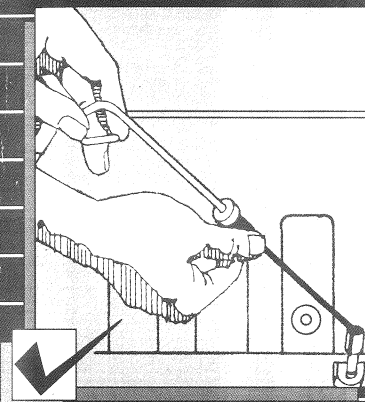
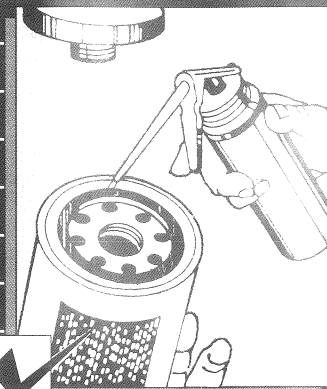
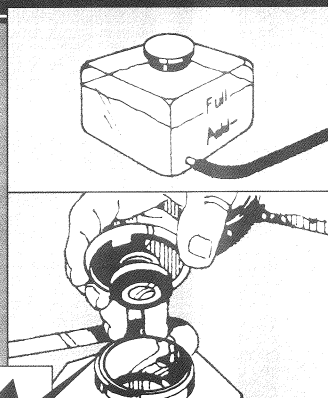


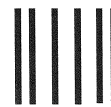


Operation and Maintenance Manual QSF3.8 CM2350 F107

THIS
PRINTED
CUMMINS MANUAL
INCLUDES
A COMPANION
DVD-ROM
VERSION



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



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 15, COLUMBUS INDIANA

—POSTAGE WILL BE PAID BY ADDRESSEE—

Cummins Inc.
Product Registration Dept.
P O Box 3005 M/C 60610
Columbus, IN 47202-3005



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

Customer Name _____

Address _____

City / State _____

Zip Code _____

Home Phone Number (____)_____

Truck Phone / Cell Phone (____)_____

E-mail Address _____

Engine Serial Number _____

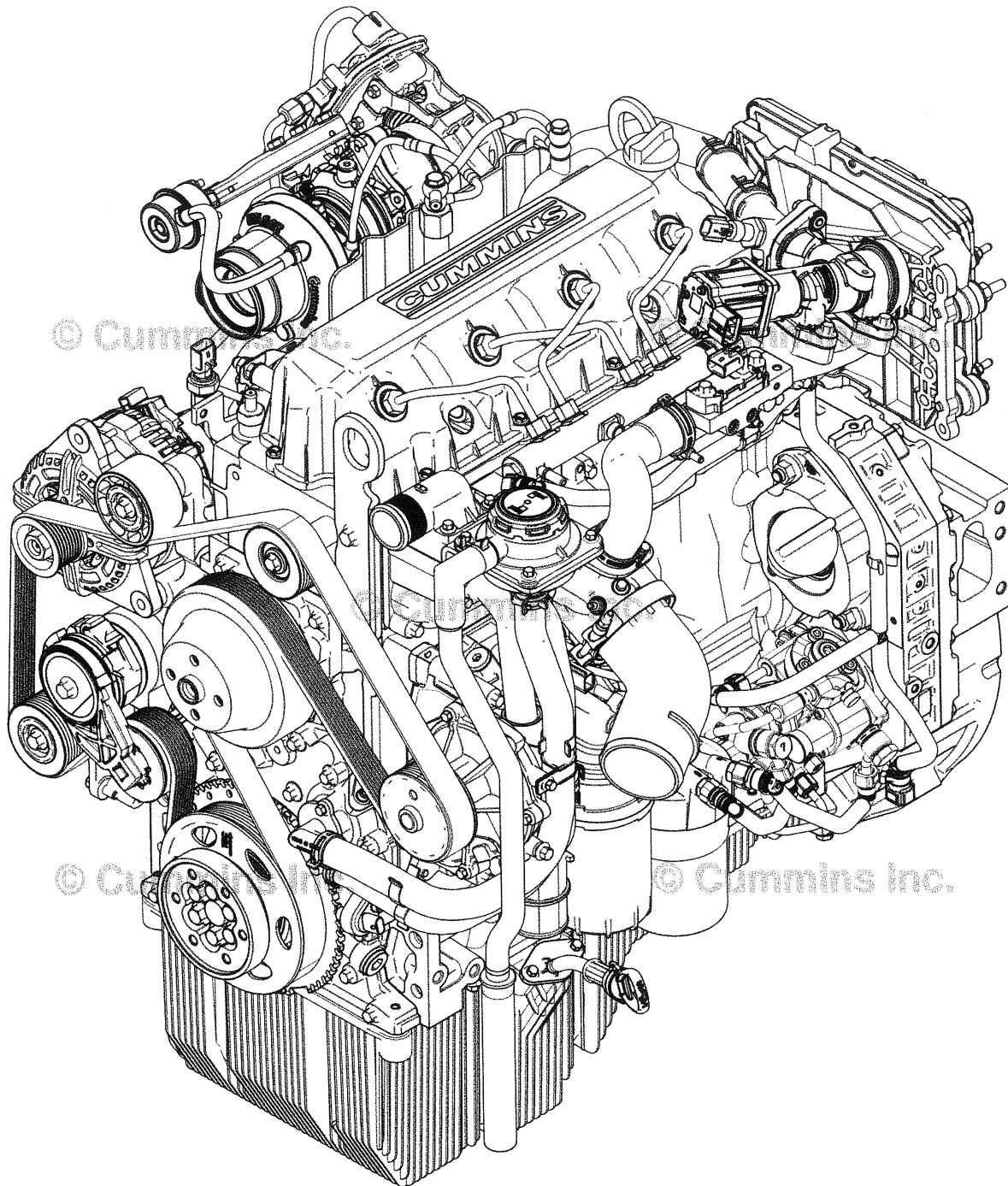
Date Purchased ____/____/____ VIN # _____

OR visit our website at www.cummins.com and select "Product Registration" to enter your registration online.

THANK YOU!!



Operation and Maintenance Manual QSF3.8 CM2350 F107



00r00032

Copyright© 2014
Cummins Inc.
All rights reserved

Bulletin 4367317
Printed 14-NOVEMBER-2014

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

Foreword

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

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 product 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 product. When replacement parts are needed, we recommend using only genuine Cummins® or ReCon® exchange parts.

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

Table of Contents

	Section	
Introduction	i	■
Engine and System Identification	E	■
Operating Instructions	1	■
Maintenance Guidelines	2	■
Maintenance Procedures at Daily Interval	3	■
Maintenance Procedures at 250 Hours or 3 Months	4	■
Maintenance Procedures at 500 Hours or 6 Months	5	■
Maintenance Procedures at 1000 Hours or 1 Year	6	■
Maintenance Procedures at 2000 Hours or 2 Years	7	■
Maintenance Procedures at 4000 Hours or 3 Years	8	■
Maintenance Procedures at 5000 Hours or 4 Years	9	■
Adjustment, Repair, and Replacement	A	■
System Diagrams	D	■
Service Literature	L	■
Service Assistance	S	■
Troubleshooting Symptoms	TS	■
Maintenance Specifications	V	■
Warranty	W	■
Back	back	■

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

	Page
About the Manual	i-2
General Information.....	i-2
Acronyms and Abbreviations	i-18
General Information.....	i-18
General Cleaning Instructions	i-13
Abrasive Pads and Abrasive Paper.....	i-13
Definition of Clean.....	i-13
Fuel System.....	i-16
Gasket Surfaces.....	i-14
Plastic Bead Cleaning.....	i-15
Solvent and Acid Cleaning.....	i-14
Steam Cleaning.....	i-15
General Repair Instructions	i-11
General Information.....	i-11
Welding on a Vehicle with an Electronic Controlled Fuel System.....	i-12
General Safety Instructions	i-9
Important Safety Notice.....	i-9
How to Use the Manual	i-3
General Information.....	i-3
Illustrations	i-8
General Information.....	i-8
Symbols	i-4
General Information.....	i-4
To the Owner and Operator	i-1
General Information.....	i-1

This Page Left Intentionally Blank

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).



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

About the Manual

General Information

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

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

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

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

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

How to Use the Manual

General Information

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

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

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

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

Symbols

General Information

The 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.

NOTE: It is possible to have four symbols for each text and graphic combination.



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



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



Indicates a **REMOVAL** or **Dissassembly** step.

Indicates an **INSTALLATION** or **ASSEMBLY** step.



INSPECTION is required.



CLEAN the part or assembly.



PERFORM a mechanical or time **MEASUREMENT**.





LUBRICATE the part or assembly.



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



TIGHTEN to a specific torque.



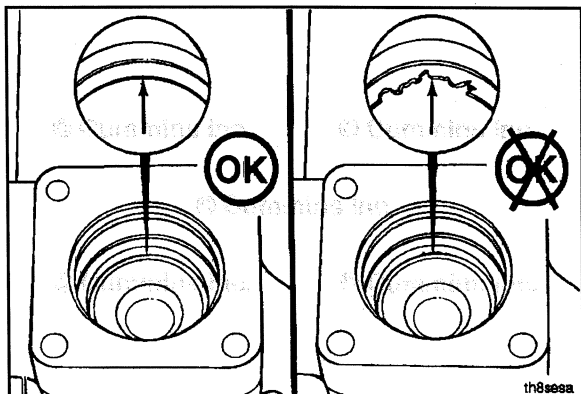
PERFORM an electrical **MEASUREMENT**.

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



The component weighs 23kg [50 lbs] or more. To reduce the possibility of personal injury, use a hoist or get assistance to lift the component.

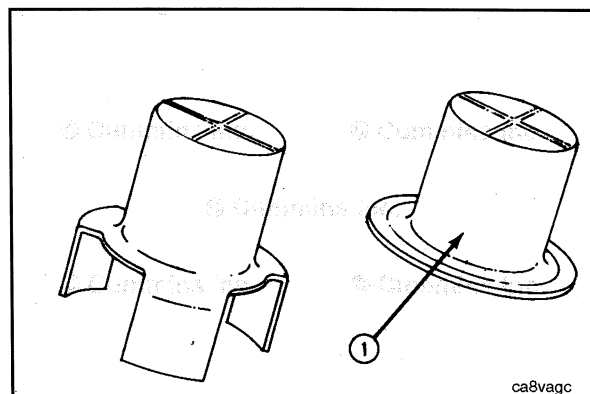




Illustrations

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



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



Cummins Inc. does not recommend or authorize any modifications or repairs to 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
- 22 Manual Service Disconnect
- 23 High Voltage Interlock Loop
- 24 High Voltage Connectors/Connections and Harnesses
- 25 High Voltage Battery System
- 26 Power Inverter
- 27 Generator Motor
- 28 Clutch Pressure Plate

- Follow all safety instructions noted in the procedures
- Follow the manufacturer's recommendations for cleaning solvents and other substances used during repairs. Some solvents 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 or system and its components **must** be kept clean during any repair. Contamination of the engine, system or components will cause premature wear.
- All components **must** be kept clean during any repair. Contamination of the components will cause premature wear.

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

- 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 low voltage 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, electronic control units or the components. Direct welding of any electronic components must not be attempted. Sensors, wiring harness, and electronic control unit should be removed if nearby welding will expose these components to temperatures beyond normal operation. Additionally, all electronic control unit 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.



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

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

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
- Belts and Hoses
- Bearings (ball or taper roller)
- Electronic Control Module (ECM)
- ECM Connectors
- Capacitive Coil Driver Module (CCD)
- Ignition Coils and Leads
- NOx Sensor
- Fuel Control Valve
- Throttle Driver and Actuator.

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.



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.



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** use 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.



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 or 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 recommendation 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 76 microns [0.003 in] in diameter. One micron measures 0.001 mm [0.00004 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.

ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society of Testing and Materials
ATDC	After Top Dead Center
BTU	British Thermal Unit
BTDC	Before Top Dead Center
°C	Celsius
CAN	Controller Area Network
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	Engine 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
H₂O	Water
inHg	Inches of Mercury
in H₂O	Inches of Water
ICM	Ignition Control Module
IEC	International Electrotechnical Commission
km/l	Kilometers per Liter
kPa	Kilopascal
LNG	Liquid Natural Gas
LPG	Liquefied Petroleum Gas
LTA	Low Temperature Aftercooling
MCRS	Modular Common Rail System
MIL	Malfunction Indicator Lamp
MPa	Megapascal
mph	Miles Per Hour
mpq	Miles Per Quart
N•m	Newton-meter

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

NOx	Mono-Nitrogen Oxides
NG	Natural Gas
O2	Oxygen
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacturer
OSHA	Occupational Safety and Health Administration
PID	Parameter Identification Descriptions
ppm	Parts Per Million
psi	Pounds Per Square Inch
PTO	Power Takeoff
REPTO	Rear Power Take Off
RGT	Rear Gear Train
rpm	Revolutions Per Minute
SAE	Society of Automotive Engineers
SCA	Supplemental Coolant Additive
SCR	Selective Catalytic Reduction
STC	Step Timing Control
SID	Subsystem Identification Descriptions
TDC	Top Dead Center
VDC	Volts of Direct Current
VGT	Variable Geometry Turbocharger
VS	Variable Speed
VSS	Vehicle Speed Sensor

Notes

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Section E - Engine and System Identification

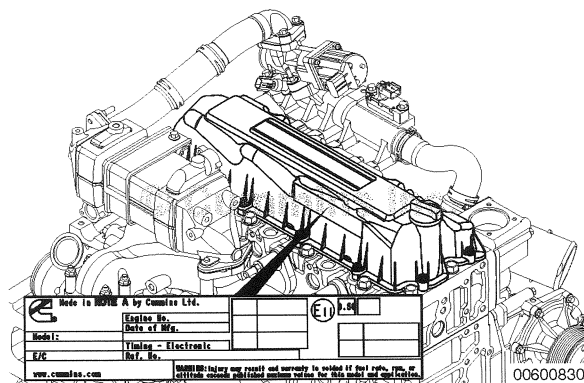
Section Contents

	Page
Cummins® Product Technology	E-16
General Information.....	E-16
Cummins® Service Engine Model Identification	E-13
General Information.....	E-13
Engine Diagrams	E-6
General Information.....	E-6
Engine Identification	E-1
Cummins® Engine Nomenclature.....	E-2
Engine Control Module Dataplate.....	E-2
Exhaust System.....	E-3
Fuel Pump Dataplate.....	E-2
General Information.....	E-1
Turbocharger Dataplate.....	E-3

This Page Left Intentionally Blank

Engine Identification

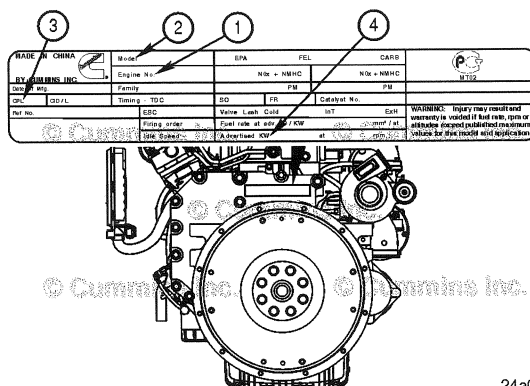
General Information



Have the following engine data available when communicating with a Cummins® Authorized Repair Location. The information on the dataplate is mandatory when sourcing service parts.

NOTE: The dataplates used on engines can differ in appearance and location of information. The following illustrations show examples of common dataplates used and the information contained on these dataplates.

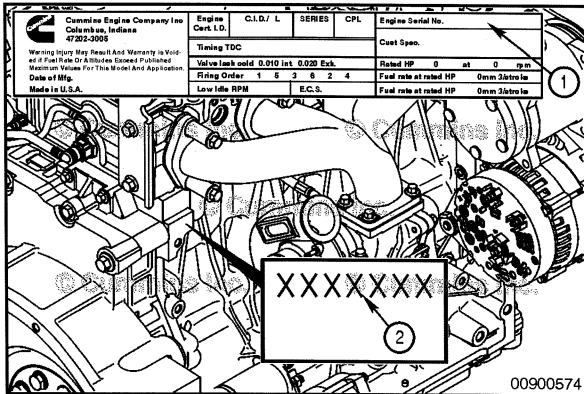
The engine dataplate shows specific facts about an engine. The dataplate is typically located on the engine rocker lever cover, but can also be located on the side of the gear housing. The engine serial number and control parts list (CPL) provide data for ordering parts and service. The engine dataplate **must not** be changed unless approved by Cummins Inc.



24a00017

There are four possible dataplates that can be found on the engine rocker lever cover, but can also be located on the side of the gear housing. They contain the following information:

- 1 Engine serial number
- 2 Engine model information
- 3 Control parts list
- 4 Horsepower and rpm rating.

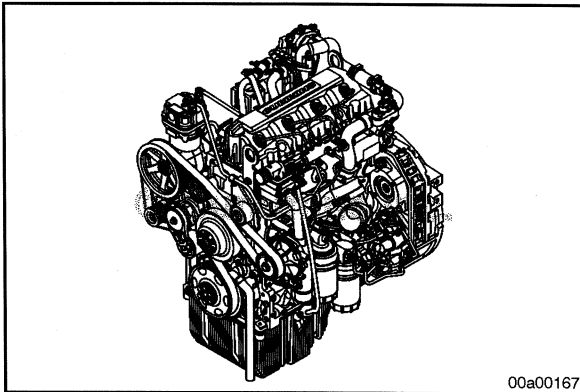


NOTE: If the engine dataplate (1) is **not** legible, the engine serial number (2) can be identified on the engine block. It is located on the exhaust side, next to the rear gear housing. Additional engine information is available by reading the engine control module (ECM) dataplate.

Cummins® Engine Nomenclature

The Cummins® Service Engine Model Identification procedure describes how to use the Cummins® Service Model Name to identify an engine. Refer to Procedure 100-005 in Section E.

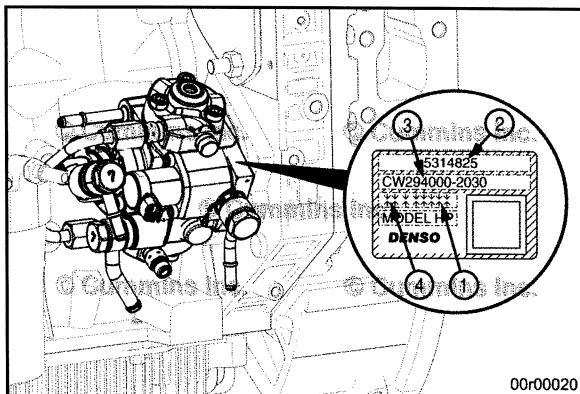
The Cummins® Product Technology procedure provides the Cummins® Service Model Name and describes the unique technology used by the engine covered by this manual. Refer to Procedure 100-006 in section E.



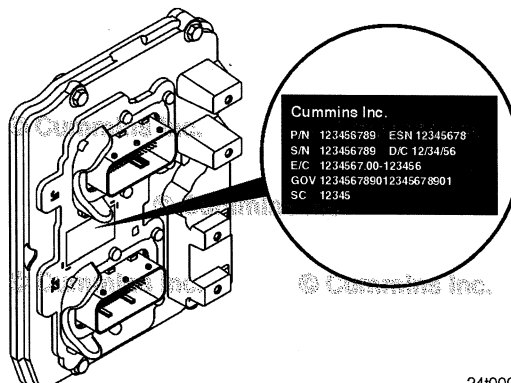
Fuel Pump Dataplate

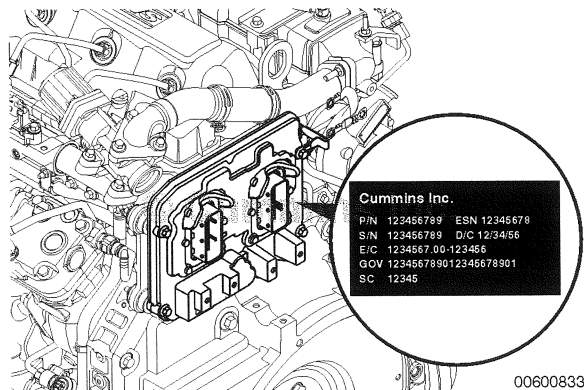
The Denso™ fuel pump dataplate is located on the fuel pump. This dataplate contains the following information to assist in servicing or replacement:

- 1 Customer part number
- 2 Denso™ part number
- 3 Production month serial number
- 4 Customer's certification number
- 5 QR code.



Engine Control Module Dataplate





NOTE: Not all engines have ECM dataplates.

Engines covered by this manual are equipped with a CM2350 ECM. A CM2350 ECM has two 96-pin connectors. One of the 96-pin connectors is for engine inputs and outputs **only**. The second 96-pin connector and 14-pin connector are for aftertreatment and vehicle inputs and outputs

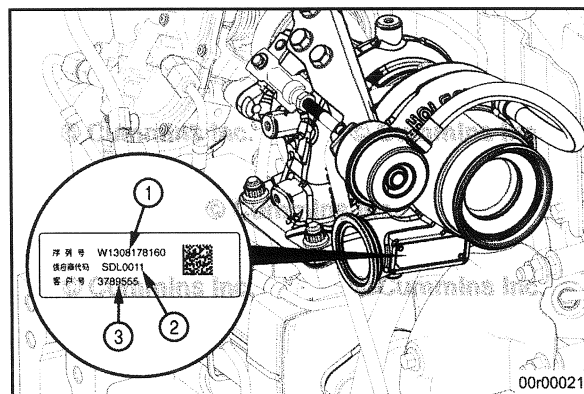
NOTE: The presence of an ECM dataplate depends on the manufacturing plant and the date the engine was manufactured. If an ECM dataplate was **not** installed by the manufacturing plant, calibration data can be found on the engine dataplate.

Turbocharger Dataplate

The Holset® turbocharger dataplate is located on the turbocharger inlet compressor housing.

The dataplate contains the following information to assist in servicing or replacement.

- 1 Serial number
- 2 Supplier code
- 3 Customer number.

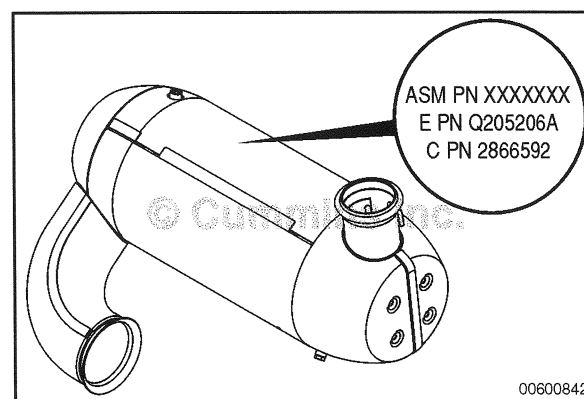


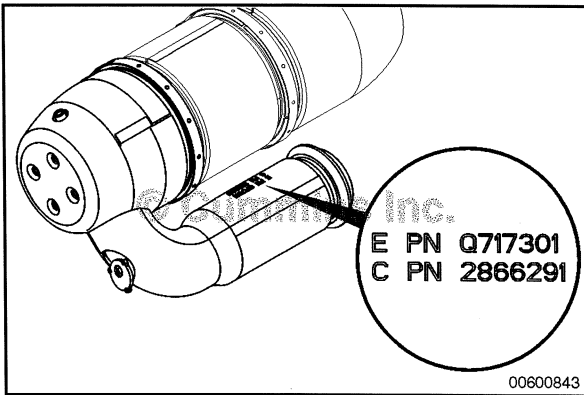
Exhaust System

The aftertreatment selective catalytic reduction (SCR) catalyst identification is located on the side of the assembly and contains the following information to assist in servicing or replacement.

- 1 Assembly part number
- 2 Cummins Emission Solutions™ part number
- 3 Cummins® part number.

NOTE: Some aftertreatment components may **only** have the Cummins Emission Solutions™ part number. For cross referencing and part number identification, reference QuickServe™ Online.

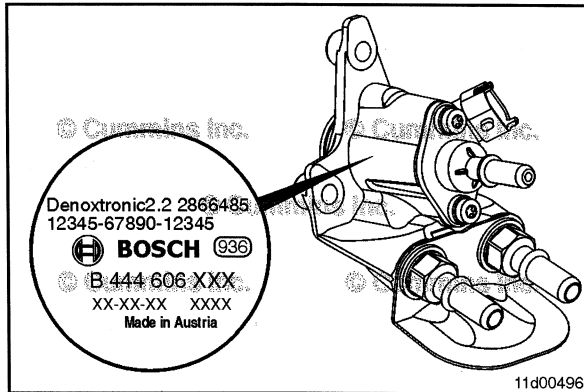




The aftertreatment decomposition tube identification is located on the side of the tube and contains the following information to assist in servicing or replacement.

- 1 Cummins Emission Solutions™ partnumber
- 2 Cummins® part number.

NOTE: Some aftertreatment components may only have the Cummins Emission Solutions™ part number. For cross referencing and part number identification, reference QuickServe™ Online.



The aftertreatment diesel exhaust fluid dosing (DEF) valve identification is located on the side of the valve and contains the following information to assist in servicing or replacement.

- 1 Cummins® part number
- 2 Cummins Emission Solutions™ partnumber
- 3 Bosch™ part number
- 4 Bosch™ production data (data code, serial number).

Example:

- 2866485 is the Cummins® part number
- 12345-67890-12345 is the location for the Cummins Emission Solutions™ part number
- B 444 606 XXX is the Bosch™ part number
- XX-XX-XX is the date code
- XXXX is the serial number.

NOTE: Some aftertreatment components can have **only** the Cummins Emission Solutions™ part number. For cross referencing and part number identification, reference QuickServe™ Online.

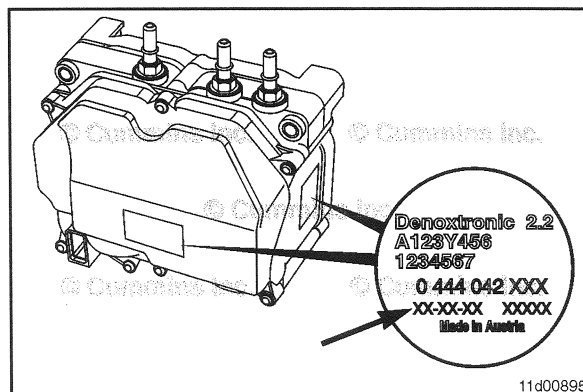
The aftertreatment DEF dosing unit identification is located on the side of the unit and contains the following information to assist in servicing or replacement.

- 1 Cummins Emission Solutions™ partnumber
- 2 Cummins® part number
- 3 Bosch™ part number
- 4 Bosch™ production data (data code, serial number).

Example:

- A123Y456 is the Cummins EmissionSolutions™ part number
- 1234567 is the Cummins® part number
- 0 444 042 XXX is the Bosch™ partnumber
- XX-XX-XX is the date code
- XXXX is the serial number

NOTE: Some aftertreatment components may have **only** the Cummins Emission Solutions™ part number. For cross referencing and part number identification, reference QuickServe™ Online.



11d00895

Engine Diagrams

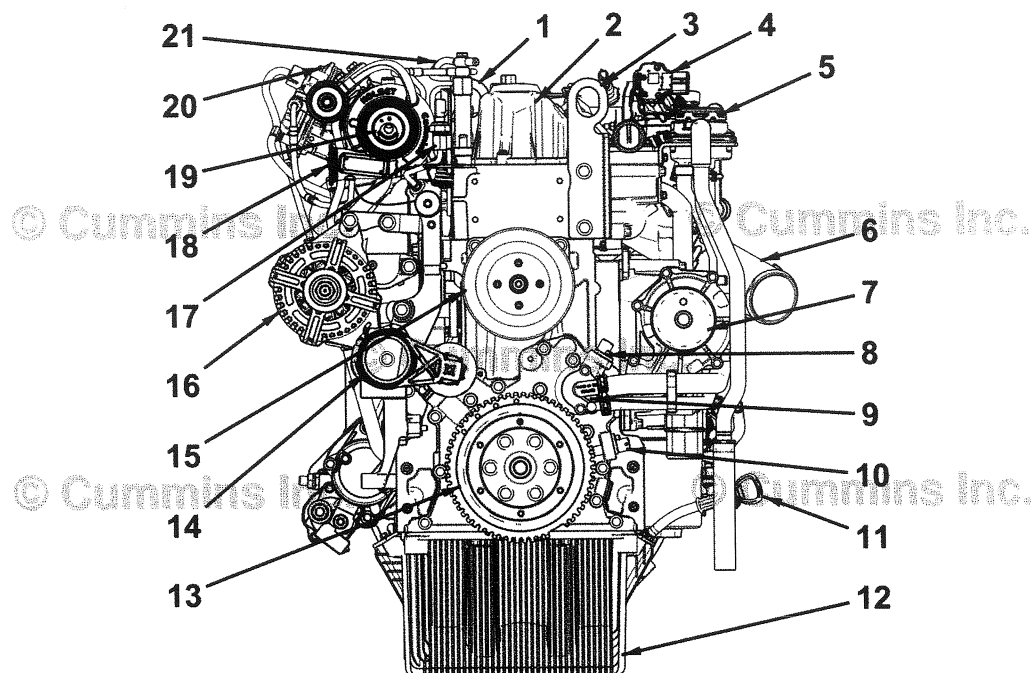
General Information

The following illustrations show the locations of the major external engine components, filters, and other service and maintenance points. Some external components are at different locations for different engine models.

NOTE: The illustrations are **only** a reference to show a typical engine.

Engine Diagrams

General Information



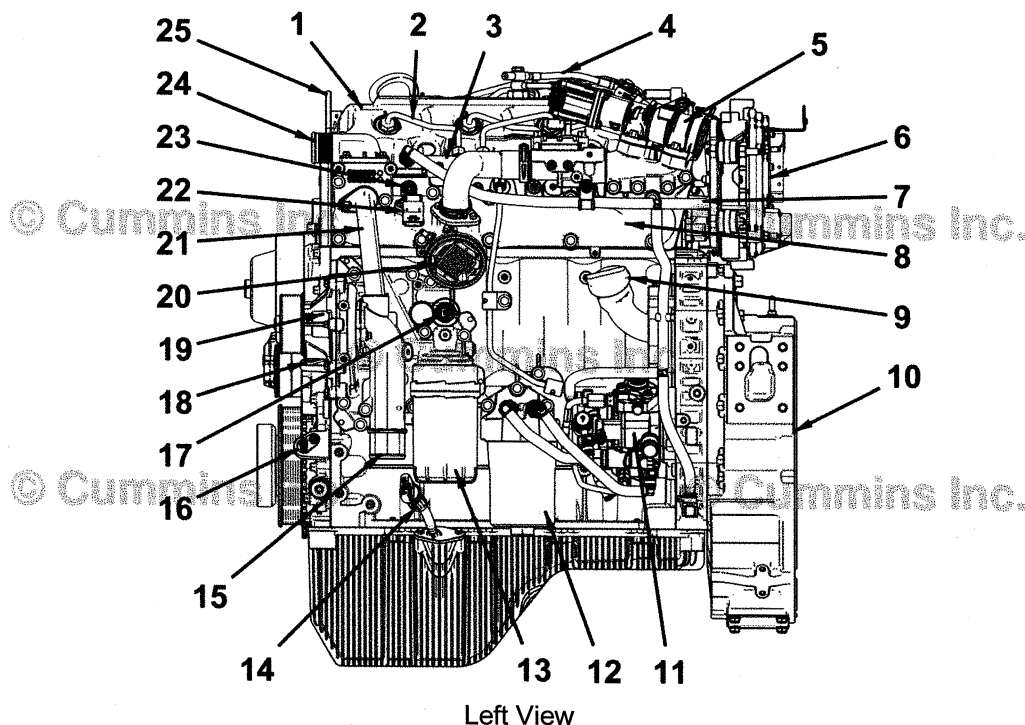
Front View

00r00015

- 1 Rear engine lifting bracket
- 2 Rocker lever cover
- 3 Front engine lifting bracket
- 4 Exhaust gas recirculation (EGR) valve
- 5 Open crankcase ventilation valve
- 6 Air intake connection
- 7 Water pump pulley
- 8 Camshaft speed/position sensor
- 9 Crankcase breather adapter
- 10 Crankshaft speed/position sensor
- 11 Lubricating oil dipstick tube
- 12 Lubricating oil pan
- 13 Crankshaft pulley
- 14 Automatic belt tensioner
- 15 Fan drive pulley
- 16 Alternator
- 17 Exhaust pressure sensor
- 18 Wastegate turbocharger compressor outlet
- 19 Wastegate turbocharger compressor inlet
- 20 Exhaust pressure regulator
- 21 EGR coolant vent tube.

Engine Diagrams

General Information



00r00017

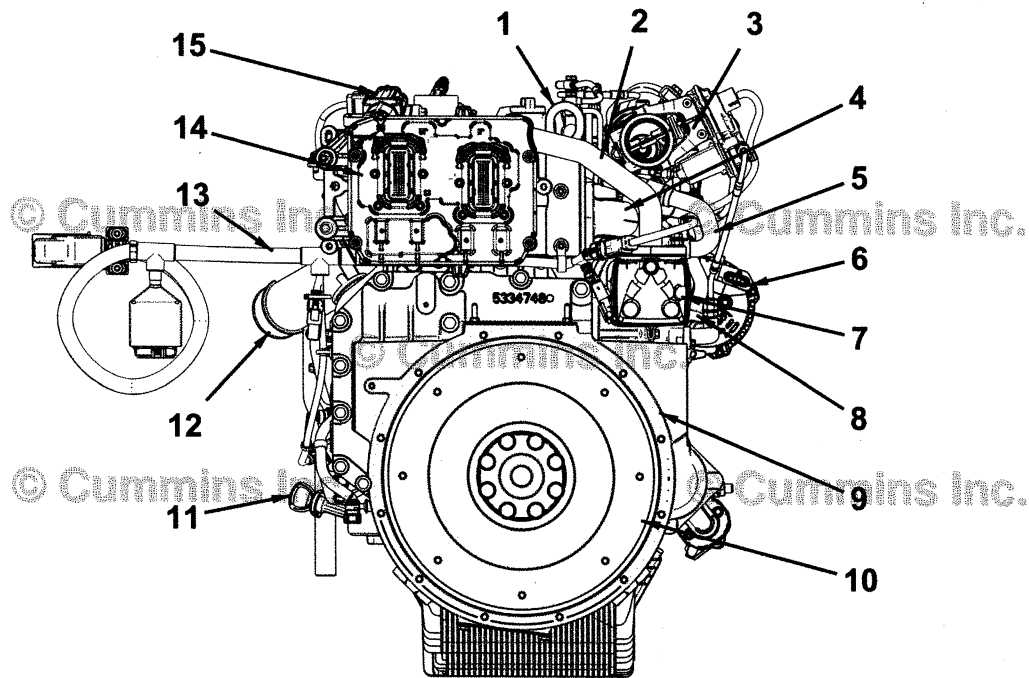
- 1 Rocker lever cover
- 2 Injector fuel supply line
- 3 Common rail fuel manifold
- 4 EGR coolant vent tube
- 5 EGR valve
- 6 Engine control module (ECM)
- 7 Fuel return line
- 8 Exhaust manifold
- 9 Lubricating oil fill cap
- 10 Flywheel housing
- 11 Fuel pump
- 12 Fuel filter
- 13 Lubricating oil filter
- 14 Lubricating oil dipstick
- 15 Water inlet connection
- 16 Crankshaft speed/position sensor
- 17 Oil pressure sensor
- 18 Camshaft speed/position sensor
- 19 Water pump
- 20 Intake air heater
- 21 Water bypass tube
- 22 Intake manifold pressure/temperature sensor
- 23 Engine coolant temperature sensor
- 24 Water outlet connection

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

25 Front engine lifting bracket.

Engine Diagrams

General Information



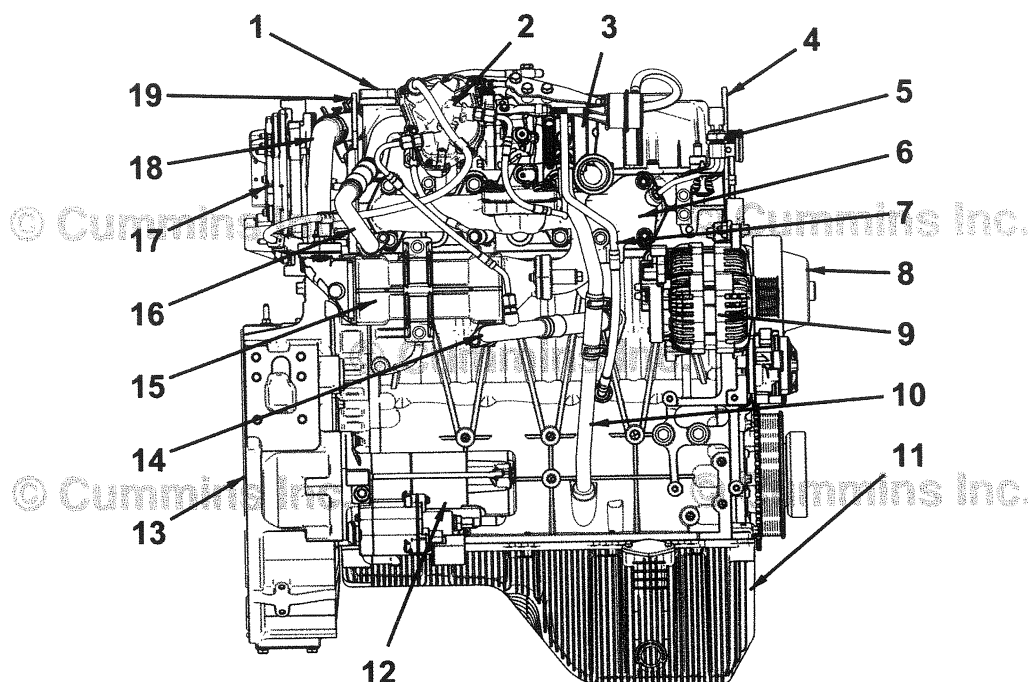
Rear View

00r00016

- 1 Rear engine lifting bracket
- 2 EGR crossover tube
- 3 Exhaust pressure regulator
- 4 Exhaust manifold
- 5 EGR coolant outlet tube
- 6 Alternator
- 7 EGR cooler
- 8 EGR coolant inlet tube
- 9 Flywheel housing
- 10 Flywheel
- 11 Lubricating oil dipstick
- 12 Intake air connection
- 13 Wiring harness
- 14 ECM
- 15 EGR valve.

Engine Diagrams

General Information



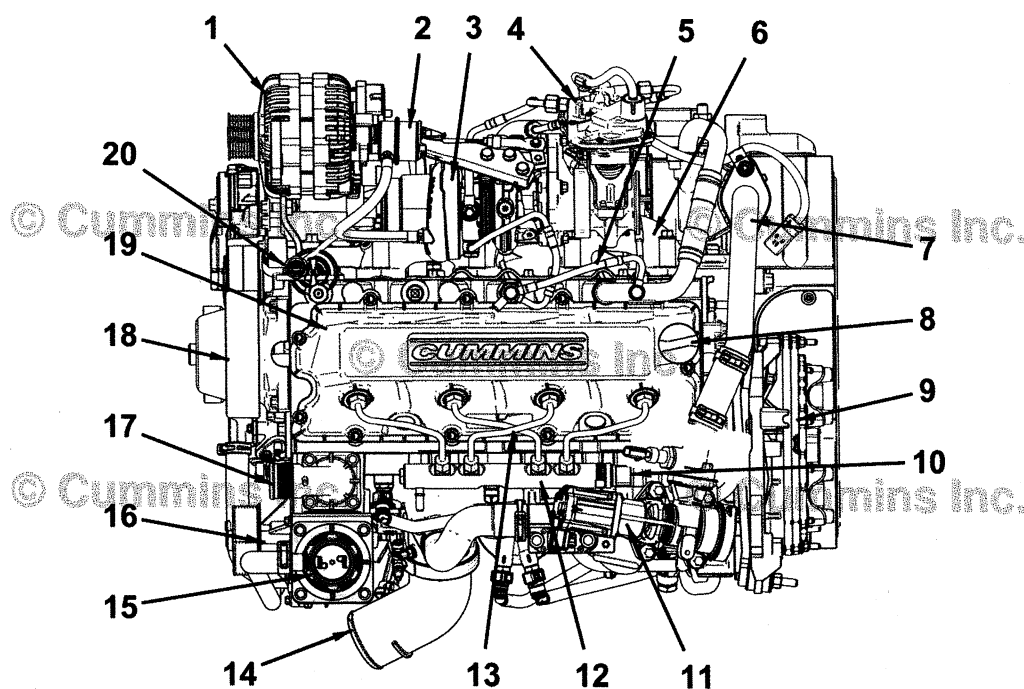
Right View

00r00018

- 1 Lubricating oil fill cap
- 2 Exhaust pressure regulator
- 3 Wastegate turbocharger
- 4 Front engine lifting bracket
- 5 Exhaust pressure sensor
- 6 Exhaust manifold
- 7 Turbocharger lubricating oil supply tube
- 8 Fan hub
- 9 Alternator
- 10 Turbocharger lubricating oil drain tube
- 11 Lubricating oil pan
- 12 Starting motor
- 13 Flywheel housing
- 14 EGR cooler coolant inlet tube
- 15 EGR cooler
- 16 EGR cooler coolant outlet tube
- 17 ECM
- 18 EGR crossover tube
- 19 Rear engine lifting bracket.

Engine Diagrams

General Information



Top View

00r00019

- 1 Alternator
- 2 Turbocharger wastegate actuator
- 3 Wastegate turbocharger
- 4 Exhaust pressure regulator
- 5 EGR coolant vent tube
- 6 Exhaust manifold
- 7 EGR crossover tube
- 8 Lubricating oil fill cap
- 9 ECM
- 10 Fuel rail pressure sensor
- 11 EGR valve
- 12 Common rail fuel manifold
- 13 Injector supply lines
- 14 Intake air connection
- 15 Open crankcase ventilation valve
- 16 Water pump
- 17 Water outlet connection (thermostat is underneath)
- 18 Fan hub
- 19 Rocker lever cover
- 20 Exhaust temperature sensor.

Cummins® Service Engine Model Identification
 General Information

The Cummins® Service Engine Model Identification procedure describes:

- The purpose of the Cummins® Service Model Name.
- How to interpret a Cummins® Service Model Name to identify a Cummins® Engine.

This includes 2013 and later products.

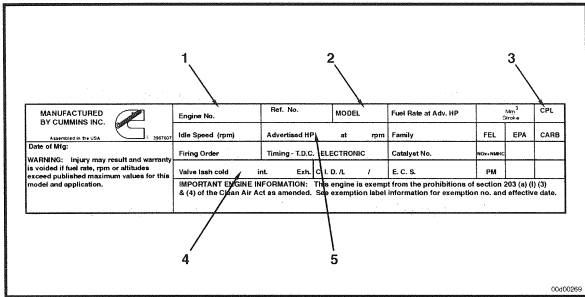
The Cummins® Service Model Name differs from the Cummins® marketing model name. Service model names are more specific and help to match the correct Cummins® service information to the correct engine. Marketing engine model names are more generic and can capture multiple engine variations in the same model name.

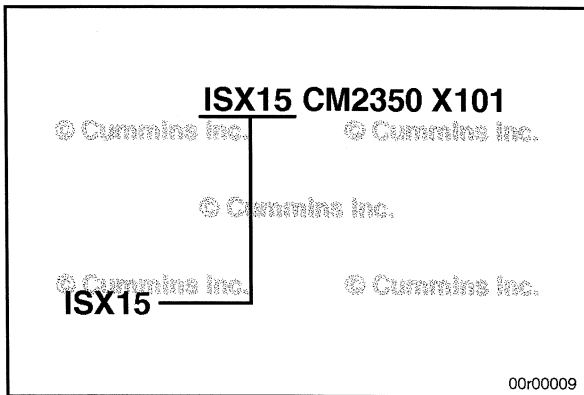
Marketing Engine Model Name	Service Model Name
ISX15	ISX15 CM2350 X101

Marketing engine model names (2) can be found on the engine dataplate, Cummins® brochures, and Cummins® promotional literature.

Examples of Cummins® service information and products that use service model names:

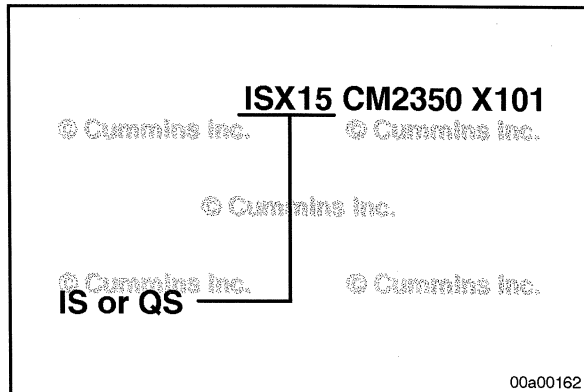
- QuickServe™ Online
- INSITE™ electronic service tool
- Owner's Manual
- Operation and Maintenance Manual
- Master Repair Manual
- Service Manual
- Wiring Diagram
- Fault Code Troubleshooting Manual
- Standard Repair Times
- Technical Service Bulletins
- Service Bulletins





The Cummins® Service Model Name begins with the marketing engine model name.

NOTE: For engines released specifically for the European market, marketing model names may include an “e” between the engine platform designation and the engine liter displacement. Service model names will not display this “e”.



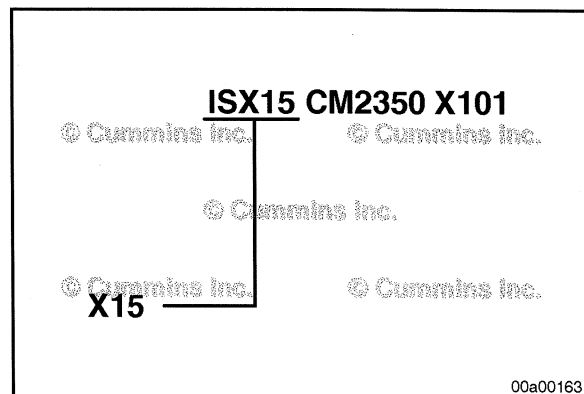
Typically, the first two letters of the marketing model name contain an “IS” or “QS” if the engine is an electronic engine.

“IS” prefix designates and On-Highway automotive engine.

“QS” prefix designates an Off-Highway industrial engine.

NOTE: Not all electronic engines use the “IS” or “QS” prefix. To verify if the engine is an electronic engine, check to see if an electronic control system is listed in the service model name. The control system that is identified as part of the service model name is referenced later in this procedure.

Non-electronic engines do not have an “IS” or “QS” prefix and do not have an electronic control system listed in the service model name.

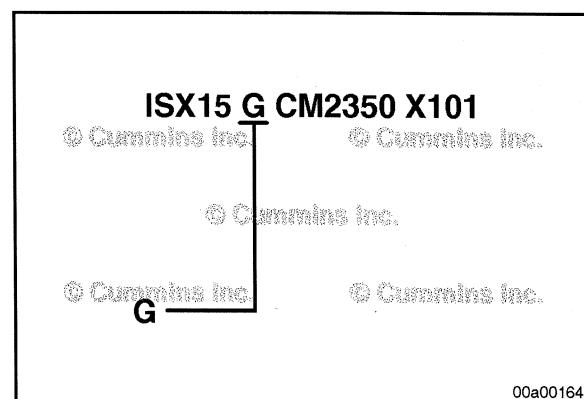


Typically, the third letter is the engine platform/series designation followed by the engine liter displacement. For the example shown in the graphic, the engine is a:

X Series engine

15 Liters in Displacement

NOTE: Some legacy engines will use the cubic inch rather than liter for engine displacement.



If a “G” indicator is located after the liter displacement, the engine is fueled by natural gas.

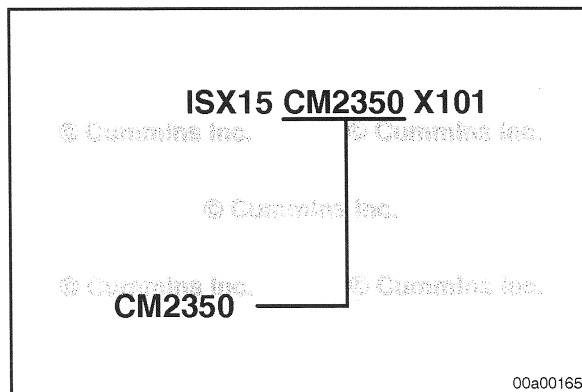
NOTE: Not all engines fueled by natural gas will have a “G” located after the displacement.

If a “M” is located after the liter displacement, the engine is in a marine application.

NOTE: Not all engines used in a marine application will have “M” located after the displacement.

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

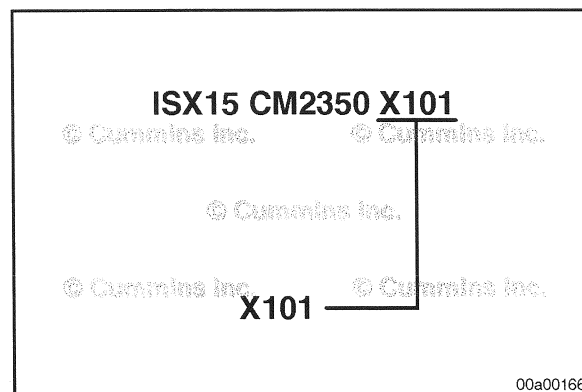
NOTE: Use of a parenthesis () indicates that either engine control module (ECM) has been used on the product. Use of a slash "/" indicates that the product has multiple ECMs.



The identifier after the control system is a letter and number combination to identify variations between products.

The letter is the engine platform designation.

The number increments as new variations of the engine platform/series are released. The first number is 101.



Cummins® Product Technology

General Information

The service model name for this product is **QSF3.8 CM2350 F107**.

This engine is being released to meet the following emission regulations:

United States and Canada

- Tier 4 (EPA Final).

European Union

- Stage IV (Euro).

This engine uses the following product agency defined emissions control system hardware, which can also be found on the engine dataplate. Use the following procedure for the location of the engine dataplate. Refer to Procedure 100-001 in Section E.

EPA Product

- Charge-Air Cooler (CAC).
- Direct Diesel Injection (DDI).
- Engine Control Module (ECM).
- Exhaust Gas Recirculation (EGR).
- Selective Catalytic Reduction - Urea (SCR-U).
- Turbocharger (TC).

This engine uses the following product technology:

Engine

- Number of Cylinders - 4.
- Engine Configuration - Inline.
- Cylinder Block Material - Cast Iron.
- Cylinder Head Material - Cast Iron.
- Camshaft Location - Cylinder Block.
- Accessory Drive Option.
- Crankcase Ventilation System - Open.

Air Handling

- Turbocharger (Single) - Wastegate.
- Charge-Air Cooler.
- Intake Air Heater.

Electronic Control System

- Engine Control Module (Single): CM2350.
- Electrical System Voltage.
- 12-VDC.
- 24-VDC.
- Engine Coolant Level Sensor.
- Engine Coolant Temperature Sensor.
- Engine Oil Pressure Switch.
- Fuel Rail Pressure Sensor.
- Fuel Pump Actuator.
- Water in Fuel Sensor.
- Camshaft Position Sensor.

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

- Crankshaft Position Sensor.
- EGR Differential Pressure Sensor.
- Exhaust Gas Pressure Sensor.
- Exhaust Temperature Sensor.
- EGR Temperature Sensor.
- Intake Manifold Pressure/Temperature Sensor.
- Aftertreatment Exhaust Gas Temperature Sensor.
- Diesel Exhaust Fluid Quality Sensor.
- Aftertreatment Intake NOx Sensor.
- Aftertreatment Outlet NOx Sensor.

Exhaust System

- Turbocharger Wastegate Assembly.
- Exhaust Pressure Regulator.
- Exhaust Gas Recirculation (EGR).
- Selective Catalytic Reduction (SCR) Catalyst.
- Aftertreatment Diesel Exhaust Fluid Dosing System.
- Integrated Diesel Exhaust Fluid Controller (controlled by the engine's ECM).

Fuel System

- Diesel.
- Common Rail Fuel System.
- Denso™ Common Rail Fuel System.

Market applications that will use this engine include, but are **not** limited to:

Industrial

- Construction.

[illegible]

Section 1 - Operating Instructions

Section Contents

	Page
Cold Weather Starting	1-5
General Information.....	1-5
Using Starting Aids.....	1-5
Driving Techniques	1-14
General Information.....	1-14
Electromagnetic Interference (EMI)	1-21
General Information.....	1-21
System EMI Radiation Levels.....	1-21
System EMI Susceptibility.....	1-21
Electronic Controlled Fuel System	1-14
Diagnostic Fault Codes.....	1-17
Engine Protection System.....	1-20
Fault Code Snapshot Data.....	1-20
General Information.....	1-14
INSITE™ Electronic Service Tool Description.....	1-20
INSITE™ Electronic Service Tool Monitor Mode.....	1-21
Engine Indicator Lamps	1-8
General Information.....	1-8
Engine Operating Range	1-13
General Information.....	1-13
Engine Shutdown	1-14
General Information.....	1-14
Normal Starting Procedure	1-2
Jump Starting.....	1-4
Starting.....	1-2
Operating Instructions - Overview	1-1
General Information.....	1-1
Operating the Engine	1-6
Ambient Temperature.....	1-6
Normal.....	1-6
Winterfronts and Shutters.....	1-7
Starting Procedure After Extended Shutdown or Oil Change	1-5
General Information.....	1-5
Unique Operating Characteristics of an Engine with Airless Selective Catalytic Reduction (SCR)	1-7
General Information.....	1-7

This Page Left Intentionally Blank

Operating Instructions - Overview



General Information

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

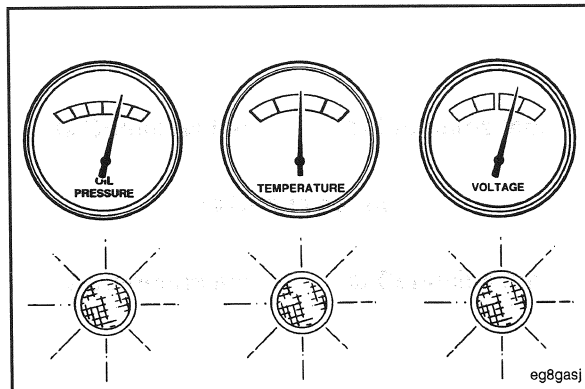
Follow the daily maintenance checks listed in Maintenance Guidelines (Section 2).

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

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



Check the oil pressure, coolant temperatures DEF level, and other engine parameters daily via the OEM front panel to make sure they are operational. Check the panel regularly for any alarm messages. Take appropriate action to rectify the alarm condition or contact your nearest Authorized Cummins® Distributor.



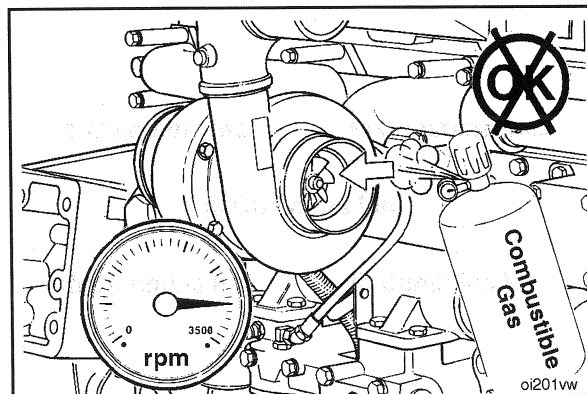
⚠ WARNING ⚠

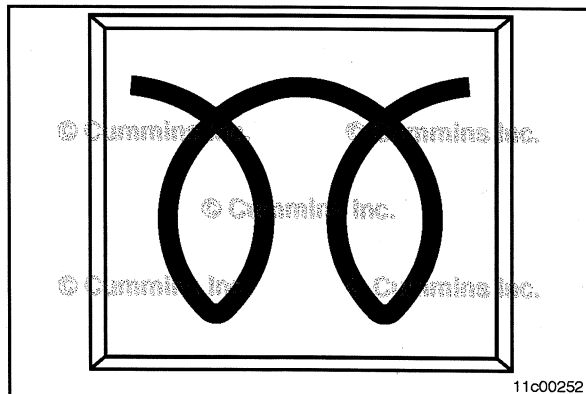
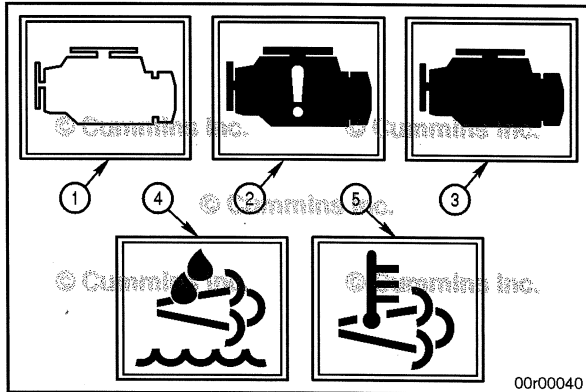
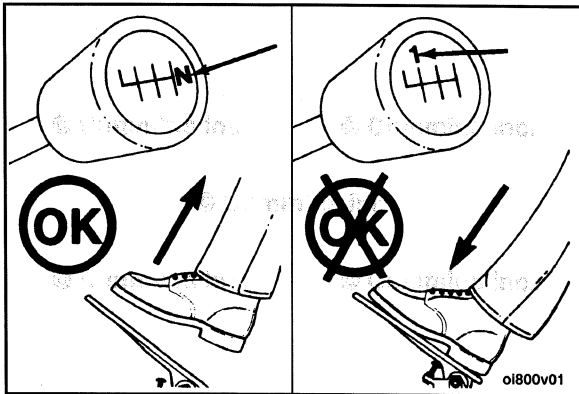
Do not operate a diesel engine where there are or can **BE COMBUSTIBLE** vapors. These vapors can be sucked through the air intake system and cause engine acceleration and over speeding that can result in a fire, an explosion, and extensive property damage. Numerous safety devices are available, such as air intake shutoff devices, to minimize the risk of over speeding where an engine, due to its application, is operating in a combustible environment, such as due to a fuel spill or gas leak. Remember, Cummins Inc. 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 A Cummins® Authorized Repair Location for further information.

⚠ CAUTION ⚠

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

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.





Normal Starting Procedure

Starting

Disengage the driving unit, or if equipped, put the transmission in NEUTRAL.

With the accelerator pedal or lever in the idle position, turn the keyswitch to the ON position.

With the keyswitch in the ON position, the engine indicator lamps will come on momentarily and then go out. The engine indicator lamps include:

- 1 WARNING (or CHECK ENGINE) lamp, amber in color
- 2 STOP (or STOP ENGINE) lamp, red in color
- 3 AFTERTREATMENT DIESEL EXHAUST FLUID lamp, amber in color
- 4 MALFUNCTION INDICATOR lamp, amber in color.
- 5 HIGH EXHAUST SYSTEM TEMPERATURE lamp, amber in color.

Use the following procedure if any of the lamps remain on or begin to flash. Refer to Procedure 101-048 in Section 1.

⚠CAUTION⚠

Do not engage the starting motor for more than 30 seconds or damage to the starting motor can result. Wait 2 minutes between each attempt to start (electrical starting motors only).

Under cold conditions, the Wait-to-Start lamp (generally a yellow lamp using a symbol similar to the graphic, or the words WAIT TO START) will illuminate at keyswitch ON, and will stay on for a period of up to 30 seconds.

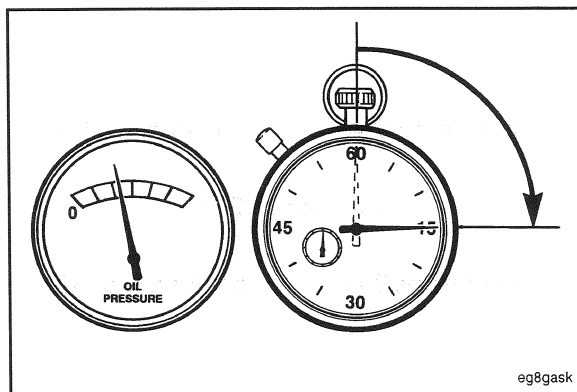
NOTE: The length of time the Wait-to-Start lamp remains illuminated depends on the ambient temperature. The lower the ambient temperature, the longer the lamp will be illuminated.

When the Wait-to-Start lamp turns off, turn the key to the starting position to start the engine.

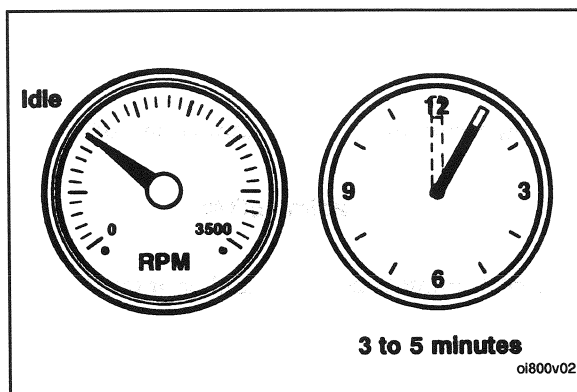
NOTE: Some vehicles are equipped with an engine starting motor protection feature. If the starting motor is engaged for 30 seconds or more, without the engine starting, the starting motor will stop operating, allowing for proper cooling of the starting motor. During this time, the Wait-to-Start lamp, if equipped, will flash for 2 minutes. Once the lamp stops flashing, the starting motor will be allowed to function.

⚠CAUTION⚠

The engine must have adequate oil pressure within 15 seconds after starting. If the **WARNING** lamp indicating low oil pressure has not gone out or there is no oil pressure indicated on a gauge within 15 seconds, shut **OFF** the engine immediately to avoid engine damage.



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



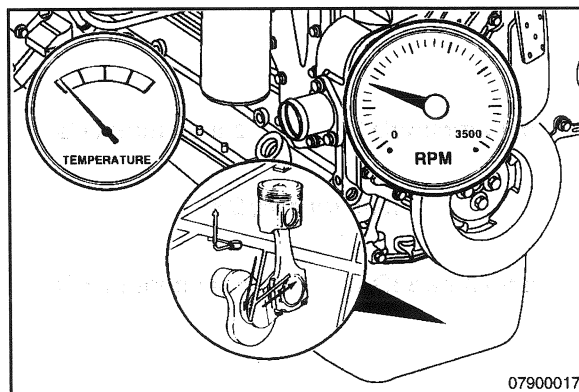
After starting a cold engine, increase the engine speed (rpm) slowly to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.

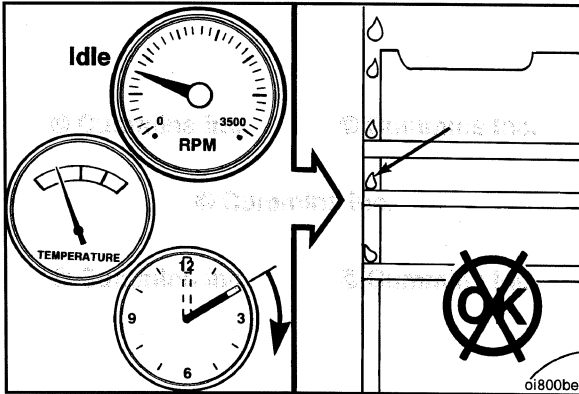
NOTE: For engines equipped with the engine warm-up protection feature; this feature limits engine speed and torque following engine start-up until sufficient oil pressure is available to the engine components. This feature reduces the risk of engine part damage due to operating at engine speeds too high or loads before adequate oil pressure is achieved.

Some engines are equipped with a Fast Idle Warm Up feature. When enabled, this feature elevates the idle speed of the engine in cold ambient conditions, in order to shorten the time necessary to warm up the engine. When the idle speed is elevated, the engine noise may change. This is normal. To bring the engine back to low idle speed:

- For vehicles equipped with a manual transmission and clutch switch: Depress the clutch pedal.
- For vehicles equipped with a brake switch: Depress the service brake pedal.
- Depress the accelerator pedal.

For more information on the Fast Idle Warm Up feature, contact a Cummins® Authorized Repair Location.





⚠ CAUTION ⚠

Do not operate the engine at low idle for long periods with engine coolant temperature below the minimum specification in Maintenance Specifications in Section V.

This can result in the following:

- Fuel dilution of the lubricating oil
- Carbon buildup in the cylinder
- Cylinder head valve sticking
- Reduced performance.

Jump Starting

⚠ WARNING ⚠

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

⚠ CAUTION ⚠

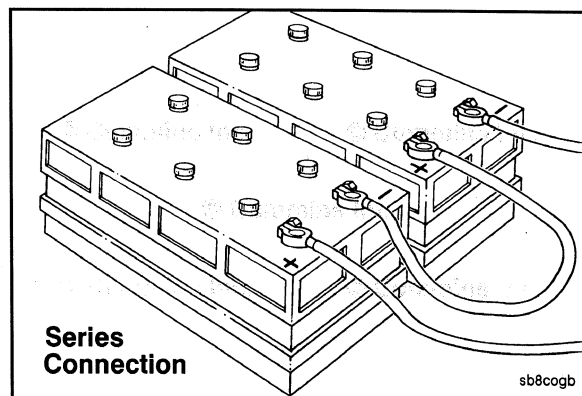
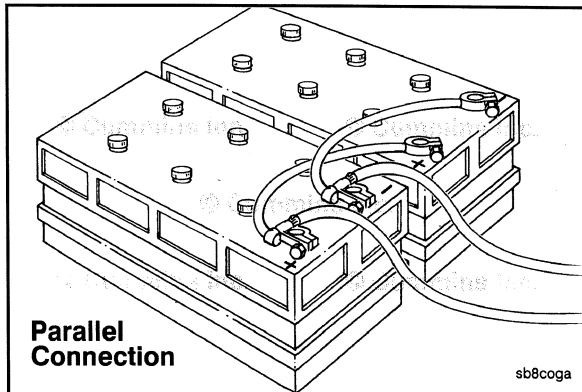
When using jumper cables to start the engine, make sure to connect the cables in parallel: positive (+) to positive (+) and negative (-) to negative (-). When using an external electrical source to start the engine, turn the disconnect switch to the OFF position. Remove the key before attaching the jumper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

⚠ CAUTION ⚠

To reduce the possibility of damage to engine parts, do not connect jumper starting or battery charging cable to any fuel system or electronic component.

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

NOTE: See equipment manufacturer service information for jump starting procedures. Failure to follow correct procedures can result in damage to the engine control module and other electrical equipment.



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

NOTE: See equipment manufacturer service information for jump starting procedures. Failure to follow correct procedures can result in damage to the engine control module and other electrical equipment.

Cold Weather Starting

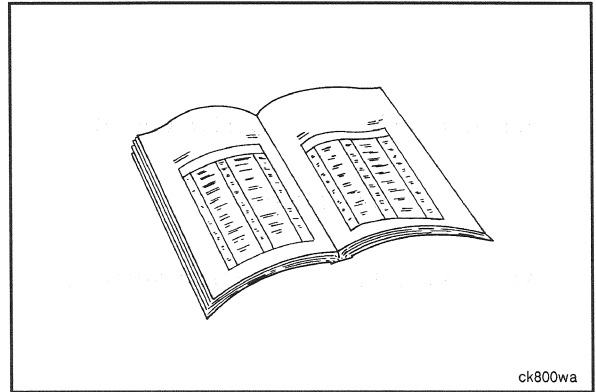
General Information

⚠ CAUTION ⚠

To reduce the possibility of damage to the lubricating oil pan, due to the composite materials used in the manufacture of the lubricating oil pan, under no circumstances should an external heat source be applied directly or indirectly to the lubricating oil pan.

Follow the Normal Starting Procedure in this section. If equipped with an intake air heater, the Wait-To-Start lamp will stay on longer.

Refer to the OEM service manual for any additional cold weather starting procedures.



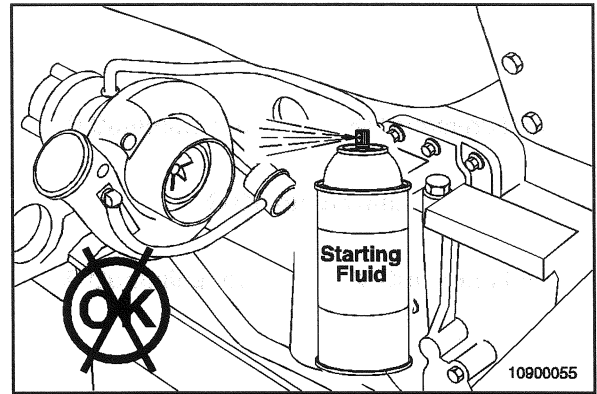
ck800wa

Using Starting Aids

⚠ WARNING ⚠

Do not use starting fluids with this engine. This engine is equipped with an intake air heater; use of starting fluid can cause an explosion, fire, personal injury, severe damage to the engine, and property damage.

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

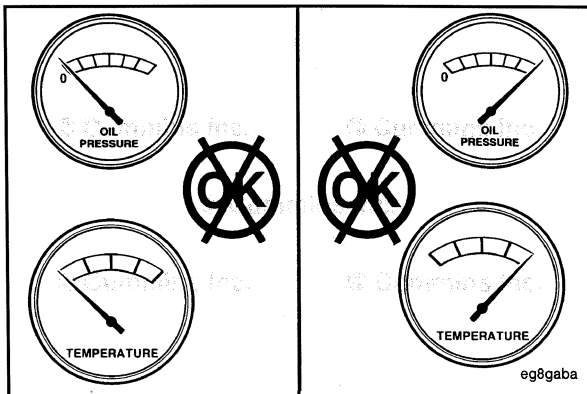


10900055

Starting Procedure After Extended Shutdown or Oil Change

General Information

Follow the Normal Starting Procedure in this section. The engine will **not** start until the minimum cranking oil pressure is detected by the ECM. It can take more cranking time to start the engine after an extended shutdown or oil change.



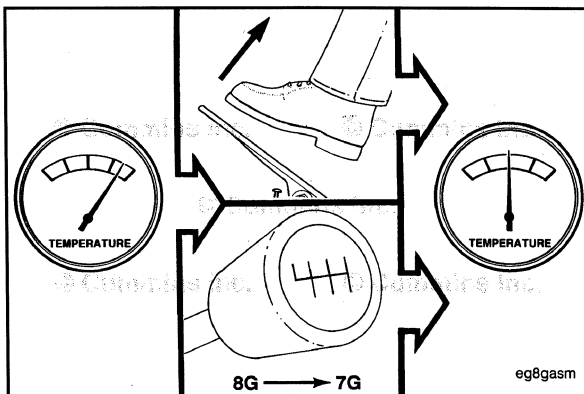
Operating the Engine

Normal

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

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

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



⚠CAUTION⚠

Do not idle for extended periods of time. Excessive idle time can cause poor engine performance.

Internal combustion engines **must not** operate at low idle speed for extended periods of time. This operating condition may lead to poor engine performance. The idle shutdown feature, available on most Cummins® engines, can be programmed to shut the engine down after a period of low idle speed operation with no driver activity. A flashing warning lamp will inform the driver of an impending shutdown. If an engine **must** idle for an extended period of time, it should be done at fast idle (1000 rpm or greater). The Power Take-Off (PTO) feature, available on most Cummins® engines, can be programmed to adjust engine speed with the use of OEM switches to pre-programmed set points.

Ambient Temperature

0 to -32°C [32 to -25°F]

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

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

-32 to -54°C [-25 to -65°F]

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

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

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

Winterfronts and Shutters

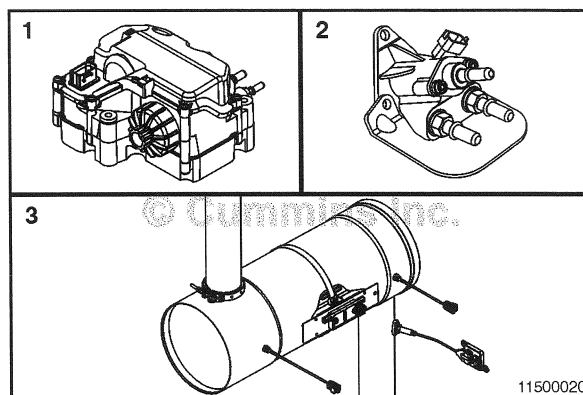
Winterfronts and shutters can be used on a vehicle or equipment to reduce air flow through the radiator core into the engine compartment. This can reduce the time required to warm the engine and help maintain the engine coolant temperature. The engine coolant temperature specifications are in the Maintenance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

Unique Operating Characteristics of an Engine with Airless Selective Catalytic Reduction (SCR)

General Information

The selective catalytic reduction (SCR) system is used to decrease the NO_x emissions from the vehicle tailpipe. The system is composed of several main components:

- 1 Aftertreatment diesel exhaust fluid (DEF) dosing unit
- 2 Aftertreatment DEF dosing valve
- 3 Aftertreatment SCR catalyst.



NOTE: It is unlawful to tamper with, modify, or remove any component of the SCR system. It is also unlawful to use DEF that does **not** meet the specifications provided or to operate the vehicle/equipment with no DEF.

DEF is required for an engine equipped with a SCR system. DEF is a fluid that is sprayed into the exhaust gas prior to the aftertreatment SCR catalyst. The DEF vaporizes and decomposes to form carbon dioxide and ammonia. The ammonia reacts with the NOx emissions over the aftertreatment SCR catalyst to form nitrogen and water.

DEF:

- may have a slight ammonia smell
- is colorless
- is non-toxic and non-polluting
- is non-flammable.
- Urea is naturally occurring and is biodegradable.

See the following procedure for DEF specifications. Refer to Procedure 018-026 in Section V.

NOTE: Cummins Inc. supplies the aftertreatment DEF dosing unit, aftertreatment DEF dosing valve, and the aftertreatment SCR catalyst. The vehicle manufacturer supplies the DEF tank, the DEF lines, the DEF tank temperature, level sensor, and all wiring between the components.

The aftertreatment DEF dosing unit pumps DEF from the DEF tank to the aftertreatment DEF dosing valve. The aftertreatment DEF dosing unit is electrically heated and contains a filter that is a maintenance item.

See the following procedure for the aftertreatment DEF dosing unit filter maintenance interval. Refer to Procedure 102-002 in Section 2.

The aftertreatment DEF dosing valve is coolant cooled, and sprays DEF into the exhaust.

The aftertreatment SCR catalyst uses DEF to reduce the nitrogen oxide emissions from the engine out of the exhaust into nitrogen and water. The aftertreatment SCR catalyst itself requires no maintenance.

A vehicle with SCR is equipped with an additional lamp on the dashboard. This is the aftertreatment DEF lamp. This lamp, along with the check engine lamp and stop engine lamp, alert the operator to the level of DEF in the tank. As the DEF tank level approaches empty, the aftertreatment DEF lamp illuminates and engine power is reduced. Attempting to operate the vehicle with no DEF in the tank will result in the vehicle speed being limited to 8 kmh [5 mph].

See the following procedure for additional information on the aftertreatment diesel fluid lamp and associated engine derates. Refer to Procedure 101-048 in Section 1.

DEF is sprayed into the exhaust when the temperature in the aftertreatment SCR catalyst reaches approximately 250°C [482°F]. The amount of DEF consumed differs from vehicle to vehicle, as DEF consumption depends on engine speed and load.

Even though DEF freezes at approximately -12°C [11°F], the SCR system is designed to be frozen and thawed. The DEF tank is heated by engine coolant and the DEF lines and aftertreatment DEF dosing unit are electrically heated. No operator interaction is needed when operating in cold temperatures; heating and thawing are controlled automatically by the ECM.

After turning the keyswitch OFF on a vehicle with SCR, a pumping sound will possibly be heard from beneath the vehicle. This sound is the aftertreatment DEF dosing unit purging any unused DEF from the system and returning it to the tank. This is normal system operation. The purge process takes approximately 60 seconds to complete. Do **not** disconnect the vehicle batteries during this process to reduce the possibility of system damage.

Under certain conditions (cold or very dry), water condensation, in the form of water vapor, can be seen coming from the vehicle tailpipe. This is normal operation and will clear within a few minutes of normal vehicle operation.

Engine Indicator Lamps

General Information

The following engine indicator lamps cover **only** the lamps controlled by the engine control module (ECM). The equipment manufacturer can provide additional indicator lamps. Please refer to the equipment owners manual for additional lamp information.

The regulated engine derate conditions vary depending on the original equipment manufacturer (OEM) and local regulations. See equipment manufacturer service information for additional derate information.

NOTE: The start and permit switches, as well as the SCR/exhaust system cleaning lamp, are common with other Cummins® systems utilizing a diesel particulate filter (DPF). Some OEMs, documentation, and tools may reference these as Aftertreatment Diesel Particulate Filter Regeneration or Aftertreatment Regeneration parameters.

Wait to Start Lamp

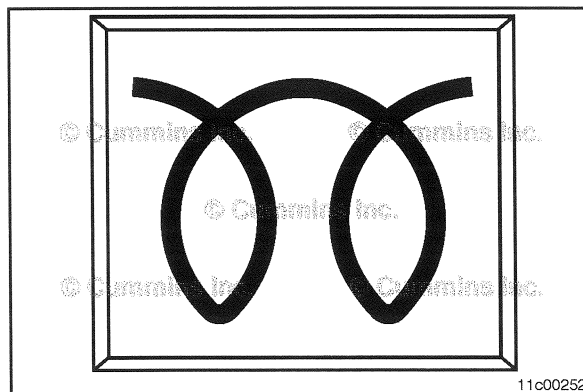
The WAIT TO START lamp illuminates when the intake air heater needs to warm the intake air prior to starting the engine.

The time for the WAIT TO START lamp to be on will vary, depending on the ambient air temperature. See Normal Starting Procedure in Section 1. Refer to Procedure 101-014 in Section 1.

For vehicles equipped with an engine starting motor protection feature, another function of the WAIT TO START lamp is to flash for two minutes if the starting motor is engaged for 30 seconds or more.

The WAIT TO START lamp can look like:

- The words WAIT TO START spelled out
- A symbol similar to the graphic illustrated
- The color of the symbol or words can vary, based on the manufacturer of the vehicle, but will typically be red or amber.



Check Engine Lamp

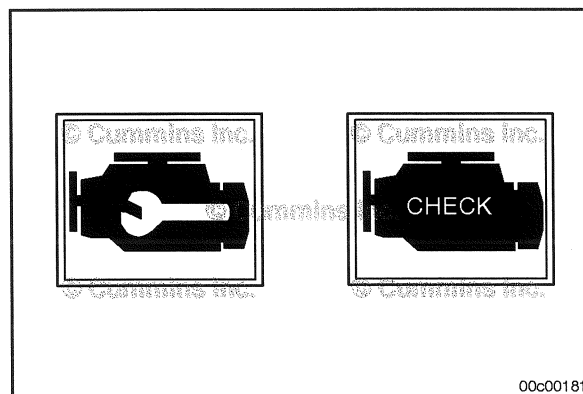
The CHECK ENGINE lamp illuminates when the engine needs to be serviced at the first available opportunity.

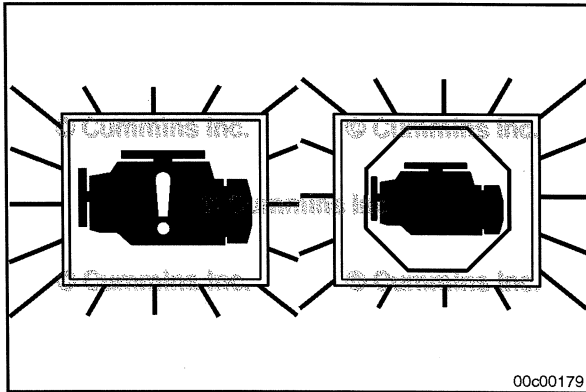
The CHECK ENGINE lamp is amber, and can look like:

- The words WARNING or CHECK ENGINE spelled out
- A symbol of an engine, similar to the graphic illustrated.

Another function of the CHECK ENGINE lamp is to flash for 30 seconds at key ON when one of the following occurs. This flashing function is referred to as the MAINTENANCE lamp. The MAINTENANCE lamp could flash for any of the following reasons:

- Maintenance required (if the Maintenance Monitor is enabled)
- Water-in-fuel is detected
- Low engine lubricating oil level, if equipped with an engine lubricating oil level sensor
- Coolant level is low.





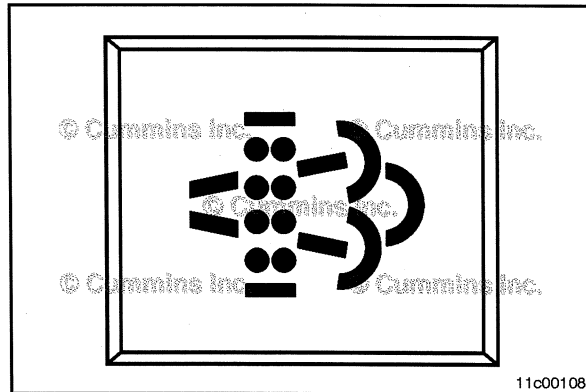
Stop Engine Lamp

The STOP ENGINE lamp indicates, when illuminated, the need to stop the engine as soon as it can be safely done. The engine **must** remain shut down until the engine can be repaired.

For engines with the Engine Protection Shutdown feature enabled, if the STOP ENGINE lamp begins to flash, the engine will automatically shut down after 30 seconds. The flashing STOP engine lamp alerts the operator to the impending shutdown.

The STOP ENGINE lamp is red in color, and can look like:

- The words STOP or STOP ENGINE spelled out
- A symbol of an engine with an exclamation point in the center, similar to the graphic illustrated.

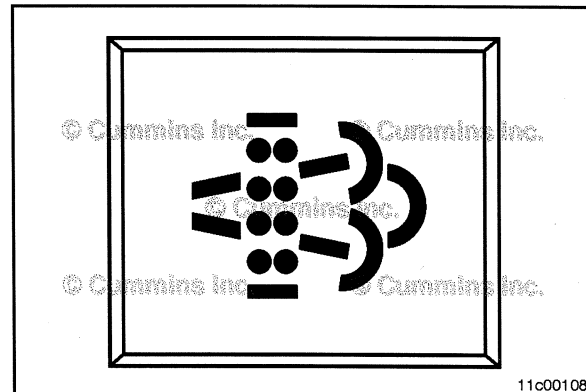


SCR System Cleaning Lamp

The SCR SYSTEM CLEANING lamp indicates the status of the aftertreatment SCR system cleaning events. An illuminated SCR SYSTEM CLEANING lamp indicates that the aftertreatment SCR system needs to be cleaned at the next opportunity. This can be accomplished by:

- 1 Changing to a more challenging duty cycle, such as highway driving, for at least 20 minutes.
- 2 Performing a stationary SCR/exhaust system cleaning. Refer to Procedure 101-050 in Section 1.

NOTE: Stationary SCR/exhaust system cleaning is considered a normal practice and is not covered by Cummins Inc. warranty.



A flashing SCR SYSTEM CLEANING lamp indicates the status of a non-mission (stationary) SCR/ exhaust system cleaning when the SCR System Cleaning Start switch has been activated. See the following procedure for more information on the Start Conditioning switch. Refer to Procedure 101-050 in Section 1. When this lamp is flashing, the operator should:

- 1 Keep the exhaust outlet away from people and anything that can burn, melt, or explode.
- 2 Nothing within 0.6 m [2 ft] of the exhaust outlet.
- 3 Nothing that can burn, melt, or explode within 1.5 m [5 ft] (such as gasoline, wood, paper, plastics, fabric, compressed gas containers, or hydraulic lines).
- 4 In an emergency, turn the engine off to stop the flow of exhaust.

High Exhaust System Temperature Lamp

⚠ WARNING ⚠

When this lamp is illuminated, the exhaust gas temperature could reach 800°C [1500°F], which is hot enough to ignite or melt common materials, and to burn people.

The HIGH EXHAUST SYSTEM TEMPERATURE lamp indicates, when illuminated, that exhaust temperatures are high due to regeneration of the aftertreatment diesel particulate filter. The lamp could illuminate during normal engine operation or during regeneration.

NOTE: The OEM determines whether or **not** the HIGH EXHAUST SYSTEM TEMPERATURE lamp is installed on the vehicle. The OEM also specifies the temperatures, vehicle speeds, and other conditions at which the lamp illuminates. See equipment manufacturer service information for additional information regarding this lamp.

When this lamp is illuminated, be sure the exhaust pipe outlet is **not** directed at any surface or material that can melt, burn, or explode.

- Keep the exhaust outlet away from people and anything that can burn, melt, or explode.
- Nothing within 0.6 m [2 ft] of the exhaust outlet.
- Nothing that can burn, melt, or explode within 1.5 m [5 ft] (such as gasoline, wood, paper, plastics, fabric, compressed gas containers, or hydraulic lines).
- In an emergency, turn the engine off to stop the flow of exhaust.

NOTE: The HIGH EXHAUST SYSTEM TEMPERATURE lamp does **not** signify the need for any kind of vehicle or engine service; It merely alerts the vehicle operator to high exhaust temperatures. It will be common for the HIGH EXHAUST SYSTEM TEMPERATURE lamp to illuminate on and off during normal vehicle operation as the engine completes regeneration.

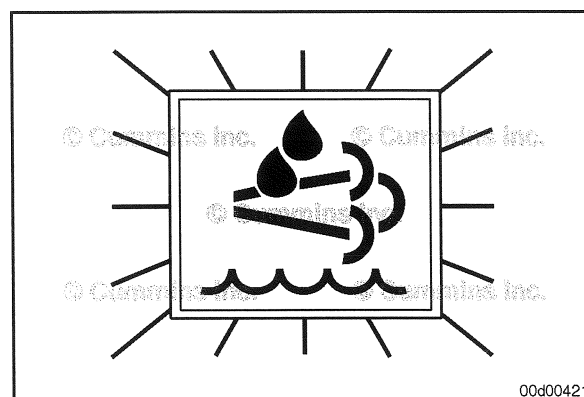
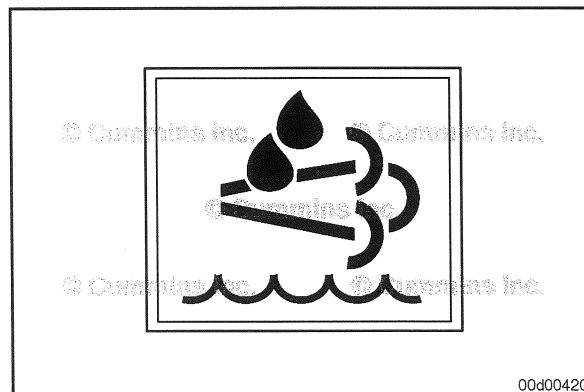
Aftertreatment Diesel Exhaust Fluid Lamp

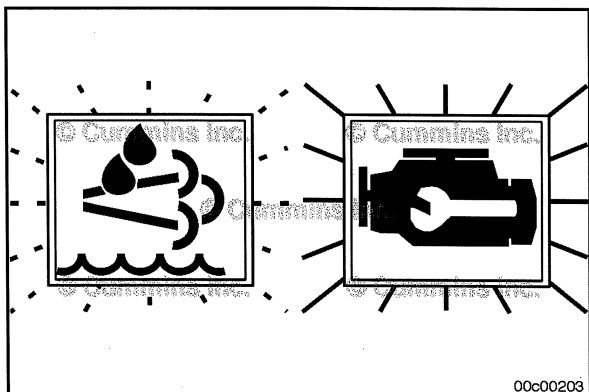
The AFTERTREATMENT DIESEL EXHAUST FLUID lamp indicates, when illuminated or flashing, that the DEF level is low.

NOTE: The OEM determines whether or **not** the HIGH EXHAUST SYSTEM TEMPERATURE lamp is installed on the vehicle. The OEM also specifies the temperatures, vehicle speeds, and other conditions at which the lamp illuminates. See equipment manufacturer information for additional information regarding this lamp.

An illuminated AFTERTREATMENT DIESEL EXHAUST FLUID lamp indicates that the DEF level has fallen below the initial warning level. This can be corrected by filling the DEF tank with DEF.

NOTE: It is recommended that the DEF tank be filled completely full of DEF in order to correct any fault conditions.



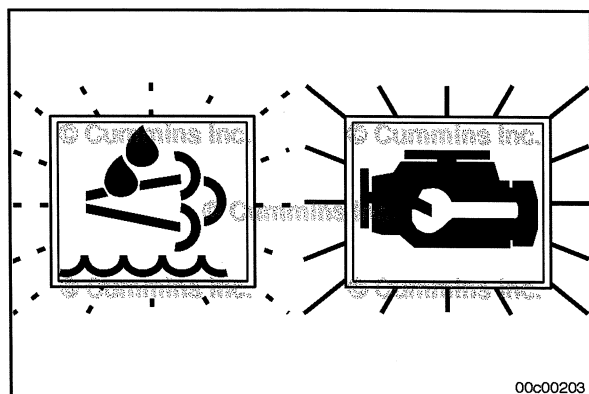


A flashing AFTERTREATMENT DIESEL EXHAUST FLUID lamp indicates that the DEF level has fallen below the critical warning level. This can be corrected by filling the DEF tank with DEF.

NOTE: It is recommended that the DEF tank be filled completely full of DEF in order to correct any fault conditions

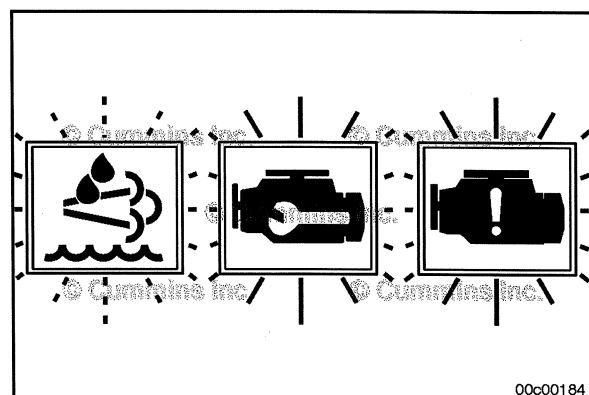
NOTE: In order to remove the final derate, the DEF tank must be filled to above 10 percent gauge reading.

NOTE: It is recommended that the DEF tank be filled completely full of DEF in order to correct any fault conditions



Allowing the DEF tank to become empty will cause the aftertreatment DEF dosing system to lose prime. A loss of prime condition may cause fault codes to become active. If corrective action is **not** taken within 30 minutes of the CHECK ENGINE lamp illumination, the engine will enter the final derate level, which may include throttle lock or engine shutdown with possible restart limitations

NOTE: It is recommended that the DEF tank be filled completely full of DEF in order to correct any fault conditions



If the engine has been shut down or has idled for an extended period of time after the DEF gauge indicates empty, the STOP ENGINE lamp will also be illuminated along with the flashing AFTERTREATMENT DIESEL EXHAUST FLUID lamp and illuminated CHECK ENGINE lamp. The engine will enter the final derate level which may include low idle lock or engine shutdown with restart limitations.

NOTE: Some emergency vehicles may perform differently from the description above.

NOTE: In order to remove the final derate, the DEF tank must be filled to above 10 percent gauge reading.

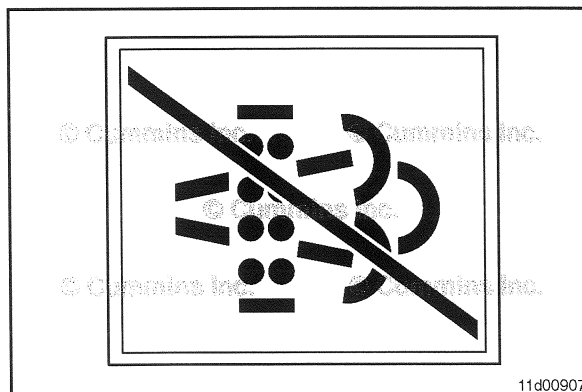
NOTE: It is recommended that the DEF tank be filled completely full of DEF in order to correct any fault conditions

SCR System Cleaning Inhibited Lamp

The SCR SYSTEM CLEANING DISABLED (INHIBIT) LAMP indicates that the inhibit switch is active, therefore automatic and manual (non-mission) SCR/exhaust system cleaning can **not** occur.

An illuminated SCR SYSTEM CLEANINGDISABLED (INHIBIT) lamp indicates that theinhibit switch is active and automatic ormanual (non-mission) SCR/exhaust systemcleaning will **not** occur. This can be correctedby switching the inhibit switch to permit mode. Refer to Procedure 101-050 in Section 1.

NOTE: The OEM determines whether or **not** the HIGH EXHAUST SYSTEM TEMPERATURE lamp is installed on the vehicle. The OEM also specifies the temperatures, vehicle speeds, and other conditions at which the lamp illuminates. See equipment manufacturer information for additional information regarding this lamp.



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.

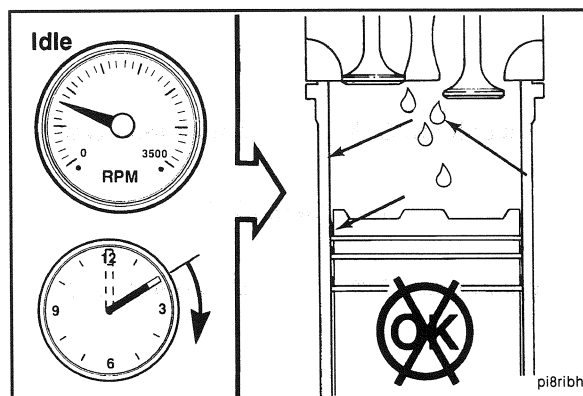
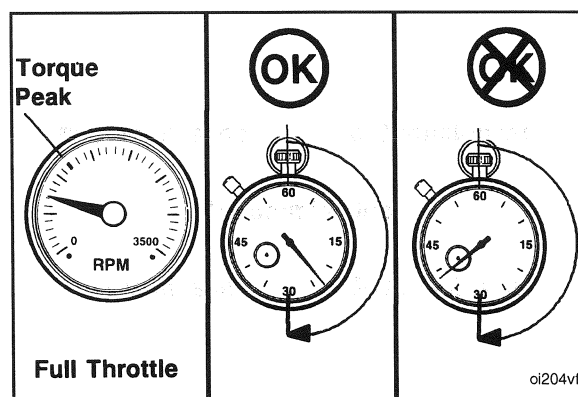
Cummins® engines are designed to operate successfully at full throttle under transient conditions down to peak torque engine speed. This is consistent with recommended operating practices.

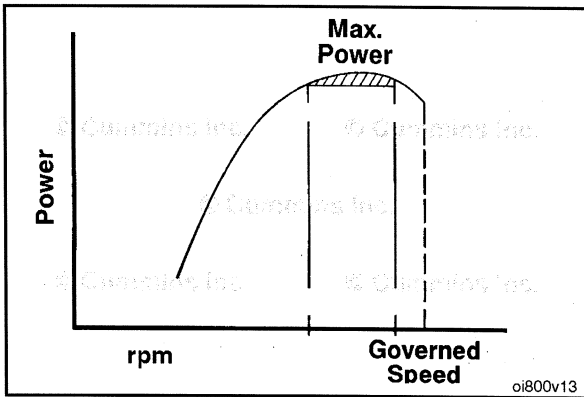
⚠CAUTION⚠

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).

⚠CAUTION⚠

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





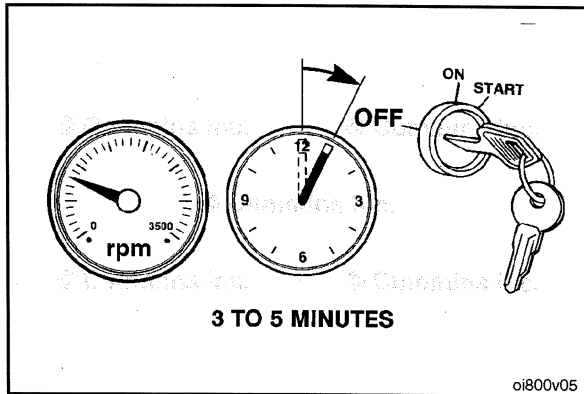
Driving Techniques

General Information

The engine produces maximum power at an rpm less than governed engine speed.

To obtain optimum engine performance on a grade, allow the engine speed to load down to near peak torque before shifting. This will result in an engine operating speed in the maximum power zone after the shift is completed.

Refer to the engine dataplate for peak torque rpm and governed speed rpm.



Engine Shutdown

General Information

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

NOTE: For engines equipped with an electronic control module (ECM) ensure the keyswitch is turned off for a minimum of 70 seconds prior to disconnecting the continuous (unswitched) battery power supply. If the unswitched battery power supply is disconnected in less than 70 seconds after the keyswitch is turned off active fault codes and incorrect ECM information can occur.

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

⚠CAUTION⚠

Failure to follow the correct shutdown procedure may result in damage to the turbocharger and shorten the turbocharger life.

Electronic Controlled Fuel System

General Information

The engine control module (ECM) is an electronically operated fuel control system that also provides many operator and vehicle features.

The base functions of the control system include fueling and timing control, limiting the engine speed operating range between the low and the high idle set points, and reducing exhaust emissions while optimizing engine performance.

The control system uses inputs from the operator and its sensors to determine the fueling and timing required to operate at the desired engine speed and the required emissions level.

Engine Control Module Inputs

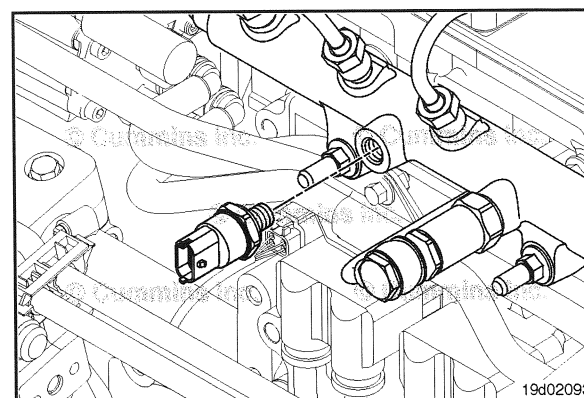
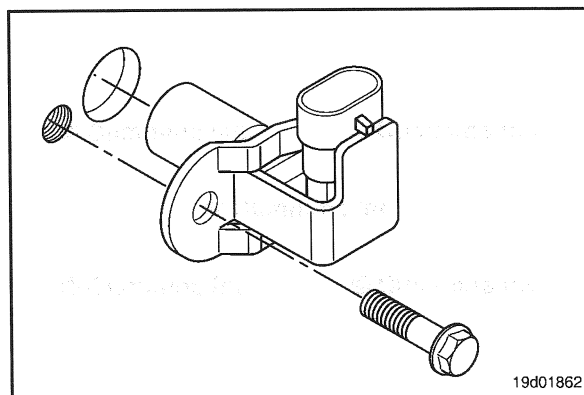
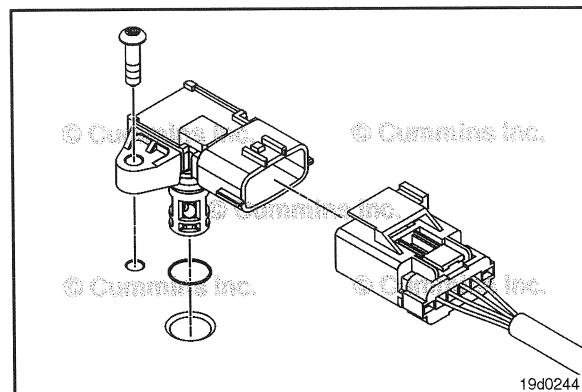
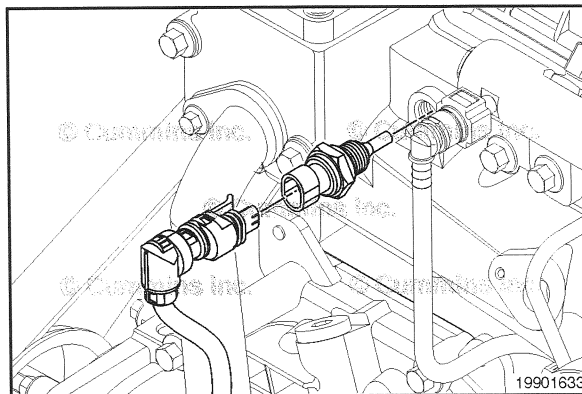
The ECM is the control center of the system. It processes all of the inputs and sends commands to the fuel system, vehicle, and engine control devices.

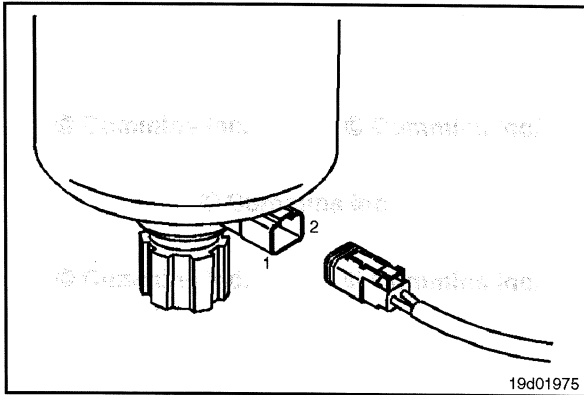
The ECM performs diagnostic tests on **most** of its circuits and will activate a fault code if a problem is detected in one of these circuits. Along with the fault code identifying the problem, a snapshot of engine operating parameters at the time of fault activation is also stored in memory.

Active fault codes will cause a diagnostic lamp to activate as a signal to the operator.

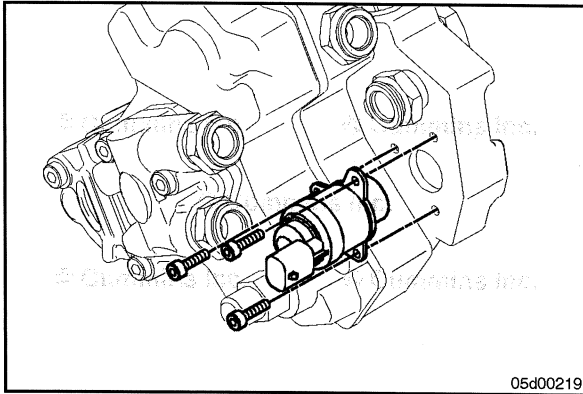
The control system uses a number of sensors to provide information on engine operating parameters. These sensors include:

- Engine coolant temperature sensor.
- Ambient air and turbocharger compressor inlet temperature sensor.
- Engine speed (crankshaft position) sensor
- Camshaft position sensor.
- Fuel rail pressure sensor.

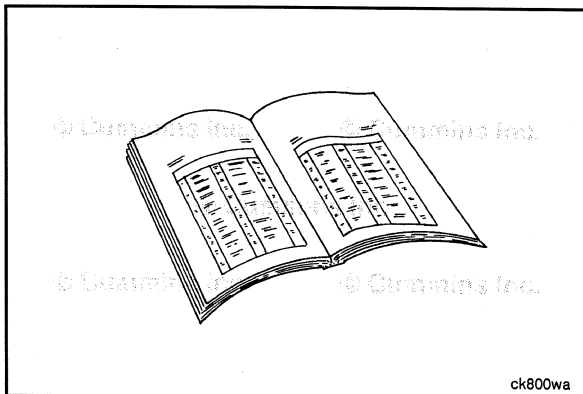




- Water-in-fuel sensor.



- Electronic fuel control actuator.



- Exhaust gas recirculation (EGR) valve
- Exhaust manifold pressure sensor
- Exhaust return temperature sensor
- EGR differential pressure sensor
- Accelerator pedal/lever position sensor
- Idle validation switch
- Engine coolant level sensor
- Vehicle speed sensors
- Feature control switches (i.e. cruise control switches)
- Fan control switch
- Air conditioner pressure switch
- Remote accelerator
- Remote power takeoff (PTO).

NOTE: These inputs are application dependent. Some applications do **not** use all of these inputs.

Engine Control Module Outputs

The ECM can communicate with service tools and some other vehicle controllers (such as transmissions, ABS, ASR, electronic dash displays, etc) through the Society of Automotive Engineers (SAE) J1939 data link or the SAE J1708 data link.

Some vehicles and equipment have SAE J1939 networks on them that link many of the "smart" controllers together. Vehicle control devices can temporarily command engine speed or torque to perform one of their functions (that is, transmission shifting, anti-lock braking, etc).

Diagnostic Fault Codes

The electronic engine control system displays and records certain detectable fault conditions. These failures are displayed as fault codes, which make troubleshooting easier. The fault codes are retained in the ECM.

There are two types of diagnostic codes:

- Engine electronic control system fault codes inform the operator that there is a problem with the control system that requires troubleshooting.
- Information and engine protection fault codes inform the operator that the control system has detected an engine condition outside the normal operating range.

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

The "STOP" or "STOP ENGINE" lamp is red and indicates the need to stop the engine as soon as it can be safely done. The engine **must** remain shut down until the engine can be repaired.

When illuminated, the yellow "WARNING" or "CHECK ENGINE" lamp indicates that the engine is in need of repair at the first available opportunity.

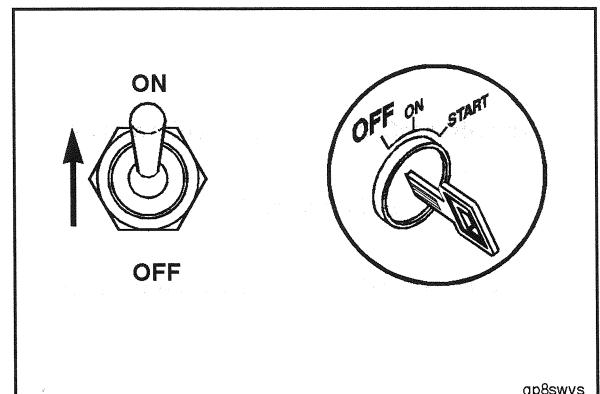
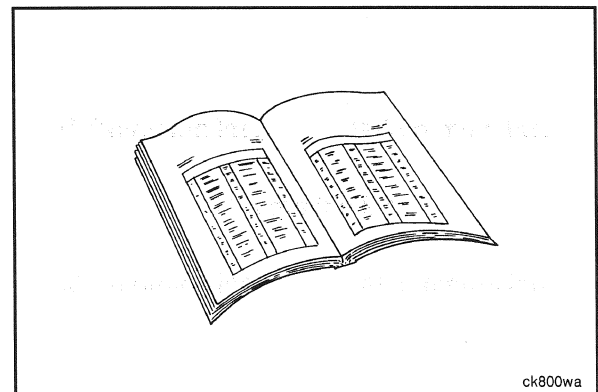
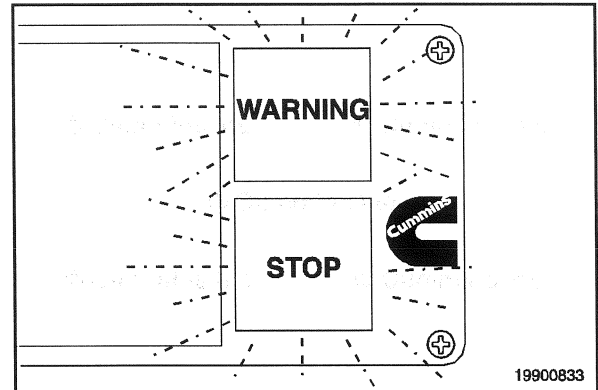
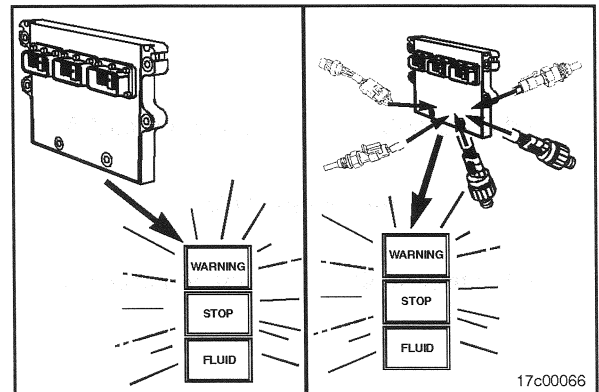
Another function of the WARNING or CHECK ENGINE lamp (yellow lamp) is to flash for 30 seconds at key ON when one of the following occurs:

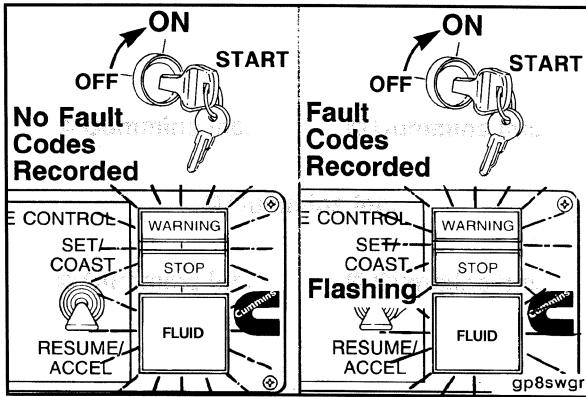
- Maintenance is required (if the Maintenance Monitor feature is enabled)
- Water-in-fuel is detected.

If the warning light flashes for 30 seconds at keyswitch ON and water is drained from the primary water-separating fuel filter, the secondary fuel filter **must** be replaced.

Fault codes can be accessed using the electronic service tool or by fault code flash out.

To check for active engine electronic fuel system and engine protection system fault codes, turn the keyswitch OFF and move the diagnostic switch to the ON position.

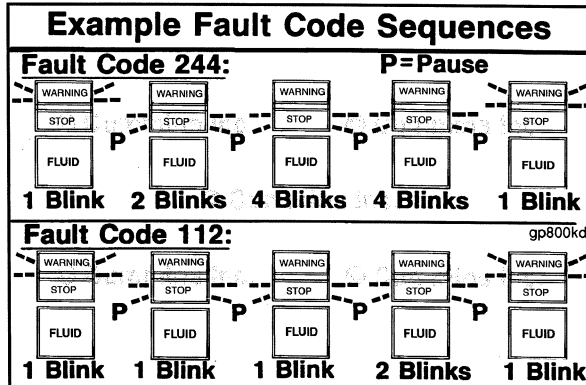




Turn the vehicle keyswitch to the ON position.

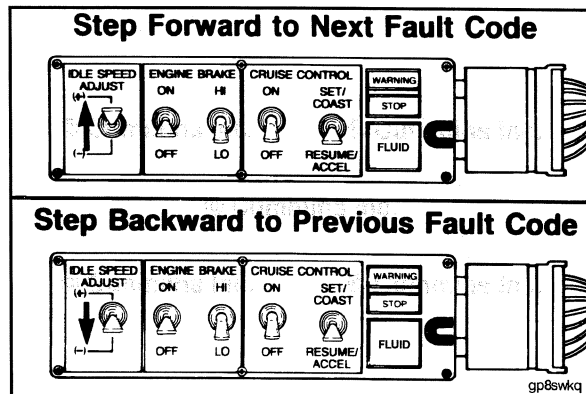
If no active fault codes are recorded, both lights will come on and stay on.

If active fault codes are recorded, both lights will come on momentarily, then begin to flash the code numbers of the recorded fault codes.

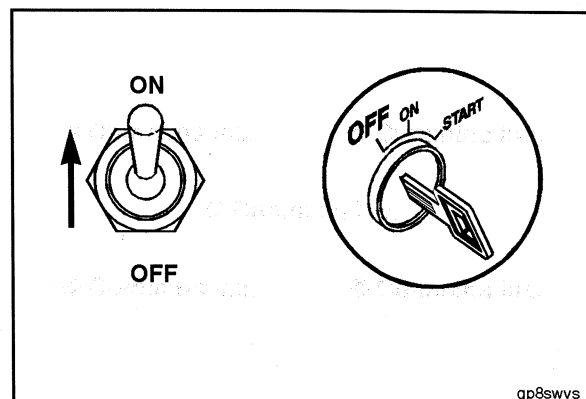


The fault code flashes in the following sequence:

- A WARNING (amber) light flashes.
- Following a short one or two second pause, the number of the recorded fault code flashes in the STOP (red) lamp.
- There is a one or two second pause between each number.
- After the number finishes flashing in red, an amber light appears again.



The lights flash each fault code out three times before advancing to the next code. To skip to the next fault code, move the Increment/Decrement switch, if equipped, momentarily to the increment (+) position. You can go back to the previous fault code by momentarily moving the Increment/Decrement switch, if equipped, to the decrement (-) position. If **only** one active fault code is recorded, the same fault code will continuously be displayed when either (+) or (-) switch is depressed.



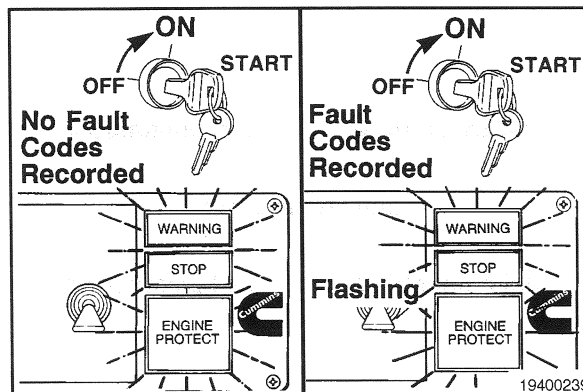
The diagnostic switch **must** remain in the OFF position (shorting plug removed) while the engine is being operated for all fault codes to be logged.

The diagnostic on/off switch circuit signals the system that the operator is requesting to read any active fault code recorded in the ECM.

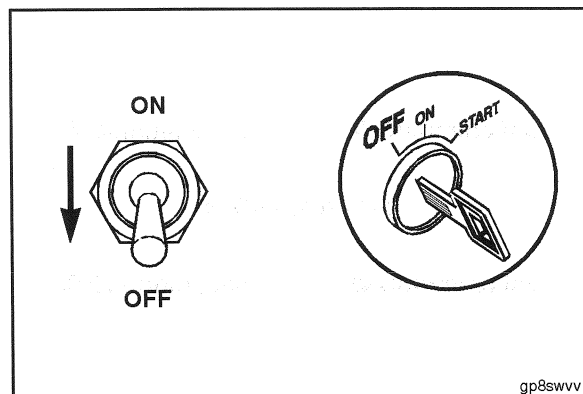
NOTE: Some original equipment manufacturers (OEMs) use a shorting plug rather than a switch.

When the ECM receives the signal from the diagnostic ON/OFF switch, the yellow and red warning lights come on and start flashing if any active fault code is recorded in the ECM. If both warning lights remain on and do **not** flash, there are no active fault codes present.

NOTE: The equipment **must** be stationary. If road speed is detected, the flashing sequence will **not** occur.



Turn the diagnostic switch OFF when the diagnostic system is **not** in use.

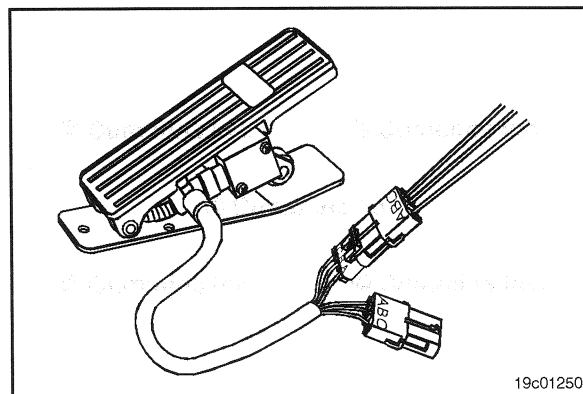


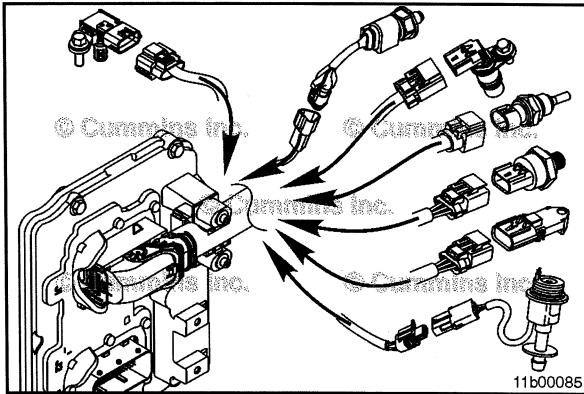
Throttle Activated Diagnostic Switch

The throttle activated diagnostic switch feature is intended to eliminate the need for a dash-mounted diagnostic switch, which is used to activate the fault code flash out on the lamps. The fault code flash out is activated through a simple sequence of throttle movements. When this feature is enabled, the engine is in stop state and the keyswitch is turned ON. Every successive cycle of the throttle leads to the next fault code to be flashed on the lamps, in the same manner as if the increment switch were depressed.

To activate this feature, the engine **must** be stopped and the keyswitch turned to the ON position. Depress the accelerator pedal completely three times. The feature should then be enabled. Transitioning to the next fault code occurs automatically after the first fault code is flashed out twice or if the throttle pedal is cycled.

NOTE: There is an optional, error-sensitive mode for this feature. If any of the throttle-related errors occur, this feature turns on the diagnostic switch automatically when the engine is stopped and the keyswitch is ON. During this mode, **only** the increment switch can be used to flash out the next fault code.





Engine Protection System

⚠CAUTION⚠

When the red STOP lamp is illuminated, the driver/operator must pull to the side of the road, when it is safe to do so, to reduce the possibility of engine damage.

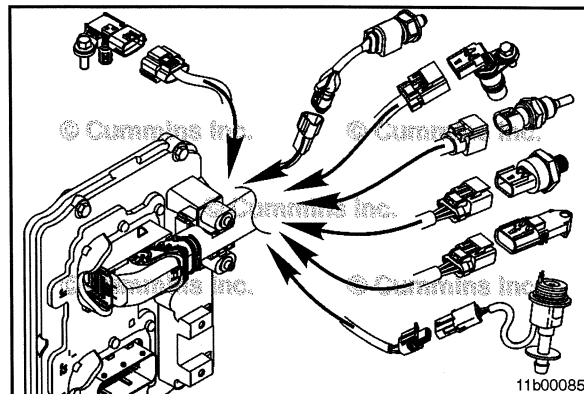
The engine is equipped with an engine protection system. The system monitors critical engine temperatures and pressures, and logs diagnostic faults when an over or under normal condition occurs. If an out-of-range condition exists and engine derate action is to be initiated, the operator is alerted by an in-cab WARNING lamp. The STOP lamp blinks or flashes when out-of-range conditions continue to worsen. The driver **must** pull to the side of the road, when it is safe to do so, to reduce the possibility of engine damage.

NOTE: Engine power and speed will gradually be reduced, depending on the level of severity of the observed condition. The engine protection system will **not** shut down the engine unless the engine protection shutdown feature has been enabled.

Fault Code Snapshot Data

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

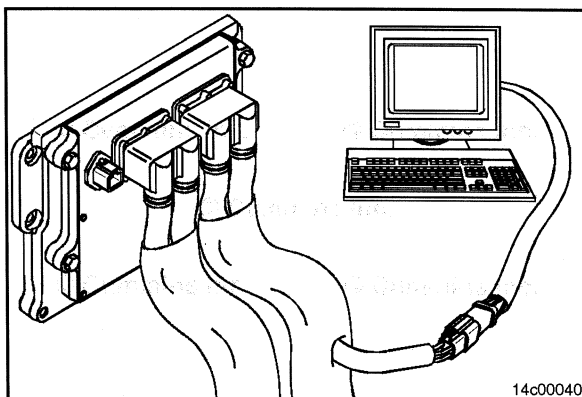
Fault code snapshot data can **only** be viewed using INSITE™ electronic service tool.



INSITE™ Electronic Service Tool Description

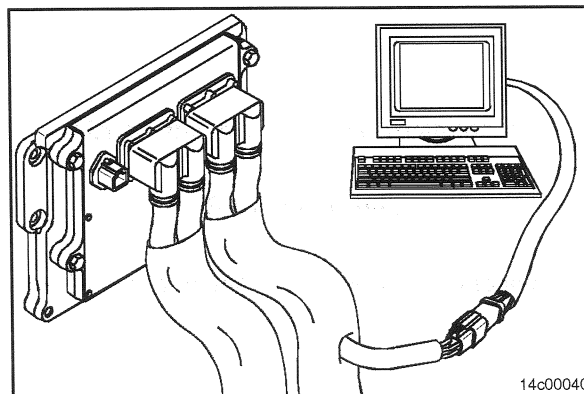
INSITE™ electronic service tool is a service tool for the electronic engine control system. Use INSITE™ electronic service tool to:

- Program customer specified information into the ECM (parameter and features)
- Aid in troubleshooting the engine
- Change the engine power or rated speed calibration
- Transfer new or update calibration files to the ECM
- Create and view trip reports, etc.



INSITE™ Electronic Service Tool Monitor Mode

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



Electromagnetic Interference (EMI)

General Information

Some applications utilize accessories such as (CB radios, mobile transmitters, etc.) if not installed and used correctly the radio frequency energy generated by these accessories can cause electromagnetic interference (EMI) conditions to exist between the accessory and the Cummins electronically controlled systems. Cummins is **not** liable for any performance problems with either the electronically controlled systems or the accessory due to EMI. EMI is **not** considered by Cummins to be a system 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 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 electronically controlled systems EMI susceptibility level will protect your systems from most, if **not** all, electromagnetic energy-emitting devices that meet the 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 systems are properly installed, they 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 electronically controlled systems 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.

Notes

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Section 2 - Maintenance Guidelines

Section Contents

	Page
Maintenance Guidelines - Overview	2-1
General Information.....	2-1
Maintenance Record Form	2-5
Maintenance Data.....	2-5
Maintenance Schedule	2-3
General Information.....	2-3
Tool Requirements	2-2
General Information.....	2-2

This Page Left Intentionally Blank

Maintenance Guidelines - Overview

General Information

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

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

OEM supplied equipment and components can impact on the performance and reliability of the engine if they are not correctly maintained.

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 S.A.E. wrenches, sockets, and screwdrivers).

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

Tool Part Number	Description	Used for
ST-1273	Pressure gauge	Measure Intake Manifold Pressure
3400158	Filter Wrench	Oil and Fuel Filters
3824591	Barring tool	Rotate the engine
CC-2800	Refractometer	Check antifreeze concentration and battery specific gravity
3164488	Digital Multimeter	Measure voltage on electrical equipment
3822525	Belt Tensioner Gauge (click type)	Check belt tension (6 to 12 v-ribbed belts)
3164795	Torque Wrench	Dial type 3/8 drive 0-250 in-lb
3164794	Torque Wrench	Micro-adjust 3/8 drive 10-100 ft-lb
3164797	Torque Wrench	Micro-adjust 1/2 drive 50-250 ft-lb

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

Maintenance Schedule

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

Use the chart provided to record maintenance. Refer to Procedure 102-001 in Section 2.

If the engine is equipped with a component or an accessory not manufactured by Cummins Inc., see equipment manufacturer service information for maintenance recommendations.

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

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

Maintenance Procedures at Daily IntervalSection 3

- Crankcase Breather Tube - Check ✓
- Fuel-Water Separator - Check
- Lubricating Oil Level - Check
- Coolant Level - Check
- Fan, Cooling - Check
- Drive Belts - Check
- Air Cleaner Restriction - Check
- Dust Ejection Valve - Check
- Air Intake Piping - Check
- Diesel Exhaust Fluid Level - Check

Maintenance Procedures at 250 Hour or 3 MonthsSection 4

- Charge-Air Cooler - Check
- Charge-Air Piping - Check

Maintenance Procedures at 500 Hours or 6 MonthsSection 5

- Fuel Filter (Canister Type) - Change
- Fuel Filter (Spin-On Type) - Change
- Lubricating Oil and Filters - Change¹
- Cooling System Antifreeze - Check²
- Cooling Fan Belt Tensioner - Check
- Batteries - Check
- Battery Cables and Connectors - Check

Maintenance Procedures at 1000 Hours or 1 YearSection 6

- Radiator Pressure Cap - Check
- Fan Hub, Belt-Driven - Check

Maintenance Procedures at 2000 Hours or 2 YearsSection 7

- Cooling System - Drain and Flush
- Radiator Hoses - Check

Maintenance Procedures at 4000 Hours or 3 YearsSection 8

- Aftertreatment Diesel Exhaust Fluid Dosing Unit Filter - Change

Maintenance Procedures at 5000 Hours or 4 YearsSection 9

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

- Overhead Set - Adjust

Notes:

- 1 Use CJ-4 (15W-40) oil that meets CES 20081 specifications.
- 2 Coolant testing for additive and glycol levels must be performed at least twice a year. The coolant must be tested for replacement limits every 4000 hours or once a year, whichever occurs first.

Use the following procedure for fuel recommendations and specifications. Refer to Procedure 018-002 in Section V.

Maintenance Data

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

Notes

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Section 3 - Maintenance Procedures at Daily Interval

Section Contents

	Page
Air Cleaner Restriction	3-8
Maintenance Check.....	3-8
Air Intake Piping	3-11
Maintenance Check.....	3-11
Coolant Level	3-4
Maintenance Check.....	3-4
Crankcase Breather Tube	3-2
Maintenance Check.....	3-2
Daily Maintenance Procedures - Overview	3-1
General Information.....	3-1
System Operation Report.....	3-1
Unusual System Noise.....	3-1
Diesel Exhaust Fluid (DEF) Level	3-11
Maintenance Check.....	3-11
Drive Belts	3-6
Maintenance Check.....	3-6
Dust Ejection Valve	3-9
Clean.....	3-9
Finishing Steps.....	3-10
General Information.....	3-9
Inspect for Reuse.....	3-10
Install.....	3-10
Maintenance Check.....	3-9
Preparatory Steps.....	3-9
Remove.....	3-10
Fan, Cooling	3-5
Inspect for Reuse.....	3-5
Fuel-Water Separator	3-3
Drain.....	3-3
General Information.....	3-3
Lubricating Oil Level	3-4
Maintenance Check.....	3-4

This Page Left Intentionally Blank

Daily Maintenance Procedures - Overview

General Information

Preventative maintenance begins with day-to-day awareness of the system. Before starting the system, check the appropriate fluid levels. Look for:

- Leaks
- Loose or damaged parts
- Worn or damaged belts
- Worn or damage low and high voltage harnesses
- Any change in system appearance.
- Odor of fuel
- Odor of electronic devices

System Operation Report

The system **must** be maintained in top mechanical and electronic 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.

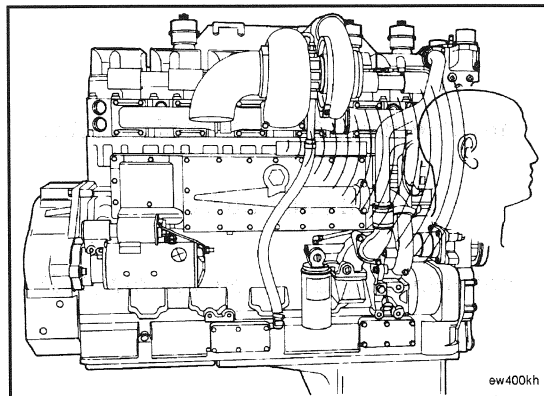
Comparison and intelligent interpretation of the daily report, along with a practical follow-up action, will eliminate most failures and emergency repairs.

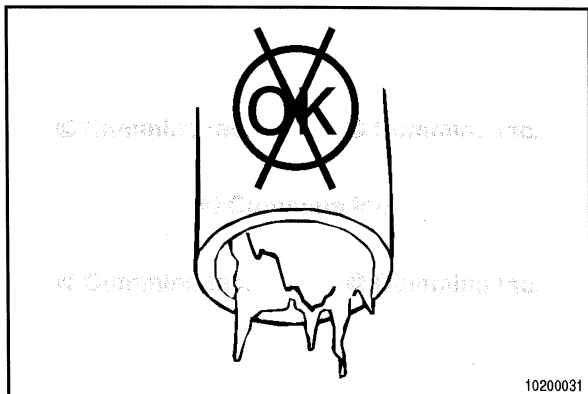
Report to the maintenance department any of the following conditions that may apply:

- 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 system 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
- Worn or damaged low or high voltage harnesses

Unusual System Noise

During daily maintenance checks, listen for any unusual system noise(s) that can indicate that service is required.

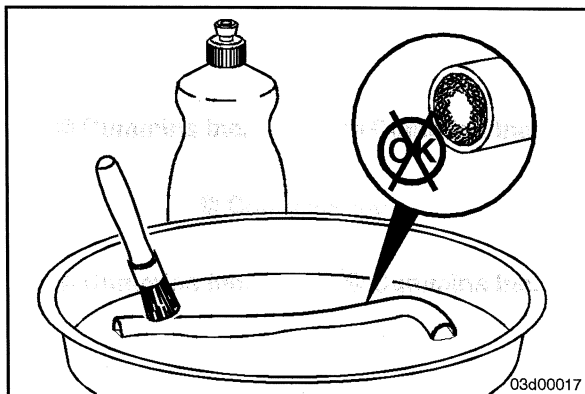




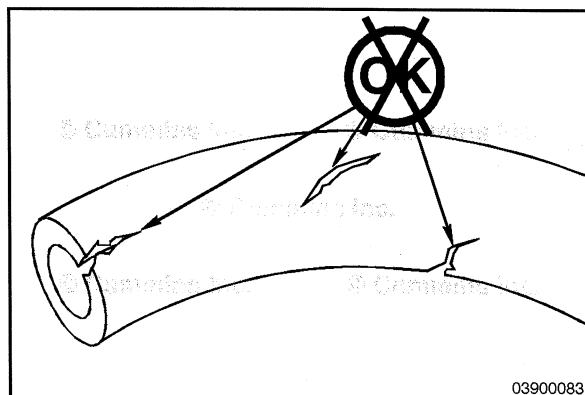
Crankcase Breather Tube Maintenance Check

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

Inspect the tube more frequently in icy conditions.



If sludge, debris, or ice is found clean the tube with detergent and warm water or a solvent. Dry the tube with compressed air.



Visually inspect the tube for cracks or damage. If damage is found, replace the crankcase breather tube. Contact your Cummins Authorized Repair Location.

Fuel-Water Separator

General Information

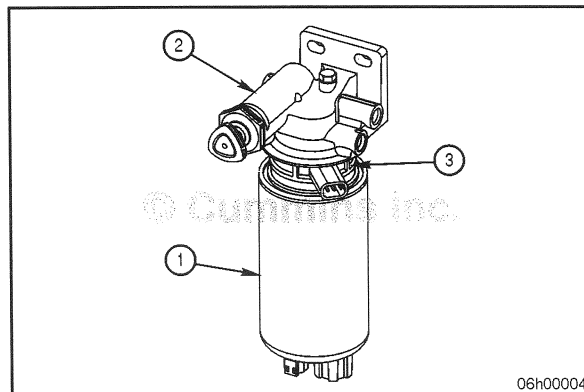
Cummins Inc. requires a fuel-water separator be installed in the fuel supply system.

This Fuel-Water Separator is mounted on the vehicle chassis. The location is determined by the original equipment manufacturer (OEM).

The Fuel-Water Separator is integrated into three components:

- 1 Fuel Filter
- 2 Fuel Filter Head (with priming pump)
- 3 Fuel Heater.

Use the priming pump on the filter head to prime the fuel system, if necessary.

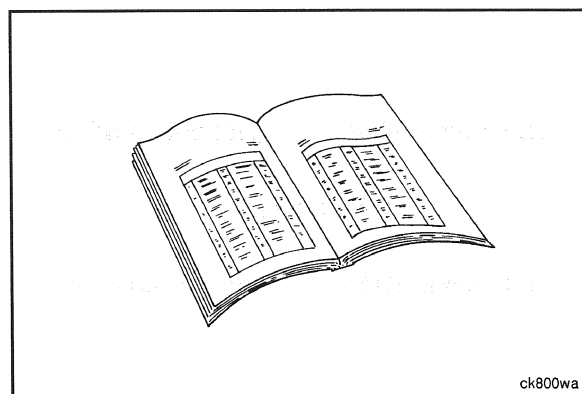


Drain

⚠ WARNING ⚠

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

Drain the water and sediment from the separator daily.



⚠ CAUTION ⚠

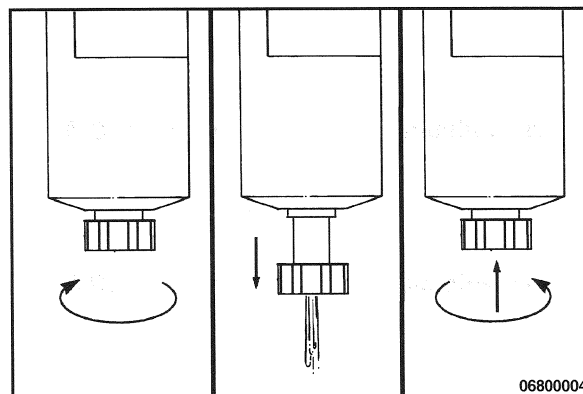
When closing the drain valve, do not overtighten the valve. Overtightening can damage the threads.

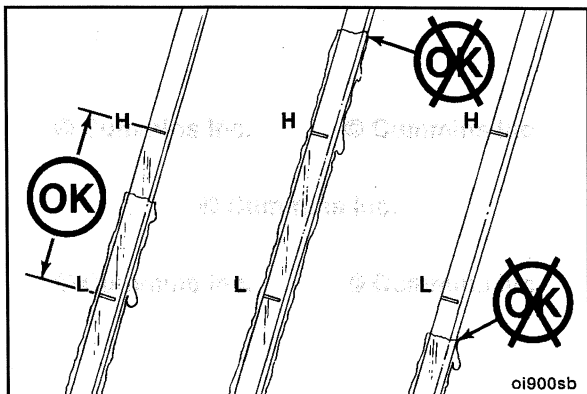
Shut off the engine.

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

Drain the filter sump until clear fuel is visible.

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





Lubricating Oil Level

Maintenance Check



⚠CAUTION⚠

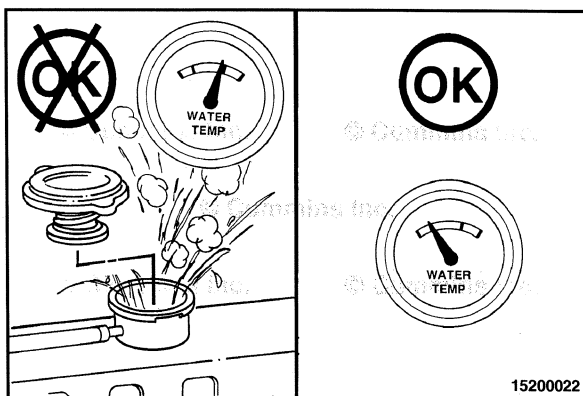
Never operate the engine with oil level below the L (low) mark or above the H (high) mark. Poor engine performance or engine damage can occur.

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

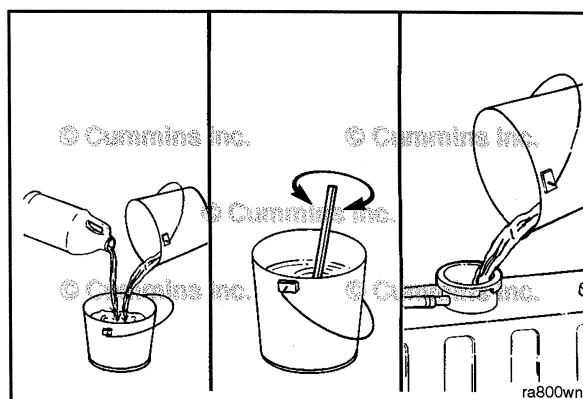
⚠WARNING⚠

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⚠

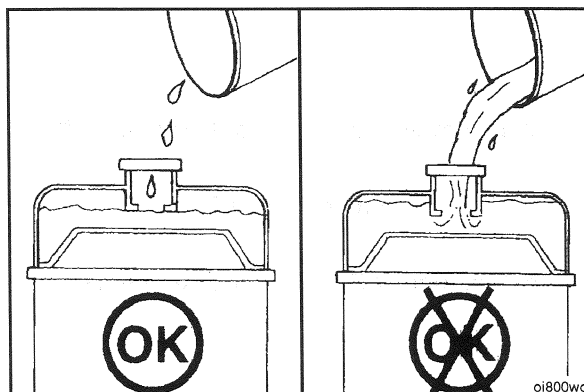
Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50°C [120°F] before adding coolant.

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.

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

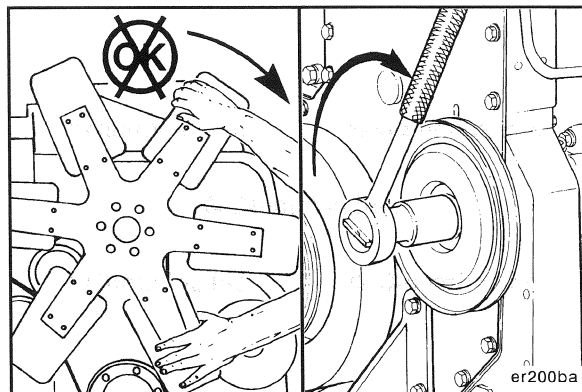


Fan, Cooling

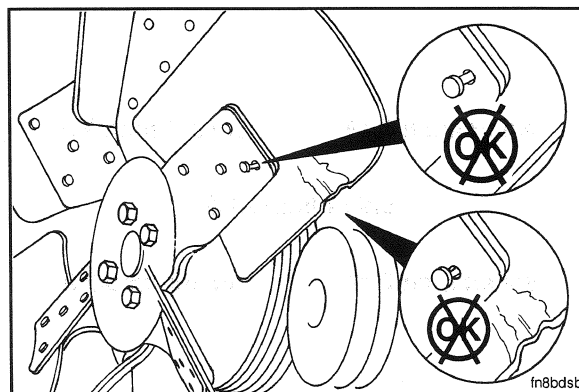
Inspect for Reuse

⚠ WARNING ⚠

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

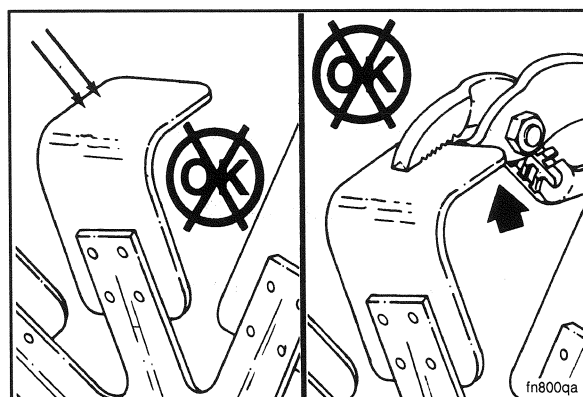


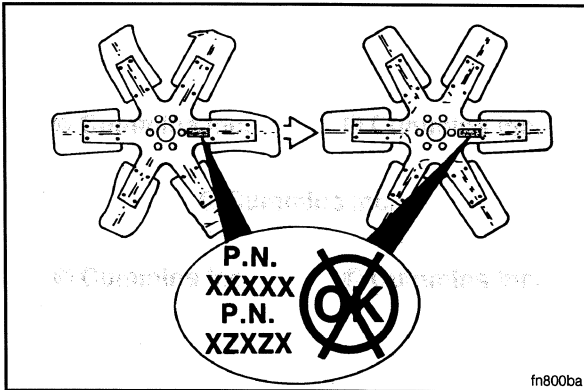
A visual inspection of the cooling fan is required daily. Check for cracks, loose rivets, and bent or loose blades. Check the fan to make sure it is securely mounted. Tighten the capscrews, if necessary.



⚠ WARNING ⚠

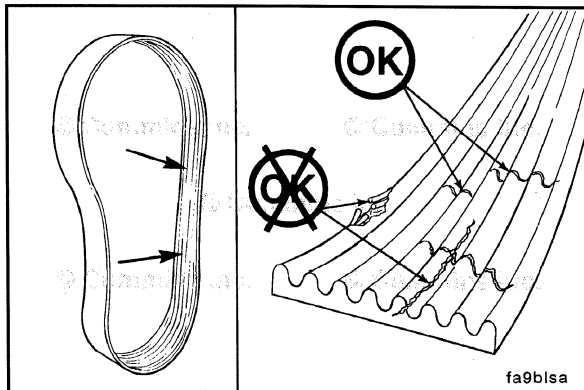
Do not straighten a bent fan blade or continue to use a damaged fan. A bent or damaged fan blade can fail during operation and cause personal injury or property damage.





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

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



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.

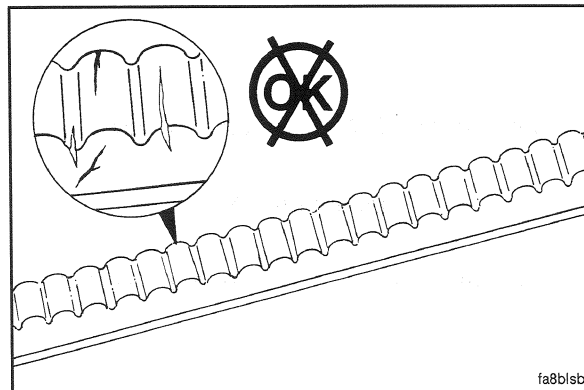
Cogged Belt

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

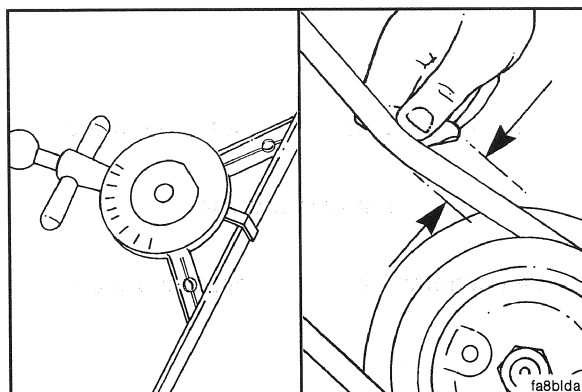


Measure the belt tension in the center span of the pulleys.

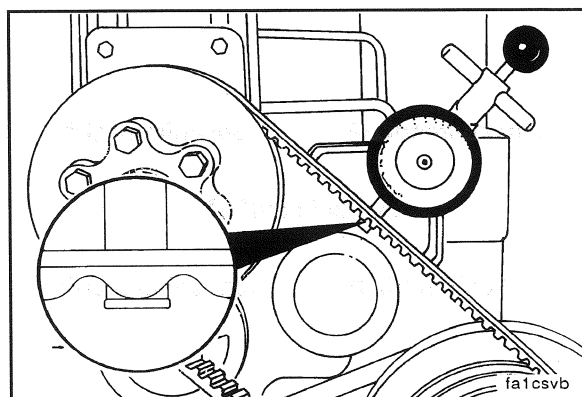
Refer to the Belt Tension Chart in Section V for the correct gauge and tension value for the belt width used.

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.



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).

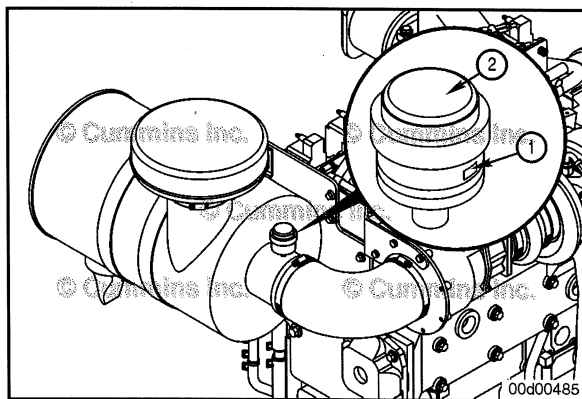
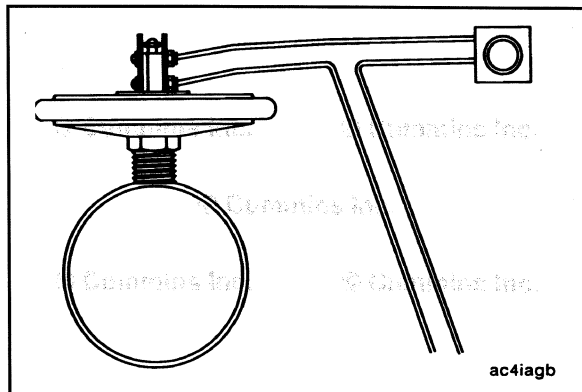
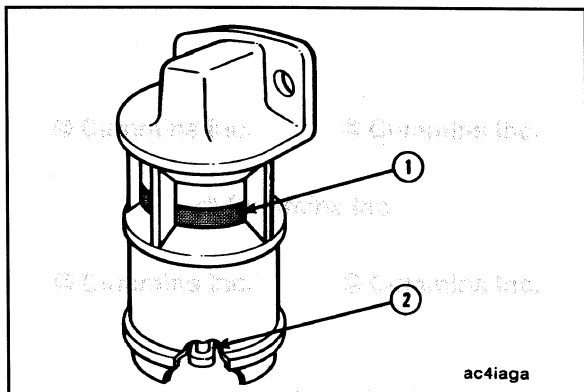
Restriction or vacuum indicators need to be installed as close as possible to the turbocharger air inlet in order to obtain a true indication of restrictions.

Vacuum Indicator

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

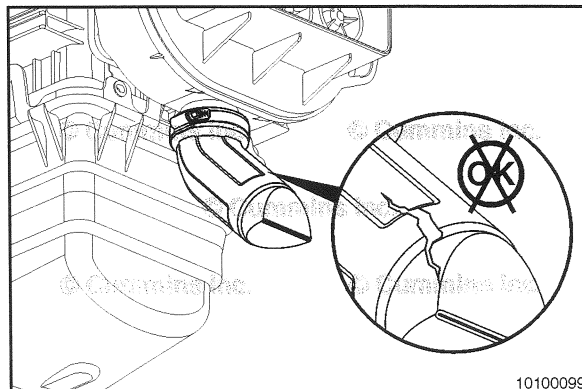
Industrial Gas Mechanical Indicator

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).



Dust Ejection Valve Maintenance Check

Inspect the dust ejection valve for cuts and tears. Replace the valve if damage is found.

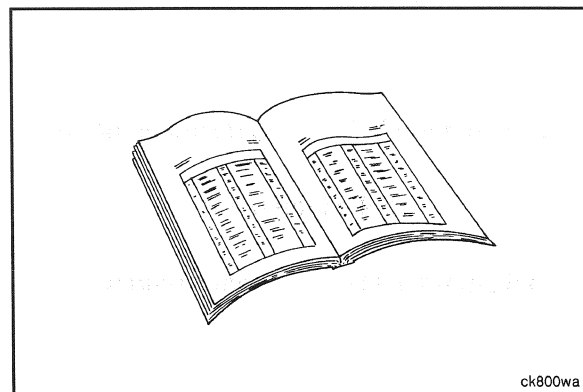


General Information

The dust ejection valve is a thin flexible rubber boot located at the bottom of the pre-cleaner on the air cleaner assembly. It is used to accumulate and remove dust ejected from the pre-cleaner.

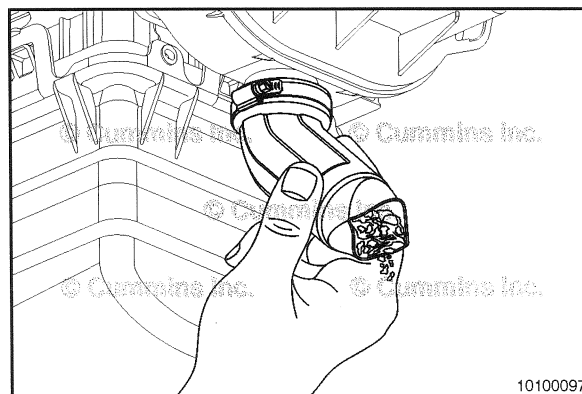
If an application is equipped with a pre-cleaner exhaust aspirator, a dust ejection valve will **not** be present, as the aspirator takes place of the dust ejection valve.

Do **not** operate the engine without a dust ejection valve or exhaust aspirator. The pre-cleaner efficiency will be greatly reduced and may result in shortened filter element life.



Clean

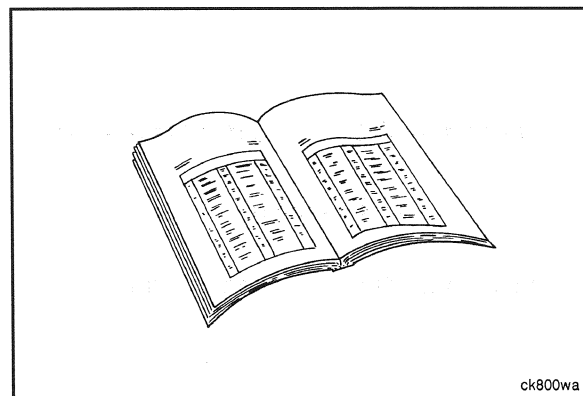
Purge the dust ejection valve of dust by squeezing the valve until it opens. This may have to be performed multiple times depending on the severity of dust or debris found in the valve. If debris is **not** able to be purged from the valve, remove the valve and clean out by hand. Reference the Remove section of this procedure.

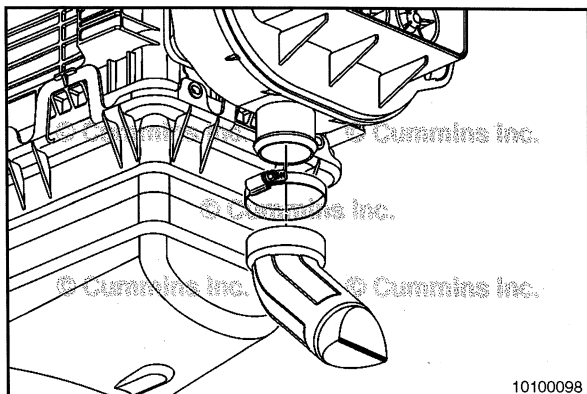


Preparatory Steps

NOTE: Before servicing any intake air system component, (such as the air cleaner, pre-cleaner, hoses, ducting, etc.), clean the fittings, mounting hardware, and the area around the component to be removed.

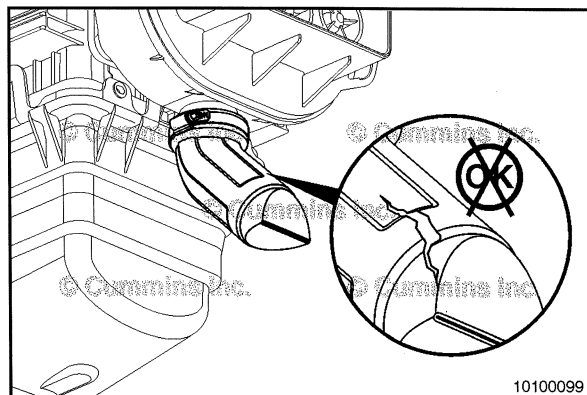
- Shut the engine OFF.





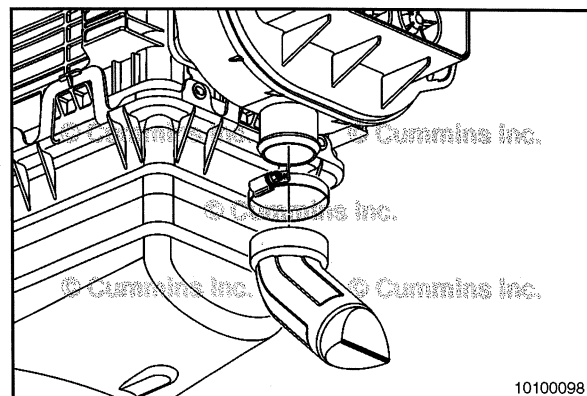
Remove

Remove the dust ejection valve from the pre-cleaner by loosening the hose clamp, if present, then rotating and pulling downward on the dust ejection tube.



Inspect for Reuse

Inspect the dust ejection valve for cuts and tears. Replace the valve if damage is found.

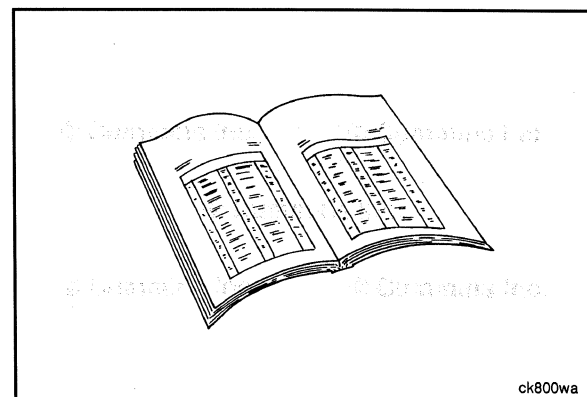


Install

Install the dust ejection valve on the pre-cleaner by attaching the hose clamp, if present. Tighten the hose clamp.



Torque Value: 5 N•m [44 in-lb]



Finishing Steps

- Start the engine.
- Check for leaks.

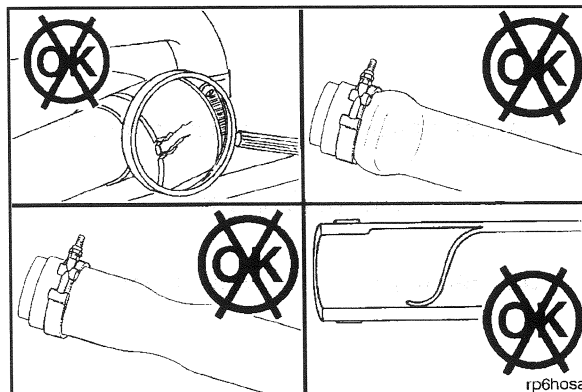
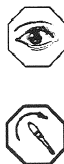
Air Intake Piping Maintenance Check

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

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

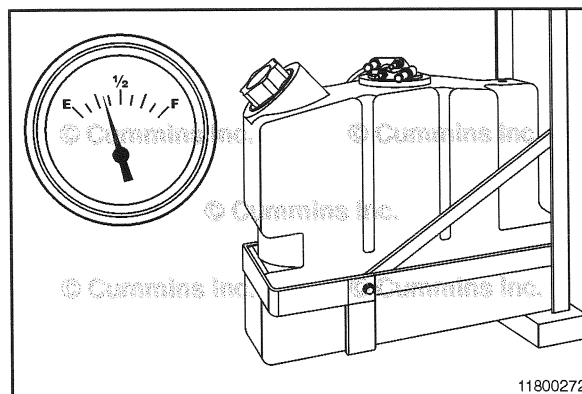
Torque Value: 8 N•m [71 in-lb]

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



Diesel Exhaust Fluid (DEF) Level Maintenance Check

The Diesel Exhaust Fluid level **must** be checked daily.



⚠ WARNING ⚠

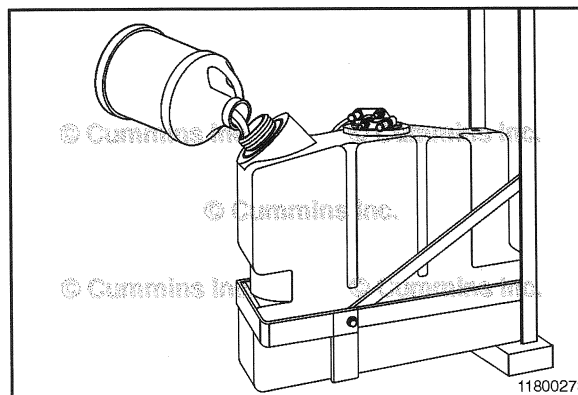
Do not allow Diesel Exhaust Fluid to contact the eyes. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Avoid prolonged contact with skin. In case of contact, immediately wash skin with soap and water. Do not swallow internally. In the event the Diesel Exhaust Fluid is ingested, contact a physician immediately.

⚠ CAUTION ⚠

It is unlawful to tamper with or remove any component of the aftertreatment system. It is also unlawful to use a catalyst solution that does not meet the specifications provided or to operate the vehicle/equipment with no catalytic solution.

If the Diesel Exhaust Fluid level is found to be low, Diesel Exhaust Fluid **must** be added.

Refer to the OEM service manual for Diesel Exhaust Fluid level check and fill instructions.



[illegible]

Section 4 - Maintenance Procedures at 250 Hours or 3 Months

Section Contents

	Page
Charge-Air Cooler	4-1
Maintenance Check.....	4-1
Charge-Air Piping	4-1
Maintenance Check.....	4-1
Maintenance Procedures - Overview	4-1
General Information.....	4-1



This Page Left Intentionally Blank

Maintenance Procedures - Overview

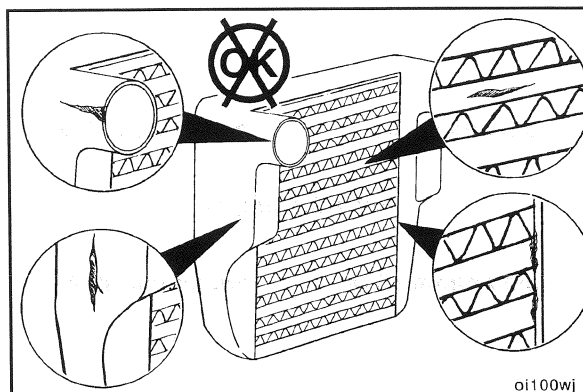
General Information

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.

Charge-Air Cooler

Maintenance Check

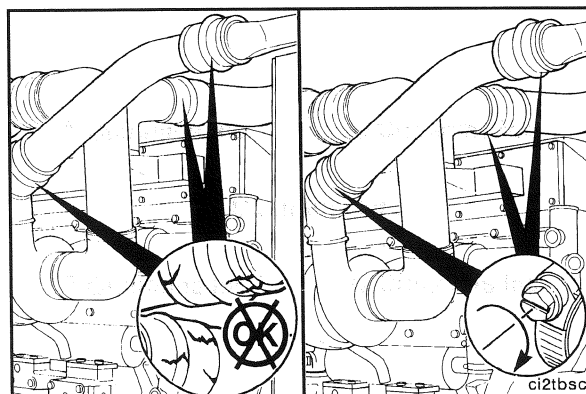
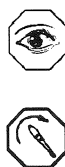
Inspect the charge-air cooler (CAC) for dirt and debris blocking the fins. Check for cracks, holes, or other damage. If damage is found, refer to the vehicle, vessel, or equipment manufacturer.



Charge-Air Piping

Maintenance Check

Inspect the charge-air piping and hoses for leaks, holes, cracks, or loose connections. Tighten the hose clamps if necessary. Refer to the vehicle or equipment manufacturer's specifications for the correct torque value.



This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Section 5 - Maintenance Procedures at 500 Hours or 6 Months

Section Contents

	Page
Batteries	5-13
Inspect.....	5-13
Battery Cables and Connections	5-14
Initial Check.....	5-14
Cooling Fan Belt Tensioner	5-9
Clean and Inspect for Reuse.....	5-12
Finishing Steps.....	5-13
Initial Check.....	5-10
Install.....	5-12
Maintenance Check.....	5-9
Preparatory Steps.....	5-11
Remove.....	5-11
Engine Coolant Antifreeze	5-9
Maintenance Check.....	5-9
Fuel Filter (Canister Type)	5-1
Install.....	5-2
Prime.....	5-3
Remove.....	5-1
Fuel Filter (Spin-On Type)	5-4
Install.....	5-4
Prime.....	5-5
Remove.....	5-4
Lubricating Oil and Filters	5-5
Drain.....	5-5
Fill.....	5-7
Install.....	5-7
Remove.....	5-6
Maintenance Procedures - Overview	5-1
General Information.....	5-1

This Page Left Intentionally Blank

Maintenance Procedures - Overview

General Information

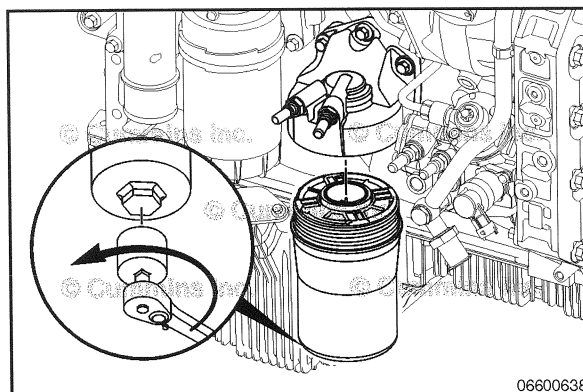
All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Fuel Filter (Canister Type)

Remove

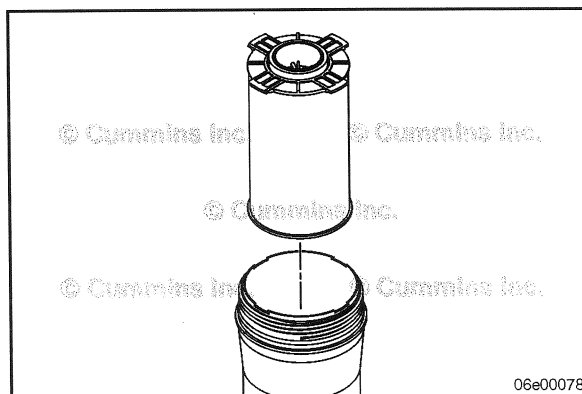
Remove the filter carefully.

Use a 32 mm hex drive on the bottom of the filter canister to remove the canister.



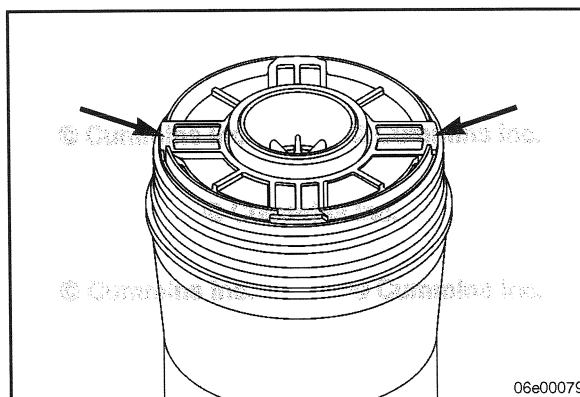
Remove and discard the filter element.

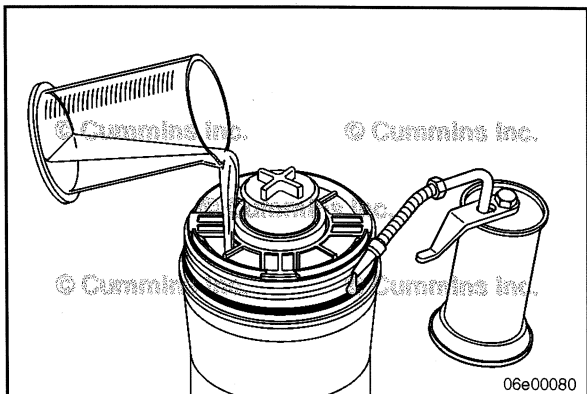
Remove and discard the o-ring seal on the filter canister.



Install a new filter element.

Make sure the tabs of the filter element are properly seated in the canister.





Install

⚠ CAUTION ⚠



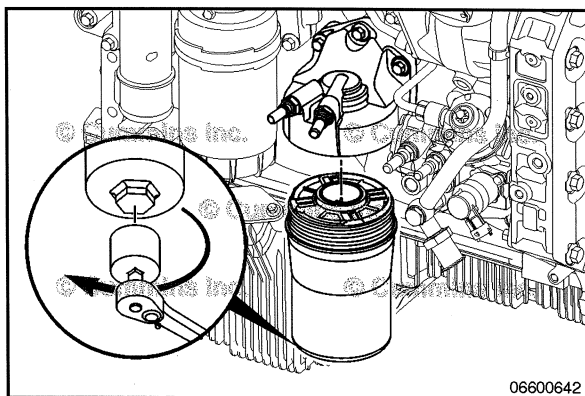
Do not pre-fill the pressure-side fuel filter with fuel unless a clean side block-off plug is used. The system must be primed after the fuel filter is installed. Pre-filling the pressure-side fuel filter can result in debris entering the fuel system and damaging fuel system components.

NOTE: If available, pre-fill new filters, both pressure-side and suction-side, with clean fuel prior to assembly using the clean side block-off plug packed with the filter. Do **not** pour fuel directly into the center of the filter, since this will allow unfiltered fuel to enter the system. Unfiltered fuel can cause damage to fuel system components.

Use the correct fuel filter. Refer to Procedure 018-024 in Section V.

Install the new fuel filter canister o-ring seal.

Lubricate the fuel filter o-ring with clean lubricating oil.



⚠ CAUTION ⚠

Mechanical overtightening can distort the threads as well as damage the filter element seal or filter can.



Install the filter on the filter head:

Install to the point of first contact for the filter and head.

Use a 32 mm hex drive to tighten the canister.

Torque Value: 32 N•m [24 ft-lb]

Prime

⚠ WARNING ⚠

The fuel pump high-pressure fuel lines and fuel rail contain very high-pressure fuel. Never loosen any fittings while the engine is running. Personal injury and property damage can result.

⚠ CAUTION ⚠

Do not engage the starter motor for more than 30 seconds at a time. Allow two minutes between cranking intervals.

NOTE: If the starting motor is engaged for 30 or more seconds, without the engine starting, the starting motor will be locked out from operating, allowing for proper cooling of the starting motor. During this time, the WAIT TO START lamp, if equipped, will flash for 2 minutes. Once the lamp discontinues flashing, the starting motor will be allowed to function.

NOTE: The priming pump can be an OEM-supplied component and can be designed or installed differently. If a priming pump is **not** installed or is a different design, see equipment manufacturer service information for fuel system priming information.

NOTE: To prevent damage to the hand pump priming seals, clean the fuel pump head and priming pump with electrical contact cleaner, Cummins® Part Number 3824510, or equivalent, and compressed air prior to priming the fuel system.

After a filter change or running the fuel tank dry, make sure there is fuel in the vehicle fuel tank.

NOTE: It is **not** necessary to vent air from the high-pressure fuel system before starting the engine. Cranking the engine will prime the fuel system.

Unlock the manual priming pump handle by turning it **counterclockwise**. Pump the primer handle until resistance is felt and the handle can **not** be pumped anymore (approximately 140 to 150 strokes for dry filters, or 20 to 60 strokes for pre-filled filters).

Lock the manual priming pump handle.

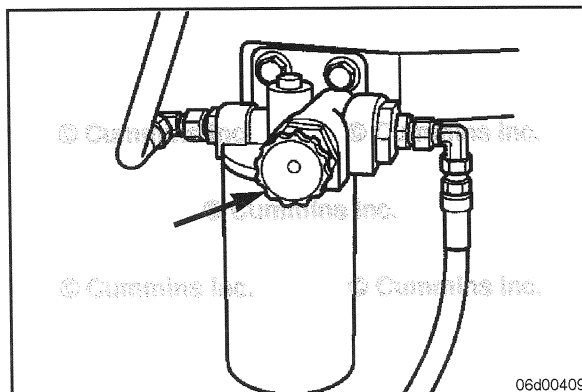
Crank the engine. If the engine does **not** start after 30 seconds, turn the key to the OFF position.

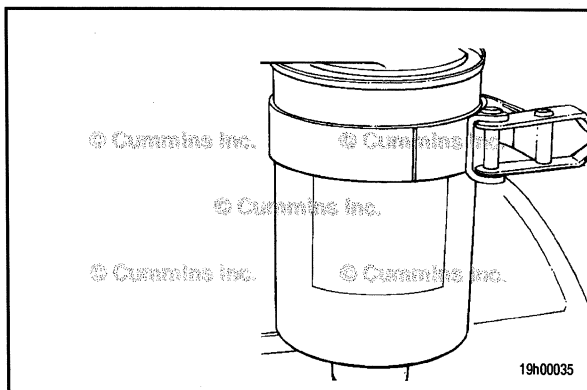
Pump the priming pump again, repeating the previous steps until the engine starts.

When the engine does start, it can operate erratically and with increased noise levels for a few minutes. This is a normal condition as air is being removed from the system.

NOTE: It is possible that Fault Code 559 can become active after fuel filter replacement, due to the air introduced in the system. Be sure to run the engine until the air is purged, and use INSITE™ electronic service tool to clear the fault code before releasing the vehicle.

Operate the engine and check for leaks.

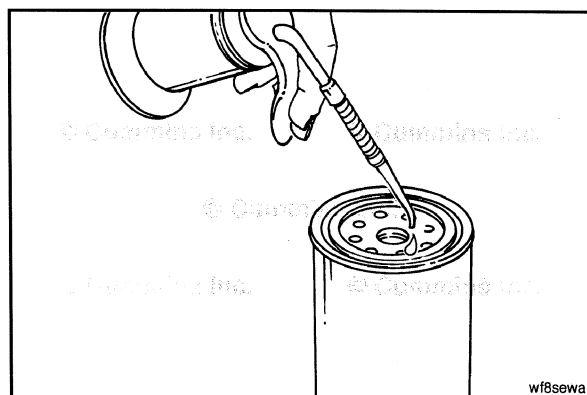




Fuel Filter (Spin-On Type)

Remove

Remove the fuel filter from the filter head with filter wrench, Cummins® Part Number 3398231, or equivalent.



Install

⚠CAUTION⚠



Do not pre-fill the suction side fuel filter with fuel unless a clean side block off plug is used. The system must be primed after the fuel filter is installed. Pre-filling the pressure side fuel filter can result in debris entering the fuel system and damaging fuel system components.

NOTE: If available, pre-fill new filters, with clean fuel prior to assembly using the clean side block-off plug packed with the filter. Do **not** pour fuel directly into the center of the filter as this will allow unfiltered fuel to enter the system and can cause damage to fuel system components.

Use the correct fuel filter.

- Refer to Procedure 018-024 in Section V.

Lubricate the fuel filter o-ring seal with clean lubricating oil.



⚠CAUTION⚠

Mechanical overtightening can distort the threads the threads as well as damage the filter element seal or filter can.

Install the filter on the filter head. Use filter wrench, Cummins® Part Number 3398231, or equivalent. Tighten the filter until the gasket contacts the filter head surface.

Tighten the fuel filter an additional 3/4 turn after contact or see equipment manufacturer service information.

Torque Value: 24 N•m [204 in-lb]

Prime

⚠ WARNING ⚠

The fuel pump, high-pressure fuel lines, and fuel rail contain very high-pressure fuel. To reduce the possibility of personal injury, never loosen any fittings while the engine is running.

⚠ CAUTION ⚠

Do not engage the starter motor for more than 30 seconds at a time. Allow two minutes between cranking intervals.

After a fuel filter change or running the vehicle tank dry, make sure there is fuel in the vehicle fuel tank.

NOTE: It is **not** necessary to vent air from the high-pressure fuel system before starting the engine. Cranking the engine will prime the fuel system.

Unlock the manual priming pump handle by turning **counterclockwise**. Pump the primer handle until resistance is felt and the handle can **not** be pumped any longer (approximately 140 to 150 strokes for dry filters, or 20 to 60 strokes for pre-filled filters).

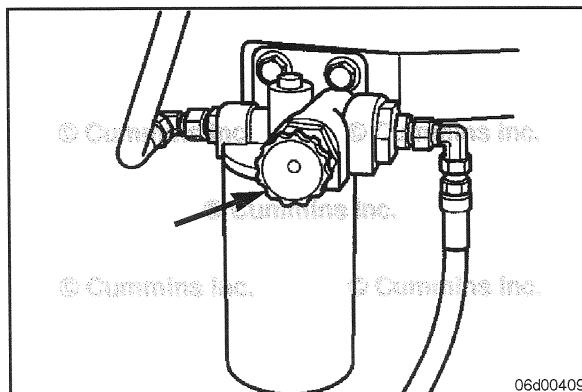
Lock the manual priming pump handle.

Crank the engine. If the engine does **not** start after 30 seconds, turn the keyswitch to the OFF position.

Pump the priming pump again, repeating the previous steps until the engine starts.

When the engine does start, it may run erratically and with increased noise levels for a few minutes. This is a normal condition.

Operate the engine and check for leaks.



Lubricating Oil and Filters

Drain

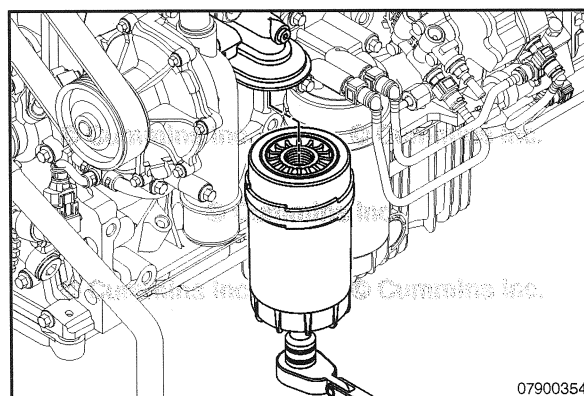
⚠ WARNING ⚠

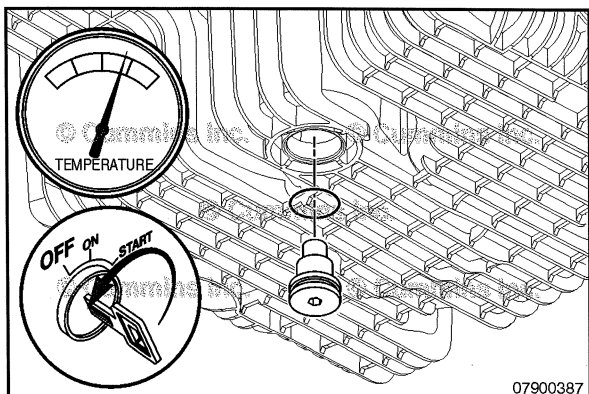
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

⚠ WARNING ⚠

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

Change the lubricating oil and filter(s) at the specified oil change interval. See the Maintenance Schedule to find the correct change interval for your application.



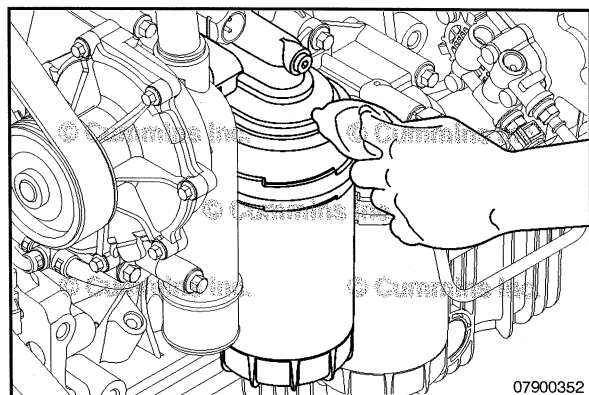


NOTE: For most engines, use a container that can hold at least 20 liters [21 qt] of lubricating oil. Some engines may be equipped with an increased capacity oil pan requiring a container that will hold 28 liters [30 qt] of lubricating oil.

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

Shut off the engine.

Remove the oil drain plug. Drain the oil immediately to be sure all the oil and suspended contaminants are removed from the engine.

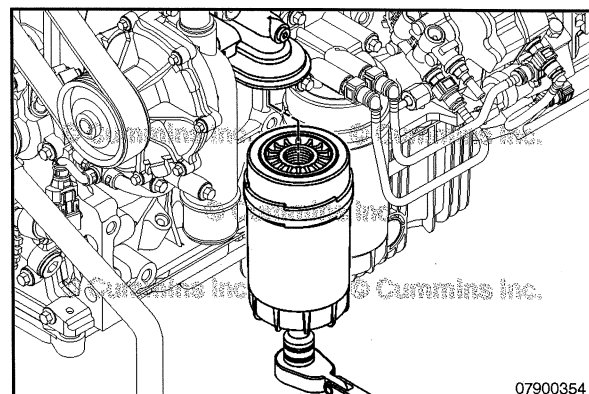


Remove

Clean the area around the lubricating oil filter head.

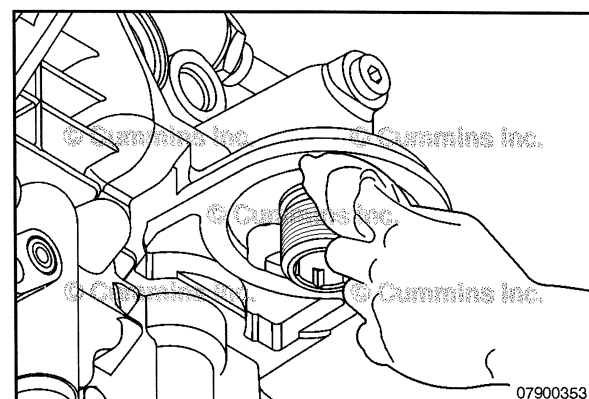


6



Use the 1/2 inch drive socket, located on the bottom of the filter for removal.

7



Clean the gasket surface of the filter head.

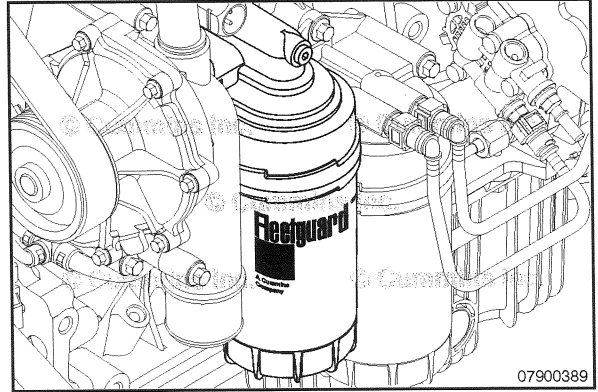
NOTE: The o-ring can stick on the filter head. Make sure it is removed before installing the new filter.



Install

Use the correct oil filter.

See Cummins®/Fleetguard® Filter Specifications for the correct oil filter part number. Refer to Procedure 018-024 in Section V.



⚠CAUTION⚠

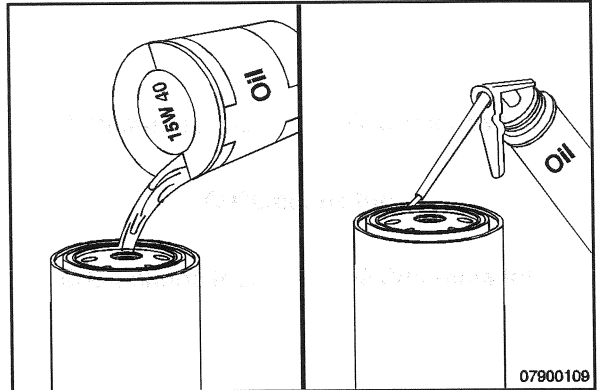
The lack of lubrication during the delay until the filter is pumped full of oil at start-up can damage the engine.

Use clean 15W-40 oil to coat the gasket surface of the filter.

Fill the filter with clean 15W-40 oil.

Apply a light film of lubricating oil to the gasket sealing surface before installing the filter.

NOTE: Be careful that **no** debris is poured into the filter. If using an oil supply with a metallic or plastic seal under the cap, be careful to peel the seal back. Puncturing the seal with a knife or sharp object can create debris in the oil container.

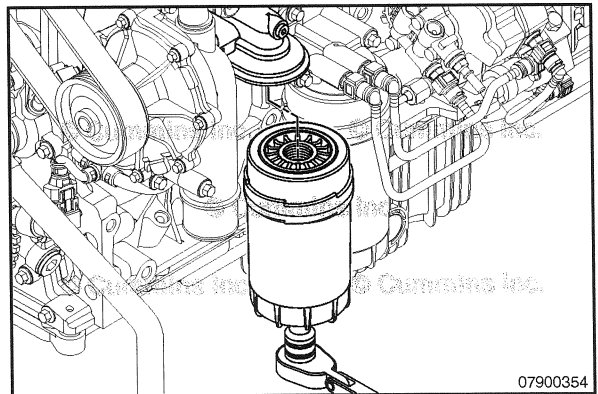


⚠CAUTION⚠

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

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

Tighten 3/4 to 1 turn after gasket makes contact with the filter head.



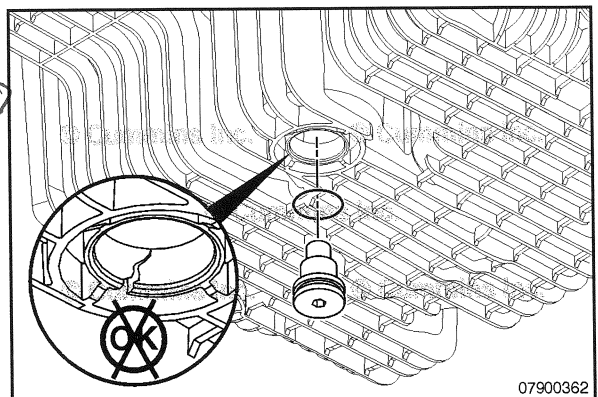
Fill

Clean and check the lubricating oil drain plug threads and sealing surface. Use new sealing washer, if damaged.

Install the lubricating oil pan drain plug.

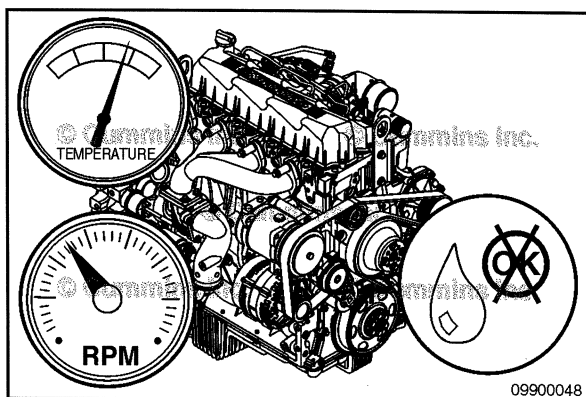
Torque Value:

Plastic Oil Pan Drain Plug Torque 24 N•m [212 in-lb]



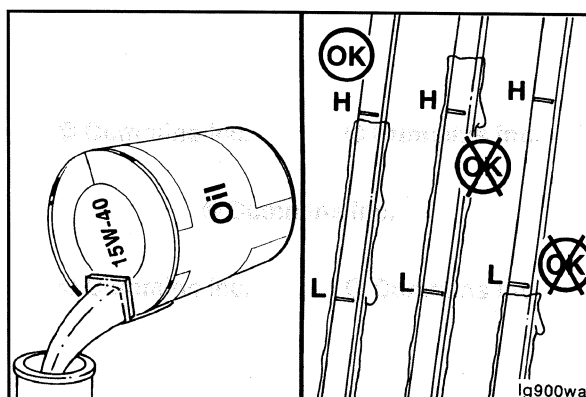


NOTE: Use a high-quality 15W-40 multiviscosity lubricating oil, such as Valvoline Premium Blue®, or its equivalent in Cummins® engines. Choose the correct lubricating oil for your operating climate as outlined in Section V.



Idle the engine to inspect for leaks at the drain plug and, if replaced, the oil filter seal.

NOTE: 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 that the correct oil level is in the oil pan.



Shut off the engine. Wait approximately 5 minutes to let the oil drain from the upper parts of the engine. Check the level again.

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

Engine Coolant Antifreeze Maintenance Check



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

Check the antifreeze concentration. Use a mixture of 50-percent water and 50-percent ethylene glycol or propylene glycol-base antifreeze to protect the engine to -32°C [-25°F] year-around.

The Fleetguard® refractometer, Part Number CC-2806 or CC-2800, provides a reliable, easy to read, and accurate measurement of freezing point protection and glycol (antifreeze) concentration.

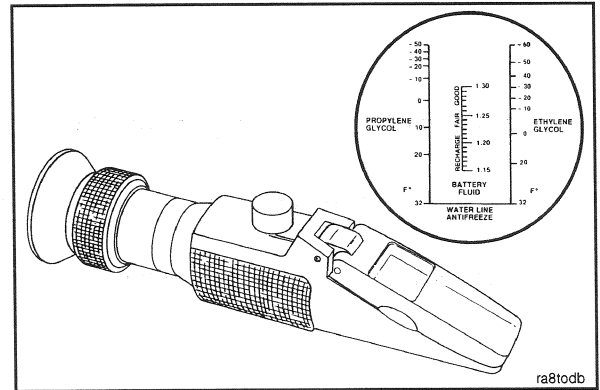
To check the antifreeze concentration:

- 1 Place a drop of coolant on the refractometer window and shut the lid.
- 2 Look through the eyepiece and focus.
- 3 Record the freeze point protection for either ethylene glycol or propylene glycol coolants.

Antifreeze is essential in every climate.

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

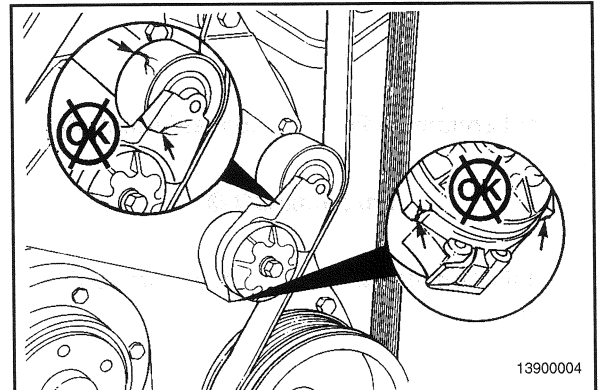
The corrosion inhibitors also protect the cooling system components from corrosion and provide longer component life.



Cooling Fan Belt Tensioner Maintenance Check

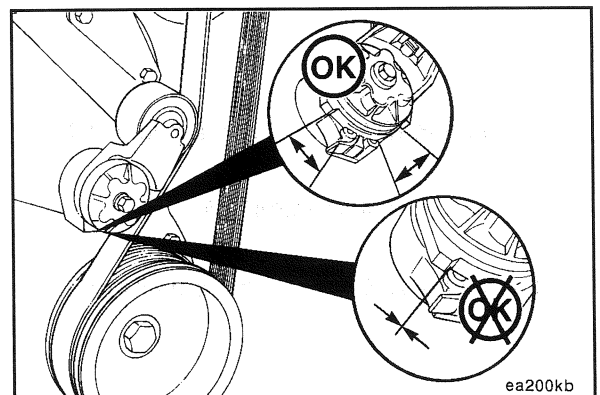
NOTE: This maintenance check is performed at the Maintenance Procedures at 500 Hours or 6 Months.

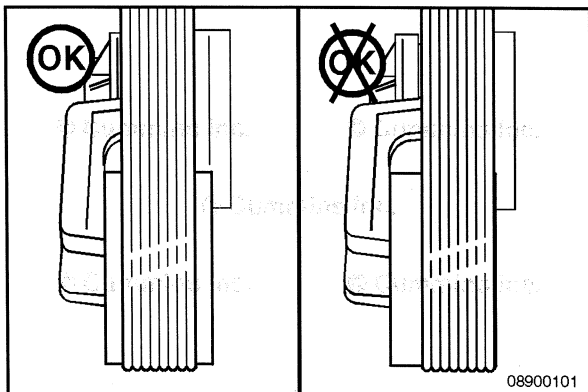
With the engine stopped, check the tensioner arm, pulley, and stops for cracks. If any cracks are noticed, the tensioner **must** be replaced.



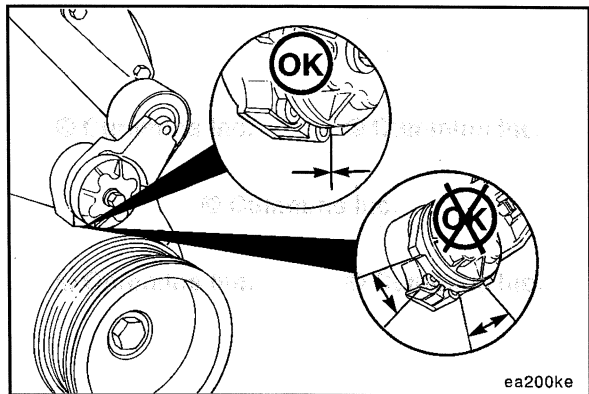
With the belt installed, verify that neither tensioner arm stop is in contact with the spring casing stop. If either of the stops is touching:

- Verify the correct belt part number is installed.
- If the correct belt is installed, replace the belt. Refer to Procedure 008-002 in Section A.





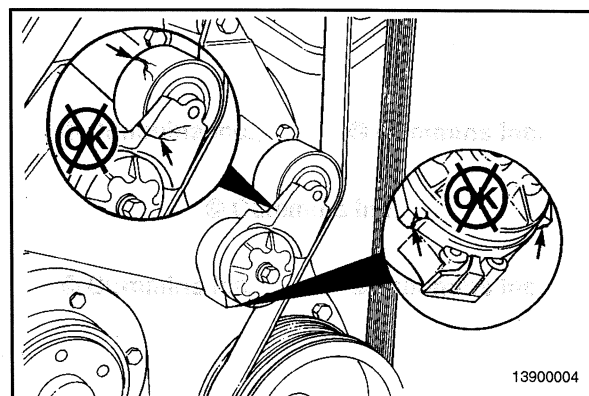
Check the location of the drive belt on the belt tensioner pulley. The belt should be centered on, or close to the middle of, the pulley. Misaligned belts, either too far forward or backward, can cause belt wear, belt roll-off malfunctions, or increase uneven tensioner bushing wear.



Remove the drive belt. Refer to Procedure 008-002 in Section A.

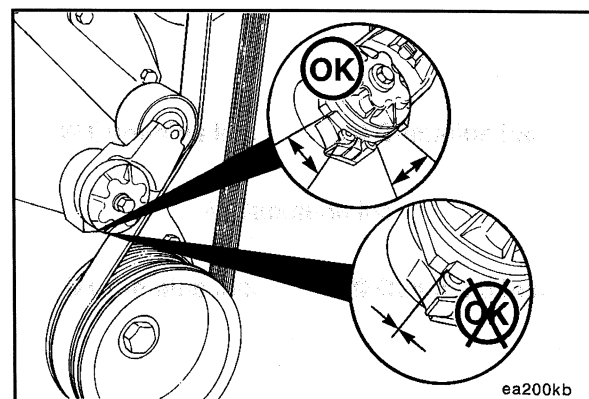


With the belt removed, verify the tensioner arm stop is in contact with the spring case stop. If they are **not** touching, the tensioner **must** be replaced.



Initial Check

With the engine stopped, check the tensioner arm, pulley, and stops for cracks. If any cracks are noticed, the tensioner **must** be replaced.



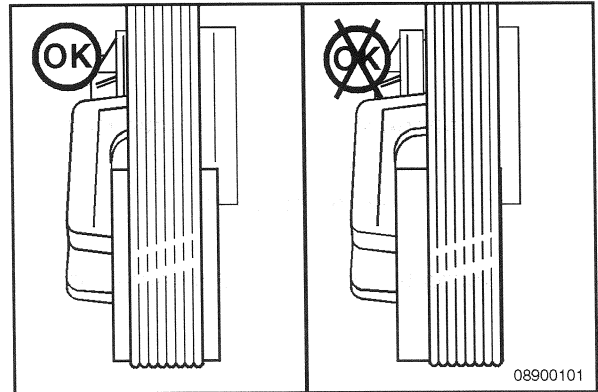
With the belt installed, verify that neither tensioner arm stop is in contact with the spring casing stop. If either of the stops is touching:



- Verify the correct belt part number is installed.
- If the correct belt is installed, replace the belt. Refer to Procedure 008-002 in Section A.

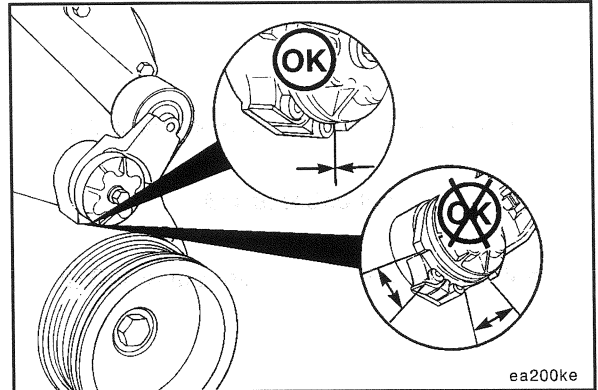
After replacing the belt, if the tensioner arm stops are still in contact with the spring case stop, replace the tensioner.

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



Remove the drive belt. Refer to Procedure 008-002 in Section A.

With the belt removed, verify the tensioner arm stop is in contact with the spring case stop. If they are **not** touching, the tensioner **must** be replaced.

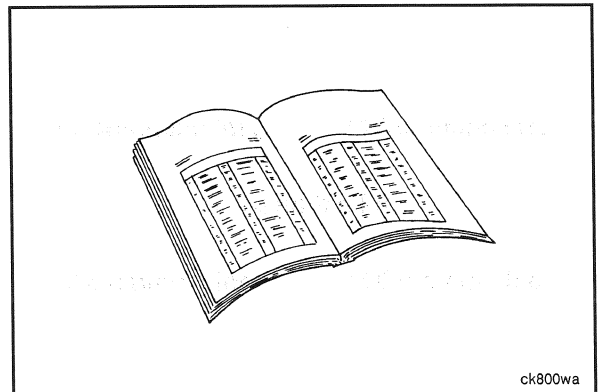


Preparatory Steps

⚠ WARNING ⚠

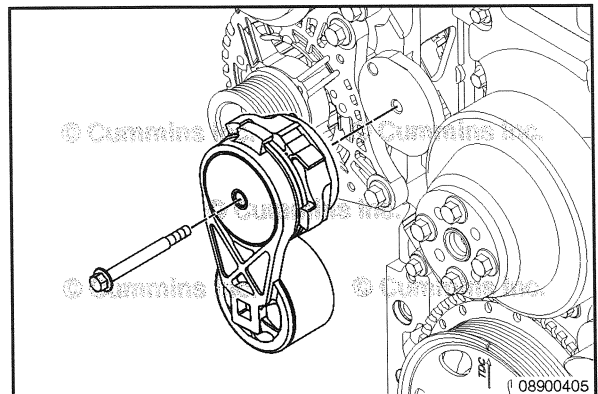
Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

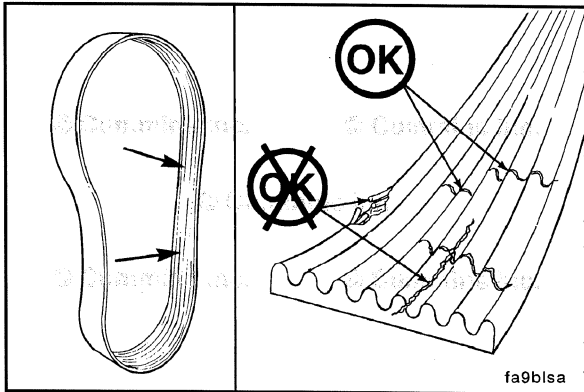
- Disconnect the batteries. See equipment manufacturer service information.
- Remove the drive belt. Refer to Procedure 008-002 in Section A.



Remove

Remove the capscrew and belt tensioner from the bracket.





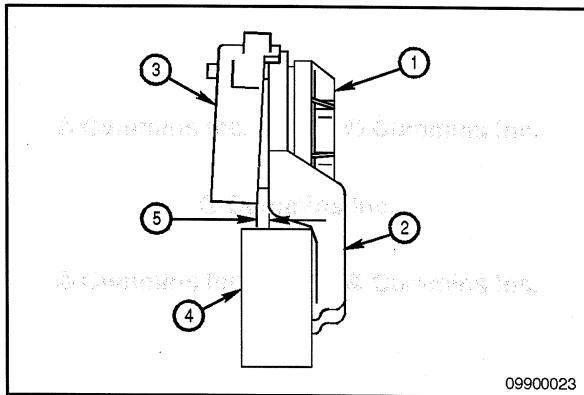
Clean and Inspect for Reuse

Check the belt for damage.

Transverse (across the belt) cracks are acceptable.

Longitudinal (direction of belt length) cracks that intersect with transverse cracks are **not** acceptable.

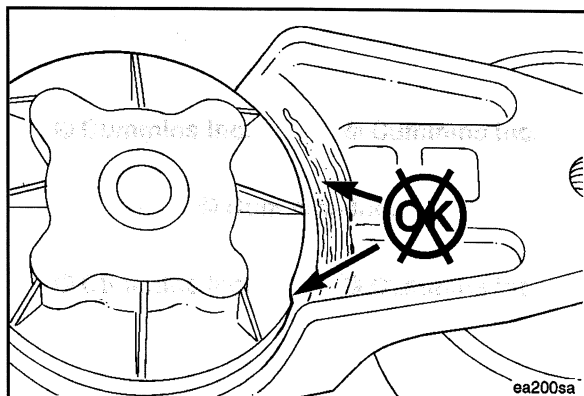
If the belt is frayed or has any piece of material missing, the belt is unacceptable and needs to be replaced.



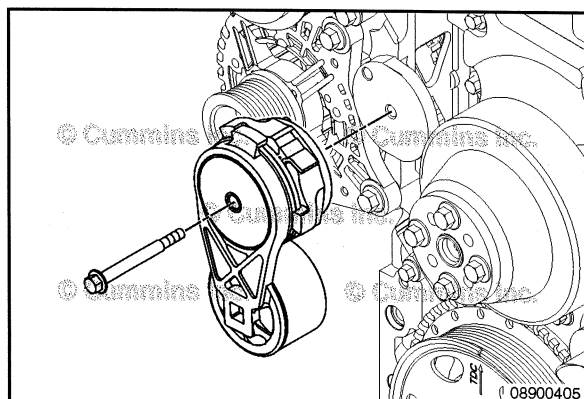
Measure the clearance between the tensioner spring and the tensioner arm to verify tensioner wear-out and uneven bearing wear. If the clearance exceeds 3 mm [0.12 in] at any point, the tensioner has failed and **must** be replaced as a complete assembly.

Tensioners generally show a larger clearance gap near the lower portion of the spring case, resulting in the upper portion rubbing against the tensioner arm. **Always** replace the belt when a tensioner is replaced.

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



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



Install

Install the belt tensioner and capscrew.

Tighten the capscrew.

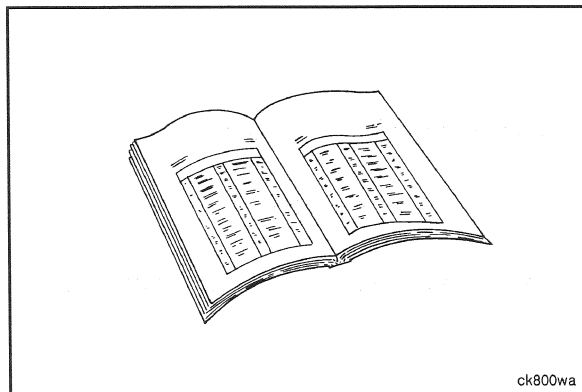
Torque Value: 43 N•m [32 ft-lb]

Finishing Steps

⚠ WARNING ⚠

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

- Install the drive belt. Refer to Procedure 008-002 in Section A.
- Connect the batteries. See equipment manufacturer service information.
- Operate the engine to check for proper operation.

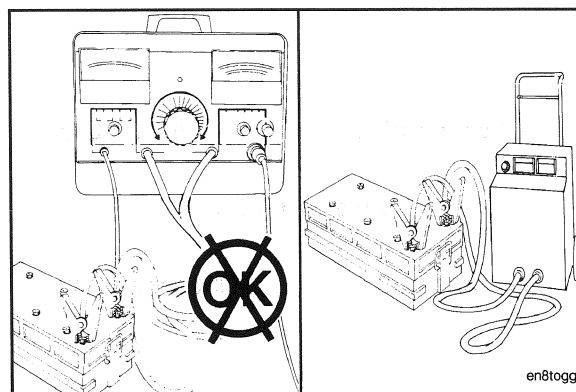


Batteries

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.

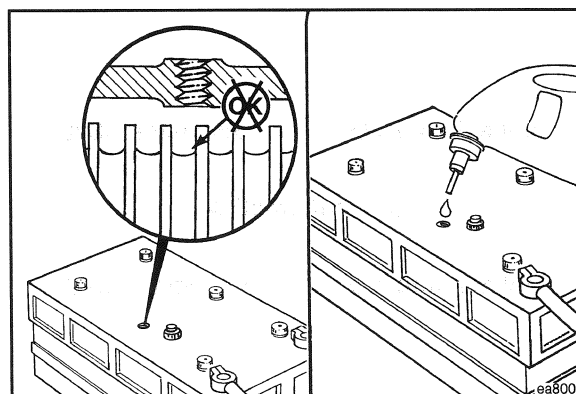


⚠ WARNING ⚠

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.

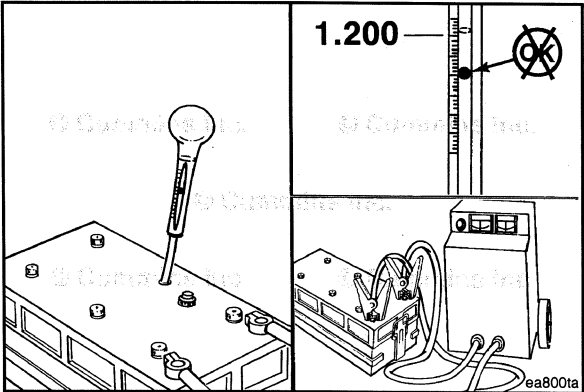
NOTE: Maintenance-free batteries are sealed and do **not** require the addition of water.

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.

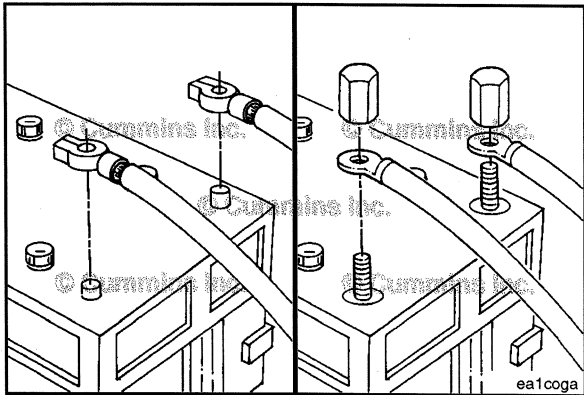
Battery State of Charge	Specific Gravity @ 27°C [80°F]
100%	1.260 to 1.280
75%	1.230 to 1.250
50%	1.200 to 1.220
25%	1.170 to 1.190
Discharged	1.110 to 1.130



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.

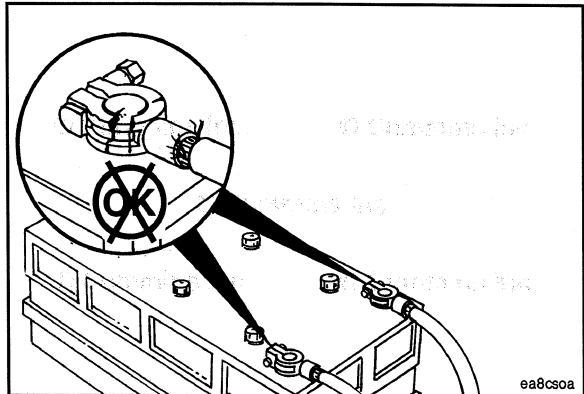


Battery Cables and Connections

Initial Check

There are two possible heavy-duty battery connections:

- Battery terminal and clamp (1)
- Threaded battery terminal and nut (2).



⚠ WARNING ⚠

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



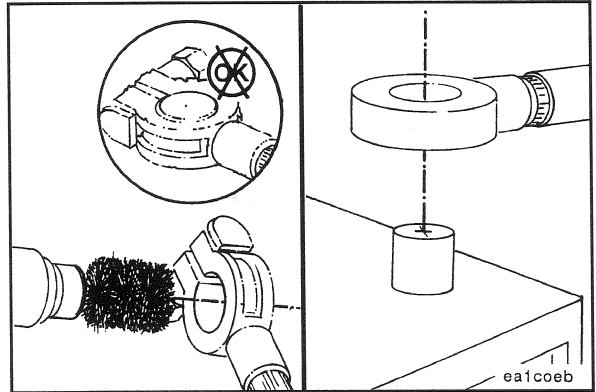
Remove and inspect the battery cables and connections for cracks or corrosion.

Replace broken terminals, connectors, or cables.

If the connections are corroded, use a battery brush or wire brush to clean the connections until shiny.



Make sure all debris is removed from the connecting surfaces.



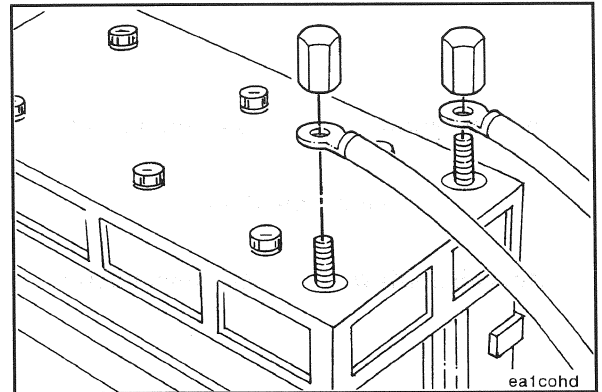
⚠ WARNING ⚠

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



Install the cables and tighten the battery connections.

Coat the terminals with grease to prevent corrosion.



This image shows a full page of blank, lined paper. It features approximately 20 evenly spaced horizontal black lines across its entire width, typical of notebook or primary school paper. The background is a solid off-white color, and there are no margins, text, or other markings present.

Section 6 - Maintenance Procedures at 1000 Hours or 1 Year

Section Contents

	Page
Fan Hub, Belt Driven	6-2
Maintenance Check.....	6-2
Maintenance Procedures - Overview	6-1
General Information.....	6-1
Radiator Pressure Cap	6-1
General Information.....	6-1
Inspect for Reuse.....	6-1

This Page Left Intentionally Blank

Maintenance Procedures - Overview

General Information

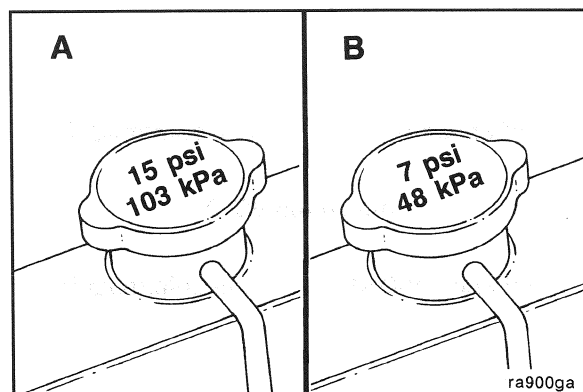
All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Radiator Pressure Cap

General Information

The cooling system is designed to use a pressure cap to prevent boiling of the coolant. See equipment manufacturer service information cooling system specifications for the correct radiator pressure cap for a specific engine application.

An incorrect or malfunctioning cap can result in the loss of coolant and the engine running hot.



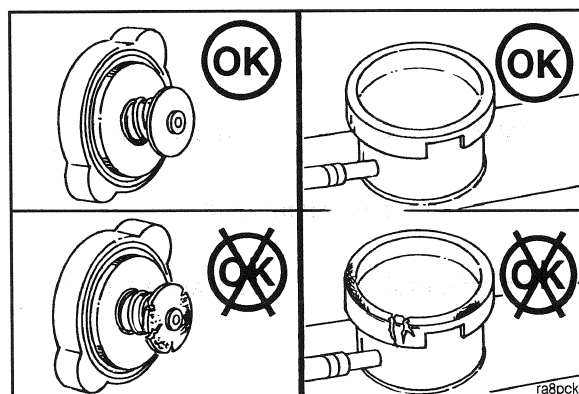
Inspect for Reuse

Make sure the correct radiator pressure cap is being used.

Inspect the rubber seal of the pressure cap for damage.

Inspect the radiator fill neck for cracks or other damage.

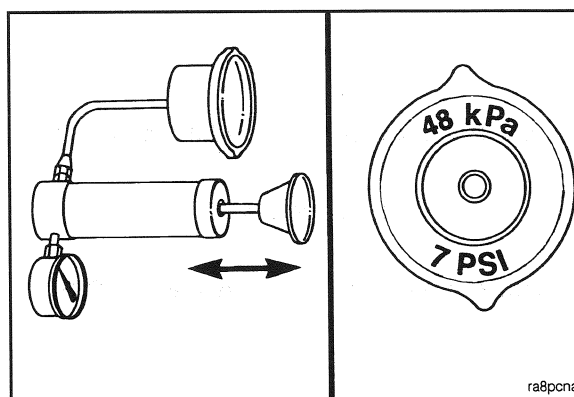
See equipment manufacturer service information for instructions if the fill neck is damaged.



Pressure-test the radiator cap. See equipment manufacturer service information for radiator cap test procedures.

The pressure cap **must** seal within 14 kPa [2 psi] of the value stated on the cap, or it **must** be replaced.

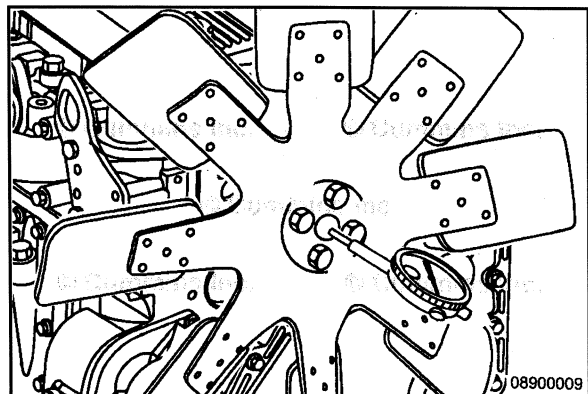
An incorrect or malfunctioning cap can result in the loss of coolant and the engine running hot.





Fan Hub, Belt Driven Maintenance Check

Remove the drive belt.



NOTE: The fan hub **must** rotate without any wobble or excessive end clearance.

Fan Hub End Clearance

mm		in
0.15	MAX	0.006

Section 7 - Maintenance Procedures at 2000 Hours or 2 Years

Section Contents

	Page
Cooling System	7-1
Drain.....	7-2
Fill.....	7-5
Flush.....	7-3
General Information.....	7-1
Maintenance Check.....	7-2
Maintenance Procedures - Overview	7-1
General Information.....	7-1
Radiator Hoses	7-7
Maintenance Check.....	7-7



This Page Left Intentionally Blank

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.

Cooling System

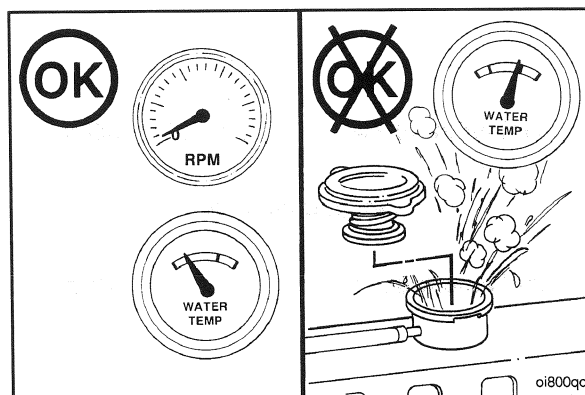
General Information

⚠ 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.

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

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



⚠ CAUTION ⚠

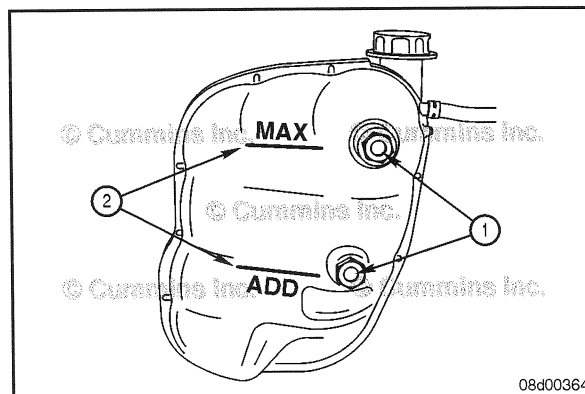
Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool below 50°C [122°F] before adding coolant.

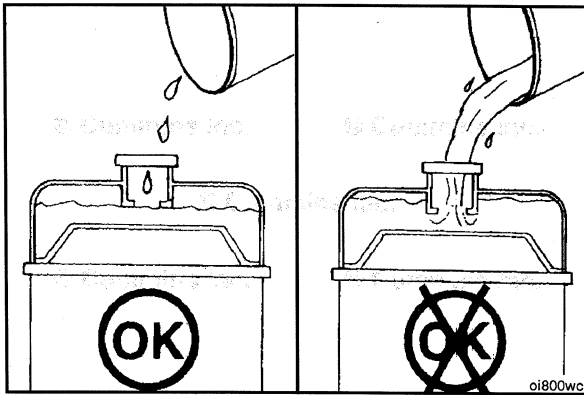
NOTE: In the event of a water pump or exhaust gas recirculation (EGR) cooler malfunction, check the coolant level switch or sensor for proper operation. See equipment manufacturer service information for operational checks and repairs.

On applications that use a coolant recovery system, check to make sure the coolant is at the appropriate level on the coolant recovery tank, for the engine temperature.

Many coolant recovery/expansion tanks, also called "top tanks", have sight glasses (1) or are made of a clear material (**not** shown) to aid in checking the coolant level (2) without removing the radiator cap.

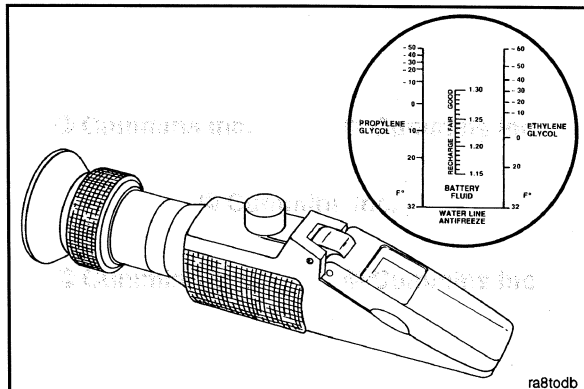
It is important to understand the impact of temperature on the expansion of the coolant. Most "top tanks" do **not** have a provision for a "FULL HOT" coolant level. Filling the top tank while hot will result in a low operating level once the system has cooled.





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

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



Maintenance Check

⚠ CAUTION ⚠

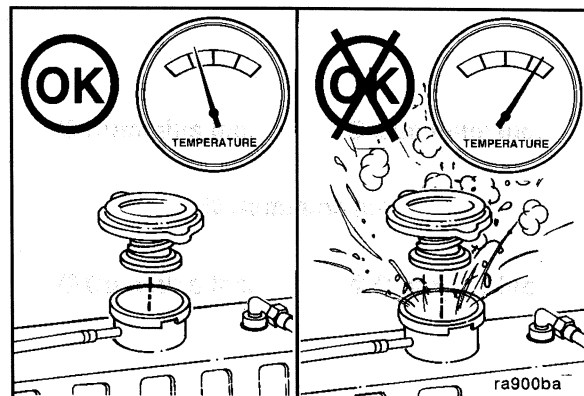
Over-concentration of antifreeze or use of high silicate antifreeze can cause damage to the engine.

Check the antifreeze concentration. Use a mixture of 50-percent water and 50-percent ethylene glycol or propylene glycol-base antifreeze to protect the engine to -32°C [-25°F] year-around.

The Fleetguard™ refractometer, Part Number CC-2806, provides a reliable, easy to read, and accurate measurement of freeze point protection and glycol (antifreeze) concentration.

Antifreeze is essential in every climate as it broadens the operating temperature by lowering the coolant freeze point and by raising its boiling point.

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



Drain

⚠ WARNING ⚠

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

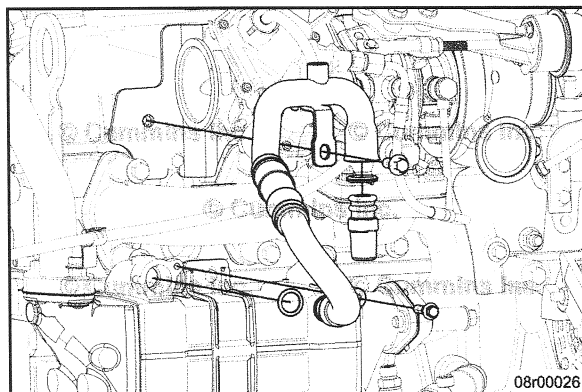
Remove the radiator/expansion tank cap.

⚠ 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 by opening the drain valve on the radiator and removing the plug in the bottom of the water inlet. A drain pan with a capacity of 19 liters [5 gal] will be adequate in most applications.

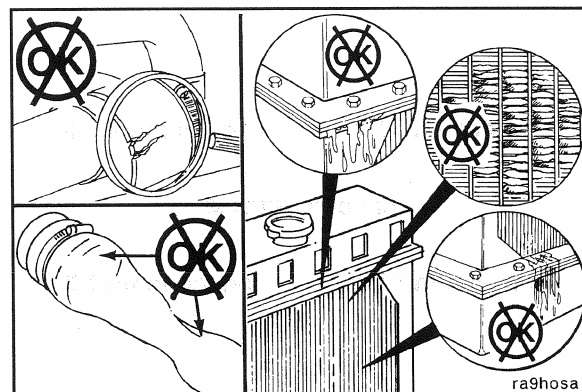
NOTE: On applications with an EGR system, disconnect the EGR cooler coolant return line to make sure the coolant is drained from the EGR cooler.



Check for damaged hoses and loose or damaged hose clamps. Replace as required.

Check the radiator for leaks, damage, and buildup of dirt. Clean and replace, as required.

NOTE: If coolant has been contaminated, the cooling system should be flushed.



Flush

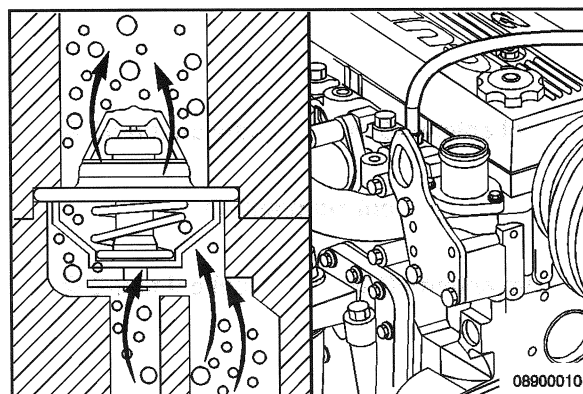
⚠ CAUTION ⚠

The cooling system must be filled properly to prevent air locks. During filling, air must be vented from the engine coolant passages. Wait 2 to 3 minutes to allow air to be vented; then add mixture to bring the level to the top.

To make sure air is vented during the fill process:

- The thermostat has check balls that allow air to vent through the thermostat when the thermostat is closed.
- A deaeration port is located next to the water outlet connection, which connects to the top tank/coolant recovery tank of the cooling system.

This provides adequate venting for a fill rate of 19 liters [5 gal] per minute.



Section 7 - Maintenance Procedures at 2000 Hours or 2 Years



NOTE: An alternate to using sodium carbonate, as outlined in this procedure, is to use Restore™.

Restore™ is a heavy-duty cooling system cleaner that removes corrosion products, 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 cleaner, higher temperatures, 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.

⚠ CAUTION ⚠

Do not install the radiator cap. The engine is to be operated without the cap for this process.

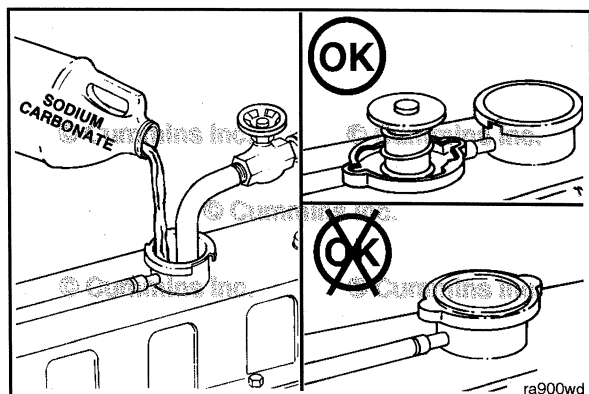
Close the radiator drain valve.

Install the plug in the water inlet connection.

Install the EGR coolant return connection.

Fill the cooling system with a mixture of sodium carbonate and water (or a commercially available equivalent).

NOTE: Adequate venting is provided for a fill rate of 11 liters [3 gal] per minute.

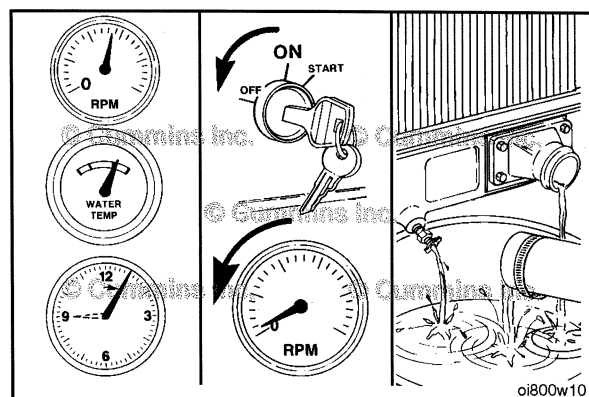


⚠ WARNING ⚠

Coolant is toxic. Keep away from children and pets. Dispose of in accordance with local environmental regulations.

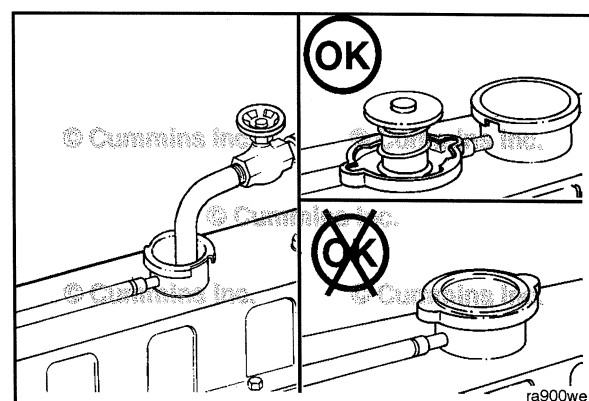
Operate the engine for 5 minutes with the coolant temperature above 80°C [176°F].

Shut the engine off, and drain the cooling system.



Fill the cooling system with clean water.

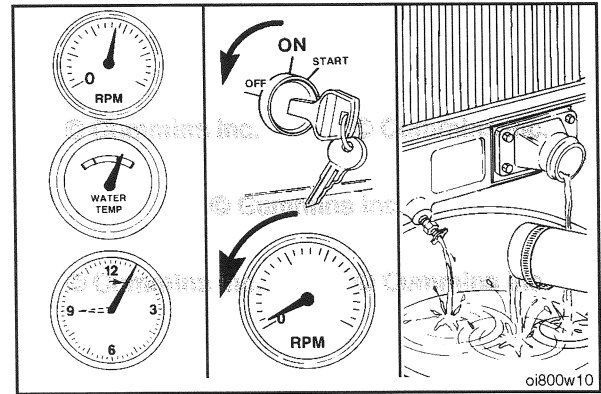
NOTE: Do **not** install the radiator cap.



Operate the engine for 5 minutes with the coolant temperature above 80°C [176°F].

Shut the engine off, and drain the cooling system.

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



Fill

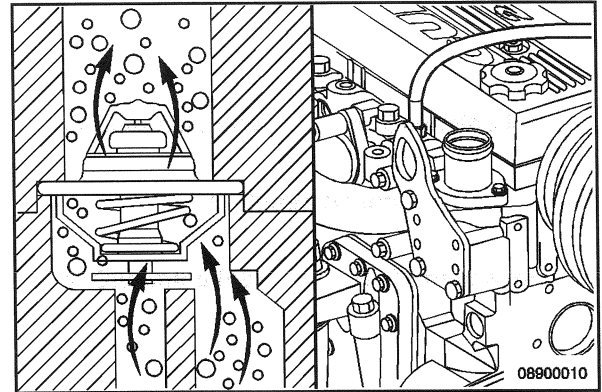
⚠CAUTION⚠

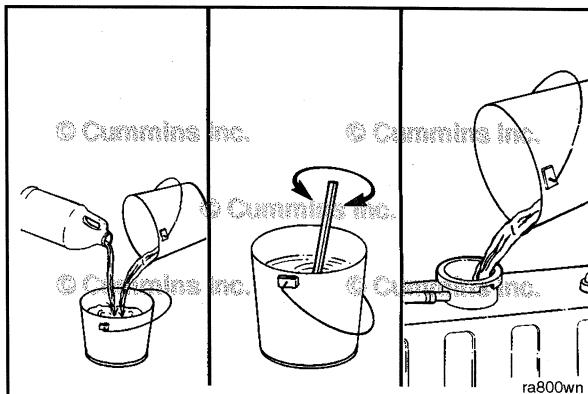
The cooling system must be filled properly to prevent air locks. During filling, air must be vented from the engine coolant passages. Wait 2 to 3 minutes to allow air to be vented; then add mixture to bring the level to the top.

To make sure air is vented during the fill process:

- The thermostat has check balls that allow air to vent through the thermostat when the thermostat is closed.
- A deaeration port is located next to the water outlet connection, which connects to the top tank/coolant recovery tank of the cooling system.

The system has a design fill rate of 19 liters [5 gal] per minute.





⚠CAUTION⚠

Before topping off the cooling system, allow the system temperature to cool to ambient. This will allow an adequate amount of coolant to be available to the water pump during all periods of operation.

⚠CAUTION⚠

Engine and component damage may result if adequate cool down time is not given after the cooling system pressure has been relieved in order to top off with coolant. System pressure is only generated with the temperature rise of the coolant. Closing the cooling system while hot will not allow for pressure to build.

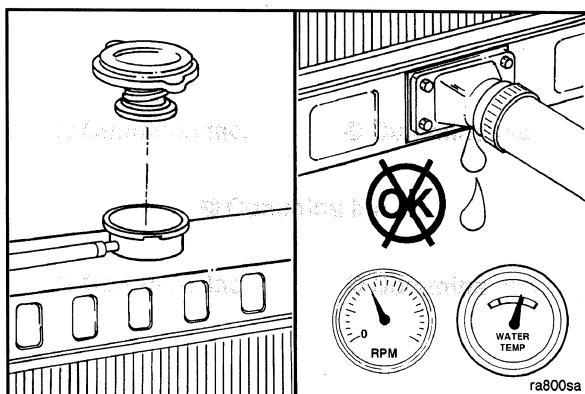
⚠CAUTION⚠

Do not use water alone for coolant. Damage from corrosion can severely damage the engine cooling system.

Use a mixture of 50-percent water and 50-percent ethylene glycol or propylene glycol antifreeze to fill the cooling system.

Reference the Cummins® Coolant Requirements and Maintenance, Bulletin 3666132, for engine coolant specifications.

Use the following procedure for cooling system capacity. Refer to Procedure 018-018 in Section V.



⚠WARNING⚠

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

⚠WARNING⚠

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Install the pressure cap.

Operate the engine until it reaches a temperature of 80°C [176°F] and check for coolant leaks.

Check the coolant level again to make certain the system is full of coolant or that the coolant level has risen to the hot level in the recovery/expansion tank in the system, if equipped.

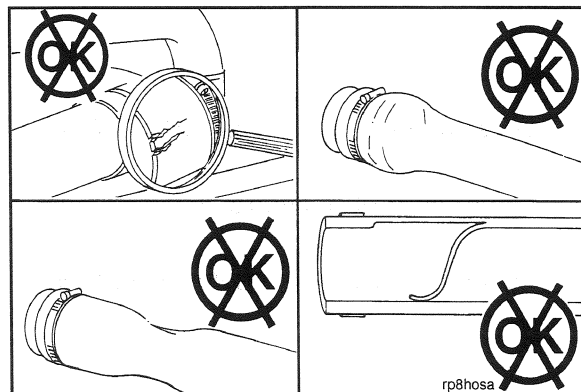
Radiator Hoses

Maintenance Check

Check all hoses for cracks, cuts, or collapsing.

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

If damage is found, replace damaged hoses. Contact your local Cummins Authorized Repair Location.



[illegible]

Section 8 - Maintenance Procedures at 4000 Hours or 3 Years

Section Contents

	Page
Aftertreatment Diesel Exhaust Fluid Dosing Unit Filter	8-1
Clean and Inspect for Reuse.....	8-3
Finishing Steps.....	8-4
General Information.....	8-1
Initial Check.....	8-2
Install.....	8-4
Preparatory Steps.....	8-2
Remove.....	8-3
Maintenance Procedures - Overview	8-1
General Information.....	8-1

This Page Left Intentionally Blank

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.

Aftertreatment Diesel Exhaust Fluid Dosing Unit Filter

General Information

The diesel exhaust fluid (DEF) dosing unit filter is designed to prevent foreign objects that may be suspended in the DEF from entering the dosing system.

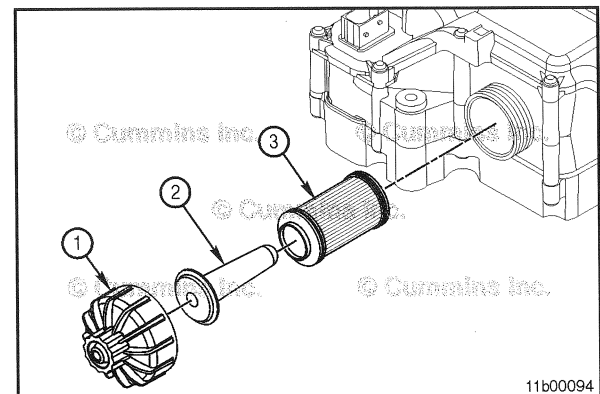
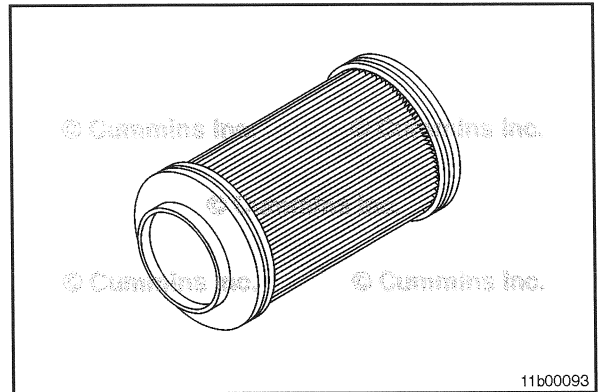
Debris can cause permanent damage and premature failure to either the aftertreatment DEF dosing unit or the aftertreatment DEF dosing valve. The aftertreatment DEF dosing unit filter is a maintenance item.

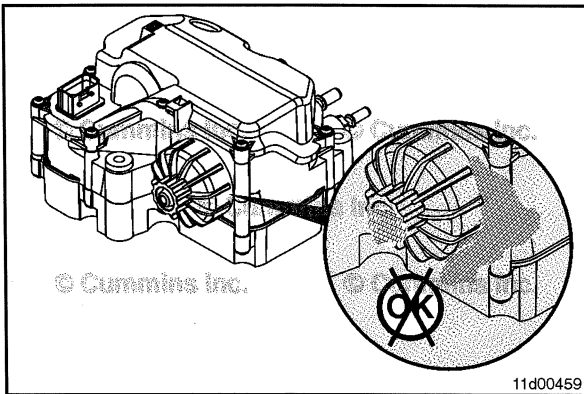
For handling incorrect or contaminated DEF, contact a Cummins® Authorized Repair Location.

Use the following procedure for handling incorrect or contaminated DEF.

The aftertreatment DEF dosing unit filter consists of the following components:

- 1 Aftertreatment DEF dosing unit filter cap
- 2 Aftertreatment DEF dosing unit filter equalizing element
- 3 Aftertreatment DEF dosing unit filter element.





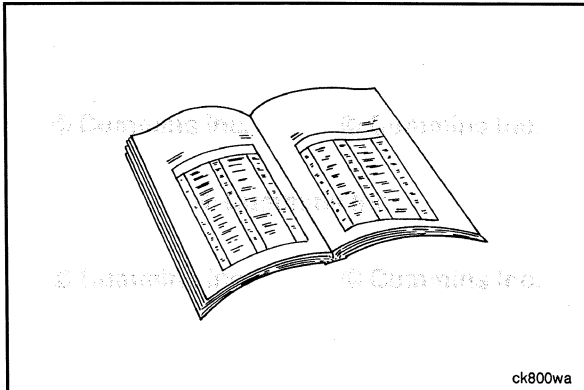
Initial Check

Locate the aftertreatment DEF dosing unit on the vehicle and notice the dome-shaped filter cap.

NOTE: The location of the aftertreatment DEF dosing unit varies on vehicles. Locate the DEF tank and follow the DEF lines to the aftertreatment DEF unit.

Inspect the area around the seal and vent of the aftertreatment DEF dosing unit filter cap for signs of leakage.

DEF leaks leave a white deposit. If deposits are found, see the Clean and Inspect for Reuse section in this procedure.



Preparatory Steps

⚠ WARNING ⚠

Diesel exhaust fluid (DEF) contains urea. Do not get the substance in your eyes. In case of contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes. Do not swallow. In the event the DEF is ingested, contact a physician immediately. Reference the Materials Safety Data Sheet (MSDS) for additional information.

⚠ WARNING ⚠

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

⚠ WARNING ⚠

The diesel exhaust fluid (DEF) line connecting the aftertreatment DEF dosing unit to the aftertreatment DEF dosing valve is under low pressure and should not be disconnected while the engine is running or before the system has completed the purge process after engine shutdown. Disconnecting the DEF line while under low pressure could cause DEF to spray.

⚠ WARNING ⚠

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

NOTE: Do not disconnect the vehicle batteries until the DEF dosing system has completed the purge cycle. Before beginning to remove and/or disconnect any components, wait at least five minutes after the keyswitch is turned OFF for the aftertreatment DEF dosing system to purge the DEF from the system. The purge cycle is an automatic process and does not require intervention to occur. The aftertreatment DEF dosing unit will create an audible pumping noise during the purging process.

NOTE: Do not power wash or steam clean this unit. Use compressed air to remove any loose debris.

- Disconnect the batteries. See equipment manufacturer service information.

Remove

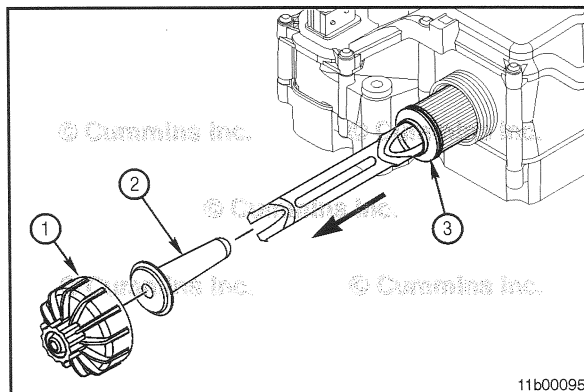
NOTE: There may be residual DEF in the filter housing. A collection container placed below the DEF filter cap is recommended.

Unscrew the DEF filter cap (1). A 27 mm wrench can be used on the cap to aid in removal.

Remove the aftertreatment DEF filter equalizing element (2).

Remove the old aftertreatment DEF dosing unit filter element (3). A disposable service tool is included with the filter to aid in filter removal. Use the appropriate end of the tool, depending on the color of the plastic on the filter. When inserting the tool, a "click" sound can be heard which indicates proper engagement with the filter.

NOTE: If the filter element and equalizing element are removed from the aftertreatment DEF dosing unit, they **must** be discarded and replaced; regardless of condition.



Clean and Inspect for Reuse

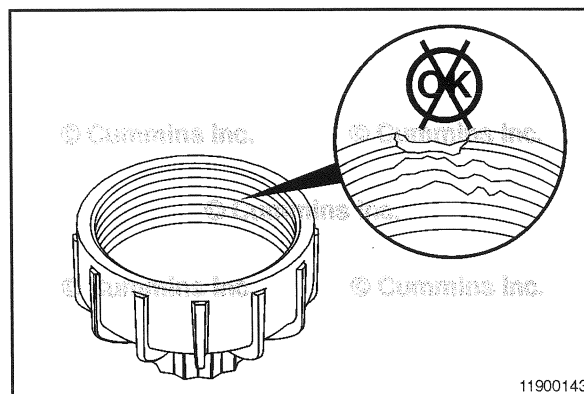
Inspect the aftertreatment DEF dosing unit filter cap for cracks or holes that could create a DEF leak path.

Check the condition of the threads on the aftertreatment DEF dosing unit cap.

If the threads are damaged, replace the aftertreatment DEF dosing unit filter cap.

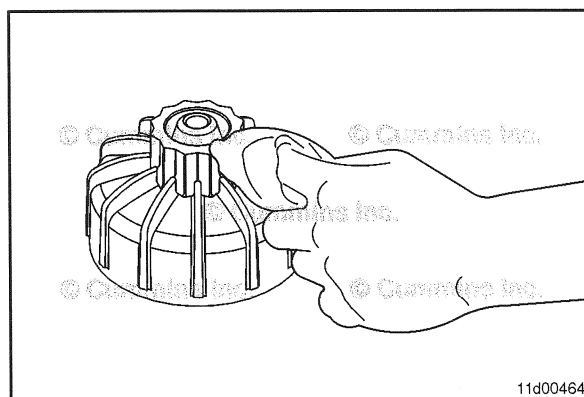
Inspect the aftertreatment DEF dosing unit threads. This is especially important if the aftertreatment DEF dosing unit cap was damaged.

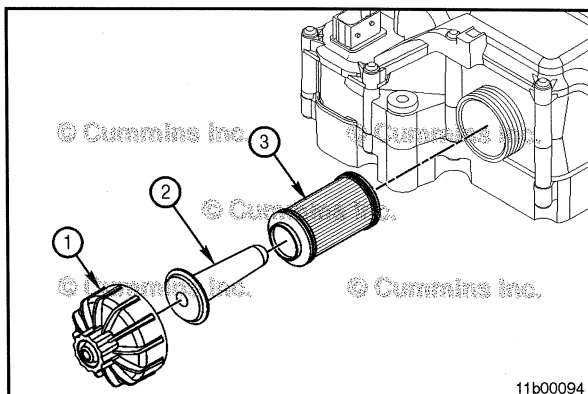
If the aftertreatment DEF dosing unit threads are damaged, replace the entire aftertreatment DEF dosing unit.



NOTE: Never operate the vehicle with the DEF cap removed.

Clean the aftertreatment DEF dosing unit cap and threads on the dosing unit with warm water and a clean cloth.





Install

NOTE: Lubrication of the DEF filter o-rings is **not** required.

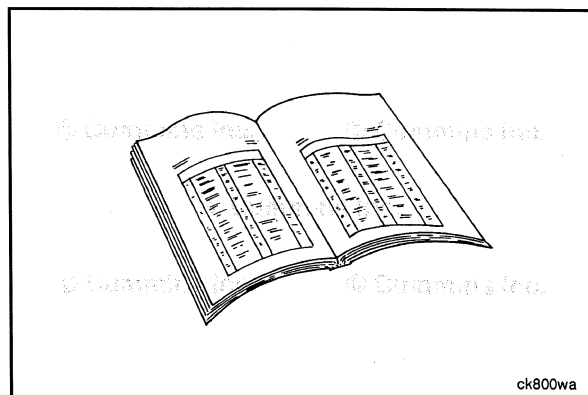


Slide the DEF filter equalizing element (2) into the DEF filter cartridge (3).

Insert the assembly into the aftertreatment DEF dosing unit.

Install and tighten the cap (1). A 27 mm wrench can be used to install and tighten the filter cap.

Torque Value: 20 N•m [177 in-lb]



Finishing Steps

⚠ WARNING ⚠



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



⚠ CAUTION ⚠

Do not use the flow test portion of the INSITE™ electronic service tool Diesel Exhaust Fluid Doser Pump Override Test to check the system for leaks. This will spray DEF into the exhaust system at temperatures too low to evaporate, resulting in deposit formations in the exhaust system.

NOTE: The aftertreatment DEF dosing system will **not** prime until the correct selective catalytic reduction (SCR) temperatures are reached. To verify that there are no DEF leaks, test drive the vehicle for a minimum of 15 minutes to get the SCR system up to temperature.

NOTE: The aftertreatment DEF dosing system will **not** prime until the correct SCR temperatures are reached. To verify that there are no DEF leaks, initiate a stationary regeneration to get the SCR system up to temperature.

- Connect the batteries. See equipment manufacturer service information.
- Operate the engine and check for leaks.

Section 9 - Maintenance Procedures at 5000 Hours or 4 Years

Section Contents

	Page
Maintenance Procedures - Overview	9-1
General Information.....	9-1
Overhead Set	9-1
Adjust.....	9-1



This Page Left Intentionally Blank

Maintenance Procedures - Overview

General Information

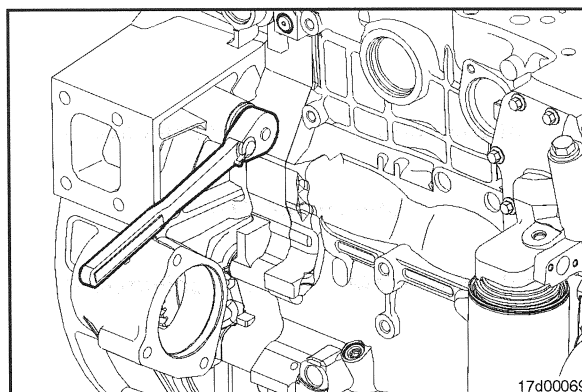
All maintenance checks and inspections listed in previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

Overhead Set

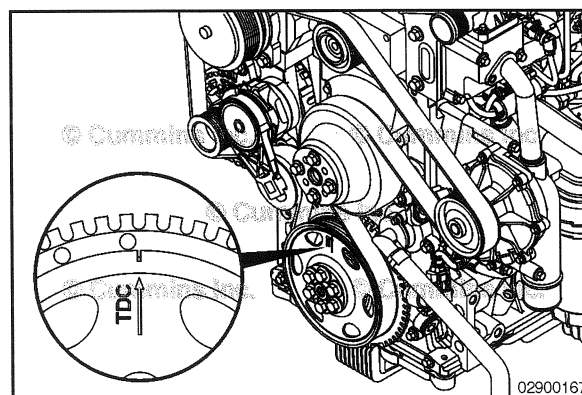
Adjust

NOTE: Engine coolant temperature **must** be less than 60°C [140°F].

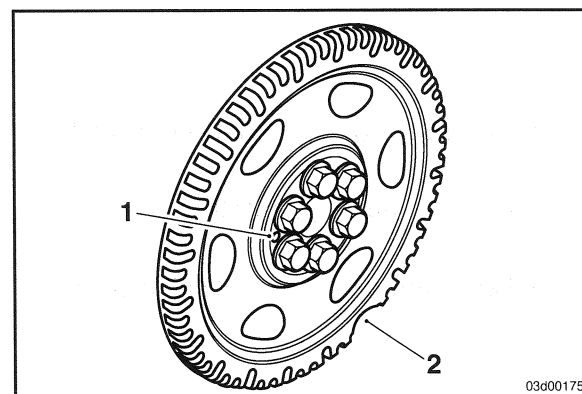
Use the barring tool, Cummins® Part Number 3824591, to rotate the crankshaft until the number 1 cylinder is at top dead center (TDC).

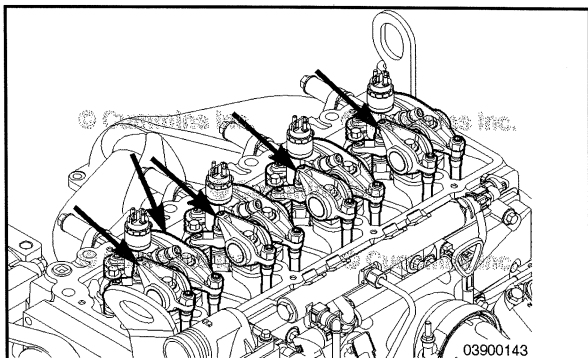


The TDC indicator is on the crankshaft speed indicator ring.



NOTE: If no TDC mark is present on either the crankshaft speed indicator ring, align the large gap in the crankshaft speed indicator ring to the 5 o'clock position (2). The dowel pin could also be visible in the 9 o'clock position (1). Check that both number 1 cylinder rocker levers are loose. If they are **not** loose, rotate the crankshaft 360 degrees and check the proper levers again.

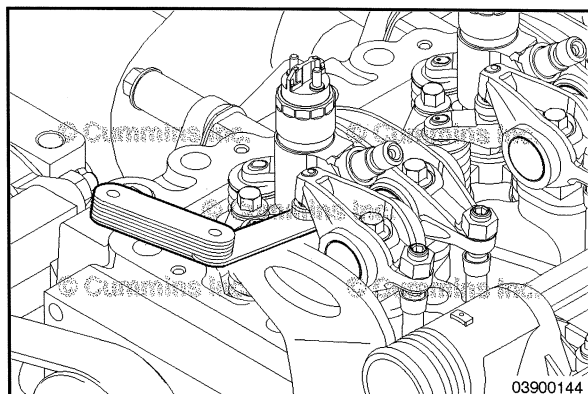




With the engine in this position, lash can be measured on the following rocker levers:

(E = Exhaust, I = Intake)

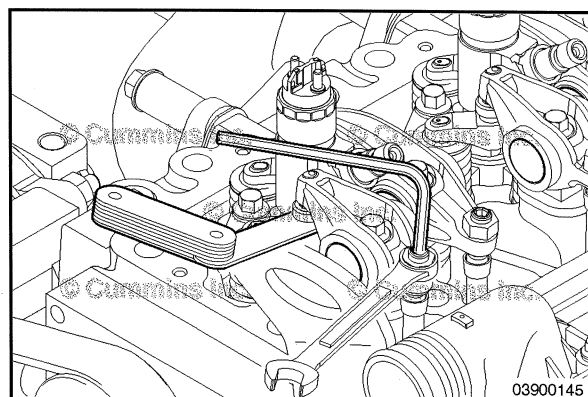
1I, 1E, 2I, and 3E:



Lash Check Limits

	mm		in
Intake	0.28	MIN	0.011
	0.381	MAX	0.015
Exhaust	0.53	MIN	0.021
	0.63	MAX	0.025

NOTE: Checking the overhead setting is usually performed as part of a troubleshooting procedure, and resetting is **not** required during checks as long as the lash measurements are within the above ranges.



NOTE: The clearance is correct when some resistance is "felt" when the feeler gauge is slipped between the crosshead and the rocker lever socket.

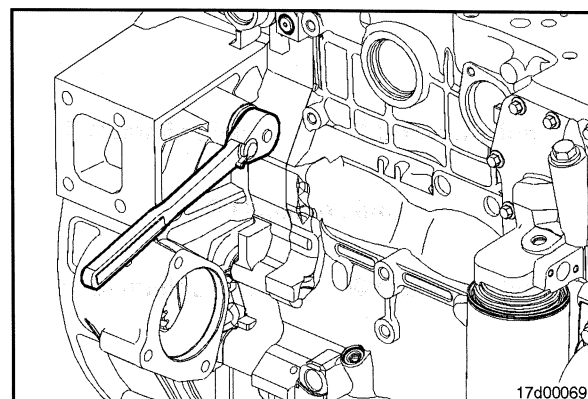


Measure lash by inserting a feeler gauge between the crosshead and the rocker lever socket. If the lash measurement is out of specification, loosen the locknut and adjust the lash to nominal specifications.

Valve Lash Specifications (Nominal)	
	mm
Intake	0.33
Exhaust	0.58

Tighten the locknut and measure the lash again.

Torque Value: 24 N•m [212 in-lb]



Use barring tool, Cummins® Part Number 3824591, to rotate the crankshaft 360 degrees.

Following the same steps and specifications as previously stated, measure lash for the following rocker levers:

(E = exhaust, I = Intake)

2E, 3I, 4E, and 4I

Adjust the lash, if out of specification.

Section A - Adjustment, Repair, and Replacement

Section Contents

	Page
Air Cleaner Element	A-6
Finishing Steps.....	A-10
General Information.....	A-6
Inspect for Reuse.....	A-9
Install.....	A-9
Measure.....	A-6
Preparatory Steps.....	A-7
Remove.....	A-7
Charging System Alternator	A-1
Finishing Steps.....	A-6
Initial Check.....	A-1
Install.....	A-4
Preparatory Steps.....	A-3
Remove.....	A-3
Test.....	A-1
Coolant Thermostat	A-10
Clean and Inspect for Reuse.....	A-13
Finishing Steps.....	A-15
General Information.....	A-10
Install.....	A-14
Leak Test.....	A-11
Measure.....	A-13
Preparatory Steps.....	A-12
Remove.....	A-13
Cooling Fan Belt Tensioner	A-18
Clean and Inspect for Reuse.....	A-20
Finishing Steps.....	A-22
Initial Check.....	A-19
Install.....	A-21
Maintenance Check.....	A-18
Preparatory Steps.....	A-20
Remove.....	A-20
Drive Belt, Cooling Fan	A-15
Clean and Inspect for Reuse.....	A-17
Finishing Steps.....	A-18
General Information.....	A-15
Install.....	A-17
Preparatory Steps.....	A-16
Remove.....	A-16
Starting Motor	A-22
Clean and Inspect for Reuse.....	A-24
Finishing Steps.....	A-26
Install.....	A-25
Measure.....	A-25
Preparatory Steps.....	A-23
Remove.....	A-24
Rotation Check.....	A-22

This Page Left Intentionally Blank

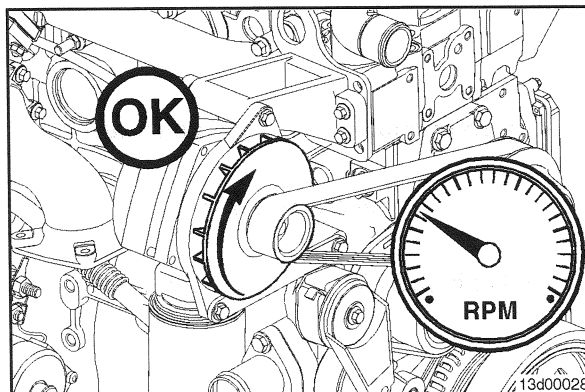
Charging System Alternator

Initial Check

Check the drive belt and alternator pulley to be sure the alternator is rotating properly.

If any problems exist, check the following:

- 1 Use the following procedure to inspect the drive belt, if the drive belt is slipping on the alternator pulley. Refer to Procedure 008-002 in Section A. Use the following to inspect the belt tensioner. Refer to Procedure 008-087 in Section A.
- 2 Remove the drive belt. Refer to Procedure 008-002 in Section A.
- 3 Check if the alternator pulley is loose on the shaft. If loose, remove the pulley and inspect for damage. Refer to the alternator manufacturer's and/or see equipment manufacturer service information.
- 4 If the alternator will **not** rotate or does **not** rotate freely, the alternator **must** be replaced. See the remove and install section of this procedure.



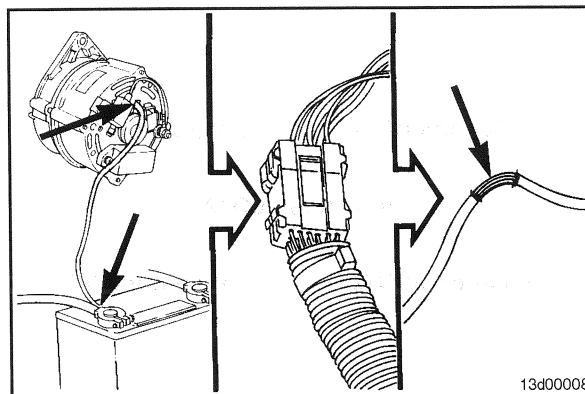
⚠ WARNING ⚠

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

Check the battery and all wiring connections.

Inspect the wiring for defects.

Check all connections for tightness and cleanliness, including the slip connectors at the alternator and engine compartment bulkhead, and the connections at the battery.



Test

NOTE: Any multimeter reading of zero voltage indicates an open circuit.

Check for open circuits.

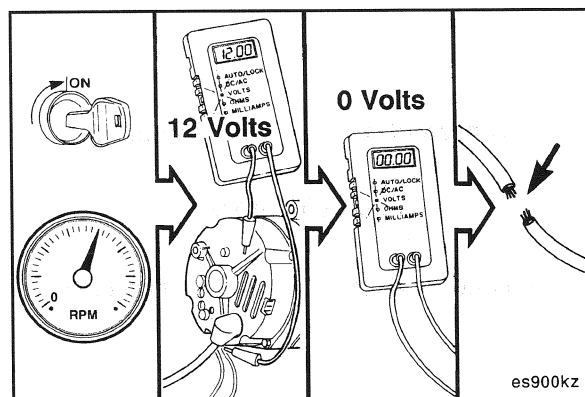
Turn the keyswitch to the ON position.

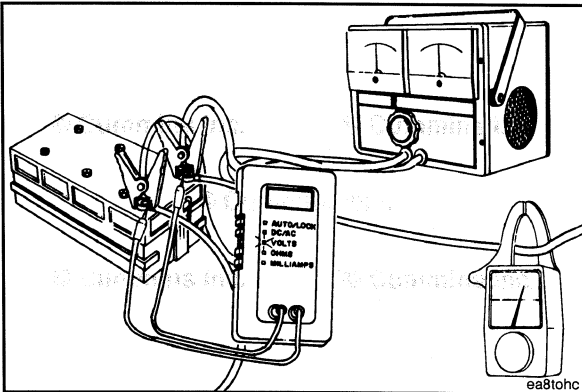
Connect a multimeter, Cummins® Part Number 3164488 or 3164489, to the following locations:

Delco™ Alternators

- 1 Alternator "BAT" terminal to ground
- 2 Alternator blade terminal "number 1" to ground
- 3 Alternator blade terminal "number 2" to ground.

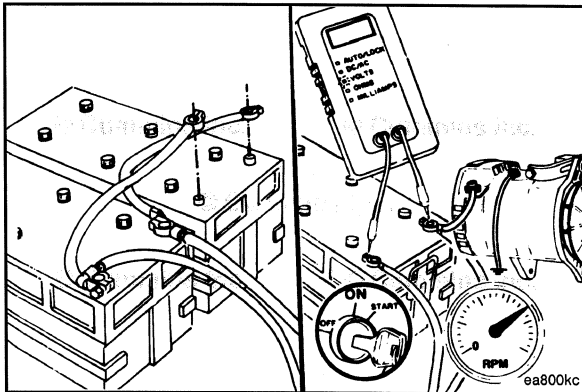
Locate and repair the open circuit.





Connect a carbon-pile load (battery/alternator tester) across the batteries in one of the battery boxes.

Clamp an induction pickup-type ampere-hour meter around the battery cable; or use the digital multimeter, Cummins® Part Number 3164488 or 3164489, with the clamp-on current probe, Part Number 3164490.



⚠ WARNING ⚠

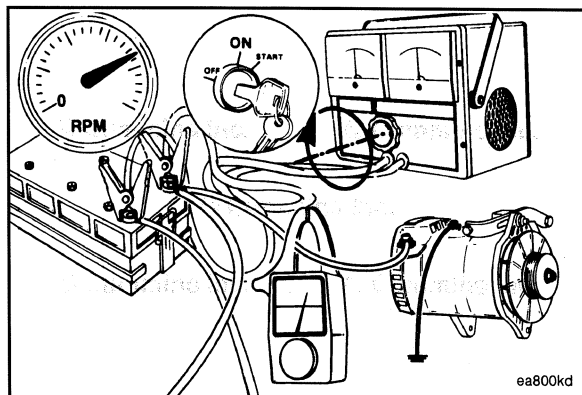
Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

⚠ WARNING ⚠

Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a tank of strong soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to reduce the possibility of serious personal injury.

Disconnect any cables that lead to any other battery boxes in the circuit, negative (-) cables first.

Operate the engine at high idle; and measure the alternator voltage output to the batteries with digital multimeter, Cummins® Part Number 3164488 or 3164489. See equipment manufacturer service information.



Operate the engine at high idle and adjust the carbon-pile load-testing equipment to apply the maximum rated amperage load to the alternator. Refer to the specifications in the OEM service manual.

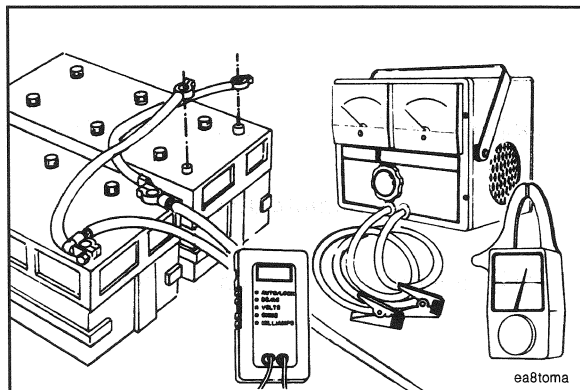
NOTE: The alternator maximum rated amperage output is normally stamped or labeled on the alternator.

Measure the alternator amperage output. See equipment manufacturer service information for specifications.

If the alternator output (amps) is **not** within 10 percent of rated output, repair or replace the alternator. See equipment manufacturer service information for repair procedures.

Shut off the engine and remove the test equipment.

Connect all battery cables, negative (-) cable last.



Preparatory Steps

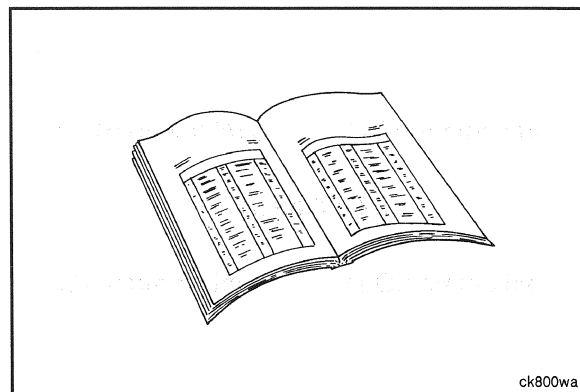
⚠ WARNING ⚠

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

⚠ WARNING ⚠

Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a tank of strong soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to reduce the possibility of serious personal injury.

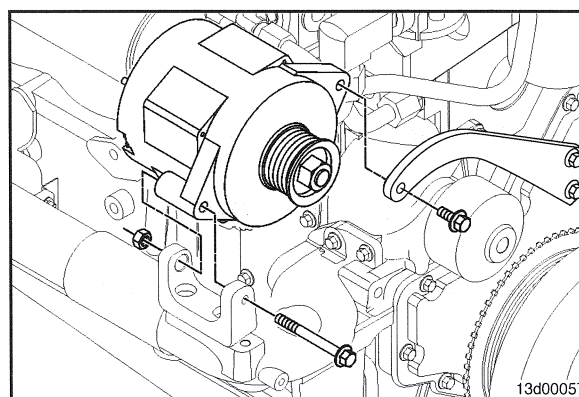
- Disconnect the batteries. See equipment manufacturer service information.
- Remove the drive belt from the alternator pulley. Refer to Procedure 008-002 in Section A.
- Tag and label all wires on the alternator.
- Disconnect the wires.

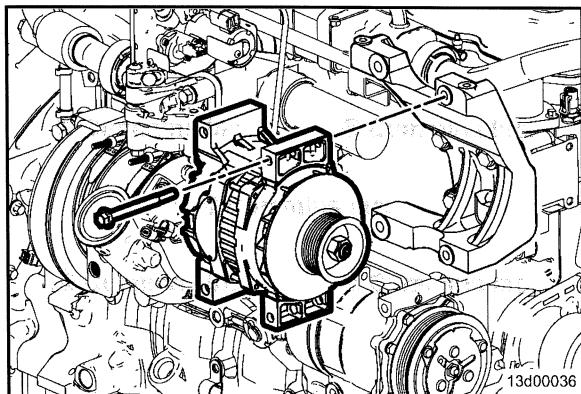


Remove

Spool Mount

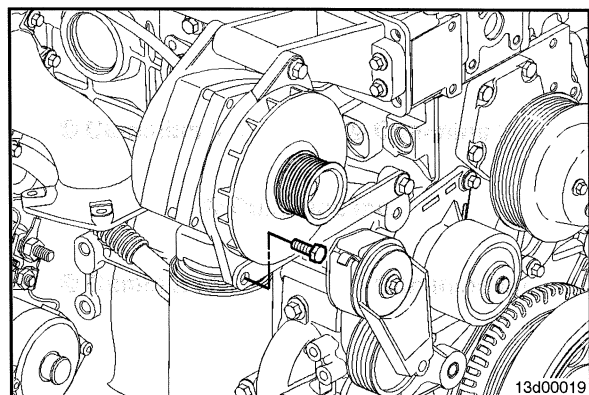
- Remove the upper alternator link capscrew.
- Remove the mounting capscrew and nut at the bottom of the alternator and alternator mounting bracket.
- Remove the alternator.





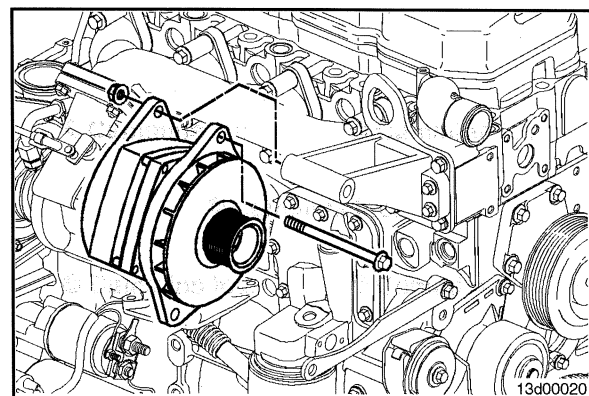
Pad Mount

- Remove the alternator mounting capscrews.
- Remove the alternator.

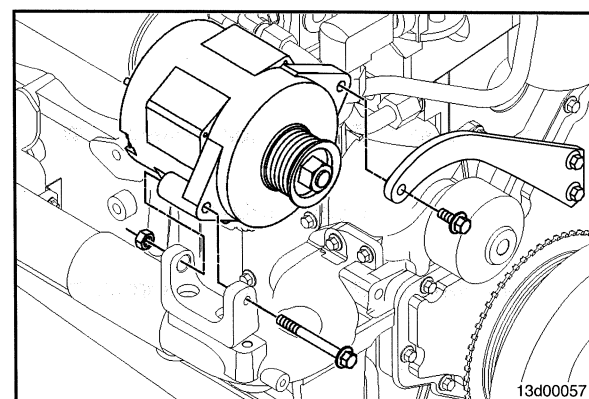


Hinge Mount

- Remove the alternator link capscrew.



- Remove the alternator mounting capscrew.
- Remove the alternator.



Install

Spool Mount

- Install the alternator and the bottom alternator mounting capscrew and nut.
- Install the upper alternator link mounting capscrew at the top of the alternator.
- Tighten the capscrews.

Torque Value:

Lower Mounting Capscrew 40 N•m [30 ft-lb]

Torque Value:

Upper Link Mounting Capscrew 24 N•m [212 in-lb]

Pad Mount

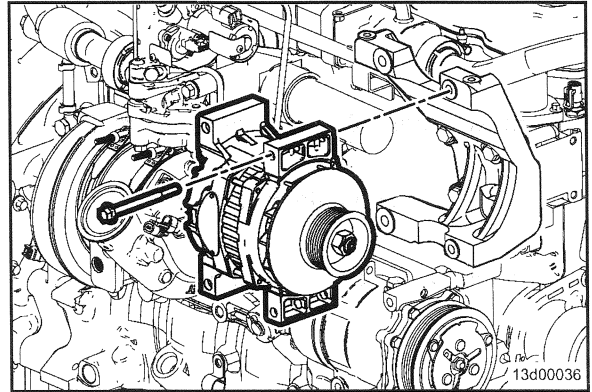
- Install the alternator.
- Install and tighten the alternator mounting capscrews.

Torque Value:

M10 Capscrew 36 N•m [27 ft-lb]

Torque Value:

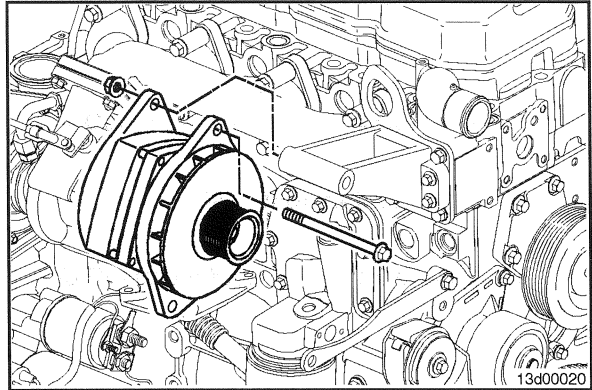
M12 Capscrew 64 N•m [47 ft-lb]



Hinge Mount

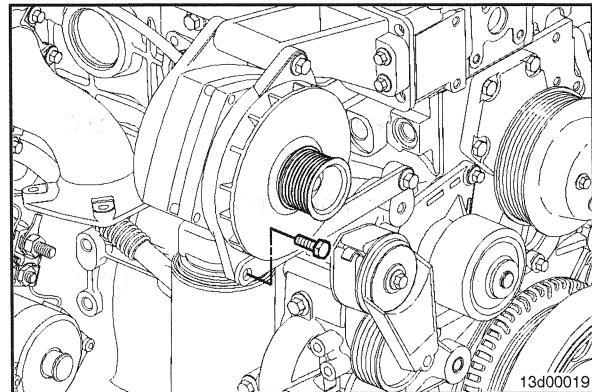
- Install the alternator.
- Install and tighten the alternator mounting capscrew.

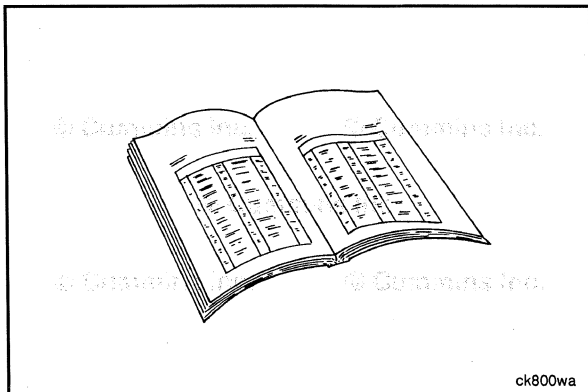
Torque Value: 40 N•m [30 ft-lb]



- Install the alternator link capscrew.

Torque Value: 24 N•m [212 in-lb]





Finishing Steps

⚠ WARNING ⚠

Batteries can emit explosive gases. To reduce the possibility of 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.

⚠ WARNING ⚠

Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a tank of strong soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to reduce the possibility of serious personal injury.

- Connect all wires to the alternator.
- Install the drive belt. Refer to Procedure 008-002 in Section A.
- Connect the batteries. Refer to the OEM instructions.
- Operate the engine and check for proper operation.

Air Cleaner Element

General Information

⚠ CAUTION ⚠

Only use the approved Cummins Filtration™ Direct Flow replacement filter elements to service the air cleaner. Use of improper filters can lead to engine damage.

NOTE: There are two different configurations in which the direct flow air cleaners can be serviced: a front service or a side service direction. Verify the configuration by reviewing the appropriate illustrations in this manual.

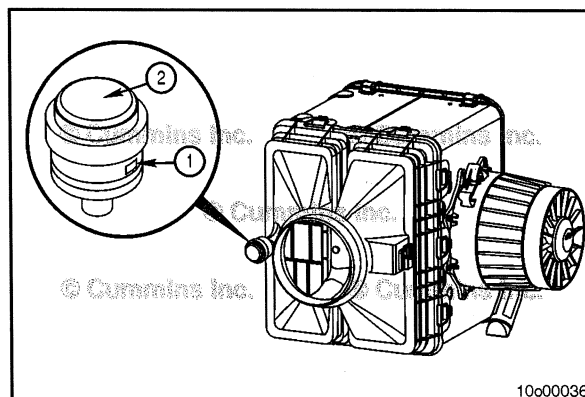
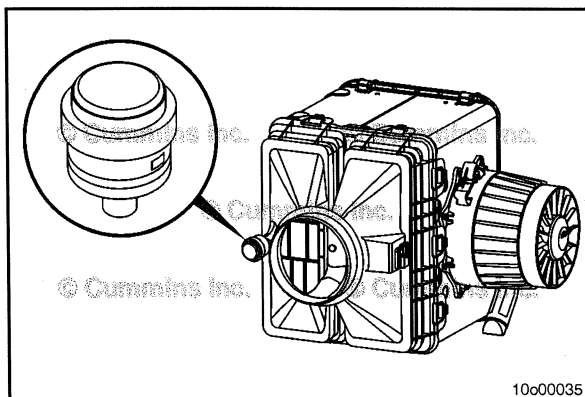
The direct flow air cleaner uses both a primary and secondary filter element for industrial applications. The direct flow air cleaner has been designed for a maximum restriction at 635 mm H₂O [25 in H₂O] of water, at which point the filter element(s) should be changed.

Measure

NOTE: The maximum restriction is reached when the vehicle is under full-load. The restriction indicator will hold the maximum restriction value read during operation, even after the engine is shut down.

Restriction Indicator Check

Check the air cleaner restriction by the restriction indicator located on the outlet end of the air cleaner. A restriction indicator can be purchased separately if **not** present on the housing. The restriction indicator is located at the pressure tap on the outlet side of the housing.



The red flag (1) in the window gradually rises as the air filter loads with dirt. When the maximum air filter restriction is indicated, the air filter **must** be replaced. After changing or replacing the air filter, reset the indicator by pushing the reset button (2).

Some restriction indicators are installed with an electronic switch that illuminates a lamp in the cab at full restriction of 635 mm H₂O [25 in H₂O] of water.

Pressure/Vacuum Gauge Measure

If a restriction indicator is **not** present, attach a pressure gauge to the pressure port on the outlet side of the filter housing. Measure the vacuum during operating conditions at the maximum load.

Preparatory Steps

⚠ WARNING ⚠

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

⚠ WARNING ⚠

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

⚠ WARNING ⚠

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

⚠ CAUTION ⚠

Dirt or contaminants can be introduced into the system and engine if the surrounding areas are not cleaned, resulting in damage to the engine.

NOTE: It is **not** recommended to open the housing if a service event is **not** required.

NOTE: Before servicing any intake air system component, (such as the air cleaner, precleaner, hoses, ducting, etc.), clean the fittings, mounting hardware, and the area around the component to be removed.

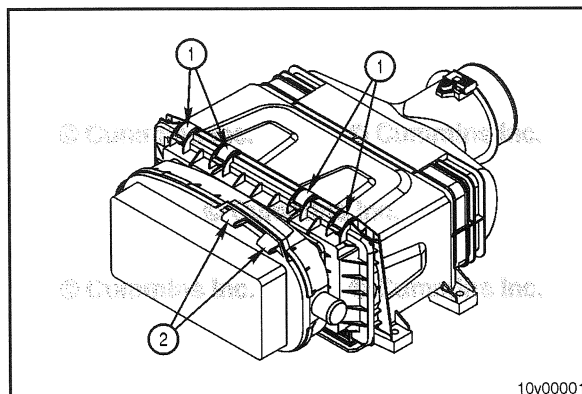
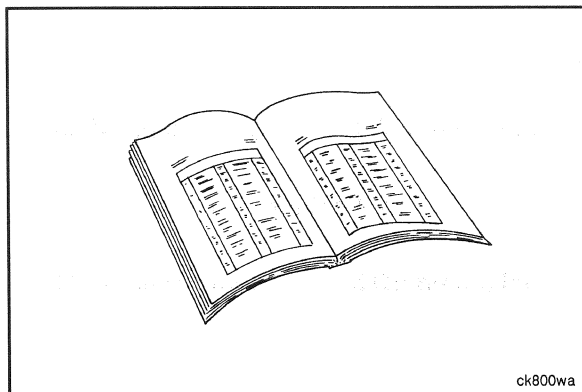
- Shut the engine OFF.
- Disconnect the battery cables. See equipment manufacturer service information.

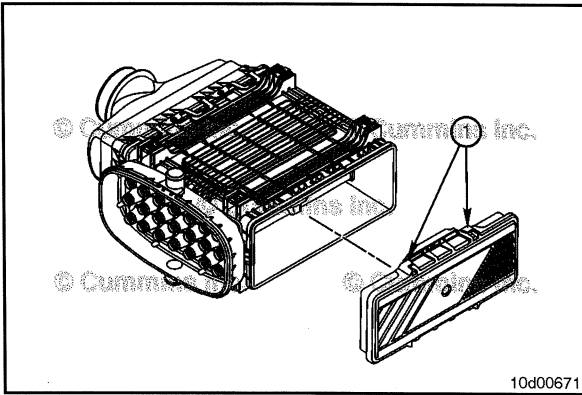
Remove

Front Service Filter Housing

Release the J-clamps to remove the pre-cleaner from the main filter housing. If present, the inlet ducting to the pre-cleaner could possibly need to be loosened or removed to remove the pre-cleaner from the housing. The pre-cleaner can be separated from the housing by sliding the mounting tabs out of the slots on the main housing.

- 1 Clip locations.
- 2 Tab locations.



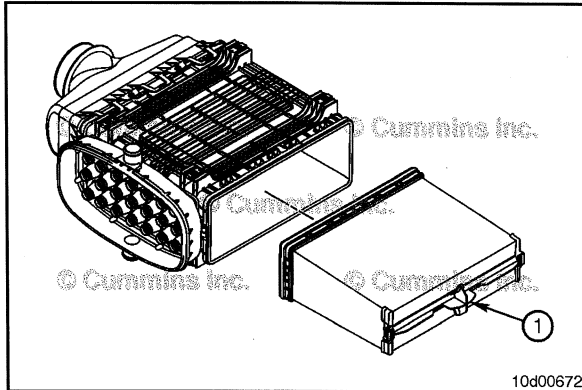


Side Service Filter Housing

The inlet ducting does **not** need to be removed to service the filter elements. To access the filter elements, remove the service door by lifting on the plastic clips on both the top and bottom sides of the housing. The service door will be completely removed from the main housing.

- 1 Service door clip (both sides).

Make sure the gasket around the service door or pre-cleaner remains seated.

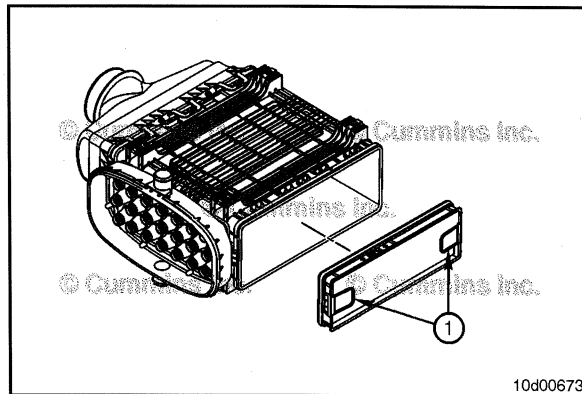


The Direct Flow primary filter element has a built-in handle for easy removal. Grasp the handle in the center of the element and pull the filter element outward.



- 1 Primary element removal handle.

Clean the inside of the housing with a damp rag to remove all loose dirt and dust.



⚠CAUTION⚠

Use caution when removing the secondary element. Any loose debris can fall into the air intake plumbing leading directly to the engine. Clean the area around the secondary filter element and replace the secondary promptly to avoid engine contamination ingestion.

⚠CAUTION⚠

Do not attempt to clean the filter elements. Cleaning filter elements by impact or compressed air voids the warranty and can degrade or damage the filter media leading to malfunction.

NOTE: The secondary element should be changed every-other time the primary element is changed. Proper inspection of the secondary element is to be performed and the element is to be changed, if necessary.

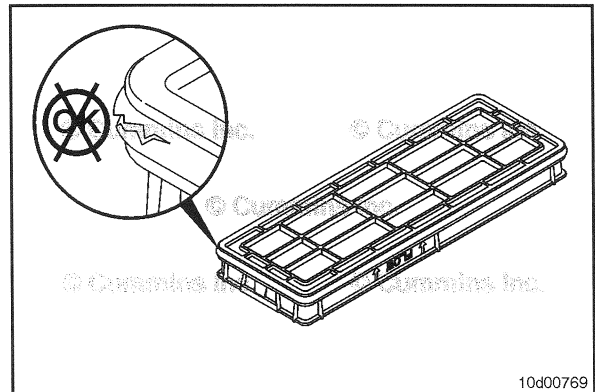
The secondary element is removed by pulling on the plastic ring tab on the inside face of the filter element.

- 1 Secondary element removal ring tab.

Inspect for Reuse

If the used filter element is to be used again, the following precautions must be taken:

- Inspect the gasket around the base of the filter element, if the gasket exhibits any damage, then change the entire filter element assembly.
- Inspect the filter media for any tears or excessive wear. Change the entire filter element assembly if the filter media is **not** intact. The media rows of the filter element may **not** appear straight and exhibit some amount of a wave pattern. This appearance is normal due to standard operation and does **not** require filter element replacement.



Install

⚠ CAUTION ⚠

Only use the approved Cummins Filtration™ aftermarket direct flow replacement filter elements to service the air cleaner. Use of improper filters can lead to engine damage.

⚠ CAUTION ⚠

Make sure any cloth or tools used during the removal process are not left in the filter housing (before installing the filter elements) or engine damage can occur.

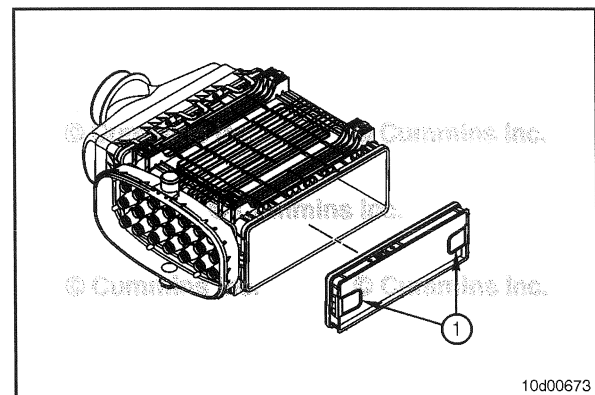
NOTE: The secondary element **must** be installed first if both the secondary and primary elements were removed.

Secondary Element

Insert the element so the orientation of the plastic removal ring is facing the inside of the housing and is accessible for the next service interval.

1 Secondary element removal ring tab should be visible.

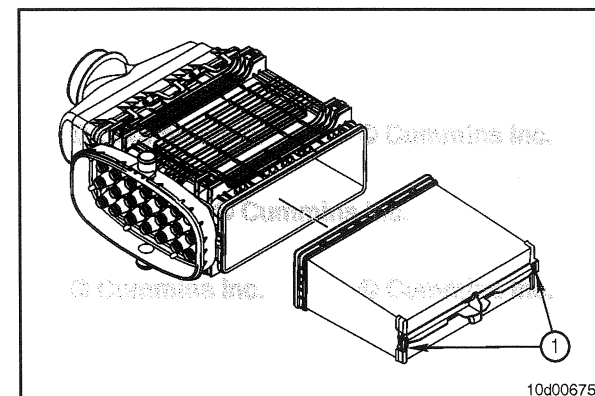
Push the secondary element into the back of the housing so all surfaces are seated inside the housing. Apply pressure to all four corners to make sure the element is secure within the housing. The secondary filter element includes an o-ring that is glued to the filter element to provide an airtight seal.

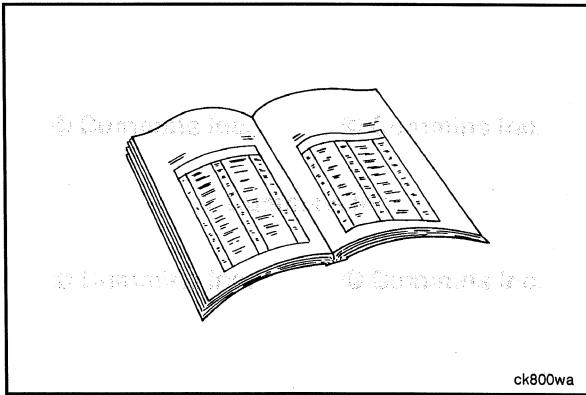


Primary Filter Element

Service Tip: Before installing a new primary filter element, use a marker to note on the element handle if a new secondary element should be installed at the next primary element service event.

Place a new primary filter element in the housing so the o-ring is toward the secondary element. Push the primary element into the housing so all surfaces are seated inside the housing. Apply pressure to the two tabs on the side of the primary element to make sure the element is secure within the housing. The tabs should seat against the center of the housing. The primary filter element also includes an o-ring that is glued to the filter element to provide an airtight seal.





Finishing Steps



⚠ WARNING ⚠

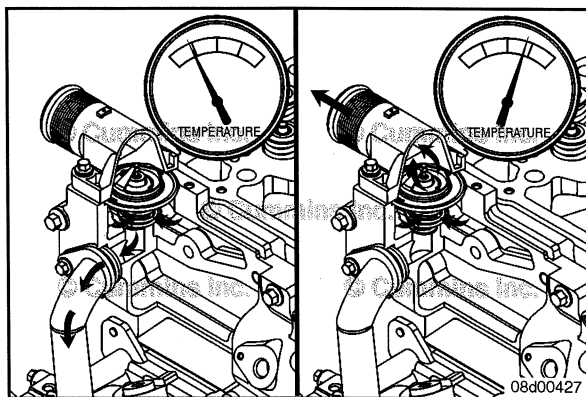
Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

NOTE: The service door or pre-cleaner assembly will **not** latch if the primary filter element is **not** fully seated into the housing.

NOTE: For the 127 mm x 381 mm x 204 mm [5 in x 15 in x 8 in] version, the pre-cleaner assembly has tabs on the opposite side that will interface with slots on the housing.

NOTE: The Direct Flow filter elements are completely disposable.

- Install the service door or pre-cleaner assembly by latching to the housing.
- Reset the restriction indicator by pushing the reset button.
- Connect the battery cables. See equipment manufacturer service information.
- Operate the engine and listen for a noise that could indicate an air leak. Use the following procedure to locate any air leaks in the air system. Refer to Procedure 010-024 in Section 10 in the QSF308 CM2350 F107 Service Manual, Bulletin 4367316.
- Operate the engine and listen for a noise that could indicate an air leak.



Coolant Thermostat

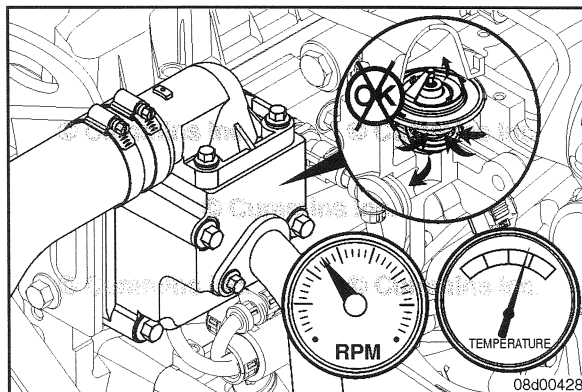
General Information

The thermostat controls the engine coolant temperature. When the coolant temperature is below the operating range, engine coolant is bypassed back to the inlet of the water pump. When the engine coolant temperature reaches the operating range, the thermostat opens, sealing off the bypass, forcing engine coolant to flow to the radiator or heat exchanger.

An incorrect or malfunctioning thermostat can cause the engine to run too hot or too cold.

⚠CAUTION⚠

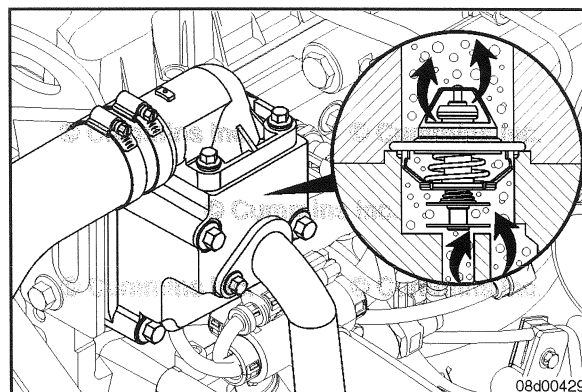
Never operate the engine without a thermostat. Without a thermostat, the path of least resistance for the coolant is through the bypass to the water pump inlet. This can cause the engine to overheat.



⚠CAUTION⚠

A missing check ball can cause the engine to run cold, resulting in engine damage.

The thermostat contains two check balls to vent air past the thermostat when it is closed. This helps to vent air during the cooling system fill process.

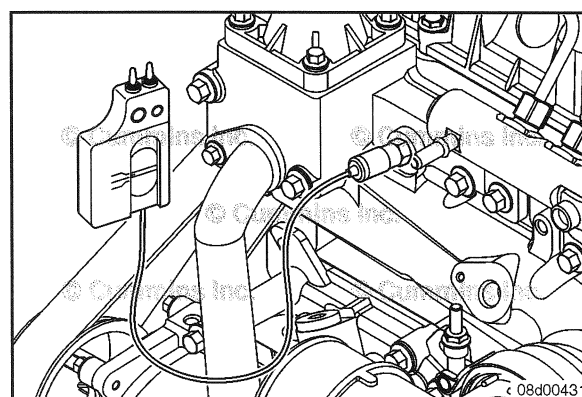


Leak Test

If the thermostat is suspected to be leaking, the following steps can be performed to check for leakage.

The following check **must** be performed with the thermostat closed for 1 minute of engine operation.

Use an electronic service tool to monitor the coolant temperature. The coolant temperature should be less than 38°C [100°F] to ensure the thermostat does **not** open during the test.

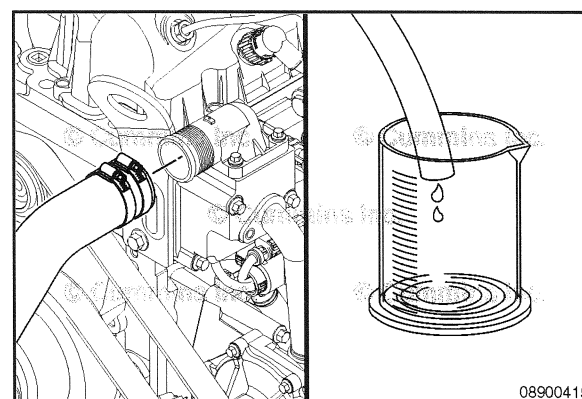


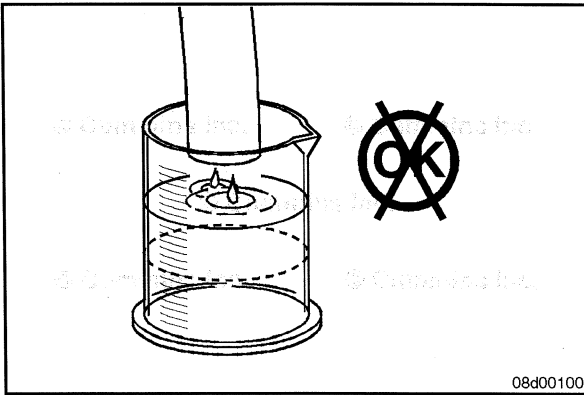
Disconnect the radiator top hose from the water outlet connection.

Install a hose of the same size on the water outlet connection long enough to reach a remote, dry container that will be used to collect coolant.

Install and tighten a hose clamp on the outlet connection.

Place the other end of the hose in a dry container.





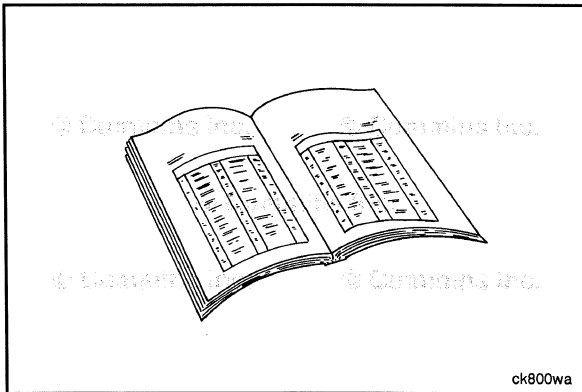
The coolant temperature should be monitored during this test to determine if the coolant temperature reaches the nominal opening temperature of the thermostat. See the Measurement step of this procedure for nominal opening temperature.) If the thermostat opens during this test, the test is invalid and **must** be repeated.

Operate the engine at rated rpm for 1 minute.

Stop the engine and measure the amount of coolant collected in the container.

The amount of coolant **must not** be more than 100 cc [3.3 fl oz].

If more than 100 cc [3.3 fl oz] of coolant is collected, the thermostat is leaking and **must** be replaced.



Preparatory Steps

⚠ WARNING ⚠

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

⚠ WARNING ⚠

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

⚠ 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.

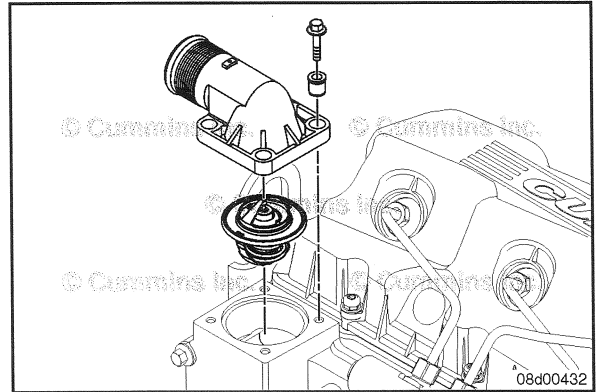
⚠ CAUTION ⚠

Use caution when draining coolant that coolant is not spilled or drained into the bilge area. Do not pump the coolant overboard. If the coolant is not reused, it must be discarded in accordance with local environmental regulations.

- Disconnect the batteries. See equipment manufacturer service information.
- Drain the coolant below the level of the thermostat. Refer to Procedure 008-018 in Section 7.
- Disconnect the upper radiator hose from the water outlet connection. See equipment manufacturer service information.

Remove

Remove the water outlet connection capscrews.
Remove the water outlet connection.
Remove the thermostat.

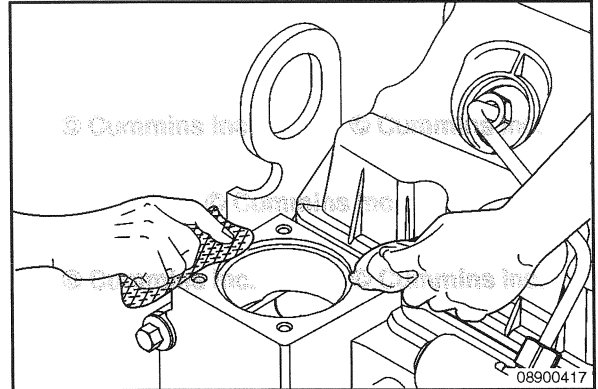


Clean and Inspect for Reuse

⚠CAUTION⚠

Do not let any debris fall into the thermostat cavity when cleaning the gasket surfaces. Damage to the cooling system and engine can occur.

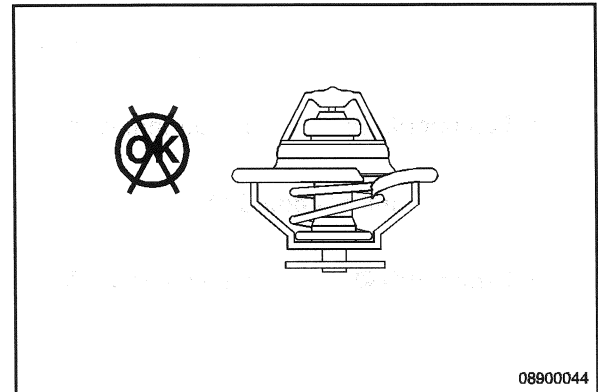
Clean the mating surfaces with an abrasive pad, Cummins® Part Number 3823258, or equivalent, and a clean cloth.



Inspect the thermostat for external damage. Inspect for cracks, embedded debris, missing check balls, damaged seat, and other damage.



Replace the thermostat if any damage is found.

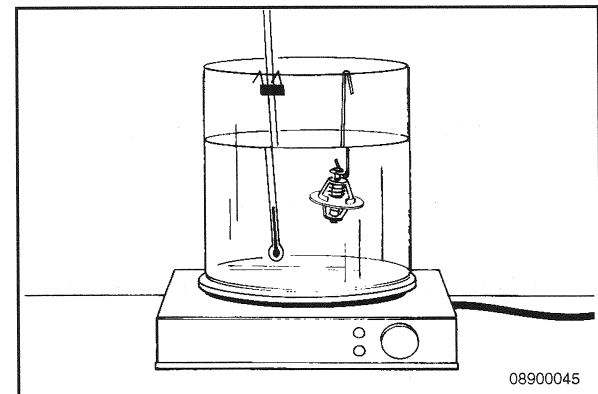


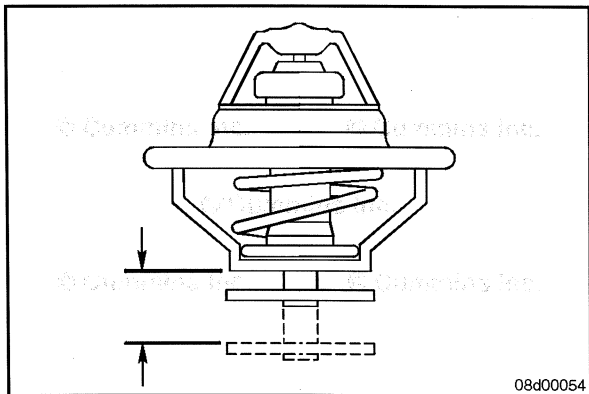
Measure

If the thermostat is suspected to be malfunctioning, the opening temperature of the thermostat should be measured to determine if the thermostat is functioning correctly.

NOTE: Do **not** allow the thermostat or thermometer to touch the container.

Suspend the thermostat and a 100°C [212°F] thermometer in a container of water.





Heat the water and check the thermostat as follows:

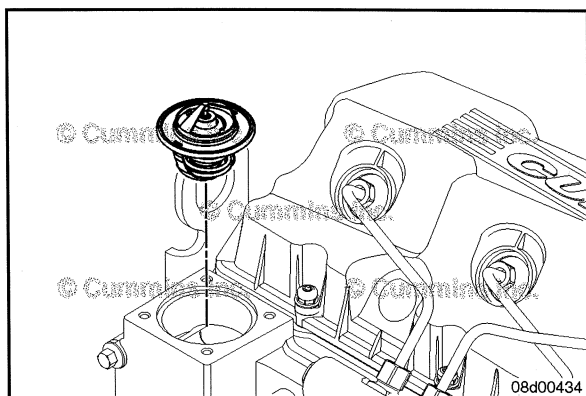
NOTE: The nominal operating temperature is stamped on the thermostat. To verify the correct temperature range thermostat is installed, make sure to reference the appropriate Part Information resources.

The thermostat **must** meet the following criteria:

82°C [180°F] Nominal Temperature Thermostat

Thermostat Opening Temperature

	°C		°F
Initial Opening	79	MIN	175
	83	MAX	182
Fully Opened	95	MAX	203



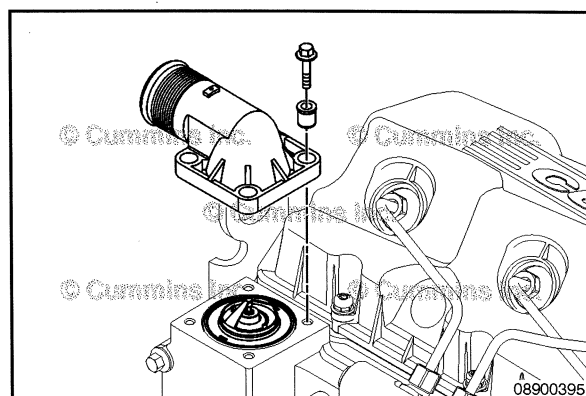
Install

⚠CAUTION⚠

Always use the correct thermostat and do not operate the engine without a thermostat installed. The engine can overheat if operated without a thermostat because the path of least resistance for the coolant is through the bypass to the pump inlet. An incorrect thermostat can cause the engine to overheat or run too cold.

NOTE: If a previously installed thermostat is being used, make sure a new thermostat seal is used.

Install the thermostat into the thermostat housing.



Install the water outlet connection and mounting cap screws.

Tighten the cap screws.



Torque Value: 7 N•m [62 in-lb]

Finishing Steps

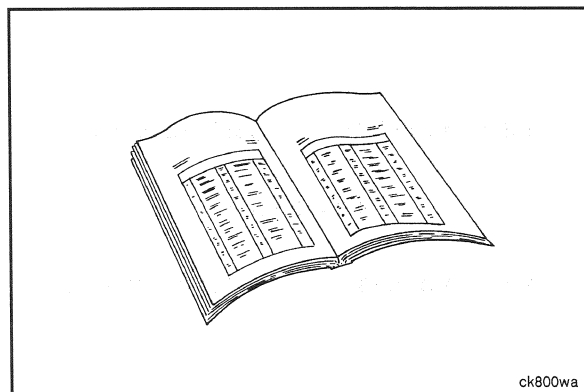
⚠ WARNING ⚠

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

⚠ CAUTION ⚠

Always vent the engine during filling to remove air from the coolant system, or overheating can result.

- Connect the upper radiator hose to the water outlet connection. See equipment manufacturer service information.
- Fill the cooling system. Refer to Procedure 008-018 in Section 7.
- Connect the batteries. See equipment manufacturer service information.
- Operate the engine and check for leaks.



Drive Belt, Cooling Fan

General Information

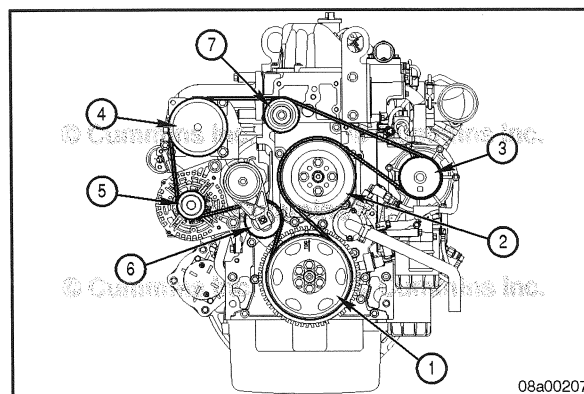
Due to the number of drive belt arrangements, this procedure does **not** cover all available cooling fan drive belt routings.

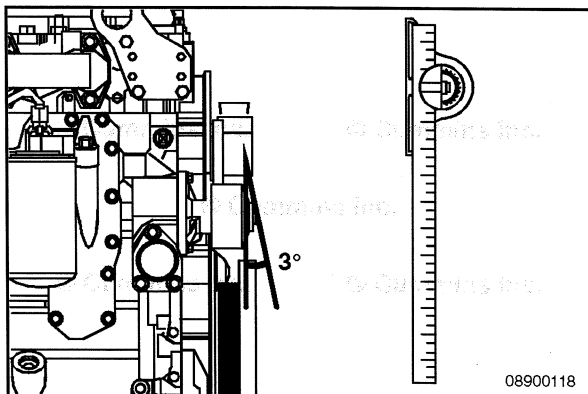
To make sure the cooling fan drive belt is routed correctly upon installation, make a diagram of the cooling fan belt routing prior to removing the belt, as shown in the illustration.

The cooling fan belt routing typically consists of the following components, but may **not** include all of them:

- 1 Crankshaft pulley/Vibration damper
- 2 Fan pulley
- 3 Water pump pulley
- 4 Refrigerant compressor pulley
- 5 Alternator pulley
- 6 Tensioner idler pulley
- 7 Idler pulley.

NOTE: Some engine driven belts are installed/supplied by the vehicle's OEM. See equipment manufacturer service information for removal and installation instructions.

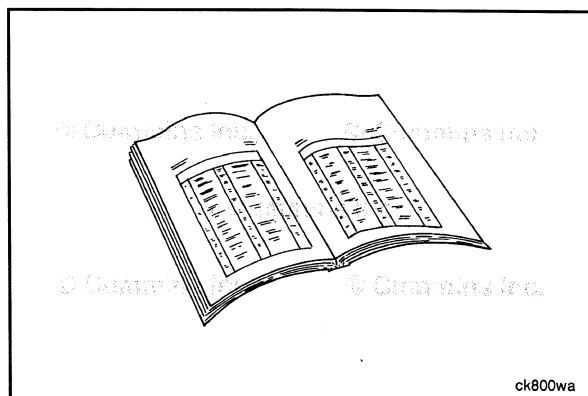




A worn belt tensioner or misaligned pulley can cause a belt to "walk" off.

To check pulley alignment, use Cummins® Pulley Alignment Fixture, Part Number 3163524. If **not** available, this measurement can be taken with a straight-edge and an inclinometer.

Maximum pulley misalignment is 3 degrees. Repair, adjust, or replace misaligned components as necessary.



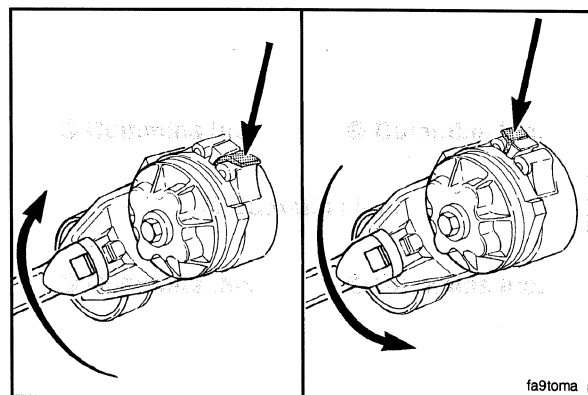
Preparatory Steps

⚠ WARNING ⚠



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

- Disconnect the batteries. See equipment manufacturer service information.

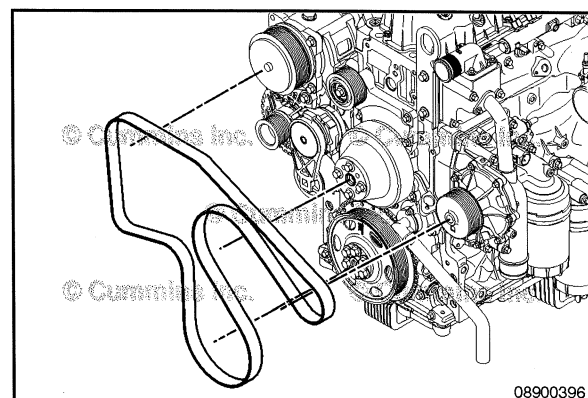


Remove

⚠ CAUTION ⚠

The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.

The belt tensioner winds in the direction that the spring tang is bent over the tensioner body. To loosen the tension on the belt, rotate the tensioner to wind the spring tighter.



⚠ CAUTION ⚠

Applying excessive force in the opposite direction of windup or after the tensioner has been wound up to the positive stop can cause the tensioner arm to break.

NOTE: Make a diagram of the belt arrangement prior to removing the drive belt. This aids in installation for proper routing of the cooling fan drive belt.

NOTE: The location of the belt tensioner can vary, depending on the front engine accessory arrangement.

Pivot the tensioner in the direction of the spring tang to remove the belt.

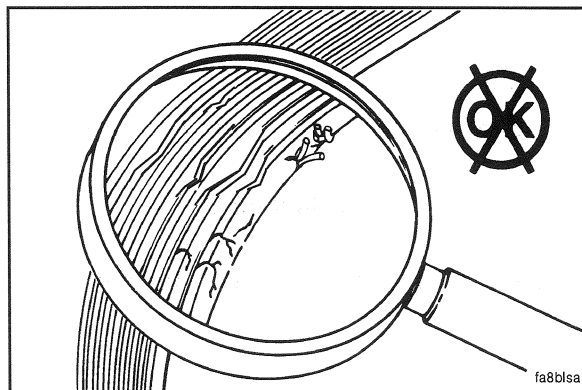
Remove the belt.

Clean and Inspect for Reuse

Inspect the drive belt for:

- Cracks
- Glazing
- Tears or cuts
- Hardening
- Excessive wear.

Replace the belt if any damage is found.



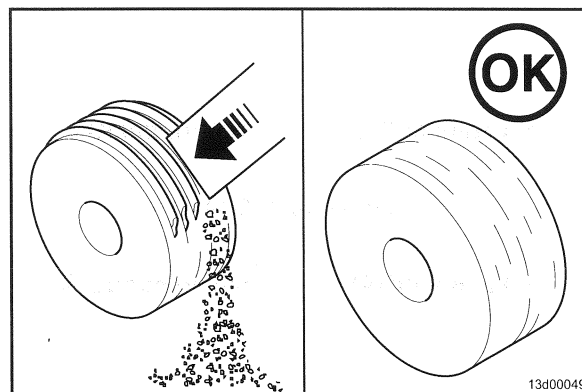
Inspect the idler and drive pulleys for wear or cracks.

Plastic pulleys often have a buildup of road dirt and belt material that is not to be confused with wear.

The dirt can be removed with a suitable tool to check for wear.

Clean, check, and reuse idlers with a buildup of dirt, rather than replacing.

Inspect the tensioner. Refer to Procedure 008-087 in Section 8.



Install

⚠CAUTION⚠

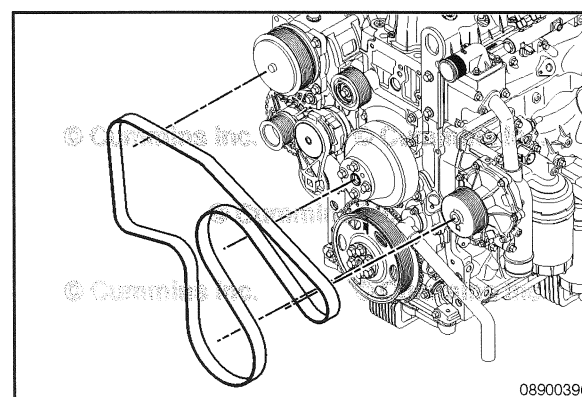
The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.

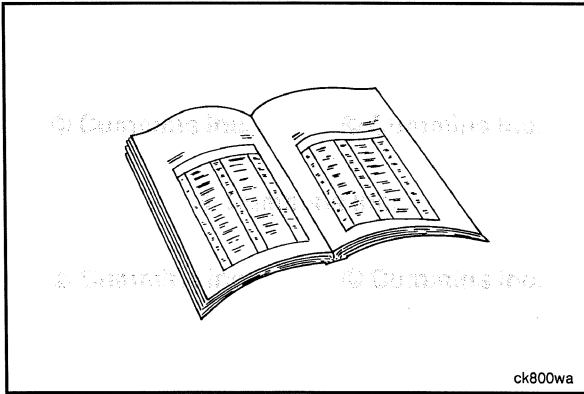
Route the drive belt on the engine. Use the belt diagram created in the Remove section. Do **not** install the belt over the water pump pulley at this time.

Pivot the tensioner in the direction of the spring tang and install the drive belt, slipping the belt over the water pump pulley last.

Release the tensioner to apply tension to the drive belt.

Check the alignment of the belt with the tensioner and the rest of the front-end auxiliary drive.





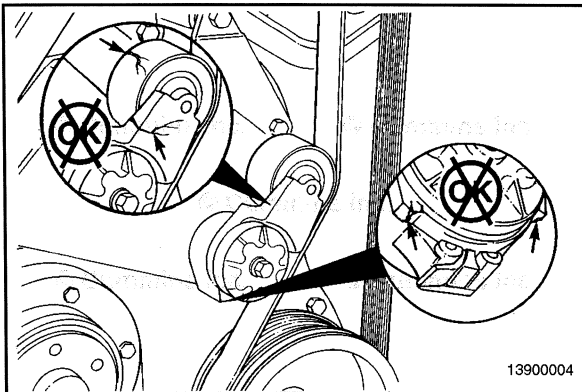
Finishing Steps



⚠ WARNING ⚠

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

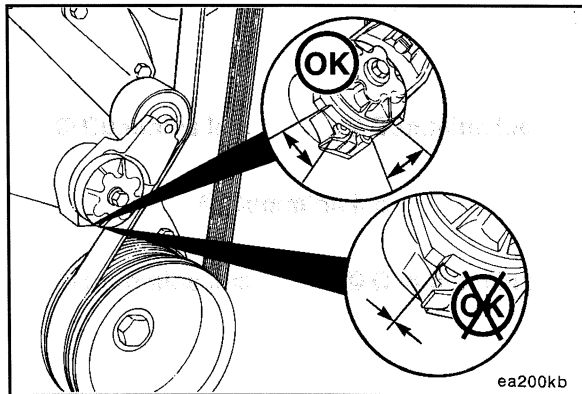
- Connect the batteries. See equipment manufacturer service information.
- Operate the engine and check for belt squeal. Excessive belt squeal indicates belt slippage.
- If belt squeal is present, check the routing of the belt to make sure the belt is installed correctly on each pulley.



Cooling Fan Belt Tensioner Maintenance Check

NOTE: This maintenance check is performed at the Maintenance Procedures at 500 Hours or 6 Months.

With the engine stopped, check the tensioner arm, pulley, and stops for cracks. If any cracks are noticed, the tensioner **must** be replaced.

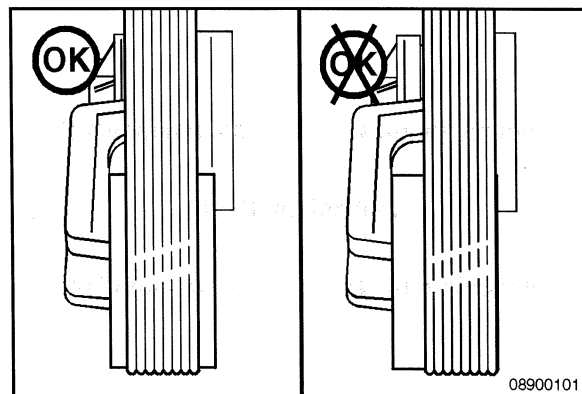


With the belt installed, verify that neither tensioner arm stop is in contact with the spring casing stop. If either of the stops is touching:



- Verify the correct belt part number is installed.
- If the correct belt is installed, replace the belt. Refer to Procedure 008-002 in Section A.

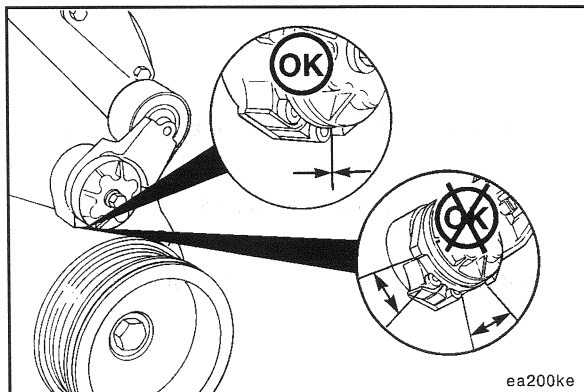
After replacing the belt, if the tensioner arm stops are still in contact with the spring case stop, replace the tensioner.



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

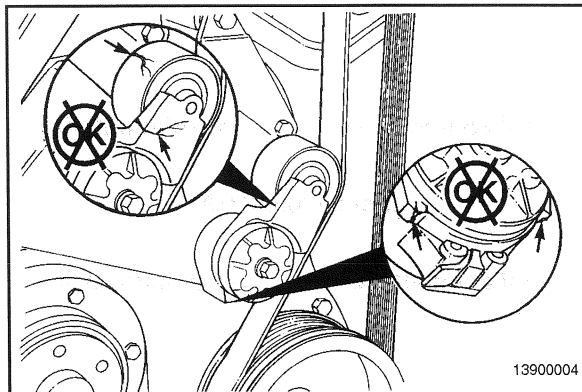
Remove the drive belt. Refer to Procedure 008-002 in Section A.

With the belt removed, verify the tensioner arm stop is in contact with the spring case stop. If they are **not** touching, the tensioner **must** be replaced.



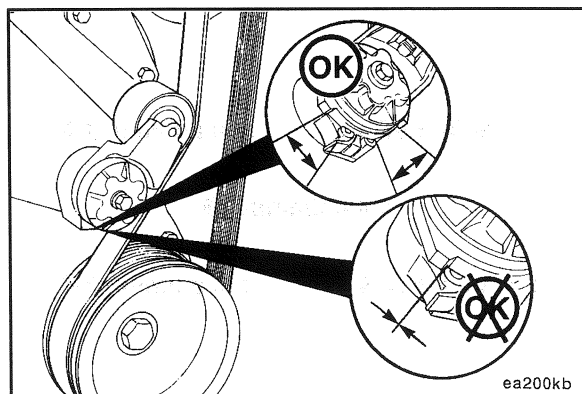
Initial Check

With the engine stopped, check the tensioner arm, pulley, and stops for cracks. If any cracks are noticed, the tensioner **must** be replaced.

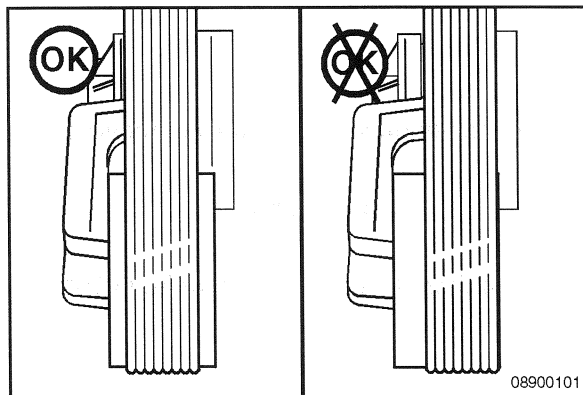


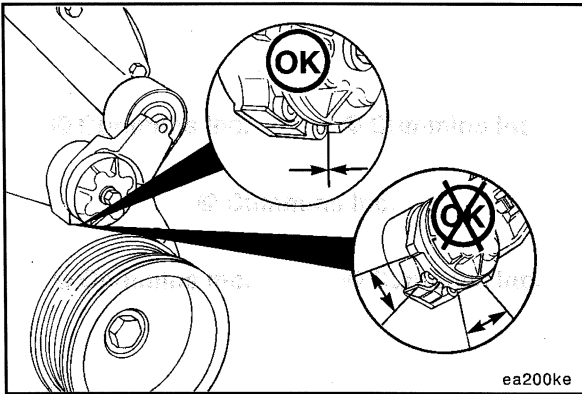
With the belt installed, verify that neither tensioner arm stop is in contact with the spring casing stop. If either of the stops is touching:

- Verify the correct belt part number is installed.
- If the correct belt is installed, replace the belt. Refer to Procedure 008-002 in Section A.



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

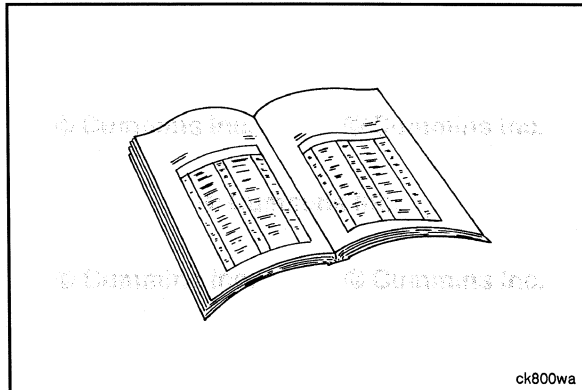




Remove the drive belt. Refer to Procedure 008-002 in Section A.



With the belt removed, verify the tensioner arm stop is in contact with the spring case stop. If they are **not** touching, the tensioner **must** be replaced.



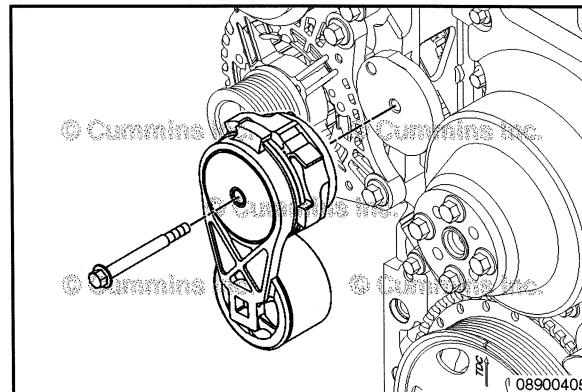
Preparatory Steps



⚠ WARNING ⚠

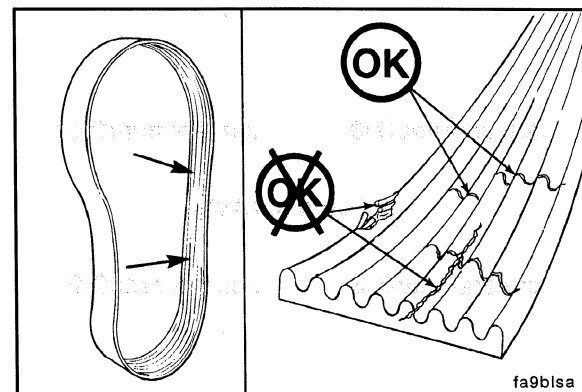
Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

- Disconnect the batteries. See equipment manufacturer service information.
- Remove the drive belt. Refer to Procedure 008-002 in Section A.



Remove

Remove the capscrew and belt tensioner from the bracket.



Clean and Inspect for Reuse

Check the belt for damage.

Transverse (across the belt) cracks are acceptable.

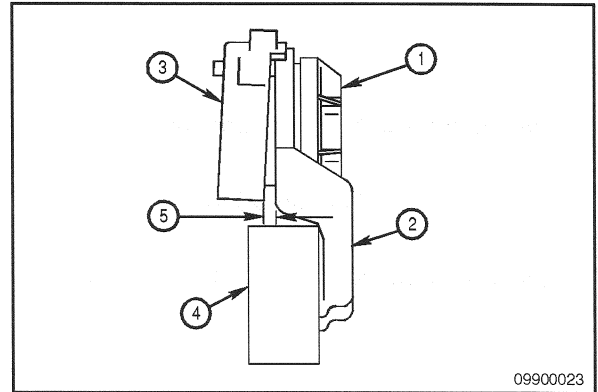
Longitudinal (direction of belt length) cracks that intersect with transverse cracks are **not** acceptable.

If the belt is frayed or has any piece of material missing, the belt is unacceptable and needs to be replaced.

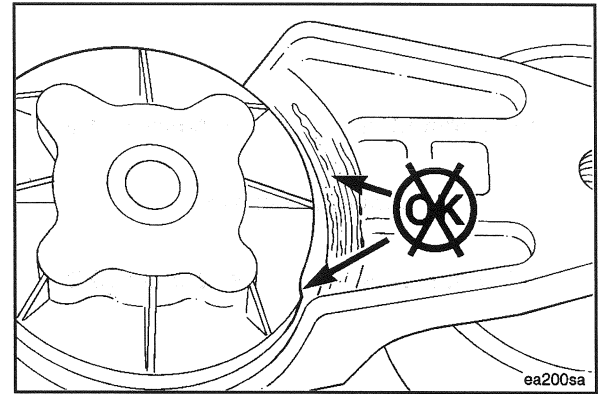
Measure the clearance between the tensioner spring and the tensioner arm to verify tensioner wear-out and uneven bearing wear. If the clearance exceeds 3 mm [0.12 in] at any point, the tensioner has failed and **must** be replaced as a complete assembly.

Tensioners generally show a larger clearance gap near the lower portion of the spring case, resulting in the upper portion rubbing against the tensioner arm. **Always** replace the belt when a tensioner is replaced.

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



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

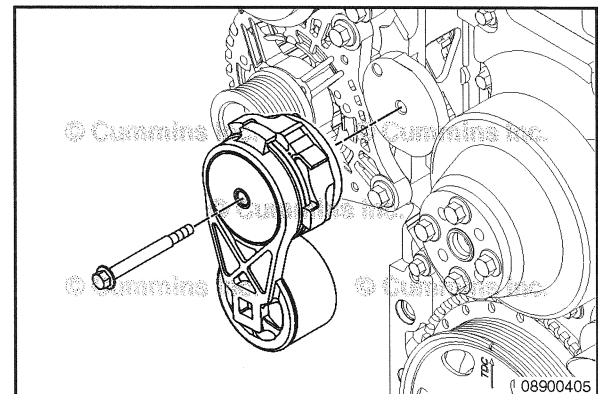


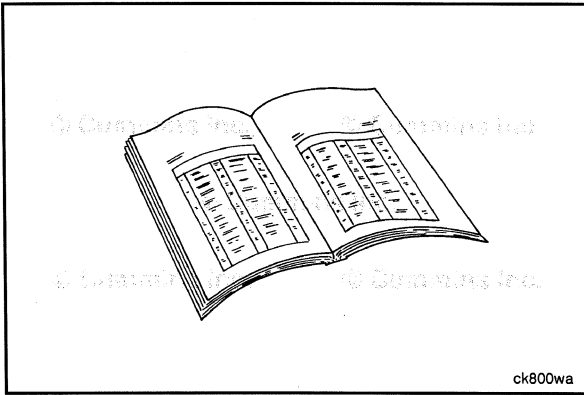
Install

Install the belt tensioner and capscrew.

Tighten the capscrew.

Torque Value: 43 N•m [32 ft-lb]





Finishing Steps

⚠ WARNING ⚠

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

- Install the drive belt. Refer to Procedure 008-002 in Section A.
- Connect the batteries. See equipment manufacturer service information.
- Operate the engine to check for proper operation.

Starting Motor

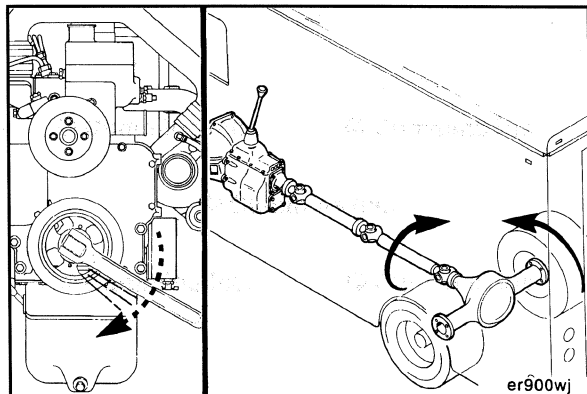
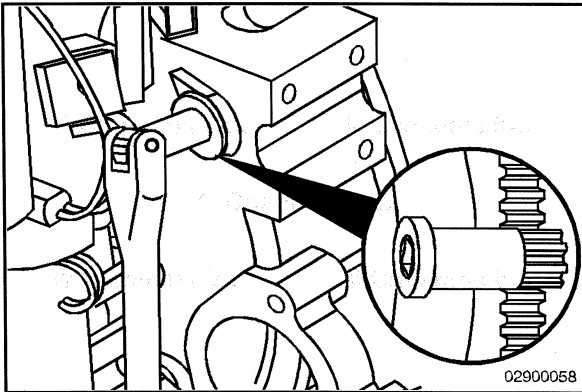
Rotation Check

If the starter solenoid is making a sound, but the engine is **not** rotating, turn the keyswitch to the OFF position, and attempt to bar the crankshaft in both directions.

Bar the engine with barring tool, Cummins® Part Number 3824591.

If the crankshaft will bar over, attempt to start the engine. If the starter motor cranks the engine, check the starter motor pinion gear and flywheel ring gear for damage.

If damage to the starter motor pinion gear and/or flywheel ring gear is found when replacing the components, make sure to measure the distance from the starting motor mounting flange to the forward face of the front side of the flywheel ring gear. Follow the measure step of this procedure.

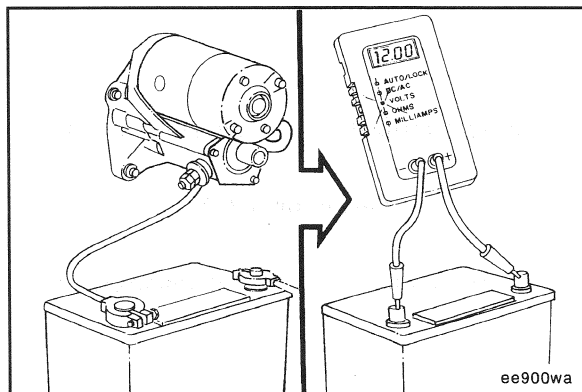


If the crankshaft does **not** rotate or requires more than the normal effort to bar, check for an internal malfunction or a problem with the drive unit and/or accessories.

If the engine cranking speed is too slow or will **not** crank at all, and the engine rotates freely:

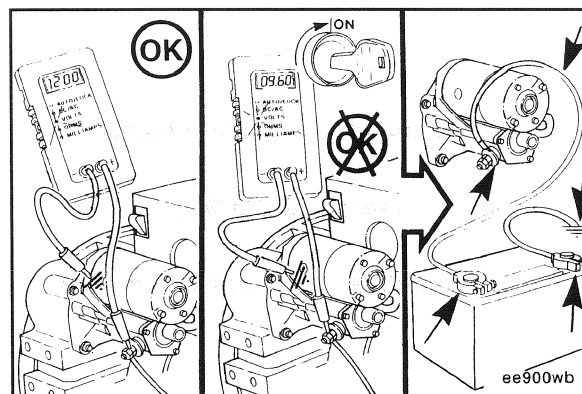
Make sure the wiring connections are clean, tight, and **not** damaged.

Check the battery voltage. See equipment manufacturer service information and/or manufacturer for specifications.



Check the voltage at the starting motor during cranking. If the voltage drops more than 2.4-VDC on a 12-VDC system and 4.8-VDC on a 24-VDC system, check that all connections are clean and tight.

If the cables are correct and the voltage drop exceeds the limit, replace the starting motor.

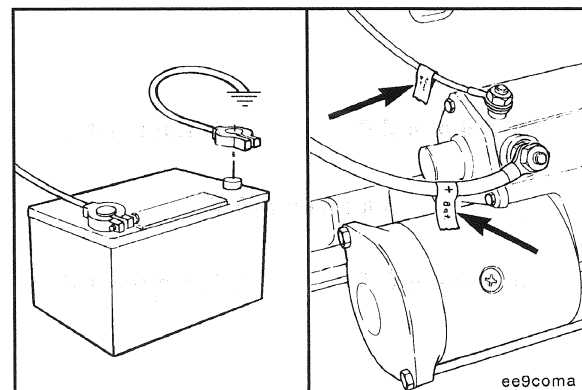


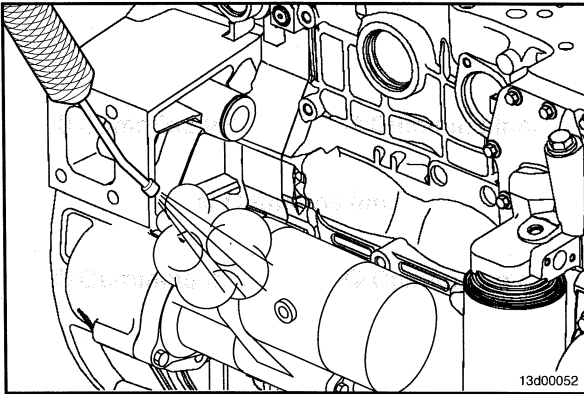
Preparatory Steps

⚠ WARNING ⚠

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

- Disconnect the batteries. See equipment manufacturer service information.
- Identify each wire with a tag indicating location on the starting motor.
- Remove the electrical connections from the starting motor.





⚠ WARNING ⚠

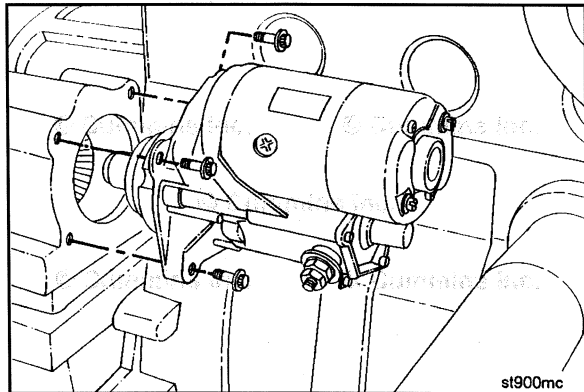
When using a steam cleaner, wear safety glasses or a face shield, as well as protective clothing. Hot steam can cause serious personal injury.

⚠ WARNING ⚠

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

Prior to removing the starter, use steam to clean the area around the starting motor to prevent debris from entering the flywheel housing.

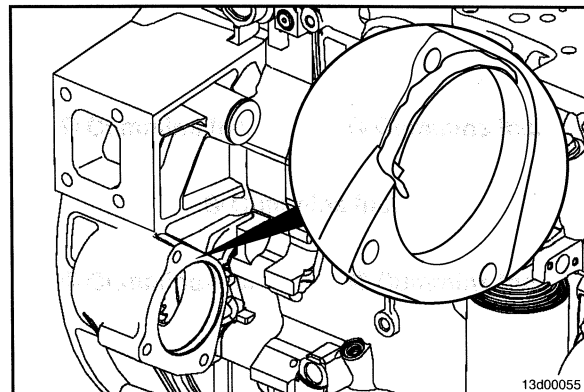
Dry with compressed air.



Remove

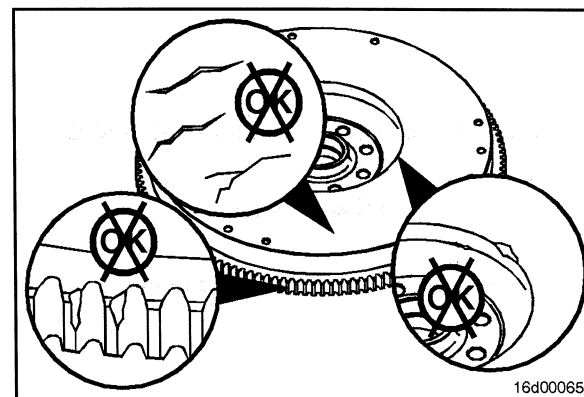
Remove the three capscrews and the starting motor.

NOTE: If equipped with a starting motor spacer, remove the spacer and clean all surfaces between the starting motor, starting motor spacer, and flywheel housing with a wire brush.



Clean and Inspect for Reuse

For engines that use wet flywheel housings, clean any leftover sealant from the starting motor mounting flange on both the flywheel housing and starting motor. Make sure these surfaces are clean of oil and debris.



Inspect the starter motor pinion gear and/or flywheel ring gear for chipping or uneven wear.

NOTE: If the starter motor pinion gear and/or flywheel ring gear teeth are damaged, they **must** be replaced.

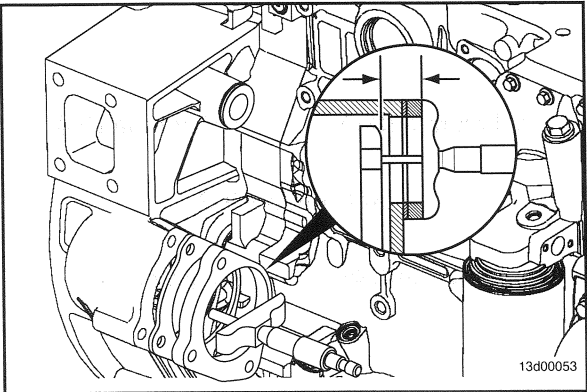
Measure

Use an inside micrometer or a vernier caliper to measure the distance from the starting motor mounting flange to the forward face of the front side of the flywheel ring gear.

NOTE: Include any spacers previously removed when completing the measurement.

Starting Motor Spacing		
mm		in
49.28	MIN	1.94
52.32	MAX	2.06

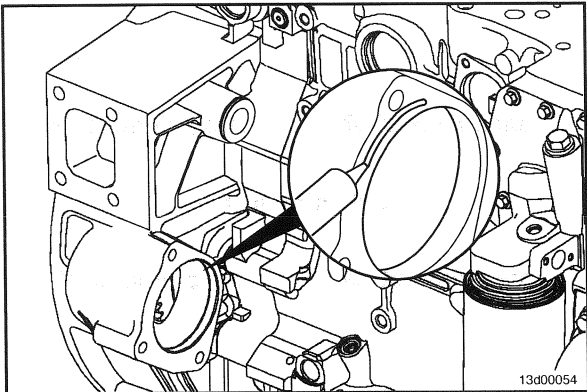
Add or remove spacers as necessary to achieve the correct starting motor spacing.



Install

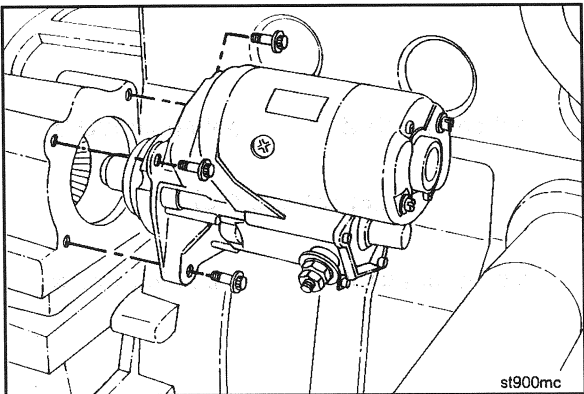
For engines with wet flywheel housings, apply a 1.5 to 2.0 mm [0.06 to 0.09 in] wide bead of sealant, Cummins® Part Number 3164067, to the flywheel housing starting motor mounting flange.

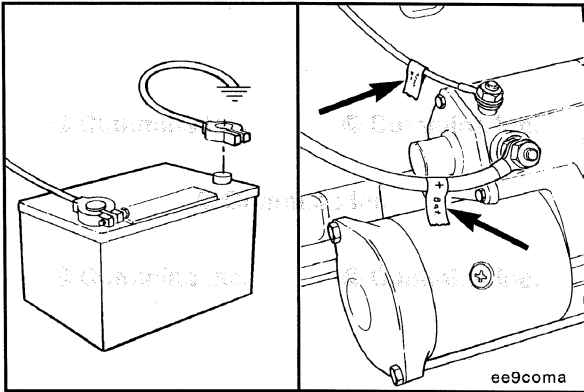
NOTE: If a starting motor spacer is required, make sure to apply sealant to the side of the spacer that contacts the starting motor.



Install the three capscrews, the starting motor, and starting motor spacer, if required.

Torque Value: 43 N•m [32 ft-lb]





Cummins® Branded Starters



⚠ WARNING ⚠

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

⚠ CAUTION ⚠

Do not overtighten the electrical connections. Starter damage can result.

NOTE: Use the location tags to help identify where each wire connection goes.

Connect the electrical connections to the starter motor.

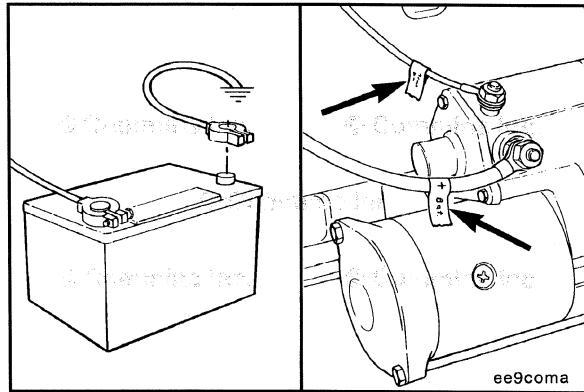
Torque Value:

M5 4 N•m [35 in-lb]

Torque Value:

M10 21 N•m [186 in-lb]

Connect the ground cable to the battery terminal.



Non-Cummins® Branded Starters



⚠ CAUTION ⚠

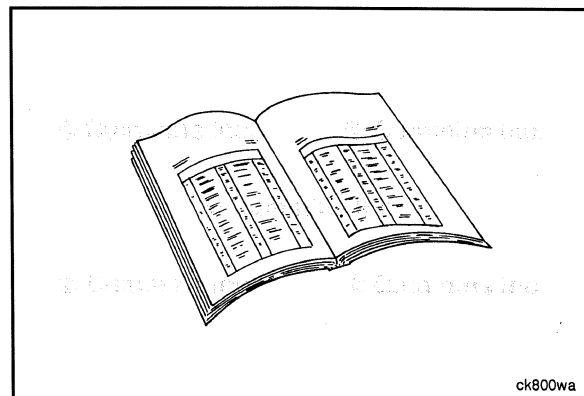
Do not overtighten the electrical connections. Starter damage can result.

NOTE: Use the location tags to help identify where each wire connection goes.



Install the starter motor electrical connections.

For Non-Cummins® branded starters, see equipment manufacturer service information for torque specifications.



Finishing Steps



⚠ WARNING ⚠

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

- Connect the batteries. See equipment manufacturer service information.
- Operate the starter to check for proper function.

Section D - System Diagrams

Section Contents

	Page
Flow Diagram, Air Intake System	D-8
Flow Diagram.....	D-8
Flow Diagram, Cooling System	D-6
Flow Diagram.....	D-6
Flow Diagram, Exhaust System	D-9
Flow Diagram.....	D-9
Flow Diagram, Fuel System	D-2
Flow Diagram.....	D-2
Flow Diagram, Lubricating Oil System	D-3
Flow Diagram.....	D-3
System Diagrams - Overview	D-1
General Information.....	D-1

This Page Left Intentionally Blank

System Diagrams - Overview

General Information

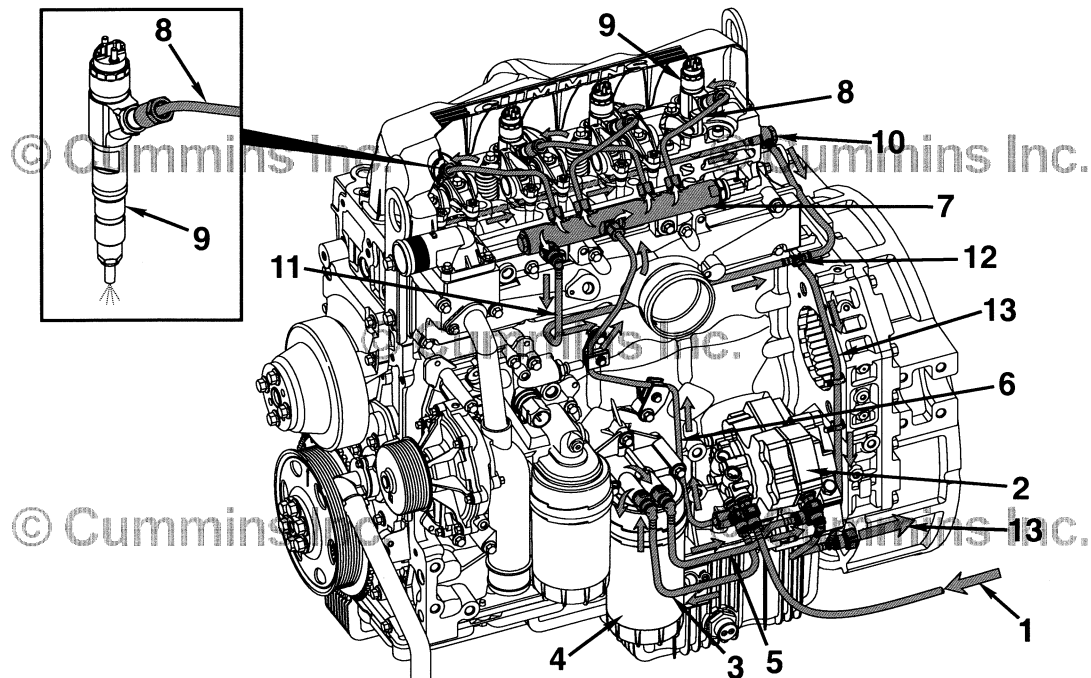
The following drawings show the flow through the engine systems. Although parts can change between different applications and installations, the flow remains the same. The systems shown are:

- Fuel System
- Lubricating Oil System
- Coolant System
- Intake Air System
- Exhaust System
- Compressed Air System.

Knowledge of the engine systems can help you in troubleshooting, service, and general maintenance of your engine.

Flow Diagram, Fuel System

Flow Diagram

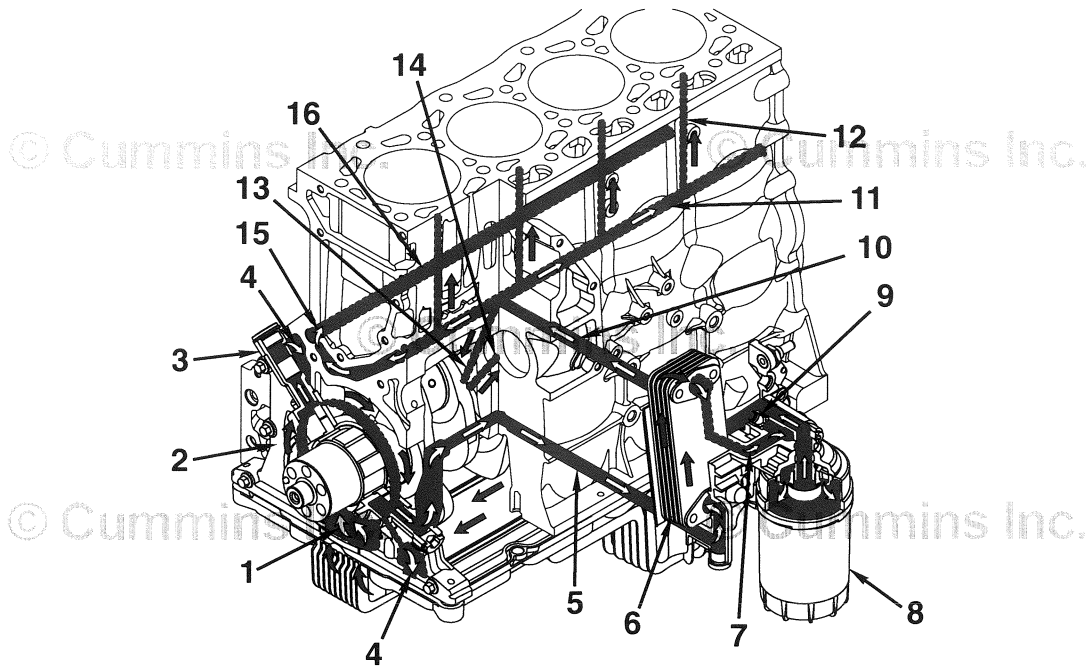


05900952

- 1 Fuel supply from tank
- 2 Fuel pump
- 3 Fuel supply to filter
- 4 Fuel filter (spin-on)
- 5 Fuel flow out of fuel pump
- 6 Fuel supply to common fuel rail
- 7 Common fuel rail
- 8 High pressure fuel to injector
- 9 Injector
- 10 Fuel return from cylinder head
- 11 Fuel return from common rail
- 12 Fuel return junction
- 13 Fuel return to tank.

Flow Diagram, Lubricating Oil System

Flow Diagram

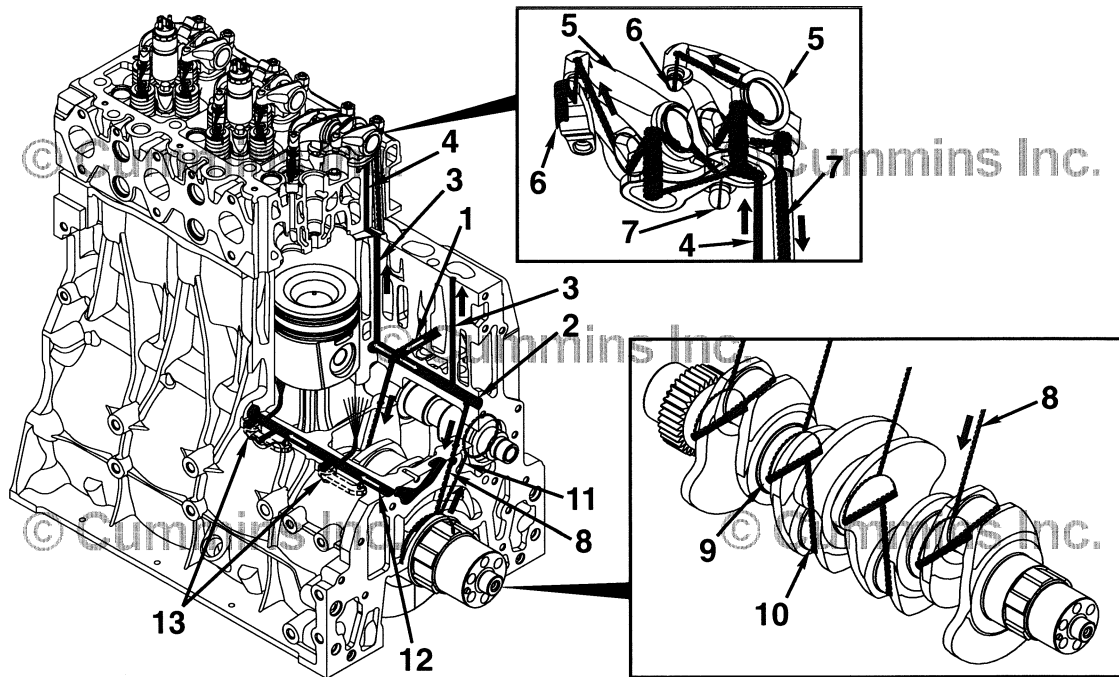


00d00405

- 1 Lubricating oil pump inlet from oil pan
- 2 Lubricating oil pump
- 3 Lubricating oil pressure regulator
- 4 Lubricating oil return to oil pan
- 5 Lubricating oil flow to oil filter
- 6 Lubricating oil cooler
- 7 Lubricating oil flow from cooler to filter
- 8 Lubricating oil filter
- 9 Lubricating oil filter bypass valve
- 10 Flow to main oil rifle
- 11 Main oil rifle
- 12 Lubricating oil flow to overhead
- 13 Lubricating oil supply to main bearing feed
- 14 Lubricating oil supply to camshaft
- 15 Lubricating oil flow to piston cooling rifle
- 16 Piston cooling rifle.

Flow Diagram, Lubricating Oil System

Flow Diagram

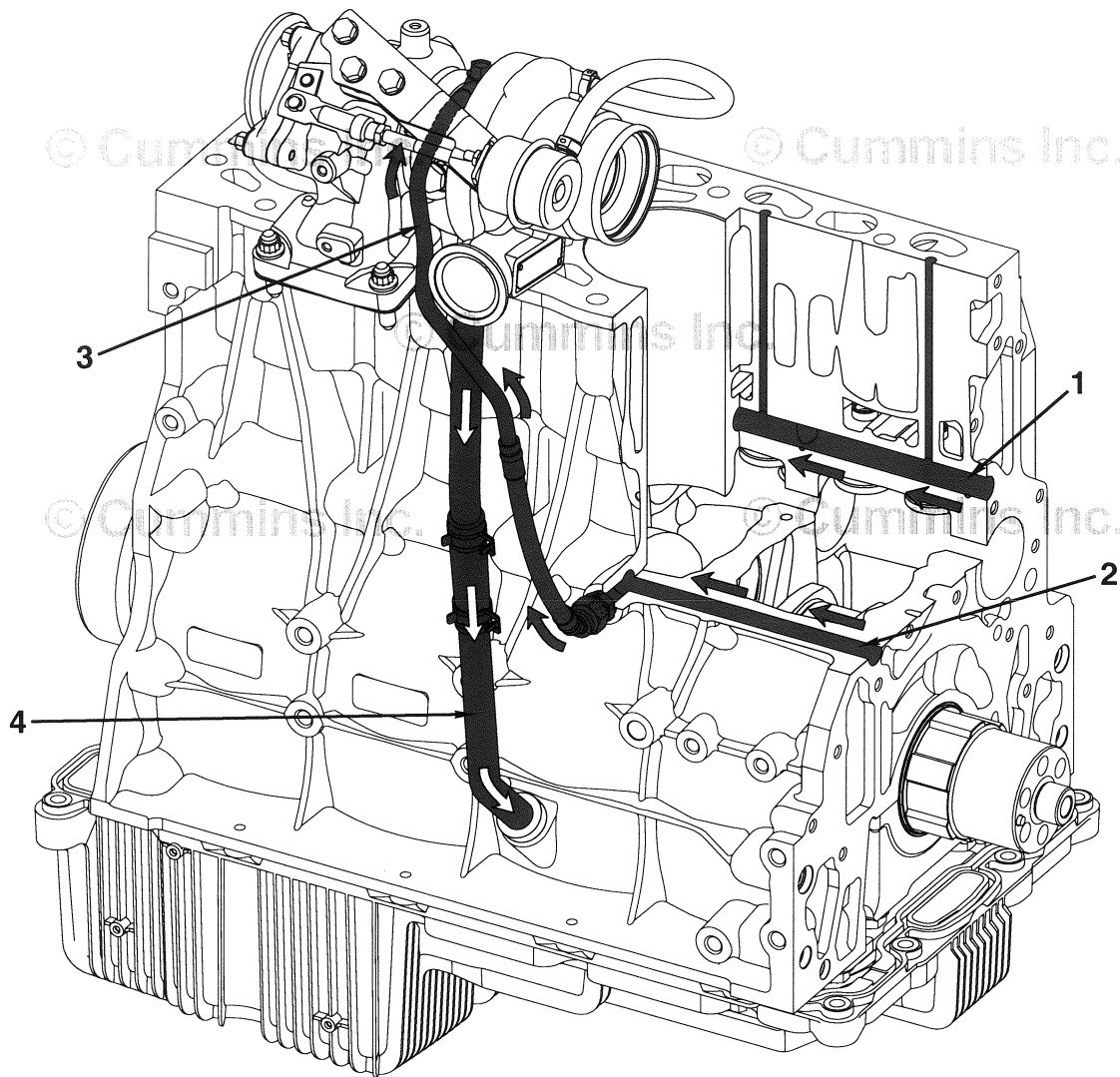


07900380

- 1 Lubricating oil flow from oil cooler
- 2 Main oil rifle
- 3 Lubricating oil flow to overhead
- 4 Lubricating oil flow to rocker levers
- 5 Rocker lever
- 6 Lubricating oil return to oil pan
- 7 Lubricating oil flow through push tube
- 8 Lubricating oil flow to crankshaft main journal
- 9 Crankshaft main journal
- 10 Crankshaft connecting rod journal
- 11 Lubricating oil flow to camshaft
- 12 Piston cooling rifle
- 13 Piston cooling nozzle.

Flow Diagram, Lubricating Oil System

Flow Diagram



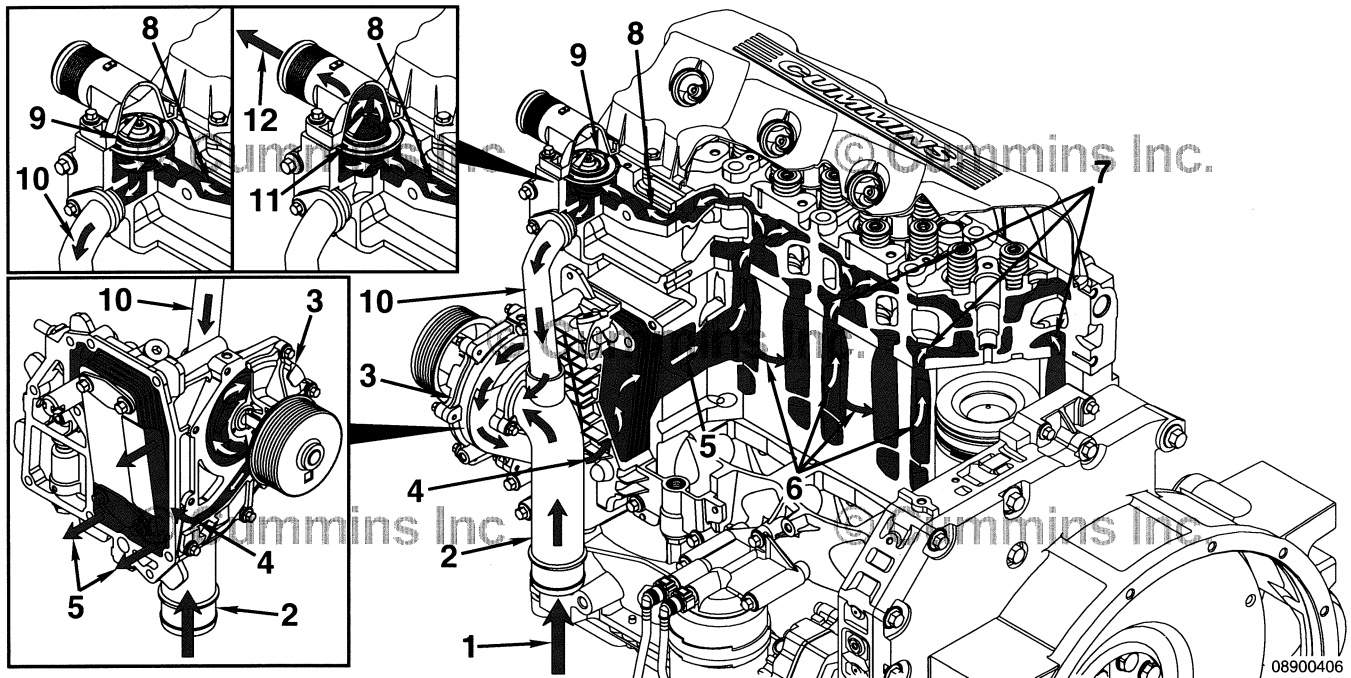
00r00026

Turbocharger Oil Lubrication

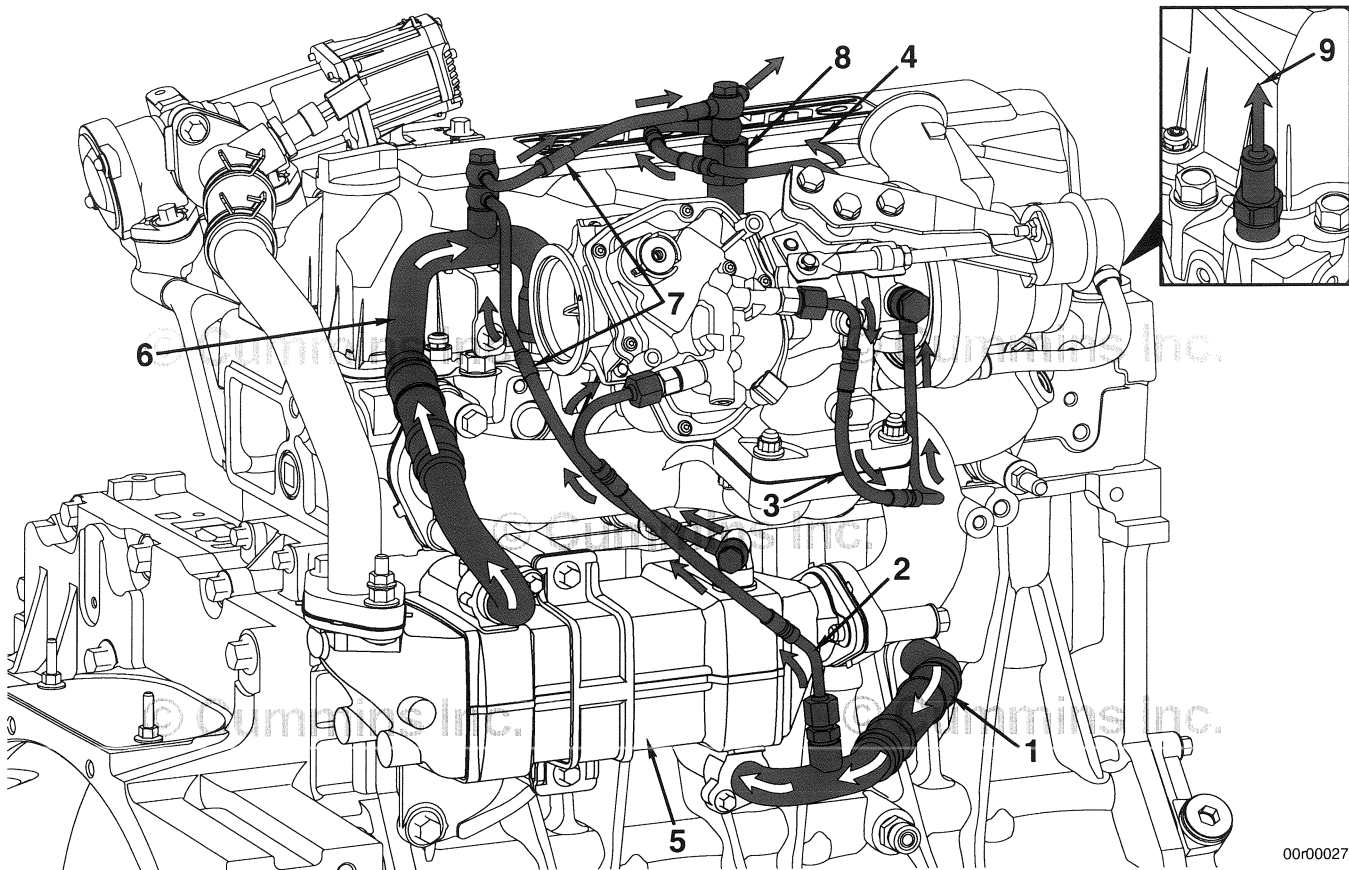
- 1 Main oil rifle
- 2 Piston cooling rifle
- 3 Turbocharger oil supply
- 4 Turbocharger oil drain.

Flow Diagram, Cooling System

Flow Diagram



- 1 Coolant flow from radiator
- 2 Water pump inlet
- 3 Water pump
- 4 Coolant flow from water pump to lubricating oil cooler
- 5 Coolant flow from lubricating oil cooler to cylinder block
- 6 Coolant flow around cylinders
- 7 Coolant flow from cylinder block to cylinder head
- 8 Coolant flow from cylinder head to thermostat housing
- 9 Thermostat closed
- 10 Coolant bypass to water pump
- 11 Thermostat open
- 12 Coolant return to radiator.

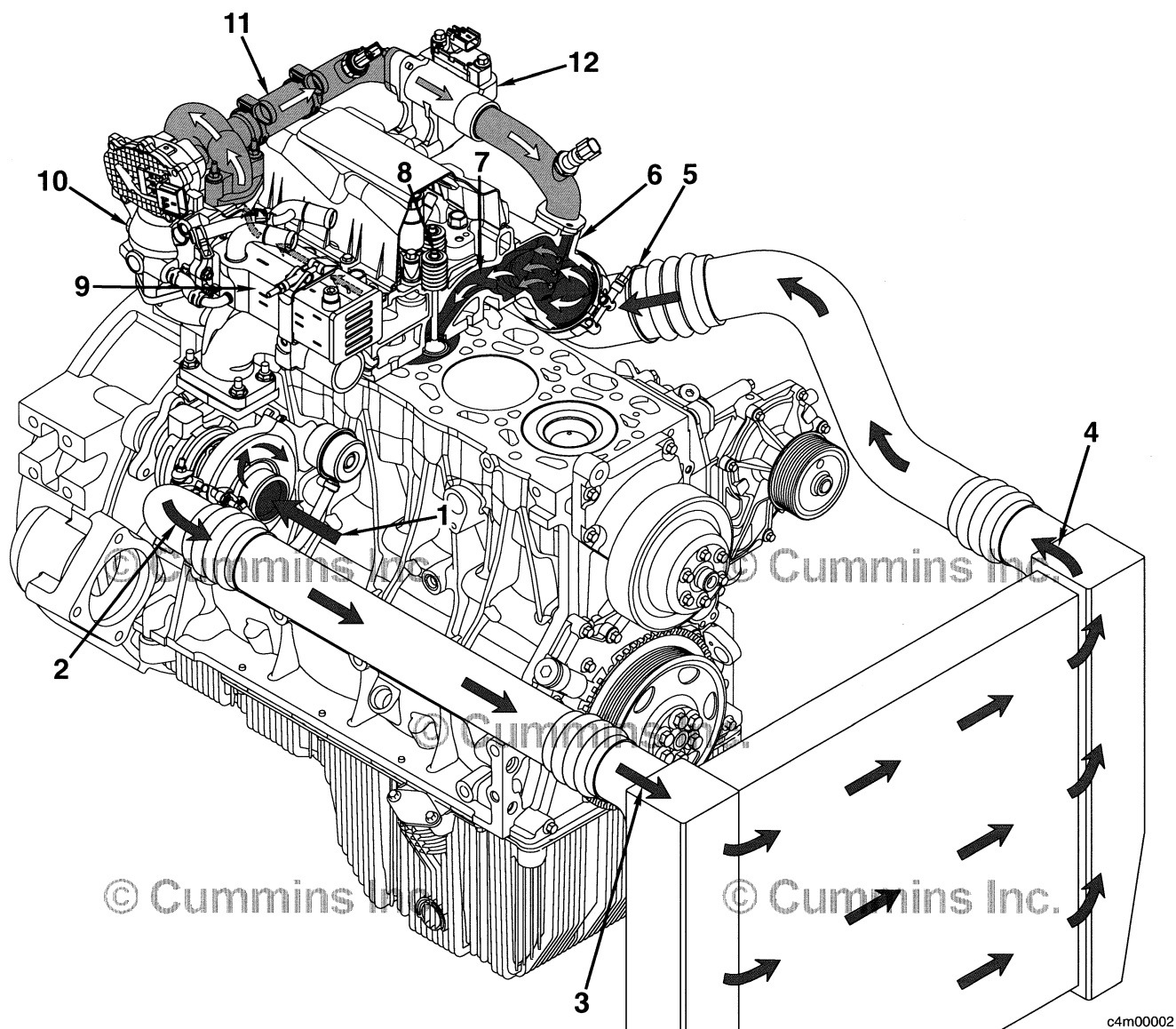


- 1 EGR cooler coolant inlet
- 2 Exhaust pressure regulator coolant inlet
- 3 Exhaust pressure regulator coolant out and turbocharger coolant inlet
- 4 Turbocharger coolant outlet
- 5 EGR cooler
- 6 EGR coolant cooler outlet
- 7 EGR cooler vent line
- 8 Coolant vent to OEM expansion tank
- 9 Cylinder head coolant vent

00r00027

Flow Diagram, Air Intake System

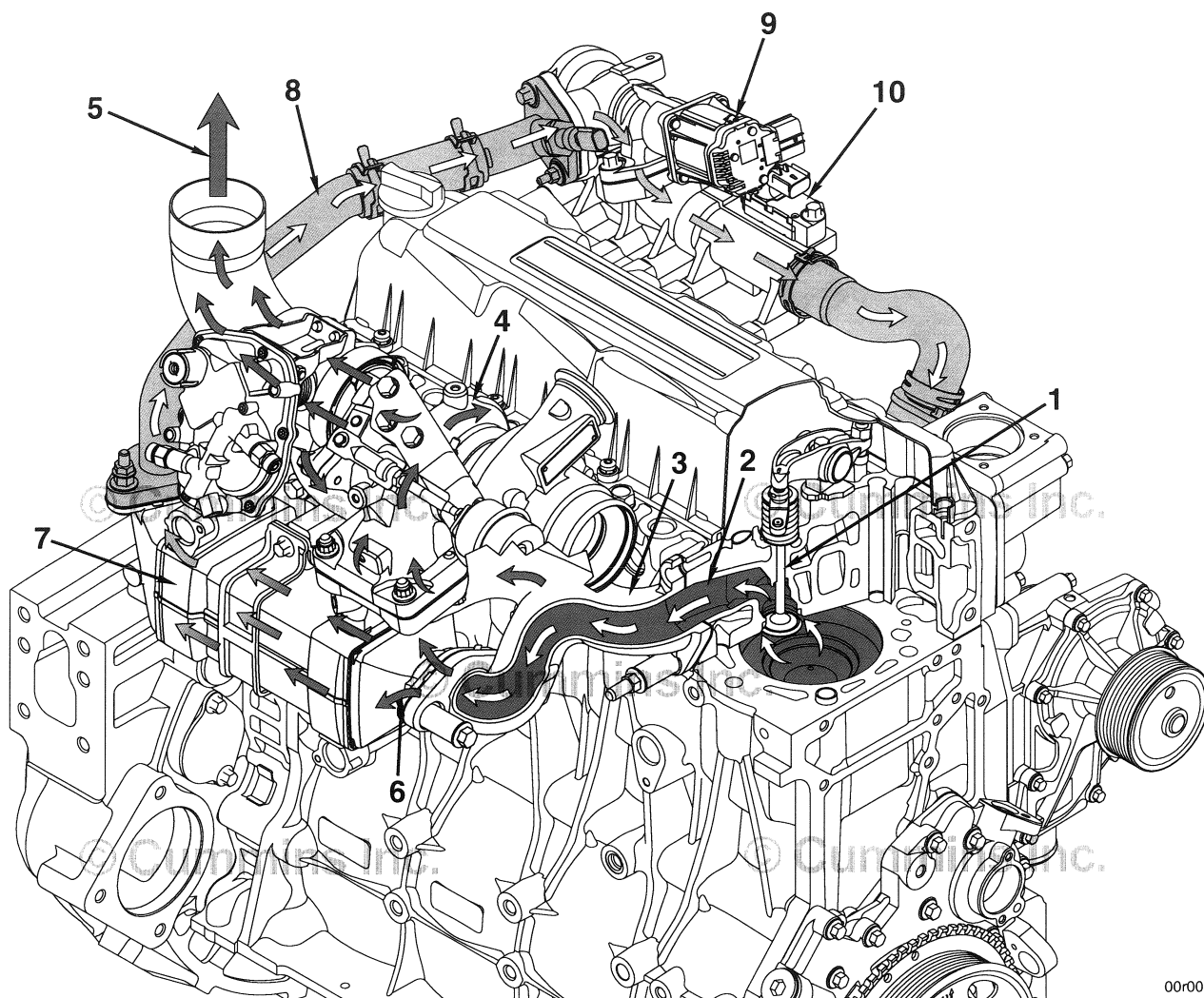
Flow Diagram



- 1 Filtered air supply to turbocharger compressor inlet
- 2 Turbocharger compressor outlet
- 3 Charge-air cooler inlet
- 4 Charge-air cooler outlet
- 5 Air intake connection
- 6 Air intake manifold
- 7 Intake port
- 8 Intake valve
- 9 Exhaust gas recirculation (EGR) cooler
- 10 EGR valve
- 11 EGR crossover tube
- 12 EGR mass measurement flow assembly.

Flow Diagram, Exhaust System

Flow Diagram

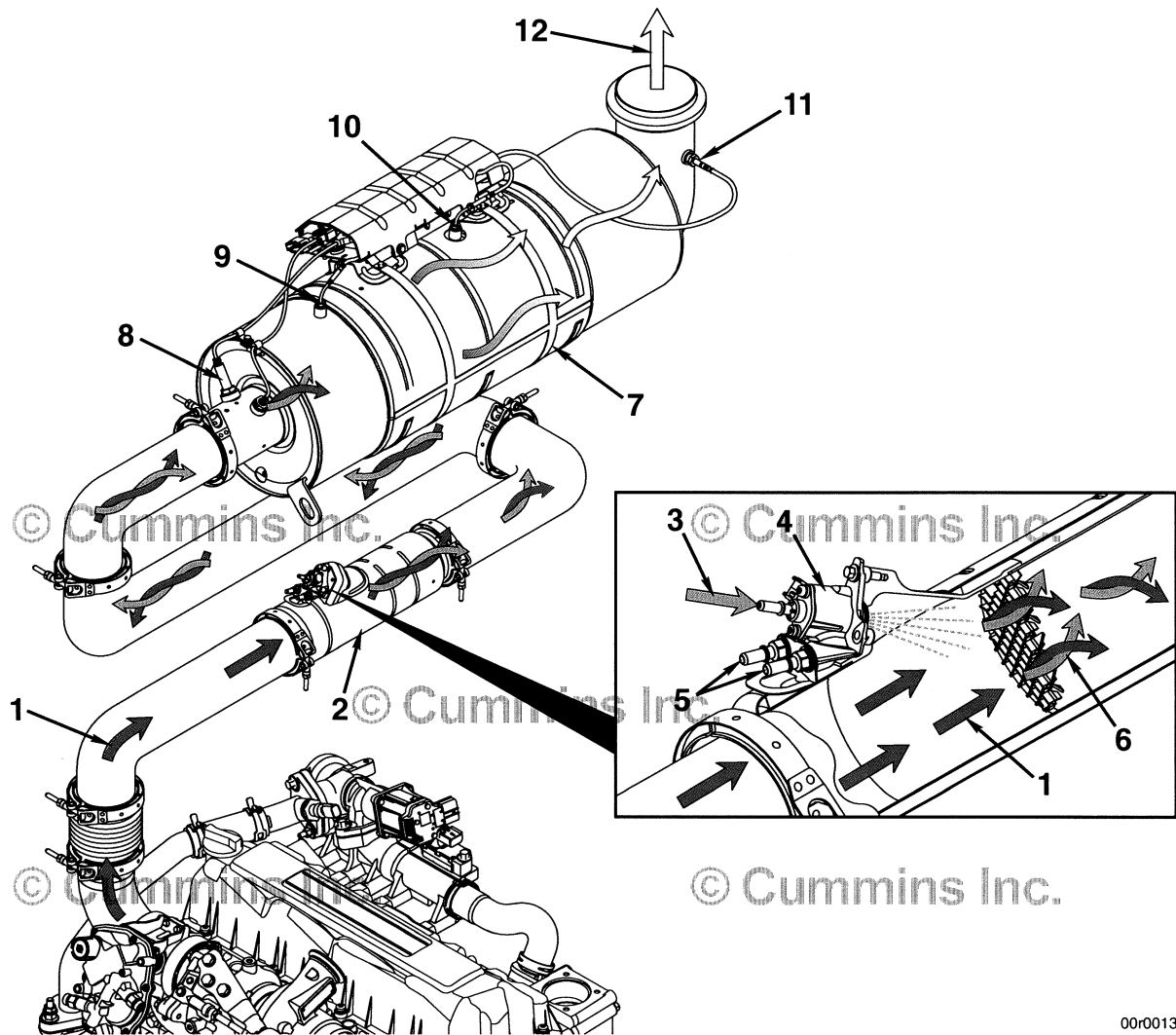


00r00132

- 1 Exhaust valve
- 2 Exhaust port
- 3 Exhaust manifold
- 4 Turbocharger
- 5 Turbocharger exhaust outlet to aftertreatment
- 6 Exhaust inlet to EGR cooler
- 7 EGR cooler
- 8 Cooled exhaust outlet to EGR valve
- 9 EGR valve
- 10 Exhaust valve differential pressure sensor.

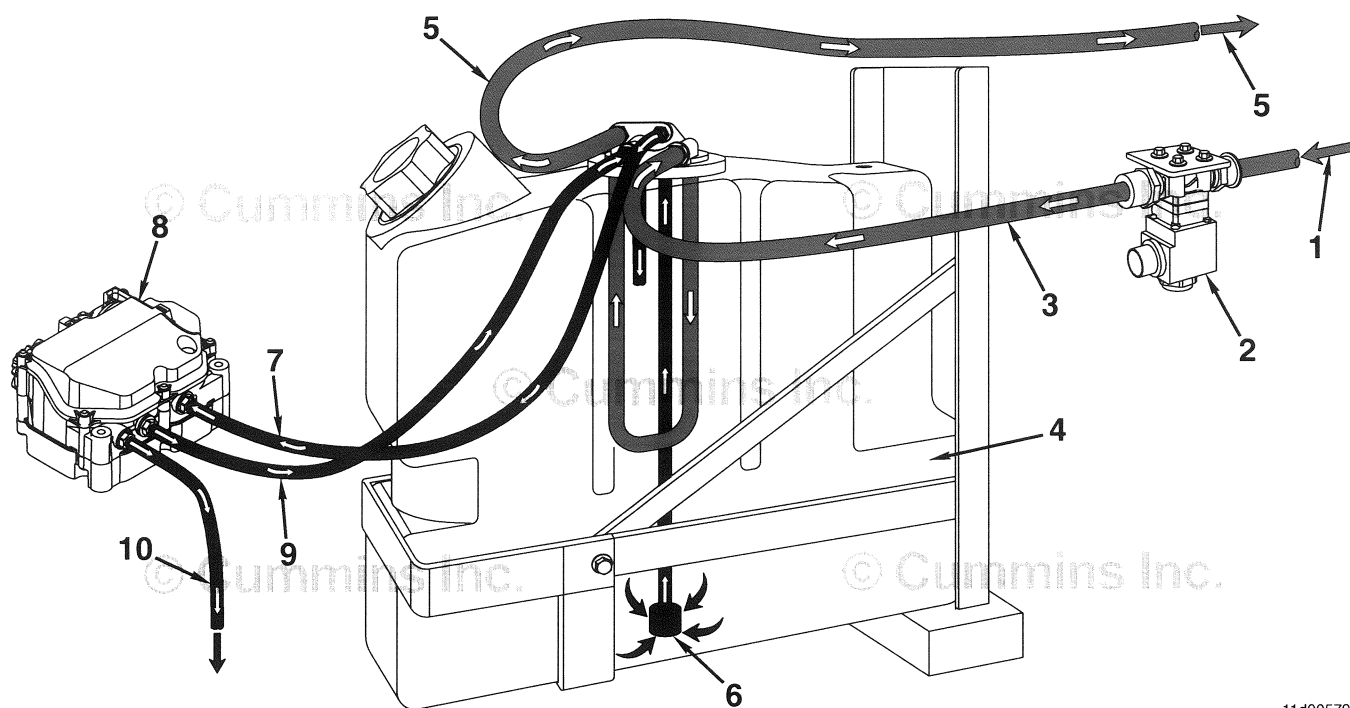
Flow Diagram, Exhaust System

Flow Diagram



- 1 Exhaust from turbocharger
- 2 Decomposition reactor
- 3 DEF supply to aftertreatment DEF dosing valve
- 4 Aftertreatment DEF dosing valve
- 5 Aftertreatment DEF dosing valve coolant fittings
- 6 Exhaust and DEF mixture
- 7 Aftertreatment SCR catalyst
- 8 Aftertreatment SCR outlet NOx sensor
- 9 Aftertreatment SCR intake temperature sensor
- 10 Aftertreatment SCR outlet temperature sensor
- 11 Aftertreatment SCR outlet NOx sensor
- 12 Exhaust flow exiting aftertreatment system.

00r00133



11d00579

- To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Cummins Service Publications Electronic Book on DVD-ROM

nclosed, we've included on DVD-ROM, an electronic copy of this publication in Adobe® Acrobat® format (PDF) for your arsonal use and reference. **Before you begin to use the DVD-ROM, you must accept the terms and conditions of the accompanying License Agreement as a "Licensee". This accompanying license agreement begins on the ext page. Also, please read the "Cummins Service Publications Electronic Book on DVD-ROM Information" rinted section, beginning on the page after the license agreement.** This section includes information about this VD-ROM including System Requirements, Local Administrative Rights requirements, How to Use, Helpful Support Tips nd other information.

By breaking the seal on the DVD-ROM
Media, you accept the terms and
conditions of the accompanying License
Agreement as a "Licensee".



**CUMMINS SERVICE PUBLICATIONS
ELECTRONIC BOOK ON DVD-ROM
SOFTWARE LICENSE AGREEMENT**

THIS SOFTWARE LICENSE AGREEMENT ("License Agreement") between Cummins Inc. ("Cummins") and Licensee sets forth the terms and conditions governing the license for use of the Cummins Service Publications Electronic Book on DVD-ROM media ("DVD-ROM Media"). The DVD-ROM Media and all of its contents constitute the entire product referred to herein, and is sometimes referred to as the "Licensed Software". The DVD-ROM Media contains a written notice referring to this License Agreement. By breaking the seal on the DVD-ROM Media, you accept the terms and conditions of this License Agreement as a "Licensee". If you do not accept the terms and conditions of this License Agreement, you must return the DVD-ROM Media and all accompanying printed materials within 30 days of your purchase. Your return of the DVD-ROM Media and printed materials must be to the place of your original purchase, either a Cummins distributor or Gannett Direct Marketing Services, Inc. Upon return as provided above, you will receive a full refund of your purchase price, excluding any shipping charges.

RECITALS:

WHEREAS, Cummins has developed certain computer programs and support documentation (which may contain electronic copies of service manuals or other information) useful in supporting, diagnosing, repairing, and maintenance of engines manufactured or sold by Cummins;

WHEREAS, Licensee desires use the Licensed Software, as permitted in this License Agreement, to assist Licensee in the support, diagnosis, repair, and maintenance of engines manufactured or sold by Cummins;

THEREFORE, in consideration of the above premises and the mutual covenants contained herein, Cummins and Licensee agree as follows:

1. License Grant and Restrictions

a. Cummins hereby grants to Licensee a non-exclusive, non-transferable and non-sublicensable license to use the Licensed Software to assist in the support, diagnosis, repair and maintenance of engines manufactured or sold by Cummins. Each copy of the Licensed Software is specifically licensed only for its intended purpose, and shall not be used for any other purpose. The Licensed Software shall not be sublicensed, sold, or otherwise distributed or shared with others, in any media or format.

b. The Licensed Software provides you with the capability to view the support documentation and to perform searches. The Licensed Software does not permit you to print, copy files, change content, extract information, make annotations, or perform any functions other than "view" and "search". The Licensed Software is copy protected, encrypted, and in read-only format. The only method to view the support documentation is from the original DVD-ROM. The licensed product may be offered as a DVD-ROM Media bundled with a printed publication or it may be offered as a stand alone DVD-ROM Media product. In either case, the Licensed Software is intended for use by the Licensee only. Copying or distribution of the Licensed Software from the DVD-ROM Media is expressly prohibited. The Licensed Software will not function from a network server DVD-ROM drive. The Licensed Software will function only in a DVD-ROM drive directly connected to your computer. Licensee is authorized to use the Licensed Software on more than one computer, but only one computer at a time.

c. Licensee agrees to use the Licensed Software in strict accordance with Cummins' published service practices and/or product warranty guidelines for the sole purpose of assisting in the support, diagnosis, repair and maintenance of engines manufactured or sold by Cummins.

d. Cummins may at any time, or from time to time, offer for sale or provide free of charge upgrades or revisions ("Upgrades") to the Licensed Software, but shall be under no obligation to do so. Further, Cummins may at any time, or from time to time, publish a newer version of the Licensed Software ("Newer Version"), but shall not be under any obligation to do so, nor shall Cummins have any obligation to provide the Newer Version to Licensee or to assure backward compatibility of the Newer Version of the Licensed Software. In the event an Upgrade or Newer Versions of the Software is published, Cummins shall determine in its sole discretion the manner in which the Upgrade or Newer Version is published, offered, and/or distributed. An Upgrade or Newer Version may include changes, updates or revisions to the support documents included as part of the Licensed Software, as determined in the sole discretion of Cummins.

e. All rights relating to the Licensed Software not specifically granted to Licensee pursuant to this License Agreement shall be retained by Cummins.

f. Licensee acknowledges that the Licensed Software may include software that Cummins has obtained or licensed from a third party, and Licensee agrees that the terms and conditions of this License Agreement shall be subject to any such third-party software. Licensee agrees to abide by any additional or modified terms and conditions with respect to such third-party software if reasonably requested in writing by Cummins and/or the third party.

2. Markings

Licensee shall use its best efforts to preserve all copyright, trademark, ownership or other notices, legends or markings on the Licensed Software as originally provided by Cummins. In the event the Licensed Software contains any copyright or other message embedded therein, Licensee shall not modify or remove such embedded message.

3. Title

Title and full ownership rights to the Licensed Software and any Upgrades thereto, including all copyright rights therein, shall remain with Cummins and/or its subsidiaries. Cummins expressly retains all rights that it may have under U.S. or foreign laws or international treaties relating to the Licensed Software, except for those rights expressly granted to Licensee herein.

4. Licensee Expenses

Costs and expenses incurred by Licensee relating to any use of the Licensed Software, or any other costs not specifically agreed upon by the parties in writing, shall be the responsibility of Licensee.

5. Payment

The sales price for the Licensed Software does not include any federal, state, local or other governmental taxes, excise taxes, or other tariffs which may be imposed on the sale, transportation, production, storage, or export of the Licensed Software. Any and all such taxes and costs shall be paid by Licensee and Cummins shall have no liability therefor.

6. Support

Cummins may provide Help Desk support to for the current version and the most recent prior version of the Licensed Software. The Help Desk support will be limited to computer operational and functionality issues only. No Help Desk support will be provided for substantive information published in the Licensed Software (i.e., how to use the product to support, diagnose, repair, and maintain engines).

7. No Modification by Licensee

Licensee agrees not to translate, reverse assemble, reverse compile, adapt, alter, modify or change in any way the Licensed Software, or any Upgrade thereto.

8. Warranties

Cummins warrants that the DVD-ROM Media containing the Licensed Software shall be free from defects in material or workmanship for a period of ninety (90) days from the date of delivery to Licensee.

9. Warranty Disclaimer

THE LICENSED SOFTWARE AND ANY AND ALL UPGRADES THERETO ARE LICENSED "AS IS" WITH THE EXCEPTION OF THE WARRANTIES SPECIFICALLY PROVIDED HEREIN. CUMMINS DOES NOT CLAIM AND DOES NOT WARRANT THAT THE LICENSED SOFTWARE WILL RUN ERROR FREE. WITH THE EXCEPTION OF THE WARRANTIES PROVIDED HEREIN, CUMMINS DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, REGARDING THE LICENSED SOFTWARE, ITS MERCHANTABILITY OR ITS FITNESS FOR ANY PARTICULAR PURPOSE, OR NON-INFRINGEMENT, AND CUMMINS WILL NOT OTHERWISE BE LIABLE FOR ANY INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM LICENSEE'S USE OF THE LICENSED SOFTWARE OR FOR ANY ERROR OR DEFECT IN THE LICENSED SOFTWARE. THE LIABILITY OF CUMMINS TO LICENSEE SHALL NOT EXCEED THE TOTAL AMOUNT OF PAYMENTS RECEIVED FROM LICENSEE AND ACCEPTED BY CUMMINS IN CONSIDERATION FOR THIS LICENSE.

10. Government Licensee

If Licensee is acquiring the Licensed Software for, or on behalf of, any department, division or unit of the United States Government, the following provisions shall be applicable:

The Government acknowledges and agrees that the Licensed Software and documentation relating thereto were developed at private expense and no part of the Licensed Software or documentation relating thereto is in the public domain.

The Government acknowledges Cummins Inc. representation that the Licensed Software is "Restricted Computer Software" as that term is defined in Clause 52.227-19 of the Department of Federal Acquisition Regulation Supplement (DFARS). The Government agrees that:

- (i) if the Licensed Software is supplied to the Department of Defense (DoD), the Licensed Software is classified as "Commercial Computer Software" and the Government is acquiring only "restricted rights" in the Licensed Software and documentation relating thereto as that term is defined in Clause 252.227-7013(c)(1) of the DFARS, and
- (ii) if the Licensed Software is supplied to any unit or agency of the United States Government other than the Department of Defense, the Government's rights in the Licensed Software and documentation relating thereto will be defined in Clause 52.227-19(c)(2) of the Federal Acquisition Regulation (FAR).

11. Restricted Rights Legend

Use, duplication, or disclosure by the Government is subject to restrictions set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013, Cummins Inc., P.O. Box 3005, Columbus, IN 47202.

12. Confidentiality

- a. Licensee hereby acknowledges that the Licensed Software contains confidential proprietary information. Consistent with the purpose of this License Agreement, Licensee agrees to use its best efforts not to release, disclose or otherwise permit unauthorized access to such confidential information.
- b. Cummins and Licensee agree to clearly mark written materials as "confidential" if they are to be treated as confidential. Verbal communications that are confidential in nature will be identified as so before, during, or immediately after the communication.
- c. Licensee will use its best efforts to ensure that all individuals who are provided access to the Licensed Software under this License Agreement will observe and perform this nondisclosure covenant.

13. Termination of License Agreement

- a. Cummins may terminate this agreement for cause, such cause including, but not limited to, supporting, diagnosing, repairing, modifying or the maintenance of Cummins engines or any component thereof when such activities are not authorized by the owner of such engines.
- b. In the event of termination of this License Agreement, all rights granted by this License Agreement shall revert to Cummins. Upon termination of this License Agreement, Licensee will deliver to Cummins all DVD-ROM Material and other material furnished by Cummins pertaining to the Licensed Software or certify that all such materials have been destroyed.
- c. In the event of termination of this License Agreement, Licensee and Cummins shall remain obligated with respect to the provisions of this License Agreement relating to confidentiality of information.

14. Completeness

Licensee and Cummins agree that this License Agreement constitutes the complete agreement and understanding between the parties relating to Licensed Software and Upgrades thereto. This License Agreement supersedes all prior agreements, understandings, and negotiations whether written or verbal with respect to the subject matter hereof. This License Agreement can only be modified by a written agreement signed by both parties.

15. Notices

Any questions concerning this License Agreement, any inquiries related to the Licensed Software, and any notices to Cummins pursuant to this License Agreement should be directed to Cummins Inc., Electronic Publications Support, MC 95030, 1460 National Road, Columbus, IN 47201. Cummins Inc. may direct that notices be sent to a different person and/or address by so requesting in writing to the other party.

16. Export Regulations

Licensee understands that the Export Administration Regulations of the Department of Commerce of the United States may prohibit the export of the Licensed Software to certain countries and agrees to conform to those regulations. Licensee also agrees to conform to these regulations. Licensee shall indemnify Cummins against any loss related to Licensee's failure to conform to those regulations.

17. Governing Law

This License Agreement shall be governed by and construed in accordance with the laws of the State of Indiana.

18. Attorneys' Fees

In the event of any legal action or other proceeding that is brought about to enforce this License Agreement, the prevailing or successful party shall be entitled to recover reasonable attorneys' fees as well as other costs incurred in that action or proceeding in addition to any compensation to which it may be entitled.

19. License Agreement Successors and Assigns

This License Agreement is not assignable by Licensee without the prior written consent of Cummins, and any assignment by Licensee in contravention of this provision shall be void and without effect. The terms and conditions of this License Agreement shall inure to the benefit of and be enforceable by Cummins and the successors and assigns of Cummins' interest in this License Agreement and/or Cummins' ownership of the Licensed Software.

Cummins Service Publications Electronic Book on DVD-ROM Information

The enclosed DVD-ROM provides you with the capability to view this publication electronically as well as perform searches. This DVD-ROM is copy protected and will not allow Printing, Changing of Content, Extracting Content or Commenting / Annotating of the PDF file.

This DVD-ROM is read only, and you will not be able to copy files from the DVD-ROM and have them open or function in any manner. The only method to view the electronic publication is from the original DVD-ROM.

This DVD-ROM is intended for use by the owner of the publication only. Copying or distribution of content from this DVD-ROM is expressly prohibited. This DVD-ROM will not function from a network server DVD-ROM drive. It will function only in a DVD-ROM drive directly connected to your computer.

This DVD-ROM requires that you have Local Administrative rights in order to use. See the System requirements section for additional details.

System Requirements:

Use of the Cummins Service Publications Electronic Book on DVD-ROM requires Adobe Acrobat, Adobe Acrobat Reader, or Adobe Reader software to be pre-installed on your computer. This product has been tested for compatibility with Adobe Acrobat software versions 7, 8 and 9. It may function properly with versions later than Adobe Acrobat 9.0, but testing has not been performed. Adobe Reader is available as a free download from www.adobe.com.

The Cummins Service Publications Electronic Book on DVD-ROM product requires the following system components:

- Microsoft Windows Auto-Play must be enabled on your computer (it is enabled by default when Windows is installed)
- DVD-ROM Drive
- Color Monitor with at least 800x600 resolution graphics
- Microsoft Windows XP Professional SP3, Microsoft Windows Vista SP1, Microsoft Windows Vista x64 SP1, Microsoft Windows 7, or Microsoft Windows 7 x64. Testing has not been performed with the x64 bit versions of Vista and Windows 7, but the product is believed to be compatible. Use on other Microsoft Operating Systems may be compatible but testing has not been performed, and while it may function, it is not supported. While we try to maintain compatibility with all popular Microsoft Operating Systems, compatibility with the listed Microsoft Operating Systems is subject to change.
- Recommended memory, processor speed and available hard-disk space is in accordance with respective Microsoft Operating System Guidelines, as well as Adobe Acrobat system requirements.

Note: The Cummins Service Publications Electronic Book on DVD-ROM product is not Macintosh compatible.

About required Local Administrative Rights:

The copy protection software requires direct access to the DVD-ROM on which the protected content is stored. Protected content may not be accessible when logged in using restricted accounts.

In order to allow the software to enable direct access to DVD-ROM drives rights under Microsoft Operating Systems, your logon account/profile must have Local Administrative Rights on the computer you will be using your Cummins Service Publications Electronic Book on DVD-ROM with. If this computer is set up in Restricted Mode, and your logon account/profile does not have Local Administrative Rights, then, with approval of your I.T. department or the owner of your computer, you can choose from the following options to allow the Cummins Service Publications Electronic Book on DVD-ROM to function properly:

- Have your computer account enabled to have Local Administrative rights and then you can run the Cummins Service Publications Electronic Book on DVD-ROM - OR -
- Have a user with Local Administrative Rights logon to your computer and run the DVD-ROM content one time. By doing this, the necessary files will be loaded to your computer and your computer will be enabled to have direct access to DVD-ROM drives. Then restart this computer. It is very important to restart the computer after you have done this. For all future needs, you can run the Cummins Service Publications Electronic Book on DVD-ROM under your own account, without requiring your logon account/profile to have Local Administrative Rights. (Note: This needs to be done only once for any Cummins Service Publications Electronic Book on DVD-ROM and then does not need to be done again for other Cummins Service Publications Electronic Book on DVD-ROM titles you may own that are of the same version of protection software).

Cummins Service Publications Electronic Book on DVD-ROM Information

(continued)

About the Copy Protection Software:

- This product may upgrade the proprietary copy protection software files it uses that are placed on your computer system to a new version, if an older version exists on your computer. If you have DVD-ROM copy protected items from other companies and they use older versions of the same TrusCont copy protection software that the Cummins Service Publications Electronic Book on DVD-ROM uses, it may render them incompatible for use on your computer.

How to Use the Cummins Service Publications Electronic Book on DVD-ROM:

To use the DVD-ROM, simply insert the DVD-ROM into your computer and it should automatically run, open Adobe Acrobat and open the Electronic Book. (This happens with Microsoft Windows Auto-Play functionality, and Adobe Acrobat pre-loaded by you on your computer).

Helpful Support Tips:

- If Windows Auto-Play is not enabled, try re-enabling it, or navigate with Windows Explorer to your DVD-ROM drive and double click on the DVD-ROM drive letter to open it. Then double-click on the program named "clickhere". (Do not attempt to directly open the PDF file by clicking on the PDF document).
- If the Cummins Service Publications Electronic Book on DVD-ROM does not function, see the prior section on "About required Local Administrative Rights:" in this documentation and verify you have Local Administrative Rights on your computer in order to run the DVD-ROM.
- While this product has been known to be very compatible with DVD-ROM drives available in computers, there are certain models of DVD-ROM drives that may be incompatible with this product.

Special Instructions for Cummins PowerSweep PC Users:

(This only applies to Cummins Inc. & Distributor Employees):

Cummins PowerSweep PC users that DO NOT have Local Administrative rights to their PC will require you to place an order from the Cummins Software Shelf. If you are a Cummins Inc. or Distributor Employee who wants to use these DVD-ROM's, and you have a PowerSweep PC – please order the 'TrusCont' software from the Cummins Software Shelf. The Software Shelf personnel will contact you to arrange a desk side installation from the DVD-ROM that you have. Once software is installed, first reboot your PC, then attempt to read your encrypted DVD-ROM manual while Cummins Software Shelf personnel are present.

Cummins Service Publications Electronic Book on DVD-ROM Information

(continued)

Electronic Book Technical Support:

Support for this product is available from Monday through Friday weekly, excluding Holidays, from 8 a.m. to 5 p.m. You may call (502) 540-4981 for telephone support. For e-mail support, please e-mail ebooksupport@merrickind.com.

DVD-ROM Media Replacement Options:

Up to 90 days from date of purchase:

Within the first 90 days from your date of purchase, if your copy of an Electronic Book on DVD-ROM does not function, and after a Cummins Electronic Book Technical Support Technician has confirmed the situation and authorized its replacement by providing you an RMA#, you may send back the DVD-ROM for a free replacement. To do so, you must package the DVD-ROM and ship/mail, with postage pre-paid by you, to the below address. You must also include a photocopy of the original invoice for proof of purchase of the publication clearly indicating the bulletin # and the purchase date. The RMA# must be on the address information of the package. If the proof of purchase copy of the invoice is not enclosed, your request will not be able to be processed and will not be returned. Delivery of the replacement will be shipped to you at no charge. Allow 3 to 4 weeks for your receipt of replacement copy. Note: Return only the non-functional DVD-ROM, do not return the entire printed publication. The replacement DVD-ROM maintains the original purchase/invoice date for the purposes of this replacement policy. This policy is subject to change at any time, without notice. For a copy of the most current replacement options policy, please e-mail ebooksupport@merrickind.com with your request.

Media Replacement Ship to Address:

Attn: Cummins Service Publications Electronic Book Technical Support
RMA#: XXXXXX (where XXXXXX is the RMA#)
808 E. Liberty Street
Louisville, KY 40204 U.S.A.

Cummins Service Publications Electronic Book on DVD-ROM is Copyright © Cummins Inc.

Adobe Acrobat Reader is a registered trademark of Adobe Systems Incorporated.

Microsoft, Windows, Windows Vista, and Windows 7 are either a registered trademark or trademark of Microsoft Corporation in the United States and/or other countries.

TrusCont™ is a trademark of TrusCont Ltd.

All other names and products used herein are trademarks for their respective owner.

Section L - Service Literature

Section Contents

	Page
Additional Service Literature	L-1
General Information.....	L-1
Cummins Customized Parts Catalog	L-3
General Information.....	L-3
Ordering the Customized Parts Catalog.....	L-3
Service Literature Ordering Location	L-2
Contact Information.....	L-2



This Page Left Intentionally Blank

Additional Service Literature General Information

The following publications can be purchased:

Bulletin	Title of Publication
4367316	QSF3.8 CM2350 F107 Service Manual
4367319	QSF3.8 CM2350 F107 Fault Code Troubleshooting Manual
4367320	QSF3.8 CM2350 F107 Wiring Diagram
4367317	QSF3.8 CM2350 F107 Operation and Maintenance Manual
4367318	QSF3.8 CM2350 F107 Owners Manual
3379000	Air for Your Engine
3379001	Fuel for Cummins® Engines
3379009	Operation - Cold Weather
3666132	Cummins® Coolant Requirements and Maintenance
3810340	Cummins® Engine Oil and Oil Analysis Recommendations
4021566	Diesel Exhaust Fluid Specifications for Cummins® Selective Catalytic Reduction Systems

Service Literature Ordering Location Contact Information

Region	Ordering Location
United States and Canada	Cummins Distributors or Credit Cards at https://store.cummins.com
All Other Countries	Cummins Distributors or Dealers

Cummins Customized Parts Catalog

General Information

Cummins is pleased to announce the availability of a parts catalog compiled specifically for you. Unlike the generic versions of parts catalogs that support general high volume parts content; Cummins Customized catalogs contain only the new factory parts that were used to build your engine.

The catalog cover, as well as the content, is customized with you in mind. You can use it in your shop, at your worksite, or as a coffee table book in your RV or boat. The cover contains your name, company name, address, and telephone number.

This new catalog was designed to provide you with the exact information you need to order parts for your engine. This will be valuable for customers that do not have easy access to Cummins QuickServe Online.

Additional Features of the Customized Catalog include:

- Engine Configuration Data
- Table of Contents
- Separate Option and Parts Indexes
- Service Kits (when applicable)
- ReCon Part Numbers (when applicable)

Ordering the Customized Parts Catalog

Ordering by Telephone

- North American Distributors, Original Equipment Manufacturers and Cummins Factory personnel order by calling Iron Mountain Fulfillment Services (IMFS) at 1-800-646-5609.
- International Distributors and Original Equipment Manufacturers order the CPC from their regional Cummins Parts Distribution Centers (PDC).
- International PDC orders are called into Iron Mountain at (++) 630-283-2420.
- Retail Credit Card Orders require a 2 step ordering process.

Ordering On-Line

Access the Cummins QSOL store at <https://store.cummins.com>

- Find the Customized Parts Catalog button located on the left of the homepage
- Select format. Your Price is also shown here
- Finalize Shopping Cart and Check Process as described on the website

North America call Iron Mountain Fulfillment Services (IMFS) at 800-646-5609, International customers call (++) 630-283-2420. Provide IMFS the catalog detail as described on the website. This step is required until we have our On Line form available.

Required information needed for your Customized Parts Catalog Order.

- Customer Name
- Street Address
- Company Name (optional)
- Telephone no.
- Credit Card No.
- Cummins Engine Serial Number (located on the engine data plate)

Unfortunately not all Cummins Engines can be supported by Customized Parts Catalogs. Engines older than 1984 or newer than 3 months may not have the necessary parts information to compile a catalog. We will contact you if this occurs and explain why we are unable to fill your order.

Customized Parts Catalogs are produced specifically for a single customer. This means they are not returnable for a refund. If we make an error and your catalog is not useable, we will correct that error by sending you a new catalog.

Notes

This image shows a full page of blank, lined paper. It features approximately 20 evenly spaced horizontal black lines across its entire width, typical of notebook or legal stationery. The background is a solid off-white color, and there are no margins, text, or other markings present.

Section S - Service Assistance

Section Contents

	Page
Distributors - International	S-33
Locations.....	S-33
Distributors and Branches	S-4
Australia.....	S-24
Canada.....	S-19
China, People's Republic.....	S-22
New Zealand.....	S-28
United States.....	S-4
Division and Regional Offices	S-3
Locations.....	S-3
Emergency and Technical Service	S-1
General Information.....	S-1
Problem Solving	S-1
General Information.....	S-1
Regional Offices - International	S-29
Locations.....	S-29
Routine Service and Parts	S-1
General Information.....	S-1



This Page Left Intentionally Blank

Routine Service and Parts

General Information

Personnel at Cummins Authorized Repair Locations can assist you with the correct operation and service of your system. Cummins has a worldwide service network of more than 5,000 Distributors and Dealers who have been trained to provide sound advice, expert service, and complete parts support. Check the telephone directory, refer to the directory in this section, or the Service Locator at www.cummins.com for the nearest Cummins Authorized Repair Location.

Emergency and Technical Service

General Information

The Cummins Customer Assistance Center provides a 24-hour, toll free telephone number to aid in technical and emergency service when a Cummins Authorized Repair Location can **not** be reached or is unable to resolve an issue with a Cummins product.

If additional assistance is required, call Toll-Free:

- 1-800-DIESELS
- (1-800-343-7357)
- Includes all 50 states, Bermuda, Puerto Rico, Virgin Islands, and the Bahamas.
- East Asia - Customer Assistance Center also for Chinese Domestic Market support Toll-Free:
- 400-810-5252
- Outside of North America contact your Regional Office. Telephone numbers and addresses are listed in the International Directory.



Problem Solving

General Information

Normally, any problem that arises with the sale, service, or repair of your engine can be handled by a Cummins Authorized Repair Location in your area. Refer to the telephone directory, the directory in this section, or the Service Locator at www.cummins.com for the nearest Cummins Authorized Repair Location. If the problem has **not** been handled satisfactorily, follow the steps outlined below:

- If the disagreement is with a Dealer, talk to the Cummins Distributor with whom he has his service agreement.
- If the disagreement is with a Distributor, call the nearest Cummins Division or Regional Office; however, most problems are solved below the Division or Regional office level. Telephone numbers and addresses are listed in this section. Before calling, write down the following information:
 - Engine model and serial number
 - Type and make of equipment
 - Total kilometers [miles] or hours of operation
 - Warranty start date
 - Nature of problem
 - Summary of the current problem arranged in the order of occurrence
 - Name and location of the Cummins Distributor or Dealer
- If a problem can **not** be resolved satisfactorily through your Cummins Authorized Repair Location or Division Office, contact:
 - Cummins Customer Assistance Center - 41403, Cummins Inc., Box 3005, Columbus, IN 47202-3005
 - Telephone: +1 800-diesels / +1 800-343-7357 (USA Only)

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

- Telephone: +1 812-377-3000 (International)

Division and Regional Offices - Locations

Australia Regional Office (This office also serves New Zealand)		Cummins Engine Company Pty. Ltd., 2 Caribbean Drive Scoresby, Victoria, 3179, Australia, Telephone: (61-3) 9765-3222, Fax: (61-3) 9763-0079
Cummins Americas Regional Office (This office serves Puerto Rico and South America excluding Brazil)		Cummins Americas Inc., 3350 SW 148 Avenue, Suite 205, Miramar, FL, 33027, U.S.A, Telephone: [1-954] 431-5511, Fax: [1-954] 433-5797
China Beijing		Cummins (China) Investment Co. Ltd, 28F, Tower A, GATEWAY, No.18, Xiaguangli North Road, East Third Ring, Chaoyang District, Beijing, 100027, China, Telephone: [86-10] 84548888, Fax: [86-10] 67876347
Brazil		Cummins Brasil Ltda., Rua Jati, 26607180-900 Guarulhos, Sao Paulo, Brazil, Phone: [55-11] 6465-9811, Fax: [55-11] 6412-1483
Daventry (Africa, Middle East, Czech Republic)		Cummins Engine Company Ltd, Royal Oak Way South, Daventry, Northants, NN11 5NU, United Kingdom, Telephone: [44-1327] 886000, Fax: [44-1327] 886106
Dubai - United Arab Emirates		Cummins Middle East FZE, Units ZF 5/6Jebel Ali Free Zone, P.O.Box No 17636, Dubai, United Arab Emirates, Telephone: [971-4] 883 8998, Fax: [971-4] 883 7971
India - Pune		Cummins India Ltd., Kothrud, Pune, Maharashtra, 411029, India, Telephone: [91-20] 2538-5435 / 0240 / 1105, Fax: [91-20] 2538-0125
Korea - Seoul		Cummins Korea Ltd., 25th floor, ASEM tower, 159-1, Samsung-Dong, Kangnam-ku, Seoul, 135-798, South Korea, Telephone: [82-2] 3420-0901, Fax: [82-2] 3452-4113 / 539-6569
SLP Mexico		Cummins, S. de R.L. de C.V., Arquimedes No. 209Col., Polanco, Mexico Distrito Federal, 11560, Mexico, Telephone: [52-5] 254-3822 / 3783 / 3622, Fax: [52-5] 254-3645
Russia - Moscow		Cummins Engine Company, Inc., Park Place, Office E708, 113/1 Leninskiy Prospect, Moscow, 117198, Russia, Telephone: [7-495] 956-51-22 / 23, Fax: [7-495] 956-53-62
Singapore		Cummins Diesel Sales Corporation, 8 Tanjong Penjuru, Singapore, 609019, Singapore, Telephone: [65] 6265-0155,

Distributors and Branches - United States

Alabama	Birmingham	Cummins Mid-South, LLC 2200 Pinson Highway P.O. Box 1147 Birmingham, AL 35217 Telephone: (205) 841-0421 FAX: (205) 849-5926
Alabama	Mobile	Cummins Mid-South, LLC 1924 N. Beltline Hwy. Mobile, AL 36617 Telephone: (334) 456-2236 FAX: (334) 452-6419
Alaska	Anchorage	Cummins Northwest, Inc. 2618 Commercial Drive Anchorage, AK 99501-3095 Telephone: (907) 279-7594 FAX: (907) 276-6340
Arizona	Phoenix	Cummins Rocky Mountain, LLC 2239 N. Black Canyon Hgwy Phoenix, AZ 85009 Telephone: (602) 252-8021 FAX: (602) 253-6725
Arkansas	Little Rock	Cummins Mid-South, Inc. 6600 Interstate 30 Little Rock, AR 72209 Telephone: Sales: (501) 569-5600 Service: (501) 569-5656 Parts: (501) 569-5613 FAX: (501) 565-2199
California	San Leandro	Cummins West, Inc. 14775 Wicks Blvd. San Leandro, CA 94577-6779 Telephone: (510) 351-6101 FAX: (510) 352-3925
California	Arcata	Cummins West, Inc. 4751 West End Road Arcata, CA 95521 Telephone: (707) 822-7392 FAX: (707) 822-7585
California	Bakersfield	Cummins West, Inc. 4601 East Brundage Lane Bakersfield, CA 93307 Telephone: (805) 325-9404 FAX: (805) 861-8719
California	Fresno	Cummins West, Inc. 5333 N Cornelia Ave Fresno, CA 93722 Telephone: (559) 277-6760 FAX: (559) 277-6769

California	Redding	Cummins West, Inc. 20247 Charlanne Drive Redding, CA 96002 Telephone: (530) 222-4070 FAX: (530) 224-4075
California	Stockton	Cummins West, Inc. 5250 Claremont Ave Suite 204 Stockton, California 95207, USA Telephone: (209) 472-3460 FAX: (209) 472-3450
California	West Sacramento	Cummins West, Inc. 875 Riverside Parkway West Sacramento, CA 95605-1502 Telephone: (916) 371-0630 FAX: (916) 371-2849
California	Los Angeles	Cummins Cal Pacific Inc. 1939 Deere Avenue (Irvine) Irvine, CA 92606 Telephone: (949) 253-6000 FAX: (949) 253-6070
California	Montebello	Cummins Cal Pacific Inc. 1105 South Greenwood Avenue Montebello, CA 90640 Telephone: (323) 728-8111 FAX: (323) 889-7499
California	Bloomington	Cummins Cal Pacific Inc. 3061 S. Riverside Avenue Bloomington, CA 92316 Telephone: (909) 877-0433 FAX: (909) 877-3787
California	San Diego	Cummins Cal Pacific Inc. 310 N. Johnson Avenue El Cajon, CA 92020 Telephone: (619) 593-3093 FAX: (619) 593-0600
California	Ventura	Cummins Cal-Pacific Inc. 3958 Transport St. Ventura, CA 93003 Telephone: (805) 644-7281 FAX: (805) 644-7284
Colorado	Denver	Cummins Rocky Mountain, Inc. 8211 East 96th Ave Henderson, Colorado 80640 Telephone: (303) 287-0201 FAX: (303) 288-7080
Colorado	Grand Junction	Cummins Rocky Mountain, Inc. 2380 U.S. Highway 6 & 50 P.O. Box 339 Grand Junction, CO 81501 Telephone: (970) 242-5776 FAX: (970) 243-5494

Connecticut	Rocky Hill	Cummins Metropower, Inc. 914 Cromwell Ave. Rocky Hill, CT 06067 Telephone: (860) 529-7474 FAX: (860) 529-7524
Florida	Ft. Myers	Cummins Power South, LLC 2671 Edison Avenue Ft. Myers, FL 33916 Telephone: (941) 337-1211 FAX: (941) 337-5374
Florida	Jacksonville	Cummins Power South 755 Pickettville Rd. Jacksonville, FL 32220 Telephone: (904) 378-1902 FAX: (904) 378-1904
Florida	Hialeah (Miami)	Cummins Power South, LLC 9900 N.W. 77th Avenue Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 FAX: (305) 557-2992
Florida	Ocala	Cummins Power South, LLC 321 Southwest 52nd Ave. Ocala, FL 34474-1892 Telephone: (352) 861-1122 FAX: (352) 861-1130
Florida	Orlando	Cummins Power South, LLC 4020 North Orange Blossom Trail Orlando, FL 32810 Telephone: (407) 298-2080 FAX: (407) 290-8727
Florida	Tampa	Cummins Power South, LLC 5421 N. 59th Street Tampa, FL 33610 Telephone: (813) 621-7202 FAX: (813) 621-8250
Florida		Cummins Power South, LLC 5906 Breckenridge Parkway Suite J Tampa, FL 33610 Telephone: (813) 664-5868 FAX: (813) 623-5442
Florida		Cummins Power South, LLC 5912 E. Hillsborough Avenue Tampa, FL 33610 Telephone: (813) 626-1101 FAX: (813) 628-8888
Florida		Cummins Power South, LLC 6606 N. 56th Street Tampa, FL 33610 Telephone: (813) 623-3330 FAX: (813) 628-4162

Georgia	Atlanta	Cummins South, Inc. 100 University Ave. S.W. Atlanta, Georgia 30315-2202 Telephone: (404) 527-7800 FAX: (404) 527-7832
Georgia		Cummins South, Inc. 5125 Georgia Highway 85 College Park, GA 30349 Telephone: (404) 763-0151 FAX: (404) 766-2132
Georgia	Albany	Cummins South, Inc. 1915 W. Oakridge Drive Albany, GA 31707-4938 Telephone: (912) 888-6210 FAX: (912) 883-1670
Georgia	Augusta	Cummins South, Inc. 1255 New Savannah Road Augusta, GA 30901-3891 Telephone: (706) 722-8825 FAX: (706) 722-7553
Georgia	Savannah	Cummins South, Inc. 8 Interchange Court Savannah, GA 31401-1627 Telephone: (912) 232-5565 FAX: (912) 232-5145
Hawaii	Kapolei	Cummins West Inc. 91-230 Kalaeloa Blvd. Kapolei, HI 96707 Telephone: (808) 682-8110 FAX: (808) 682-8477
Idaho	Boise	Cummins Rocky Mountain, LLC 8949 So. Federal Way City Boise, Idaho 84716 Telephone: (208) 336-5000 FAX: (208) 338-5436
Illinois	Chicago	Cummins Power, LLC 7145 Santa Fe Drive Hodgkins, IL 60525 Telephone: (708) 579-9222 FAX: (708) 352-7547
Illinois	Bloomington	Cummins Mid-States Power, Inc. (at U.S. 51 N and I-55) 414 W. Northtown Road Bloomington-Normal, IL 61761 Telephone: (309) 452-4454 FAX: (309) 452-1642
Illinois	Onan Branch	Cummins/Onan Northern Illinois 8745 W. 82nd Place Justin, IL 60458 Telephone: (708) 563-7070 FAX: (708) 563-7095

Illinois	Madison	Cummins Mid-South, LLC 222 SR-203 Madison, Illinois 62060 Telephone: (618) 798-9512 FAX: (618) 798-9521
Illinois	Rock Island	Cummins Central Power, LLC 7820 - 42nd Street West Rock Island, IL 61201 Telephone: (309) 787-4300 FAX: (309) 787-4397
Indiana	Indianapolis	Cummins Mid-States Power, Inc. P.O. Box 42917 3762 West Morris Street Indianapolis, IN 46242-0917 Telephone: (317) 243-7979 FAX: (317) 240-1925
Indiana		Cummins Mid-States Power, Inc. P.O. Box 42917 3661 West Morris St Indianapolis, IN 46241 Telephone: (317) 486-5287 FAX: (317) 486-5281
Indiana		Cummins Mid-States Power, Inc. 4301 W. Morris St. 3762 West Morris Street Indianapolis, IN 46241 Telephone: (317) 240-1967 FAX: (317) 240-1975
Indiana	Evansville	Cummins Cumberland, Inc. 7901 Highway 41 North Evansville, IN 47725 Telephone: (812) 867-4400 FAX: (812) 867-4411
Indiana	Ft. Wayne	Cummins Mid-States Power, Inc. 3415 Coliseum Blvd. West (At Jct. I-69 & 30/33) Ft. Wayne, IN 46808 Telephone: (219) 482-3691 FAX: (219) 484-8930
Indiana	Gary	Cummins Northern Illinois, Inc. 1440 Texas Street Gary, IN 46402 Telephone: (219) 885-5591 FAX: (219) 883-4817
Indiana	Indianapolis	Cummins Mid-States Power, Inc. 3661 West Morris St Indianapolis, IN 46241 Telephone: (317) 486-5287 FAX: (317) 486-5281
Iowa	Cedar Rapids	Cummins Central Power, LLC 625 - 33rd Avenue SW Cedar Rapids, IA 52404 Telephone: (319) 366-7537 (24 hours) FAX: (319) 366-7562

Iowa	Des Moines	Cummins Central Power, LLC 1680 N.E. 51st Avenue Des Moines, IA 50313 Telephone: (515) 262-9591 Parts: (515) 262-9744 FAX: (515) 262-0626
Kansas	Colby	Cummins Central Power, LLC 1880 South Range Colby, KS 67701 Telephone: (785) 462-3945 FAX: (785) 462-3970
Kansas	Garden City	Cummins Central Power, LLC 1285 Acraway Garden City, KS 67846 Telephone: (316) 275-2277 FAX: (316) 275-2533
Kansas	Wichita	Cummins Central Power, LLC 5101 North Broadway Wichita, KS 67219 Telephone: (316) 838-0875 FAX: (316) 838-0704
Kentucky	Louisville	Cummins Cumberland, Inc. (Corporate Office) 2301 Nelsonville Parkway Louisville, KY 40223 Telephone: (502) 254-7375 FAX: (502) 254-1215
Kentucky	Hazard	Cummins Cumberland, Inc. Highway 15 South Hazard, KY 41701 Telephone: (606) 436-5718 FAX: (606) 436-5038
Kentucky	Louisville	Cummins Cumberland, Inc. 9820 Bluegrass Parkway Louisville, KY 40299 Telephone: (502) 491-4263 FAX: (502) 499-0896
Louisiana	Morgan City	Cummins Mid-South, LLC 9508 Highway 90 E Amelia, LA 70340 Telephone: (504) 631-0576 FAX: (504) 631-0081
Louisiana	New Orleans	Cummins Mid-South, LLC 110 E. Airline Highway Kenner, LA 70062 Telephone: (504) 465-3412 FAX: (504) 465-3408
Maine	Scarborough	Cummins Northeast, Inc. 10 Gibson Road Scarborough, ME 04074 Telephone: (207) 883-8155 FAX: (207) 883-5526

Maryland	Baltimore	Cummins Power Systems, Inc. 1907 Park 100 Drive MD 21061 Telephone: (410) 590-8700 FAX: (410) 590-8731
Massachusetts	Boston	Cummins Northeast, Inc. 100 Allied Drive Dedham, MA 02026 Telephone: (781) 329-1750 FAX: (781) 329-4428
Massachusetts	Springfield	Cummins Northeast, Inc. 177 Rocus Street Springfield, MA 01104 Telephone: (413) 737-2659 FAX: (413) 731-1082
Michigan	Detroit (New Hudson)	Standby Power, Div. of Cummins Bridgeway, LLC 21810 Clessie Ct New Hudson, Michigan 48165 Telephone: (248) 573-1600
Michigan		Cummins Bridgeway, LLC 54240 Grand River Ave New Hudson, Michigan 48165 Telephone: (517) 573-1900
Michigan	Grand Rapids	Cummins Bridgeway, LLC 3715 Clay Avenue, S.W. Grand Rapids, MI 49508 Telephone: (616) 538-2250 FAX: (616) 538-3830
Michigan	Grand Rapids	Standby Power, Inc. 7580 Expressway Drive S.W. Grand Rapids, MI 49548 Telephone: (616) 281-2211 FAX: (616) 281-3177
Michigan	Iron Mountain	Cummins NPower, LLC 1901 Stevenson Avenue Iron Mountain, MI 49801 Telephone: (906) 774-2424 FAX: (906) 774-1190
Michigan	Saginaw	Cummins Bridgeway, LLC 722 N. Outer Drive Saginaw, MI 48605 Telephone: (989) 752-5200 FAX: (989) 752-4194
Minnesota	St. Paul	Cummins NPower, LLC 3030 Centre Pointe Drive Suite 500 Roseville, MN 55113 Telephone: (651) 636-1000 FAX: (651) 638-2442
Minnesota	Duluth	Cummins NPower, LLC 3115 Truck Center Drive Duluth, MN 55806-1786 Telephone: (218) 628-3641 FAX: (218) 628-0488

Mississippi	Jackson	Cummins Mid-South, LLC 325 New Highway 49 South Jackson, MS 39288-4224 Telephone: (601) 939-7016 FAX: (601) 932-7399
Missouri	Kansas City	Cummins Central Power, LLC 8201 NE Parvin Road Kansas City, MO 64161 Telephone: (816) 414-8200 FAX: (816) 414-8299
Missouri	Joplin	Cummins Central Power, LLC 3507 East 20th Street Joplin, MO 64801 Telephone: (417) 623-1661 FAX: (417) 623-1817
Missouri	Springfield	Cummins Central Power, LLC 3637 East Kearney Springfield, MO 65803 Telephone: (417) 862-0777 FAX: (417) 862-4429
Missouri	Columbia	Cummins Mid-South, LLC 5221 Highway 763 North Columbia, MO 65205 Telephone: (314) 449-3711 FAX: (314) 449-3712
Missouri	Sikeston	Cummins Mid-South, LLC 101 Keystone Drive Sikeston, MO 63801 Telephone: (573) 472-0303 FAX: (573) 472-0306
Missouri	Industrial Power Branch	Cummins Mid-South, LLC 3256 E. Outer Road Scott City, MO 63780 Telephone: (573) 335-7399 FAX: (573) 335-7062
Montana	Billings	Cummins Rocky Mountain, LLC 5151 Midland Road Billings, MT 59101 Telephone: (406) 245-4194 FAX: (406) 245-7923 Toll Free #: (800) 332-7788
Montana	Missoula	Cummins Northwest, Inc. 4950 North Reserve Street Missoula, MT 59802-1498 Telephone: (406) 728-1300 FAX: (406) 728-8523
Nebraska	Omaha	Cummins Great Plains Diesel, Inc. 5515 Center Street Omaha, NE 68106 Telephone: (402) 551-7678 (24 Hours) FAX: (402) 551-1952

Nebraska	Kearney	Cummins Central Power, LLC 515 Central Avenue Kearney, NE 68847 Telephone: (308) 234-1994 FAX: (308) 234-5776
Nevada	Elko	Cummins Rocky Mountain, LLC 5370 East Idaho Street Elko, NV 89801 Telephone: (702) 738-6405 FAX: (702) 738-1719
Nevada	Las Vegas	Cummins Rocky Mountain, LLC 2750 Losee Road North Las Vegas, NV 89030 Telephone: (702) 399-2614 FAX: (702) 399-7457
Nevada	Sparks	Cummins Rocky Mountain, LLC 150 Glendale Avenue Sparks, NV 89431 Telephone: (775) 331-4983 FAX: (775) 331-7429
New Jersey	Newark	Cummins Metropower, Inc. 41-85 Doremus Ave. Newark, NJ 07105 Telephone: (973) 491-0100 FAX: (973) 578-8873
New Mexico	Albuquerque	Cummins Rocky Mountain, LLC 1921 Broadway N.E. Albuquerque, NM 87102 Telephone: (505) 247-2441 FAX: (505) 842-0436
New Mexico	Farmington	Cummins Rocky Mountain, LLC 1101 North Troy King Road Farmington, NM 87401 Telephone: (505) 327-7331 FAX: (505) 326-2948
New York	Bronx	Cummins Metropower, Inc. 890 Zerega Avenue Bronx, NY 10473 Telephone: (718) 892-2400 FAX: (718) 892-0055
New York	Albany	Cummins Northeast, Inc. 101 Railroad Avenue Albany, NY 12205 Telephone: (518) 459-1710 FAX: (518) 459-7815
New York	Buffalo	Cummins Northeast, Inc. 480 Lawrence Bell Dr. Williamsville, NY 14221-7090 Telephone: (716) 631-3211 FAX: (716) 626-0799

New York	Syracuse	Cummins Northeast, Inc. 6193 Eastern Avenue Syracuse, NY 13211 Telephone: (315) 437-2751 FAX: (315) 437-8141
North Carolina	Charlotte	Cummins Atlantic, Inc. 11101 Nations Ford Road Charlotte, NC 28273 Telephone: (704) 588-1240 FAX: (704) 587-4870
North Carolina	Charlotte	Cummins Atlantic, Inc. 3700 North Interstate 85 Charlotte, NC 28206 Telephone: (704) 596-7401 FAX: (704) 596-3038
North Carolina	Greensboro	Cummins Atlantic, Inc. 513 Preddy Boulevard Greensboro, NC 27406 Telephone: (336) 275-4531 FAX: (336) 275-8304
North Dakota	Fargo	Cummins NPower, LLC 3801 - 34th Ave. SW Fargo, ND 58104 Telephone: (701) 282-2466 FAX: (701) 277-5399
North Dakota	Grand Forks	Cummins NPower, LLC 4728 Gateway Drive Grand Forks, ND 58201 Telephone: (701) 775-8197 FAX: (701) 775-4833
North Dakota	Minot	Cummins NPower, LLC 1501 - 20th Avenue, S.E. Minot, ND 58701 Telephone: (701) 852-3585 FAX: (701) 852-3588
Ohio	Columbus	Cummins Bridgeway, LLC 4000 Lyman Drive Hilliard (Columbus), OH 43026 Telephone: (614) 771-1000 FAX: (614) 771-0769
Ohio	Cincinnati	Cummins Interstate Power, Inc. 10470 Evendale Drive Cincinnati, OH 45241 Telephone: (513) 563-6670 FAX: (513) 563-0594
Ohio	Cleveland	Cummins Bridgeway, LLC 7585 Northfield Road Cleveland, OH 44146 Telephone: (440) 439-6800 FAX: (440) 439-2131 Toll Free: (800) 243-6885

Ohio	Toledo	Cummins Bridgeway, LLC 801 Illinois Avenue Maumee , OH 43537 Telephone: (419) 893-8711 FAX: (419) 893-5362
Ohio	Youngstown	Cummins Bridgeway, LLC 7145 Masury Road Hubbard (Youngstown), OH 44425 Telephone: (216) 534-1935 FAX: (216) 534-5606
Oklahoma	Oklahoma City	Cummins Southern Plains ,Ltd. 5800 West Reno Oklahoma City, OK 73127 Telephone: (405) 946-4481 (24 hours) FAX: (405) 946-3336
Oklahoma	Tulsa	Cummins Southern Plains, Ltd. 16525 East Skelly Drive Tulsa, OK 74116 Telephone: (918) 234-3240 FAX: (918) 234-2342
Oregon	Coburg/Eugene	Cummins Northwest, Inc. 91201 Industrial Parkway Coburg, OR 97401 (Telephone: (541) 687-0000 FAX: (541) 687-1977 Toll Free Telephone (800)777-0336
Oregon	Medford	Cummins Northwest, Inc. 4045 Crater Lake Highway Medford, OR 97504-9796 Telephone: (541) 779-0151 FAX: (541) 772-2395 Toll Free Telephone (800)826-9414
Oregon	Pendleton	Cummins Northwest, Inc. 223 S.W. 23rd Street Pendleton, OR 97801-1810 Telephone: (541) 276-2561 FAX: (541) 276-2564 Toll Free Telephone (800)666-2561
Oregon	Portland	Cummins Northwest, Inc. 4711 N. Basin Avenue Portland, OR 97217-3557 Telephone: (503)286-5938 FAX: (503)286-5938 Toll Free Telephone: ((800)283-0336 FAX: (503)240-5553
Pennsylvania	Philadelphia	Cummins Power Systems, Inc. 2727 Ford Road Bristol, PA 19007 Telephone: (215) 785-6005 FAX: (215) 785-4085

Pennsylvania	Pittsburgh	Cummins Power Systems, Inc. 3 Alpha Drive Pittsburgh, PA 15138-2901 Telephone: (412) 820-8300 FAX: (412) 820-8308
Pennsylvania	Harrisburg	Cummins Power Systems, Inc. 4499 Lewis Road Harrisburg, PA 17111-2541 Telephone: (717) 564-1344 FAX: (717) 558-8217
Puerto Rico		Cummins de Puerto Rico, Inc. Calle 1 G1 Urb. Industrial, Barrio Palmas Cataño ZIP / Postal Code: 00962 Puerto Rico Telephone: (787) 275-2000 FAX: (787) 275-2030
South Carolina	Charleston	Cummins Atlantic Inc. 231 Farmington Road Charleston, SC 29483 Telephone: (843) 851-9819 FAX: (843) 875-4338
South Carolina	Columbia	Cummins Atlantic, Inc. 2791 Shop Road Ext Columbia, South Carolina 29209 Telephone: (803) 799-2410 FAX: (803) 779-3427
South Dakota	Sioux Falls	Cummins Central Power, LLC 701 East 54th Street North Sioux Falls, SD 57104 Telephone: (605) 336-1715 FAX: (605) 336-1748
Tennessee	Memphis	Cummins Mid-South, LLC 670 Riverside Drive Memphis, TN 38173 Telephone: (901) 577-0600 FAX: (901) 522-8758
Tennessee	Chattanooga	Cummins South, Inc. 1509 East 26th Street Chattanooga, TN 37407-1095 Telephone: (423) 629-1447 FAX: (423) 629-1494
Tennessee	Knoxville	Cummins Cumberland, Inc. 1211 Ault Road Knoxville, TN 37914 Telephone: (423) 523-0446 FAX: (423) 523-0343
Tennessee	Memphis	Cummins Mid-South, LLC 1784 E. Brooks Road Memphis, TN 38116 Telephone: (901) 577-0666 FAX: (901) 522-8758

Tennessee	Nashville	Cummins Cumberland, Inc. 706 Spence Lane Nashville, TN 37217 Telephone: (615) 366-4341 FAX: (615) 366-5693
Texas	Arlington	Cummins Southern Plains, Ltd. 600 N Watson Road Arlington, TX 76004-76011 Telephone: (817) 640-6801 FAX: (817) 640-6852
Texas	Amarillo	Cummins Southern Plains, Ltd. 5224 Interstate 40 - Expressway East Amarillo, TX 79120-1570 Telephone: (806) 373-3793 (24 hours) FAX: (806) 372-8547
Texas	Dallas	Cummins Southern Plains, Ltd. 3707 Irving Boulevard Dallas, TX 75247 Telephone: (214) 631-6400 (24 hours) FAX: (214) 631-2322
Texas	El Paso	Cummins Rocky Mountain, LLC 14333 Gateway West El Paso, TX 79927 Telephone: (915) 852-4200 FAX: (915) 852-3295
Texas	Fort Worth	Cummins Southern Plains, Ltd. 3250 North Freeway Fort Worth, TX 76111 Telephone: (817) 624-2107 (24 hours) FAX: (817) 624-3296
Texas	Houston	Cummins Southern Plains, Ltd. 7045 North Loop East Houston, Texas 77028 Telephone: (713) 679-2220 FAX: (713) 679-7774
Texas	Mesquite	Cummins Southern Plains, Ltd. 2615 Big Town Blvd. Mesquite, TX 75150 Telephone: (214) 321-5555 (24 hours) FAX: (214) 328-2732
Texas	Odessa	Cummins Southern Plains, Ltd. 1210 South Grandview P.O. Box 633 Odessa, Texas 79761 Telephone: (915) 332-9121 (24 hours) FAX: (915) 333-4655
Texas	San Antonio	Cummins Southern Plains, Ltd. 6226 Pan Am Expressway North San Antonio, TX 78218-0385 Telephone: (512) 655-5420 (24 hours) FAX: (512) 655-3865

Utah	Salt Lake City	Cummins Rocky Mountain, LLC 1030 South 300 West Salt Lake City, UT 84101 Telephone: (801) 524-1321 FAX: (801) 524-1351
Virginia		
Virginia	Richmond	Cummins Atlantic, Inc. 3900 Deepwater Terminal Road Richmond, VA 23234 Telephone: (804) 232-7891 FAX: (804) 232-7428
Virginia	Tidewater	Cummins Atlantic, Inc. 3729 Holland Blvd. Chesapeake, VA 23323 Telephone: (757) 485-4848 FAX: (757) 485-5085
Washington	Seattle	Cummins Northwest, Inc. 811 S.W. Grady Way Renton, WA 98055 Telephone: (425) 235-3400 FAX: (425) 235-8202 Toll Free: (800) 274-0336
Washington	Chehalis	Cummins Northwest, Inc. 926 N.W. Maryland Chehalis, WA 98532-0339 Telephone: (360) 748-8841 FAX: (360) 748-8843 Toll Free: (800) 451-5506
Washington	Spokane	Cummins Northwest, Inc. 11134 W. Westbow Blvd. Spokane, WA 99204 Telephone: (509) 455-4411 FAX: (509) 624-4681 Toll Free: (800) 825-2122
Washington	Tacoma	Cummins Northwest, Inc. 3701 Pacific Highway East Tacoma, WA 98424-1135 Telephone: (253) 922-2191 FAX: (253) 922-2379
Washington	Yakima	Cummins Northwest, Inc. 1905 East Central Avenue Yakima, WA 98901 Telephone: (509) 248-9033 FAX: (509) 248-9035 Toll Free: (800) 688-9033
West Virginia	Charleston	Cummins Cumberland, Inc. 3100 MacCorkle Ave. SW P.O. Box 8456 South Charleston, WV 25303 Telephone: (304) 744-6373 FAX: (304) 744-8605

West Virginia	Fairmont	Cummins Cumberland, Inc. Rt 73 So. 145 Middletown Rd Fairmont, WV 26554 Telephone: (304) 367-0196 FAX: (304) 367-1077
Wisconsin	DePere	Cummins NPower, LLC Corporate Office 875 Lawrence Drive DePere, WI 54115-5070 Telephone: (920) 337-1991 FAX: (920) 337-9746
Wisconsin		Cummins NPower, LLC 939 Lawrence Dr DePere, Wisconsin 54115 Telephone: (920) 336-9631 FAX: (920) 7336-8984
Wisconsin	Eau Claire	Cummins NPower, LLC W2600 Jopke Road P. O. Box 5070 Eau Claire, Wisconsin 54701 Telephone: (715)830-0996 FAX: (715) 830-1087
Wisconsin	Milwaukee	Cummins NPower, LLC 840 West Ryan Road Oak Creek, WI 53154 Telephone: (414) 768-7400 FAX: (414) 768-9441
Wisconsin	Wausau	Cummins NPower, LLC 7815 Camp Phillips Rd Wausau, WI 54476 Telephone: (715) 359-6888 FAX: (715) 359-3744
Wyoming	Gillette	Cummins Rocky Mountain, LLC 2700 Hwy. 14 & 16 North P.O. Box 1207 (82717) Gillette, WY 82716 Telephone: (307) 682-9611 FAX: (307) 682-8242 Toll Free: (800) 773-9611
Wyoming	Rock Springs	Cummins Rocky Mountain, LLC 2000 Foothill Blvd. P.O. Box 1634 Rock Springs, WY 82901 Telephone: (307) 362-5168 FAX: (307) 362-5171

Distributors and Branches - Canada

Alberta	Edmonton	Cummins Western Canada 11751 - 181 Street Edmonton, AB T5S 2K5 Telephone: (780) 455-2151 FAX: (780) 454-9512
Alberta		Cummins Western Canada 4887 - 35th Street S.E. Calgary, Alberta T2B 3H6, Canada Telephone: (403) 569-1122 FAX: (403) 569-0027
Alberta	Hinton	Cummins Western Canada 122 Hampshire Road Hinton, Alberta T7V 1G8, Canada Telephone: (780) 865-5111 FAX: (780) 865-5714
Alberta	Lethbridge	Cummins Western Canada 4005 - 14th Ave N Lethbridge, Alberta T1H 6P6, Canada Telephone: (403) 329-6144 FAX: (403) 320-5383
British Columbia	Vancouver	Cummins Western Canada 18452 - 96th Avenue Surrey, B.C., Canada V4N 3P8 Telephone: (604) 882-5000 FAX: (604) 882-5080
British Columbia	Kamloops	Cummins Western Canada 976 Laval Crescent Kamloops, B.C. Canada V2C 5P5 Telephone: (250) 828-2388 FAX: (250) 828-6713
British Columbia	Prince George	Cummins Western Canada Prince George, B.C. V2M 6E9 Telephone: (250) 564-9111 FAX: (250) 564-5853
British Columbia	Sparwood	Cummins Western Canada 731 Douglas Fir Road Sparwood, B.C. VOB 2G0, Canada Telephone: (250) 425-0522 FAX: (250) 425-0323
New Brunswick	Fredericton	Cummins Eastern Canada, LP R.R.#1 Doak Road Fredericton, New Brunswick E3B 4X2, Canada Telephone: (506) 451-1929 FAX: (506) 451-1927
Newfoundland	St. John's	Cummins Eastern Canada, LP 122 Clyde Avenue Donovans Industrial Park Mount Pearl, Newfoundland A1N 2C2 Canada Telephone: (709) 747-0176 FAX: (709) 747-2283

Newfoundland	Wabush	Cummins Eastern Canada, LP Wabush Industrial Park Wabush, Newfoundland A0R 1B0 Telephone: (709) 282-3626 FAX: (709) 282-3108
Nova Scotia	Halifax	Cummins Eastern Canada, LP 50 Simmonds Drive Dartmouth, Nova Scotia B3B 1R3 Telephone: (902) 468-7938 FAX: (902) 468-5177
Ontario		
Ontario	Kenora	Cummins Mid-Canada Ltd. Highway 17 East P.O. Box 8 Kenora, Ontario P9N 3X1 Telephone: (807) 548-1941 FAX: (807) 548-8302
Ontario	Ottawa	Cummins Eastern Canada, LP 3189 Swansea Crescent Ottawa, Ontario K1G 3W5, Telephone: (613) 736-1146 FAX: (613) 736-1202
Ontario	Thunder Bay	Cummins Eastern Canada, LP 1400 W. Walsh Street Thunder Bay Ontario P7E 4X4 Telephone: (807) 577-7561 FAX: (807) 577-1727
Quebec	Dorval	Cummins, Eastern Canada, LP 580 Lepihe Dorval, Quebec H9H 1G2 Telephone: (514) 631-5000 FAX: (514) 631-0104
Quebec	Quebec City	Cummins Eastern Canada, LP Branch of Cummins Americas, Inc. 2400 Watt Street Ste Foy, Quebec G1P 3T3 Canada Telephone: (418) 651-2911 FAX: (418) 651-0965
Quebec	Val D'Or	Cummins, Eastern Canada, LP Val D'Or, Quebec J9P 4P6 Telephone: (514) 695-8410 FAX: (514) 695-8917
Saskatchewan	Lloydminster	Cummins Western Canada 3709 - 44th Street Lloydminster, SK S9V 0Y9 Telephone: (305) 825-2062 FAX: (305) 825-6702
Saskatchewan	Regina	Cummins Western Canada 110 Kress Street Regina, SK S4P 2Z5 Telephone: (306) 721-9710 FAX: (306) 721-2962

Saskatchewan	Saskatoon	Cummins Western Canada 3001 Faithful Avenue Saskatoon, SK S7K 4R4, Canada Telephone: (306) 933-4022 FAX: (306) 242-1722
---------------------	------------------	---

Distributors and Branches - China, People's Republic

	Beijing	Cummins Engine (Beijing) Co., Ltd. No. 8, Wan Yuan Street, Beijing Economic and Technology Development Zone, Beijing, 100176, People's Republic of China. Telephone: (86-10) 67882258 Fax: (86-10) 67882285
	Shenyang	Cummins Engine (China) Investment Co., Ltd. ShenYang Workshop & Branch Office. No.5-2 Seventh Street, Shenyang Economic-Technological Development Area, Shenyang, Liaoning 110141, China. Telephone: (86-24) 25506611 Fax: (86-24) 25365599
	Kunming	Cummins (China) Investment Co. Ltd. Kunming Branch. Room 606, Hongta Mansion, No.155 Beijing Road, Kunming, Yunnan 650011, Telephone: (86-871) 3579471/511/579/958 Fax: (86-871) 3579210
	Shanghai	Cummins (China) Investment Co., Ltd. Shanghai Distributor Branch. No. 581, New jin Qiao Road, Pu Dong New Area, Shanghai, Shanghai 201206, China. Telephone: (86-21) 50318966 Fax: (86-21) 50318528
	Urumqi	Cummins Engine (China) Investment Co., Ltd Urumqi Branch. No.7, Shanghai Rd. Urumqi, Xinjiang 830011, China. Telephone: (86-991) 3780332/5/6/7/8/9 Fax: (86-991) 3780334
	Wuhan	Cummins Engine (China) Investment Co., Ltd. Wuhan Branch. No.2 Zhang Po Road, Dong Xi Hu District, A-Kaili Commercial Building, Wuhan, Hubei 430040, China. Telephone: (86-27) 83081677 Fax: (86-27) 83259369 / 83259370
	Guangzhou	Cummins (China) Investment Co., Ltd. Guangzhou. Branch G/F, Unit 1 & 2, Block 5, Xing Hui Yuan, NO. 46, Jinsui Road, Zhu Jiang New City, Guangzhou, Guangdong 510623, China. Telephone: (86-20) 38621009 Fax: (86-20) 38621144

	Shenzhen	Shenzhen Chongfa Cummins Engine Company Ltd. Tian An Che Gong Miao Industrial Estate,Unit F2.6 - 2D, Shenzhen Shennan Da Dao, Shenzhen, Guangdong 518040, China. Telephone: (86-755) 83415479 Fax: (86-755) 83415480
--	-----------------	---

Distributors and Branches - Australia

Branches:	Gepps Cross	Cummins Engine Company, Pty. Ltd. P.O. Box 108 Blair Athol, 5084 South Australia, Australia Location: 45-49 Cavan Road Gepps Cross, 5094 Telephone: (61-8) 8262-5211
Branches:	Dosra	Cummins Engine Company, Pty. Ltd. P.O. Box 124 Darra, 4076 Queensland, Australia Location: 33 Kimberley Street Darra, 4076, Australia Telephone: (61-7) 3375-3277
Branches:	Bunbury	Cummins Engine Company, Pty. Ltd. P.O. Box 1751 Bunbury, WA 6230 Australia Location: 11 Dryanda Court Picton, WA 6230 Telephone: (61-8) 9725-6777 FAX: (61-8) 9725-6444
Branches:	Cairns	Cummins Engine Company, Pty. Ltd. P.O. Box 7189 Cairns Mail Centre, 4870 Queensland, Australia Location: Liberty Street Cairns, 4870 Telephone: (61-7) 935-2999
Branches:	Campbellfield	Cummins Engine Company, Pty. Ltd. Private Bag 9 Campbellfield, 3061 Victoria, Australia Location: 1788-1800 Hume Highway Campbellfield, 3061 Telephone: (613) 9357-9200
Branches:	Dandenong	Cummins Engine Company, Pty. Ltd. Lot 7 Greens Road Dandenong, 3175 Victoria, Australia Telephone: (613) 9706-8088
Branches:	Darwin	Cummins Engine Company, Pty. Ltd. P.O. Box 37587 Winnellie, 0821 Northern Territory, Australia Location: Lot 1758 Graffin Crescent Winnellie, 0821 Telephone: (61-8) 8947-0766

Branches:	Devonport	Cummins Engine Company, Pty. Ltd. P.O. Box 72E Tasmania, Australia Location: 2 Matthews Way Devonport, 7310 Telephone: (61-3) 6424-8800
Branches:	Emerald	Cummins Engine Company, Pty. Ltd. P.O. Box 668 Emerald, 4720 Queensland, Australia Location: Capricorn Highway Emerald, 4720 Telephone: (61-7) 4982-4022
Branches:	Grafton	Cummins Engine Company, Pty. Ltd. P.O. Box 18 South Grafton, 2461 New South Wales, Australia Location: 18-20 Induna Street South Grafton, 2461 Telephone: (61-2) 6642-3655
Branches:	Hexham	Cummins Engine Company, Pty. Ltd. 21 Galleghan Street Hexham New South Wales, Australia Telephone: (61-2) 4964-8466 FAX: (61-2) 4964-8616
Branches:	Kalgoorlie	Cummins Engine Company, Pty. Ltd. P.O. Box 706 Kalgoorlie, 6430 Western Australia, Australia Location: 16 Atbara Street Kalgoorlie, 6430 Telephone: (61-8) 9021-2588
Branches:	Karratha	Cummins Engine Company, Pty. Ltd. P.O. Box 377 Karratha, WA 6714 Australia Location: 1490 Lambert Road Karratha, WA 6714 Australia Telephone: (61-8) 9144-4646 FAX: (61-8) 9143-1507
Branches:	Laverton	Cummins Engine Company, Pty. Ltd. Locked Bag 1 Laverton, Victoria 3028 Australia Location: 195 Boundary Road Laverton North, Victoria 3028 Australia Telephone: (61-3) 9360-0800 FAX: (61-3) 9360-0438

Branches:	Leeton	Cummins Engine Company, Pty. Ltd. P.O. Box 775 Leeton, NSW 2705 Australia Location: 29 Brady Way Leeton, NSW 2705 Australia Telephone: (61-2) 6953-3077 FAX: (61-2) 6953-3109
Branches:	Mackay	Cummins Engine Company, Pty. Ltd. P.O. Box 842 Mackay, 4740 Queensland, Australia Location: 4 Presto Avenue Mackay, 4746 Telephone: (61-7) 4955-1222
Branches:	Mount Gambier	Cummins Engine Company, Pty. Ltd. P.O. Box 2219 Mount Gambier, 5290 South Australia, Australia Location: 2 Avey Road Mount Gambier, 5290 Telephone: (61-87) 25-6422
Branches:	Penrith	Cummins Engine Company, Pty. Ltd. P.O. Box 132 Cambridge Park, 2747 New South Wales, Australia Location: 7 Andrews Road Penrith, 2750 Telephone: (61-2) 4729-1313
Branches:	Queanbeyan	Cummins Engine Company, Pty. Ltd. P.O. Box 527 Queanbeyan, 2620 New South Wales, Australia Location: 15-27 Bayldon Road Queanbeyan, 2620 Telephone: (61-2) 6297-3433 FAX: (61-2) 6297-6709
Branches:	Regency Park	Cummins Engine Company, Pty. Ltd. P.O. Box 2147 Regency Park, SA 5942 Australia Location: 11 Manton Street Hindmarsh, SA 5942 Australia Telephone: (61-8) 8346-3832 FAX: (61-8) 8340-2045

Branches:	Swan Hill	Cummins Engine Company, Pty. Ltd. P.O. Box 1264 Swan Hill, 3585 Victoria, Australia Location: 5 McAllister Road Swan Hill, 3585 Telephone: (61-3) 5032-1511
Branches:	Tamworth	Cummins Engine Company, Pty. Ltd. P.O. Box 677 Tamworth, 2320 New South Wales, Australia Location: Lot 65 Gunnedah Road Tamworth, 2340 Telephone: (61-2) 6765-5455
Branches:	Townsville	Cummins Engine Company, Pty. Ltd. P.O. Box 7339 Garbutt Business Centre, QLD4814 Australia Location: 704-710 Ingham Road Townsville, QLD 4814 Telephone: (61-7) 4774-7733 FAX: (61-7) 4774-7640
Branches:	Welshpool	Cummins Engine Company, Pty. Ltd. P. O. Box 52 Welshpool, 6986 Western Australia, Australia Location: 50 Kewdale Road Welshpool, 6106 Telephone: (61-8) 9458-5911
Branches:	Wetherill Park	Cummins Engine Company, Pty. Ltd. Private Bag 150 Wetherill Park, NSW 2164 Australia Location: 492-494 Victoria Street Wetherill Park, NSW 2164 Australia Telephone: (61-2) 9616-5300 FAX: (61-2) 9616-5399
Branches:	Wodonga	Cummins Engine Company, Pty. Ltd. P.O. Box 174 Wodonga, 3690 Victoria, Australia Location: 9-11 McKoy Street Wodonga, 3690 Telephone: (61-2) 6024-3655

Distributors and Branches - New Zealand

Auckland		Cummins Engine Company, Pty. Ltd. Private Bag 92804 Penrose, Auckland, New Zealand Location: 440 Church Street Penrose Telephone: (64-9) 579-0085
Branches:	Auckland	Cummins Engine Company, Pty. Ltd. Private Bag 92804 Penrose, Auckland, New Zealand Location: 440 Church Street Penrose Telephone: (64-9) 579-0085
Branches:	Christchurch	Cummins Engine Company, Pty. Ltd. P.O. Box 16-149 Hornby, Christchurch, New Zealand Location: 35 Parkhouse Road Sockburn, Christchurch Telephone: (64-3) 348-8170
Branches:	Dunedin	Cummins Engine Company, Pty. Ltd. P.O. Box 2333 South Dunedin, New Zealand Location: 8 Devon Street Dunedin Telephone: (643) 477-8818
Branches:	Palmerston North	Cummins Engine Company, Pty. Ltd. P.O. Box 9024 Palmerston North, New Zealand Location: 852-860 Tremaine Avenue Telephone: (64-6) 356-2209
Branches:	Rotorua	Cummins Engine Company, Pty. Ltd. P.O. Box 934 Rotorua, New Zealand Location: 328 Te Ngae Road Rotorua Telephone: (647) 345-6699

Regional Offices - International - Locations

Regional Office - Daventry	
<p>Cummins Engine Co. Ltd (Serving Czech Republic), (Middle East), (Africa) Royal Oak Way South Daventry, Northamptonshire ZIP / Postal Code: NN11 8NU Brussels Telephone: (44-1327) 886 000 Fax: (44-1327) 886 100</p>	
<p>Region: Africa</p> <p>Countries Covered:</p> <p>Burkina Faso Cameroon Chad Congo (People's Republic) Djibouti Eritrea Gabon Ghana Guinea-Bissau Liberia Mali Mauritania Niger Rwanda Senegal Somalia Tunisia Cape Verde</p> <p>Region: Czech Republic</p> <p>Countries Covered:</p> <p>Austria Hungary</p> <p>Region: Middle East</p> <p>Countries Covered:</p> <p>Afghanistan Cyprus Jordan Lebanon Pakistan Republic of Yemen Turkey</p>	<p>Burundi Central African Republic Congo (Democratic Republic), Cote d'Ivoire (Ivory Coast) Equatorial Guinea, Ethiopia Gambia Guinea Kenya Libya Malta Morocco Nigeria Sao Tome & Principe Sierra Leone Togo Uganda</p> <p>Czech Republic Poland</p> <p>Bahrain Egypt Iraq Kuwait Oman Qatar Saudi Arabia United Arab Emirates</p>

Cumbrasa Regional Office - Brazil

Cummins Brasil Ltda.
Rua Jati, 266
07180-900 Guarulhos
Sao Paulo, Brazil
Telephone: (55-11) 6465-9811
Fax: (55-11) 6412-1483

Country Covered: Brazil

Beijing Regional Office - China	
Cummins Corporation Beijing Branch (CCBJ) 28, Tower A, Gateway, 18, Xiaguangli North Road, East Third Ring Chaoyang District Beijing 100027 People's Republic of China Telephone: (86-10) 84548888 Fax: (86-10) 6462-0226	
Countries Covered: <div> China Hong Kong S.A.R Mongolia Taiwan </div>	

Gross-Gerau Regional Office - Germany	
Cummins Diesel Deutschland GmbH Odenwaldstr. 23 Groß-Gerau 64521 Germany Telephone: (49-6152) 174-0 Fax: (49-6152) 174-141	
Countries <div> Germany Switzerland </div>	

Cummins India Ltd.	
Kothrud Pune ZIP / Postal Code: 411038 India Telephone: +91-20-2538 5435 or 2538 0240 Fax: +91-20-2538 0125 www.cumminsindia.com	
Countries Covered: <div> Bhutan India Nepal </div>	

Tokyo Regional Office - Japan	
Cummins Japan Ltd. 2nd Floor, Ichiboshi Shiba Bldg 2-14, Shiba 2-chome Minato, Tokyo ZIP / Postal Code: 105-0014 Japan Telephone: (81-3) 5444-7600 Fax: (81-3) 5444-0530	
Country Covered: <div> Japan </div>	

Seoul Regional Office - Korea	
Cummins Korea Ltd. 25th floor, ASEM tower 159-1, Samsung-Dong Kangnam-ku, Seoul ZIP / Postal Code: 135-798 South Korea Telephone: (82-2) 3420-0901 Fax: (82-2) 3452-4113 / 539-6569	
Country Covered: South Korea	

Col. Polanco Regional Office - Mexico	
Cummins, S. de R.L. de C.V. Arquimedes No. 209 Col. Polanco 4605 Modern Lane Mexico, Distrito Federal ZIP / Postal Code: 11560 Mexico Telephone: (52-5) 254-3822 / 3783 / 3622 Fax: (52-5) 254-3645	
Country Covered: Mexico Costa Rica Guatemala Nicaragua Honduras Panama	

Moscow Regional Office - Russia	
Cummins Engine Co., Inc. Park Place Office E708 113/1 Leninsky Prospect Russia 117198 Telephone: (7-495) 956-51-22 / 23 Fax: (7-495) 956-53-62	
Countries Covered: Armenia Moldova Azerbaijan Russia Belarus Tajikistan Turkmenistan Georgia Ukraine Kyrgyzstan Uzbekistan Kazakhstan	

Southeast Asia Regional Office - Singapore Singapore		
Cummins Diesel Sales Corporation 8 Tanjong Penjuru ZIP / Postal Code: 609019 Singapore Telephone: (65) 265-0155 Fax - Parts/MIS/Shipping: (65) 6264-0664		
Countries Covered:	Bangladesh Brunei Cambodia Indonesia Laos	Malaysia Philippines Singapore Sri Lanka Thailand Vietnam

Latin America Regional Office - Miramar (U.S.A.)		
Cummins Americas, Inc. 3350 SW 148 Avenue Suite 205 Miramar, FL 33027 U.S.A. Telephone: (954) 431-5511 Fax: (954) 433-5797		
Countries Covered:	Argentina Bolivia Chile Colombia Dominican Republic El Salvador Ecuador Costa Rica Dominican	Paraguay Peru Uruguay Venezuela Honduras Nicaragua

Distributors - International - Locations

Cummins Middle East FZE	Cummins Middle East FZE	P.O. Box No 17636, Units ZF 05 & 06Jebel Ali Free Zone, DubaiUnited Arab EmiratesTelephone: 00 9714 8838998Fax: 00 9714 8838997,
United Arab Emirates	Cummins Emirates Sales & Service LLC	P.O. Box No 54044Al Quoz Industrial Estate, DubaiUnited Arab EmiratesTelephone: 00 9714 3478184Fax: 00 9714 3478185Toll Free: 800 4184 ,
United Arab Emirates	Cummins Emirates Sales & Service LLC	P.O. Box No 70242, Abu DhabiUnited Arab EmiratesTelephone: 00 9712 6722980Fax: 00 9712 6722981,
ALBANIA		(Please contact the Central & Eastern European Regional Office)Cummins Diesel Deutschland GmbHGross-GerauOdenwaldstraße 23Groß-GerauZIP / Postal Code: 64521GermanyTelephone: (49-6152) 174-0Fax: (49-6152) 174-141,
ALGERIA		(Please contact) Cummins Diesel S.A.39 rue AmpèreBP 190Chassieu cédex 69680FranceTelephone: (33-4) 72 22 92 72Fax: (33-4) 78 90 19 56,
ALGERIA		-See SOUTH PACIFIC ISLANDS(Please contact) Cummins2 Caribbean DriveScoresby 3179VictoriaAUSTRALIATelephone: (61-3) 9765-3222Fax: (61-3) 9763-0079,
ANDORRA		- See European Regional Office - Mechelen ,
ANDORRA		Cummins Belgium Egide Walschaertsstraat, 2Industriepark Zuid2800 MechelenBelgiumEuropeTelephone: (32-15) 47 91 00Fax: (32-15) 27 56 86,
ANDORRA		,
ANGOLA	(Please contact) Cummins Diesel South Africa (Pty) Ltd	13 Eastern Service RoadKelvin (Neighbourhood), AlexandraRua Major Kahangulo, 134/140Gauteng, South AfricaZIP / Postal Code: 2054South AfricaTelephone: (27-11) 321 8700Fax: (27-11) 444 2012,
ANTIGUA		Miami (Office In U.S.A.)Cummins Power South, LLC9900 N.W. 77 Ave.Hialeah Gardens, FL 33016 Telephone: (305) 821-4200Fax: (305) 557-2992,
ARGENTINA	Buenos Aires	Distribuidora Cummins, S.A.Ruta Panamericana KM 32.5El Talar de Pacheco, Buenos AiresZIP / Postal Code: CP 1618Argentina Telephone: (54-11) 4736-6400Fax: (54-11) 4736-6479 / 6466 ,
ARUBA, ISLAND OF		(Please contact) Cummins Power South, LLC9900 N W 77th Ave.Hialeah Gardens, Florida 33016Telephone: (1-305) 821-4200Fax: (1-305) 557-2992,
AUSTRALIA	Bunbury	Cummins11 Dryanda CourtPictonBunbury, Western Australia 6229Telephone: (61-8) 9725-6777Fax: (61-8) 9725-6444,

AUSTRALIA	Cairns	Cummins11 Liberty Street Cairns, Queensland 4870AustraliaTelephone: (61-7) 935-2999 Fax: (61-7) 4035 2909,
AUSTRALIA	Campbellfield	Cummins1788-1800 Hume Highway Campbellfield, Victoria 3061AustraliaTelephone: (613) 9357-9200 Fax: (613) 9357 9916,
AUSTRALIA	Dandenong	Cummins46 Greens Road Dandenong, Victoria 3175 Australia Telephone: (613) 9706-8088Fax: (613) 9706 8016,
AUSTRALIA	Darwin	CumminsLot 1758 Graffin Crescent Winnellie, Darwin Northern Territory 0820 AustraliaTelephone: (61-8) 8947-0766 Fax: (61-8) 8984 4569,
AUSTRALIA	Devonport	Cummins2 Matthews Way Devonport, Tasmania 7310 AustraliaTelephone: (61-3) 6424-8800 Fax: (61-3) 6424 2200,
AUSTRALIA	Emerald	Cummins23 Old Sheeppark PlaceEmerald, Queensland 4720AustraliaTelephone: (61-7) 4982 4022Fax: (61-7) 4982 4159,
AUSTRALIA	Grafton	Cummins18 - 20 Induna StreetSouth Grafton, New South Wales 2460AustraliaTelephone: (61-2) 6641 1000Fax: (61-2) 6641 1099,
AUSTRALIA	Hexham	Cummins Engine Company, Pty. Ltd.21 Galleghan Street Hexham Newcastle, New South Wales, Australia 2322Telephone: (61-2) 4964-8466 Fax: (61-2) 4964-8616,
AUSTRALIA	Kalgoorlie	CumminsLot 62 Great Eastern HighwayCnr Hunter StreetKalgoorlie, Western AustraliaZIP / Postal Code: 6430AustraliaTelephone: (61-8) 9080 1300Fax: (61-8) 9091 7933,
AUSTRALIA	Karratha	Cummins1964 Anderson RoadKarratha, Western Australia 6714AustraliaTelephone: (61-8) 9144 4646 Fax: (61-8) 9143 1507,
AUSTRALIA	Laverton	Cummins191-195 Boundary RoadLaverton North, Victoria 3026AustraliaTelephone: (61-3) 8368 0800Fax: (61-3) 9360 0438,
AUSTRALIA	Leeton	Cummins29 Brady WayLeeton, NSW 2705AustraliaTelephone: (61-2) 6953-3077Fax: (61-2) 6953-3109,
AUSTRALIA	Mackay	Cummins46 Southgate DrivePaget, QueenslandZIP / Postal Code: 4740AustraliaTelephone: (61-7) 4952 8100Fax: (61-7) 4952 5631,
AUSTRALIA	Mount Gambier	Cummins2 Avey RoadMount Gambier, South Australia 5290AustraliaTelephone: (61-8) 8725 6422Fax: (61-8) 8724 9764,
AUSTRALIA	Penrith	CumminsTotal Truck Centre141 Coreen AvenuePenrith, New South Wales 2750AustraliaTelephone: (61-2) 4731 2188Fax: (61-2) 4731 1140,

AUSTRALIA	Queanbeyan	Cummins15-17 Bayldon RoadQueanbeyan, New South Wales 2620AustraliaTelephone: (61-2) 6297 3433Fax: (61-2) 6297 6709,
AUSTRALIA	Swan Hill	Cummins5 McAllister RoadSwan Hill, Victoria 3585AustraliaTelephone: (61-3) 5033 1511Fax: (61-3) 5032 9662,
AUSTRALIA	Tamworth	CumminsLot 65 Gunnedah RoadTamworth, New South Wales 2340AustraliaTelephone: (61-2) 6765 5455Fax: (61-2) 6765 5443,
AUSTRALIA	Townsville	Cummins704-710 Ingham RoadTownsville, Queensland 4810AustraliaTelephone: (61-7) 4774 7733 Fax: (61-7) 4774 7640,
AUSTRALIA	Welshpool	Cummins443 Horrie Miller DriveIndustrial ParkPerth International Airport, Western Australia 6105AustraliaTelephone: (61-7) 9475 8777Fax: (61-7) 9475 8666,
AUSTRALIA	Wetherill Park	Cummins492-494 Victoria StreetWetherill Park, New South Wales 2164AustraliaTelephone: (61-2) 9616 5300Fax: (61-2) 9616 5399,
AUSTRALIA	Wodonga	Cummins9 - 11 McKoy StreetWodonga, Victoria 3690AustraliaTelephone: (61-2) 6024 3655Fax: (61-2) 6024 3102,
AUSTRIA	Neudörfel	CumminsBickfordstraße 25Neudörfel, Burgenland 7201Austria Telephone: (43-2622) 77418 0Fax: (43-2622) 77418 4,
BAHAMAS	Miami (Office in U.S.A.)	Cummins Power South, LLC9900 N W 77th Ave.Hialeah Gardens, FL 33016 Telephone: (305) 821-4200Fax: (305) 557-2992 ,
BAHRAIN	Bahrain	Yusuf Bin Ahmed Kanoo W.L.L.Commercial Division832 Majlees Al Tawoon Highway, Al-Hamriya 611, SitraManamaZIP / Postal Code: Kingdom of BahrainBahrain Telephone: (973) 17 738200Fax: (973) 17 732828,
BALEARIC ISLANDS	Madrid (Office in Spain)	Cummins Ventas y Servicio, S.A.Torrelaguna, 56 Madrid 28027SpainTelephone: (34-91) 367-2000 376-2404Fax: (34-91) 407 6604,
BANGLADESH	Jakson International Ltd.	87 Suhrawardi Avenue (5th Floor) Baridhara, Dhaka-1212, Bangladesh Cell: +8801730358629 Tel: +88029893621, 9895783 Fax: +88029863307,
BARBADOS	Miami (Office in U.S.A.)	Cummins Power South, LLC900 N W 77th Ave.Hialeah Gardens, Florida 33016Telephone: (305) 821-821-4200Fax: (305) 557-2992,
BELGIUM	Mechelen	Cummins Distributor Egide Walschaertsstraat, 2Industriepark ZuidMechelenZIP / Postal Code: 2800BelgiumTelephone: (32-15) 479 100Fax: (32-15) 275 686,
BELIZE	Tampa (Office in U.S.A.)	Cummins Power South, LLC5421 N. 59th Street Tampa, FL 33610 Telephone: (813) 621-7202 Fax: (813) 621-8250,
BENIN		- See Togo ,

BENIN	TOGOMAT s.a.	Zone Industrielle CNPPMELomeTogoTelephone: (228) 2272395Fax: (228) 2270310,
BERMUDA	Bronx (Office in U.S.A.)	Cummins Metropower, Inc. 890 Zerega Avenue Bronx, NY 10473 Telephone: (718) 892-2400Fax: (718) 892-0055,
BHUTAN	Pune (Office in India)	Cummins Diesel Sales & Service (India) Ltd35A/1/2, Erandawana Pune, Maharashtra 411038IndiaTelephone: (91-20) 25431234 / 25430666 25431703Fax: (91-20) 25439490,
BOTSWANA- See Southern Africa Regional Office - Kelvin	Cummins Diesel South Africa (Pty)	9 Impala Road Kelvin (Neighbourhood), AlexandraGauteng, South Africa 2054South AfricaTelephone: (27-11) 321 8800Fax: (27-11) 444 3254,
BRAZIL	Belo Horizonte	Distribuidora Cummins Minas Ltda.Anel Rodoviario, Km 01 - Bairro Olhos D'Agua NorteBelo Horizonte, Minas Gerais 31950Brazil Telephone: (55-31) 3288-1344Fax: (55-31) 3288-1141,
BRAZIL	Campo Grande	Cummins Distribuidora de Motores Diesel e Equipamentos Ltda. Av. Rod. BR 163, nr. 5185Campo Grande, MATO GROSSO DO SUL 79060BrazilTelephone: (55-67) 387-8707Fax: (55-67) 387-8707,
BRAZIL	Curitiba	Distribuidora Parana de Motores Cummins Ltda.Abel Scuiatti 3020, Bairro AtubaCuritiba, PARANA 83408Brazil Telephone: (55-41) 3675-4500Fax: (55-41) 3675-6077,
BRAZIL	Fortaleza	Distribuidora Cummins Diesel do Nordeste LtdaBR 116, km.10 - nr.10.001, MessejanaFortaleza, CEARAZIP / Postal Code: 60871Brazil Telephone: (55-85) 4011-6400Fax: (55-85) 4011-6400,
BRAZIL	Goianian	Distribuidora Cummins Centro Oeste Ltda.Centro Oeste Ltda. Av. Caiapo , 777 Bairro Santa GenovevaGoiania, GOIAS 74672Brazil Telephone: (55-62) 269-1010 / 1011Fax: (55-62) 269-1032 / 1021,
BRAZIL	Manaus	Powertech Comercial Ltda.Av. Efigenio Sales 1717 - Parque 10Estrada da Ponta Negra, 6080 - SaoManaus, AMAZONAS 69060Brazil Telephone: (55-92) 642-2014Fax: (55-92) 236-6711,
BRAZIL	Porto Alegre	Distribuidora Meridional Motores Cummins Ltda.Av. Assis Brasil , 9000 SarandiPorto Alegre, RIO GRANDE DO SUL 91140BrazilTelephone: (55-51) 3021-2288Fax: (55-51) 3364-2288,
BRAZIL	Rio de Janeiro	Cummins Distribuidora de Motores Diesel e Equipamentos Ltda.Av. Brasil, 20289BotafogoRio de Janeiro, RIO DE JANEIRO 21515BrazilTelephone: (55-21) 2196-3131Fax: (55-21) 2196-3121,
BRAZIL	Sao Paulo	Cummins Distribuidora de Motores Diesel e Equipamentos Ltda.Rua Coronel Euclides Machado, 52Freguesia do OSao Paulo, SAO PAULO 02713BrazilTelephone: (55-11) 3931-2900Fax: (55-11) 3931-2900,

BRITISH VIRGIN ISLANDS		- See Puerto Rico ,
BRITISH VIRGIN ISLANDS	Cummins de Puerto Rico, Inc.	Calle 1 G1Urb. Industrial, Barrio PalmasCataño 00962Puerto RicoTelephone: (787) 275-2000Fax: (787) 275-2030,
BRUNEI		- See Malaysia ,
BRUNEI	Scott & English (M) Sdn Bhd	12 Jalan U1/15, Seksyen U1Hicom-Glenmarie Industrial ParkShah Alam, Selangor Darul Ehsan 40150MalaysiaTelephone: (60-3) 7805-1111Fax: (60-3) 7803-5122,
BURKINA - FASO		- See North/West/East and Central Africa Regional Office - Daventry,
BURKINA - FASO	Cummins Engine Company Ltd	Royal Oak Way SouthDaventry, NorthantsZIP / Postal Code: NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,
BULGARIA		-See Germany Regional Office - Gross-Gerau ,
BULGARIA	Cummins Diesel Deutschland GmbH	Odenwaldstraße 23Groß-Gerau, Hessen 64521GermanyTelephone: (49-6152) 174-0Fax: (49-6152) 174-141,
BURMA	Kuala Lumpur (Office In Malaysia)	Scott & English (M) Sdn Bhd12 Jalan U1/15, Seksyen U1Hicom-Glenmarie Industrial ParkShah Alam, Selangor Darul Ehsan 40150MalaysiaTelephone: (60-3) 7805-1111Fax: (60-3) 7803-5122,
BURUNDI	Brussels (Office in Belgium)	Cummins Belgium N.V./S.A.Egide Walschaertsstraat, 2Industriepark ZuidMechelen 2800BelgiumTelephone: (32-15) 479 100Fax: (32-15) 275 686,
CAMBODIA		Scott & English (Cambodia) Ltd.No. 20A E0/E1 Russian BoulevardPhnom PenhCambodiaTelephone: (855-23) 723741Fax: (855-23) 723741,
CANARY ISLANDS	Madrid (Office in Spain)	Cummins Ventas y Servicio S. A.Torrelaguna 56Madrid 28027Spain Telephone: (34-91) 367 20 00 / 367 24 04Fax: (34-91) 407 66 04,
CAPE VERDE		- See ECV PortugalElectro Central Vulcanizadora, LdaRua Conselheiro Martins de CarvalhoLote 1480 ResteloLisbonZIP / Postal Code: 1400PortugalTelephone: (351-21) 3034800Fax: (351-21) 3034801 / 2,
CENTRAL AFRICAN REPUBLIC		- See North/West Africa Regional Office - DaventryCummins Engine Company LtdRoyal Oak Way SouthDaventry, Northants NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,
CHAD		- See North/West/East and Central Africa Regional Office - DaventryCummins Engine Company LtdRoyal Oak Way SouthDaventry, Northants NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,

CHILE	Santiago	Distribuidora Cummins Chile, S.A. Avda. Americo Vespucio # 0631 Santiago, Quilicura ZIP / Postal Code: 873-0596 Chile Telephone: (56-2) 655-7253 / 7245 Fax: (56-2) 655-7216 / 7436,
CHINA, PEOPLE'S REPUBLIC	Beijing	Cummins Engine (Beijing) Co., Ltd. No. 8, Wan Yuan Street Beijing Economic and Technology Development Zone Beijing, 100176 People's Republic of China Telephone: (86-10) 67882258 Fax: (86-10) 67882285,
CHINA, PEOPLE'S REPUBLIC	Shenyang	Cummins Engine (China) Investment Co., Ltd. ShenYang Workshop & Branch Office No.5-2 Seventh Street Shenyang Economic-Technological Development Area Shenyang, Liaoning 110141 China Telephone: (86-24) 25506611 Fax: (86-24) 25365599,
CHINA, PEOPLE'S REPUBLIC	Kunming	Cummins (China) Investment Co. Ltd. Kunming Branch Room 606, Hongta Mansion No.155 Beijing Road Kunming, Yunnan 650011 Telephone: (86-871) 3579471/511/579/958 Fax: (86-871) 3579210,
CHINA, PEOPLE'S REPUBLIC	Shanghai	Cummins (China) Investment Co., Ltd. Shanghai Distributor Branch No. 581, New jin Qiao Road Pu Dong New Area Shanghai, Shanghai 201206 China Telephone: (86-21) 50318966 Fax: (86-21) 50318528,
CHINA, PEOPLE'S REPUBLIC	Urumqi	Cummins Engine (China) Investment Co., Ltd Urumqi Branch No.7, Shanghai Rd. Urumqi, Xinjiang 830011 China Telephone: (86-991) 3780332/5/6/7/8/9 Fax: (86-991) 3780334,
CHINA, PEOPLE'S REPUBLIC	Wuhan	Cummins Engine (China) Investment Co., Ltd. Wuhan Branch No.2 Zhang Po Road, Dong Xi Hu District A-Kaili Commercial Building Wuhan, Hubei 430040 China Telephone: (86-27) 83081677 Fax: (86-27) 83259369 / 83259370,
CHINA, PEOPLE'S REPUBLIC	Guangzhou	Cummins (China) Investment Co., Ltd. Guangzhou Branch G/F, Unit 1 & 2, Block 5, Xing Hui Yuan NO. 46, Jinsui Road, Zhu Jiang New City, Guangzhou, Guangdong 510623 China Telephone: (86-20) 38621009 Fax: (86-20) 38621144,
CHINA, PEOPLE'S REPUBLIC	Shenzhen	Shenzhen Chongfa Cummins Engine Company Ltd. Tian An Che Gong Miao Industrial Estate, Unit F2.6 - 2D Shenzhen Shennan Da Dao Shenzhen, Guangdong 518040 China Telephone: (86-755) 83415479 Fax: (86-755) 83415480,
COLOMBIA	Barranquilla	Cummins de Colombia, S.A. Calle 65 (Avenida Murillo) #6-31 Diagonal a Gran Abastos Soledad, Atlantico Colombia Telephone: (57-53) 282600 / 282601 / 282602 / 282603 / 282604 Fax: (57-53) 282640 / 282641,
COLOMBIA	Bogota	Cummins de los Andes S.A. Avenida Ciudad de Cali No. 11-22 Location: Bogota, Cundinamarca Colombia Telephone: (57-1) 294-8444 Fax: (57-1) 2294-8431,

COLOMBIA	Bucaramanga	Cummins API Ltda. Kilómetro 7 Vía a Girón - Zona Industrial A.A. 1821Bucaramanga, Colombia Bucaramanga, Santander ColombiaTelephone: (57-76) 468060 / 469262 / 469263Fax: (57-76) 468065,
COLOMBIA	Cali	Tecnodiesel LimitadaApartado Aereo No. 6398 Carrera 8, No. 27-43Cali, ValleColombiaTelephone: (57-2) 442-2422Fax: (57-2) 442-1798,
COLOMBIA	Medellin	EquitelCarrera 52, # 10-184 Medellin, AntioquiaColombiaTelephone: (57-4) 255-4200Fax: (57-4) 255-4104,
COLOMBIA	Pereira	Tecnodiesel Limitada Carrera 16 No. 9 - 68Avenida Simon Bolivar, DosquebradasPereira, RisaraldaColombiaTelephone: (57-63) 306102Fax: (57-63) 300062,
COMOROS		- See Southern Africa Regional Office - Kelvin ,
COMOROS		Cummins Diesel South Africa (Pty) Ltd9 Impala RoadKelvin (Neighbourhood), AlexandraGauteng, South Africa 2054South AfricaTelephone: (27-11) 321 8800Fax: (27-11) 444 3254,
CONGO, PEOPLE'S REPUBLIC	Mechelen (Office in Belgium)	Cummins Belgium N.V./S.A.Egide Walschaertsstraat, 2Industriepark ZuidMechelen 2800BelgiumTelephone: (32-15) 479 100Fax: (32-15) 275 686,
CORSICA		- See France (Please contact) Cummins Diesel S.A. 39 rue AmpèreBP 190Chassieu cédex 69680Telephone: (33-4) 479 100Fax: (33-4) 78 90 19 56,
COSTA RICA	San Jose	Oficina Regional Cummins de Centro AmericaUrbanización Rincón Verde DosCasa 13ESan Pablo de HerediaCosta RicaTelephone: (506) 238-1160Fax: (506) 238-1108,
CYPRUS	Nicosia	Alexander Dimitriou & Sons Limited158 Limassol AveLatsiaNicosia CY-2235CyprusTelephone: (357-22) 715 300Fax: (357-22) 715 400,
CZECH REPUBLIC		- See Central & Eastern EuropeCummins Czech Republic s.r.o.Komerční zona Pruhonice CestliceObchodní 132Praha, Prague 251 01Czech RepublicTelephone: (420-272) 680 110Fax: (420-272) 680 090,
DENMARK	Glostrup	Cummins Diesel Salg & Service A/SHovedvejen 233B, ØstvedRoskilde 4000 Denmark Telephone: (45-46) 42 35 50Fax: (45-46) 42 30 50,
DJIBOUTI		- See North/West/East and Central Africa,
DJIBOUTI		Cummins Engine Company LtdRoyal Oak Way South Daventry, NorthantsZIP / Postal Code: NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,

DOMINICAN REPUBLIC	Santo Domingo	Argico C. por A.Calle Jose A. Soler No.3Esq. Lope de Vega Santo Domingo, Distrito NacionalDominican RepublicTelephone: (809) 562-6281Fax: (809) 562-4233 ,
DUBAI		- See United Arab Emirates ,
DUBAI		Cummins Middle East FZEP.O. Box No 17636, Units ZF 05 & 06Jebel Ali Free Zone, DubaiUnited Arab EmiratesTelephone: (00 9714) 8838998 Fax: (00 9714) 8838997,
DUBAI	United Arab Emirates	Cummins Emirates Sales & Service LLC P.O. Box No 54044United Arab EmiratesTelephone: (00 9714) 3478184Fax: (00 9714) 3478185Toll Free: (800) 4184 ,
ECUADOR	Guayaquil	Indusur S.A.Ave. Carlos Julio Arosemena Km. 4Guayaquil, GuayasEcuadorTelephone: (593-4) 220-1177 / 220-0655Fax: (593-4) 220-1052,
ECUADOR	Quito	Rectificadora Botar S.A. Av. 10 de Agosto # 5980Quito, PichinchaEcuadorTelephone: (593-2) 2265-177 / 2265-209 / 2265-225 / 2265-193Fax: (593-2) 2459-031,
EGYPT	Cairo	Egyptian International Motors CO. Ltd (EIM)Autostrade RoadAl-Mugattam, CairoEgyptTelephone: (20-2) 5061600 / 1 / 2Fax: (20-2) 5065620,
EL SALVADOR	San Salvador	Maquinaria Salvadoreña, S.A. de C.V.Blvd. Ejercito Nacional y 54 Ave. Norte Edificio MAQSA San SalvadorEl SalvadorTelephone: (503) 2293-1666Fax: (503) 2293-1656,
ENGLAND		- See United Kingdom ,
ENGLAND		Cummins UKRutherford DrivePark Farm SouthWellingborough, NorthantsZIP / Postal Code: NN8 6ANUnited KingdomTelephone: (44-1933) 334200Fax: (44-1933) 334198,
EQUATORIAL GUINEA		- See North/West/East and Central Africa Regional Office - Daventry ,
EQUATORIAL GUINEA		Cummins Engine Company LtdRoyal Oak Way SouthDaventry, NorthantsZIP / Postal Code: NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,
ESTONIA		Cummins Czech Republic s.r.o.Komerční zona Pruhonice CestliceObchodní 132Praha, Prague 251 01Czech RepublicTelephone: (420-272) 680 110Fax: (420-272) 680 090,
FAROE ISLANDS	Wellingborough (Office in United Kingdom)	Cummins UKRutherford Drive Park Farm SouthWellingborough, Northants NN8 6ANEngland Telephone: (44-1933) 334200Fax: (44-1933) 334198,
FERNANDO PO		- See Spain ,
FERNANDO PO		Cummins Ventas y Servicio S. A.Torrelaguna 56Madrid 28027SpainTelephone: (34-91) 367 20 00 / 367 24 04Fax: (34-91) 407 66 04,

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

FIJI		- See Cummins New Zealand,
FIJI		Cummins9 Langley RoadManukau City Centre, Auckland 1702New ZealandTelephone: (64-3) 277 1000Fax: (64-3) 277 1001,
FINLAND	Helsinki	Machinery OyAnsatie 5VantaaZIP / Postal Code: FIN-01741FinlandTelephone: (358-9) 89551,
FRANCE	Lyon	CUMMINS DIESEL S.A.39 rue Ampère BP 190Chassieu cédex 69680 FranceTelephone: (33-4) 72 22 92 72 Fax: (33-4) 78 90 19 56,
GABON		- See North/West/East and Central Africa Regional Office - Daventry ,
GAMBIA		Matforce10 Avenue FaidherbeDakarSenegalTelephone: (221-8) 399500Fax: (221-8) 399531 / 399550,
GEORGIA		- See Moscow Regional Office - Moscow ,
GEORGIA		Cummins Engine Company, Inc.Park PlaceOffice E708, 113/1 Leninskiy ProspectMoscowZIP / Postal Code: 117198RussiaTelephone: (7-495) 956-51-22 / 23Fax: (7-495) 956-53-62,
GERMANY	Gross-Gerau	Cummins Diesel Deutschland GmbHOdenwaldstraße 23Groß-Gerau, Hessen 64521 GermanyTelephone: (49-6152) 174-0 Fax: (49-6152) 174-141,
GHANA	Accra	J&D Diesels and SystemsP.O. Box c2381CantonmentsAccra, Ghana Telephone: (233-21) 30-14-51Fax: (233-21) 301 201,
GREECE	Athens	ERGOTRAK Industrial Machinery & Equipment Trading Company14 km. National Road of Athens- LamiaKifissia 14510GreeceTelephone: (30-210) 6293400 / 41Fax: (30-210) 6201845,
GREENLAND		- See DenmarkCummins Diesel Salg & Service A/ SHovedvejen 233B, ØstedsRoskilde 4000Denmark Telephone: (45-46) 42 35 50Fax: (45-46) 42 30 50,
GRENADA	Miami (Office in U.S.A.)	Cummins Power South, LLC 9900 N W 77th Ave. Hialeah Gardens, Florida 33016Telephone: (305) 821-4200Fax: (305) 557-2992,
GUADELOUPE	Miami (Office in U.S.A.)	Cummins Power South, LLC 9900 N W 77th Ave.Hialeah Gardens, Florida 33016Telephone: (305) 821-4200Fax: (305) 557-2992,
GUAM	Barrigada	Mid-Pac Far East, Inc. Airport Industrial Park 825 Tiyan Parkway Barrigada, Guam 96931Telephone: (671) 632-5160Fax: (671) 632-5186,
GUATEMALA	Guatemala City	Maquinaria y Equipos, S.A. Carretera a Amatitlan, Kilómetro 12, Zona 12, Guatemala City GuatemalaGuatemala Telephone: (502) 2477-2746 / 2477-2747 / 2477-2748 / 2477-2749 / 2477-2750Fax: (502) 2477-3929 ,

GUINEA	Mechelen (Office in Belgium)	Cummins Belgium N.V./S.A.Egide Walschaertsstraat, 2Industriepark ZuidMechelen 2800BelgiumTelephone: (32-15) 479 100Fax: (32-15) 275 686,
GUINEA BISSAU		- See North/West/East and Central Africa Regional Office - DaventryCummins Engine Company LtdRoyal Oak Way SouthDaventry, Northants NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,
GUYANA	Miami (Office in U.S.A.)	Cummins Power South, LLC 9900 N.W. 77 Court Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 Fax: (305) 557-2992,
GUYANA, FRENCH	See France	CUMMINS DIESEL S.A.39 rue AmpèreBP 190Chassieu cédex 69680FranceTelephone: (33-4) 72 22 92 72Fax: (33-4) 78 90 19 56,
HAITI	Miami (Office in U.S.A.)	Cummins Power South, LLC9900 N W 77th Ave.Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 Fax: (305) 557-2992,
HOLLAND	- See Netherlands	Cummins Holland B VGalvanistraat 35Dordrecht, Zuid-Holland 3316 GHNetherlandsTelephone: (31-78) 6181200Fax: (31-78) 6176579,
HONDURAS	Tegucigalpa	Comercial Laeisz Honduras, S.A.Desvio Colonia La Pradera,Bldv. ToncontinTegucigalpaHondurasTelephone: (504) 233-5615 / 234-7072Fax: (504) 233-9531 / 234-3718,
HONG KONG	Kowloon	Cummins Hong Kong Ltd.2/F Unison Industrial Centre27-31 Au Pui Wan Street, Fo Tan, Shatin, N.T.Hong Kong, Hong KongHong Kong S.A.R.ong Kong Telephone: (852) 2606-5678 Fax: (852) 2691-1641,
ICELAND	Velasalan H.F.	Ananastrum 1Reykjavik 121 IcelandTelephone: (354) 5526122Fax: (354) 580 5301,
INDIA	Pune	Cummins Diesel Sales & Service (India) Ltd 35A/1/2, Erandawana Pune, Maharashtra 411038 Telephone: (91-20)25431234 , 25430666, 25431703Fax: (91-20) 25439490,
INDIA	Kolkata	Cummins Diesel Sales & Service (India) Ltd94, Tivoli Court, 1/C Ballygunge Circular RoadKolkata, West Bengal 700019India Telephone: (91-33) 22472481 / 22470774 / 22478065Fax: (91-33) 22473833,
INDIA	New Delhi	Cummins Diesel Sales & Service (India) Ltd.911-912, Hemkunt Tower,98 Nehru Place New Delhi, Delhi 110019IndiaTelephone: (91-11) 26431051 / 26445756 / 26445759 / 26416947Fax: (91-11) 26212817,
INDIA	Raipur	Cummins Diesel Sales & Service (India) Ltd.Vanijya Bhavan' 1st Floor, Sai Nagar FafadihDevendra Nagar RoadRaipur, Madhya Pradesh 492009IndiaTelephone: (91-771) 2521101 / 2521102Fax: (91-771) 2521103,

INDIA	Ranchi	Cummins Diesel Sales & Service (India) Ltd. 'Shanti Kunj' C-202, Vidyalaya Marg Road No. 01, Ashok Nagar, Ranchi, Jharkhand 834002 India Telephone: (91-651) 2241948 / 2241521 Fax: (91-651) 2242815,
INDONESIA	Jakarta	P.T. Alltrak 1978 J1. R.S.C. Veteran No. 4 Bintaro, Rempoa Jakarta 12330 Indonesia Telephone: (62-21) 736-1978 / 3301 / 5085 Fax: (62-21) 736-1977 / 3302,
IRAQ		- See Middle East Regional Office or United Arab Emirates,
IRAQ		Cummins Emirates Sales & Service LLC P.O. Box No 54044 Al Quoz Industrial Estate, Dubai United Arab Emirates Telephone: 00 9714 3478184 Fax: 00 9714 3478185 Toll Free: 800 4184 ,
IRELAND	Wellingborough (Office in England)	Cummins UK Rutherford Drive Park Farm South Wellingborough, Northants NN8 6AN United Kingdom Telephone: (44-1933) 334200 Fax: (44-1933) 334198,
ISRAEL	Tel Aviv	Israel Engines & Trailers 33 Hahashmal Street Tel Aviv 61003 Israel Telephone: (972-3) 7106222 Fax: (972-3) 5604540,
ITALY	Milan	Cummins Italia S.p.A. Via Einaudi, 5 Peschiera Borromeo, Milano 20068 Italy Telephone: (39-02) 51 65 581 Fax: (39-02) 51 65 58 56 ,
IVORY COAST		- See Cote d'Ivoire Ste. des Ets. Lemerrier et Fils 10 rue des Brasseurs Abidjan 15 Cote d'Ivoire Cote d'Ivoire Telephone: (225-21) 352522 / 350687 / 350676 Fax: (225-21) 358562 / 243938,
JAMAICA		Cummins Power South, LLC 9900 N W 77th Ave. Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 Fax: (305) 557-2992,
JAPAN	Tokyo	Cummins Japan Ltd. 2-11, Higashi-Kojiya 6-chome Ota-ku, Tokyo 144-0033 Japan Telephone: (81-3) 5735-0600 Fax: (81-3) 5735-0605,
JORDAN	Amman	SETI Jordan Ltd. Bayader Wadi Alseer Industrial Street Amman, Jordan Jordan Telephone: (962-6) 582 7300 / 4261 Fax: (962-6) 585 6854,
KENYA	Nairobi	Simba Colt Motors Ltd Cummins Engine Division, PO Box 48296, Code 00100 Shimo-La-Tewa Road, Nairobi Kenya Telephone: (254-20) 650029 Fax: (254-20) 534870 ,
KOREA - SOUTH KOREA	Seoul	Cummins Diesel Sales & Service Co., Ltd. 354-4, Chonheung-ri, Songgo-eup Chonan-city, Choongchungnam-do 330-836 South Korea Telephone: (82-41) 620-9202/3 Fax: (82-41) 621-9121 to 2,
KOREA - SOUTH KOREA		Cummins Korea Ltd 2nd Floor, Choyang Bldg. 113 Samsung Dong, Kangnam-ku Seoul, Korea Telephone: (82-2) 3420-0901 Fax: (82-2) 3452-4113 / 539-6569,

KUWAIT	Kuwait	General Transportation & Equipment Co. (GTE)(Sales Department) Safat 13011KuwaitTelephone: (965) 483 3380/1/2Fax: (965) 481 2860,
LAOS		Diethelm & Co. LtdBan Phonsinouan, Unit 18,New Road Sisattanak District,VientianeLaos P.D.R.Telephone: (856-21) 453 100Fax: (856-21) 453-103,
LATVIA	Please contact the Central & Eastern European Regional Office	Cummins Diesel Deutschland GmbH Odenwaldstraße 23Groß-GerauZIP / Postal Code: 64521GermanyTelephone: (49-6152) 174-0Fax: (49-6152) 174-141,
LEBANON	Beirut	S.E.T.I. Charles Keller SALCorniche du Fleuve BeirutLebanonLebanonTelephone: (961-1) 425040 / 425041 / 426042Fax: (961-1) 425637 / 425389,
LESOTHO	- See South Africa	Cummins Diesel South Africa (Pty) Ltd13 Eastern Service RoadKelvin (Neighbourhood), AlexandraGauteng, South Africa 2054South AfricaTelephone: (27-11) 321 8700Fax: (27-11) 444 2012,
LIBYA	- See North/West Africa Regional Office - Daventry	Cummins Engine Company LtdRoyal Oak Way SouthDaventry, Northants NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,
LIECHTENSTEIN	- See Switzerland	AKSA Wurenlos AGGrosszelgstrasse 15Wuerenlos CH-5436SwitzerlandTelephone: (41-56) 436 77 00Fax: (41-56) 436 77 19,
LUXEMBOURG		Cummins Diesel Deutschland GmbH Odenwaldstraße 23Groß-Gerau, Hessen 64521GermanyTelephone: (49-6152) 174-0Fax: (49-6152) 174-141,
MACAU	- See Hong Kong	Cummins Hong Kong Ltd.2/F Unison Industrial Centre27-31 Au Pui Wan Street, Fo Tan, Shatin, N.T.ccccHong Kong, Hong KongHong Kong S.A.R.Telephone: (852) 2606-5678Fax: (852) 2691-1641,
MADAGASCAR	- See Southern Africa Regional Office	Cummins Diesel South Africa (Pty) Ltd13 Eastern Service RoadKelvin (Neighbourhood), AlexandraGauteng, South Africa 2054ZIP South AfricaTelephone: (27-11) 321 8700Fax: (27-11) 444 2012,
MADEIRA ISLANDS	- See Portugal	Electro Central Vulcanizadora, LdaRua Conselheiro Martins de CarvalhoLote 1480 Restelo Lisbon 1400PortugalTelephone: (351-21) 3034800Fax: (351-21) 3034801 / 2,
MALAYSIA	Kuala Lumpur	Scott & English (M) Sdn Bhd 12 Jalan U1/15, Seksyen U1 Hicom-Glenmarie Industrial ParkShah Alam, Selangor Darul Ehsan 40150MalaysiaTelephone: (60-3) 7805-1111Fax: (60-3) 7803-5122,
MALI	- See Senegal (Matforce)	Matforce10 Avenue FaidherbeDakarSenegalTelephone: (221-8) 399500Fax: (221-8) 399531 / 399550,

MALTA	Valletta	International Machinery Ltd Regency House 254 Republic Street Valletta, Malta Telephone: (356-21) 232620 / 233343 Fax: (356-21) 235484 / 247571,
MARTINIQUE		Cummins Power South, LLC 9900 N.W. 77 Ave. Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 Fax: (305) 557-2992,
MEXICO	Guadalajara	Distribuidora Megamak de Occidente Metalurgia No. 2980 Fracc. Alamo Industrial Guadalajara, Jalisco 45560 Mexico Telephone: (52-3) 666-0329 / 666-0383 Fax: (52-3) 666-0333,
MEXICO	Monterrey	Converto Dixel Monterrey Privada Nazry Hasbun #2, Carr. Migue Aleman 14.8 Parque Industrial Hasna Apodaca, Nuevo León 66473 Mexico Telephone: (52-81) 81310200 Fax: (52-81) 81310200,
MEXICO	Merida	Distribuidora Megamak del Sureste Av. Aviacion Civil No. 647 Col. Sambula Merida, Yucatan 97259 Mexico Telephone: (52-9) 930-1300 Fax: (52-9) 930-1315,
MEXICO	Puebla	Cummins De Oriente, S.A. de C.V. Km. 10+400 Carr. Fed. Puegla-Tlaxcala Puebla, Puebla 72100 Mexico Telephone: (52-2) 248-7674 / 5 / 30-5083 / 6 Fax: (52-2) 249-7679,
MEXICO	Queretaro	Converto Dixel Queretaro Blvd. Bernardo Quintana No. 518, Col. Arboledas Queretaro, Queretaro ZIP / Postal Code: 76140 Mexico Telephone: (52-442) 211-8700 Fax: (52-442) 211-8700,
MOROCCO	Casablanca	Groupe Auto Hall 44 avenue Lalla Yacout Casablanca Morocco Telephone: (212-22) 442121 / 317044 / 317052 Fax: (212-22) 318915 / 315633,
MOZAMBIQUE	- See Southern Africa Regional Office - Kelvin	Cummins Diesel South Africa (Pty) Ltd 13 Eastern Service Road Kelvin (Neighbourhood), Alexandra Gauteng, South Africa 2054 South Africa Telephone: (27-11) 321 8700 Fax: (27-11) 444 2012,
NEPAL	Pune (Office in India)	Cummins Diesel Sales & Service (India) Ltd. 35A/1/2, Erandawana Pune, Maharashtra 411038 India Telephone: (91-20) 25431234 / 25430666 / 25431703 Fax: (91-20) 25439490,
NETHERLANDS	Dordrecht	Cummins Holland B V Galvanistraat 35 Dordrecht, Zuid-Holland 3316 GH Netherlands Telephone: (31-78) 6181200 Fax: (31-78) 6176579,
NETHERLANDS ANTILLES		Cummins Power South, LLC 9900 N W 77th Ave. Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 Fax: (305) 557-2992,
NEW GUINEA	- See Papua New Guinea	Cummins Macdhui Street Lae Papua New Guinea Telephone: (675) 472 3699 Fax: (675) 472 3803,

NEW GUINEA	- See Papua New Guinea	CumminsMacdhui StreetLaePapua New GuineaTelephone: (675) 472 3699Fax: (675) 472 3803,
New Zealand	Auckland	Cummins9 Langley RoadManukau City Centre, South Auckland 1702 New Zealand Telephone: (64-9) 277 1000Fax: (64-9) 277 1001,
New Zealand	Christchurch	Cummins33 Parkhouse RoadChristchurchNew ZealandTelephone: (64-3) 348 8170Fax: (64-3) 348 8007,
New Zealand	Dunedin	Cummins8 Devon StreetDunedinNew ZealandTelephone: (64-3) 477 8818Fax: (64-3) 477 8061,
New Zealand	Palmerston North	Cummins852 - 860 Tremaine AvenuePalmerston North, Wanganui-Manawatu 5301New ZealandTelephone: (64-3) 356 2209Fax: (64-3) 356 9130,
New Zealand	Rotorua	Cummins328 Te Ngae RoadBay of PlentyRotoruaNew ZealandTelephone: (64-7) 345 6699Fax: (64-7) 345 6694,
NICARAGUA	Managua	F. Alf. Pellas, S.A.Gadala Maria Cuatro Cuadras OesteBarrio AcahualincaManagua, NicaraguaNicaraguaTelephone: (505) 268-2244Fax: (505) 266-1060,
NIGERIA	Lagos	Scoa Power (A Division of Scoa Nigeria Plc) 15, Creek RoadApapaLagosNigeriaTelephone: (234-1) 5873623 / 5877322Fax: (234-1) 5450646,
NIGERIA	Paris (Office in France)	SCOA InterImmeublearie JosepheRue du Marechal de Lattre de Tassigny78990 Elancourt, FranceFranceTelephone: (33-1) 30 688 268Fax: (33-1) 30 688 269,
NORTHERN IRELAND	- See United Kingdom	Cummins Engine Company LtdRoyal Oak Way SouthDarenty, NorthantsZIP / Postal Code: NN11 5NUUnited Kingdom Telephone: (44-1327) 886000Fax: (44-1327) 886106,
NORWAY	Oslo	Cummins Norway A SHestehagen 3 Postboks 151 Drobak 1441Norway Telephone: (47) 64 90 70 80Fax: (47) 64 90 70 90,
OMAN	Ruwi	Universal Engineering Services LLCPO Box 2688Ruwi 112OmanTelephone: (968) 597531 / 597537Fax: (968) 597514,
PAKISTAN	Karachi	Cummins Sales & Service Pakistan2 Bangalore Town Main Shahrah-e-Faisal Karachi 75350 Pakistan Telephone: +92-21-4539603 / 4539604/ 4539605Fax: +92-21-4532519,
PANAMA	Panama City	Grupo Tiesa, S.A. Via Transistmica Milla 8 Frente a BacardiPartilloPanama Panama Telephone: (507) 231-0266Fax: (507) 231-2535,
PARAGUAY	Asuncion	De La Sobera S.A.Eusebio Ayala 1947P.O. Box 1160 AsuncionParaguay Telephone: (595) 21 202 913,

PERU	Lima	Mitsui Maquinarias Peru, S.A.Av. Nicolas Ayllon 2648Parcela Rustica Sta. Angelica AteLima ZIP / Postal Code: 03PeruTelephone: (51-1) 326-4957Fax: (51-1) 326-4954,
PHILIPPINES	EDSA	Cummins Sales & Service Philippines, Inc.Lot 1 & 2, Block 15, LIIP Avenue,Laguna International Industrial Park, Mamlasan, BinanLagunaPhilippinesTelephone: (63-2) 843-0630 Fax: (63-2) 539-0290,
POLAND		Cummins Engine Company Limited Sp. z.o.o. Oddzial w Polsceul. Stawowa 119Krakow 31-346Poland Telephone: (48-12) 661 53 05 & (48-12) 661 53 25Fax: (48-12) 661 53 15,
PORTUGAL	Lisbon	Electro Central Vulcanizadora, Lda Rua Conselheiro Martins de CarvalhoLisbonZIP / Postal Code: 1400PortugalTelephone: (351-21) 3034800Fax: (351-21) 3034801 / 2,
QATAR	Doha	Jaidah Motors & Trading Co. P.O. Box 150 Doha, Qatar (Arabian Gulf) Telephone: (974) 4466888Fax: (974) 441 4100 / 441 5400,
REUNION	- See Lyon Regional Office - Lyon	CUMMINS DIESEL S.A.39 rue AmpèreBP 190Chassieu cédex 69680FranceTelephone: (33-4) 72 22 92 72Fax: (33-4) 78 90 19 56,
RIO DE ORO	- See Spain	Cummins Ventas y Servicio S. A.Torrelaguna 56Madrid 28027SpainTelephone: (34-91) 367 20 00 / 367 24 04Fax: (34-91) 407 66 04,
ROMANIA	- See Germany Regional Office - Gross-Gerau	Cummins Diesel Deutschland GmbHODenwaldstraße 23Groß-Gerau, Hessen 64521GermanyTelephone: (49-6152) 174-0Fax: (49-6152) 174-141,
RUSSIA		OOO CumminsKlyazma 1GKhimki District, Moscow Region 141400RussiaTelephone: (7-495) 540 86 24 / 25Fax: (7-495) 540 86 99,
RWANDA	Mechelen	Cummins Belgium N.V./S.A. Egide Walschaertsstraat, 2Industriepark ZuidMechelen 2800BelgiumTelephone: (32-15) 479 100Fax: (32-15)275 686,
ST. LUCIA		Cummins Power South, LLC9900 N W 77th Ave.Hialeah Gardens, FL 33016 Telephone: (305) 821-4200Fax: (305) 557-2992,
ST. LUCIA	Miami (Office in U.S.A.)	Cummins Power South, LLC 9900 N W 77th Ave.Hialeah Gardens, FL 33016 Telephone: (305) 821-4200Fax: (305) 557-2992,
SAN MARINO	- See Italy	Cummins Italia S.p.A.ItalyVia Einaudi, 5Peschiera Borromeo, Milano 20068Telephone: (39-02) 51 65 581Fax: (39-02) 51 65 58 56 ,
SAO TOME AND PRINCIPE	- See North/West/East and Central Africa Regional Office - Daventry, England	Cummins Engine Company LtdRoyal Oak Way SouthDaventry, NorthantsZIP / Postal Code: NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,

SAUDI ARABIA	Al-Khobar	General Contracting Company - OLAYANP.O. Box 356 King Abdul Aziz Road Al-KhobarSaudi Arabia Telephone: (966-3) 882-0888Fax: (966-3) 8828560 / 8827914,
SCOTLAND	- See United Kingdom	Cummins UKRutherford DrivePark Farm SouthWellingborough, NorthantsZIP / Postal Code: NN8 6ANUnited KingdomTelephone: (44-1933) 334200Fax: (44-1933) 334198,
SENEGAL	Dakar	Matforce 10 Avenue FaidherbeDakarSenegal Telephone: (221-8) 399500 Fax: (221-8) 399531/399550 Equipements et Services (Mining Only) BP 15372-Fann Dakar Senegal Contacts: Mr. Jean Smets Tel: (221-8) 60 77 76 & 24 73 62 Fax: (221-8) 60 95 98,
SEYCHELLES	- See North/West/East & Central Africa Regional Office - Daventry, England	Cummins Engine Company LtdRoyal Oak Way SouthDaventry, NorthantsZIP / Postal Code: NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,
SIERRA LEONE	- See North/West/East and Central Africa Regional Office - Daventry	Cummins Engine Company LtdRoyal Oak Way SouthDaventry, NorthantsZIP / Postal Code: NN11 5NUUnited KingdomTelephone: (44-1327) 886000Fax: (44-1327) 886106,
SINGAPORE	Singapore	Cummins Engine (Singapore) Pte Ltd8 Tanjong Penjuru Singapore 609019SingaporeTelephone: (65) 6261-3555Fax: (65) 6261-2405,
SLOVAKIA		- See European Regional Office - Gross-Gerau,
SOLOMON ISLANDS	The Czech branch covers sales and service for the Czech Republic and Slovakia	Cummins Czech Republic s.r.o.Komerční zona Pruhonice CestliceObchodní 132Praha, Prague 251 01Czech RepublicTelephone: (420-272) 680 110Fax: (420-272) 680 090,
SOLOMON ISLANDS	-See SOUTH PACIFIC ISLANDS	(Please contact) Cummins2 Caribbean DriveScoresby 3179VictoriaTelephone: (61-3) 9765-3222Fax: (61-3) 9763-0079,
SOMALIA	- see Southern Africa Regional Office	(Please contact) Cummins Diesel South Africa (Pty) Ltd13 Eastern Service RoadKelvin (Neighbourhood), AlexandraGauteng, South Africa 2054South AfricaTelephone: (27-11) 321 8700Fax: (27-11) 444 2012,
SOUTH AFRICA	Johannesburg	Cummins Diesel South Africa (Pty) Ltd 13 Eastern Service Road Kelvin (Neighbourhood), AlexandraGauteng, South Africa 2054South Africa Telephone: (27-11) 321 8700Fax: (27-11) 444 2012 ,
SOUTHWEST AFRICA	- see Southern Africa Regional Office	(Please contact) Cummins Diesel South Africa (Pty) Ltd13 Eastern Service RoadKelvin (Neighbourhood), AlexandraGauteng, South Africa 2054South AfricaTelephone: (27-11) 321 8700Fax: (27-11) 444 2012 ,
SPAIN	Madrid	Cummins Ventas y Servicio S. A.Torrelaguna, 56 Madrid 28027Spain Telephone: (34-91) 367 20 00 / 367 24 04Fax: (34-91) 407 66 04,

SPANISH GUINEA	- See Spain	Cummins Ventas y Servicio S. A.Torrelaguna, 56 Madrid 28027Spain Telephone: (34-91) 367 20 00 / 367 24 04Fax: (34-91) 407 66 04,
SRI LANKA	Colombo	Trade Promoters Ltd 272/25, Sudharshana MawathaMalabe Sri Lanka Telephone: (94-11) 2413002Fax: (94-11) 5550034,
SUDAN	- See Middle East Regional Office - United Arab Emirates	United Arab EmiratesCummins Middle East FZEUnits ZF 5/6Jebel Ali Free ZoneP.O.Box No 17636DubaiUnited Arab EmiratesTelephone: (971-4) 883 8998Fax: (971-4) 883 7971,
SURINAM		Cummins Power South, LLC9900 N W 77th Ave.Hialeah Gardens, FL 33016 Telephone: (305) 821-4200Fax: (305) 557-2992,
SWAZILAND	- See South Africa	Cummins Diesel South Africa (Pty) Ltd13 Eastern Service RoadKelvin (Neighbourhood), AlexandraGauteng, South AfricaZIP / Postal Code: 2054South AfricaTelephone: (27-11) 321 8700Fax: (27-11) 444 2012,
SWEDEN	Stockholm	Cummins Sweden Maskingata 17CBrista IndustriomadeMärsta, Stockholm 195 60Sweden Telephone: (46-8) 595 133 90Fax: (46-8) 595 133 99,
SWITZERLAND	Regensdorf	AKSA Wurenlos AGGrosszelgstrasse 15Wuerenlos CH-5436Switzerland Telephone: (41-1) 436 77 00Fax: (41-56) 436 77 19,
SYRIA	Damascus	Puzant Yacoubian & Sons Yacoubian BuildingAbou Baker El Saddik StreetDamascusSyriaTelephone: (963-11) 212 8600Fax: (963-11) 212 8611,
TAHITI, ISLAND OF	- See French Polynesia	Cummins MerCruiser Diesel245 Brisbane RoadBiggera Waters, Queensland 4216AustraliaTelephone: (61-7) 5500 9060Fax: (61-7) 5500 9070,
TAIWAN		Cummins Taiwan Pte. Ltd.No.49 Ting Hu RoadTkuei Shan HsiangTaoyuan, Taiwan 104TaiwanTelephone: (886-3) 211-5160Fax: (886-2) 211-4158,
TANZANIA	- See South African Regional Office - Kelvin, South Africa	Cummins Diesel South Africa (Pty) Ltd13 Eastern Service RoadKelvin (Neighbourhood), AlexandraGauteng, South AfricaZIP / Postal Code: 2054South AfricaTelephone: (27-11) 321 8700Fax: (27-11) 444 2012,
THAILAND	Bangkok	DKSH (Thailand) Ltd1696 New Petchburi Road Bangkok 10310Thailand Telephone: (66-2) 254-4900 / 454-2173Fax: (66-2) 253-5560 / 652-9417 / 8 / 9,
TOGO (and BENIN)	Lome	TOGOMAT s.a.Zone Industrielle CNPPMELomeTogo Telephone: (228) 2272395Fax: (228) 2270310,
TONGA, ISLAND OF	-See SOUTH PACIFIC ISLANDS	(Please contact) Cummins2 Caribbean DriveScoresby 3179VictoriaAUSTRALIATelephone: (61-3) 9765-3222Fax: (61-3) 9763-0079,
TRINIDAD and TOBAGO		Cummins Power South, LLC 9900 N W 77th Ave.Hialeah Gardens, FL 33016 Telephone: (305) 821-4200Fax: (305) 557-2992,

TURKEY	Istanbul	Hamamcioglu Muesseseleri Ticaret T.A.S. Okul Cad. No. 1334956 Orhanli - P.K. 62 TuzlaIstanbulTurkey Telephone: (90-216) 394 3210Fax: (90-216) 394 3208 / 9,
UKRAINE	- See Moscow Regional Office - Moscow	Cummins Engine Company, Inc.Park PlaceOffice E708, 113/1 Leninskiy ProspectMoscow 117198RussiaTelephone: (7-495) 956-51-22 / 23 Fax: (7-495) 956-53-62 ,
UNITED ARAB EMIRATES	Dhabi	Cummins Middle East FZE Units ZF 05&06Jebel Ali Free ZoneDhabiUnited Arab Emirates Telephone: (971-4) 883 8998Fax: (971-4) 883 7971,
UNITED KINGDOM	Wellingborough	Cummins UKRutherford DrivePark Farm SouthWellingborough, Northants NN8 6ANUnited Kingdom Telephone: (44-1933) 334200Fax: (44-1933) 334198,
VATICAN CITY	- See Italy	Cummins Italia S.p.A.Via Einaudi, 5Peschiera Borromeo, Milano 20068ItalyTelephone: (39-02) 51 65 581Fax: (39-02) 51 65 58 56 ,
VENEZUELA	Caracas	Dieselval, C.A.Ave. Lisandro Alvarado, Sector La FloridaEdificio DieselvalValencia, CaraboboVenezuela ZIP / Postal Code: VenezuelaVenezuelaTelephone: (58-241) 8353074 / 8355265Fax: (58-241) 8314553 / 8314818,
VIETNAM	Hanoi	Diethelm & Co. Ltd., Engrg.94, Tran Quoc Toan Street,Hoan Kiem DistrictHanoiVietnam Telephone: (84-4) 9424-725Fax: (84-4) 9424-730,
VIETNAM	Ho Chi Minh City	Diethelm & Co. Ltd., Engrg.189 Dien Bien Phu Street, Ward 15Binh Thanh DistrictHo Chi Minh City, S.R. Vietnam Telephone: (84-8) 5121-334Fax: (84-8) 5121-335,
WESTERN SAMOA	-See SOUTH PACIFIC ISLANDS	(Please contact) Cummins2 Caribbean DriveScoresby 3179VictoriaAUSTRALIATelephone: (61-3) 9765-3222Fax: (61-3) 9763-0079,
YEMEN	Sana'a	Zubieri Trading CompanyAl Qiyadah StreetSana'aRepublic of YemenTelephone: (967-1) 223943 / 224051Fax: (967-1) 221611 / 245838,
SERBIA & MONTENEGRO		Cummins Dizel Motori Prodaja i ServisAutoput, 2211080 ZemumBeograd, Serbia & MontenegroSerbia & MontenegroTelephone: (381-11) 314 90 71Fax: (381-11) 314 91 27,
ZAMBIA	Ndola	Cummins Zambia LtdLufunza AvenueNdola, ZambiaZambiaTelephone: (260-2) 610 729Fax: (260-2) 612 756,
ZIMBABWE	Harare	Cummins Zimbabwe (Pvt) Ltd. 72 Birmingham RoadSoutherton, ZimbabweZimbabwe Telephones: (263-4) 621871 / 2 / 3 / 4 / 5Fax: (263-4) 621880,

Section TS - Troubleshooting Symptoms

Section Contents

	Page
Troubleshooting Procedures and Techniques	TS-1
General Information.....	TS-1
Troubleshooting Symptoms Charts	TS-2
General Information.....	TS-2
Charging System Alternator Not Charging or Insufficient Charging.....	TS-3
Charging System Alternator Overcharging.....	TS-4
Coolant Contamination.....	TS-5
Coolant Loss - External.....	TS-6
Coolant Temperature Above Normal - Gradual Overheat.....	TS-8
Coolant Temperature Above Normal - Sudden Overheat.....	TS-10
Coolant Temperature Below Normal.....	TS-12
Engine Acceleration or Response Poor.....	TS-13
Engine Difficult to Start or Will Not Start (Exhaust Smoke).....	TS-15
Engine Difficult to Start or Will Not Start (No Exhaust Smoke).....	TS-17
Engine Noise Excessive.....	TS-19
Engine Noise Excessive - Combustion Knocks.....	TS-21
Engine Power Output Low.....	TS-22
Engine Runs Rough at Idle.....	TS-24
Engine Runs Rough or Misfires.....	TS-26
Engine Shuts Off Unexpectedly or Dies During Deceleration.....	TS-28
Engine Speed Surges at Low or High Idle.....	TS-29
Engine Speed Surges in PTO or Cruise Control.....	TS-32
Engine Speed Surges Under Load or in Operating Range.....	TS-30
Engine Starts But Will Not Keep Running.....	TS-33
Engine Vibration Excessive.....	TS-34
Engine Will Not Reach Rated Speed (RPM).....	TS-35
Fault Code Warning Lamps Do Not Illuminate.....	TS-38
Fault Code Warning Lamps Stay On (No Apparent Reason).....	TS-37
Fuel Consumption Excessive.....	TS-39
Fuel in Coolant.....	TS-41
Fuel in the Lubricating Oil.....	TS-42
Intake Manifold Air Temperature Above Specification.....	TS-43
Intake Manifold Pressure (Boost) is Below Normal.....	TS-45
Lubricating Oil Consumption Excessive.....	TS-46
Lubricating Oil Contaminated.....	TS-47
Lubricating Oil Loss.....	TS-48
Lubricating Oil Pressure High.....	TS-49
Lubricating Oil Pressure Low.....	TS-50
Lubricating Oil Sludge in the Crankcase Excessive.....	TS-52
Smoke, Black - Excessive.....	TS-53
Smoke, White - Excessive.....	TS-54
Turbocharger Leaks Engine Oil or Fuel.....	TS-56

This Page Left Intentionally Blank

Troubleshooting Procedures and Techniques

General Information

This guide describes some typical operating problems, their causes, and some acceptable corrections to those problems. Unless noted otherwise, the problems listed are those which an operator can diagnose and repair.



Performing troubleshooting procedures NOT outlined in this section can result in equipment damage or personal injury or death. Troubleshooting must be performed by trained, experienced technicians. Consult a Cummins Authorized Repair Location for diagnosis and repair beyond that which is outlined, and for symptoms not listed in this section. Before beginning any troubleshooting, refer to General Safety Instructions in Section i of this manual.

Follow the suggestions below for troubleshooting:

- Study the complaint thoroughly before acting
- Refer to the engine system diagrams
- Do the easiest and most logical things first
- Find and correct the cause of the complaint

Troubleshooting Symptoms Charts

General Information

Use the charts on the following pages of this section to aid in diagnosing specific symptoms. Read each row of blocks from top to bottom. Follow through the chart to identify the corrective action.



Troubleshooting presents the risk of equipment damage, personal injury or death. Troubleshooting must be performed by trained, experienced technicians.

Charging System Alternator Not Charging or Insufficient Charging

Cause	Correction
-------	------------

<p>STEP 1</p> <p>Alternator pulley is loose on the shaft</p> <p>OK</p> <p>Go To Next Step</p>	<p>Tighten the pulley. Refer to equipment manufacturer service information.</p>
<p>STEP 2</p> <p>Batteries have malfunctioned</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check the condition of the batteries. Replace the batteries, if necessary. Refer to equipment manufacturer service information.</p>
<p>STEP 3</p> <p>Battery cables or connections are loose, broken, or corroded (excessive resistance)</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check the battery cables and connections.</p>
<p>STEP 4</p> <p>Alternator is overloaded, or alternator capacity is below specification</p> <p>OK</p> <p>Go To Next Step</p>	<p>Install an alternator with a higher capacity. Refer to equipment manufacturer service information.</p>
<p>STEP 5</p> <p>Alternator or voltage regulator is malfunctioning</p> <p>OK</p> <p>Go To Next Step</p>	<p>Test the alternator output. Replace the alternator or voltage regulator, if necessary. Refer to equipment manufacturer service information.</p>
<p>STEP 6</p> <p>Battery temperature is above specification</p> <p>OK</p> <p>Go To Next Step</p>	<p>Position the batteries away from heat sources. Refer to equipment manufacturer service information.</p>
<p>STEP 7</p> <p>Electrical system is "open" (blown fuses, broken wires, or loose connections)</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check the fuses, wires, and connections. Refer to equipment manufacturer service information.</p>
<p>STEP 8</p> <p>Vehicle gauge is malfunctioning</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check the vehicle gauge. Refer to equipment manufacturer service information.</p>
<p>STEP 9</p> <p>Contact a Cummins® Authorized Repair Facility</p>	

Charging System Alternator Overcharging

Cause

Correction

STEP 1

Batteries have failed

Check the condition of the batteries. Replace the batteries, if necessary. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Voltage regulator is malfunctioning

Check the voltage regulator. Replace the voltage regulator, if necessary. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 3

Contact a Cummins® Authorized Repair Facility

Coolant Contamination

Cause

Correction

STEP 1

Coolant is rusty and has debris

Drain and flush the cooling system. Fill with the correct mixture of antifreeze and water. Refer to Procedure 008-018 in Section 7.

OK

Go To Next Step

STEP 2

Transmission oil cooler or torque converter cooler is leaking

If applicable, check the transmission oil cooler and torque converter cooler for coolant leaks. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 3

Lubricating oil cooler is leaking

Check the lubricating oil cooler for coolant leaks and cracks. Refer to a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 4

Cylinder head gasket is leaking

Check the cylinder head gasket.

OK

Go To Next Step

STEP 5

Contact a Cummins® Authorized Repair Facility

Coolant Loss - External

Cause

Correction

STEP 1

Coolant level is below specification

Check the coolant level. Check for an external leak. Refer to equipment manufacturer service information. Sample the lubricating oil and have a laboratory check for coolant in the oil (internal leak).

OK

Go To Next Step

STEP 2

External coolant leak

Inspect the engine for coolant leaking externally from items such as coolant hoses, drain valves, coolant manifolds, expansion and pipe plugs, fittings, exhaust gas recirculation cooler coolant lines, turbocharger coolant lines, transmission oil cooler or torque converter oil cooler, water pump seal, radiator core, heat exchanger, lubricating oil cooler housing, aftertreatment diesel exhaust fluid tank heater and hoses, aftertreatment diesel exhaust fluid dosing valve coolant lines, and original equipment manufacturer mounted components that have coolant flow. If necessary, pressure test the cooling system. Refer to Procedure 008-018 in Section 7.

OK

Go To Next Step

STEP 3

Radiator cap is **not** correct, is malfunctioning, or has low-pressure rating

Check the radiator pressure cap. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 4

Cooling system hose is collapsed, restricted, or leaking

Inspect the hoses. Refer to Procedure 008-045 in Section 7.

OK

Go To Next Step

STEP 5

Coolant fill line is restricted or obstructed

Check the coolant fill line for restrictions or obstructions. Refer to Procedure 008-018 in Section 7.

OK

Go To Next Step

STEP 6

Coolant is rusty and has debris

Drain and flush the cooling system. Fill with the correct mixture of antifreeze and water. Refer to Procedure 008-018 in Section 7.

OK

Go To Next Step

STEP 7

Engine is overheating

Refer to the Coolant Temperature is Above Normal - Sudden Overheat or the Coolant Temperature is Above Normal - Gradual Overheat troubleshooting symptom tree in Section TS.

OK

Go To Next Step

Coolant Loss - External

Cause

Correction

STEP 8

Contact a Cummins® Authorized Repair Facility

Coolant Temperature Above Normal - Gradual Overheat

Cause

Correction

STEP 1

Charge-air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris

Inspect the charge-air cooler, air conditioner condenser, and radiator fins. Clean, if necessary. Refer to Procedure 010-027 in Section 4 and see equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Cold weather radiator cover or winterfront is closed

Open the cold weather radiator cover or the winterfront. Maintain a minimum of 387 cm²[60 in²] of opening at all times. Refer to Procedure 101-015 in Section 1.

OK

Go To Next Step

STEP 3

Coolant level is below specification

Check the coolant level. Check for an external leak. Refer to Procedure 008-066 in Section 3. Sample the lubricating oil and have a laboratory check for coolant in the oil (internal leak).

OK

Go To Next Step

STEP 4

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 5

Fan shroud is damaged or missing or the air recirculation baffles are damaged or missing

Inspect the shroud and the recirculation baffles. Repair, replace, or install, as necessary. Refer to Procedure 101-007 in Section 1.

OK

Go To Next Step

STEP 6

Lubricating oil is contaminated with coolant or fuel

Refer to the Lubricating Oil Contaminated symptom tree in Section TS.

OK

Go To Next Step

STEP 7

Cooling system hose is collapsed, restricted, or leaking

Inspect the hoses. Refer to Procedure 008-045 in Section 7.

OK

Go To Next Step

STEP 8

Coolant mixture of antifreeze and water is **not** correct

Verify the concentration of antifreeze in the coolant. Add antifreeze or water to correct the concentration. Refer to Procedure 008-018 in Section 7 and Procedure 018-004 in Section V.

OK

Go To Next Step

Coolant Temperature Above Normal - Gradual Overheat

Cause

Correction

STEP 9

Lubricating oil level is above or below specification

Check the oil level. Add or drain oil, if necessary. Refer to Procedure 007-043 in Section 3 and Procedure 018-003 in Section V.

OK

Go To Next Step

STEP 10

Coolant temperature gauge is malfunctioning

Test the temperature gauge. Repair or replace the gauge, if necessary. Contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 11

Fan drive belt is loose, tight, or **not** in alignment

Check the fan drive belt. Refer to Procedure 008-087 in Section 7.

OK

Go To Next Step

STEP 12

Vehicle cooling system is **not** adequate

Verify that the engine and vehicle cooling systems are using the correct components. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 13

Contact a Cummins® Authorized Repair Facility

Coolant Temperature Above Normal - Sudden Overheat

Cause

Correction

STEP 1

Coolant level is below specification

Check the coolant level. Check for an external leak. Refer to Procedure 008-066 in Section 3. Sample the lubricating oil and have a laboratory check for coolant in the oil (internal leak).

OK

Go To Next Step

STEP 2

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 3

Air in the cooling system

Inspect and vent the cooling system. Refer to Procedure 008-018 in Section 7.

OK

Go To Next Step

STEP 4

Fan drive belt is broken

Check the fan drive belt. Replace the belt, if necessary. Refer to Procedure 008-002 in Section A.

OK

Go To Next Step

STEP 5

Radiator cap is **not** correct, is malfunctioning, or has low-pressure rating

Check the radiator pressure cap. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 6

Cooling system hose is collapsed, restricted, or leaking

Inspect the hoses. Refer to Procedure 008-045 in Section 7.

OK

Go To Next Step

STEP 7

Coolant temperature gauge is malfunctioning

Test the temperature gauge. Repair or replace the gauge, if necessary. Contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 8

Charge-air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris

Inspect the charge-air cooler, air conditioner condenser, and radiator fins. Clean, if necessary. Refer to Procedure 010-027 in Section 4 and equipment manufacturer service information.

OK

Go To Next Step

Coolant Temperature Above Normal - Sudden Overheat

Cause

STEP 9

Cold weather radiator cover or winterfront is closed

OK

Go To Next Step

STEP 10

Contact a Cummins® Authorized Repair Facility

Correction

Open the cold weather radiator cover or the winterfront. Maintain a minimum of 387 cm²[60 in²] of opening at all times. Refer to Procedure 101-015 in Section 1.

Coolant Temperature Below Normal

Cause

Correction

STEP 1

Coolant temperature gauge or sensor is malfunctioning

Test the gauge or the sensor. Repair or replace, if necessary. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 3

Engine is operating at low ambient temperature

Check the winterfront, shutters, and under-the-hood air. Use under-the-hood intake air in cold weather. Refer to the following bulletin, Cold Weather Operation, Bulletin 3387266. Refer to Procedure 101-015 in Section 1.

OK

Go To Next Step

STEP 4

Fan drive or fan controls are malfunctioning

Check the fan drive and controls. Contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 5

Coolant temperature gauge is malfunctioning

Test the temperature gauge. Repair or replace the gauge, if necessary. Contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 6

Thermostat is **not** correct or is malfunctioning

Check the thermostat for the correct part number and for correct operation.

OK

Go To Next Step

STEP 7

Contact a Cummins® Authorized Repair Facility

Engine Acceleration or Response Poor

Cause

Correction

STEP 1

Operator technique is **not** correct

Refer to Procedure 101-014 in Section 1.

OK

Go To Next Step

STEP 2

Fuel level is low in the tank

Fill the supply tank. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 3

Vehicle parasitics are excessive

Check the vehicle for brakes dragging, transmission malfunction, cooling fan operation cycle time, and engine-driven units. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 4

Clutch is malfunctioning or is **not** correct

Compare the drivetrain specifications to Cummins Inc. recommendations. Check the clutch for correct operation. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 5

Drivetrain is **not** correctly matched to the engine

Check for correct gearing and drivetrain components. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 6

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 7

Fuel leak

Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 8

Intake manifold air temperature is above specification

Refer to the Intake Manifold Air Temperature Above Specification symptom tree in Section TS.

OK

Go To Next Step

STEP 9

Charge-air cooler is restricted or leaking

Inspect the charge-air cooler for air restrictions or leaks. Refer to Procedure 010-027 in Section 4.

OK

Go To Next Step

Engine Acceleration or Response Poor

Cause

Correction

STEP 10

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 11

Air intake or exhaust leaks

Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to Procedure 010-058 in Section 3.

OK

Go To Next Step

STEP 12

Air intake system restriction is above specification

Check the air intake system for restriction. Replace the air filter and inlet piping as necessary. Refer to Procedure 010-059 in Section 3.

OK

Go To Next Step

STEP 13

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

STEP 14

Fuel filter or fuel suction line is restricted

Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 15

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 16

Contact a Cummins® Authorized Repair Facility

Engine Difficult to Start or Will Not Start (Exhaust Smoke)

Cause

Correction

STEP 1

Starting procedure is **not** correct

Verify the correct starting procedure. Refer to Procedure 101-014 in Section 1.

OK

Go To Next Step

STEP 2

Fuel level is low in the tank

Fill the supply tank. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 3

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 4

Starting aid, if necessary for cold weather, is malfunctioning

Check for correct operation of the cold weather starting aid. Refer to Procedure 101-004 in Section 1 or the manufacturer's instructions.

OK

Go To Next Step

STEP 5

Engine block heater is malfunctioning, if equipped

Check the electrical sources and wiring to the cylinder block heater. Replace the block heater, if necessary. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 6

Fuel heater is malfunctioning, if equipped

Check the fuel heater and replace, if necessary. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 7

Battery voltage is low

Check the batteries and the unswitched battery supply circuit. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 8

Keyswitch circuit is malfunctioning

Check the vehicle keyswitch circuit. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 9

Engine cranking speed is too slow

Determine if the cranking speed is slower than 150 rpm. Refer to the Engine Will Not Crank or Cranks Slowly symptom tree.

OK

Go To Next Step

Engine Difficult to Start or Will Not Start (Exhaust Smoke)

Cause

Correction

STEP 10

Vehicle parasitics are excessive

Check the vehicle for brakes dragging, transmission malfunction, cooling fan operation cycle time, and engine-driven units. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 11

Fuel leak

Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 12

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 13

Air intake system restriction is above specification

Check the air intake system for restriction. Replace the air filter and inlet piping as necessary. Refer to Procedure 010-059 in Section 3.

OK

Go To Next Step

STEP 14

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

STEP 15

Fuel filter or fuel suction line is restricted

Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 16

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 17

Contact a Cummins® Authorized Repair Facility

Engine Difficult to Start or Will Not Start (No Exhaust Smoke)

Cause

Correction

STEP 1

Starting procedure is **not** correct

Verify the correct starting procedure. Refer to Procedure 101-014 in Section 1.

OK

Go To Next Step

STEP 2

Fuel level is low in the tank

Fill the supply tank. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 3

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

STEP 4

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 5

Original equipment manufacturer (OEM) engine protection system is malfunctioning

Isolate the OEM engine protection system. Follow the OEM service manual instructions to check for a malfunction

OK

Go To Next Step

STEP 6

Battery voltage is low

Check the batteries and the unswitched battery supply circuit. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 7

Keyswitch circuit is malfunctioning

Check the vehicle, equipment, or vessel keyswitch circuit. Refer to a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 8

Battery supply to the engine control module (ECM) is low, interrupted, or open

Check the battery connections, fuses, and unswitched battery supply circuit. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 9

Moisture in the wiring harness connectors

Dry the connector with Cummins® electrical contact cleaner, Part Number 3824510. Refer to equipment manufacturer service information.

OK

Go To Next Step

Engine Difficult to Start or Will Not Start (No Exhaust Smoke)

Cause

Correction

STEP 10

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 11

Engine control module (ECM) is locked up

Disconnect the battery cables for 30 seconds. Connect the battery cables and start the engine.

OK

Go To Next Step

STEP 12

Fuel filter or fuel suction line is restricted

Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 Section 5.

OK

Go To Next Step

STEP 13

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 Section 5.

OK

Go To Next Step

STEP 14

Fuel drain backup

Verify the fuel return line is plumbed to the bottom of the fuel tank.

OK

Go To Next Step

STEP 15

Contact a Cummins® Authorized Repair Facility

Engine Noise Excessive

Cause

Correction

STEP 1

Fan drive belt is loose, tight, or **not** in alignment

Check the fan drive belt. Refer to Procedure 008-087 in Section 5.

OK

Go To Next Step

STEP 2

Lubricating oil is thin or diluted

Refer to Procedure 018-003 in Section V. If the oil pressure is low, refer to the Lubricating Oil Pressure Low troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 3

Crankshaft pulley is damaged

Inspect the crankshaft pulley.

OK

Go To Next Step

STEP 4

Air intake or exhaust leaks

Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to Procedure 010-058 in Section 3.

OK

Go To Next Step

STEP 5

Air intake or exhaust piping is contacting the chassis or cab

Inspect the air piping, chassis, and cab for contact points. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 6

Air intake system restriction is above specification

Check the air intake system for restriction. Replace the air filter and inlet piping as necessary. Refer to Procedure 010-059 in Section 3.

OK

Go To Next Step

STEP 7

Coolant temperature is above specification

Refer to the Coolant Temperature is Above Normal - Sudden Overheat or the Coolant Temperature is Above Normal - Gradual Overheat symptom tree in Section TS.

OK

Go To Next Step

STEP 8

Engine mounts are worn, damaged, or **not** correct

Check the engine mounts. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 9

Fan clutch, hydraulic pump, or refrigerant compressor noise is excessive

Isolate each component and check for noise. Refer to equipment manufacturer service information.

OK

Go To Next Step

Engine Noise Excessive

Cause

Correction

STEP 10

Fan is loose, damaged, or has excessive hub bearing end clearance

Check the fan. Refer to Procedure 008-087 in Section 5.

OK

Go To Next Step

STEP 11

Contact a Cummins® Authorized Repair Facility

Engine Noise Excessive - Combustion Knocks

Cause Correction

<p>STEP 1</p> <p>Engine is operating at low ambient temperature</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check the winterfront, shutters, and under-the-hood air. Use under-the-hood intake air in cold weather. Refer to Procedure 101-015 in Section 1.</p>
<p>STEP 2</p> <p>Fuel grade is not correct for the application or the fuel quality is poor</p> <p>OK</p> <p>Go To Next Step</p>	<p>Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.</p>
<p>STEP 3</p> <p>Air in the fuel system</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.</p>
<p>STEP 4</p> <p>Coolant temperature is below specification</p> <p>OK</p> <p>Go To Next Step</p>	<p>Refer to the Coolant Temperature Below Normal troubleshooting symptom tree in Section TS.</p>
<p>STEP 5</p> <p>Contact a Cummins® Authorized Repair Facility</p>	

Engine Power Output Low

Cause	Correction
<p>STEP 1</p> <p>Electronic fault codes are active or high counts of inactive fault codes</p> <p>OK</p> <p>Go To Next Step</p>	<p>Review instructions for reading active fault codes.</p>
<p>STEP 2</p> <p>Fuel grade is not correct for the application or the fuel quality is poor</p> <p>OK</p> <p>Go To Next Step</p>	<p>Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.</p>
<p>STEP 3</p> <p>Engine is operating above recommended altitude</p> <p>OK</p> <p>Go To Next Step</p>	<p>Engine power decreases above recommended altitude. Refer to equipment manufacturer service information.</p>
<p>STEP 4</p> <p>Tachometer is not calibrated or is malfunctioning</p> <p>OK</p> <p>Go To Next Step</p>	<p>Compare the tachometer reading with a handheld tachometer or an electronic service tool reading. Calibrate or replace the tachometer as necessary. Refer to equipment manufacturer service information.</p>
<p>STEP 5</p> <p>Intake and exhaust system restricted</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check the intake and exhaust systems for restrictions. Inspect the intake air filter and replace as necessary. Refer to Procedure 010-059 in Section 3.</p>
<p>STEP 6</p> <p>Air intake system restriction is above specification</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check the air intake system for restriction. Replace the air filter and inlet piping as necessary. Refer to Procedure 010-059 in Section 3.</p>
<p>STEP 7</p> <p>Air intake or exhaust leaks</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to Procedure 010-058 in Section 3.</p>
<p>STEP 8</p> <p>Air leak between the turbocharger and the intake manifold</p> <p>OK</p> <p>Go To Next Step</p>	<p>Check for leaks in the air crossover tube, charge-air cooler connections, hoses, or through holes in the manifold cover and repair or replace if necessary. Refer to equipment manufacturer service information.</p>

Engine Power Output Low

Cause

Correction

STEP 9

Charge-air cooler is restricted or leaking

Inspect the charge-air cooler for air restrictions or leaks. Refer to Procedure 010-027 in Section 4.

OK

Go To Next Step

STEP 10

Fuel leak

Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 11

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 12

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 13

Fuel return restriction excessive

Inspect the fuel return lines for restrictions. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 14

Fuel filter or fuel suction line is restricted

Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 15

Vehicle parasitics are excessive

Check the vehicle for brakes dragging, transmission malfunction, cooling fan operation cycle time, and engine-driven units. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 16

Lubricating oil level above specification

Check the oil level. Verify the oil pan capacity. Fill the system to the specified level. Refer to Procedure 018-017 in Section V.

OK

Go To Next Step

STEP 17

Contact a Cummins® Authorized Repair Facility

Engine Runs Rough at Idle

Cause

Correction

STEP 1

Engine is cold

Allow the engine to warm to operating temperature. If the engine will **not** reach operating temperature, refer to the Coolant Temperature Below Normal troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 2

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 3

Idle speed is set too low for accessories

Check and adjust the low-idle screw. Refer to a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 4

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 5

Fuel filter or fuel suction line is restricted

Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 6

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 7

Engine mounts are worn, damaged, or **not** correct

Check the engine mounts. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 8

Moisture in the wiring harness connectors

Dry the connector with Cummins® electrical contact cleaner, Part Number 3824510. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 9

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

Engine Runs Rough at Idle

Cause

Correction

STEP 10

Contact a Cummins® Authorized Repair Facility

Engine Runs Rough or Misfires

Cause	Correction
<p>STEP 1 Engine is cold</p> <p>OK Go To Next Step</p>	<p>Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal troubleshooting symptom tree in Section TS.</p>
<p>STEP 2 Electronic fault codes are active or high counts of inactive fault codes</p> <p>OK Go To Next Step</p>	<p>Review instructions for reading active fault codes.</p>
<p>STEP 3 Air in the fuel system</p> <p>OK Go To Next Step</p>	<p>Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to equipment manufacturer service information.</p>
<p>STEP 4 Fuel grade is not correct for the application or the fuel quality is poor</p> <p>OK Go To Next Step</p>	<p>Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.</p>
<p>STEP 5 Fuel leak</p> <p>OK Go To Next Step</p>	<p>Check the fuel lines, fuel connections, and fuel filters for leaks. Refer to equipment manufacturer service information.</p>
<p>STEP 6 Fuel filter is plugged</p> <p>OK Go To Next Step</p>	<p>Measure the fuel pressure before and after the fuel filter. Refer to Procedure 006-015 in Section 5.</p>
<p>STEP 7 Fuel supply is not adequate</p> <p>OK Go To Next Step</p>	<p>Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 in Section 5.</p>
<p>STEP 8 Engine mounts are worn, damaged, or not correct</p> <p>OK Go To Next Step</p>	<p>Check the engine mounts. Refer to equipment manufacturer service information.</p>

Engine Runs Rough or Misfires

Cause

STEP 9

Moisture in the wiring harness connectors

Correction

Dry the connector with Cummins® electrical contact cleaner, Part Number 3824510. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 10

Contact a Cummins® Authorized Repair Facility

Engine Shuts Off Unexpectedly or Dies During Deceleration

Cause

Correction

STEP 1

Engine will **not** restart

Refer to the Engine Difficult to Start or Will **Not** Start troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 2

Fuel level is low in the tank

Fill the supply tank. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 3

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 4

Idle Shutdown or power takeoff (PTO) Shutdown features are activated

Check the time limit on Idle Shutdown and PTO Shutdown features with an electronic service tool. Refer to Procedure 101-007 in Section 1.

OK

Go To Next Step

STEP 5

Moisture in the wiring harness connectors

Dry the connectors with electrical contact cleaner, Part Number 3824510.

OK

Go To Next Step

STEP 6

OEM engine protection system is malfunctioning

Isolate the OEM engine protection system. Follow the OEM service manual instructions to check for a malfunction.

OK

Go To Next Step

STEP 7

Battery voltage supply to the engine control module (ECM) is low, interrupted, or open

Check the battery connections, the fuses, and the unswitched battery supply circuit. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 8

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 9

Contact a Cummins® Authorized Repair Facility

Engine Speed Surges at Low or High Idle

Cause

Correction

STEP 1

Fuel level is low in the tank

Fill the supply tank. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Engine idle speed is set too low

Adjust the idle speed. Refer to a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 3

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 4

Moisture in the wiring harness connectors

Dry the connector with Cummins® electrical contact cleaner, Part Number 3824510. Refer to Procedure 101-007 in Section 1.

OK

Go To Next Step

STEP 5

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 6

Fuel filter is plugged

Measure the fuel pressure before and after the fuel filter. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 7

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 8

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

STEP 9

Contact a Cummins® Authorized Repair Facility

Engine Speed Surges Under Load or in Operating Range

Cause

Correction

STEP 1

Fuel level is low in the tank

Fill the supply tank. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 3

Moisture in the wiring harness connectors

Dry the connector with Cummins® electrical contact cleaner, Part Number 3824510. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 4

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 5

Fuel filter is plugged

Measure the fuel pressure before and after the fuel filter. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 6

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 7

Vehicle parasitics are excessive

Check the vehicle for brakes dragging, transmission malfunction, cooling fan operation cycle time, and engine-driven units. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 8

Clutch is malfunctioning or is **not** correct

Compare the drivetrain specifications to Cummins Inc. recommendations. Check the clutch for correct operation. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 9

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

Engine Speed Surges Under Load or in Operating Range
Cause

Correction

STEP 10

Contact a Cummins® Authorized Repair Facility

Engine Speed Surges in PTO or Cruise Control

Cause

Correction

STEP 1

Engine speed also surges at idle

Refer to the Engine Speed Surges at Low or High Idle troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 2

Engine speed surges while in the normal operating range and **not** in PTO or cruise control

Refer to the Engine Speed Surges Under Load or in Operating Range troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 3

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 4

Moisture in the wiring harness connectors

Dry the connector with Cummins® electrical contact cleaner, Part Number 3824510. Refer to the Engine Speed Surges Under Load or in Operating Range troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 5

Fuel filter is plugged

Measure the fuel pressure before and after the fuel filter. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 6

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 7

Contact a Cummins® Authorized Repair Facility

Engine Starts But Will Not Keep Running

Cause

Correction

STEP 1

Fuel level is low in the tank

Fill the supply tank. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Battery voltage supply to the control module (ECM) is low, interrupted, or open

Check the battery connections. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 3

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 4

Idle speed is set too low for accessories

Check and adjust the low-idle screw. Refer to a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 5

Engine-driven units are engaged

Disengage engine-driven units. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 6

Air in the fuel system

Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe, and fuel filters as necessary.

OK

Go To Next Step

STEP 7

Fuel filter or fuel suction line is restricted

Replace the fuel filter. Check the fuel suction line for restriction. Refer to Procedure 006-015 in Section 5.

OK

Go To Next Step

STEP 8

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

STEP 9

Contact a Cummins® Authorized Repair Facility

Engine Vibration Excessive

Cause

Correction

STEP 1

Belt-driven accessories are malfunctioning

Check the fan hub, alternator, refrigerant compressor, and hydraulic pump for interference. Isolate belt-driven accessories and check for vibration. Refer to Procedure 008-036 in Section 6 and Procedure 013-001 in Section A.

OK

Go To Next Step

STEP 2

Engine idle speed is set too low (electronically controlled fuel systems)

Check the engine data plate to verify the correct idle speed setting. Refer to Procedure 101-007 in Section 1. Increase the idle speed with the idle increment switch or an electronic service tool. Refer to the appropriate electronic service tool manual.

OK

Go To Next Step

STEP 3

Engine mounts are worn, damaged, or **not** correct

Check the engine mounts. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 4

Fan is loose, damaged, or has excessive hub bearing end clearance

Check the fan. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 5

Engine is misfiring

Refer to the Engine Runs Rough or Misfires troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 6

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 7

Crankshaft pulley is damaged or loose

Inspect the crankshaft pulley. Refer to a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 8

Alternator bearing worn or damaged

Replace the alternator, if damaged. See equipment manufacturer service information.

OK

Go To Next Step

STEP 9

Contact a Cummins® Authorized Repair Facility

Engine Will Not Reach Rated Speed (RPM)

Cause

Correction

STEP 1

Vehicle parasitics are excessive

Check the vehicle for brakes dragging, transmission malfunction, cooling fan operation cycle time, and engine-driven units. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 3

Vehicle speed is too low for adequate cooling with high engine load

Reduce the engine load. Increase the engine (fan) rpm by downshifting.

OK

Go To Next Step

STEP 4

Tachometer is **not** calibrated or is malfunctioning

Compare the tachometer reading with a handheld tachometer or an electronic service tool reading. Calibrate or replace the tachometer as necessary. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 5

Air-fuel tube leaking, wastegate diaphragm ruptured, or wastegate plumbing damaged

Tighten the fittings, repair the plumbing, and/or replace the wastegate diaphragm. Refer to equipment manufacturer service information or contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 6

Charge-air cooler restricted, if equipped

Inspect the charge-air cooler for internal and external restrictions. Replace the restricted cooler if necessary. See equipment manufacturer service information.

OK

Go To Next Step

STEP 7

Fuel supply is **not** adequate

Check the flow through the filter to locate the source of the restriction. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 8

Exhaust back pressure too high

Measure and correct if above specification. Refer to equipment manufacturer service information or contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

Engine Will Not Reach Rated Speed (RPM)

Cause Correction

STEP 9

Contact a Cummins® Authorized Repair Facility

Fault Code Warning Lamps Stay On (No Apparent Reason)

Cause

Correction

STEP 1

Diagnostic shorting plug is installed

Remove the diagnostic shorting plug.

OK

Go To Next Step

STEP 2

Diagnostic switch is in the ON position

Turn OFF the diagnostic switch.

OK

Go To Next Step

STEP 3

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes. Contact a Cummins® Authorized Repair Location, if fault codes are active.

OK

Go To Next Step

STEP 4

Contact a Cummins® Authorized Repair Facility

Fault Code Warning Lamps Do Not Illuminate

Cause

Correction

STEP 1

Keyswitch is in the OFF position

Turn the keyswitch to the ON position.

OK

Go To Next Step

STEP 2

Battery supply to the engine control module (ECM)
is low, interrupted, or open

Check the battery connections, fuses, and
unswitched battery supply circuit. Refer to the
original equipment manufacturer (OEM) service
manual.

OK

Go To Next Step

STEP 3

Idle Shutdown or Power Take-Off (PTO) Shutdown
features are activated

Check the time limit on Idle Shutdown and PTO
Shutdown features with an electronic service tool.
Refer to Procedure 101-007 in Section 1.

OK

Go To Next Step

STEP 4

Contact a Cummins® Authorized Repair Facility

Fuel Consumption Excessive

Cause

Correction

STEP 1

Operator technique is **not** correct

Refer to Procedure 101-015 in Section 1.

OK

Go To Next Step

STEP 2

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 3

Fuel leak

Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 4

Hubometer or odometer is miscalibrated

Check the hubometer and odometer calibrations. Calibrate or replace the hubometer or odometer, if necessary. Calculate fuel consumption with new mileage figures.

OK

Go To Next Step

STEP 5

Hour meter is miscalibrated

Check the hour meter. Calibrate or replace the hour meter, if necessary. Calculate fuel consumption with new figures.

OK

Go To Next Step

STEP 6

Air intake or exhaust leaks

Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to Procedure 010-058 in Section 3.

OK

Go To Next Step

STEP 7

Air intake system restriction is above specification

Check the air intake system for restriction. Replace the air filter and inlet piping as necessary. Refer to Procedure 010-059 in Section 4.

OK

Go To Next Step

STEP 8

Equipment and environmental factors are affecting fuel consumption

Consider ambient temperatures, wind, tire size, axle alignment, routes, and use of aerodynamic aids when evaluating fuel consumption.

OK

Go To Next Step

Fuel Consumption Excessive

Cause

Correction

STEP 9

Lubricating oil level above specification

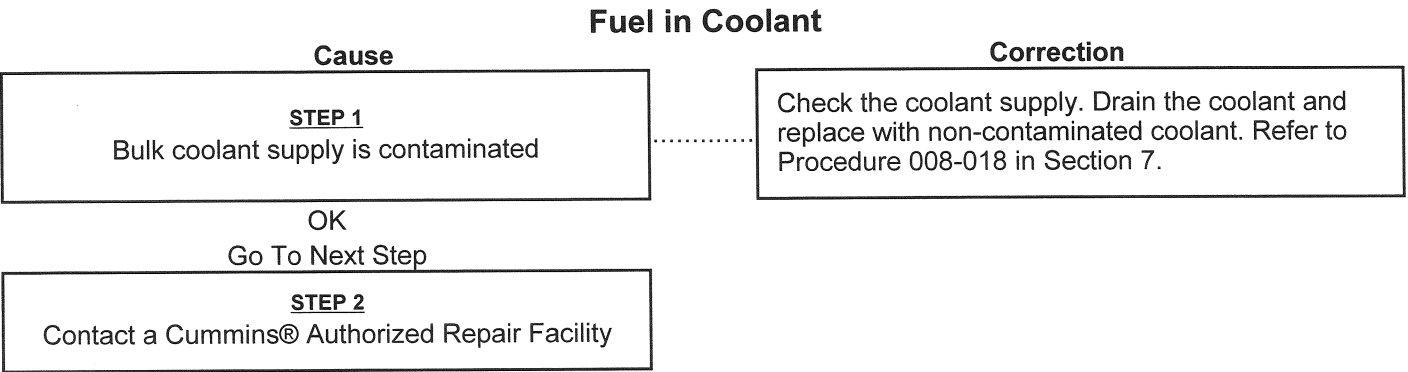
Check the oil level. Verify the oil pan capacity. Fill the system to the specified level. Refer to Procedure 007-043 in Section 3 and Procedure 018-017 in Section V.

OK

Go To Next Step

STEP 10

Contact a Cummins® Authorized Repair Facility



Fuel in the Lubricating Oil

Cause	Correction
<div>STEP 1</div> <div>Engine idle time is excessive</div> <div>OK</div> <div>Go To Next Step</div>	<div>Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes). Shut the engine OFF rather than idle for long periods.</div>
<div>STEP 2</div> <div>Bulk oil supply is contaminated</div> <div>OK</div> <div>Go To Next Step</div>	<div>Check the bulk oil supply. Drain the oil and replace with non-contaminated oil. Replace the oil filter(s). Refer to Procedure 007-002 in Section 5.</div>
<div>STEP 3</div> <div>Contact a Cummins® Authorized Repair Facility</div>	

Intake Manifold Air Temperature Above Specification

Cause

Correction

STEP 1

Charge-air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris

Inspect the charge-air cooler, air conditioner condenser, and radiator fins. Clean, if necessary. Refer to Procedure 010-027 in Section 4 and equipment manufacturer service information.

OK

Go To Next Step

STEP 2

Cold weather radiator cover or winterfront is closed

Open the cold weather radiator cover or the winterfront. Maintain a minimum of 387 cm²[60 in²] of opening at all times. Refer to Procedure 101-015 in Section 1.

OK

Go To Next Step

STEP 3

Fan drive belt or water pump belt is broken

Check the fan drive belt and water pump belt. Replace the belts, if necessary. Refer to Procedure 103-002 in Section 3.

OK

Go To Next Step

STEP 4

Fan shroud is damaged or missing or the air recirculation baffles are damaged or missing

Inspect the shroud and the recirculation baffles. Repair, replace, or install, as necessary. Refer to Procedure 103-002 in Section 3.

OK

Go To Next Step

STEP 5

Radiator shutters are **not** opening completely or the shutterstat setting is wrong

Inspect the radiator shutters. Repair or replace, if necessary. Refer to the manufacturer's instructions. Check the shutterstat setting. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 6

Vehicle speed is too low for adequate cooling with high engine load

Reduce the engine load. Increase the engine (fan) rpm by downshifting.

OK

Go To Next Step

STEP 7

Vehicle cooling system is **not** adequate

Verify that the engine and vehicle cooling systems are using the correct components. Refer to equipment manufacturer service information.

OK

Go To Next Step

STEP 8

Intake manifold temperature gauge is malfunctioning, if equipped

Refer to equipment manufacturer service information.

OK

Go To Next Step

Cause

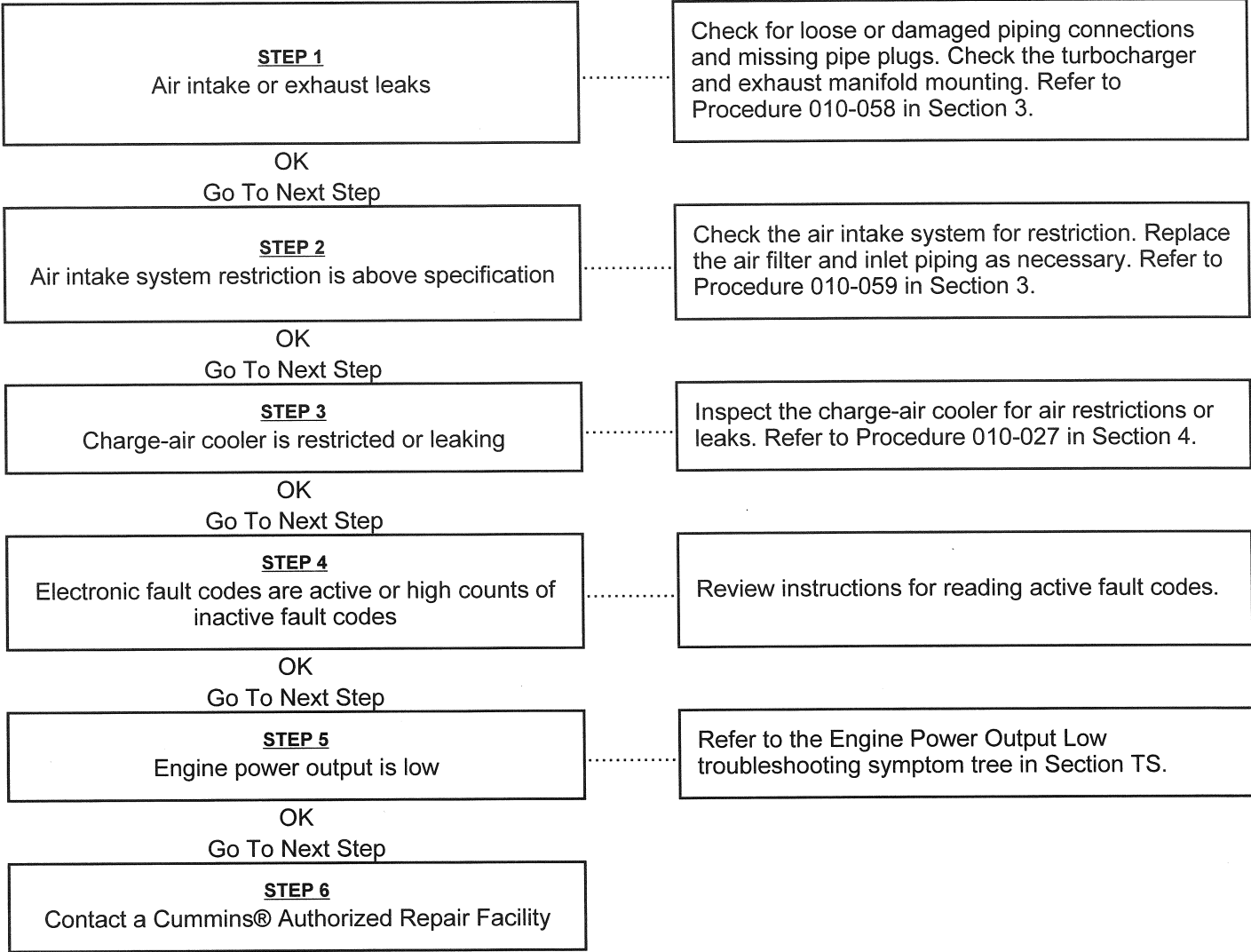
STEP 9

Verify that the fan is the correct size. Refer to equipment manufacturer service information.

Go To Next Step

Contact a Cummins® Authorized Repair Facility

Intake Manifold Pressure (Boost) is Below Normal
Cause **Correction**



Lubricating Oil Consumption Excessive

Cause

Correction

STEP 1

Crankcase ventilation system is plugged

Check and clean the crankcase breather and vent tube. Refer to Procedure 003-018 in Section 3.

OK

Go To Next Step

STEP 2

Lubricating oil does **not** meet specifications for operating conditions

Change the oil and filter(s). Refer to Procedure 007-002 in Section 5. Use the following procedure for oil recommendations. Refer to Procedure 018-003 in Section V.

OK

Go To Next Step

STEP 3

Lubricating oil drain interval is excessive

Verify the correct lubricating oil drain interval. Refer to Procedure 102-002 in Section 2.

OK

Go To Next Step

STEP 4

Lubricating oil leak (external)

Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace gaskets, if necessary.

OK

Go To Next Step

STEP 5

Verify the oil consumption rate

Check the amount of oil added versus the hours of operation.

OK

Go To Next Step

STEP 6

Contact a Cummins® Authorized Repair Facility

Lubricating Oil Contaminated

Cause

Correction

STEP 1

Lubricating oil sludge is excessive

Change the oil and filters. Refer to the Lubricating Oil Sludge in the Crankcase Excessive troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 2

Lubricating oil is contaminated with coolant or fuel

Change the oil and filters. Refer to Procedure 007-002 in Section 5. Use the following procedure for oil recommendations. Refer to Procedure 018-003 in Section V.

OK

Go To Next Step

STEP 3

Fuel lift pump is malfunctioning

Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump, if necessary. Refer to the original equipment manufacturer (OEM) service manual or a contact Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 4

Bulk oil supply is contaminated

Check the bulk oil supply. Drain the oil and replace with non-contaminated oil. Replace the oil filter(s). Refer to Procedure 007-002 in Section 5.

OK

Go To Next Step

STEP 5

Contact a Cummins® Authorized Repair Facility

Lubricating Oil Loss

Cause	Correction
STEP 1 Lubricating oil leak (external)	Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace gaskets, if necessary.
OK Go To Next Step	
STEP 2 Lubricating oil level is below specification	Check the oil level. Verify the dipstick calibration and the oil pan capacity. Fill the system to the specified level. Refer to Procedure 007-043 in Section 3. Use the following procedure for oil recommendations. Refer to Procedure 018-003 in Section V.
OK Go To Next Step	
STEP 3 Lubricating oil does not meet specifications for operating conditions	Change the oil and filter(s). Refer to Procedure 007-002 in Section 5. Use the following procedure for oil recommendations. Refer to Procedure 018-003 in Section V.
OK Go To Next Step	
STEP 4 Lubricating oil pressure switch, gauge, or sensor is malfunctioning or is not in the correct location.	Check the oil pressure switch, gauge, or sensor for correct operation and location. Contact a Cummins® Authorized Repair Location.
OK Go To Next Step	
STEP 5 Electronic fault codes are active or high counts of inactive fault codes	Review instructions for reading active fault codes.
OK Go To Next Step	
STEP 6 Lubricating oil cooler is leaking	Check the lubricating oil cooler for coolant leaks and cracks. Refer to original equipment manufacturer (OEM) service manual or contact a Cummins® Authorized Repair Location.
OK Go To Next Step	
STEP 7 Blowby excessive	Check for excessive blowby. Contact a Cummins® Authorized Repair Location.
OK Go To Next Step	
STEP 8 Turbocharger oil seal is leaking	Check the turbocharger for oil seals and for leaks. Refer to the Turbocharger Leaks Engine Oil or Fuel troubleshooting symptom tree in Section TS.
OK Go To Next Step	
STEP 9 Contact a Cummins® Authorized Repair Facility	

Lubricating Oil Pressure High

Cause

Correction

STEP 1

Coolant temperature is below specification

Refer to the Coolant Temperature Below Normal troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 2

Lubricating oil does **not** meet specifications for operating conditions

Change the oil and filters. Refer to Procedure 007-002 in Section 5. Use the oil recommended in Section V.

OK

Go To Next Step

STEP 3

Lubricating oil pressure switch, gauge, or sensor is malfunctioning or is **not** in the correct location.

Check the oil pressure switch, gauge, or sensor for correct operation and location. Contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 4

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 5

Contact a Cummins® Authorized Repair Facility

Lubricating Oil Pressure Low

Cause	Correction
STEP 1 Engine angularity during operation exceeds specification	Refer to equipment manufacturer service information.
OK Go To Next Step	
STEP 2 Lubricating oil does not meet specifications for operating conditions	Change the oil and filter(s). Refer to Procedure 007-002 in Section 5. Use the oil recommended in the following procedure. Refer to Procedure 018-003 in Section V.
OK Go To Next Step	
STEP 3 Lubricating oil is diluted with water	Check for a missing dipstick, rain caps, or oil fill caps. Change the oil and filter. Refer to equipment manufacturer service information.
OK Go To Next Step	
STEP 4 Lubricating oil filter is plugged	Change the oil and filter(s). Refer to Procedure 007-002 in Section 5. Use the oil recommended in the following procedure. Refer to Procedure 018-003 in Section V.
OK Go To Next Step	
STEP 5 Lubricating oil is contaminated with coolant or fuel	Refer to the Lubricating Oil Contaminated troubleshooting symptom tree in Section TS.
OK Go To Next Step	
STEP 6 Lubricating oil leak (external)	Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace gaskets, if necessary.
OK Go To Next Step	
STEP 7 Lubricating oil level is above or below specification	Check the oil level. Add or drain oil, if necessary. Refer to Procedure 007-002 in Section 5. Use the oil recommended in the following procedure. Refer to Procedure 018-003 in Section V.
OK Go To Next Step	
STEP 8 Electronic fault codes are active or high counts of inactive fault codes	Review instructions for reading active fault codes.
OK Go To Next Step	

Lubricating Oil Pressure Low

Cause

Correction

STEP 9

Lubricating oil pressure switch, gauge, or sensor is malfunctioning or is **not** in the correct location.

Check the oil pressure switch, gauge, or sensor for correct operation and location. Contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 10

Contact a Cummins® Authorized Repair Facility

Lubricating Oil Sludge in the Crankcase Excessive

Cause

Correction

STEP 1

Bulk oil supply is contaminated

Check the bulk oil supply. Drain the oil and replace with non-contaminated oil. Replace the oil filter(s). Refer to Procedure 007-002 in Section 5. Use the following procedure for oil recommendations. Refer to Procedure 018-003 in Section V.

OK

Go To Next Step

STEP 2

Coolant temperature is below specification

Refer to the Coolant Temperature Below Normal troubleshooting symptom tree in Section TS.

OK

Go To Next Step

STEP 3

Crankcase ventilation system is plugged

Check and clean the crankcase breather and vent tube. Refer to Procedure 003-018 in Section 3.

OK

Go To Next Step

STEP 4

Fuel grade is **not** correct for the application or the fuel quality is poor

Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.

OK

Go To Next Step

STEP 5

Lubricating oil does **not** meet specifications for operating conditions

Change the oil and filter(s). Refer to Procedure 007-002 in Section 5. Use the following procedure for oil recommendations. Refer to Procedure 018-003 in Section V.

OK

Go To Next Step

STEP 6

Contact a Cummins® Authorized Repair Facility

Smoke, Black - Excessive

Cause

Correction

STEP 1

Electronic fault codes are active or high counts of inactive fault codes

Review instructions for reading active fault codes.

OK

Go To Next Step

STEP 2

Air intake system restriction is above specification

Check the air intake system for restriction. Replace the air filter and inlet piping as necessary. Refer to Procedure 010-059 in Section 3.

OK

Go To Next Step

STEP 3

Air intake or exhaust leaks

Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to Procedure 010-058 in Section 3.

OK

Go To Next Step

STEP 4

Charge-air cooler is restricted or leaking

Inspect the charge-air cooler for air restrictions or leaks. Refer to Procedure 010-027 in Section 4.

OK

Go To Next Step

STEP 5

Contact a Cummins® Authorized Repair Facility

Smoke, White - Excessive

Cause	Correction
STEP 1 Starting procedure is not correct	Verify the correct starting procedure. Refer to Procedure 101-014 in Section 1.
OK Go To Next Step	
STEP 2 Engine is cold	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal troubleshooting symptom tree in Section TS.
OK Go To Next Step	
STEP 3 Engine is operating at low ambient temperature	Check the winterfront, shutters, and under-the-hood air. Use under-the-hood intake air in cold weather. Refer to Procedure 101-015 in Section 1 or Operation of Diesel Engines in Cold Climates, Bulletin 3379009.
OK Go To Next Step	
STEP 4 Electronic fault codes are active or high counts of inactive fault codes	Review instructions for reading active fault codes.
OK Go To Next Step	
STEP 5 Starting aid is malfunctioning	Check for correct operation of cold-starting aid. Refer to Procedure 101-004 in Section 1 or a Cummins® Authorized Repair Location.
OK Go To Next Step	
STEP 6 Coolant temperature is below specification	Refer to the Coolant Temperature is Below Normal troubleshooting symptom tree in Section TS.
OK Go To Next Step	
STEP 7 Fuel grade is not correct for the application or the fuel quality is poor	Operate the engine from a tank of known high quality fuel. Refer to Procedure 018-002 in Section V.
OK Go To Next Step	
STEP 8 Air intake or exhaust leaks	Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to Procedure 010-058 in Section 3.
OK Go To Next Step	

Smoke, White - Excessive

Cause

Correction

STEP 9

Air intake system restriction is above specification

Check the air intake system for restriction. Replace the air filter and inlet piping as necessary. Refer to Procedure 010-059 in Section 3.

OK

Go To Next Step

STEP 10

Charge-air cooler is restricted or leaking

Inspect the charge-air cooler for air restrictions or leaks. Refer to Procedure 010-027 in Section 4.

OK

Go To Next Step

STEP 11

Contact a Cummins® Authorized Repair Facility

Turbocharger Leaks Engine Oil or Fuel

Cause

Correction

STEP 1

Engine is operating for extended periods under light or no-load conditions (slobbering)

Review the engine operating instructions. Refer to Procedure 101-015 in Section 1.

OK

Go To Next Step

STEP 2

Lubricating oil or fuel is entering the turbocharger

Remove the intake and exhaust piping, and check for oil or fuel. Refer to the original equipment manufacturer (OEM) service manual or contact a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 3

Turbocharger oil drain line is restricted

Remove the turbocharger oil drain line and check for restriction. Clean or replace the oil drain line. Refer to a Cummins® Authorized Repair Location .

OK

Go To Next Step

STEP 4

Turbocharger oil supply line loose or leaking

Check and tighten oil supply line fitting(s), if necessary. Refer to a Cummins® Authorized Repair Location.

OK

Go To Next Step

STEP 5

Contact a Cummins® Authorized Repair Facility

Section V - Maintenance Specifications

Section Contents

	Page
Air Intake System	V-5
Specifications.....	V-5
Capscrew Markings and Torque Values	V-21
Capscrew Markings and Torque Values - Metric.....	V-21
Capscrew Markings and Torque Values - U.S. Customary.....	V-22
General Information.....	V-21
Coolant Recommendations and Specifications	V-16
Cooling System Sealing Additives.....	V-17
Cooling System Soluble Oils.....	V-18
Fully Formulated Coolant/Antifreeze.....	V-16
Cooling System	V-4
Specifications.....	V-4
Cummins®/Fleetguard® Filter Specifications	V-8
General Information.....	V-8
Diesel Exhaust Fluid Recommendations and Specifications	V-9
Contamination/Incorrect Fluid.....	V-11
Disposal.....	V-10
Freezing.....	V-11
General Information.....	V-9
Handling.....	V-10
Storage.....	V-10
Test.....	V-11
Drive Belt Tension	V-19
Tension Chart.....	V-19
Electrical System	V-7
Batteries (Specific Gravity).....	V-7
Specifications.....	V-7
Exhaust System	V-6
Specifications.....	V-6
Fraction, Decimal, Millimeter Conversions	V-23
Conversion Chart.....	V-23
Fuel Recommendations and Specifications	V-12
Fuel Recommendations.....	V-12
Fuel System	V-2
Specifications.....	V-2
General Engine	V-1
Specifications.....	V-1
Lubricating Oil Recommendations and Specifications	V-14
AfterMarket Oil Additive Usage.....	V-15
General Information.....	V-14
Lubricating Oil System	V-3
Specifications.....	V-3
Newton-Meter to Foot-Pound Conversions	V-24
Conversion Chart.....	V-24
Pipe Plug Torque Values	V-25
Torque Table.....	V-25
Sealants	V-20
General Information.....	V-20
Tap-Drill Chart - U.S. Customary and Metric	V-26
General Information.....	V-26
Weights and Measures - Conversion Factors	V-27
Conversion Chart.....	V-27

This Page Left Intentionally Blank

General Engine

Specifications

Listed below are the general specifications for this engine.

Horsepower.....Refer to engine dataplate
Bore and Stroke.....102 mm [4.02 in] x 115 mm [4.53 in]
Firing Order.....1-3-4-2

Engine Weight (with standard accessories):

Dry Weight for 3.8 liter engine [231 C.I.D.].....348 kg [767 lb]
Crankshaft Rotation (viewed from the front of the engine)..... **Clockwise**

Valve Clearance:

Intake.....0.330 mm [0.013 in]
Exhaust.....0.584 mm [0.023 in]

Maximum Overspeed Capability (15 seconds maximum).....3750 rpm

Minimum Ambient Air Temperature for Unaided Cold Start.....- 12.2°C [10°F]

Minimum Engine Cranking Speed.....120 rpm

Engine Idle Speed.....700 rpm

Altitude Maximum Before Derate Occurs

3.8 liter engine.....1676 m [5500 ft]

Oil Carryover:

Open crankcase ventilation system.....Less than 2 grams/hour [0.07 oz/hr]

Engine Blowby (with orifice size 5.61 mm [0.221 in]):

New.....101.6 mm H₂O [4.0 in H₂O]

Used.....431.8 mm H₂O [17.0 in H₂O]

NOTE: The engine features a no-adjust overhead. Adjustment of the valve lash is **not** required for normal service during the first 5000 hours. The valve train operates acceptably within the limits of 0.229 to 0.457 mm [0.009 to 0.018 in] intake valve lash and 0.457 to 0.838 mm [0.018 to 0.033 in] exhaust valve lash. It is recommended that the valve lash be checked at 5000 hours and every 2000 hours thereafter.

Fuel System

Specifications

For performance and fuel rate values, see the Engine Data Sheet.

Maximum Fuel Inlet Restriction - With gear pump only (at gear pump inlet).....	14 kPa [12 in-Hg]
Rail Pressure.....	250 to 2,000 bar [3,626 to 29,008 psi]
Maximum Fuel Pressure Range at Fuel Filter Outlet (engine cranking) - With gear pump only	3.3 kPa [1 in-Hg]
Maximum	
Fuel Pressure Range at Fuel Filter Inlet (engine running) - With gear pump only	400 to 810 kPa [58 to 117 psi]
Maximum Fuel Drain Line Restriction.....	20 kPa [5.9 in-Hg]
Maximum Fuel Inlet Temperature.....	70°C [158°F]

Lubricating Oil System

Specifications

Oil Pressure

Low idle (minimum allowed).....	69 kPa [10 psi]
At rated speed (minimum allowed).....	275 kPa [40 psi]
Oil-regulating valve-opening pressure range.....	525 kPa to 600 kPa [76 psi to 87 psi]
Oil filter differential pressure to open bypass.....	345 kPa [50 psi]
Lubricating oil filter capacity.....	0.85 liters [0.9 qt]

Oil Capacity of Standard Engine

Low Capacity Rear Sump Oil Pan

Pan only	8 liters [8.4 qt]
Total system.....	10.6 liters [11.2 qt]
High to low (on dipstick).....	1.5 liters [1.6 qt]
Maximum Oil Temperature.....	135°C [275°F]

NOTE: If the type/oil capacity of the oil pan is **not** known:

- 1 Contact a Cummins® Authorized Repair Location.
- 2 Determine the capacity of the oil pan option for the engine being serviced. Use QuickServe™ Online and the engine serial number.
- 3 Fill the lubricating oil pan to the smallest oil pan capacity listed for the engine being serviced. Then add 0.95 liters [1 qt] of oil at a time until it reaches the high mark on the dipstick. Record the number of quarts added, so that the capacity is known the next time the oil is drained.

Cooling System

Specifications

Engine Coolant Capacity.....	7.3 liters [7.7 qt]
Standard Modulating Thermostat - Range.....	82 to 95°C [180 to 203°F]
Maximum Allowed Operating Temperature.....	107°C [225°F]
Minimum Recommended Operating Temperature.....	70°C [158°F]
Minimum Recommended Pressure Cap at Sea Level.....	90 kPa [13 psi]

Air Intake System

Specifications

Maximum Intake Restriction:	
Clean Air Filter Element.....	3.71 kPa / 378 mm H ₂ O [15 in H ₂ O]
Dirty Air Filter Element.....	6.2 kPa / 632 mm H ₂ O [25 in H ₂ O]
Charge-Air Cooler Temperature Differential:	
Maximum Differential.....	30°C [86°F]
Charge-Air Cooler Pressure Differential:	
Maximum Charge-Air Cooler Pressure Drop.....	13.5 kPa [1.96 psi]
Recommended Intake Piping Size.....	76 mm [3 in]

Exhaust System

Specifications

Maximum Back Pressure (imposed by complete exhaust system).....18 kPa [5.3 Hg]
Exhaust Pipe Size (normally acceptable inside diameter).....75 mm [3 in]

Electrical System

Specifications

Recommended Battery Capacity

System Voltage	Ambient Temperature			
	-18°C [0°F]		-29°C [-20°F]	
	Cold Cranking Amperes	Reserve Capacity (minutes) ¹	Cold Cranking Amperes	Reserve Capacity (minutes) ¹
12-VDC	950	180	1200	180
24-VDC ²	550	130	700	130
¹ The number of plates within a given battery size determines reserve capacity. Reserve capacity is the length of time for which a battery at 27°C [81°F] can supply 25 amperes at 10.5-VDC or greater.				
² Cold cranking amperes are based on two 12-VDC batteries in series.				

Batteries (Specific Gravity)

Specific Gravity at 27°C [81°F]	State of Charge
1.260 to 1.280	100%
1.230 to 1.250	75%
1.200 to 1.220	50%
1.170 to 1.190	25%
1.110 to 1.130	Discharged

Cummins®/Fleetguard® Filter Specifications

General Information

Cummins Filtration™, which produces Fleetguard® products, is a division of Cummins Inc. Fleetguard® filters are developed through joint testing at Cummins Inc. and are standard on new Cummins® engines. Cummins Inc. recommends their use.

Fleetguard® products meet all Cummins® Source Approval Test standards to provide the quality filtration necessary to achieve the engine's design life. If other brands are substituted, the purchaser **must** insist on products that the supplier has tested to meet Cummins Inc. high-quality standards.

Cummins Inc. can **not** be responsible for problems caused by non-genuine filters that do **not** meet Cummins Inc. performance or durability requirements.

Filter Part Numbers

Lubricating Oil Filter	
Cummins® Part Number	5262313
Fleetguard® Part Number	LF16352
Fuel Filter Cartridge (Primary)	
Cummins® Part Number	5304517
Fleetguard® Part Number	FF73000
Fuel Filter (Prefilter with WIF sensor) *	
Cummins® Part Number	5308722
Fleetguard® Part Number	FS20038
Aftertreatment DEF Dosing Unit Filter	
Cummins® Part Number	2888182

* The fuel filter (prefilter with WIF sensor) could be supplied by the original equipment manufacturer (OEM).

Air Cleaner Element:

There are several air cleaner elements available. **Always** replace the element with the same part number as the element removed.

Diesel Exhaust Fluid Recommendations and Specifications

General Information

⚠ WARNING ⚠

It is unlawful to tamper with or remove any component of the aftertreatment system. It is also unlawful to use a Diesel Exhaust Fluid (DEF) that does not meet the specifications provided or to operate the vehicle/equipment with no Diesel Exhaust Fluid (DEF).

⚠ WARNING ⚠

Diesel Exhaust Fluid (DEF) contains urea. Do not get the substance in your eyes. In case of contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes. Do not swallow internally. In the event the diesel exhaust fluid is ingested, contact a physician immediately. Reference the Materials Safety Data Sheet (MSDS) for additional information.

⚠ CAUTION ⚠

Never attempt to create Diesel Exhaust Fluid by mixing agricultural grade urea with water. Agricultural grade urea does not meet the necessary specifications required and the aftertreatment system may be damaged.

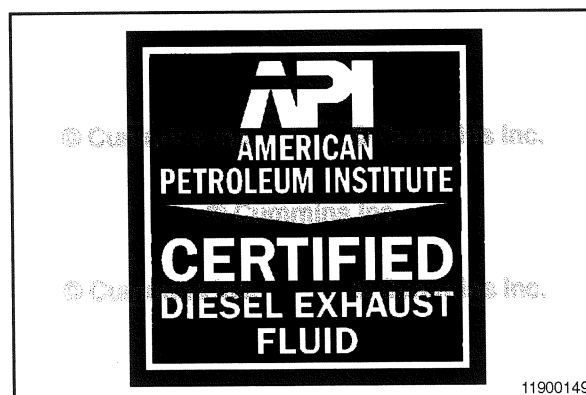
Cummins Inc. requires the use of Diesel Exhaust Fluid meeting ISO 22241-1. There is NO acceptable substitute.

NOTE: Some locations may reference the DIN 70070 standard. Diesel Exhaust Fluid specification limits of this standard are identical to ISO 22241-1.

Cummins Inc. is not responsible for failures or damage resulting from what Cummins Inc. determines to be abuse or neglect, including but not limited to: operation without correctly specified Diesel Exhaust Fluid; lack of maintenance of aftertreatment; improper storage, or shutdown practices; unauthorized modifications of the engine and aftertreatment. Cummins is also not responsible for failures caused by incorrect Diesel Exhaust Fluid or by water, dirt or other contaminants in the Diesel Exhaust Fluid

For further details and discussion of Diesel Exhaust Fluid (DEF) for Cummins® engines. Refer to the Diesel Exhaust Fluid Specifications for Cummins® Selective Catalytic Reduction Systems, Service Bulletin Number 4021566.

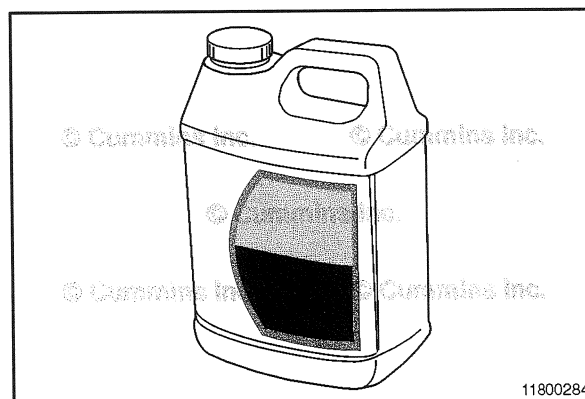
For engines using SCR operating in the United States and Canada, it is also strongly recommended that the Diesel Exhaust Fluid (DEF) used be certified by the American Petroleum Institute (API). This would be indicated by a symbol on the container/dispensing system as shown.



To ensure the correct Diesel Exhaust Fluid (DEF) is used, Cummins Inc. recommends the use of Fleetguard® Diesel Exhaust Fluid. Fleetguard® carries different quantity options from small to bulk containers.

For customers located in the United States and Canada, for assistance locating Diesel Exhaust Fluid (DEF), contact the Cummins Customer Assistance Center: 1-800 DIESELS (1-800-343-7357).

For customers outside of the United States and Canada, contact your local Cummins authorized repair location for assistance in locating Diesel Exhaust Fluid (DEF).



The following are other common names used for Diesel Exhaust Fluid (DEF):

- Urea
- AUS 32 (Aqueous Urea Solution 32)
- AdBlue
- NOx Reduction Agent
- Catalyst Solution
- DEF

Regardless of what the Diesel Exhaust Fluid is called, the Diesel Exhaust Fluid must meet the specifications as outlined in the General Information section of this procedure.

Storage

NOTE: The following information is for reference and is to be used as a guideline only. There are many factors that determine Diesel Exhaust Fluid (DEF) shelf life, with temperature and duration being two of the major determining contributors. If in doubt, check the concentration of the Diesel Exhaust Fluid (DEF), refer to the Test step of this procedure, or replace the fluid with known quality Diesel Exhaust Fluid.

Diesel Exhaust Fluid has a limited shelf life, both in the vehicle's diesel exhaust fluid tank and in storage/bulk/transportation containers.

The following conditions are ideal for maintaining DEF quality and shelf life during prolonged transportation and storage:

- Storage temperature between 23°F and 77°F (-5°C and 25°C)
- Store in sealed containers to avoid contamination
- Avoid direct sunlight

In these conditions, DEF has a minimum expected shelf life of 18 months. If stored at higher temperatures for extended periods of time, the shelf life will be reduced by approximately 6 months for every 5°C [9°F] above the highest storage temperature listed above.

Long term storage in a vehicle (in excess of 6 months) is not recommended. If long term storage is necessary, periodic testing of the Diesel Exhaust Fluid is recommended to be performed to ensure the concentration does not fall out of specification. Follow the Test step of this procedure.

NOTE: To assist in preventing Diesel Exhaust Fluid from deteriorating when stored in the vehicles DEF tank, locate and plug the tanks venting to seal the tank exposure to the atmosphere.

Handling

Diesel Exhaust Fluid is not harmful to handle, but can be corrosive to certain materials over time. Such as carbon steels, iron, zinc, nickel, copper, aluminum and magnesium.

- Make sure to only use approved containers to transport and store Diesel Exhaust Fluid. Containers made of polyethylene and polypropylene are recommended.
- If Diesel Exhaust Fluid is spilled, rinse and clean immediately with water.
- Avoid prolonged contact with skin. In case of contact, wash with immediately with soap and water. If not washed immediately, when the diesel exhaust fluid dries, a white film will be left that can be more difficult to wash off.

NOTE: Spilled Diesel Exhaust Fluid if left to dry or wiped away with a cloth only will leave a white residue. Failure to clean the spilled Diesel Exhaust Fluid may result in an incorrectly diagnosed leak of the Diesel Exhaust Fluid Dosing system.

Before using containers, funnels, etc. that will be used to dispense, handle or store Diesel Exhaust Fluid, make sure to wash thoroughly to remove any contaminants and then rinse with distilled water.

NOTE: Do not use tap water to rinse components that will be used to deliver diesel exhaust fluid. Tap water will contaminate the Diesel Exhaust Fluid. If distilled water is not available, rinse with tap water and then rinse with Diesel Exhaust Fluid.

Disposal

If disposing of Diesel Exhaust Fluid (DEF), always check with the local authority regulations on proper disposing process and requirements.

Test

Having the correct concentration of Diesel Exhaust Fluid is critical to the engine and aftertreatment system performing correctly.

To test the concentration of the Diesel Exhaust Fluid, use the Cummins Diesel Exhaust Fluid Refractometer, service tool part number 4919554. Follow the instructions provided with the service tool.

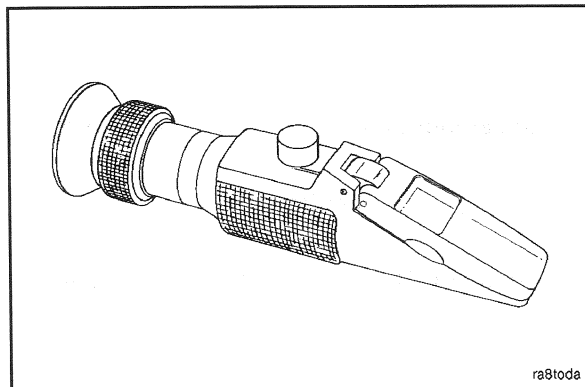
Percent Urea Concentration: 32.5 +/- 1.5%

The specification listed above takes into consideration the refractometer tool tolerances, variability, and calibration when measuring Diesel Exhaust Fluid concentration.

If the Diesel Exhaust Fluid concentration is found to be outside of this specification, drain the Diesel Exhaust Fluid tank, flush with distilled water and fill with new and/or known good Diesel Exhaust Fluid. Recheck the Diesel Exhaust Fluid concentration.

Concentration of the Diesel Exhaust Fluid should be checked when:

- The vehicle has been stored for an extended period of time.
- It is suspected that water has been added to the Diesel Exhaust Fluid tank



Contamination/Incorrect Fluid



Never add water or any other fluid besides what is specified to the Diesel Exhaust Fluid (DEF) tank. The aftertreatment system may be damaged.

In the event that the incorrect fluid is added to the Diesel Exhaust Fluid tank, such as, but not limited to:

- Water
- Diesel Fuel
- Hydraulic Fluid
- Coolant
- Windshield Washer Fluid

Contact a local Cummins Authorized Repair location to determine the appropriate repair direction.

If only water has been added to the Diesel Exhaust Fluid (DEF) tank, drain the Diesel Exhaust Fluid (DEF) tank, flush with distilled water and refill with new and/or known good Diesel Exhaust Fluid (DEF). Check the Diesel Exhaust Fluid (DEF) concentration after completing the refill, follow to the Test step of this procedure.

Freezing



Do NOT add any chemicals/additives to the Diesel Exhaust Fluid in an effort to prevent freezing. If chemicals/additives are added to the Diesel Exhaust Fluid, the aftertreatment system may be damaged.

Diesel Exhaust Fluid will freeze around -11°C [12°F]. The diesel exhaust fluid system on the vehicle is designed to accommodate this and does not require any intervention by the vehicle operator.

The Operating the Engine (101-015) procedure in Section 1 of the Owners and Operation and Maintenance Manual will provide information on proper cold weather set up for your engine/vehicle.

Fuel Recommendations and Specifications

Fuel Recommendations

The engine **must** operate on ultra-low sulfur diesel with a maximum sulfur content of 15 ppm in the United States and Canada and 10 ppm in the EU. Failure to do so can permanently damage engine and aftertreatment systems in a short period of time. Ultra-low sulfur biodiesel brands up to B20 (20% biodiesel) supplied by a BQ9000 certified supplier are acceptable. Fuel compatibility for Cummins® engines is documented in Fuels for Cummins® Engines, Service Bulletin 3379001 at <https://quickserve.cummins.com>.

Ultra-low sulfur diesel fuel is defined as diesel fuel **not** exceeding 0.0010 (10 ppm) mass percent sulfur content. The following Cummins® engines are required to operate on ULSD.

- Engines operating with aftertreatment systems including: diesel particulate filters (DPF), diesel oxidation catalysts (DOC), and selective catalytic reduction (SCR).
- Engines operating where regional, national, or international regulations require the use of ultra-low sulfur diesel in diesel engines.

In general, ultra-low sulfur diesel regulations make the fuel compatible with diesel engines with higher tolerance for sulfur content. The low sulfur content does slightly change some of the fuel properties. When transitioning from low sulfur diesel which can contain up to 500ppm sulfur, to ultra-low sulfur diesel, the following precautions are beneficial

- Properly label all fuel tanks and delivery pumps.
- Be sure that the fuel lubricity meets the specifications outlined in Table 1: Cummins Inc. Required Diesel Fuel Specifications in this bulletin.
- Ultra-low sulfur diesel has lower lubricity than low sulfur diesel, so lubricity additives need to be added by the fuel supplier to prevent fuel system damage.
- Be sure that fuel tanks are completely empty before transitioning from low sulfur diesel to ultra-low sulfur diesel, and consider tank cleaning.
- It takes **only** a small amount of low sulfur diesel blended with ultra-low sulfur diesel to bring the fuel sulfur content above 15 ppm.
- Consider using a stability additive for fuel in bulk storage.
- Ultra-low sulfur diesel is more prone to oxidation than low sulfur diesel.
- Consult your fuel supplier to determine if an additive is needed to maintain fuel quality in storage tanks.
- Closely monitor the fuel system for leaks, especially when first transitioning to ultra-low sulfur diesel, and correct them immediately.
- Ultra-low sulfur diesel reacts differently than low sulfur diesel with certain seal and gasket compounds commonly found in fuel systems, which means that leaks are more likely to occur, especially in older engines which were designed to run on low sulfur diesel.

Fuels meeting national and international specifications can be used if they observe the specifications listed in Table 1: Cummins Inc. Required Diesel Fuel Specifications. Cummins® engines will operate satisfactorily on fuels meeting all the properties listed in Table 1; however, fuels meeting **only** the required specifications will **not** give the same level of performance, efficiency, reliability, or maintenance costs as premium fuels.

Table 1: Cummins Inc. Required Diesel Fuel Specifications ¹	
Viscosity	1.3 to 4.1 centistokes at 40°C [104°]
Cetane Number	42 minimum above 0°C [32°F]; 45 minimum below 0°C [32°F] ²
Sulfur Content	Maximum sulfur content of 15 ppm in the United States and Canada and 10 ppm in the EU
Active Sulfur	Copper strip corrosion not to exceed number 3 rating after 3 hours at 50°C [122°F].
Water Sediment	Not to exceed 0.05 volume-percent
Carbon Residue	Not to exceed 0.35 mass-percent on 10 volume-percent residuum
Density	0.816 to 0.876 grams per cubic centimeter (g/cc) at 15°C [59°F]
Cloud Point	6°C or 11°F below lowest ambient temperature at which the fuel is expected to operate

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

Table 1: Cummins Inc. Required Diesel Fuel Specifications ¹	
Ash	Not to exceed 0.02 mass-percent. For vehicles equipped with exhaust aftertreatment, there shall be no detectable ash in the fuel
Distillation	10 volume-percent at 282°C [540°F] maximum, 90 volume-percent at 360°C [680°F] maximum, 100 volume-percent at 385°C [725°F] maximum. The distillation curve must be smooth and continuous
Lubricity (HFRR) or (SLBOCLE)	High Frequency Reciprocating Rig (HFRR): Maximum of 0.52 mm [0.020 in] Wear Scar Diameter (WSD) at 60°C [140°F]. Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE): Minimum of 3100 grams

1. In addition to the requirement in Table 1, Cummins Inc. strongly recommends the use of fuel with particle counts less than the ISO 4406 code of 18/16/13.

2. Fuel **must** observe proper flashpoint requirements to satisfy local safety regulations.

Regional, national, or international regulations can require a lower sulfur content than what is listed in Table 1.

Lubricating Oil Recommendations and Specifications

General Information



Extending the oil and filter change interval beyond the recommendations will decrease the engine life due to factors such as corrosion, deposits, and wear.

The engine requires low ash oil that meets Cummins® Engineering Standard CES 20081 as referenced in Cummins® Engine Oil and Oil Analysis Recommendations, Service Bulletin, 3810340 located at www.quickserve.com. This oil is commonly referred to as CJ-4 or ACEA E9.

The use of quality engine lubricating oils, combined with appropriate oil drain and filter change intervals, is a critical factor in maintaining engine performance and durability. Extending the oil and filter change interval beyond the recommendations will decrease engine life due to factors such as corrosion, deposits, and wear. Use the following procedure to determine which oil drain interval to use for an application. Refer to Procedure 102-002 in Section 2.

NOTE: The responsibility is with the owner. If recommendations are ignored, warranty could be affected.



CES	Cummins® Engineering Standard
API	American Petroleum Institute
ACEA	Association des Constructeurs Européen d'Automobiles

To determine if the oil meets CES, API, or ACEA standard, review the label on the back of the lubricating oil bottle for a label containing the specification information. If acquiring the lubricating oil in bulk, contact the supplier to confirm the oil recommendation is met.

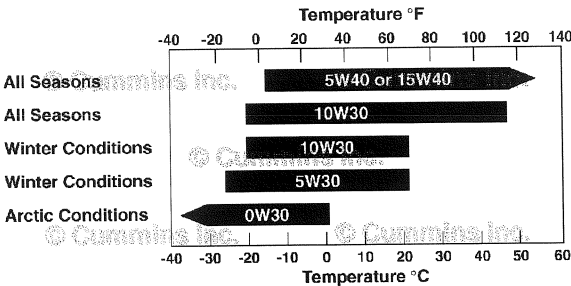
Cummins Inc. recommends the use of a high-quality SAE 15W-40 heavy-duty engine oil, such as Valvoline Premium Blue™, which meets or exceeds CES 20081, the API performance classification CJ-4, and the ACEA performance classification E9.

Cummins® Engineering Standard (CES) Classifications	American Petroleum Institute (API) Classification	Association des Constructeurs Européen d'Automobiles (ACEA) Classification
CES-20081	API CJ-4	ACEA E-9

Special break-in oils are **not** recommended for use in new or rebuilt Cummins® engines. Use the same lubricating oil that will be used in normal engine operations.

Use of synthetic engine oils (those made with API group 3 or group 4 base stocks) is permitted, subject to the same performance and viscosity limitations of petroleum (mineral) based engine oils. The same oil change intervals that are applied to petroleum (mineral) based engine oils **must** be applied to synthetic oils.

For further details and discussion of engine lubricating oils for Cummins® engines, see the following service bulletin; Cummins® Engine Oil and Oil Analysis Recommendations, Bulletin 3810340.



07d00260

While the preferred viscosity grade is 15W-40, lower viscosity multigrade oils can be used in colder climates. See the accompanying chart. Any viscosity grade lower than 15W-40 **must** still meet CES 20081.

Synthetic engine oils, API Group III and Group IV basestocks, are recommended for use in Cummins® engines operating in ambient temperature conditions consistently below -25°C [-13°F]. Synthetic 0W-30 oils that meet the requirements of API Group III or Group IV basestocks, can be used in operations where the ambient temperature **never** exceeds 0°C [32°F]. Multiviscosity oils rated 0W-30 do **not** offer the same level of protection against fuel dilution as do higher multigrade oils. Higher cylinder wear can be experienced when using 0W-30 oils in high-load situations.

As these oils have directionally thinner oil films than 15W-40 oils, top-quality Fleetguard® filters **must** be used above 20°C [70°F]. Some oil suppliers might claim better fuel economy for these oils. Cummins Inc. can neither approve nor disapprove any product **not** manufactured by Cummins Inc. These claims are between the customer and the oil supplier. Obtain a commitment from the oil supplier that the oil will give satisfactory performance in Cummins® engines, or do **not** use the oil.

AfterMarket Oil Additive Usage

Cummins Inc. does **not** recommend the use of aftermarket oil additives. Present high-quality fully additive engine lubricating oils are very sophisticated, with precise amounts of additives blended into the lubricating oil to meet stringent requirements. These oils meet performance characteristics that conform to the lubricant industry standards. Aftermarket lubricating oil additives are **not** necessary to enhance engine oil performance, and in some cases, can reduce the finished oil's ability to protect the engine.

Coolant Recommendations and Specifications

Fully Formulated Coolant/Antifreeze

Cummins Inc. recommends the use of fully formulated antifreeze/coolant meeting Cummins® Engineering Standards (C.E.S.) 14603. For further details and discussion of coolant for Cummins® engines, refer to Cummins® Coolant Requirements and Maintenance, Bulletin 3666132.

Typically, antifreeze/coolants meeting ASTM D3306 or ASTM D6210 criteria are acceptable antifreeze/coolants.

Cummins Inc. recommends using either a 50/50 mixture of water (See water quality table.) and fully formulated antifreeze, or fully formulated coolant when filling the cooling system.

Water quality is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

Water Quality	
Calcium/Magnesium (hardness)	Maximum 170 ppm as (CaCO ₃ + MgCO ₃)
Chlorides	Maximum 40 ppm as (Cl)
Sulfur	Maximum 100 ppm as (SO ₄)

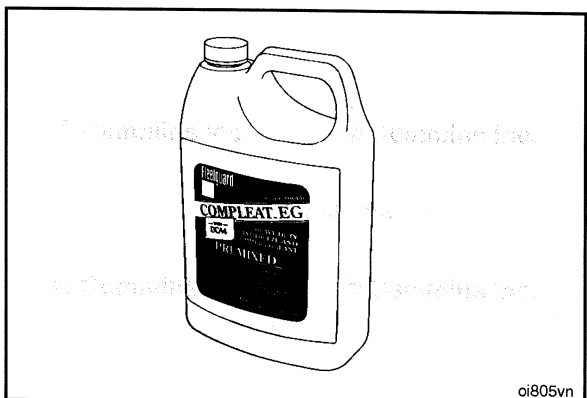
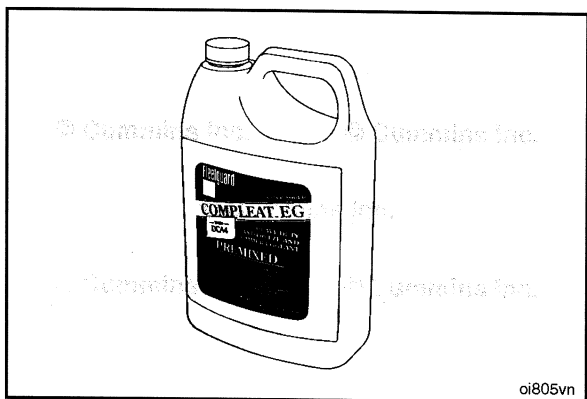
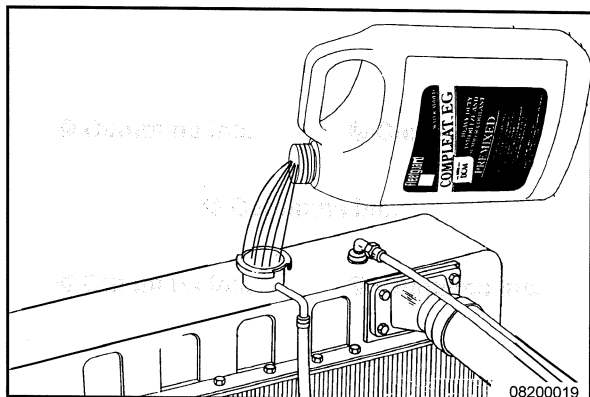
Cummins Inc. recommends using Fleetguard® COMPLEAT™. It is available in both glycol forms (ethylene and propylene).

Coolant Testing

Reasons for testing the coolant:

- 1 To determine the additive concentration and glycol level of the coolant.
- 2 To make sure there is adequate freeze point protection.

Coolant testing for additive and glycol levels **must** be performed at least twice a year. The coolant **must** be tested for replacement limits every 4000 hours, or once a year, whichever occurs first.

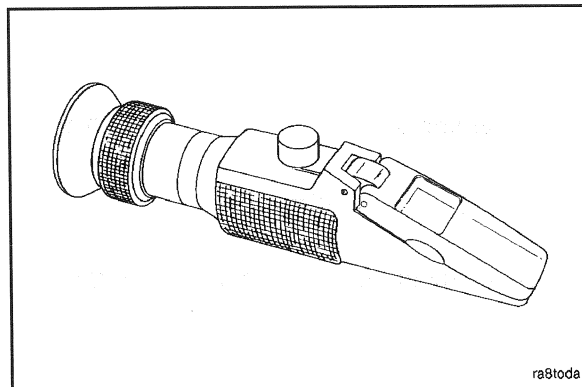
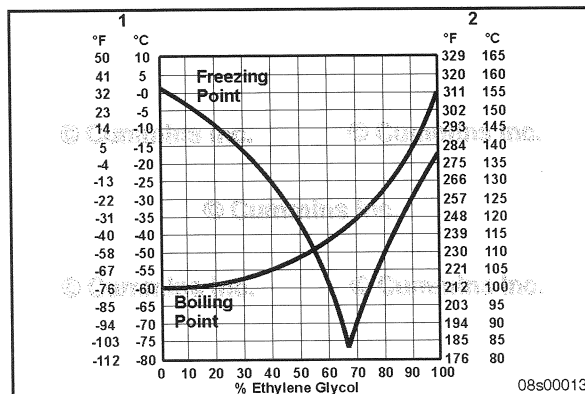


Fully formulated antifreeze **must** be mixed with water (See water quality table.) at a 50/50 ratio (40- to 60-percent working range). A 50/50 mixture of antifreeze and water gives a -36°C [-33°F] freezing point and a 108°C [226°F] boiling point, which is adequate for locations in North America. The actual lowest freezing point of ethylene glycol antifreeze is at 68 percent. Use of higher concentrations of antifreeze will raise the freezing point of the solution and increase the possibility of a silica gel problem.

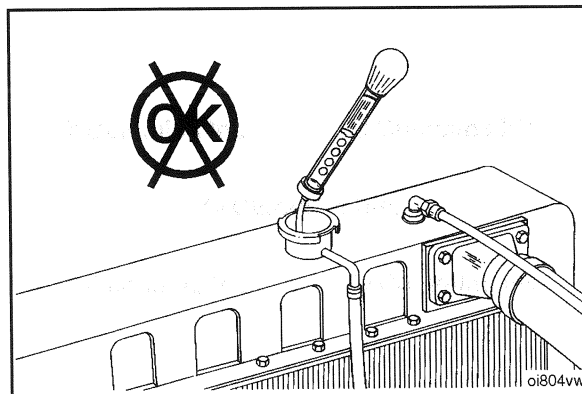
Legend

- 1 Freezing Point Temperature Scale
- 2 Boiling Point Temperature Scale.

A refractometer **must** be used to measure the freezing point of the coolant **accurately**. Use Fleetguard® refractometer, Part Number CC-2806.



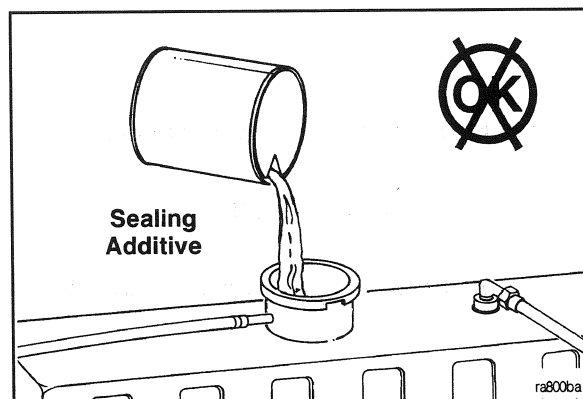
Do **not** use a floating ball hydrometer. The use of a floating ball hydrometer can give an incorrect reading.

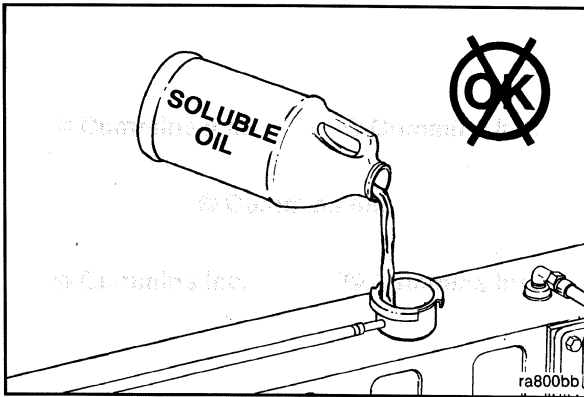


Cooling System Sealing Additives

Do **not** use sealing additives in the cooling system. The use of sealing additives will:

- Cause buildup in coolant low-flow areas
- Plug the radiator and oil cooler
- Possibly damage the water pump seal.





Cooling System Soluble Oils

Do **not** use soluble oils in the cooling system. The use of soluble oils will:

- Corrode brass and copper
- Damage heat transfer surfaces
- Damage seals and hoses.

Drive Belt Tension

Tension Chart

SAE Belt Size	Belt Tension Gauge Part No.		Belt Tension New		Belt Tension Range Used*	
	Click-type	Burroughs	N	lbf	N	lbf
0.380 in	3822524		620	140	270 to 490	60 to 110
0.440 in	3822524		620	140	270 to 490	60 to 110
1/2 in	3822524	ST-1138	620	140	270 to 490	60 to 110
11/16 in	3822524	ST-1138	620	140	270 to 490	60 to 110
3/4 in	3822524	ST-1138	620	140	270 to 490	60 to 110
7/8 in	3822524	ST-1138	620	140	270 to 490	60 to 110
4 rib	3822524	ST-1138	620	140	270 to 490	60 to 110
5 rib	3822524	ST-1138	670	150	270 to 530	60 to 120
6 rib	3822525	ST-1293	710	160	290 to 580	65 to 130
8 rib	3822525	ST-1293	890	200	360 to 710	80 to 160
10 rib	3822525	3823138	1110	250	440 to 890	100 to 200
12 rib	3822525	3823138	1330	300	530 to 1070	120 to 240
12 rib K section	3822525	3823138	1330	300	890 to 1070	200 to 240
31 rib	-	3164750	1668	375	1330 to 1560	300 to 350

NOTE: This chart does not apply to automatic belt tensioners.

* A belt is considered used if it has been in service for ten minutes or longer.

* If used belt tension is less than the minimum value, tighten the belt to the maximum used belt value.

Sealants

General Information

Use the sealants listed below or sealants containing equivalent properties.

Item	Cummins® Part Number	Generic Description
Pipe Plugs	3375066	Teflon™ Pipe Sealant
Cup Plugs	3375068	Sealant
O-Rings	3163087	Assembly Lube
Oil Pan T-Joint	3164067	RTV Sealant
Flywheel Housing to Rear Gear Housing Joint	3164070	RTV Sealant
Front Gear Cover to Block Joint	3164070	RTV Sealant
Rear Gear Housing to Block Joint	3164070	RTV Sealant

Capscrew Markings and Torque Values

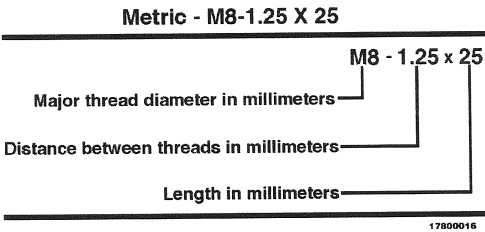
General Information



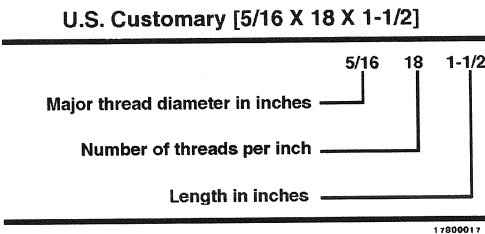
When replacing capscrews, always use a capscrew of the same measurement and strength as the capscrew being replaced. Using the wrong capscrews can result in engine damage.

Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts. U.S. Customary capscrews are identified by radial lines stamped on the head of the capscrew.

The following examples indicate how capscrews are identified:

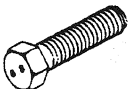

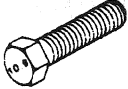

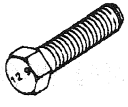



- **Always** use the torque values listed in the following tables when specific torque values are **not** available.
- Do **not** use the torque values in place of those specified in other sections of this manual.
- The torque values in the table are based on the use of lubricated threads.
- When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.



- **Always** use the torque values listed in the following tables when specific torque values are **not** available.
- Do **not** use the torque values in place of those specified in other sections of this manual.
- The torque values in the table are based on the use of lubricated threads.
- When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.




Capscrew Markings and Torque Values - Metric

Commercial Steel Class		8.8		10.9		12.9	
Capscrew Head Markings							
						17800014	

Body Size	Torque				Torque				Torque			
	Cast Iron		Aluminium		Cast Iron		Aluminium		Cast Iron		Aluminium	
	Diameter				Diameter				Diameter			
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	13	10	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7

Body Size	Torque				Torque				Torque			
Diameter	Cast Iron		Aluminium		Cast Iron		Aluminium		Cast Iron		Aluminium	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
8	23	17	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	65	50	30	25	70	50	30	25
12	80	60	55	40	115	85	55	40	125	95	55	40
14	125	90	90	65	180	133	90	65	195	145	90	65
16	195	140	140	100	280	200	140	100	290	210	140	100
18	280	200	180	135	390	285	180	135	400	290	180	135
20	400	290	—	—	550	400	—	—	—	—	—	—

Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5	8
Capscrew Head Markings		
These are all SAE Grade 5 (3 line)		17800015
		
Capscrew Torque - Grade 5 Capscrew		Capscrew Torque - Grade 8 Capscrew

Capscrew Body Size	Cast Iron		Aluminium		Cast Iron		Aluminium	
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4 - 20	9	7	8	6	15	11	8	6
1/4 - 28	12	9	9	7	18	13	9	7
5/16 - 18	20	15	16	12	30	22	16	12
5/16 - 24	23	17	19	14	33	24	19	14
3/8 - 16	40	30	25	20	55	40	25	20
3/8 - 24	40	30	35	25	60	45	35	25
7/16 - 14	60	45	45	35	90	65	45	35
7/16 - 20	65	50	55	40	95	70	55	40
1/2 - 13	95	70	75	55	130	95	75	55
1/2 - 20	100	75	80	60	150	110	80	60
9/16 - 12	135	100	110	80	190	140	110	80
9/16 - 18	150	110	115	85	210	155	115	85
5/8 - 11	180	135	150	110	255	190	150	110
5/8 - 18	210	155	160	120	290	215	160	120
3/4 - 10	325	240	255	190	460	340	255	190
3/4 - 16	365	270	285	210	515	380	285	210
7/8 - 9	490	360	380	280	745	550	380	280
7/8 - 14	530	390	420	310	825	610	420	310
1 - 8	720	530	570	420	1100	820	570	420
1 - 14	800	590	650	480	1200	890	650	480

Fraction, Decimal, Millimeter Conversions

Conversion Chart

Fraction	inch	mm	Fraction	inch	mm
1/64	0.0156	0.397	33/64	0.5156	13.097
1/32	0.0313	0.794	17/32	0.5313	13.494
3/64	0.0469	1.191	35/64	0.5469	13.891
1/16	0.0625	1.588	9/16	0.5625	14.288
5/64	0.0781	1.984	37/64	0.5781	14.684
3/32	0.0938	2.381	19/32	0.5938	15.081
7/64	0.1094	2.778	39/64	0.6094	15.478
1/8	0.1250	3.175	5/8	0.6250	15.875
9/64	0.1406	3.572	41/64	0.6406	16.272
5/32	0.1563	3.969	21/32	0.6563	16.669
11/64	0.1719	4.366	43/64	0.6719	17.066
3/16	0.1875	4.763	11/16	0.6875	17.463
13/64	0.2031	5.159	45/64	0.7031	17.859
7/32	0.2188	5.556	23/32	0.7188	18.256
15/64	0.2344	5.953	47/64	0.7344	18.653
1/4	0.2500	6.350	3/4	0.7500	19.050
17/64	0.2656	6.747	49/64	0.7656	19.447
9/32	0.2813	7.144	25/32	0.7813	19.844
19/64	0.2969	7.541	51/64	0.7969	20.241
5/16	0.3125	7.938	13/16	0.8125	20.638
21/64	0.3281	8.334	53/64	0.8281	21.034
11/32	0.3438	8.731	27/32	0.8438	21.431
23/64	0.3594	9.128	55/64	0.8594	21.828
3/8	0.3750	9.525	7/8	0.8750	22.225
25/64	0.3906	9.922	57/64	0.8906	22.622
13/32	0.4063	10.319	29/32	0.9063	23.019
27/64	0.4219	10.716	59/64	0.9219	23.416
7/16	0.4375	11.113	15/16	0.9375	23.813
29/64	0.4531	11.509	61/64	0.9531	24.209
15/32	0.4688	11.906	31/32	0.9688	24.606
31/64	0.4844	12.303	63/64	0.9844	25.003
1/2	0.5000	12.700	1	1.0000	25.400

Conversion Factor: 1 inch = 25.4 mm

Newton-Meter to Foot-Pound Conversions

Conversion Chart

N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1	9 in-lb	55	41	155	114
5	44 in-lb	60	44	160	118
6	53 in-lb	65	48	165	122
7	62 in-lb	70	52	170	125
8	71 in-lb	75	55	175	129
9	80 in-lb	80	59	180	133
10	89 in-lb	85	63	185	136
11	97 in-lb	90	66	190	140
12	106 in-lb	95	70	195	144
14	124 in-lb	100	74	200	148
15	133 in-lb	105	77	205	151
16	142 in-lb	110	81	210	155
18	159 in-lb	115	85	215	159
20	15 ft-lb	120	89	220	162
25	18	125	92	225	165
30	22	130	96	230	170
35	26	135	100	235	173
40	30	140	103	240	177
45	33	145	107	245	180
50	37	150	111	250	184

NOTE: To convert from Newton-Meters to Kilogram-Meters divide Newton-Meters by 9.803.

Pipe Plug Torque Values

Torque Table

Size		Torque		Torque	
Thread	Actual Thread O.D.	In Aluminum Components		In Cast Iron or Steel Components	
in	in	N•m	ft-lb	N•m	ft-lb
1/16	0.32	5	45 in-lb	15	10
1/8	0.41	15	10	20	15
1/4	0.54	20	15	25	20
3/8	0.68	25	20	35	25
1/2	0.85	35	25	55	40
3/4	1.05	45	35	75	55
1	1.32	60	45	95	70
1-1/4	1.66	75	55	115	85
1-1/2	1.90	85	65	135	100

Tap-Drill Chart - U.S. Customary and Metric

General Information

NOTE ON SELECTING TAP-DRILL SIZES: The tap drill sizes shown on this card give the theoretical tap drill size for approximately 60% and 75% of full thread depth. Generally, it is recommended that drill sizes be selected in the 60% range as these sizes will provide about 90% of the potential holding power. Drill sizes in the 75% range are recommended for shallow hole tapping (less than 1 1/2 times the hole diameter) in soft metals and mild steel.

Tap Size		Drill Size	Tap Size		Drill Size	Tap Size		Drill Size	Tap Size		Drill Size
60%	75%		60%	75%		60%	75%		60%	75%	
		48			4.40mm			7.50mm			13.25mm
		1.95mm			16			19/64			17/32
		5/64			4.50mm			7.60mm			13.50mm
		47			15			N			13.75mm
		2.00mm			4.60mm			7.70mm			35/64
		2.05mm			14			7.75mm			14.00mm
		46			13			7.80mm			14.25mm
		45			4.70mm			7.90mm			9/16
		2.10mm			4.75mm			5/16			14.50mm
		2.15mm			3/16			8.00mm			37/64
		44			12			O			14.75mm
		2.20mm			4.80mm			8.10mm			15.00mm
		2.25mm			11			8.20mm			19.32
		43			4.90mm			P			15.25mm
		2.30mm			10			8.25mm			39/64
		2.35mm			9			8.30mm			15.50mm
		42			5.00mm			21/64			15.75mm
		3/32			8			8.40mm			5/8
		2.40mm			5.10mm			Q			16.00mm
		41			7			8.50mm			16.25mm
		2.45mm			13/64			8.60mm			41/64
		40			6			R			16.50mm
		2.50mm			5.20mm			8.70mm			21/32
		39			5			11/32			16.75mm
		38			5.25mm			8.75mm			17.00mm
		2.60mm			5.30mm			8.80mm			43/64
		37			4			S			17.25mm
		2.70mm			5.40mm			8.90mm			11/16
		36			3			9.00mm			17.50mm
		2.75mm			5.50mm			T			17.75mm
		7/64			7/32			9.10mm			45/64
		35			5.60mm			23/64			18.00mm
		2.80mm			2			9.20mm			18.25mm
		34			5.70mm			9.30mm			23/32
		33			5.75mm			U			18.50mm
		2.90mm			1			9.40mm			47/64
		32			5.80mm			9.50mm			18.75mm
		3.00mm			5.90mm			3/8			19.00mm
		31			A			V			3/4
		3.10mm			15/64			9.60mm			19.25mm
		1/8			6.00mm			9.70mm			49/64
		3.20mm			B			9.75mm			19.50mm
		3.25mm			6.10mm			9.80mm			25/32
		30			C			9.90mm			19.75mm
		3.30mm			6.20mm			25/64			20.00mm
		3.40mm			D			10.00mm			51/64
		29			6.25mm			X			20.25mm
		3.50mm			6.30mm			10.20mm			20.50mm
		28			E			Y			13/16
		9/64			1/4			13/32			20.75mm
		3.60mm			6.40mm			Z			21.00mm
		27			6.50mm			10.50mm			53/64
		3.70mm			F			27/64			21/25mm
		26			6.60mm			10.75mm			27/32
		3.75mm			G			11.00mm			21.50mm
		25			6.70mm			7/16			21.75mm
		3.80mm			17/64			11.25mm			55/64
		24			6.75mm			11.50mm			22.00mm
		3.90mm			H			29/64			7/8
		23			6.80mm			11.75mm			22.25mm
		5/32			6.90mm			11.90mm			22.50mm
		22			I			12.00mm			57/64
		4.00mm			7.00mm			12.25mm			22.75mm
		21			J			31/64			23.00mm
		20			7.10mm			12.50mm			23.25mm
		4.10mm			K			1/2			59/64
		4.20mm			7.20mm			12.75mm			23.50mm
		19			7.25mm			13.00mm			15/16
		4.25mm			7.30mm			33/64			
		4.30mm			L						
		18			7.40mm						
		11/64			M						
		17									

17800013

Weights and Measures - Conversion Factors

Conversion Chart

Quantity	U.S. Customary		Metric		From U.S. Customary To Metric Multiply By	From Metric To U.S. Customary Multiply By
	Unit Name	Abbreviation	Unit Name	Abbreviation		
Area	sq. inch	in ²	sq. millimeters	mm ²	645.16	0.001550
			sq. centimeters	cm ²	6.452	0.155
	sq. foot	ft ²	sq. meter	m ²	0.0929	10.764
Fuel Consumption	pounds per horsepower hour	lb/hp-hr	grams per kilowatt hour	g/kW-hr	608.277	0.001645
Fuel Performance	miles per gallon	mpg	kilometers per liter	km/l	0.4251	2.352
	gallons per mile	gpm	liters per kilometer	l/km	2.352	0.4251
Force	pounds force	lbf	Newton	N	4.4482	0.224809
Length	inch	in	millimeters	mm	25.40	0.039370
	foot	ft	millimeters	mm	304.801	0.00328
Power	horsepower	hp	kilowatt	kW	0.746	1.341
Pressure	pounds force per sq. inch	psi	kilopascal	kPa	6.8948	0.145037
	inches of mercury	in Hg	kilopascal	kPa	3.3769	0.29613
	inches of water	in H ₂ O	kilopascal	kPa	0.2488	4.019299
	inches of mercury	in Hg	millimeters of mercury	mm Hg	25.40	0.039370
	inches of water	in H ₂ O	millimeters of water	mm H ₂ O	25.40	0.039370
	bars	bars	kilopascals	kPa	100.001	0.00999
	bars	bars	millimeters of mercury	mm Hg	750.06	0.001333
Temperature	fahrenheit	°F	centigrade	°C	(°F-32) ÷ 1.8	(1.8 x °C) + 32
Torque	pound force per foot	ft-lb	Newton-meter	N•m	1.35582	0.737562
	pound force per inch	in-lb	Newton-meter	N•m	0.113	8.850756
Velocity	miles/hour	mph	kilometers/hour	kph	1.6093	0.6214
Volume: liquid displacement	gallon (U.S.)	gal.	liter	l	3.7853	0.264179
	gallon (Imp*)	gal.	liter	l	4.546	0.219976
	cubic inch	in ³	liter	l	0.01639	61.02545
	cubic inch	in ³	cubic centimeter	cm ³	16.387	0.06102
Weight (mass)	pounds (avoir.)	lb	kilograms	kg	0.4536	2.204623
Work	British Thermal Unit	BTU	joules	J	1054.5	0.000948
	British Thermal Unit	BTU	kilowatt-hour	kW-hr	0.000293	3414
	horsepower hours	hp-hr	kilowatt-hour	kW-hr	0.746	1.341

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Section W - Warranty

Section Contents

	Page
All Engines International Industrial (Off-Highway)	W-4
All Engines United States And Canada Industrial (Off-Highway)	W-1
California Emission Control System Warranty, Off-Highway	W-6
.....	W-7

This Page Left Intentionally Blank

All Engines United States And Canada Industrial (Off-Highway)

Coverage

Products Warranted

This Warranty applies to new Engines sold by Cummins and delivered to the first user on or after April 1, 1999, that are used in Industrial (Off-Highway) applications in the United States* and Canada, except for Engines used in marine, generator drive and certain defense applications, for which different Warranty Coverage is provided.

Base Engine Warranty

This Warranty covers any failures of the Engine, under normal use and service, which result from a defect in material or factory workmanship (Warrantable Failures).

Coverage begins with the sale of the Engine by Cummins. Coverage continues for two years or 2,000 hours of operation, whichever occurs first, from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first. If the 2,000 hour limit is exceeded during the first year, Coverage continues until the end of the first year.

Engine aftertreatment components included in the Cummins Critical Parts List (CPL) and marked with a Cummins part number are covered under Base Engine Warranty.

Additional Coverage is outlined in the Emission Warranty section.

Extended Major Components Warranty

The Extended Major Components Warranty covers Warrantable Failures of the Engine cylinder block, camshaft, crankshaft and connecting rods (Covered Parts).

Bushing and bearing failures are not covered.

This Coverage begins with the expiration of the Base Engine Warranty and ends three years or 10,000 (3,000 hours for A Series Engines) hours of operation from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or from when the Engine has been operated for 50 hours, whichever occurs first.

Consumer Products

The Warranty on Consumer Products in the United States* is a LIMITED Warranty. **CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.** Any implied Warranties applicable to Consumer Products in the United States* terminate concurrently with the expiration of the express Warranties applicable to the product. In the United States*, some states do not allow the exclusion of incidental or consequential damages, or limitations on how long an implied Warranty lasts, so the limitations or exclusions herein may not apply to you.

These Warranties are made to all Owners in the chain of distribution and Coverage continues to all subsequent Owners until the end of the periods of Coverage.

Cummins Responsibilities

During The Base Engine Warranty

Cummins will pay for all parts and labor needed to repair the damage to the Engine resulting from a Warrantable Failure.

Cummins will pay for the lubricating oil, antifreeze, filter elements and other maintenance items that are not reusable due to the Warrantable Failure.

Cummins will pay reasonable costs for mechanics to travel to and from the equipment site, including meals, mileage and lodging, when the repair is performed at the site of the failure.

Cummins will pay reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

During The Extended Major Components Warranty

Cummins will pay for the repair or, at its option, replacement of the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner Responsibilities

During The Base Engine Warranty

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items provided during Warranty repairs unless such items are not reusable due to the Warrantable Failure.

During The Extended Major Components Warranty

Owner is responsible for the cost of all labor needed to repair the Engine, including the labor to remove and reinstall the Engine. When Cummins elects to repair a part instead of replacing it, Owner is not responsible for the labor needed to repair the part.

Owner is responsible for the cost of all parts required for the repair except for the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during repair of a Warrantable Failure.

During The Base Engine And Extended Major Components Warranties

Owner is responsible for the operation and maintenance of the Engine as specified in the applicable Cummins Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed.

Before the expiration of the applicable Warranty, Owner must notify a Cummins distributor, authorized dealer or other repair location approved by Cummins of any Warrantable Failure and make the Engine available for repair by such facility. Service locations are listed on the Cummins Worldwide Service Locator at cummins.com.

Owner is responsible for communication expenses, meals, lodging and similar costs incurred as a result of a Warrantable Failure.

Owner is responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs and other losses resulting from a Warrantable Failure.

Limitations

Engines with an emissions certification listed below must be operated using only diesel fuel having no more than the corresponding maximum sulfur content. Failure to use the specified fuel as listed in the Cummins Fuel Bulletin #3379001 Table 1 (Cummins Inc. Required Diesel Fuel Specifications) can damage the Engine and aftertreatment system within a short period of time. This damage could cause the Engine to become inoperable and failures attributable to the use of incorrect fuels will be denied Warranty Coverage. Fuel specifications also need to comply with local fuel regulations (EN590 for Europe and ASTM D975 for North America) for Warranty eligibility.

Maximum sulfur levels by emissions certification level as listed on the Engine's dataplate are:

EPA 2007/2010/2013	max. 15 parts per million
EPA Tier 4 Interim / Final	max. 15 parts per million
EU Stage IIIB 2011	max. 15 parts per million
Euro 4/5	max. 50 parts per million
Euro 6	max. 10 parts per million

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications of the Engine. Cummins is also not responsible for failures caused by incorrect oil, fuel or diesel exhaust fluid or by water, dirt or other contaminants in the fuel, oil or diesel exhaust fluid.

For power units and fire pumps (package units), this Warranty applies to accessories, except for clutches and filters, supplied by Cummins which bear the name of another company.

For all other Industrial engines (except those previously mentioned), this Warranty does not apply to accessories which bear the name of another company. Such non-warranted accessories include, but are not limited to: alternators, starters, fans**, air conditioning compressors, clutches, filters, transmissions, torque converters, steering pumps, and non-Cummins fan drives, Engine compression brakes and air compressors.

Cummins Compusave units are covered by a separate Warranty.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that consumption exceeds Cummins published standards.

Failures of belts and hoses supplied by Cummins are not covered beyond the first 500 hours or one year of operation, whichever occurs first.

Parts used to repair a Warrantable Failure may be new Cummins parts, Cummins approved rebuilt parts or repaired parts. Cummins is not responsible for failures resulting from the use of parts not approved by Cummins.

A new Cummins or Cummins approved rebuilt part used to repair a Warrantable Failure assumes the identity of the part it replaced and is entitled to the remaining Coverage hereunder.

For all A Series Applications, including Industrial, travel reimbursement for non-transportable equipment will be limited to 4.0 hours, \$0.25/mile and 250 miles maximum. Any costs beyond this limit are the customer's responsibility.

CUMMINS DOES NOT COVER WEAR OR WEAROUT OF COVERED PARTS.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

THESE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS IN REGARD TO THESE ENGINES. CUMMINS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This Warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Emission Warranty

Products Warranted

This Emission Warranty applies to new Engines marketed by Cummins that are used in the United States* and Canada in vehicles designed for Industrial Off-Highway use. This Warranty applies to Engines delivered to the ultimate purchaser on or after April 1, 1999, for Engines up to 750 horsepower and on or after January 1, 2000, for Engines 751 horsepower and over.

Coverage

Cummins warrants to the ultimate purchaser and each subsequent purchaser that the Engine is designed, built and equipped so as to conform at the time of sale by Cummins with all U.S. Federal emission regulations applicable at the time of manufacture and that it is free from defects in workmanship or material which would cause it not to meet these regulations within the longer of the following periods: (A) ***Five years or 3,000 hours of operation for industrial applications, five years or 3,500 hours of operation for industrial spark-ignited Engines (GTA855, G855, G5.9C, G8.3-C, GTA8.9E, QSK19G) and five years or 2,500 hours of operation for industrial spark-ignited Engines (GKTA19-GC), whichever occurs first, as measured from the date of delivery of the Engine to the ultimate purchaser, or (B) The Base Engine Warranty.

If the vehicle in which the Engine is installed is registered in the state of California, a separate California Emission Warranty also applies.

Limitations

Engines with an emissions certification listed below must be operated using only diesel fuel having no more than the corresponding maximum sulfur content. Failure to use the specified fuel as listed in the Cummins Fuel Bulletin #3379001 Table 1 (Cummins Inc. Required Diesel Fuel Specifications) can damage the Engine and aftertreatment system within a short period of time. This damage could cause the Engine to become inoperable and failures attributable to the use of incorrect fuels will be denied Warranty Coverage. Fuel specifications also need to comply with local fuel regulations (EN590 for Europe and ASTM D975 for North America) for Warranty eligibility.

Maximum sulfur levels by emissions certification level as listed on the Engine's dataplate are:

EPA 2007/2010/2013	max. 15 parts per million
EPA Tier 4 Interim / Final	max. 15 parts per million
EU Stage IIIB 2011	max. 15 parts per million
Euro 4/5	max. 50 parts per million
Euro 6	max. 10 parts per million

Failures, other than those resulting from defects in materials or workmanship, are not covered by this Warranty.

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolant or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications of the Engine. Cummins is also not responsible for failures caused by incorrect oil, fuel or diesel exhaust fluid or by water, dirt or other contaminants in the fuel, oil or diesel exhaust fluid.

Cummins is not responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all business costs or other losses resulting from a Warrantable Failure.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

* United States includes American Samoa, the Commonwealth of Northern Mariana Islands, Guam, Puerto Rico and the U.S. Virgin Islands.

** Alternators, starters, and fans ARE covered for the duration of the Base Engine Warranty on A Series and B3.3 Engines.

** Alternators and starters are covered for the duration of the Base Engine Warranty on QSK23 Engines.

*** Emissions Warranty for BLPG Industrial Off-Highway Engines is 5 years / 3,500 hours.

All Engines International Industrial (Off-Highway) Coverage

Products Warranted

This Warranty applies to new Engines sold by Cummins and delivered to the first user on or after April 1, 1999, that are used in Industrial (Off-Highway) applications anywhere in the world where Cummins approved service is available, except the United States and Canada. Different Warranty Coverage is provided for Engines used in marine, generator drive and certain defense applications.

Base Engine Warranty

This Warranty covers any failures of the Engine, under normal use and service, which result from a defect in material or factory workmanship (Warrantable Failure).

Coverage begins with the sale of the Engine by Cummins. Coverage continues for two years or 2,000 hours of operation, whichever occurs first, from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first. If the 2,000 hour limit is exceeded during the first year, Coverage continues until the end of the first year.

Engine aftertreatment components included in the Cummins Critical Parts List (CPL) and marked with a Cummins part number are covered under Base Engine Warranty.

Extended Major Components Warranty

The Extended Major Components Warranty covers Warrantable Failures of the Engine cylinder block, camshaft, crankshaft and connecting rods (Covered Parts).

Bushing and bearing failures are not covered.

This Coverage begins with the expiration of the Base Engine Warranty and ends three years or 10,000 hours (3,000 hours for A Series Engines) of operation, from the date of delivery of the Engine to the first user, or from the date the unit is first leased, rented or loaned, or when the Engine has been operated for 50 hours, whichever occurs first.

These Warranties are made to all Owners in the chain of distribution, and Coverage continues to all subsequent Owners until the end of the periods of Coverage.

Cummins Responsibilities

During The Base Engine Warranty

Cummins will pay for all parts and labor needed to repair the damage to the Engine resulting from a Warrantable Failure.

Cummins will pay for the lubricating oil, antifreeze, filter elements and other maintenance items that are not reusable due to a Warrantable Failure.

Cummins will pay reasonable costs for mechanics to travel to and from the equipment site, including meals, mileage and lodging, when the repair is performed at the site of the failure.

Cummins will pay reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

During The Extended Major Components Warranty

Cummins will pay for the repair or, at its option, replacement of the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner Responsibilities

During The Base Engine Warranty

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during Warranty repairs unless such items are not reusable due to the Warrantable Failure.

During The Extended Major Components Warranty

Owner is responsible for the cost of all labor needed to repair the Engine, including the labor to remove and reinstall the Engine. When Cummins elects to repair a part instead of replacing it, Owner is not responsible for the labor needed to repair the part.

Owner is responsible for the cost of all parts required for the repair except for the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during repair of a Warrantable Failure.

During The Base Engine Warranty And Extended Major Components Warranties

Owner is responsible for the operation and maintenance of the Engine as specified in the applicable Cummins Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed.

Before the expiration of the applicable Warranty, Owner must notify a Cummins distributor, authorized dealer or other repair location approved by Cummins of any Warrantable Failure and make the product available for repair by such facility. Service locations are listed in the Cummins Worldwide Service Locator at cummins.com.

Owner is responsible for communication expenses, meals, lodging and similar costs incurred as a result of a Warrantable Failure.

Owner is responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs and other losses resulting from a Warrantable Failure.

Limitations

Engines with an emissions certification listed below must be operated using only diesel fuel having no more than the corresponding maximum sulfur content. Failure to use the specified fuel as listed in the Cummins Fuel Bulletin #3379001 Table 1 (Cummins Inc. Required Diesel Fuel Specifications) can damage the Engine and aftertreatment system within a short period of time. This damage could cause the Engine to become inoperable and failures attributable to the use of incorrect fuels will be denied Warranty Coverage. Fuel specifications also need to comply with local fuel regulations (EN590 for Europe and ASTM D975 for North America) for Warranty eligibility.

Maximum sulfur levels by emissions certification level as listed on the Engine's dataplate are:

EPA 2007/2010/2013	max. 15 parts per million
EPA Tier 4 Interim / Final	max. 15 parts per million
EU Stage IIIB 2011	max. 15 parts per million
Euro 4/5	max. 50 parts per million
Euro 6	max. 10 parts per million

Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications of the Engine. Cummins is also not responsible for failures caused by incorrect oil, fuel or diesel exhaust fluid or by water, dirt or other contaminants in the fuel, oil or diesel exhaust fluid.

For power units and fire pumps (package units) the Warranty applies to accessories, except for clutches and filters supplied by Cummins which bear the name of another company.

Except for the accessories noted previously, Cummins does not warrant accessories which bear the name of another company. Such non-warranted accessories include, but are not limited to: alternators, starters, fans*, air conditioning compressors, clutches, filters, transmissions, torque converters, steering pumps, non-Cummins fan drives and air cleaners.

Cummins Compusave units are covered by a separate Warranty.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that consumption exceeds Cummins published standards.

Failures of belts and hoses supplied by Cummins are not covered beyond the first 500 hours or one year of operation, whichever occurs first.

Parts used to repair a Warrantable Failure may be new Cummins parts, Cummins approved rebuilt parts or repaired parts. Cummins is not responsible for failures resulting from the use of parts not approved by Cummins.

A new Cummins or Cummins approved rebuilt part used to repair a Warrantable Failure assumes the identity of the part it replaced and is entitled to the remaining Coverage hereunder.

For all A Series Applications, including Industrial, travel reimbursement for non-transportable equipment will be limited to 4.0 hours, \$0.25/mile and 250 miles maximum. Any costs beyond this limit are the customer's responsibility.

CUMMINS DOES NOT COVER WEAR OR WEAROUT OF COVERED PARTS.

CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

THESE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS IN REGARD TO THESE ENGINES. CUMMINS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

In the case of consumer sales, in some countries, the Owner has statutory rights which cannot be affected or limited by the terms of this Warranty.

Nothing in this Warranty excludes or restricts any contractual rights the Owner may have against third parties.

* Alternators, starters, and fans ARE covered for the duration of the Base Engine Warranty on A Series and B3.3 Engines.

* Alternators and starters are covered for the duration of the Base Engine Warranty on QSK23 Engines.

To buy Cummins Parts and Service Manuals, Training Guides, or Tools go to our website at <https://store.cummins.com>

California Emission Control System Warranty, Off-Highway Products Warranted

This Emission Control System Warranty applies to off-road diesel engines certified with the California Air Resources Board beginning with the year 1996 for engines up to 750 horsepower, beginning with the year 2000 for 751 horsepower and over, marketed by Cummins, and registered in California for use in industrial off-highway applications.

Your Warranty Rights and Obligations

The California Air Resources Board and Cummins Engine Company, Inc., are pleased to explain the emission control system warranty on your engine. In California, new off-road diesel engines must be designed, built and equipped to meet the State's stringent anti-smog standards. Cummins must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, Cummins will repair your off-road diesel engine at no cost to you including diagnosis, parts and labor.

Manufacturer's Warranty Coverage

This warranty coverage is provided for 5 years or 3,000 hours of engine operation, whichever first occurs from the date of delivery of the engine to the first user. If any emission-related part on your engine is defective, the part will be repaired or replaced by Cummins.

Coverage

This emission control system warranty applies only to the following A series, B3.3, B3.9, B4.5s, B5.9, B6.7s, QSB3.9-30, QSB4.5-30, QSB5.9-30, QSB5.9-44, C8.3, QSC8.3, QSF2.8, QSF3.8, and QSL9 emission control parts:

EPA Diesel

Aftertreatment System

Component

Aftertreatment Electrical Connections
Aftertreatment Fuel Drain Valve
Aftertreatment Fuel Injector/Regulator
Aftertreatment Fuel Pressure Sensor
Aftertreatment Fuel Shut-Off Valve
Aftertreatment Injector Manifold
Aftertreatment Inlet and Outlet Modules
Aftertreatment Temperature Interface Module
Aftertreatment Temperature Sensors

Aftertreatment System (cont')

Component

Decomposition Tube
DEF Dosing Controller (DCU)
DEF Dosing Unit (Pump)
DEF Dosing Valve
Diesel Oxidation Catalyst
Diesel Particulate Filter (except for ash maintenance)
Diesel Particulate Filter Differential Pressure Sensor
NH3 Sensor
NOx Sensors
SCR Catalyst

Air Handling

Component

Barometric Air Pressure Sensor
Exhaust Gas Pressure Sensor

Exhaust Manifold
Grid Heater
Humidity Sensor
Intake Air Throttle Actuator
Intake Manifold
Intake Manifold Air Temperature Sensor

Air Handling (cont')

Component

Intake Manifold Temperature/Pressure Sensor
Turbocharger Actuator
Turbocharger Assembly
Turbocharger Compressor Inlet Air Temperature Sensor
Turbocharger Speed Sensor

Base Engine System

Component

Camshaft
Camshaft Injector Lobe
Camshaft Valve Lobe
Coolant Temperature Sensor
Crankcase Breather
Engine Oil Pressure Sensor
Engine Speed, Position Sensor, Cam Position Sensor
Exhaust Valve
Static Cam Timing

EGR System

Component

EGR Cooler
EGR Differential Pressure Sensor
EGR Mixer/Venturi
EGR Temperature Sensor
EGR Valve

Electronic Control System

Component

Engine Control Module
Wiring Harness Circuits Connected at Both Ends to
Emissions Warrantable Components
Engine Control Module Calibration
Engine Control Module Calibration

Fuel System

Component

Fuel Control Valve
Fuel Lines
Fuel Pressure Sensor
Fuel Pump
Fueling/Timing Actuators

EPA Diesel

Ignition System
Component
Ignition Coils
Ignition Control Module

Fuel System (cont')
Component
Injector
Secondary Fuel Pressure/Temperature Sensor

About the Manual	i-2	Install.....	A-21
General Information.....	i-2	Maintenance Check.....	A-18
Acronyms and Abbreviations	i-18	Preparatory Steps.....	A-20
General Information.....	i-18	Remove.....	A-20
Additional Service Literature	L-1	Cooling System	7-1
General Information.....	L-1	Drain.....	7-2
Aftertreatment Diesel Exhaust Fluid Dosing Unit Filter	8-1	Fill.....	7-5
Clean and Inspect for Reuse.....	8-3	Flush.....	7-3
Finishing Steps.....	8-4	General Information.....	7-1
General Information.....	8-1	Maintenance Check.....	7-2
Initial Check.....	8-2	Cooling System	V-4
Install.....	8-4	Specifications.....	V-4
Preparatory Steps.....	8-2		W-7
Remove.....	8-3	Crankcase Breather Tube	3-2
Air Cleaner Element	A-6	Maintenance Check.....	3-2
Finishing Steps.....	A-10	Cummins Customized Parts Catalog	L-3
General Information.....	A-6	General Information.....	L-3
Inspect for Reuse.....	A-9	Ordering the Customized Parts Catalog.....	L-3
Install.....	A-9	Cummins® Product Technology	E-16
Measure.....	A-6	General Information.....	E-16
Preparatory Steps.....	A-7	Cummins® Service Engine Model Identification	E-13
Remove.....	A-7	General Information.....	E-13
Air Cleaner Restriction	3-8	Cummins®/Fleetguard® Filter Specifications	V-8
Maintenance Check.....	3-8	General Information.....	V-8
Air Intake Piping	3-11	Daily Maintenance Procedures - Overview	3-1
Maintenance Check.....	3-11	General Information.....	3-1
Air Intake System	V-5	System Operation Report.....	3-1
Specifications.....	V-5	Unusual System Noise.....	3-1
All Engines International Industrial (Off-Highway)	W-4	Diesel Exhaust Fluid (DEF) Level	3-11
All Engines United States And Canada Industrial (Off-Highway)	W-1	Maintenance Check.....	3-11
Batteries	5-13	Diesel Exhaust Fluid Recommendations and Specifications	V-9
Inspect.....	5-13	Contamination/Incorrect Fluid.....	V-11
Battery Cables and Connections	5-14	Disposal.....	V-10
Initial Check.....	5-14	Freezing.....	V-11
California Emission Control System Warranty, Off-Highway	W-6	General Information.....	V-9
Capscrew Markings and Torque Values	V-21	Handling.....	V-10
Capscrew Markings and Torque Values - Metric.....	V-21	Storage.....	V-10
Capscrew Markings and Torque Values - U.S. Customary.....	V-22	Test.....	V-11
General Information.....	V-21	Distributors - International	S-33
Charge-Air Cooler	4-1	Locations.....	S-33
Maintenance Check.....	4-1	Distributors and Branches	S-4
Charge-Air Piping	4-1	Australia.....	S-24
Maintenance Check.....	4-1	Canada.....	S-19
Charging System Alternator	A-1	China, People's Republic.....	S-22
Finishing Steps.....	A-6	New Zealand.....	S-28
Initial Check.....	A-1	United States.....	S-4
Install.....	A-4	Division and Regional Offices	S-3
Preparatory Steps.....	A-3	Locations.....	S-3
Remove.....	A-3	Drive Belt Tension	V-19
Test.....	A-1	Tension Chart.....	V-19
Charging System Alternator Not Charging or Insufficient Charging.....	TS-3	Drive Belt, Cooling Fan	A-15
Charging System Alternator Overcharging.....	TS-4	Clean and Inspect for Reuse.....	A-17
Cold Weather Starting	1-5	Finishing Steps.....	A-18
General Information.....	1-5	General Information.....	A-15
Using Starting Aids.....	1-5	Install.....	A-17
Coolant Contamination.....	TS-5	Preparatory Steps.....	A-16
Coolant Level	3-4	Remove.....	A-16
Maintenance Check.....	3-4	Drive Belts	3-6
Coolant Loss - External.....	TS-6	Maintenance Check.....	3-6
Coolant Recommendations and Specifications	V-16	Driving Techniques	1-14
Cooling System Sealing Additives.....	V-17	General Information.....	1-14
Cooling System Soluble Oils.....	V-18	Dust Ejection Valve	3-9
Fully Formulated Coolant/Antifreeze.....	V-16	Clean.....	3-9
Coolant Temperature Above Normal - Gradual Overheat.....	TS-8	Finishing Steps.....	3-10
Coolant Temperature Above Normal - Sudden Overheat.....	TS-10	General Information.....	3-9
Coolant Temperature Below Normal.....	TS-12	Inspect for Reuse.....	3-10
Coolant Thermostat	A-10	Install.....	3-10
Clean and Inspect for Reuse.....	A-13	Maintenance Check.....	3-9
Finishing Steps.....	A-15	Preparatory Steps.....	3-9
General Information.....	A-10	Remove.....	3-10
Install.....	A-14	Electrical System	V-7
Leak Test.....	A-11	Batteries (Specific Gravity).....	V-7
Measure.....	A-13	Specifications.....	V-7
Preparatory Steps.....	A-12	Electromagnetic Interference (EMI)	1-21
Remove.....	A-13	General Information.....	1-21
Cooling Fan Belt Tensioner	5-9	System EMI Radiation Levels.....	1-21
Clean and Inspect for Reuse.....	5-12	System EMI Susceptibility.....	1-21
Finishing Steps.....	5-13	Electronic Controlled Fuel System	1-14
Initial Check.....	5-10	Diagnostic Fault Codes.....	1-17
Install.....	5-12	Engine Protection System.....	1-20
Maintenance Check.....	5-9	Fault Code Snapshot Data.....	1-20
Preparatory Steps.....	5-11	General Information.....	1-14
Remove.....	5-11	INSITE™ Electronic Service Tool Description.....	1-20
Cooling Fan Belt Tensioner	A-18	INSITE™ Electronic Service Tool Monitor Mode.....	1-21
Clean and Inspect for Reuse.....	A-20	Emergency and Technical Service	S-1
Finishing Steps.....	A-22	General Information.....	S-1
Initial Check.....	A-19	Engine Acceleration or Response Poor.....	TS-13

Index
Page X-2

Engine Coolant Antifreeze	5-9	General Information.....	i-8
Maintenance Check.....	5-9	Intake Manifold Air Temperature Above Specification.....	TS-43
Engine Diagrams	E-6	Intake Manifold Pressure (Boost) is Below Normal.....	TS-45
General Information.....	E-6	Lubricating Oil and Filters	5-5
Engine Difficult to Start or Will Not Start (Exhaust Smoke).....	TS-15	Drain.....	5-5
Engine Difficult to Start or Will Not Start (No Exhaust Smoke).....	TS-17	Fill.....	5-7
Engine Identification	E-1	Install.....	5-7
Cummins® Engine Nomenclature.....	E-2	Remove.....	5-6
Engine Control Module Dataplate.....	E-2	Lubricating Oil Consumption Excessive.....	TS-46
Exhaust System.....	E-3	Lubricating Oil Contaminated.....	TS-47
Fuel Pump Dataplate.....	E-2	Lubricating Oil Level	3-4
General Information.....	E-1	Maintenance Check.....	3-4
Turbocharger Dataplate.....	E-3	Lubricating Oil Loss.....	TS-48
Engine Indicator Lamps	1-8	Lubricating Oil Pressure High.....	TS-49
General Information.....	1-8	Lubricating Oil Pressure Low.....	TS-50
Engine Noise Excessive.....	TS-19	Lubricating Oil Recommendations and Specifications	V-14
Engine Noise Excessive - Combustion Knocks.....	TS-21	AfterMarket Oil Additive Usage.....	V-15
Engine Operating Range	1-13	General Information.....	V-14
General Information.....	1-13	Lubricating Oil Sludge in the Crankcase Excessive.....	TS-52
Engine Power Output Low.....	TS-22	Lubricating Oil System	V-3
Engine Runs Rough at Idle.....	TS-24	Specifications.....	V-3
Engine Runs Rough or Misfires.....	TS-26	Maintenance Guidelines - Overview	2-1
Engine Shutdown	1-14	General Information.....	2-1
General Information.....	1-14	Maintenance Procedures - Overview	4-1
Engine Shuts Off Unexpectedly or Dies During Deceleration.....	TS-28	General Information.....	4-1
Engine Speed Surges at Low or High Idle.....	TS-29	Maintenance Procedures - Overview	5-1
Engine Speed Surges in PTO or Cruise Control.....	TS-32	General Information.....	5-1
Engine Speed Surges Under Load or in Operating Range.....	TS-30	Maintenance Procedures - Overview	6-1
Engine Starts But Will Not Keep Running.....	TS-33	General Information.....	6-1
Engine Vibration Excessive.....	TS-34	Maintenance Procedures - Overview	7-1
Engine Will Not Reach Rated Speed (RPM).....	TS-35	General Information.....	7-1
Exhaust System	V-6	Maintenance Procedures - Overview	8-1
Specifications.....	V-6	General Information.....	8-1
Fan Hub, Belt Driven	6-2	Maintenance Procedures - Overview	9-1
Maintenance Check.....	6-2	General Information.....	9-1
Fan, Cooling	3-5	Maintenance Record Form	2-5
Inspect for Reuse.....	3-5	Maintenance Data.....	2-5
Fault Code Warning Lamps Do Not Illuminate.....	TS-38	Maintenance Schedule	2-3
Fault Code Warning Lamps Stay On (No Apparent Reason).....	TS-37	General Information.....	2-3
Flow Diagram, Air Intake System	D-8	Newton-Meter to Foot-Pound Conversions	V-24
Flow Diagram.....	D-8	Conversion Chart.....	V-24
Flow Diagram, Cooling System	D-6	Normal Starting Procedure	1-2
Flow Diagram.....	D-6	Jump Starting.....	1-4
Flow Diagram, Exhaust System	D-9	Starting.....	1-2
Flow Diagram.....	D-9	Operating Instructions - Overview	1-1
Flow Diagram, Fuel System	D-2	General Information.....	1-1
Flow Diagram.....	D-2	Operating the Engine	1-6
Flow Diagram, Lubricating Oil System	D-3	Ambient Temperature.....	1-6
Flow Diagram.....	D-3	Normal.....	1-6
Fraction, Decimal, Millimeter Conversions	V-23	Winterfronts and Shutters.....	1-7
Conversion Chart.....	V-23	Overhead Set	9-1
Fuel Consumption Excessive.....	TS-39	Adjust.....	9-1
Fuel Filter (Canister Type)	5-1	Pipe Plug Torque Values	V-25
Install.....	5-2	Torque Table.....	V-25
Prime.....	5-3	Problem Solving	S-1
Remove.....	5-1	General Information.....	S-1
Fuel Filter (Spin-On Type)	5-4	Radiator Hoses	7-7
Install.....	5-4	Maintenance Check.....	7-7
Prime.....	5-5	Radiator Pressure Cap	6-1
Remove.....	5-4	General Information.....	6-1
Fuel in Coolant.....	TS-41	Inspect for Reuse.....	6-1
Fuel in the Lubricating Oil.....	TS-42	Regional Offices - International	S-29
Fuel Recommendations and Specifications	V-12	Locations.....	S-29
Fuel Recommendations.....	V-12	Routine Service and Parts	S-1
Fuel System	V-2	General Information.....	S-1
Specifications.....	V-2	Sealants	V-20
Fuel-Water Separator	3-3	General Information.....	V-20
Drain.....	3-3	Service Literature Ordering Location	L-2
General Information.....	3-3	Contact Information.....	L-2
General Cleaning Instructions	i-13	Smoke, Black - Excessive.....	TS-53
Abrasive Pads and Abrasive Paper.....	i-13	Smoke, White - Excessive.....	TS-54
Definition of Clean.....	i-13	Starting Motor	A-22
Fuel System.....	i-16	Clean and Inspect for Reuse.....	A-24
Gasket Surfaces.....	i-14	Finishing Steps.....	A-26
Plastic Bead Cleaning.....	i-15	Install.....	A-25
Solvent and Acid Cleaning.....	i-14	Measure.....	A-25
Steam Cleaning.....	i-15	Preparatory Steps.....	A-23
General Engine	V-1	Remove.....	A-24
Specifications.....	V-1	Rotation Check.....	A-22
General Repair Instructions	i-11	Starting Procedure After Extended Shutdown or Oil Change	1-5
General Information.....	i-11	General Information.....	1-5
Welding on a Vehicle with an Electronic Controlled Fuel System.....	i-12	Symbols	i-4
General Safety Instructions	i-9	General Information.....	i-4
Important Safety Notice.....	i-9	System Diagrams - Overview	D-1
How to Use the Manual	i-3	General Information.....	D-1
General Information.....	i-3	Tap-Drill Chart - U.S. Customary and Metric	V-26
Illustrations	i-8	General Information.....	V-26

To the Owner and Operator	i-1
General Information.....	i-1
Tool Requirements	2-2
General Information.....	2-2
Troubleshooting Procedures and Techniques	TS-1
General Information.....	TS-1
Troubleshooting Symptoms Charts	TS-2
General Information.....	TS-2
Turbocharger Leaks Engine Oil or Fuel.....	TS-56
Unique Operating Characteristics of an Engine with Airless Selective Catalytic Reduction (SCR)	1-7
General Information.....	1-7
Weights and Measures - Conversion Factors	V-27
Conversion Chart.....	V-27

Cummins Inc.
Box 3005
Columbus, Indiana, U.S.A., 47202

Registered Office
Cummins Ltd.
49 - 51 Gresham Road,
Staines,
Middlesex TW18 2BD,
England
Registration 573951 England

Copyright© 2014
Cummins Inc.

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

