternate droop is available for industrial calibrations only and is specific to each calibration and application.

The alternate droop feature provides the ability to select different droop settings as follows. An OEM-provided switch can be used to select up to three droop settings (base, alternate 1, and alternate 2) and/or vehicle speed can be used to select up to five droop settings (base, alternate 1, alternate 2, Jcomm, and no selection). The final droop is based on a user-defined priority assigned to either the switch or the vehicle speed. The availability of these droop settings and abilities is dependent on the individual OEM setup and application.



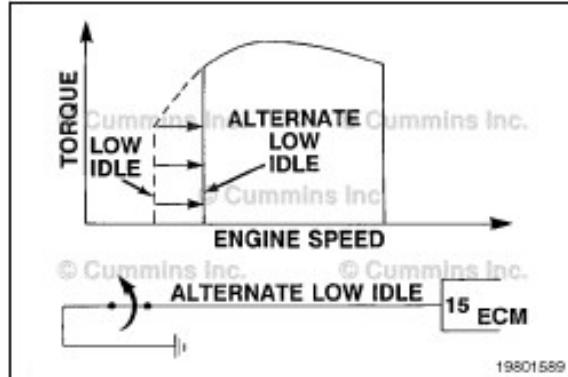


Each alternate droop setting provides the ability to select the breakpoint droop percent for the automotive governor and droop percent for VS governor. The breakpoint speed determines what position on the engine torque curve the automotive governor will start to limit engine torque output.

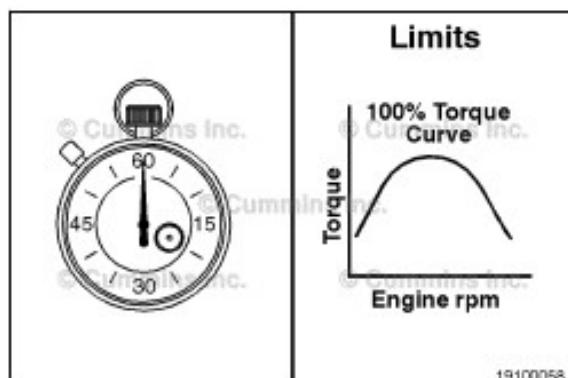


#### Alternate Low Idle Speed

This feature allows for two different low-idle speed settings with normal throttle control above the low-idle speed setting. This feature is often used on electric drive haul trucks when they are traveling above 5 kph [3 mph].



The alternate low-idle feature is activated whenever the normally closed alternate low-idle switch is opened and 5 VDC are detected on the alternate low-idle signal line. The following art illustrates an alternate low-idle speed that is above the normal low-idle speed.



#### Automatic Boost Power

The automatic boost power feature will limit the time that the engine can operate on the 100-percent torque curve. Engine load, intake manifold temperature and coolant temperature will be compared to thresholds to determine if boost power is available. Once boost power has been selected, the amount of the time spent on the 100-percent torque curve is limited. Boost power will be active and not time-limited when the engine speed is below a calibration threshold. A boost power lamp will be illuminated while active, and will flash as boost power is about to time out. The availability of this feature is dependent on the individual OEM application.

### Sensed Parameters

This feature allows an OEM-provided pressure sensor and/or an OEM-provided temperature sensor to be read by the ECM. It also determines the out-of-range limits for each sensor. If the sensor value is outside the limits, then a fault will be logged corresponding to the out-of-range sensor and a default value will be used for the out-of-range sensor. This feature can be enabled or disabled by INSITE™ electronic service tool. The Number of Inputs, Upper and Lower Pressure Thresholds, and Upper and Lower Temperature Thresholds can be adjusted by INSITE™ electronic service tool.

The temperature and pressure sensors can be used by the ECM to control other features, such as the Electronic Fan Clutch or Switched Outputs.

### Low Idle Shutdown

The low-idle shutdown feature automatically shuts off an engine after a period of idling when there is no activity from the driver such as clutch, brake, or throttle actuation. The time interval can be changed using an electronic service tool.

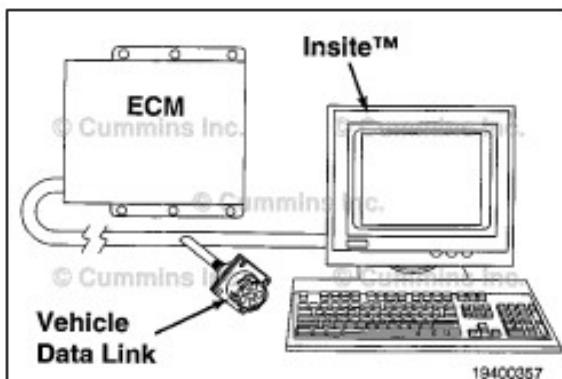
The idle shutdown system will not be active at coolant temperatures below 43°C [109°F].

After an engine has been automatically shut OFF, the key must be turned OFF for 5 seconds before attempting a restart.

**NOTE:** This feature will shut off the engine only. It will not remove power from other accessories powered by the keyswitch.

### Hot Shutdown Monitor

The hot shutdown monitor is a selectable feature within the INSITE™ electronic service tool. If this feature is enabled, the ECM will log an inactive fault when the engine is turned OFF while still "hot" by the operator or by the engine protection feature.



An engine is considered "hot" when the hot shutdown load percent of the engine is above the threshold set by the INSITE™ electronic service tool. The hot shutdown load percent is based on the duty cycle load factor, which is determined from engine fueling levels.

#### **Engine Protection Shutdown Manual Override**

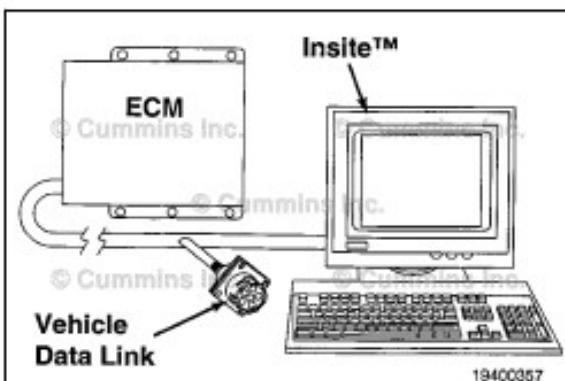
The engine protection shutdown manual override feature can override the engine shutdown process when it is necessary. The engine protection shutdown manual override feature detects the operator request for engine protection shutdown manual override, records the times of occurrences, and sends a flag to inform the engine protection shutdown feature and lamp control to restart the shutdown warning period. This feature can be enabled by INSITE™ electronic service tool.

During an engine protection shutdown sequence, the warning lamp will flash. With the engine protection shutdown manual override feature enabled, the shutdown will be overridden if the dash-mounted override switch is turned on as the warning lamp is flashing. The feature will also record a snapshot that can be viewed under the Engine Protection Data in INSITE™ electronic service tool.

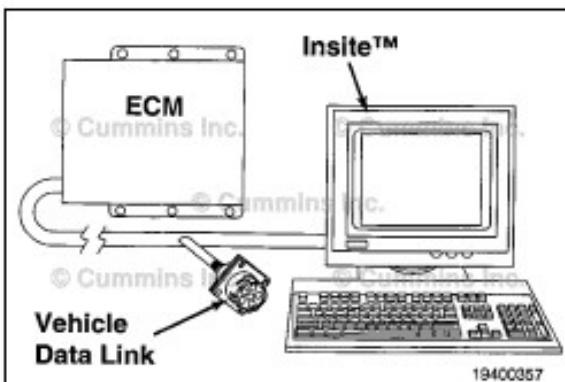
#### **Electronic Fan Clutch**

The electronic fan clutch feature provides a pulse-width modulated signal to control a variable-speed fan clutch based on the need provided by eight possible sensor inputs, or an input from an electronic service tool. This feature will reduce fuel consumption by minimizing fan on-time and lengthen belt life by eliminating belt hop and slippage.

The electronic fan clutch can be enabled or disabled with the INSITE™ electronic service tool. The fan percent ON (0 to 100 percent) can be monitored and the fan clutch ramp rate adjusted in units of percent/second. Adjusting the ramp rate allows different applications to be tuned for different fan characteristics.



The INSITE™ electronic service tool also has the capability to control the fan clutch percent ON with the fan clutch control dialog. While the engine is running and the service tool is connected to the datalink, the user can enter the fan percent ON request between 0 and 100 percent. Controlling the fan clutch with the service tool will aid in troubleshooting and diagnostics of the fan clutch and engine cooling system. Refer to INSITE™ Electronic Service Tool Manual, Bulletin 3666148.

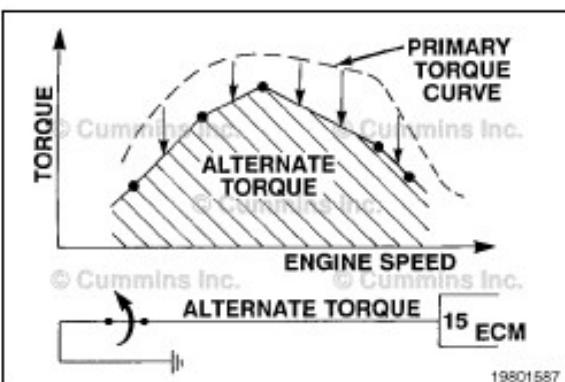


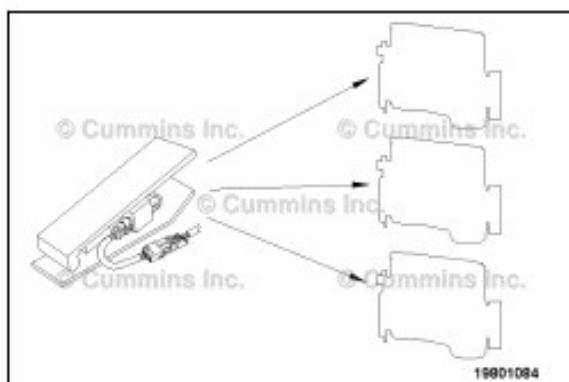
### Switchable (Alternate) Torque

This feature enables an alternative electronically controlled maximum engine torque curve for optimum operating efficiency in loaded versus unloaded conditions.

The alternate torque feature is activated whenever the normally closed alternate torque switch is opened and 5 VDC are detected on the alternate torque signal line. Five torque versus engine speed points define the alternate torque curve.

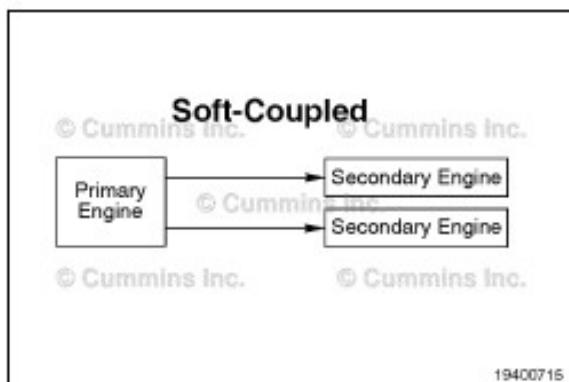
Shown is a graph illustrating an alternate torque curve that is below the normal torque curve.



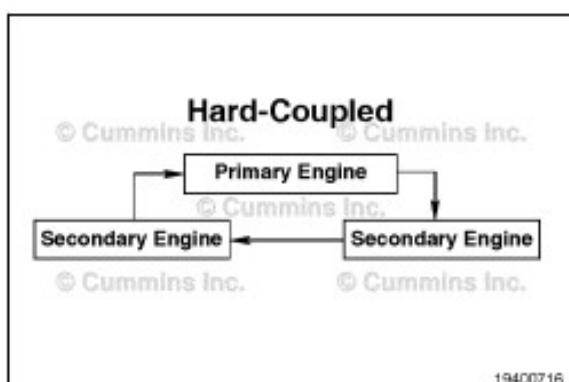


### Multiple Unit Synchronization

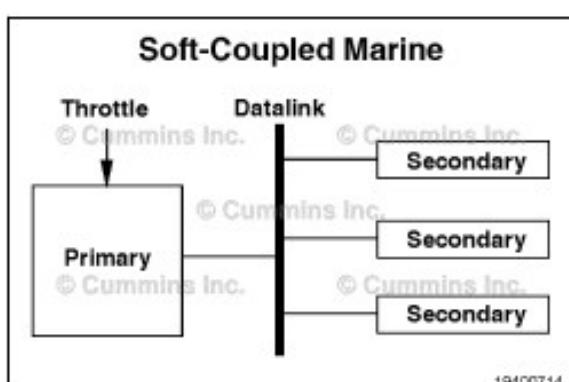
The multiple unit synchronization feature allows two or more engines (up to a maximum of 11) to be controlled by a single throttle signal. There are three engine configurations available with this feature. They are soft-coupled, hard-coupled, and soft-coupled marine.



The soft-coupled configuration has all secondary engines in parallel.

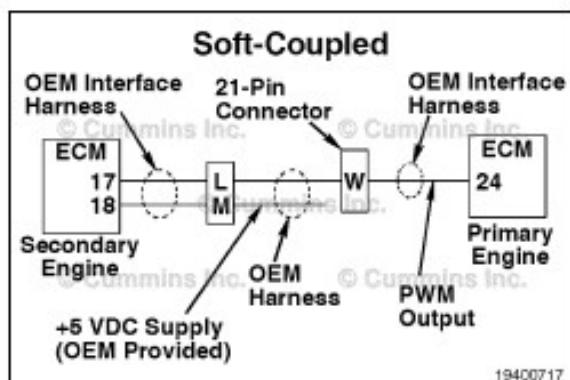


The hard-coupled configuration has all secondary engines in series.

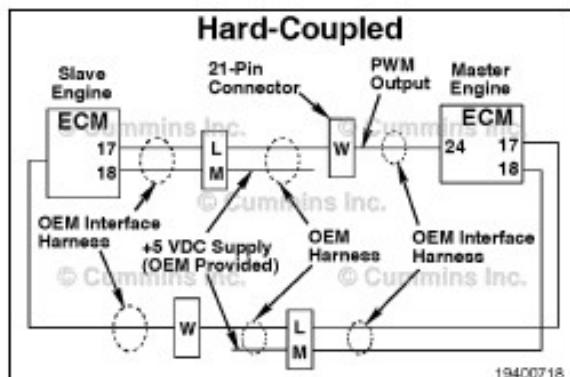


The soft-coupled marine configuration has all engines connected to a J1939 datalink.

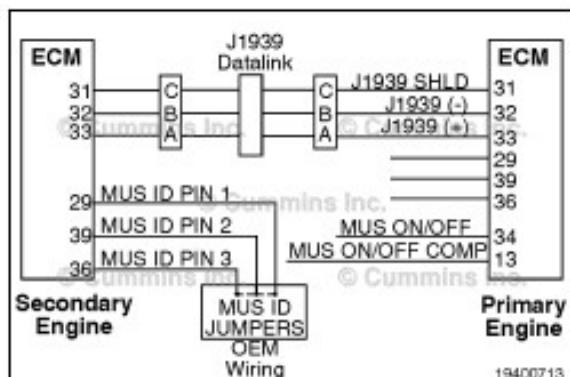
In the soft-coupled configuration, the primary engine outputs a throttle signal on ECM pin 24. This signal is received by the secondary engine(s) on ECM pin 17. The secondary engine also receives a +5-VDC supply (OEM provided) to ECM pin 18 to complete the circuit. This setup allows all engines to remain running if a secondary engine stops running.



In the hard-coupled configuration, the primary engine outputs a throttle signal on ECM pin 24. This signal is received by the secondary engine(s) on ECM pin 17. The secondary engine also receives a +5-VDC supply (OEM provided) to ECM pin 18. The secondary engine then outputs the throttle signal on ECM pin 24 to the next secondary engine in the series. This process is repeated by all secondary engines until the throttle signal and +5-VDC supply are received by the primary engine.



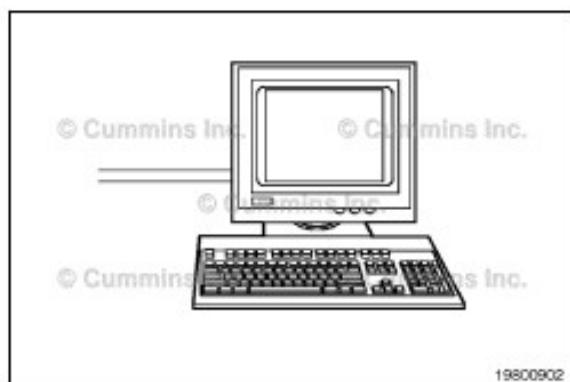
In the soft-coupled marine configuration, the primary engine outputs a throttle signal to the J1939 data link pins 31, 32, and 33. Secondary engines that are connected to the data link then read the throttle value. The soft-coupled marine application also allows for primary/secondary configuration via wiring harness jumpers (pins 29, 39, and 36) instead of specific calibrations. The soft-coupled marine configuration uses a multiple unit synchronization on/off switch (pins 13 and 34) to control the enabling or disabling of the engine synchronization.

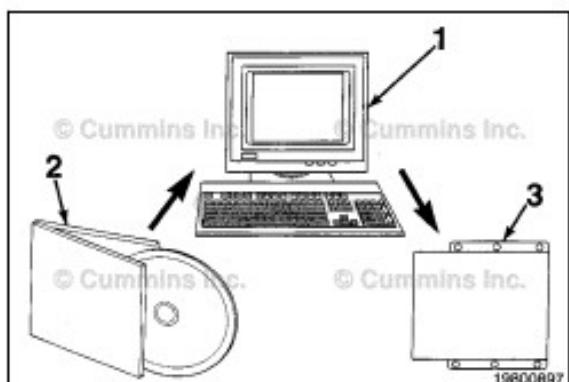


INSITE™ electronic service tool can be used to monitor the following parameters:

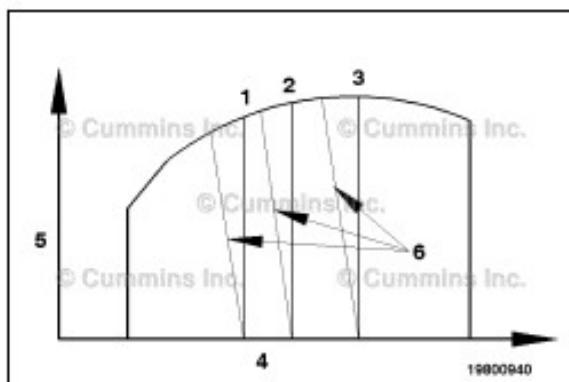
- Multiple unit synchronization couple type (soft-coupled, hard-coupled, or soft-coupled marine)
- Multiple unit synchronization engine type (primary or secondary)
- Multiple unit synchronization on/off switch
- Percent pulse-width modulate output (throttle signal).

The multiple unit synchronization couple type is not adjustable by the INSITE™ electronic service tool, but the type can be changed by downloading a calibration to the ECM.





This feature can **only** be enabled or disabled by calibration. An electronic service tool (1) will be required to download a calibration from the ESDN (2) to the electronic control module (3) if this feature needs to be enabled or disabled.



#### Intermediate-Speed Control

The intermediate-speed control feature can control the engine to three programmable engine set speeds (1, 2, 3) in three different modes of operation. The three set speeds are determined by a three-position switch and a two-position switch. The three modes of operation are a manual normal set speed operation, a low speed limit operation, and a high speed limit operation.

**NOTE:** These three modes of operation are set by the calibration and are **not** customer-adjustable.

An intermediate-speed droop is also programmable.

**NOTE:** Depending on the electronic calibration, the third intermediate speed switch can act as a validation switch. The purpose of the validation switch is to eliminate accidentally switching to intermediate speed 1 or 2. To switch to intermediate speed 1 or 2, the validation switch **must** be engaged first; then move the intermediate-speed switch to 1 or 2.

This feature also uses a momentary increment and decrement switch to raise the engine set speed while in operation.

### Switched Outputs

This feature provides up to two fully independent switched outputs for OEM use. The state of each switched output is determined by up to 12 different inputs to the ECM. The ECM can provide different outputs if any of the inputs are above or below calibrated thresholds. Each switched output is independent of the other in controlling parameter input and threshold settings. This feature can be enabled or disabled with INSITE™ electronic service tool. The thresholds can not be adjusted with INSITE™ electronic service tool.

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

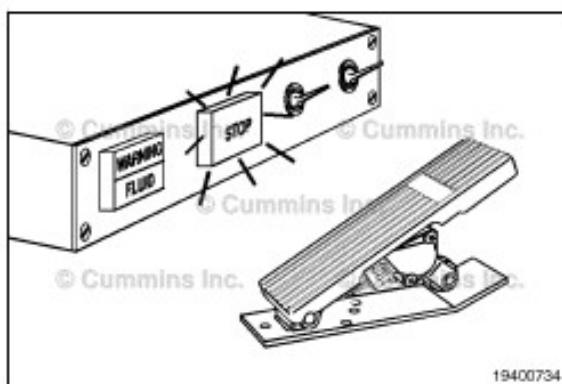
- Engine speed
- Fueling command (cubic mm per second)
- Boost pressure (in Hg)
- Auxiliary speed input (rpm)
- Oil pressure (psi)
- Coolant temperature (degrees Fahrenheit)
- Commanded throttle (percent)
- ISC 2 status (off or active)
- OEM temperature (degrees Fahrenheit)
- OEM pressure (psi)
- OEM supplied sensor (volts)
- OEM supplied switch (open or ground)

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 crossed. Also, each output can be calibrated to change states if either any threshold is crossed or all thresholds are crossed.

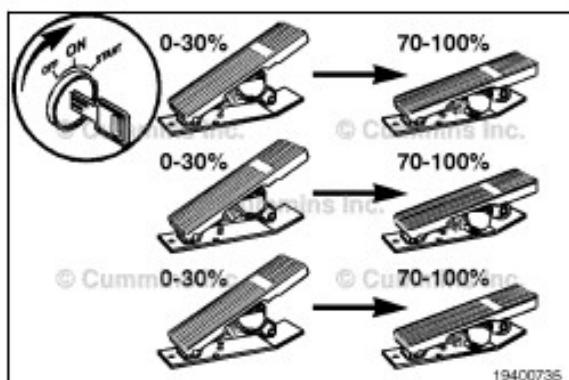
### Throttle Activated Diagnostic Switch

Throttle-activated diagnostic switch is intended to eliminate the need for a dash-mounted diagnostic switch, which is used to activate the diagnostic mode to display active fault codes in a sequence of flashing lamps. The throttle-activated diagnostic switch feature eliminates the need for a dash-mounted diagnostic switch by providing a simple sequence of throttle movements that activate the diagnostic mode.

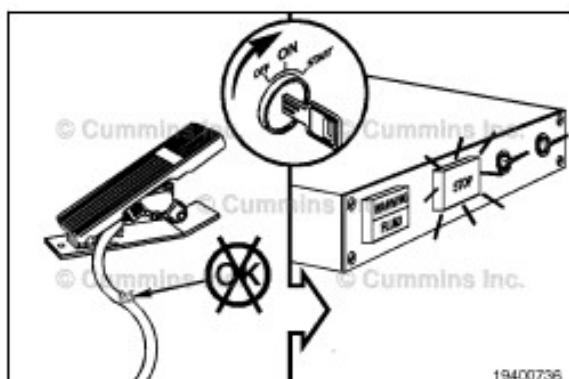
NOTE: This feature will work with all throttle types.



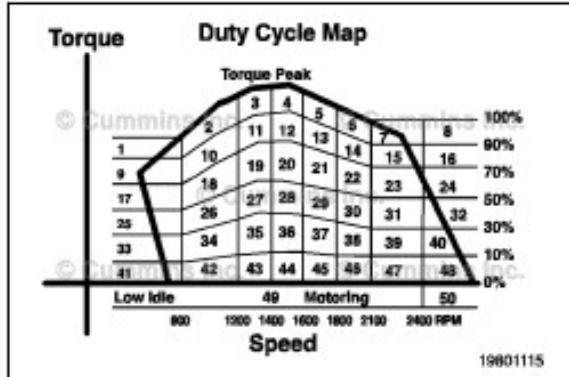
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When the engine is **not** running, the keyswitch is turned on, and the feature flag is enabled, a sequence of three throttle cycles from 30 to 70 percent within a specific time will activate the diagnostic mode. The increment/decrement switch can be used to navigate to the next or previous fault code. In case these switches are not available, a throttle cycle from 30 to 70 percent will also increment to the next fault.

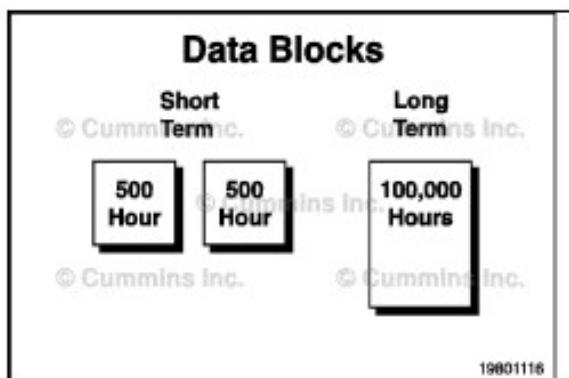


A sensitive mode is enabled when this feature is enabled. The sensitive mode is an algorithm that **will** automatically activate the diagnostic mode when the engine is **not** running, the keyswitch is turned ON, and any throttle-related errors are detected. This allows the user to activate the diagnostic mode when throttle errors prevent them from doing so with throttle movements.



#### Duty Cycle Monitor

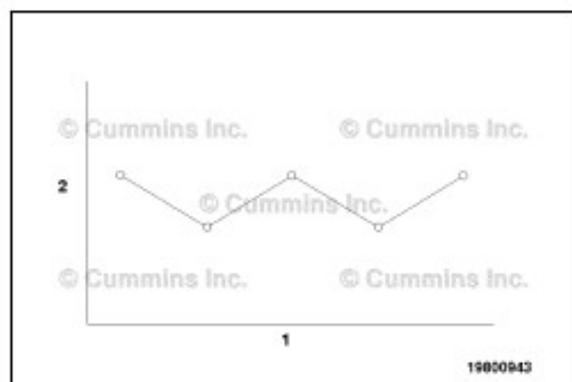
The duty cycle monitor tracks the time the engine spends in 50 different operating regions. These operating regions are based on engine speed and engine torque.



This feature provides two short-term 500-hour resettable data blocks and one long-term 100,000-hour nonresettable data block.

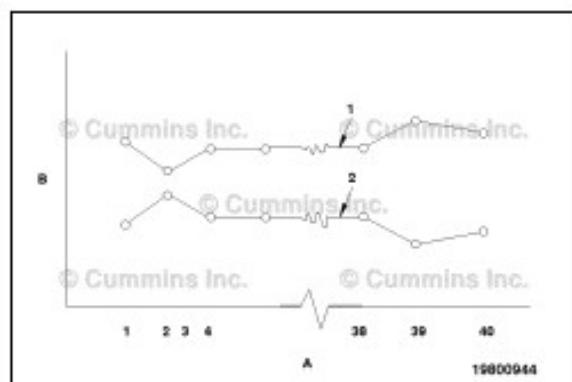
#### Fuel Consumption Rate Logger

The fuel consumption rate feature allows an electronic service tool to access fuel consumption data (1=time, 2=gallons/hour).



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This feature provides two resettable 40-hour fuel consumption periods (1 and 2). Each period records fuel consumption data in forty 1-hour segments. These 40 data segments can be graphed to show fuel consumption over both 40-hour periods (A=hours, B=gallons/hour).

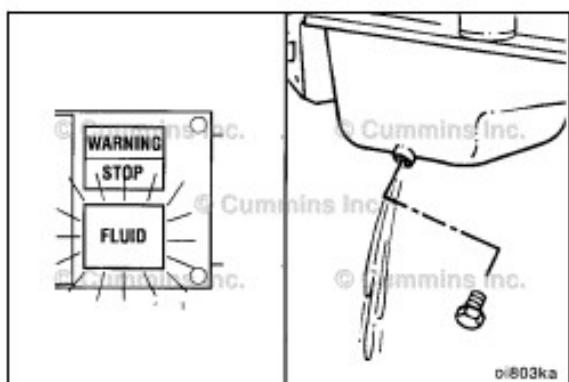


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An instantaneous fuel consumption rate and a nonresettable lifetime or running average fuel consumption rate are available on the monitor screen of an electronic service tool. In addition, the two 40-hour fuel consumption periods are individually resettable using an electronic service tool.



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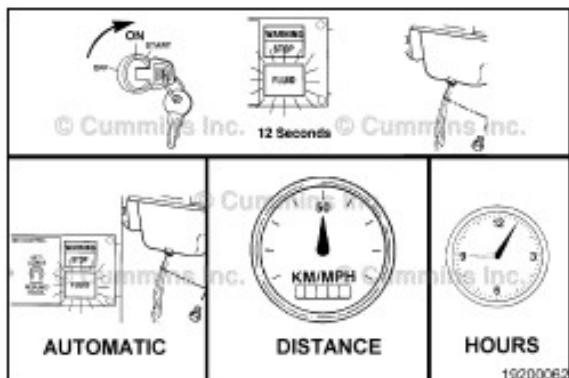
### Maintenance Monitor

**NOTE:** The maintenance monitor is designed to alert the operator of the need for a routine maintenance stop. Maintenance records **must** still be maintained for historical purposes.

**NOTE:** The maintenance monitor uses data received from the ECM to determine the amount of fuel burned. Whenever a VSS, injector circuit, or battery voltage fault has occurred, the maintenance monitor data can be inaccurate.

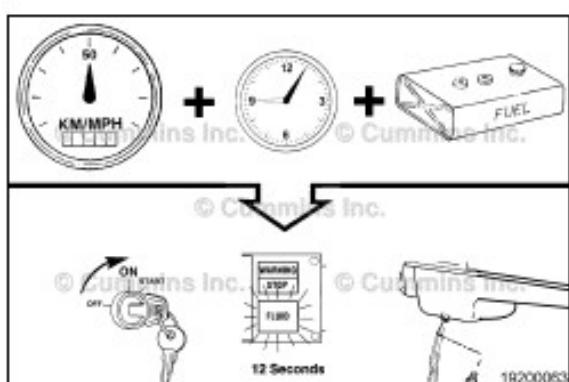
The maintenance monitor is an optional feature that will alert the operator when it is time to change oil and perform any other simultaneous maintenance tasks. The maintenance monitor continuously monitors the time the engine has been operating and the amount of fuel burned to determine when it is time to change oil.

The operator **must** still be alert for any indications that the engine needs other service.



The maintenance monitor has two modes of operation:

- Automatic mode
- Time mode.



The automatic mode alerts the operator when it is time to change oil based on Cummins Inc. recommended interval. It determines the maintenance interval based on engine operating time and fuel burned.

When the automatic mode is selected, the severe oil drain interval duty cycle is the default.

The original factory programmed value is AUTOMATIC.

**CAUTION**

Select the correct oil change interval for your application. Cummins Engine Company, does not recommend exceeding these published intervals and is not responsible for damage sustained due to overextended drain intervals.

The maintenance monitor automatic mode is easily adjusted to accommodate severe-, normal-, or light-duty applications and Valvoline Premium Blue 2000™ engine oil. This is done by using a Compulink™ or Echek™ service tool to enter an interval factor that corresponds to the appropriate duty cycle and type of product used.

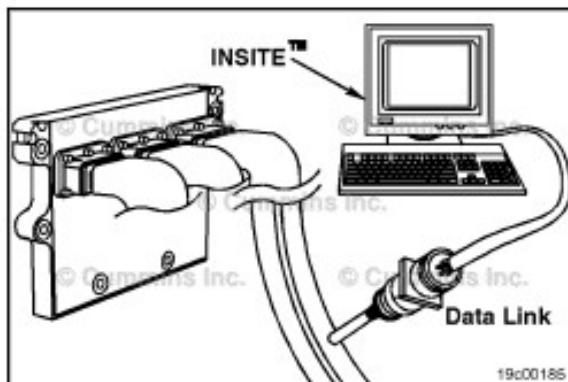
When selecting the correct interval factor for your application, Refer to Procedure 102-002 (Maintenance Schedule) in Section 2, to determine which oil drain interval duty cycle fits your application: Severe duty, normal duty, or light duty. Once the duty cycle is chosen, use an interval factor of 1.00 for severe duty, 1.50 for normal duty, and 2.00 for light duty.

**NOTE:** These interval factors **must** be adjusted accordingly if Valvoline Premium Blue 2000™ oil is used to extend the oil drain interval. See the Valvoline Premium Blue 2000™ product literature to determine how much your drain interval can be extended.

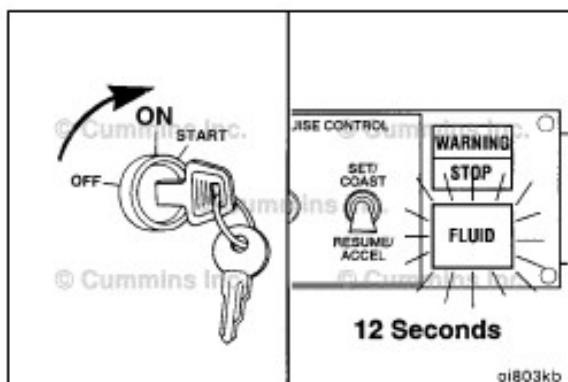
The time mode allows the customer to enter a desired time interval. The maintenance monitor will then monitor the time the engine has been operating and alert the operator when the interval has been consumed.

**Alerting the operator:** The maintenance monitor will alert the operator of the need to change oil by flashing the engine protection lamp (fluids lamp) for approximately 12 seconds after keyswitch ON. The flashing sequence will be three quick flashes, followed by a pause. This flash sequence will go through five cycles in the 12-second period. This sequence will occur at every keyswitch ON until the maintenance monitor has been reset.

**NOTE:** The diagnostic switch **must** be in the OFF position for the flashing sequence to occur.



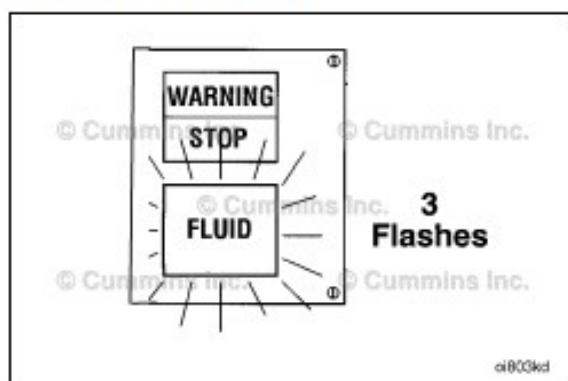
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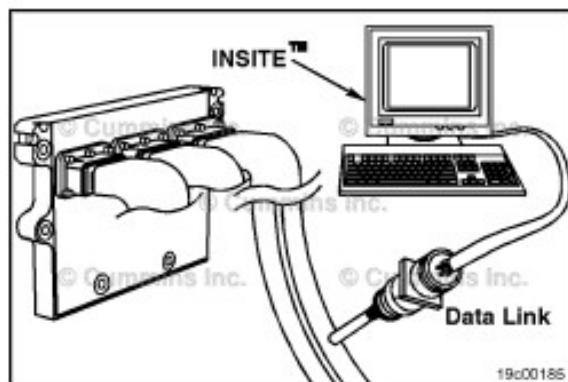
Resetting the Maintenance Monitor. The maintenance monitor can be reset using INSITE™ electronic service tool or by following steps 1 through 10 below. Steps 3 through 8 **must** be done within 12 seconds in order for the maintenance monitor to be reset. The diagnostic switch **must** be in the OFF position and the vehicle air system **must** be fully charged.

- 1 Turn the keyswitch ON (engine **must not** be operating)
- 2 Make sure brakes are released (service and trailer brakes)
- 3 Hold throttle pedal at 100-percent throttle
- 4 Press and release service brake three times
- 5 Release throttle pedal
- 6 Depress and hold throttle pedal at 100-percent throttle again
- 7 Press and release service brake three more times
- 8 Release throttle pedal
- 9 The light will flash three times
- 10 Turn the keyswitch OFF.



As soon as the throttle pedal is released (step 8), the engine protection lamp will flash three quick flashes. This means that the reset command has been received and the maintenance monitor will reset its distance (miles or kilometers), time (hours), and fuel (gallons or liters) to zero the next time the keyswitch is turned off (step 10).

**NOTE:** If the engine protection lamp does **not** flash after the throttle pedal is released on step 8 above, the reset sequence **must** be performed again.



When viewing maintenance monitor data with INSITE™ electronic service tool, the following maintenance data can be viewed or printed from the ECM:

- Percent of present interval consumed (by either distance, time, or fuel burned)
- Distance since last reset
- Time since last reset
- Reset log (distance and time at the last three resets).

The interval factor is **only** used in the maintenance monitor Auto mode to adjust the following applications:

- Severe duty
- Normal duty
- Light duty
- Extended interval when using Valvoline® Premium Blue® 2000
- Other products that extend maintenance intervals.

The interval factor can be adjusted between 0 and 5.0.

The original factory programmed value is 1.

The maintenance monitor interval alert percentage allows the user to enter the percentage of the present interval at which the light should come on indicating the need for an oil change. The parameter allows the user to obtain an early warning of the need for a maintenance stop.

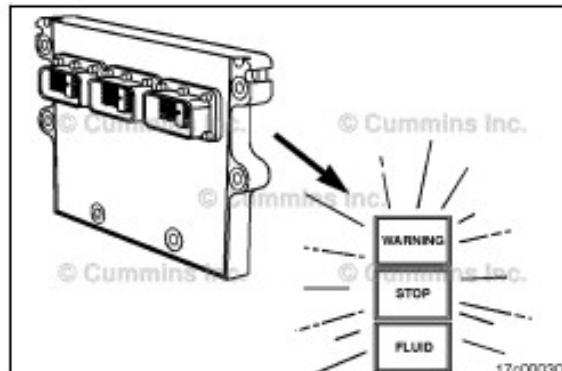
For example, if the distance mode is set to 24,194 km [15,000 mi] and the interval alert percentage is set to 90 percent, the lamp will illuminate at 21,774 km [13,500 mi], which is 90 percent of 24,174 km [15,000 miles].

The interval alert percentage can be set between 0 and 100 percent.

The original factory programmed value is 100 percent.

### Fault Lamp Sequencing

The fault lamp sequencing feature is used to determine whether the diagnostic dashboard lamps have been installed and wired correctly. After keyswitch ON, all dashboard diagnostic lamps will turn on at once and then turn off in sequence.

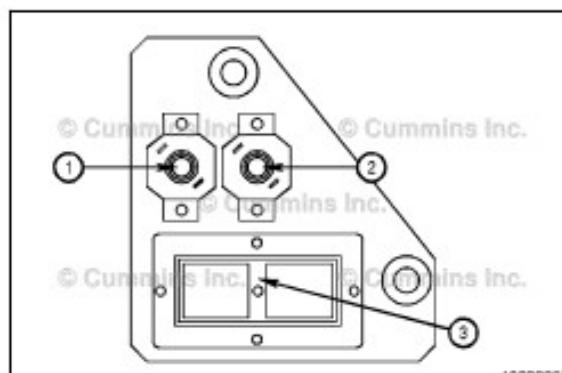


### Circuit Breakers

#### Marine Applications

The QSM11 marine engine is equipped with two circuit breakers, located on the ECM side of the engine.

A 5-amperage circuit breaker (1) is used for keyswitched power and a 10-amperage circuit breaker (2) is used for non-keyswitched power. The circuit breaker panel also houses a 40-pin OEM connector (3).



## 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 transmitting antenna as far away from the engine and as high as possible.
- 2 Locate the transmitting 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:
  - Accurately calibrate 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.

## 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. For gas fueled generator sets, shorter maintenance intervals are also required, if operating at loads below 70% for prolonged periods. 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 and SAE wrenches, sockets, and screwdrivers.

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

Tool Part Number:	Description:
3400157	Oil filter wrench
3376592	Torque wrench (valve and injector adjustment)
3163196	Torque wrench adapter (used with 3376592 torque wrench)
3400158	Engine coolant and fuel filter wrench
3822524	Belt tension gauge, click type (v-belts and v-ribbed with 4 or 5 ribs)
3822525	Belt tension gauge, click type (v-ribbed with 6 to 12 ribs)
ST-1138	Belt tension gauge (v-belts)
ST-537	Dial depth gauge
3164019	Chip removal tool
ST-1293	Belt tension gauge (v-ribbed belts)
CC-2800	Refractometer
CC-2602	Coolant test kit

Contact a Cummins® Authorized Repair Location for the required service tools.

## Maintenance Schedule

### General Information

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

#### Maintenance Procedures at Daily Interval .....**Section 3**

- Drive Belts - Check
- Fuel-Water Separator - Drain
- Lubricating Oil Level - Check
- Coolant Level - Check
- Sea Water Strainer - Clean
- Air Cleaner Restriction - Check
- Crankcase Breather Restriction - Check
- Marine Gear<sup>2</sup> - Check

#### Maintenance Procedures at 250 Hours, or 6 Months<sup>1</sup> .....**Section 4**

- Fuel Filter (Spin-On Type) - Change
- Lubricating Oil and Filters<sup>3</sup> - Change
- Coolant Filter<sup>4</sup> - Change
- Supplemental Coolant Additive (SCA) and Antifreeze Concentration - Check
- Zinc Anode<sup>5</sup> - Check
- Engine Wiring Harness - Check

#### Maintenance Procedures at 600 Hours, or 1 Year<sup>1</sup> .....**Section 5**

- Overhead Set - Adjust
- Crankcase Breather Element (Commercial Marine engines) - Replace

#### Maintenance Procedures at 1500 Hours, or 1 Year<sup>1</sup> .....**Section 6**

- Engine Steam Cleaning - Clean
- Sea Water Pump - Check
- Water Pump - Check
- Sea Water System - Clean
- Sea Water Hoses - Inspect for Reuse
- Air Cleaner Assembly (Engine-Mounted) - Check
- Air Leaks, Air Intake and Exhaust Systems - Check
- Turbocharger - Check
- Air Cleaner Restriction - Check
- Batteries - Check
- Engine Mounting Bolts - Check

#### Maintenance Procedures at 6000 Hours, or 2 Years<sup>1</sup> .....**Section 7**

- Vibration Damper, Viscous - Check
- Cooling System - Flush
- Crankcase Breather Element (Recreational Marine engines) - Replace

Reference the appropriate sections for complete inspection and maintenance procedures.

<sup>1</sup> These maintenance intervals **must** be performed at hours or months, whichever interval occurs first. At each scheduled maintenance interval, perform all previous maintenance procedures that are due for scheduled maintenance.

- 2 Follow the gear manufacturer's recommended maintenance procedures for checking, filling, and changing oil. Some gear manufacturers require an initial oil change at low hours, in addition to their regular maintenance.
- 3 Fuel burn is the most accurate method for determining oil change intervals. Oil change intervals can be required more frequently, depending on the quality of the oil available. Reference the Oil Drain Interval table for marine and industrial engines in this procedure for additional oil change intervals.
- 4 Do not change the coolant filter if the SCA concentration level is over three units.
- 5 Depending upon the quality of electrical bonding and water conditions, increased maintenance of the zinc anode plugs could possibly be necessary.

## Oil Drain Intervals

QSM11 Marine Engines - Oil Drain Intervals				
Oil Type	Fuel Burned	Hours	Months	Acceptable Filter
CF-4 <sup>(1)</sup>	6625 liters [1750 gal]	125	6	LF9001 <sup>(4)</sup>
CG-4	13,249 liters [3500 gal]	250	6	LF9001 <sup>(4)</sup>
CH-4 (CES 20071) <sup>(2)</sup>	15,142 liters [4000 gal]	300	12	LF9001 <sup>(4)</sup>
CES 20076 <sup>(3)</sup>	15,142 liters [4000 gal]	300	12	LF9001 <sup>(4)</sup>

**Notes:**

- 1 CF-4 oil is not recommended and can only be used if better quality oil is not available.
- 2 Valvoline™ Premium Blue™ meets and exceeds API CH-4 and CES20071 specifications.
- 3 Valvoline™ Premium Blue™ 2000 meets and exceeds CES 20076 specifications.
- 4 Oil filters must meet CES 10065 specifications. LF9001 meets and exceeds CES 10065 specifications.

## Maintenance Record Form

## Maintenance Data

## 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.

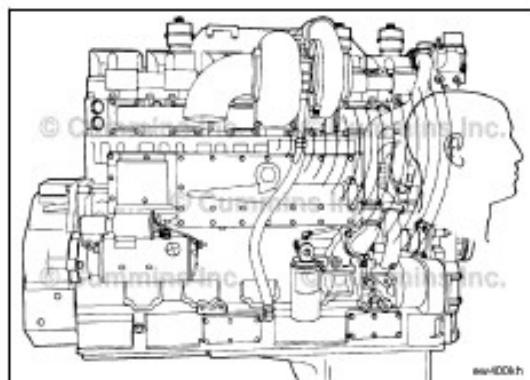
Comparison and intelligent interpretation of the daily report, along with a practical follow-up action, will eliminate most failures and emergency repairs.

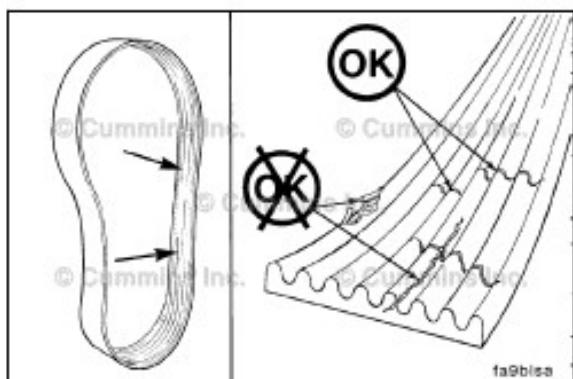
Report to the maintenance department any of the following conditions:

- 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.





## Drive Belts Maintenance Check



### Poly-Vee Belt

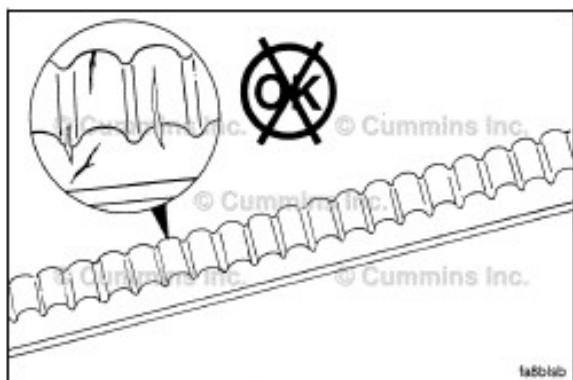
#### CAUTION

Make sure that the engine is switched off and any starting mechanisms are isolated before any inspections are made. Daily belt inspections can be carried out through an appropriate aperture. Do not remove any guards.

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:

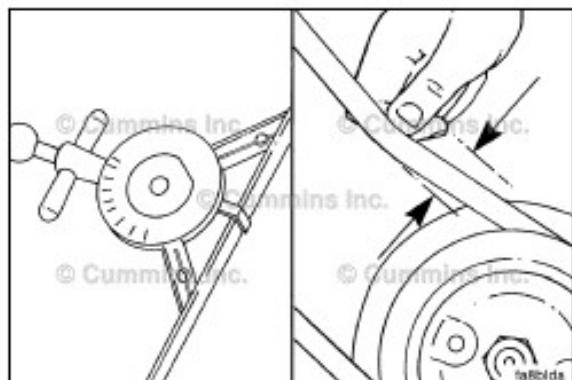
- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil or grease on the belts

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

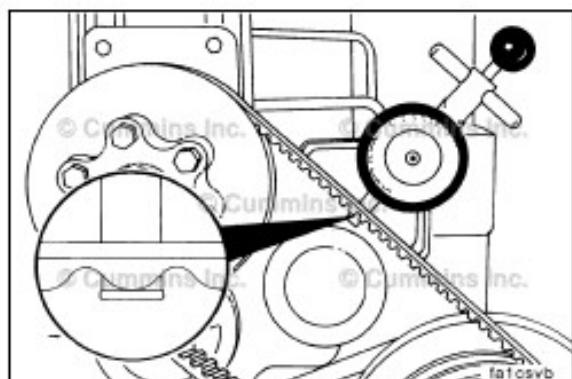
Refer to the Belt Tension Chart in Section V for the correct gauge and tension value for the belt width used.

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.



## 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.

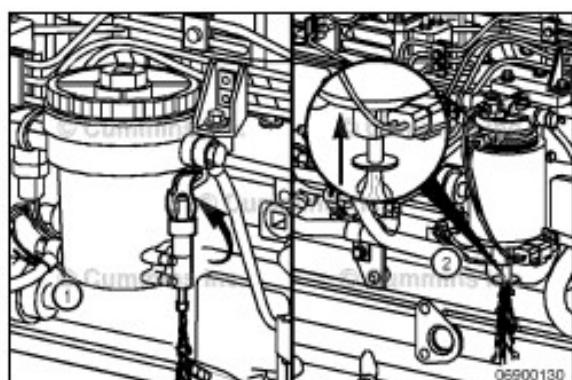
Drain the water and sediment from the separator daily.

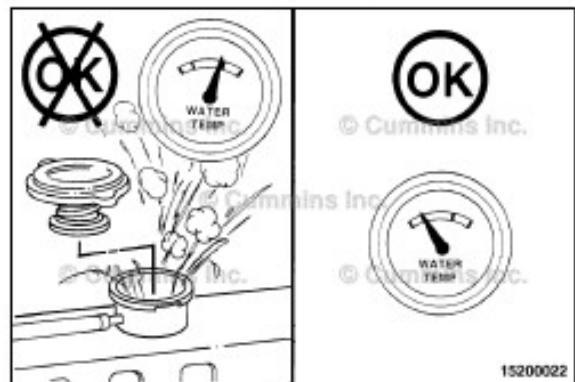
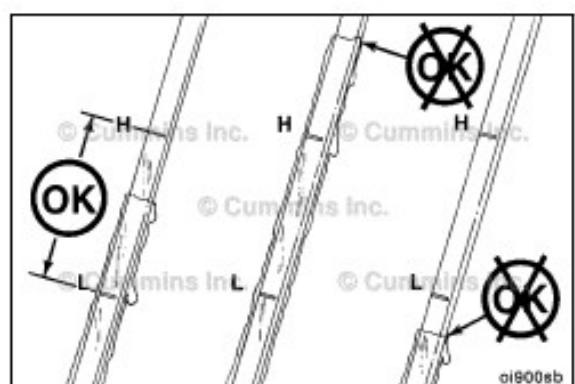
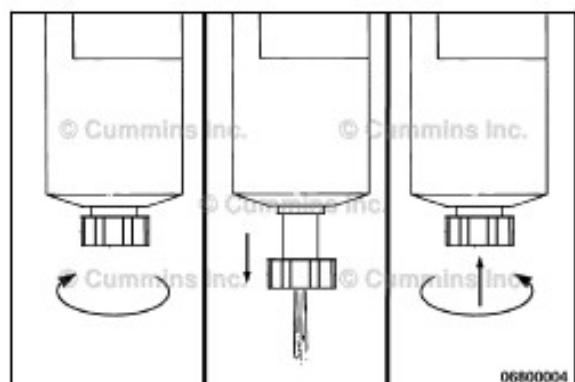
### Canister Type

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  $3\frac{1}{2}$  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



#### 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).

### 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.

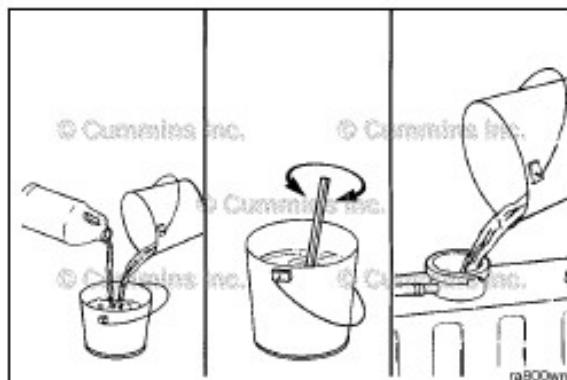
The coolant level must be checked daily.

**CAUTION**

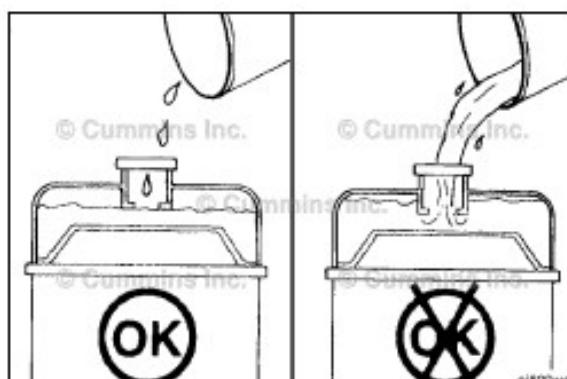
Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50°C [120°F] before adding coolant.

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).



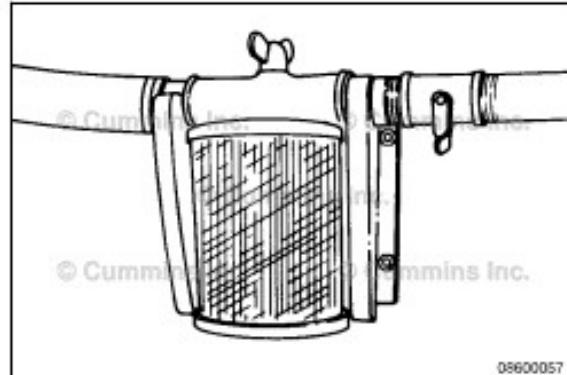
Fill the cooling system with coolant. Refer to the markings on the radiator or expansion tank for coolant levels or refer to the OEM manual.



## Sea Water Strainer General Information

### Marine Applications

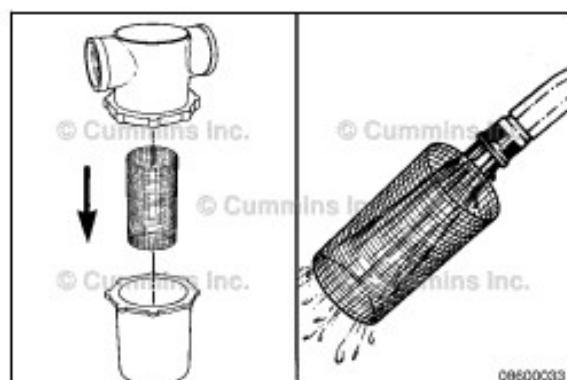
NOTE: Most sea water systems for heat exchanger cooled engines use a sea water strainer. The strainer removes debris from the sea water before it enters the sea water pump.

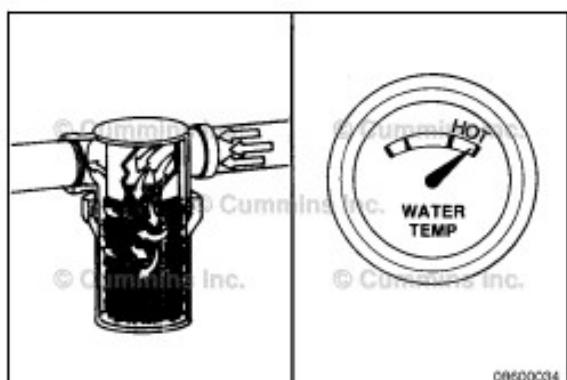


NOTE: Sea water strainer arrangements may differ.



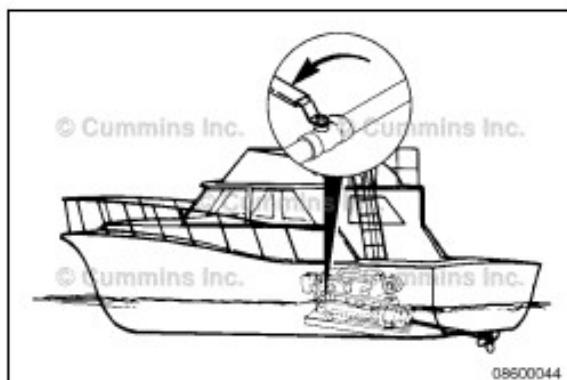
Inspect the sea water strainer daily for any foreign objects that could restrict water flow.



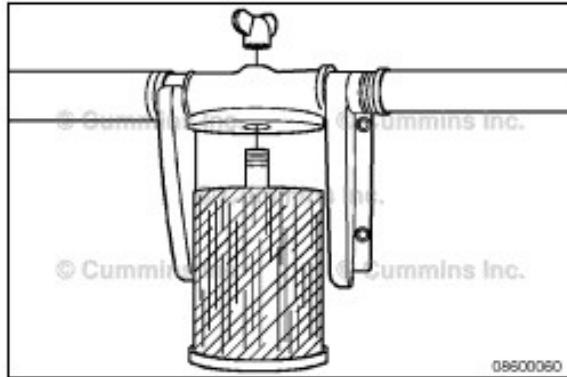


**CAUTION**  
A restricted or clogged sea water strainer can result in hotter than normal, or overheated, engine coolant and marine gear oil temperatures.

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

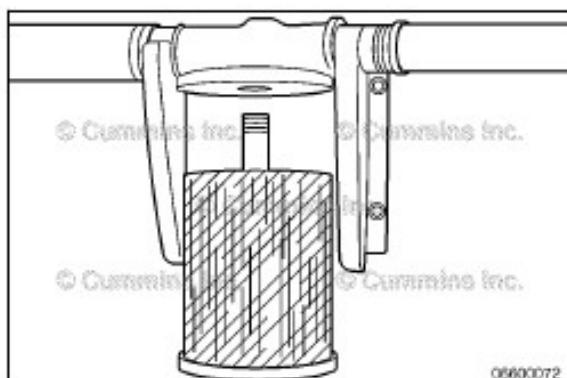


**NOTE:** If the sea water strainer is below the water level, close the sea water inlet valves before servicing the sea water strainer.



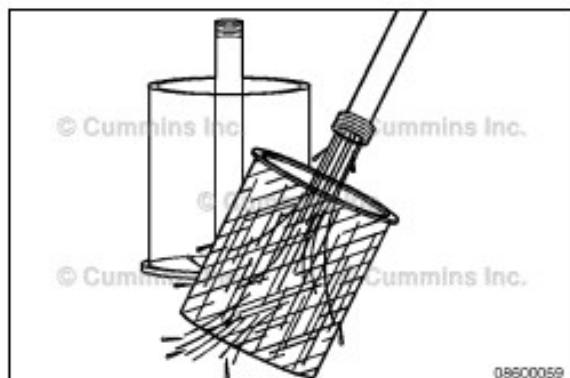
### Disassemble Marine Applications

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.

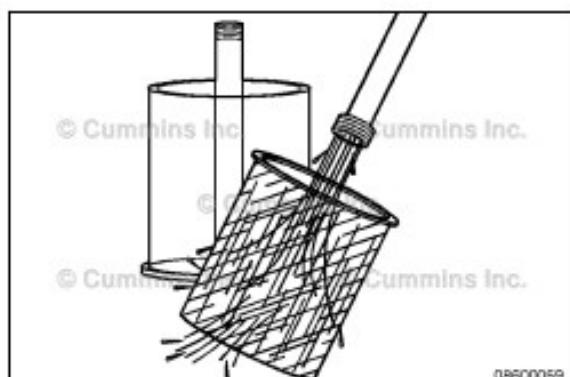
Remove the sea water strainer basket.



## Clean

### Marine Applications

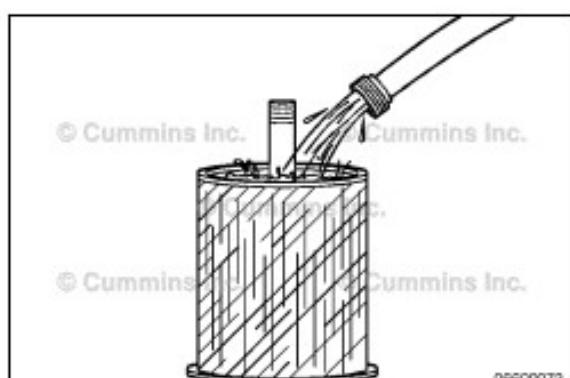
Empty all debris from the sea water strainer basket.



## Prime

### Marine Applications

Prime the sea water strainer with clean water.

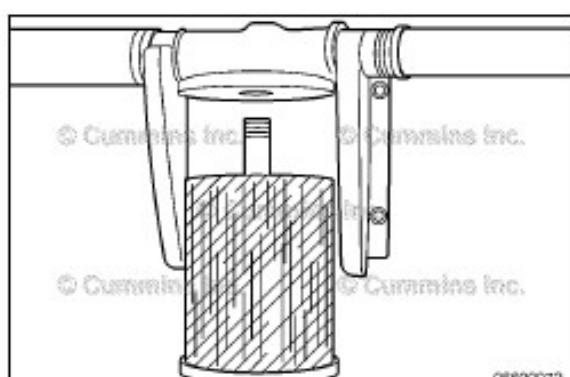


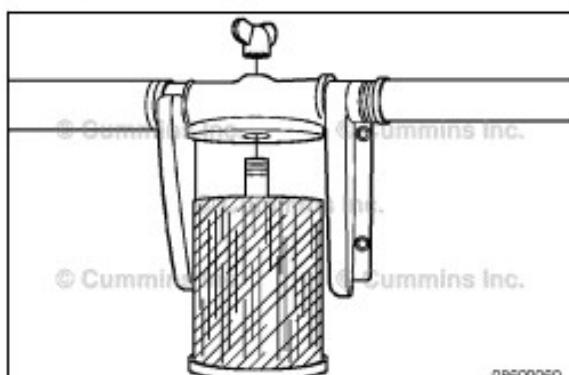
## Assemble

### Marine Applications

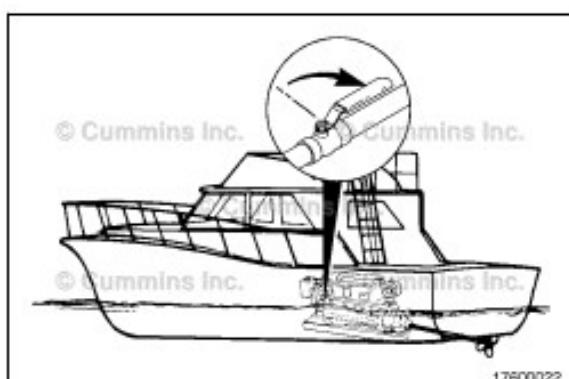
Install the sea water strainer.

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

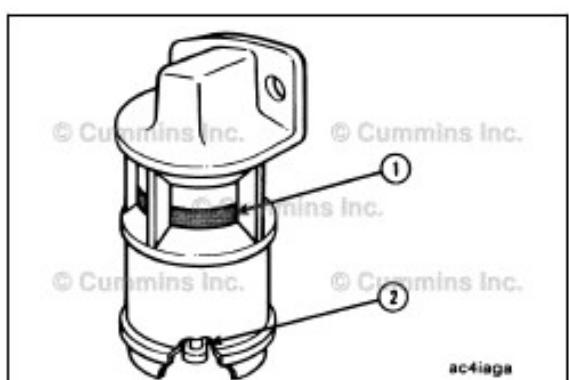




Install and tighten the wing nut(s).



Open the sea water inlet valves.



## Air Cleaner Restriction Maintenance Check Mechanical Indicator

### 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.

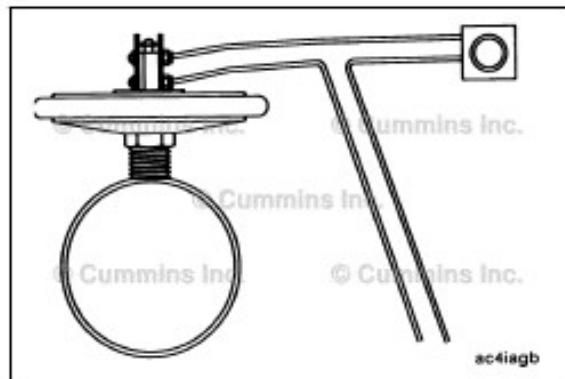
**NOTE:** Do not remove the felt washer from the indicator. The felt washer absorbs moisture.

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.

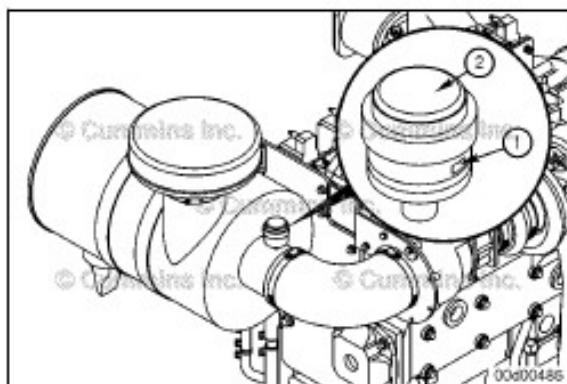
### Vacuum Indicator

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



### Industrial Gas Mechanical Indicator

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



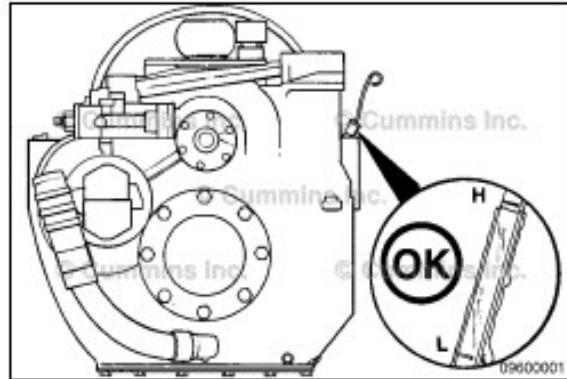
## Marine Gear Maintenance Check

### 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.



## Notes

## Section 4 - Maintenance Procedures at 250 Hours or 6 Months

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Install.....	4-10
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## Maintenance Procedures - Overview

### General Information

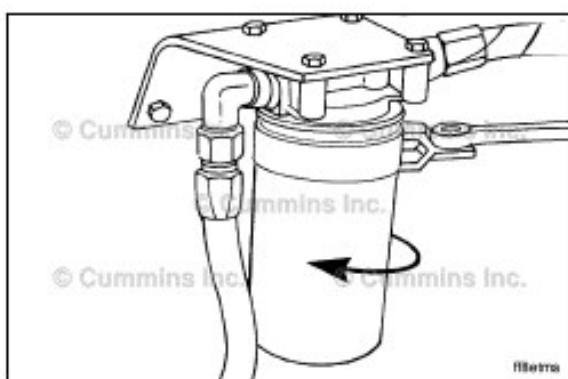
All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

## Fuel Filter (Spin-On Type)

### Remove

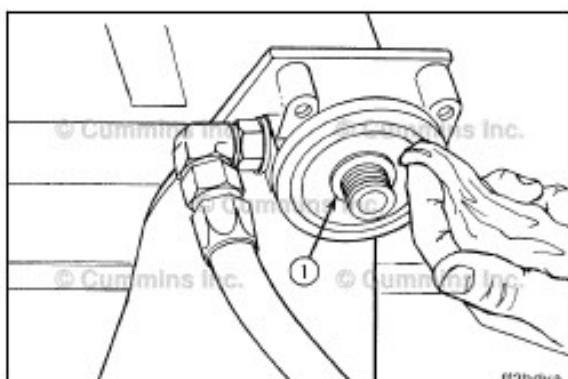
Clean the area around the fuel filter and the fuel filter head.

Remove the fuel filter with a filter wrench.



Remove the thread adapter sealing ring (1).

Use a clean, lint-free towel to clean the gasket surface on the fuel filter head.



### Install

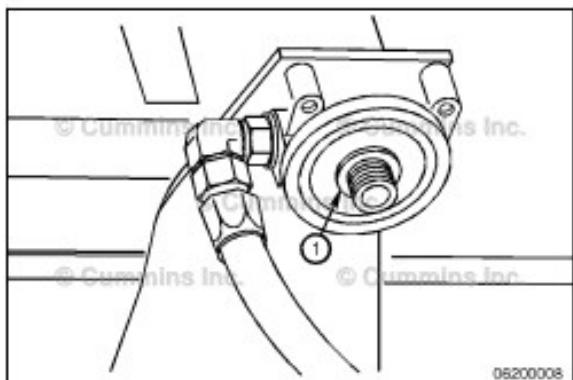
Use the correct filter(s) for your engine. Refer to Procedure 018-024 in Section V.

Clean the area around the fuel filter and the fuel filter head.

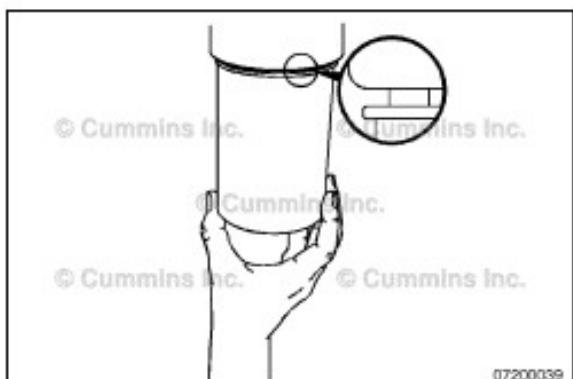
Lubricate the fuel filter gasket with clean engine oil.

Fill the new fuel filter with clean diesel fuel.





Install the new thread adapter sealing ring (1) supplied with the new filter.



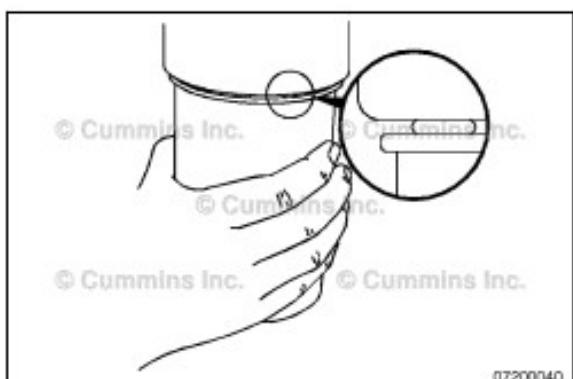
**CAUTION**  
If the filter canister is damaged in any way, do not use it. Dents or scrapes can lead to a rupture or premature failure of the filter.



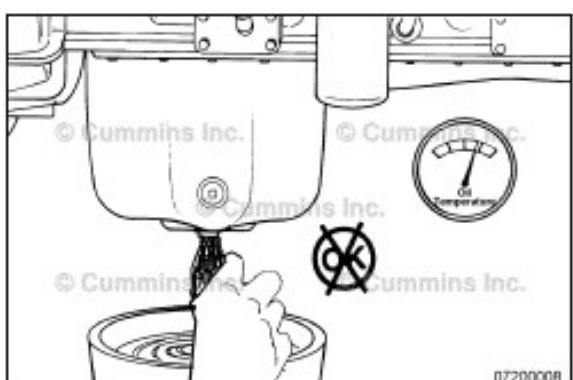
**CAUTION**  
Mechanical overtightening of the filter can distort the threads and damage the fuel filter seal.

Install the filter on the filter head.

Turn the filter until the gasket contacts the filter head surface.



Tighten the filter, by hand, an additional  $\frac{1}{2}$  to  $\frac{3}{4}$  of a turn after the gasket contacts the filter head surface, or as specified by the filter manufacturer.



## Lubricating Oil and Filters Drain



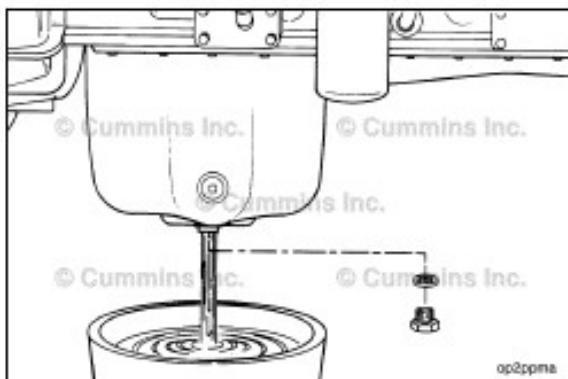
**WARNING**  
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused dispose of in accordance with local environmental regulations.



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

Operate the engine until the water temperature reaches 60°C [140°F]. Shut off the engine. Remove the oil drain plug from the bottom of the lubricating oil pan. Do not remove the plugs on either side of the oil pan to drain the oil. They will not allow the oil to drain completely.

**NOTE:** Do not remove the plugs on either side of the oil pan to drain the oil. They will not allow the oil to drain completely.

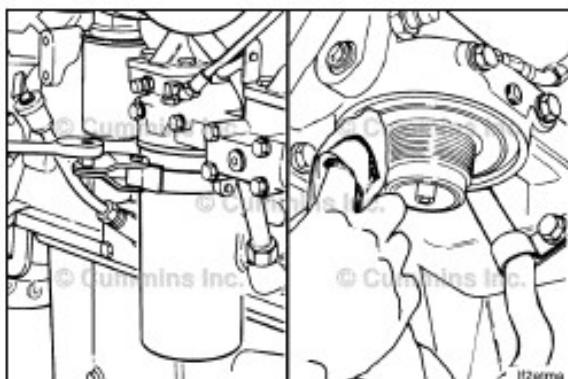


Clean the area around the lubricating oil filter head.

Use oil filter wrench, Part Number 3375049, to remove the oil filter(s).

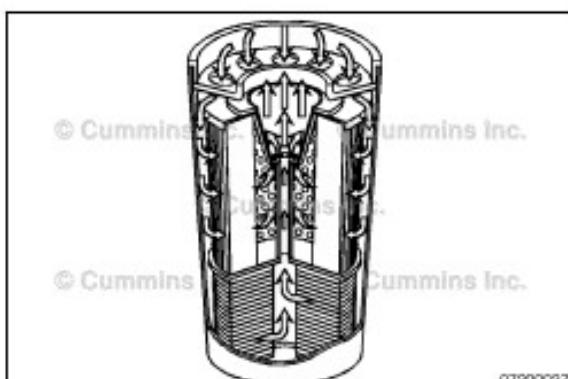


Clean the gasket surface of the oil filter head. The o-ring can stick on the filter head; make sure it is removed.



## Fill

Use the correct oil filter for your engine. Refer to Procedure 102-002 in Section 2.



### △ CAUTION △

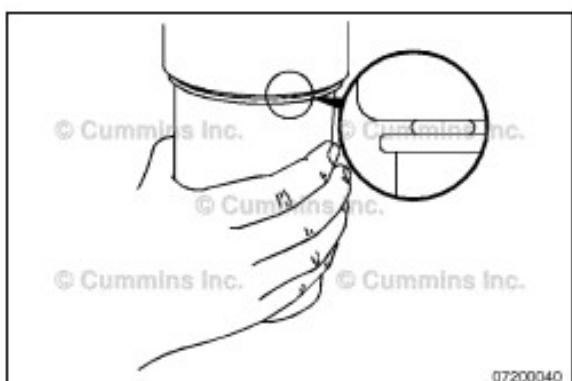
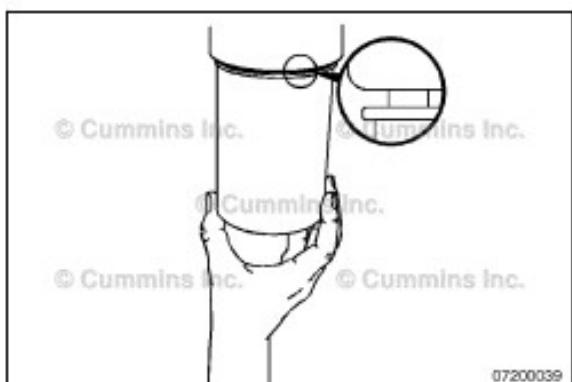
If the filter canister is damaged in any way, do not use it. Dents or scrapes can lead to a rupture or premature failure of the filter.

### △ CAUTION △

Lack of lubrication during start-up is harmful to the engine.

Fill the new oil filter(s) with clean engine oil.

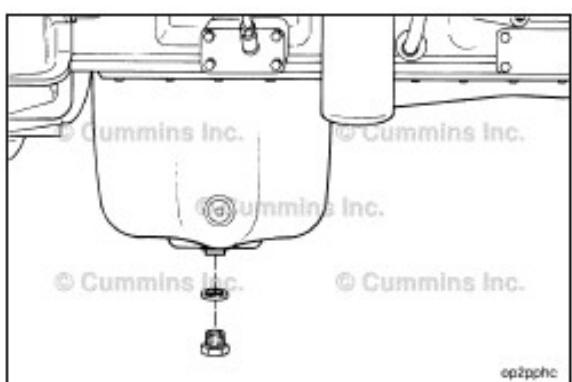




**CAUTION**  
Mechanical overtightening of the filter can distort the threads or damage the filter element seal.

Install the new oil filter on the filter head.

Turn the filter until the gasket contacts the filter head surface.



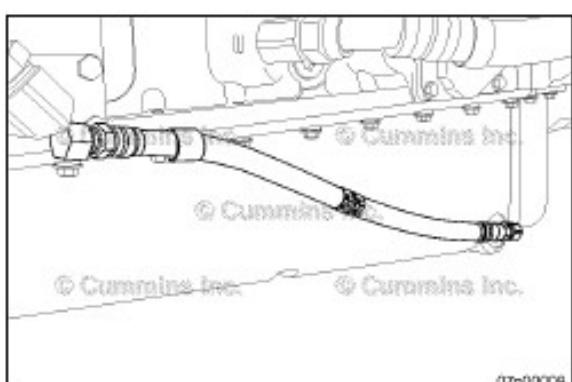
Clean and check the oil drain plug threads and the seal surface.



Install the oil drain plug in the lubricating oil pan.



**Torque Value:** 88 N·m [ 65 ft-lb ]

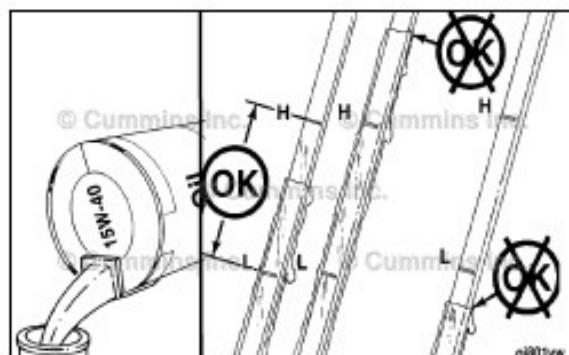


If a remote drain hose has been provided, and a change oil pump used, disconnect the hose from the pump and install the cap onto the end of the hose and secure the hose to the side of the lubricating oil pn using the clips that are provided.

Use a high-quality multiviscosity oil such as Valvoline® Premium Blue™, Valvoline® Premium Blue™ 2000, or equivalent. Choose the correct oil for a specific operating climate. Refer to Procedure 018-003 Section V.

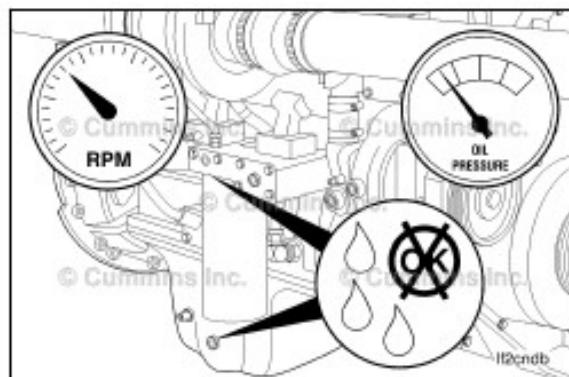


Fill the engine with clean oil to the H (high) mark on the dipstick. For total system capacity including filter, Refer to Procedure 018-017 in Section V.



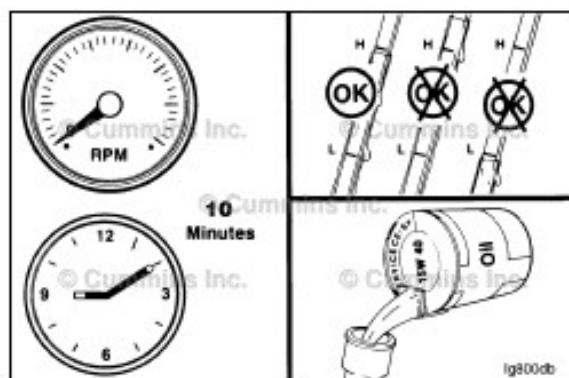
**CAUTION**  
Engine oil pressure must be indicated on the gauge within 15 seconds after starting. If oil pressure is not registered within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm the correct oil level is in the oil pan.

Operate the engine at idle speed to inspect for leaks at the filter and the drain plugs.



Shut off the engine. Wait approximately 10 minutes for the oil to drain back from the upper parts of the engine to the oil pan.

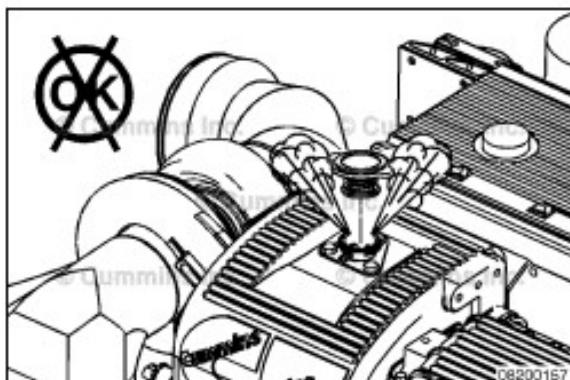
Check the oil level again. Add oil as necessary to bring the level up to the "H" (high) mark on the dipstick.





## Coolant Filter Remove

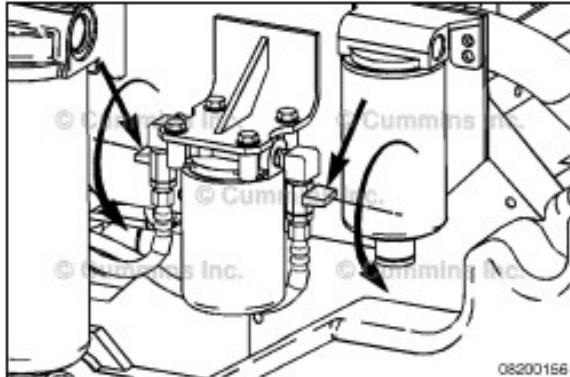
The correct coolant filter to be used is determined by the total cooling system capacity and other operational factors. Refer to Procedure 018-004 in Section V for the correct filter for your engine.



### ▲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 cooling system pressure cap.



Turn the valve on the coolant filter head to the OFF position.

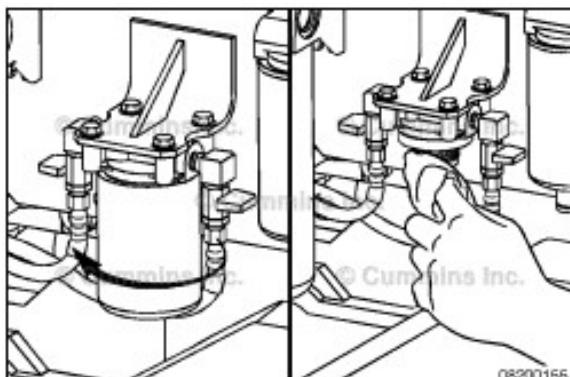


### ▲WARNING▲

A small amount of coolant can leak when servicing the coolant filter with the shutoff valve in the OFF position. To reduce the possibility of personal injury, avoid contact with hot coolant.

Remove and discard the coolant filter.

Using a lint free cloth, clean the coolant filter head gasket's surface.



## Install

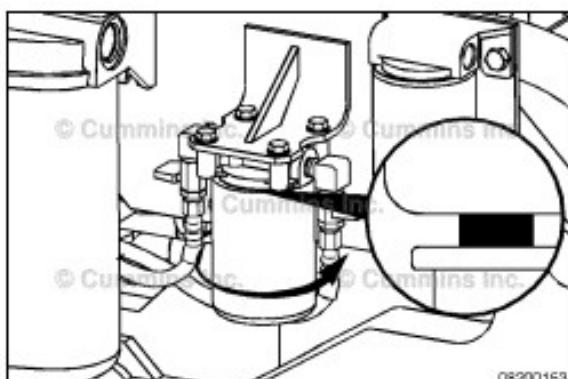
### CAUTION

If the filter canister is damaged in any way, do not use it. Dents or scrapes can lead to a rupture or premature failure of the filter.

Apply a thin film of clean engine oil to the gasket sealing surface before installing the new coolant filter.



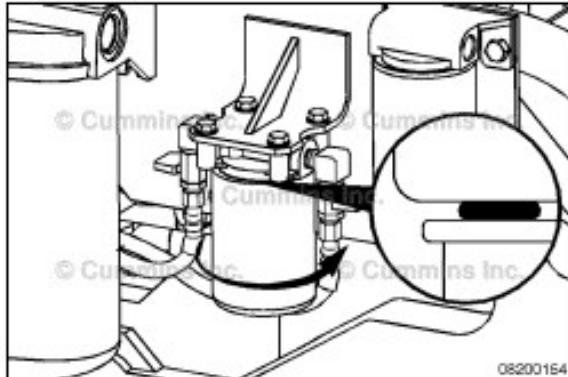
Install the new filter on the filter head. Tighten the filter until the gasket contacts the filter head surface.



### CAUTION

Mechanical overtightening can distort the filter threads or damage the filter head.

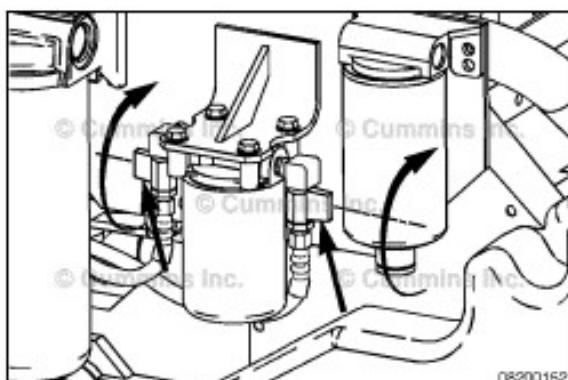
Tighten the filter an additional  $\frac{1}{2}$  to  $\frac{3}{4}$  of a turn, or as specified by the filter manufacturer.

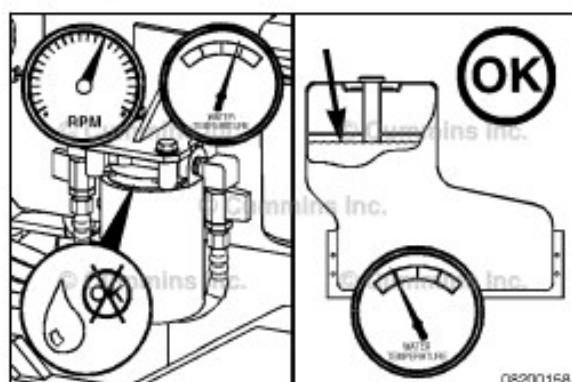


### CAUTION

The valve(s) must be in the ON position to reduce the possibility of engine damage.

Turn the valve on the filter head to the ON position, and install the coolant system pressure cap.





Operate the engine and check for leaks.

After the air has been purged from the system, check the coolant level again.



## Supplemental Coolant Additive (SCA) and Antifreeze Concentration Maintenance Check

### Supplemental Coolant Additive (SCA)

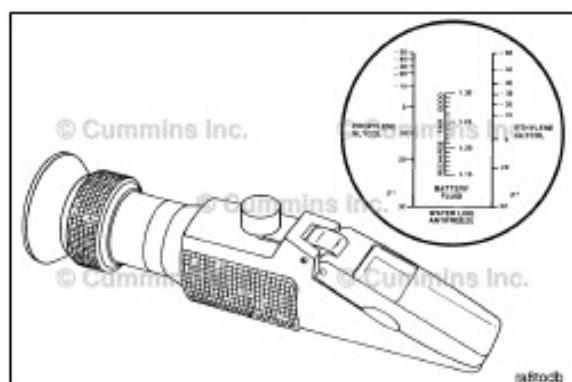
#### CAUTION

Failing to maintain the required SCA concentration level can cause engine damage.

#### 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. Use the 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.

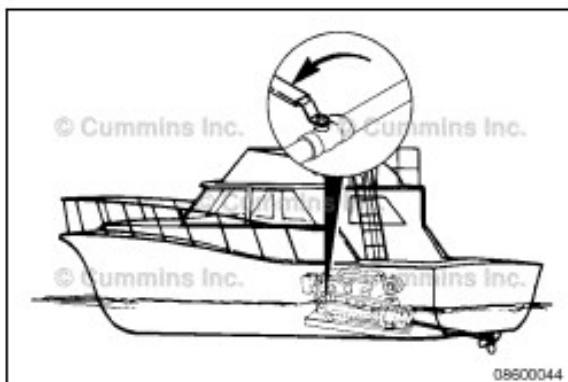
The corrosion inhibitors also protect the cooling system components from corrosion and prolong component life.

## Zinc Anode

### Remove

#### Marine Applications

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



08600044

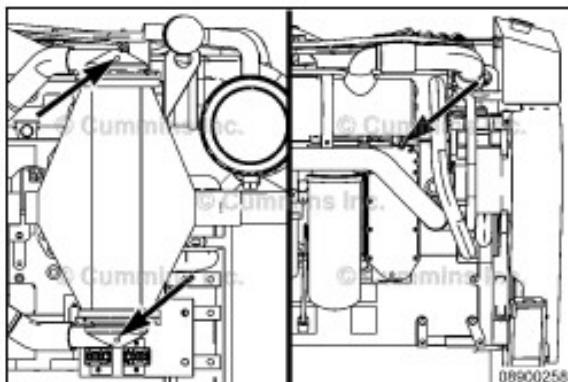
### CAUTION

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).

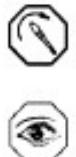
NOTE: The illustration shown is generic. For engine-specific locations, see to Section E.



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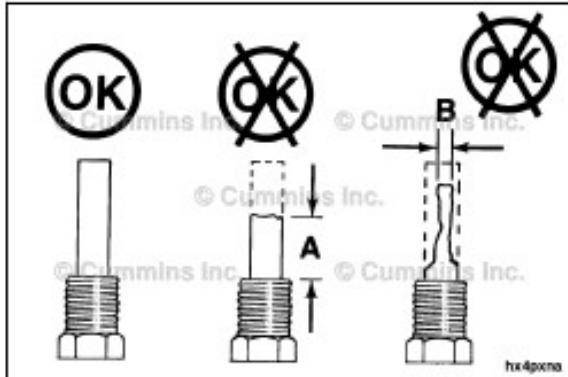
## Inspect for Reuse

#### 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.

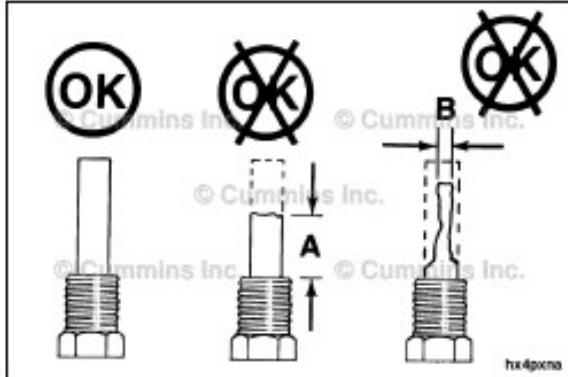


hx4pxna

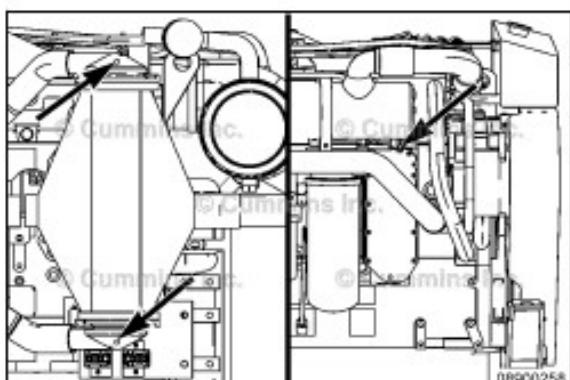
### Zinc Plug Erosion Limits

	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.



hx4pxna



## Install

### Marine Applications

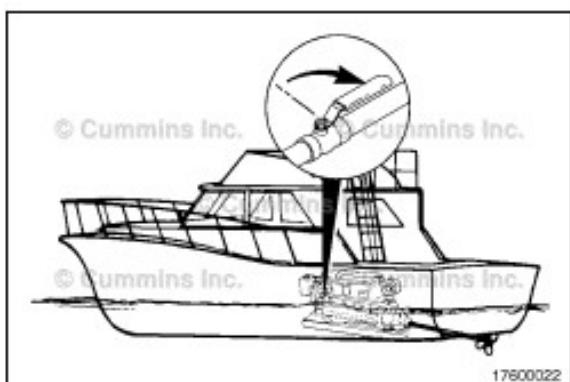
Install and tighten the zinc plug(s).



**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.

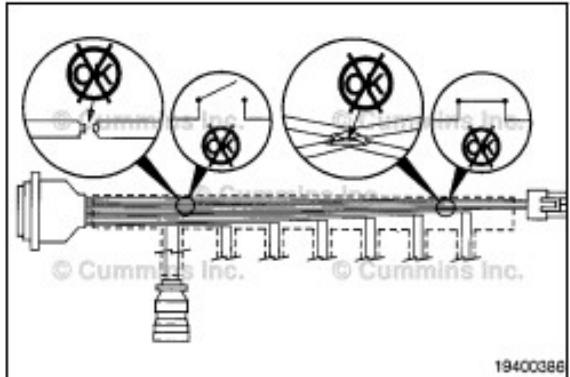
### Torque Value:

1/4-inch Plug	12 N·m	[ 9 ft-lb ]
3/8-inch Plug	22 N·m	[ 17 ft-lb ]
1/2-inch Plug	30 N·m	[ 22 ft-lb ]



Open the sea water valve on the vessel hull.

Operate the engine and check for leaks.



## Engine Wiring Harness Maintenance Check

### WARNING

Never touch any wiring connection when the keyswitch is in the ON position. An electrical shock or personal injury can result.

Inspect all wiring connections and wiring harnesses for damage. Damage to the wiring can cause improper engine operation and poor performance.

## Section 5 - Maintenance Procedures at 600 Hours or 1 Year

### Section Contents

	Page
Crankcase Ventilation Filter .....	.5-6
Initial Check.....	.5-6
Install.....	.5-7
Remove.....	.5-6
Maintenance Procedures - Overview .....	.5-1
General Information.....	.5-1
Overhead Set .....	.5-1
Adjust.....	.5-1

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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

### Adjust

#### General Information

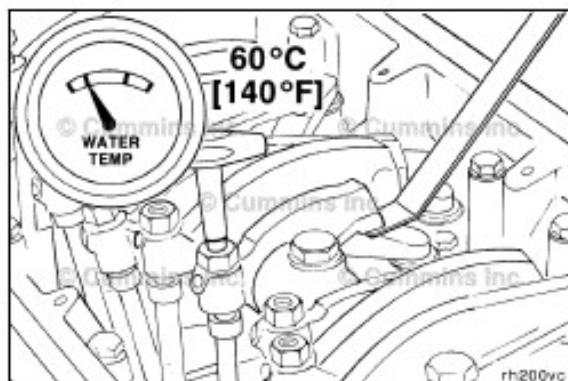
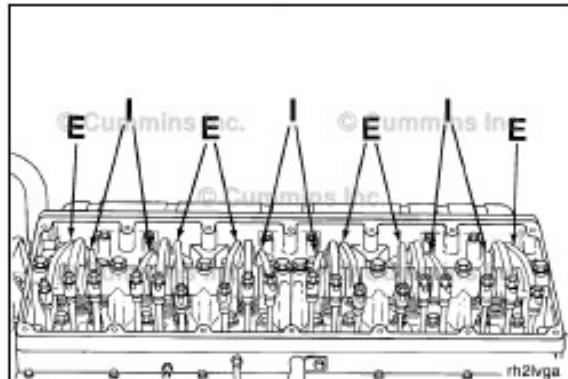
The valves and injectors **must** be correctly adjusted for the engine to operate efficiently. Valve and injector adjustment **must** be done using the values listed in this section. The accompanying table gives the adjustment specifications.

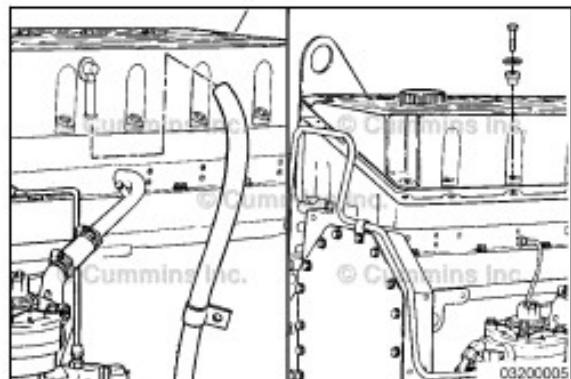
**NOTE:** If the valves and injectors have been adjusted during troubleshooting or before the 600 hour scheduled interval, adjustment is **not** required at this time.

Valve Lash Specifications

	mm	in
Intake Valve	0.36	MIN
Exhaust Valve	0.69	MIN

All valve and injector adjustments **must** be made when the engine is cold (stabilized coolant temperature at 60°C [140°F] or below).

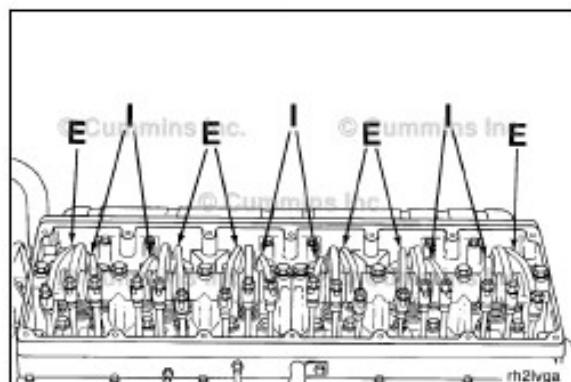




Remove the crankcase breather tube from the crankcase breather outlet.

Remove the 16 capscrews, isolators, and spacers from the rocker lever cover.

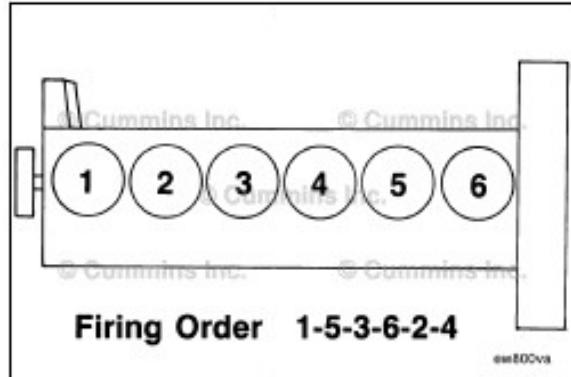
Remove the rocker lever cover and gasket.



Each cylinder has three rocker levers:

- The long rocker lever (E) is the exhaust lever.
- The center rocker lever is the injector lever.
- The short rocker lever (I) is the intake lever.

Refer to the accompanying figure for the intake and exhaust valve rocker lever locations.



The cylinders are numbered from the front gear housing end of the engine.

The crankshaft rotation is clockwise when viewed from the front of the engine.

The engine firing order is 1-5-3-6-2-4.

See the example before attempting to begin the adjusting procedure.

The valves and injectors on the same cylinders are adjusted at the same index mark on the accessory drive pulley.

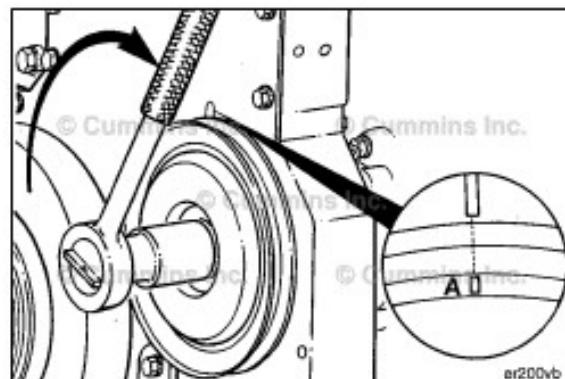
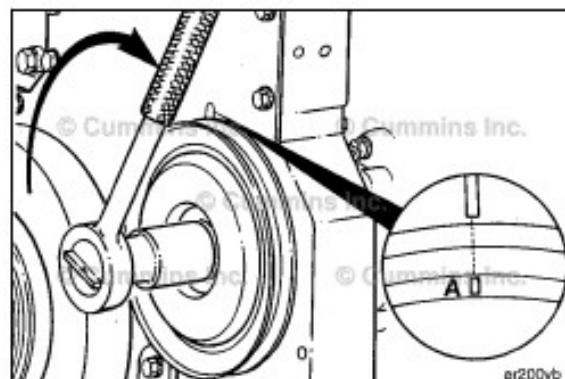
One pair of valves and one injector are adjusted at each pulley index mark before rotating the accessory drive to the next index mark.

Two crankshaft revolutions are required to adjust all the valves and injectors.

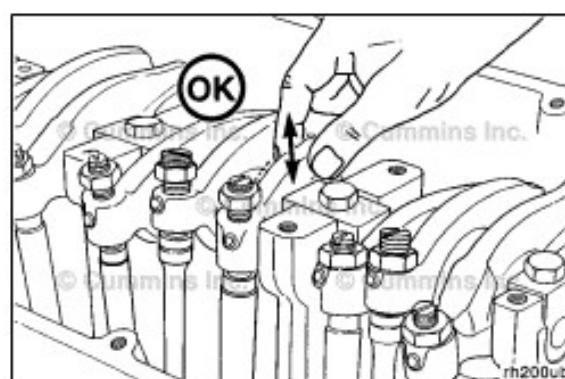
Injector and Valve Measurement Sequence				
Bar engine in direction of rotation	Pulley position	Set Cylinder		
		Inject or	Valve	
Start	A	1	1	
Advance to	B	5	5	
Advance to	C	3	3	
Advance to	A	6	6	
Advance to	B	2	2	
Advance to	C	4	4	
Firing Order: 1-5-3-6-2-4				

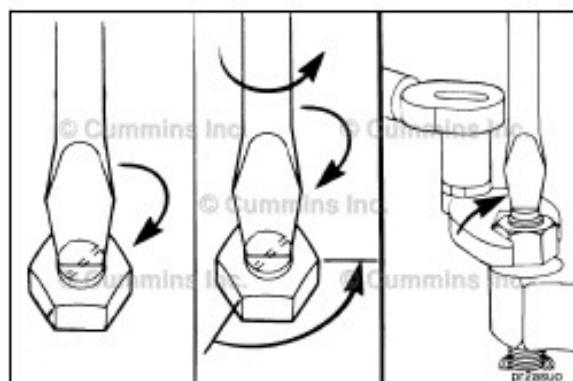
The adjustment can begin on any valve set mark. In the following example, the adjustment will begin on the "A" valve set mark with cylinder number 1 valves closed and ready for adjustment.

Rotate the accessory drive clockwise until the "A" valve set mark on the accessory drive pulley is aligned with the pointer on the gear cover.



When the "A" mark is aligned with the pointer, the intake and exhaust valves for cylinder Number 1 must be closed. If these conditions are not correct, cylinder number 6 injector and valves must be ready to set. Set the injector and valves on the cylinder so that both the intake and exhaust valve rocker lever arms are loose and can be moved from side-to-side.





### Injectors

Loosen the injector adjusting screw locknut.

Using a screwdriver and the adjusting screw, bottom the injector plunger three or four times to remove any fuel in the injector.

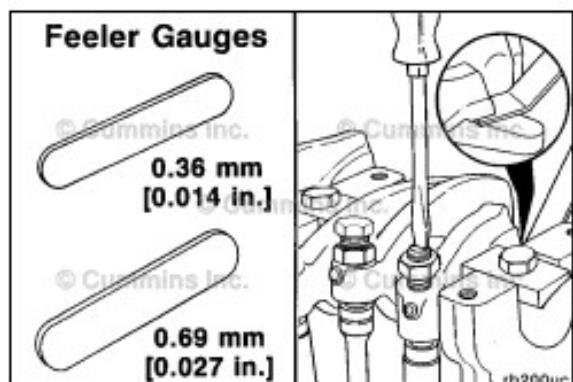
Turn the adjusting screw in until it just bottoms the plunger.

**NOTE:** Do not use excessive force when bottoming the plunger.

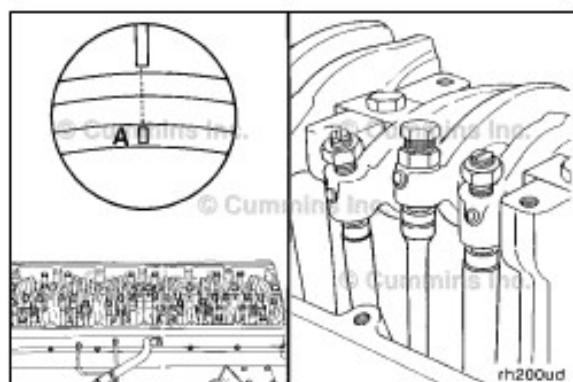
Back out the adjusting screw two flats, 120 degrees.

Hold the adjusting screw, and tighten the locknut.

**Torque Value:** 61 N·m [ 45 ft-lb ]

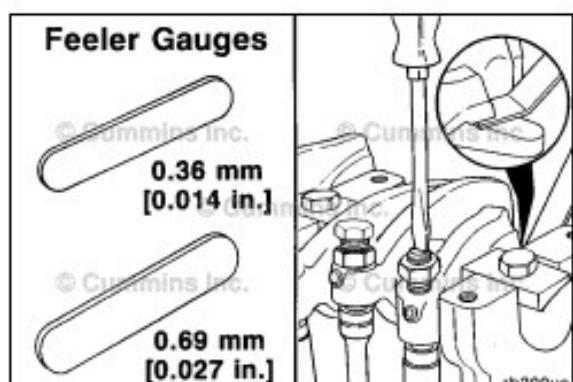


After setting the injector, set the valves on the same cylinder.



### Valves

With the "A" valve set mark aligned with the pointer on the gear cover and both valves closed on the cylinder to be adjusted, loosen the adjusting screw locknuts on the intake and exhaust valves.



Select a feeler gauge for the correct valve lash specification.

Valve Lash Specifications			
	mm	in	
Intake Valve	0.36	MIN	0.014
Exhaust Valve	0.69	MIN	0.027

Insert the feeler gauge between the top of the crosshead and the rocker lever pad.

Two different methods for establishing valve lash clearance are described below. Either method can be used; however, the torque wrench method has proven to be the most consistent. It eliminates the need to feel the drag on the feeler gauge.

- **Torque Wrench Method:** Insert the correct feeler gauge. Use an inch-pound torque wrench, Part Number 3376592, normally used to set preload on top-stop injectors, and tighten the adjusting screw.

**Torque Value:** 0.7 N·m [ 6 in-lb ]

- **Touch Method:** Tighten the adjusting screw until a slight drag is felt on the feeler gauge.

Hold the adjusting screw in the position shown. The adjusting screw **must not** turn when the locknut is tightened.

**Torque Value:**

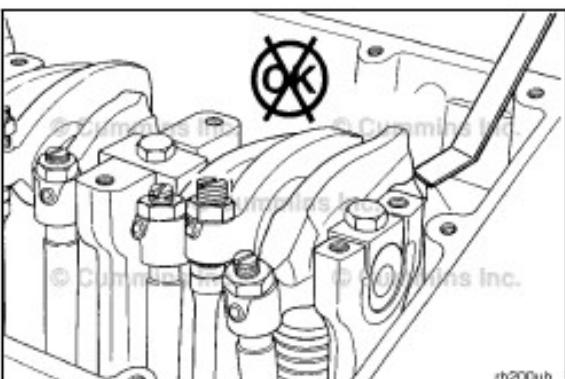
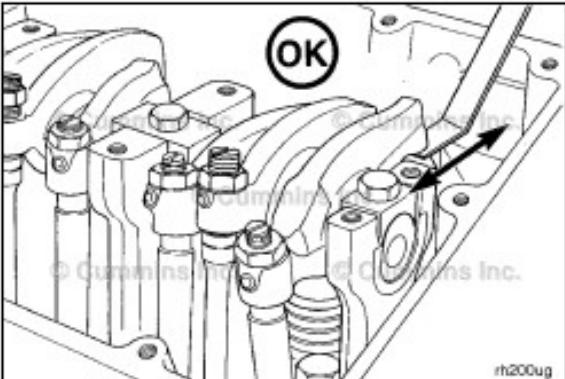
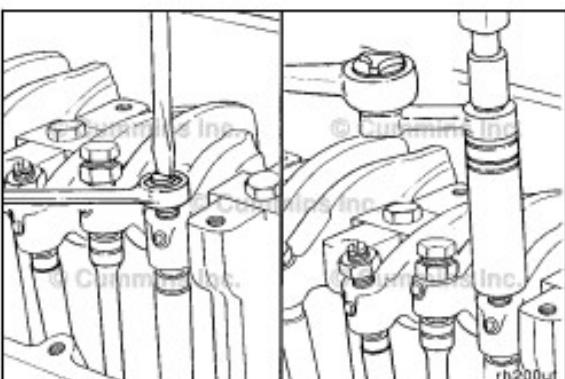
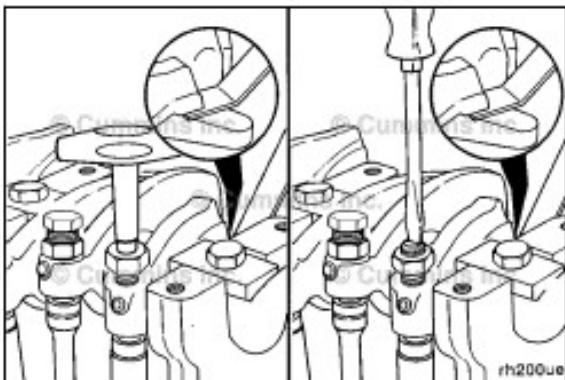
Without torque wrench adapter:

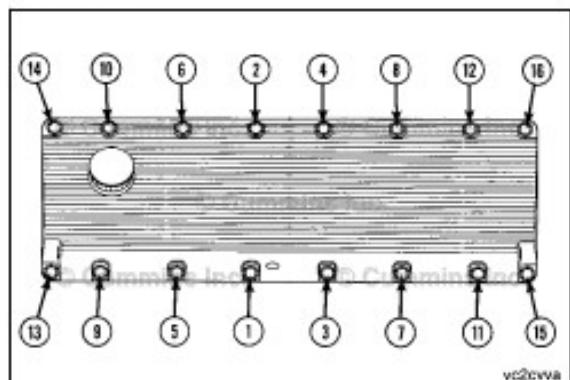
Step 1      61 N·m      [ 45 ft-lb ]

**Torque Value:**

With torque wrench adapter, Part Number 3163196:

Step 1      47 N·m      [ 35 ft-lb ]





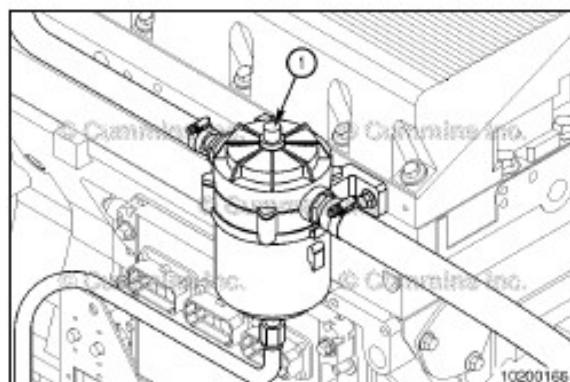
Install the cover on the rocker lever housing.

Install the 16 isolators, spacers, and capscrews in the cover.



Tighten the capscrews in the sequence shown.

**Torque Value:** 15 N·m [ 130 in-lb ]

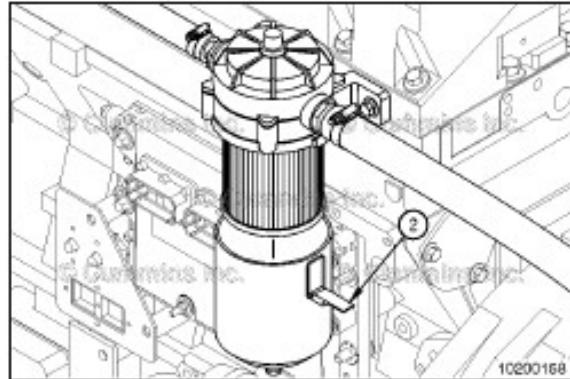


## Crankcase Ventilation Filter Initial Check

If the filter becomes clogged before the normal service interval, the added pressure will cause the filter service indicator (1) to appear.

To reset the indicator, unscrew the clear cover and push the indicator down.

Replace the cover.



## Remove

### ⚠ 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.

### ⚠ CAUTION ⚠

It is recommended that all service be performed with the engine shut down.

Identify a place to set the canister without spilling any oil remaining in it.

Use shop towels to clean up any oil that drips from the canister or filter.

Hold onto the canister and release the four latches (2) which hold the canister to the filter head assembly.

Pull the canister down, being careful not to spill any oil remaining in the bottom of the canister.

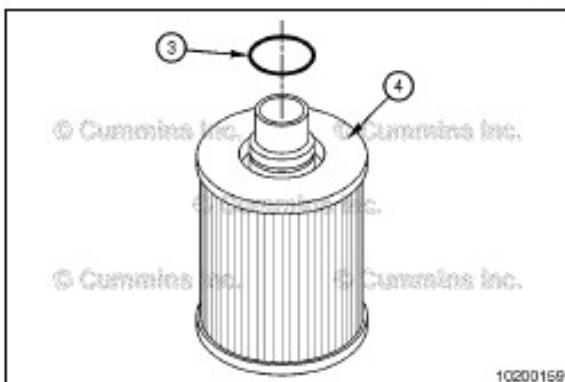
Set the canister in the place identified earlier.

Pull down on the filter to remove it. Make sure the o-ring (3) on the top of the end cap is removed with the filter. Dispose of the filter.

Remove the o-ring from the bottom of the head assembly, if a new o-ring is available.

## Install

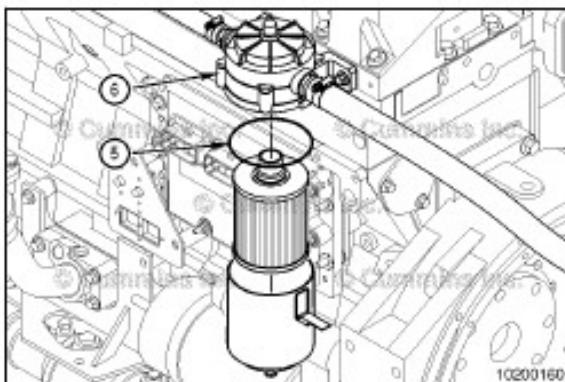
Make sure there is a new o-ring (3) on the end cap of the new element (4).



Install a new o-ring (5) onto the bottom of the head assembly (6), as needed.



Install the new element pushing the end cap into the hole in the bottom of the head assembly (6).



Install the canister on the bottom of the head assembly.

Align the latches.

Hook the four latches and snap closed.

## Notes

## Section 6 - 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.

## Engine Steam Cleaning

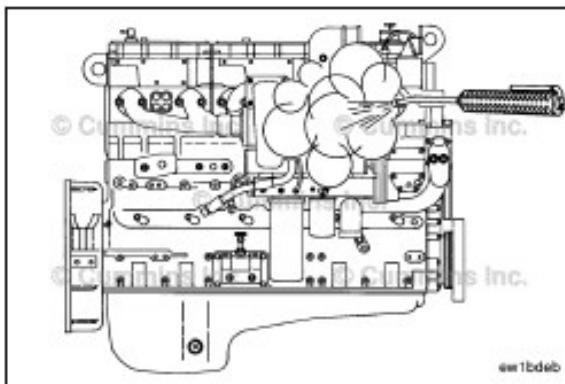
### Clean



**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.



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## Sea Water Pump

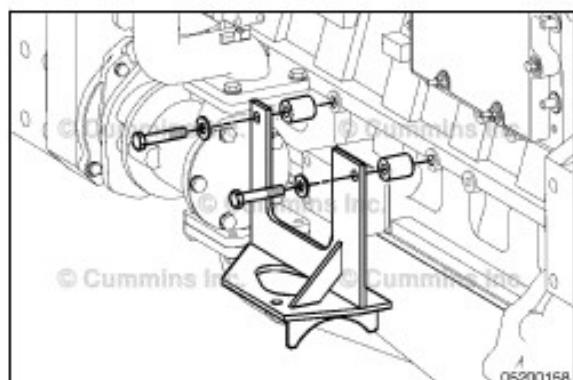
### General Information

#### Marine Applications

The engine uses a vane-type, positive displacement, self-priming sea water pump.



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## Preparatory Steps

### CAUTION

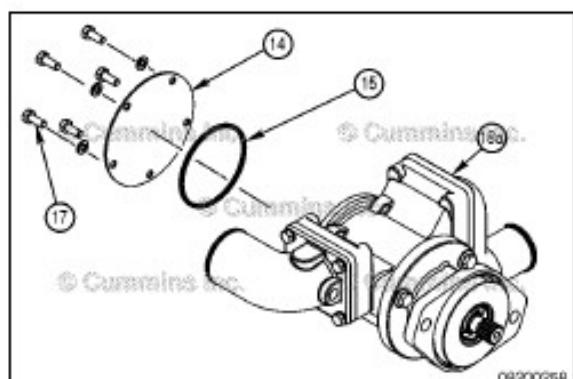
Do not spill or drain fuel into the bilge area when disconnecting or removing fuel lines, replacing filters, and priming the fuel system. Do not drop or throw filter elements into the bilge area. The fuel and fuel filters must be disposed of in accordance with local environmental regulations

- Shut off the sea water inlet valves.
- Shut off the fuel supply and return valves (if a major kit repair is planned).
- Remove the fuel cooler (if a major kit repair is planned).
- Remove the fuel cooler mounting bracket for access to the sea water pump cover.



## Remove

If a major kit repair is being performed, remove the sea water pump.



## Disassemble

### Marine Applications

If a minor kit repair is being performed, remove the cover plate.

Remove the five capscrews (17) and the washers and the cover (14) from the sea water pump.

Remove and discard the quad-ring (15).

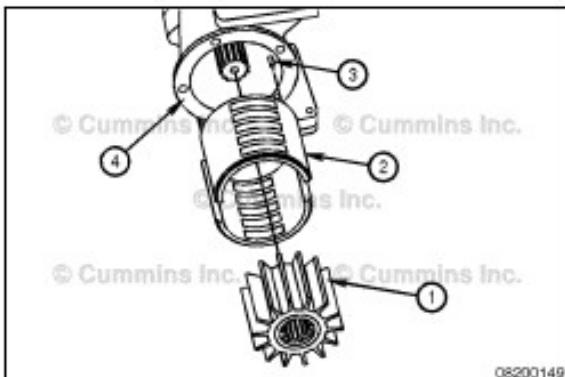
**CAUTION**

Do not pry against the cam liner to remove the impeller as this will break the cam liner.

NOTE: The two-piece cam liner will separate when removed. Do not drop the cam liner.

Check the direction of the impeller blades to make sure the impeller is properly installed at assembly.

Remove the impeller (1), two-piece cam liner (2), and pin (3) from the sea water pump (4).

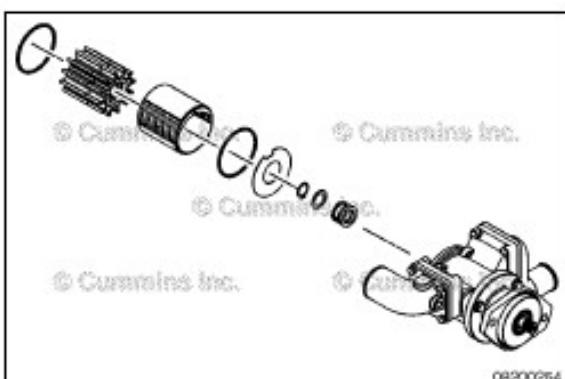


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Remove the second quad ring and wearplate.



Remove the retaining ring from the shaft. Slide the washer and mechanical seal off of the shaft.



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Remove the bolts holding the body to the housing.



Slide the housing off of the shaft and body assembly.



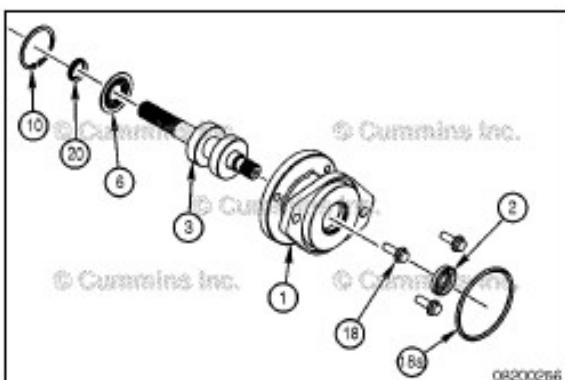
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## Assemble

### Marine Applications



Press the lip seal (2) into the pump body (1) with the backing ring of the lip seal toward the main pump housing.



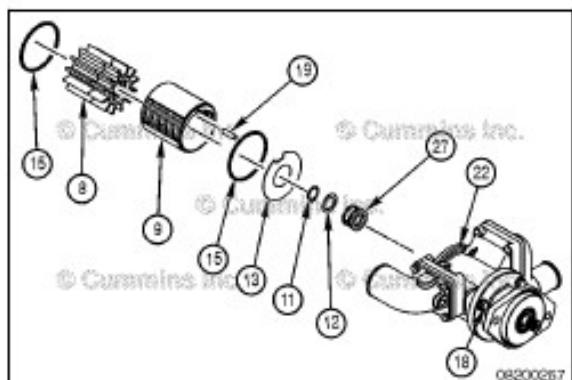
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Align the lip seal so that it is uniformly pressed in the pump body. Press the shaft and bearing assembly (3) into the pump body (1).

Slide the bearing shield (6) into the pump body and against the inner bearing.

Place the V-ring (20) on the shaft against the bearing shield, with the open end of the V-ring toward the bearing assembly.

Use snap ring pliers to install the retaining ring (10) into the body.



### CAUTION

Do not use petroleum based lubricant. A petroleum based lubricant will cause damage to the impeller.

**NOTE:** Grease can be used to hold the pin in place during installation.

Press the mechanical seal (27) into the housing with the white ceramic seal face toward the impeller.

Lubricate the outside of the seat boot with a water-soluble lubricant or soapy water for easier assembly.

Slide the housing (22) over the shaft and body assembly.

Install the three bolts (18).

**Torque Value:** 34 N·m [ 25 ft-lb ]

Install the washer (12) onto the shaft and use snap ring pliers to install the retaining ring (11) into the groove in the shaft (3) to compress the mechanical seal.

Install the wearplate (13) with the hole in the plate lined up with the slot in the housing.

Install the quad ring (15) into the housing on top of the wearplate.

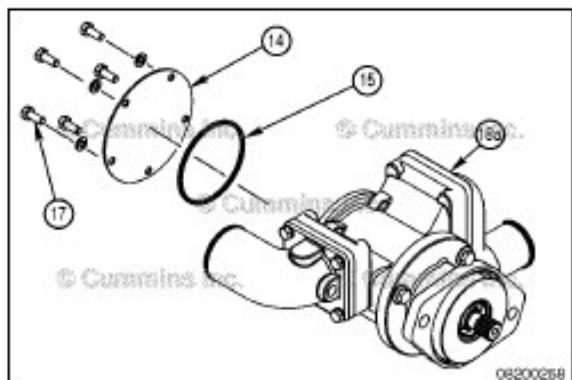
Assemble the cam halves (9) together and install the pin (19) into the cam liner.

Place the cam assembly into the housing, align the pin with the slot in the housing.

Insert the impeller (8) in the housing (22) using a twisting motion.

Make sure the impeller blades are in the same orientation as when removed.

Apply a silicon lubricant to aid in the installation of the impeller.



Insert the remaining quad ring (15) into the groove.

Install the cover (14) onto the housing (18a).

Install bolts (17).

**Torque Value:** 11 N·m [ 96 in-lb ]

Install the front flange sealing o-ring onto the pump body.

## Install

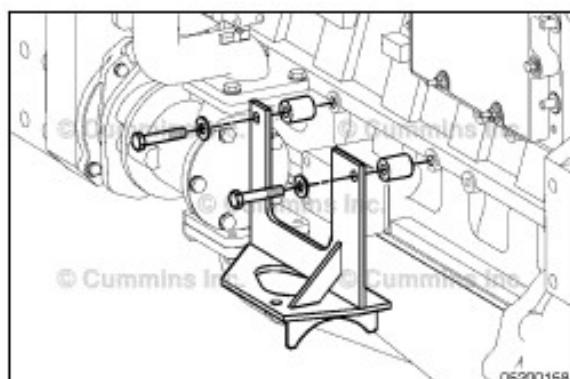
If a major kit repair was performed, install the sea water pump.



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## Finishing Steps

- Install the fuel cooler mounting bracket.
- Install the fuel cooler (if a major repair kit was installed).
- Open the fuel supply and return valves (if the fuel cooler was removed).
- Open the sea water inlet valve.
- Operate the engine and check for leaks.



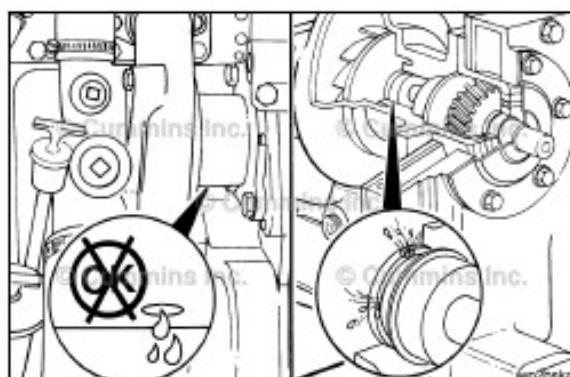
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## Water Pump Maintenance Check

A streak or chemical buildup at the weep hole is not justification for water pump replacement.

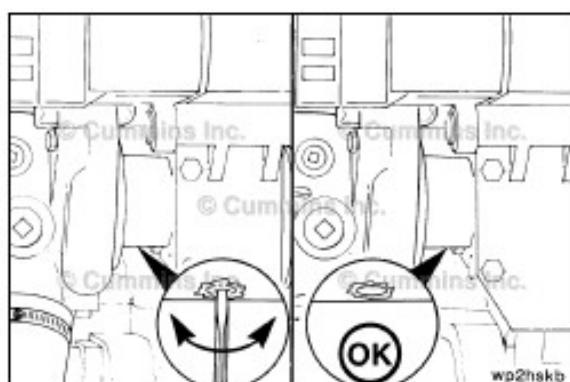


If a steady flow or drip of coolant or oil is observed at the weep hole, replace the water pump with a new or rebuilt unit. Reference the Remove and Install sections of this procedure.

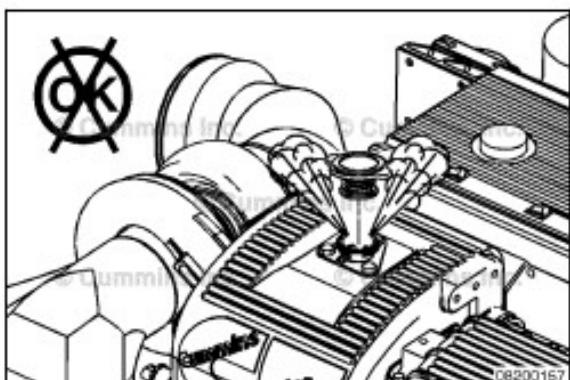


A small screwdriver or similar tool can be used to remove any debris.

Make sure the weep hole is open.



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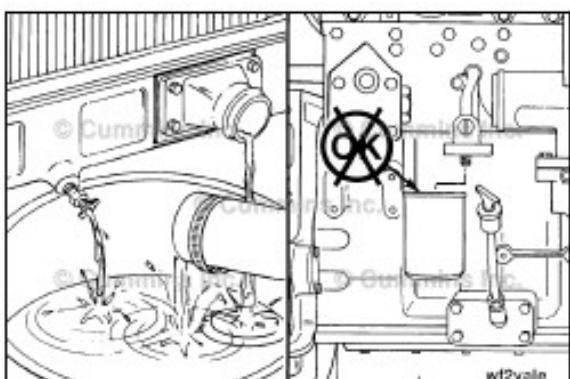


## Remove

### 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.

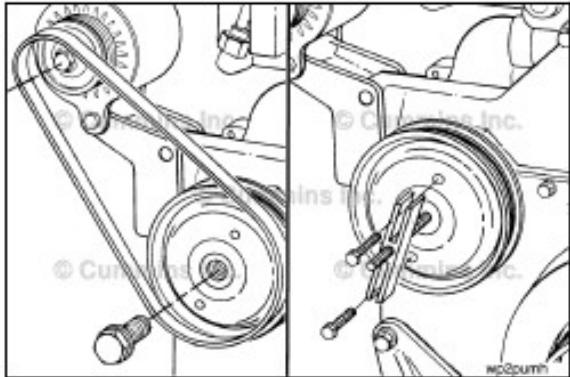
Remove the pressure cap when the engine is cool.



### WARNING

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

Drain the cooling system. Refer to Procedure 008-018 in Section 7.

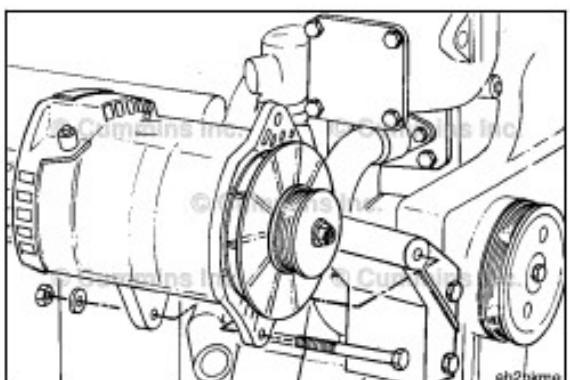


**NOTE:** Make sure the pulley capscrews are threaded all the way through the pulley before applying pressure to the pulley screw.

Remove the alternator drive belt. Refer to Procedure 013-005 in Section A.

Remove the water pump pulley retaining capscrew.

Use the standard pulley puller, Part Number ST-647, or equivalent, and two 5/16 x 18 x 2 capscrews to remove the pulley.



Remove the alternator. Refer to a Cummins® Authorized Repair Location.

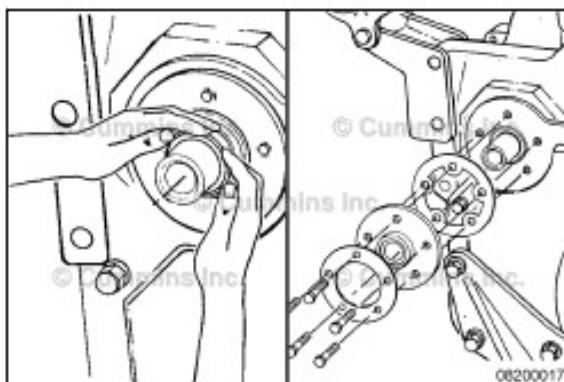
NOTE: Remove the dust seal as the seal carrier is removed, or use a heel bar, or similar tool, to pry the dust seal away from the seal case. Then remove the dust seal by hand.



Remove the dust seal.

Remove the five water pump oil seal capscrews, clamping ring, oil seal, and gasket.

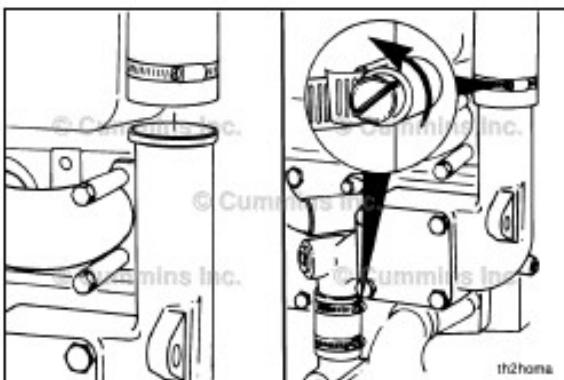
Discard the oil seal and dust seal.



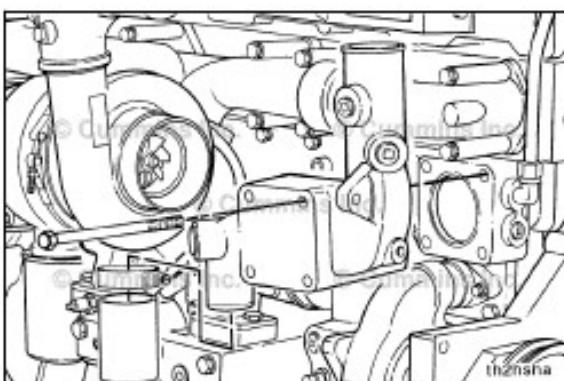
Loosen the coolant bypass hose clamps on both the upper and lower hoses.



Remove the upper coolant hose from the thermostat housing.



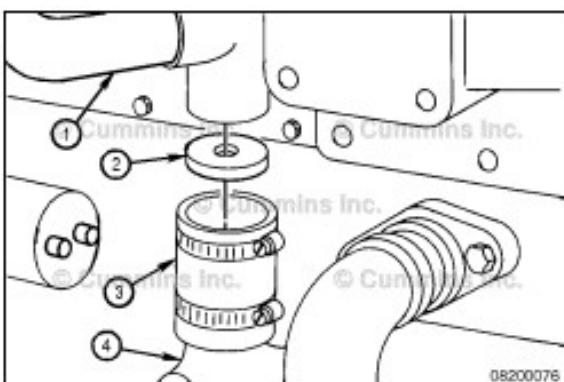
Remove the four thermostat housing mounting capscrews and the thermostat housing.

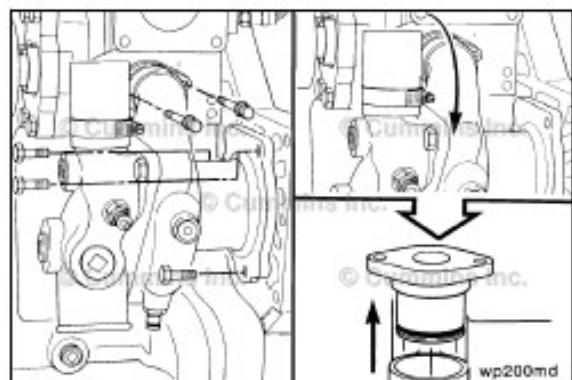


The coolant flow that provides cooling to the torque converter (if equipped) is achieved in different manners.

ISM and QSM Series engines use a torque converter cooler disc inside the coolant bypass hose to direct engine coolant to the inlet side of the torque converter cooler.

- 1 Torque converter coolant supply.
- 2 Torque converter disc (orifice).
- 3 Bypass hose.
- 4 Water pump.





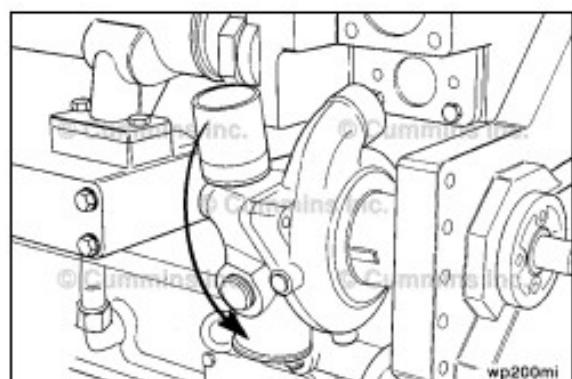
**QSM11 Marine**  
**Section 6 - Maintenance Procedures at 1500 Hours or 1 Year**

Remove the two water pump water transfer connection capscrews.

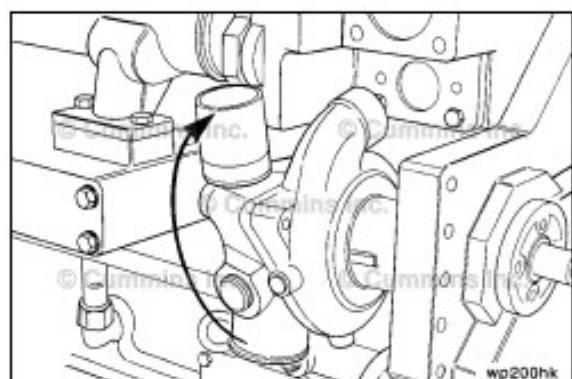
Remove the three water pump mounting capscrews.

Rotate the water pump outward so the water transfer connection can be removed from the water pump.

Remove the water transfer connection from the water pump.



Remove the water pump. Twist the pump outward from the top, and angle the rear of the pump downward, as it is being removed, to allow the pump to pass the thermostat housing support.

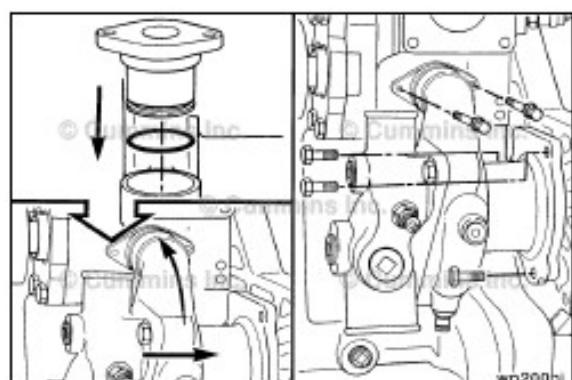


### Install

**NOTE:** The water pump **must** be twisted outward from the top until the transfer outlet clears the thermostat housing support during installation.

Install a new o-ring on the water pump mounting flange.

Install the water pump.



Install a new o-ring on the water pump water transfer tube.

Install the connection into the water pump.

Twist the water pump inward, and install the three water pump mounting capscrews.

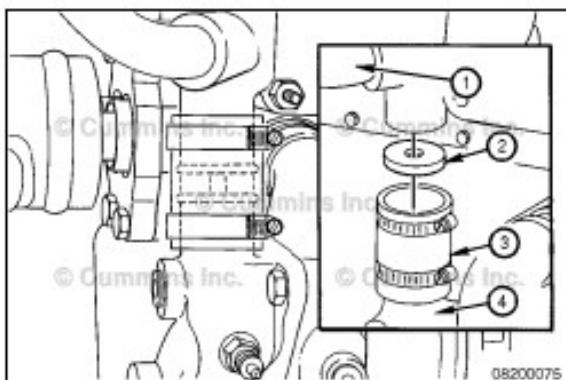
**Torque Value:** 47 N·m [ 35 ft-lb ]

Install a new gasket on the water pump water transfer connection. Install and tighten the water transfer connection capscrews.

**Torque Value:** 25 N·m [ 221 in-lb ]

If the engine is equipped with a torque converter cooler, install the disc in the bypass hose before installing the thermostat housing.

- 1 Torque converter cooler coolant supply.
- 2 Torque converter cooler disc (orifice).
- 3 Bypass hose.
- 4 Water pump.



Install the thermostat in the housing.



Install a new seal in the groove on the thermostat housing mounting surface.



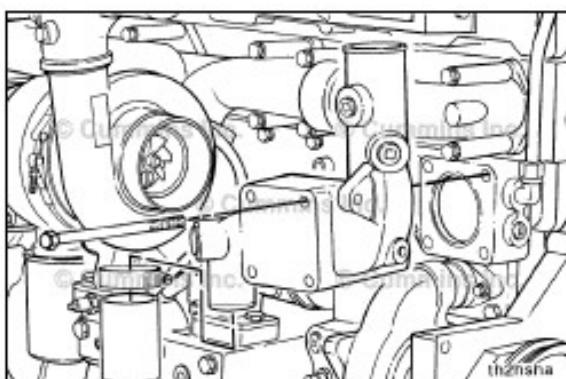
Install the hose on the thermostat housing bypass outlet.



Install the thermostat housing and four mounting capscrews.



**Torque Value:** 54 N·m [ 40 ft-lb ]



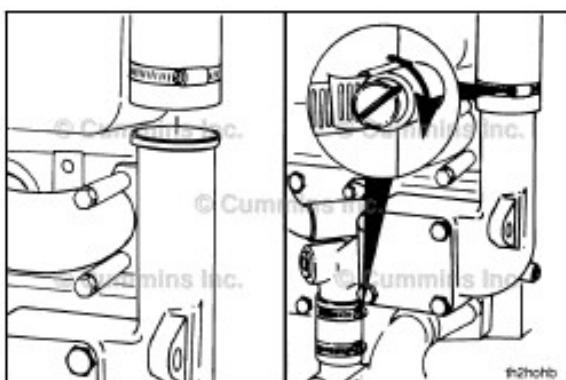
Equally space the bypass hose over the water pump connection and thermostat housing connection, and tighten the bypass hose clamps.

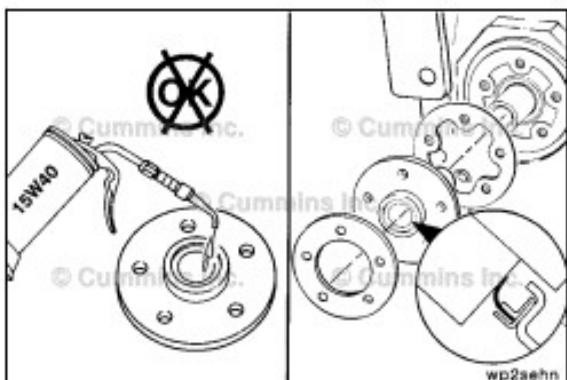


**Torque Value:** 3 N·m [ 27 in-lb ]



Install the upper and lower coolant hoses. Refer to the OEM's specifications for the correct torque value.





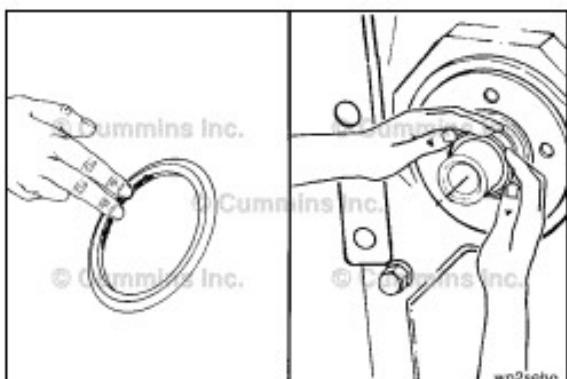
The oil seal **must** be installed with the lip of the seal and the shaft clean and dry. Do **not** lubricate. The yellow dust lip **must** be facing out.

Install the new gasket and oil seal. Use the installation sleeve provided with the new seal to install the seal.

The capscrew threads **must** be coated with thread sealant, Part Number 3823494 or equivalent, to prevent oil leakage.

**Torque Value:**

Step 1	7 N·m	[ 62 in-lb ]
Step 2	20 N·m	[ 177 in-lb ]



Place a light film of oil or antifreeze on the inside diameter of the dust seal.

Install the dust seal onto the shaft with the larger outside diameter facing the engine.

Push the dust seal back by hand on the shaft until the entire dust seal contacts the oil seal case.

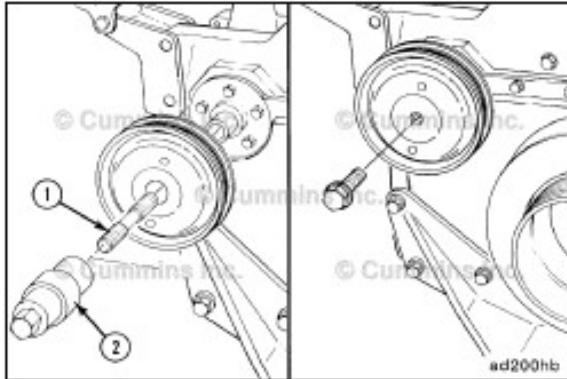


Use pulley pusher adapter (1), Part Number 3377401, or equivalent, and pulley pusher (2), Part Number 3376326, or equivalent, to **install** the pulley.



Install the capscrew in the shaft.

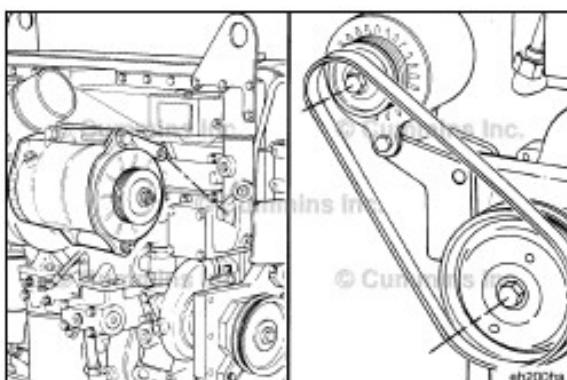
**Torque Value:** 75 N·m [ 55 ft-lb ]



Install the alternator. Refer to a Cummins® Authorized Repair Location.

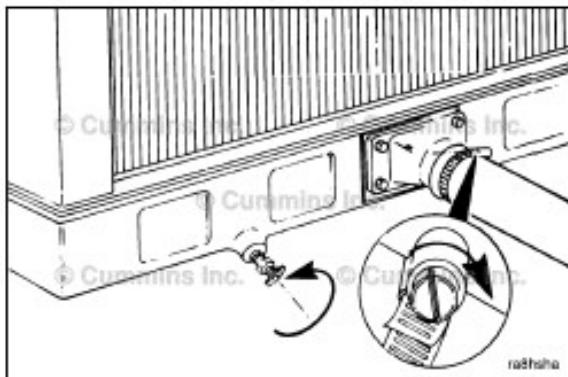


Install and adjust the alternator drive belt. Refer to Procedure 013-005 in Section A.



Close the cooling system draincock, and install the lower coolant hose.

Tighten the hose clamp(s). Refer to the manufacturer's specifications for the correct torque value.

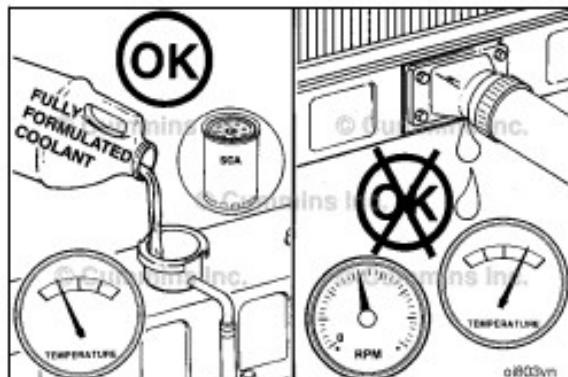


The correct concentration of coolant additives **must** be used in the cooling system. Refer to Procedure 018-004 in Section V.



Fill the cooling system.

Refer to Procedure 008-018 in Section 7.



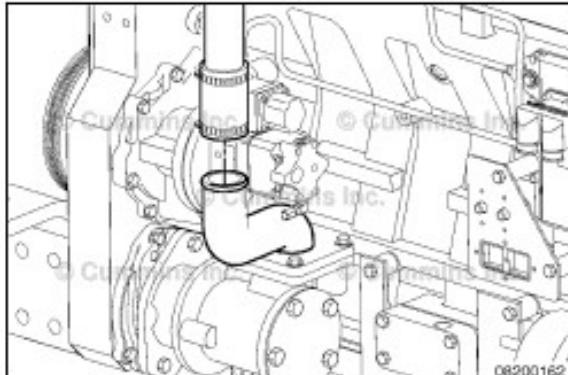
## **Sea Water System**

### **Flush**

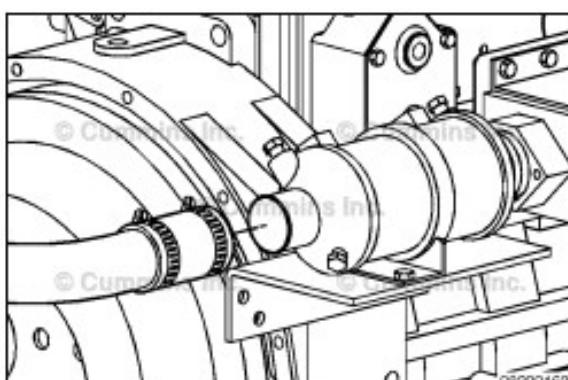
#### **Marine Applications**

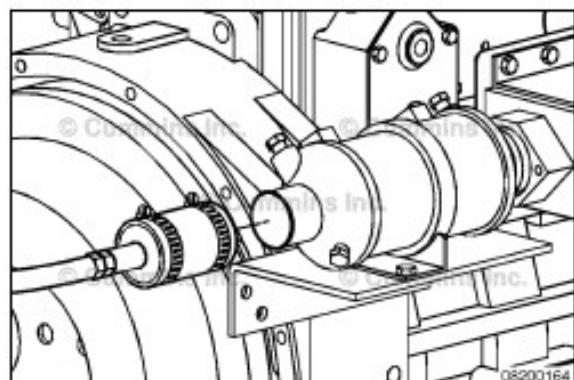
Remove the hose from the sea water pump outlet.

**NOTE:** Place the hose into a container to catch the backflushed water.



Remove the sea water discharge line from the gear cooler.

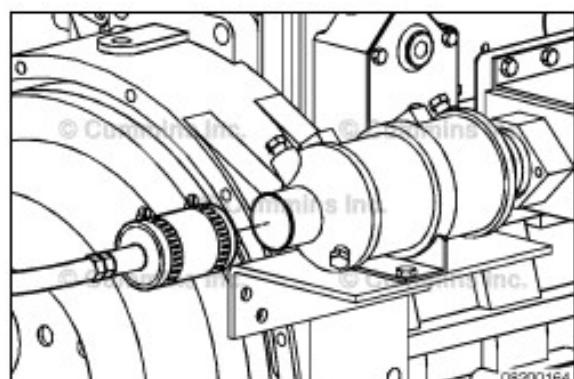




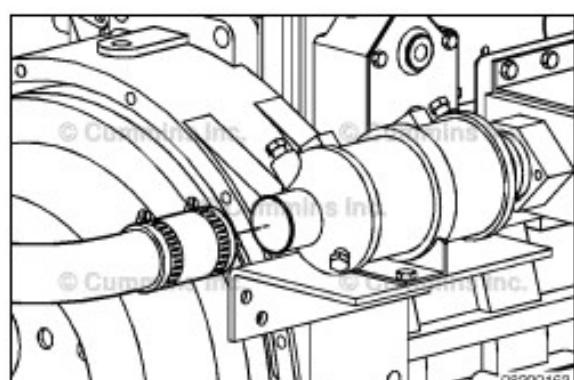
**QSM11 Marine**  
**Section 6 - Maintenance Procedures at 1500 Hours or 1 Year**

Using hose reducers, install a clean, fresh water supply to the outlet of the gear oil cooler.

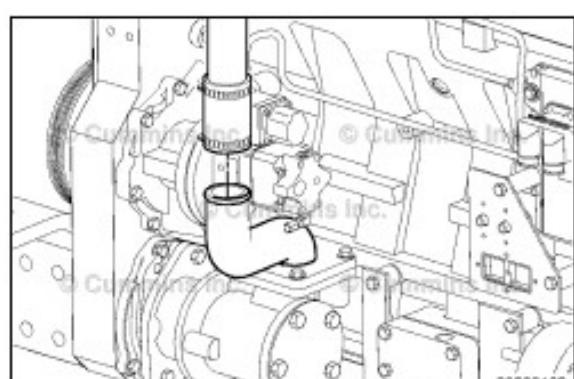
Flush the sea water system.



Remove the fresh water supply.



Install the sea water discharge line to the gear cooler.



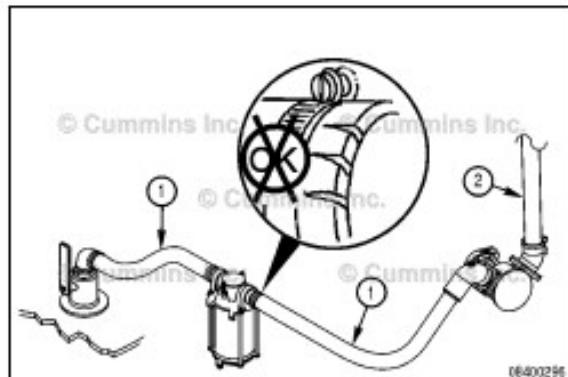
Install the sea water pump outlet line onto the sea water pump.



## Sea Water Hoses

### Inspect

Start engine, and inspect all hoses and connections for deterioration or leaks. Replace damaged hoses and clamps, if necessary.



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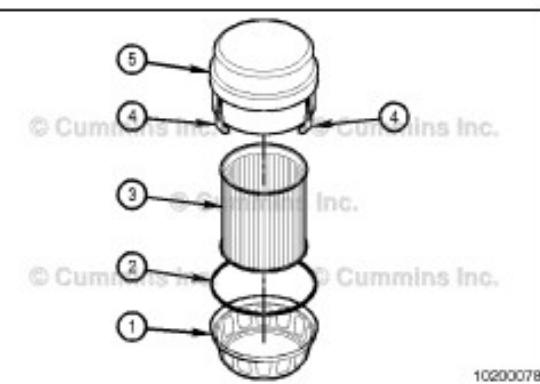
## Air Cleaner Assembly (Engine-Mounted)

### Maintenance Check



**CAUTION**  
Holes, loose-end seals, dented sealing surfaces, and other forms of damage render the air cleaner inoperative and require immediate replacement.

Elements that have been cleaned several times will finally clog and airflow to the engine will be restricted. After cleaning the element, check the intake air restriction as previously described. Replace the element, if necessary.



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To avoid damage to the element, pull the cover and the element straight out when removing them from the air cleaner housing.



Unsnap the latches (4) that secure the cover (1) to the air cleaner housing (5). Remove the cover (1).

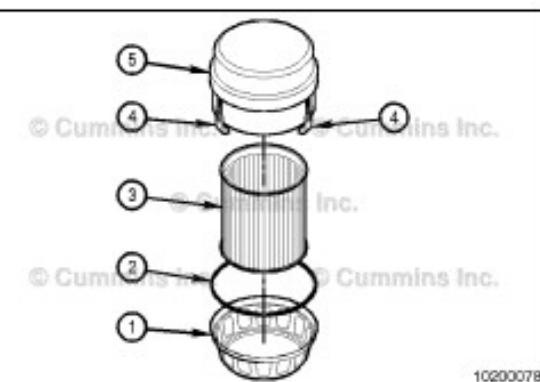
Pull the element (3) out of the housing.

Remove the o-ring (2) from the cover (1) and inspect. If the o-ring (2) is damaged, it **must** be replaced.

Install the air cleaner element (3) into the housing.

Make sure that the o-ring (2) is seated properly on the cover (1). Install the cover (1).

Snap the latches (4) to secure the cover (1).



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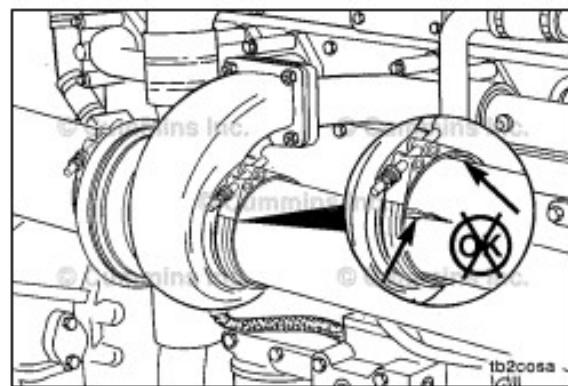
## Air Leaks, Air Intake and Exhaust Systems

### Maintenance Check

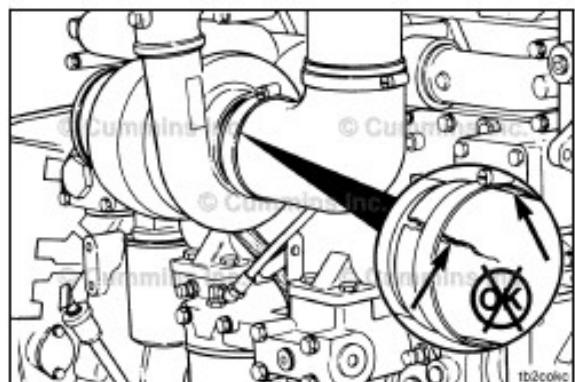


The engine's intake air must be filtered to prevent dirt and debris from entering the engine. If any of the intake air piping is damaged or loose, unfiltered air will enter the engine, which can cause premature wear and engine failure.

Inspect the intake air piping once a week for cracked hoses, damage, or loose clamps.



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Replace damaged pipes and tighten loose clamps as necessary to make sure the air intake system does **not** leak.

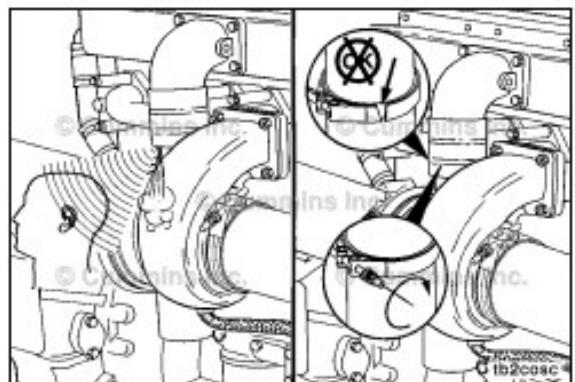


**Torque Value:** 8 N·m [ 71 in-lb ]

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



Disassemble and clean the intake air piping as required.



Noise can be caused by an air leak from the:

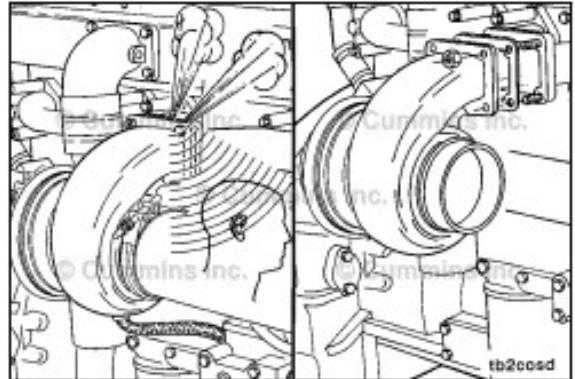


- Turbocharger-to-discharge-elbow connection

Inspect for damage. Tighten loose clamps.



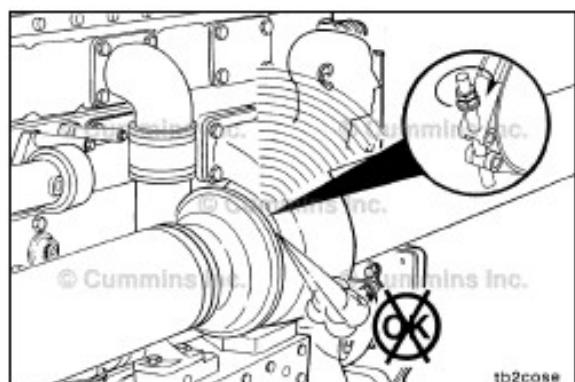
**Torque Value:** 8 N·m [ 71 in-lb ]



- Turbocharger-to-exhaust-manifold mounting gasket



Replace the gasket. Refer to a Cummins® Authorized Repair Location for turbocharger removal and installation.



- Turbine housing sealing surface exhaust leak

Tighten the turbine housing capscrews or V-band clamps.



**Torque Value:**

Capscrews

Step 1                  14 N·m

[ 120 in-lb ]



**Torque Value:**

V-band

Step 1                  9 N·m

[ 80 in-lb ]

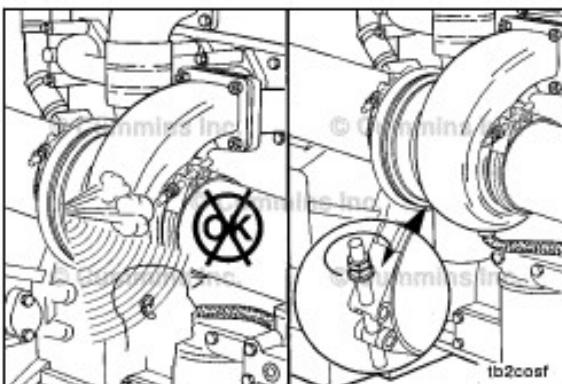
- Compressor housing sealing surface air leak.

Tighten the compressor housing V-band clamp nut.

**Torque Value:**

Capscrews

Step 1      7 N·m      [ 62 in-lb ]



**Torque Value:**

V-band

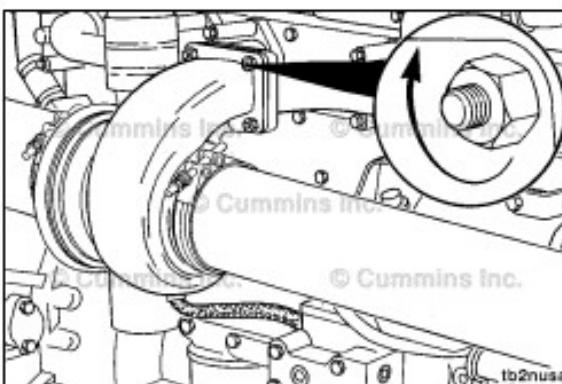
Step 1      9 N·m      [ 80 in-lb ]

If damage resulted in coolant, oil, excessive fuel or excessive black smoke entering the exhaust system, the aftertreatment system **must** be inspected. Refer to a Cummins® Authorized Repair Location.

## Turbocharger Maintenance Check

Tighten the turbocharger mounting nuts.

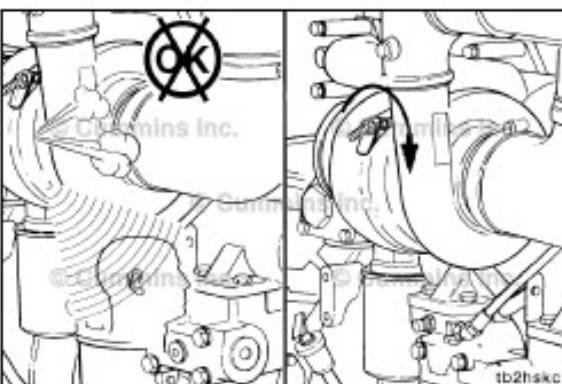
**Torque Value:** 61 N·m [ 45 ft-lb ]



Check the turbine housing's sealing surface for exhaust leaks.

If a leak is found, tighten the V-band clamp nut.

**Torque Value:** 9 N·m [ 80 in-lb ]

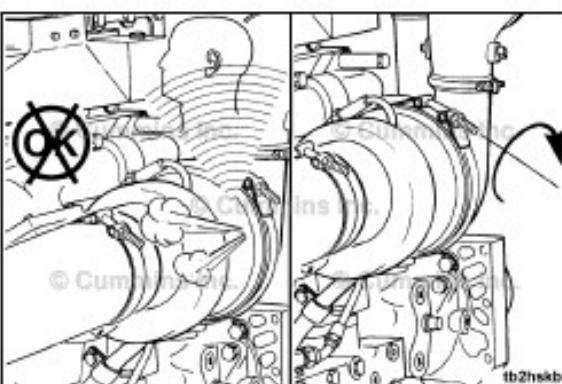


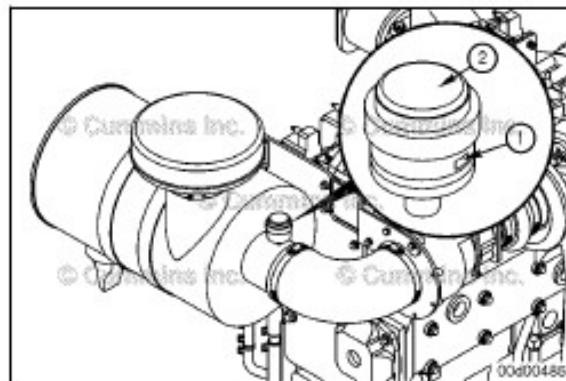
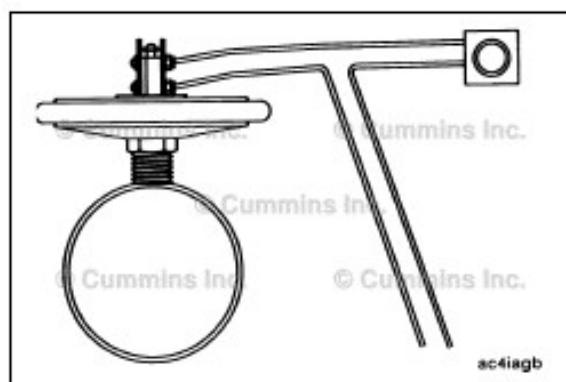
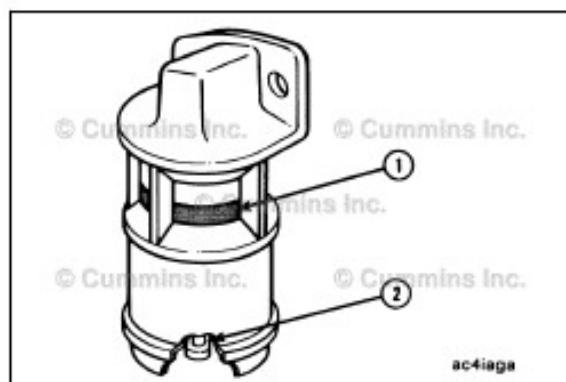
Check the compressor housing sealing surface for leaks.

If a leak is found, tighten the V-band clamp nut.

**Torque Value:** 9 N·m [ 80 in-lb ]

If malfunction resulted in coolant, oil, excessive fuel or excessive black smoke entering the exhaust system, the aftertreatment system **must** be inspected. Refer to a Cummins® Authorized Repair Location.





## Air Cleaner Restriction

### Maintenance Check

#### Mechanical Indicator

##### 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.

**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.

#### Vacuum Indicator

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

#### Industrial Gas Mechanical Indicator

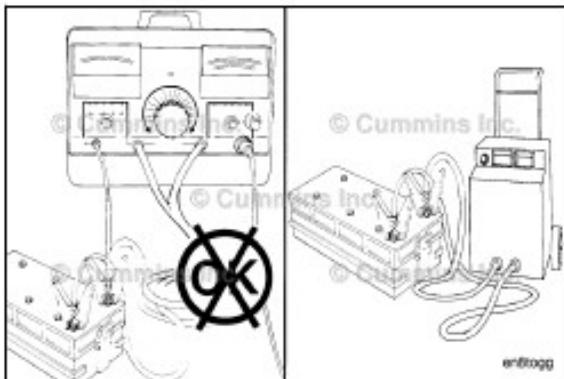
A mechanical restriction indicator is available to indicate excessive air restriction through a dry-type air cleaner. This instrument is mounted in the air cleaner outlet. The red flag (1) in the window gradually rises as the cartridge loads with dirt. When air restriction is indicated the air filter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

## 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.



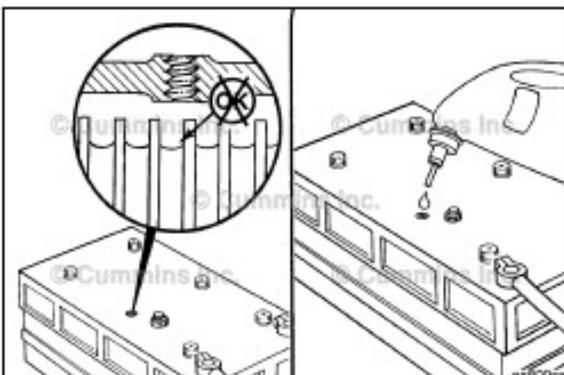
If conventional batteries are used, remove the cell caps or covers and check the electrolyte (water and sulfuric acid solution) level.



**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.



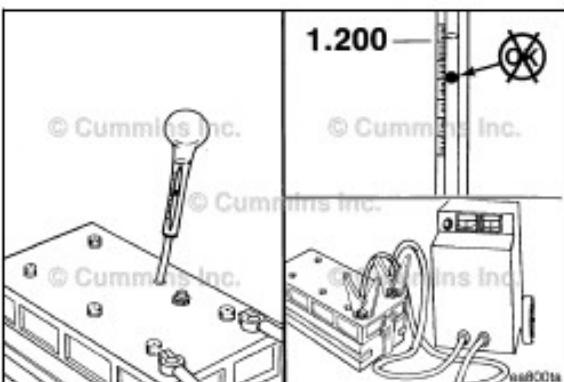
Refer to the accompanying table to determine the battery state of charge based on the specific-gravity readings.

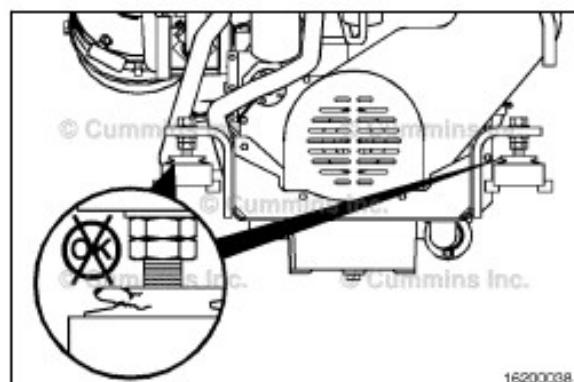
Battery State of Charge	Specific Gravity @ 27°C [80°F]
100%	1.260 to 1.280
75%	1.230 to 1.250
50%	1.200 to 1.220
25%	1.170 to 1.190
Discharged	1.110 to 1.130

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.





## Engine Mounting Bolts Maintenance Check



Inspect the engine mounts for rubber deterioration, age hardening, and broken or lost bolts. Replace any broken or lost bolts and damaged rubber.



Tighten the engine mounting nuts and bolts.

**Torque Value:** 109 to 136 N·m [ 80 to 100 ft-lb ]

## Section 7 - Maintenance Procedures at 6000 Hours or 2 Years

### Section Contents

	Page
<b>Cooling System</b>	<b>7-1</b>
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<b>Maintenance Procedures - Overview</b>	<b>7-1</b>
General Information.....	7-1
<b>Vibration Damper, Viscous</b> .....	<b>7-1</b>
Inspect.....	7-1

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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.

## Vibration Damper, Viscous Inspect

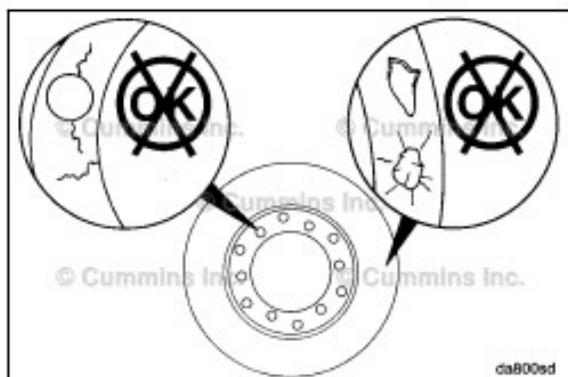
### CAUTION

The silicone fluid in the vibration damper will become solid after extended service and will make the damper inoperative. An inoperative vibration damper can cause major engine or drivetrain failures.

Check the vibration damper for evidence of fluid loss, dents, and wobble. Inspect the vibration damper thickness for any deformation or raising of the damper cover plate.

If any of these conditions are identified, contact your local Cummins Authorized Repair Location to replace the vibration damper.

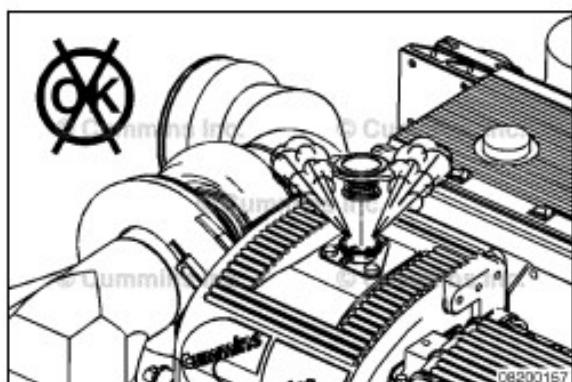
For vibration damper location, refer to Engine Diagrams in Engine Identification (Section E).



## Cooling System General Information

Restore™ is a heavy-duty cooling system cleaner that removes corrosion, silica gel, and other deposits. The performance of Restore™ is dependent 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 times, or the use of Restore Plus™. Up to twice the recommended concentration levels of Restore™ can be used safely. Restore Plus™ **must** be used **only** at its recommended concentration level. Extremely scaled or fouled systems can require more than one cleaning.





## Drain

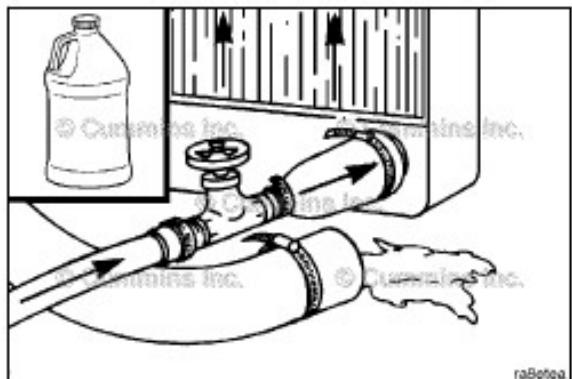
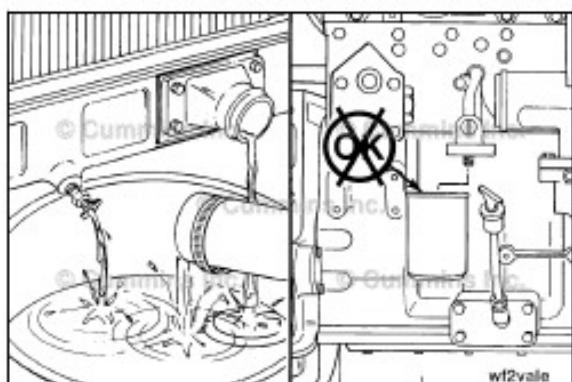
### ⚠️ WARNING ⚠️

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.

### ⚠️ WARNING ⚠️

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

Remove the pressure cap.

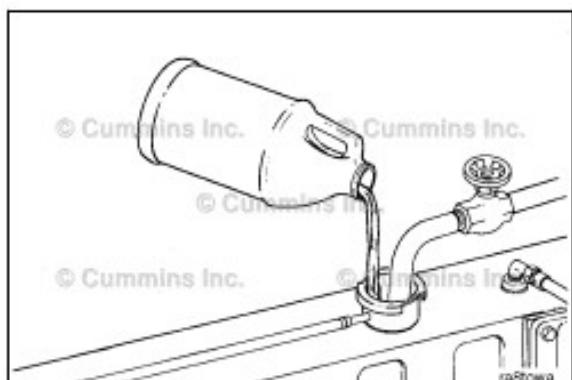


## Flush

### ⚠️ CAUTION ⚠️

Do not use caustic cleaners in the cooling system. Aluminum components will be damaged.

The cooling system must be clean to work correctly and to eliminate buildup of harmful chemicals.



### ⚠️ CAUTION ⚠️

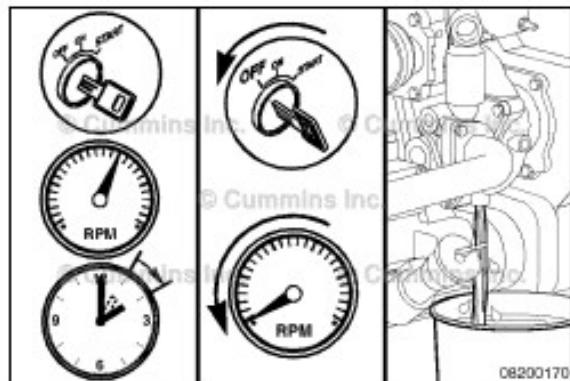
Fleetguard® Restore™ contains no antifreeze. Do not allow the cooling system to freeze during the cleaning operation.

Immediately add 3.8 liters [1 gal] of Fleetguard® Restore™, Restore™ Plus, or the equivalent, for each 38 to 57 liters [10 to 15 gal] of cooling system capacity, and fill the system with plain water.

Operate the engine at normal operating temperatures, at least 85°C [185°F], for 1 to 1-1/2 hours.

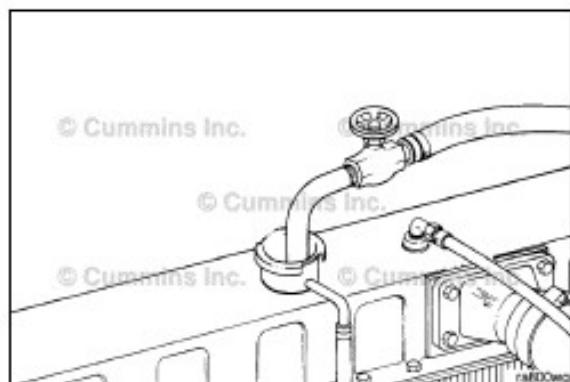


Shut off the engine, allow to cool to 50° C [120°F], and drain the cooling system.



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Fill the cooling system with clean water.



### ▲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.

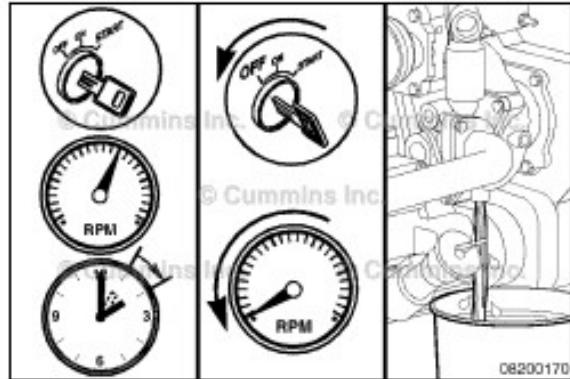
### ▲WARNING▲

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

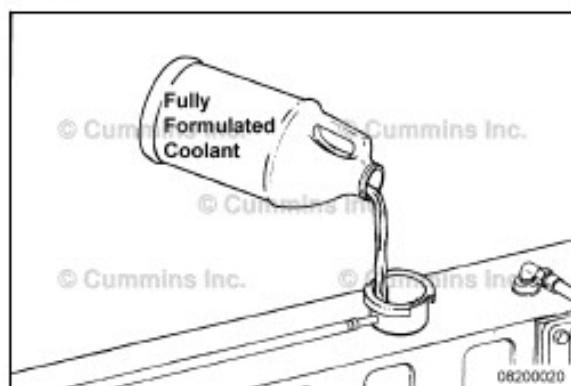
Operate the engine at high idle for five minutes with the coolant temperature above 85°C [185°F].

Shut off the engine, allow to cool to 50° C [120°F] and drain the cooling system.

If the water being drained is still dirty, the system must be flushed again until the water is clean.



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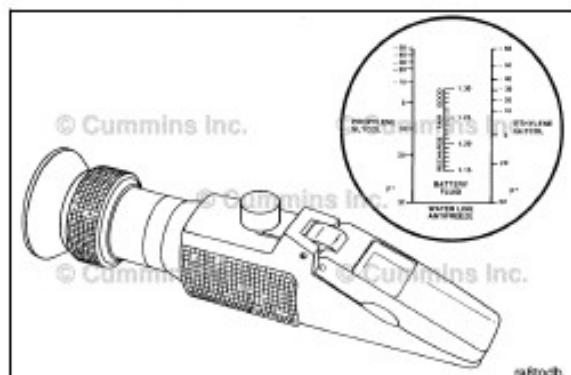
## Fill

### CAUTION

To reduce the possibility of engine damage, do not add coolant while the engine is hot.

Fill the cooling system with fully formulated coolant or a 50/50 mixture of fully formulated antifreeze and good quality water. Use a service filter to bring the coolant to the correct SCA concentration level. Refer to Procedure 018-004 in Section V.

Install the pressure cap. Operate the engine until it reaches a temperature of 80°C [180°F], and check for coolant leaks.



The freeze point protection must be checked after coolant is added to the cooling system.

The Fleetguard™ refractometer, Part Number C2800, provides a reliable, easy-to-read, and accurate measurement of freeze point protection and antifreeze concentration.

Refer to the OEM service manual instructions for the correct operation instructions for the Fleetguard® refractometer, Part Number C2800.

## Section A - Adjustment, Repair, and Replacement

### Section Contents

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