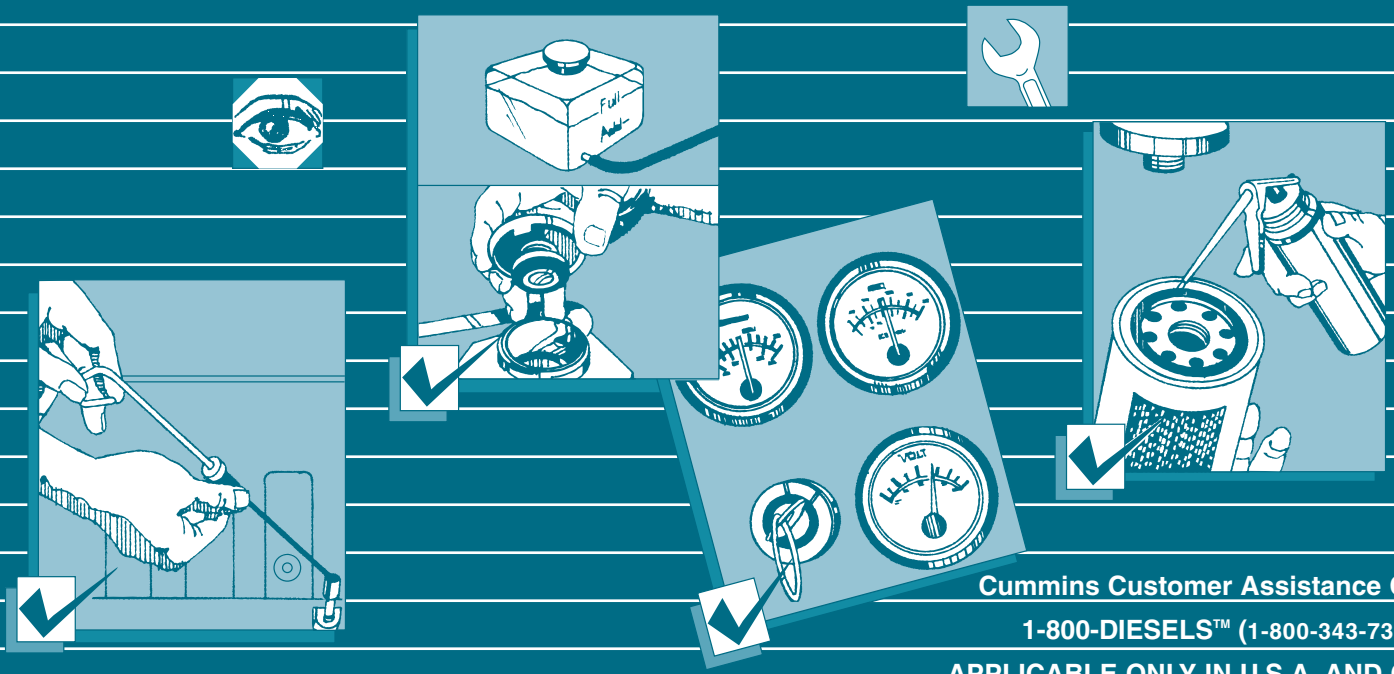
Owners Manual
QSL9 CM2350 L102



Cummins Customer Assistance Center

1-800-DIESELS™ (1-800-343-7357)

APPLICABLE ONLY IN U.S.A. AND CANADA

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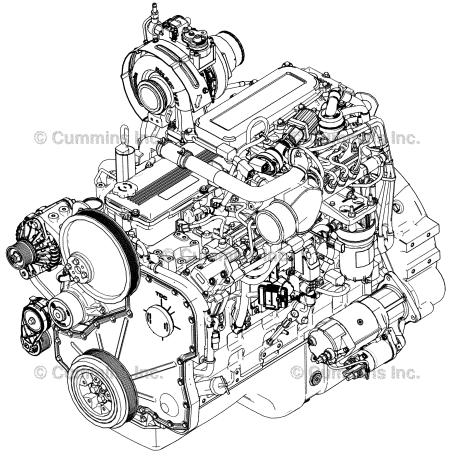
QSL9 CM2350 L102



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Bulletin 4332798
Printed 14-APRIL-2015

Foreword

This manual contains information for the correct operation and maintenance of your Cummins® Product.

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.

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Important Reference Numbers

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

Name	Number	Number
Engine Model		
Engine Serial Number (ESN)		
Control Parts List (CPL)		
Fuel Pump Part Number		
Electronic Control Module (ECM)		
Electronic Control Module Serial Numbers (ECM)		
Filter Part Numbers:		
• Air Cleaner Element		
• Lubricating Oil		
• Fuel		
• Fuel-Water Separator		
• Coolant		
• Crankcase Ventilation		
• Cummins Particulate Filter		
Governor Control Module (GCM) (if applicable)		
Belt Part Numbers:		

•		
•		
•		
Clutch or Marine Gear (if applicable):		
• Model		
• Serial Number		
• Part Number		
• Oil Type		
• Sea Water Pump		
- Model		
- Part Number		

Section i - Introduction

Section Contents

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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.

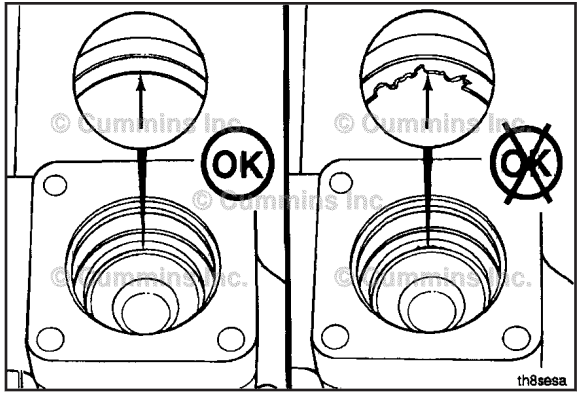
Indicates that a **WRENCH** or **TOOL SIZE** will be given.

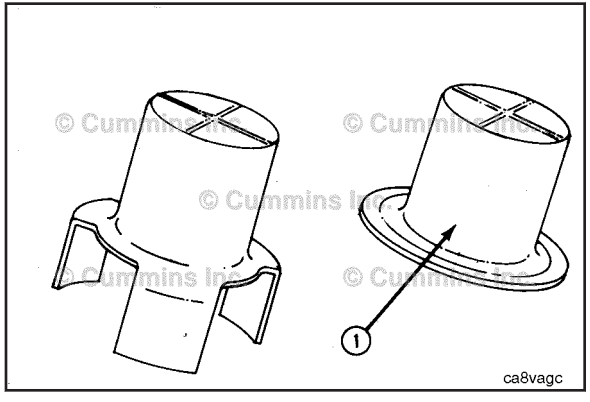
TIGHTEN to a specific torque.

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

⚠ WARNING ⚠

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

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

- Work in an area surrounding the product that is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- **Always** wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do **not** wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do **Not** Operate" tag in the operator's compartment or on the controls.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do **not** attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before slowly loosening the filler cap to relieve the pressure from the cooling system.

- **Always** use blocks or proper stands to support the product before performing any service work. Do **not** work on anything that is supported ONLY by lifting jacks or a hoist.
- Relieve all pressure in the air, oil, fuel, and cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do **not** check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect liquid refrigerant (Freon) lines in a well ventilated area. To protect the environment, liquid refrigerant systems **must** be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capturing and recycling refrigerant.
- To reduce the possibility of personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. **Always** use a spreader bar when necessary. The lifting hooks **must not** be side-loaded.
- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do **not** get the substance in eyes. Avoid prolonged or repeated contact with skin. Do **not** swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and **must** be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.
- To reduce the possibility of burns, be alert for hot parts on products that have just been turned off, exhaust gas flow, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use the tools before performing any service work. Use ONLY genuine Cummins® or Cummins ReCon® replacement parts.

- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lesser quality if replacements are necessary.
- When necessary, the removal and replacement of any guards covering rotating components, drives, and/or belts should only be carried out be 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.

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
ESN	Engine Serial Number
°F	Fahrenheit
ft-lb	Foot-Pound Force
FMI	Failure Mode Indentifier
GVW	Gross Vehicle Weight
Hg	Mercury
hp	Horsepower
H_2O	Water
inHg	Inches of Mercury
in H_20	Inches of Water
ICM	Ignition Control Module
IEC	International Electrotechnical Commission
km/l	Kilometers per Liter
kPa	Kilopascal
LNG	Liquid Natural Gas

LPG	Liquified 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
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

Section E - Engine and System Identification

Section Contents

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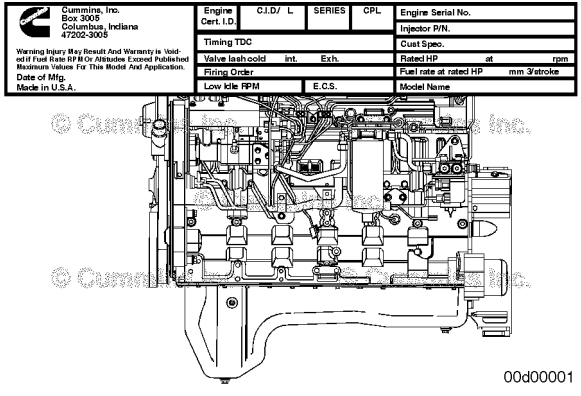
Engine Identification

Engine Dataplate



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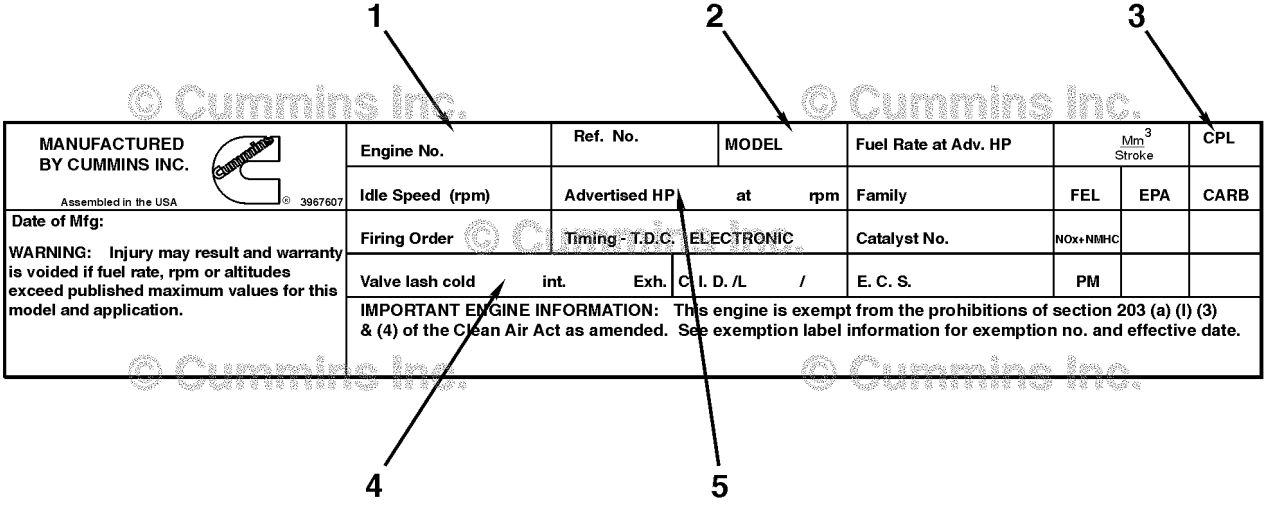
The engine dataplate provides important information about the engine. The engine serial number (ESN) and control part list (CPL) provide information for service and for ordering parts. The engine dataplate **must not** be changed unless approved by Cummins Inc.

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.



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1 Engine serial number (ESN)

2 Engine model information

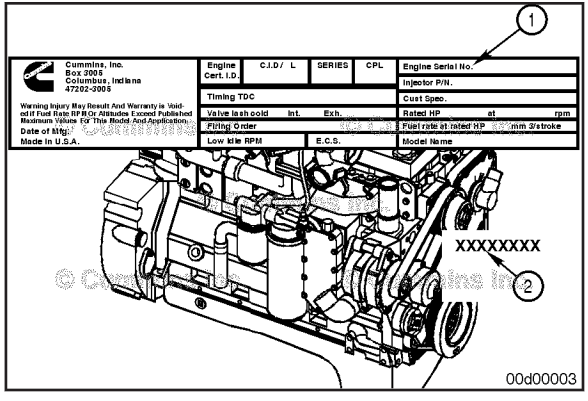
3 Control parts list (CPL)

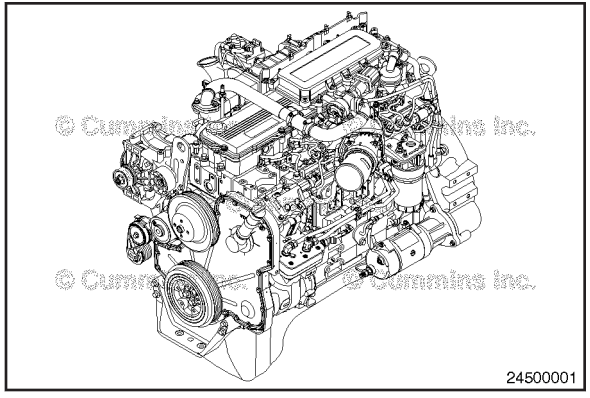
4 Valve lash (overhead) setting

5 Horsepower and rpm rating.

NOTE: Depending on the manufacturing plant, calibration data may also be be found on the engine dataplate.

If the engine dataplate (1) is **not** legible, the engine serial number (ESN) (2) can be found on the engine block, on top of the lubricating oil cooler housing. Additional engine information is on the engine control module dataplate.

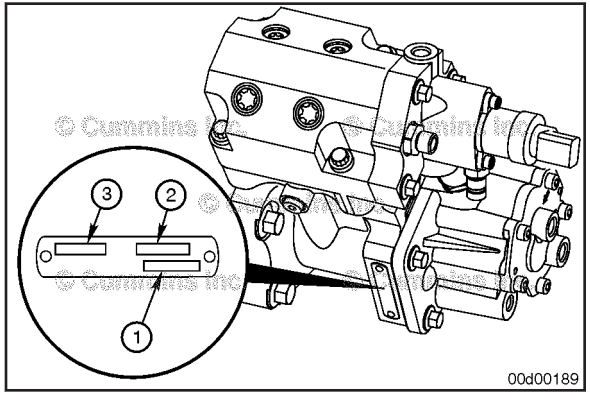




Cummins® Engine Nomenclature

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 fuel pump dataplate is located on the side of the high-pressure pump. The dataplate contains the following information:

1 Cummins® part number

2 Pump serial number

3 Factory code.

Engine Control Module Dataplate

The engine control module (ECM) dataplate is located on the front of the ECM.

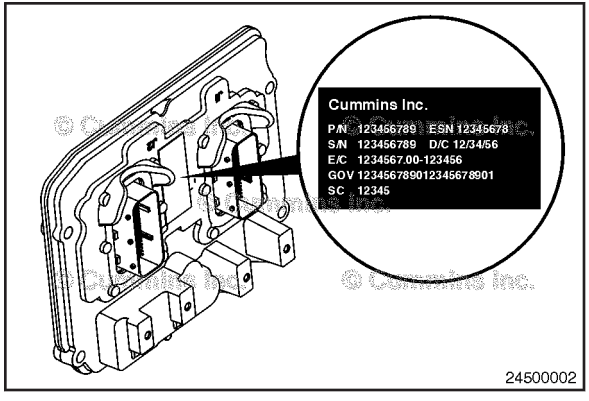
The following information is found on the engine control module dataplate:

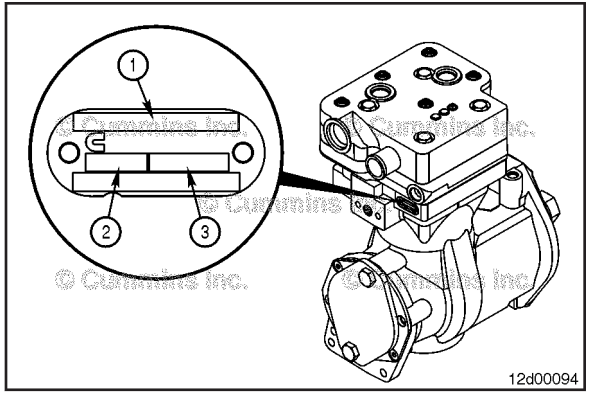
- ECM part number (PN)
- ECM serial number (SN)
- ECM date code (DC)
- Engine serial number (ESN)
- ECM Code: identifies the software in the ECM).

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.

NOTE: Not all engines will have ECM dataplates.

Engines covered by this manual are equipped with a CM2350 ECM. A CM2350 engine control module has two 96-pin connectors.





Air Compressor

NOTE: Not all engines are equipped with an air compressor.

The Cummins® branded air compressor dataplate, identified by the Cummins Inc. logo on the dataplate, is typically located on the rear side of the air compressor. The dataplate contains the following information that assists in service or replacement.

1 Cummins® part number

2 Date code

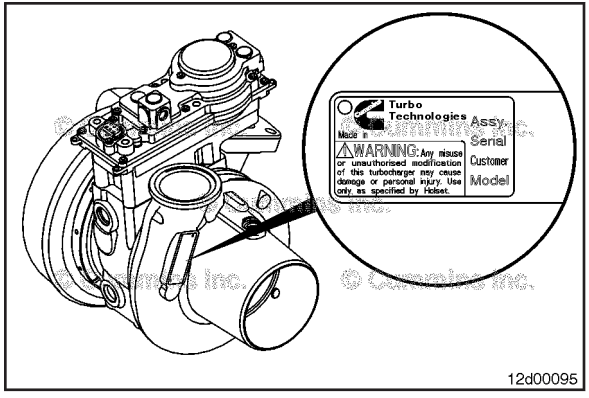
3 Serial number.

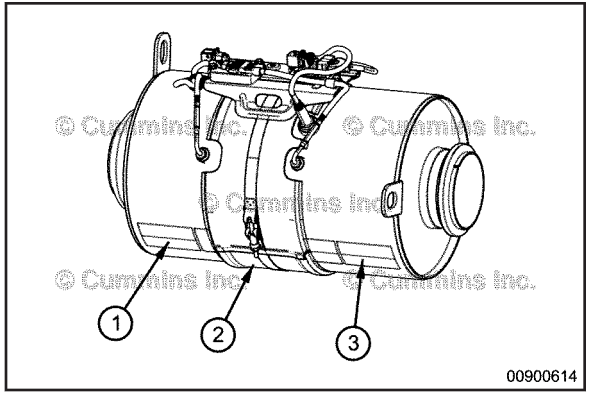
Variable Geometry Turbocharger

The variable geometry turbocharger dataplate is located on the turbocharger inlet compressor housing. The dataplate contains the following information which will assist in service or replacement.

- Cummins® assembly part number
- Serial number
- Customer number
- Model number.

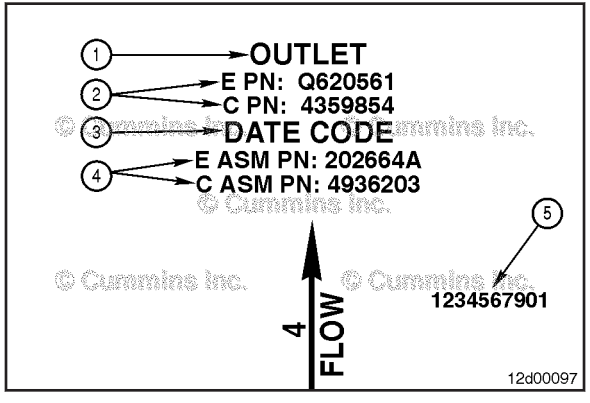
NOTE: The electronic actuator on the variable geometry turbocharger is a serviceable component and has a separate dataplate that assists in service or replacement.





Exhaust System

The diesel oxidation catalyst (DOC) aftertreatment assembly has important information for service and replacement stamped into the canister.



A typical aftertreatment information stamping can provide the following:

1 Section name

2 Part number

3 Date code

4 Assembly number (**only** located on the outlet section)

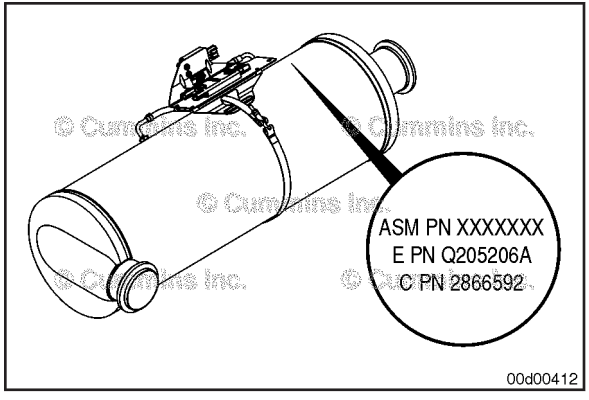
5 Serial number.

NOTE: Some aftertreatment components could possibly **only** have the Cummins Emission Solutions™ part number for cross referencing and part number identification. Reference to QuickServe® Online.

The aftertreatment selective catalytic reduction catalyst identification is located on the side of the part and contains the following information to assist in service or replacement:

- Assembly part number
- Cummins Emission Solutions™ part number
- Cummins® part number.

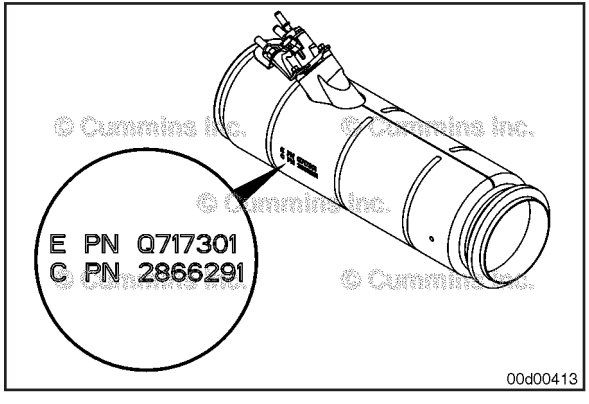
NOTE: Some aftertreatment components could possibly **only** have the Cummins Emission Solutions™ part number for cross referencing and part number identification. Reference to QuickServe® Online.

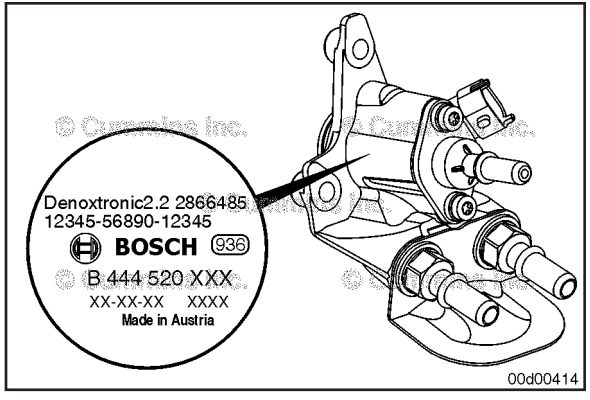


The aftertreatment decomposition tube identification is located on the side of the part and contains the following information to assist in service or replacement:

- Cummins Emission Solutions™ part number
- Cummins® part number.

NOTE: Some aftertreatment components may **only** have the Cummins Emission Solutions™ part number for cross referencing and part number identification. Reference to QuickServe® Online.





The aftertreament diesel exhaust fluid dosing valve identification is located on the side of the valve and contains the following information to assist in service or replacement:

- Cummins® part number
- Cummins Emission Solutions™ part number
- Bosch™ part number
- Bosch™ production data (date code and serial number).

Example:

- 2866485 is the Cummins® part number
- 12345-67890-12345 is 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 may **only** have the Cummins Emission Solutions™ part number for cross referencing and part number identification. Reference to QuickServe® Online.

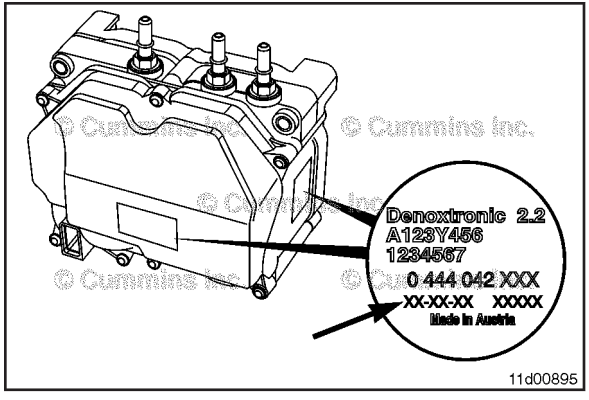
The aftertreament diesel exhaust fluid dosing unit identification is located on the side of the part and contains the following information to assist in servicing or replacement:

- Cummins Emission Solutions™ part number
- Cummins® part number
- Bosch™ part number
- Bosch™ production data (date code and serial number).

Example:

- A123Y456 is the Cummins Emission Solutions™ part number
- 1234567 is the Cummins® part number
- 0 444 042 XXX is the Bosch™ part number
- XX-XX-XX is the date code
- XXXXX is the serial number.

NOTE: Some aftertreatment components may **only** have the Cummins Emission Solutions™ part number for cross referencing and part number identification. Reference to QuickServe® Online.



Cummins® Service Engine Model Identification

General Information

The Cummins® Service Engine Model Identification procedure describes:

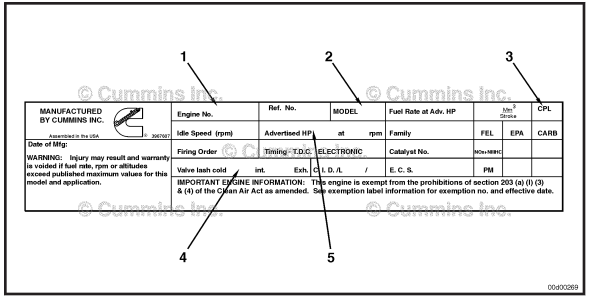
- The purpose of the Cummins® Service Model Name.
- How to interpret a Cummins® Service Model Name to identify a Cummins® Engine.

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.

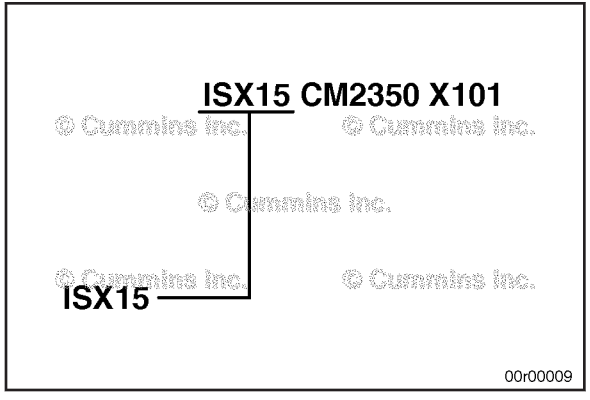
Marketing Engine Model Name	Service Model Name
ISX15	ISX15 CM2350 X101

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”.

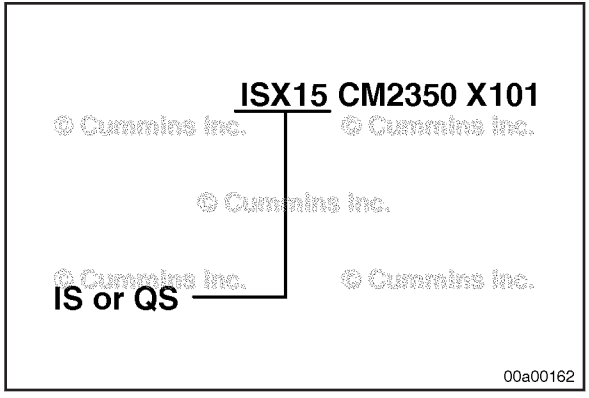
Typically, the first two letters of the marketing model name contain an “IS” or “QS” if the engine is an electronic engine.

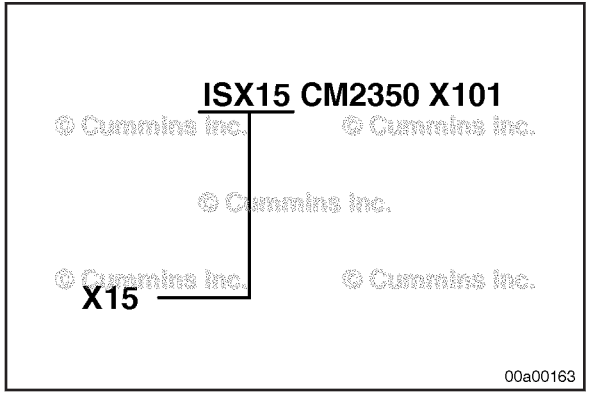
“IS” prefix designates and On-Highway automotive engine.

“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.



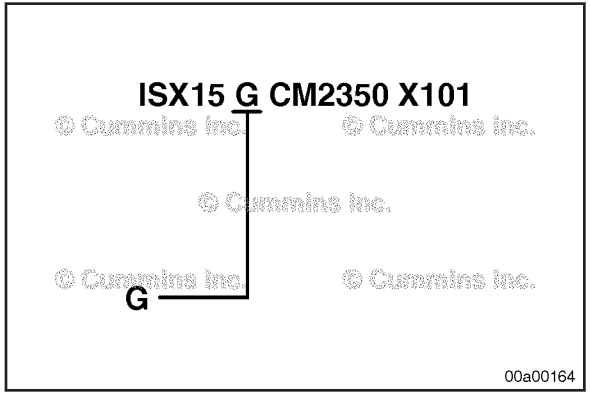


Typically, the third letter is the engine platform/series designation followed by the engine liter displacement. For the example shown in the graphic, the engine is a:

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.

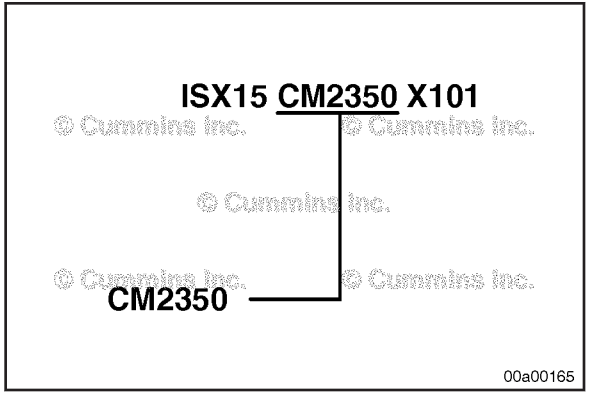
NOTE: Not all engines fueled by natural gas will have a “G” located after the displacement.

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.

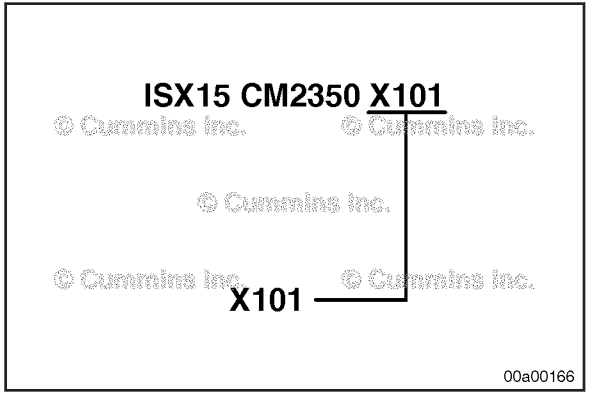
NOTE: Use of a parenthesis ( ) indicates that either engine control module (ECM) has been used on the product. Use of a slash "/" indicates that the product has multiple ECMs.



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 **QSL9 CM2350 L102**.

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

- United States and Canada
- Tier 4 (EPA Final)
- European Union
- Stage IV (Euro)
- Japan
- Korea (South).

This engine has the following Agency defined Emissions Control System (ECS) 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 Products

- Engine Control Module (ECM)
- Exhaust Gas Recirculation (EGR)
- Oxidation Catalyst (OC)
- Selective Catalytic Reduction - Urea (SCR-U)
- Turbocharger (TC).

This engine uses the following product technology:

Engine

- Number of Cylinders - 6
- Engine Configuration - Inline
- Cylinder Block Material - Cast Iron
- Cylinder Head Material - Cast Iron
- Camshaft Location - Cylinder Block.

Electronic Control System

- Control Module: CM2350
- Engine Coolant Level Sensor
- Engine Coolant Temperature Sensor
- Engine Oil Pressure Sensor
- Engine Oil Pressure Switch
- Engine Oil Level Sensor
- Fuel Rail Pressure Sensor
- Fuel Pump Actuator
- Water-in-Fuel Sensor
- Camshaft Position Sensor
- Crankshaft Position Sensor

- EGR Differential Pressure Sensor
- Exhaust Gas Pressure Sensor
- EGR Temperature Sensor
- Intake Manifold Pressure/Temperature Sensor
- Turbocharger Speed Sensor
- Turbocharger Compressor Intake Pressure/Temperature Sensor
- Ambient Air Temperature Sensor
- Crankcase Pressure Sensor
- Aftertreatment Exhaust Gas Temperature Sensor
- Diesel Exhaust Fluid Quality Sensor
- Aftertreatment Intake mono-nitrogen oxides (NOx) Sensor
- Aftertreatment Outlet NOx Sensor.

Air Handling

- Turbocharger (Single)
- Variable Geometry
- Intake Air Heater.

Fuel System

- Diesel
- Common Rail Fuel System

- Cummins XPI Common Rail Fuel System.

Exhaust System

- Exhaust Gas Recirculation (EGR)
- Aftertreatment Fuel Injection
- Internal
- Diesel Oxidation Catalyst (DOC)
- Selective Catalytic Reduction (SCR) Catalyst
- Aftertreatment Diesel Exhaust Fluid Dosing System
- Airless Diesel Exhaust Fluid Dosing Unit
- Integrated Diesel Exhaust Fluid Controller (controlled by the engine's ECM).

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

Industrial

- Agriculture
- Construction
- Fire Pump
- Locomotive
- Power Unit
- Rail Car
- Oil and Gas

- Welding
- Air Compressor
- Underground Mining
- Track Maintenance.

Section 1 - Operating Instructions

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Operating Instructions - Overview

General Information

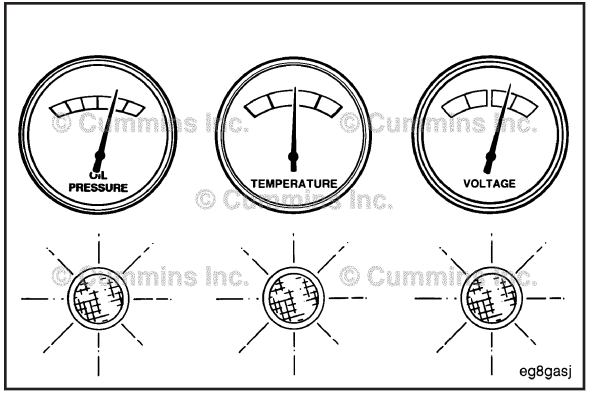
Correct care of your engine will result in longer life, better performance, and more economical operation.

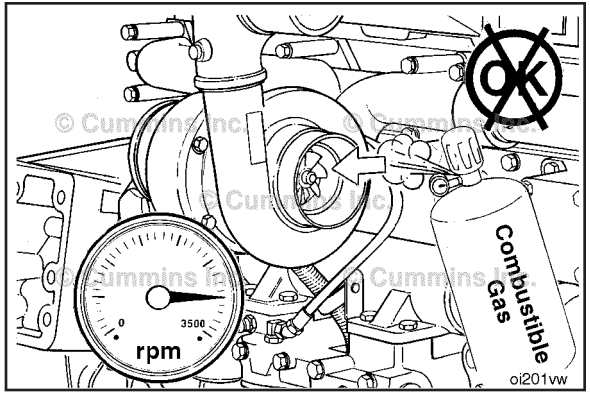
Follow the daily maintenance checks listed in Maintenance Guidelines (Section 2).

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

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

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.

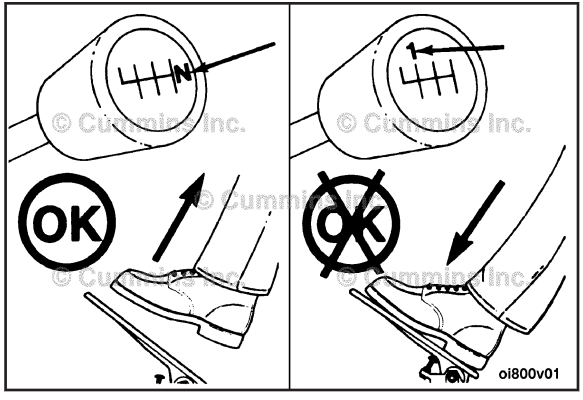
Cummins recommends the installation of an air intake shutoff device or a similar safety device to minimize the risk of overspeeding when an engine is operating in a combustible environment, such as due to a fuel spill or gas leak.

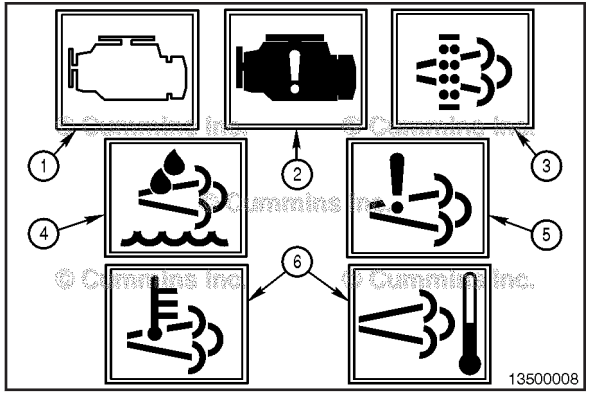
Normal Starting Procedure

Starting

Disengage the driven 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 key 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 SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM CLEANING lamp, amber in color

4 DIESEL EXHAUST FLUID lamp, amber in color

5 SCR SYSTEM CLEANING INHIBIT lamp, amber in color.

Additionally, some engines have an additional lamp, (6) HIGH EXHAUST SYSTEM TEMPERATURE, which is amber in color. If any of the lamps remain on or begin to flash, see the following procedure. 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).

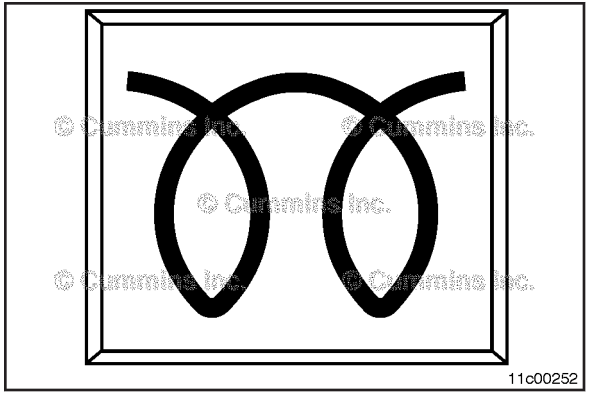
Under cold conditions, the WAIT-TO-START lamp (generally a yellow lamp using a symbol similar to the graphic, or the words WAIT TO START) will also illuminate at key ON, and will stay on for a period of up to 30 seconds.

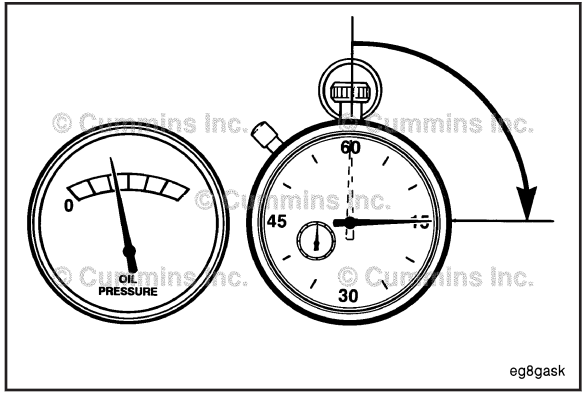
NOTE: The length of time the WAIT-TO-START lamp remains illuminated depends on the ambient temperature. The lower the ambient temperature, the longer the lamp will be illuminated.

Once the WAIT-TO-START lamp turns off, turn the key to the start position to start the engine. If the engine will not start reference the appropriate Troubleshooting Symptoms tree in Section TS in the Operation and Maintenance manual.

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

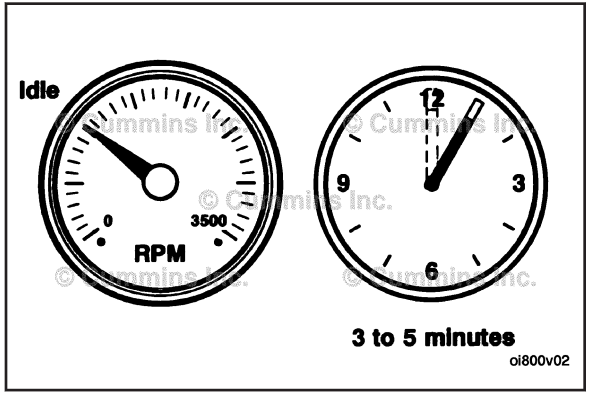
NOTE: Engines equipped with air starting motors require a minimum of 480 kPa [70 psi].





⚠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 the engine OFF immediately to reduce the possibility of engine damage.



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

NOTE: After the engine is started, the voltmeter, if equipped, may show a gauge fluctuation under certain engine temperature conditions (both warm and cold). This cycling operation is caused by the post-heat cycle of the intake manifold heater system. The number of cycles and the length of the cycling operation is controlled by the engine control module. The cycling action will cause temporary dimming of the headlamps, interior lamps, and other vehicle electrical accessories.

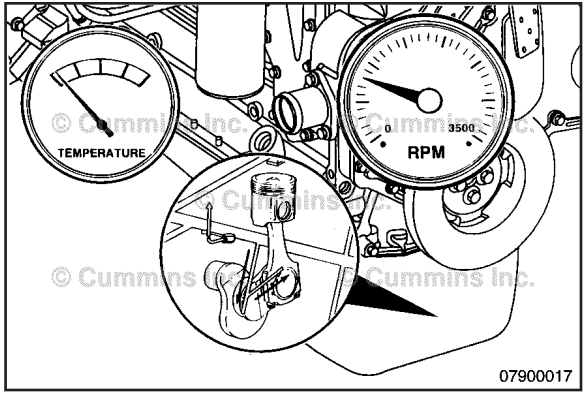
After starting a cold engine, increase the engine speed (rpm) slowly to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.

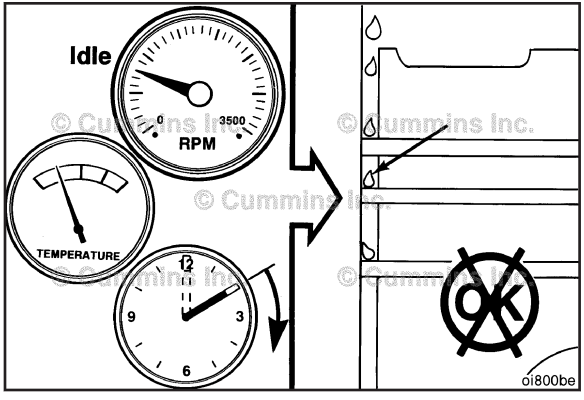
NOTE: For engines equipped with engine warm-up protection feature; this feature limits engine speed and torque following engine start-up until sufficient oil pressure is available to the engine components. This feature reduces the risk of engine part damage due to operating at engine speeds too high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

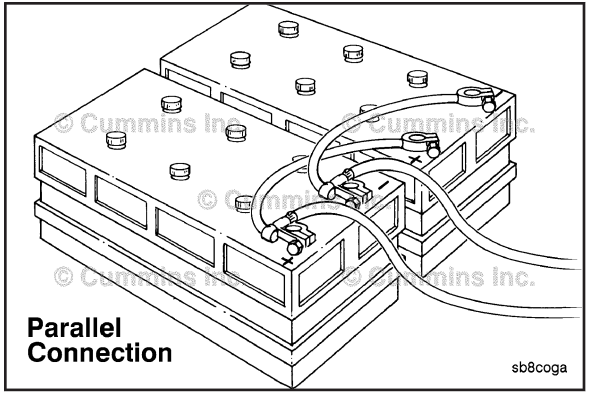
⚠WARNING⚠
Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

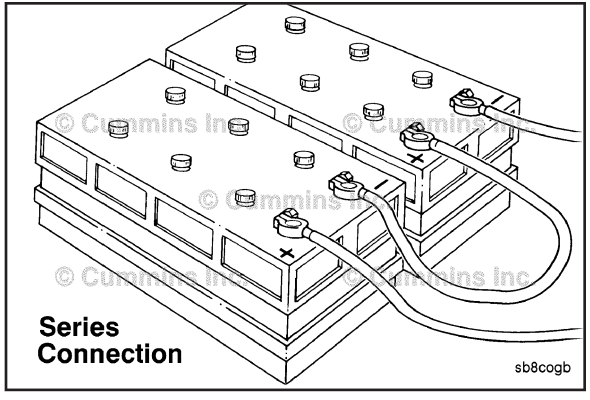
⚠CAUTION⚠
When using jumper cables to start the engine, make sure to connect the cables in parallel: Positive (+) to positive (+) and negative (-) to negative (-). When using an external electrical source to start the engine, turn the disconnect switch to the OFF position. Remove the key before attaching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

⚠CAUTION⚠
To reduce the possibility of damage to engine parts, do not connect the 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: Always reference the relevant OEM literature for jump starting procedures. Failure to follow correct procedures can result in damage to the engine control module and other electrical equipment.



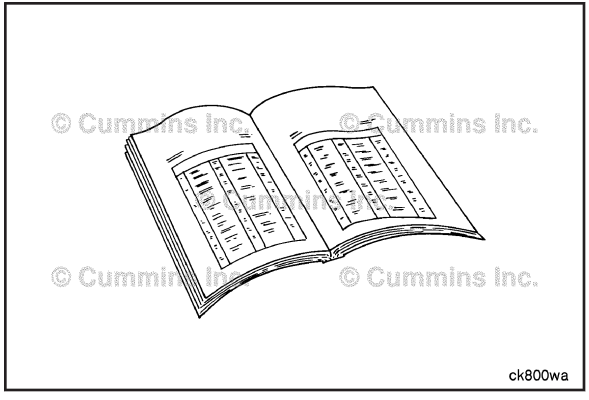


This illustration shows a typical series battery connection. This arrangement, positive (+) to negative (-), doubles the voltage.

NOTE: Always reference the relevant OEM literature 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

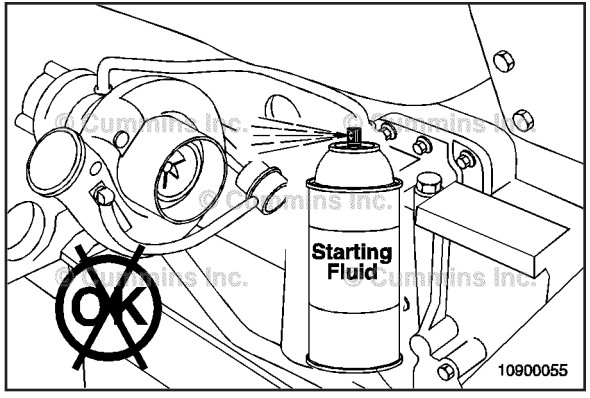


⚠CAUTION⚠

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.



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.

Starting Procedure After Extended Shutdown or Oil Change

General Information

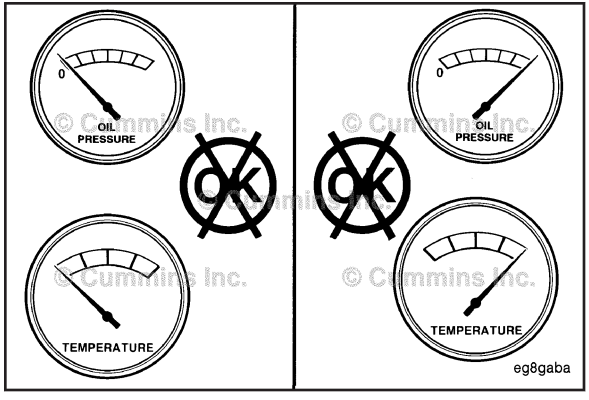
Follow the Normal Starting Procedure in this section. The engine will **not** start until the minimum cranking oil pressure is detected by the ECM. It can take more cranking time to start the engine after an extended shut down or oil change.

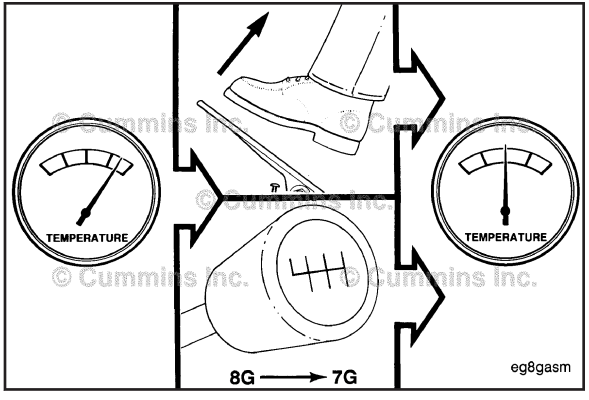
Operating the Engine

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).

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. Refer to the original equipment manufacturer (OEM) service manual for additional lamp information.

The regulated engine derate conditions vary depending on the OEM and local regulaltions. Refer to the OEM service manual 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

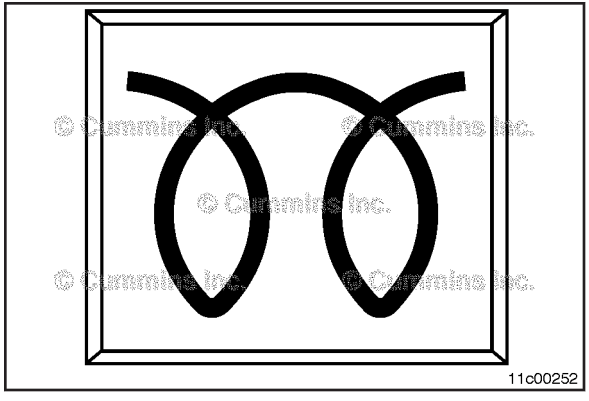
The WAIT TO START lamp illuminates when the intake air heater needs to warm the intake air prior to starting the engine.

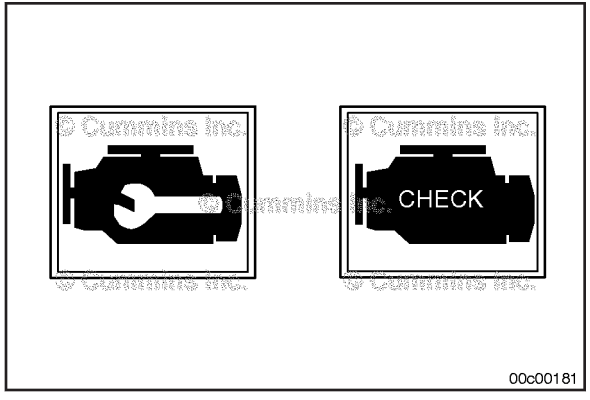
The time for the WAIT TO START lamp to be on will vary, depending on the ambient air temperature. Refer to Procedure 101-014 in Section 1.

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
- 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.

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
- Coolant level is low.

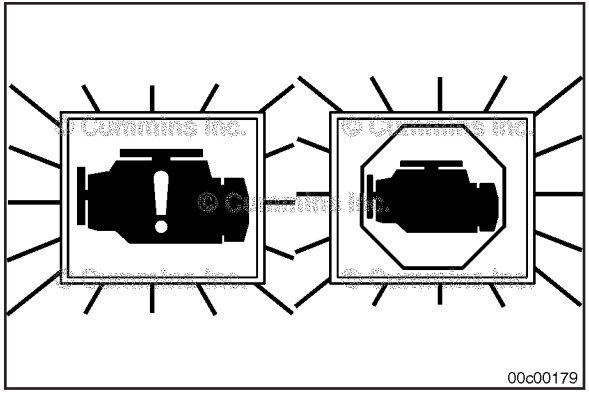
Stop Engine Lamp

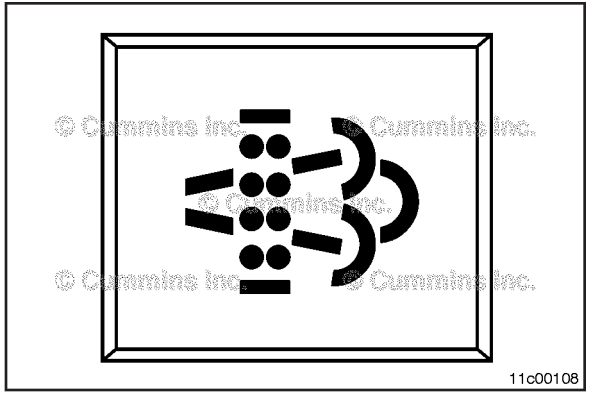
The STOP ENGINE lamp indicates, when illuminated, the need to stop the engine as soon as it can be safely done. The engine **must** remain shut down until the engine can be repaired.

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.





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.

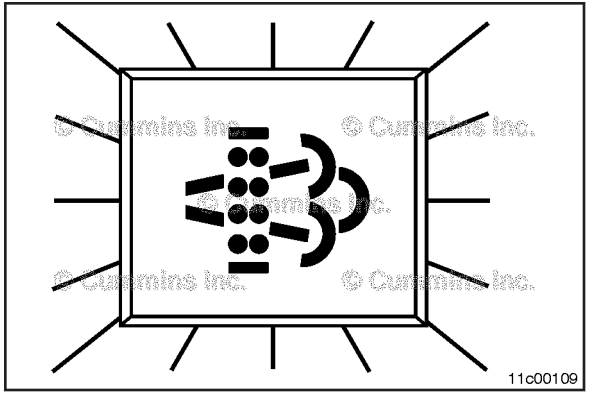
A flashing SCR SYSTEM CLEANING lamp indicates the status of a non-mission (stationary) SCR/ exhaust system cleaning when the SCR System Cleaning Start switch has been activated. See the following procedure for more information on the Start Conditioning switch. Refer to Procedure 101-050 in Section 1.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

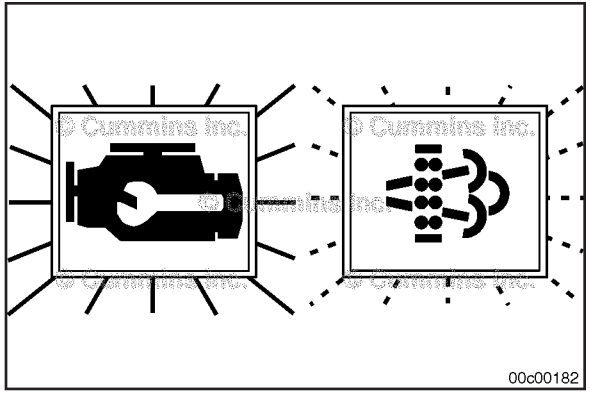
1 Keep the exhaust outlet away from people and anything that can burn, melt, or explode.

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.





A solid SCR SYSTEM CLEANING lamp combined with an illuminated WARNING or CHECK ENGINE lamp indicates that the aftertreatment SCR needs to be cleaned immediately. Engine power will be reduced automatically if action is **not** taken.

When these lamps are illuminated, a stationary SCR/ exhaust system cleaning is required. Refer to Procedure 101-050 in Section 1.

NOTE: If a stationary SCR/exhaust system cleaning is **not** performed, the STOP ENGINE lamp will illuminate and the vehicle will need to be taken to a Cummins® Authorized Repair Location.

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.

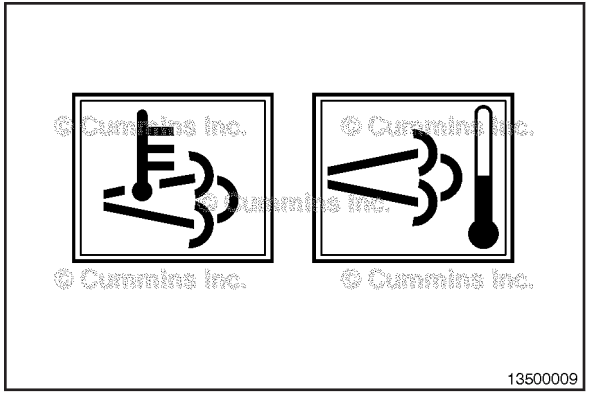
The HIGH EXHAUST SYSTEM TEMPERATURE lamp indicates, when illuminated, that exhaust temperatures are high. The lamp could illuminate during normal engine operation or during SCR/exhaust system cleaning.

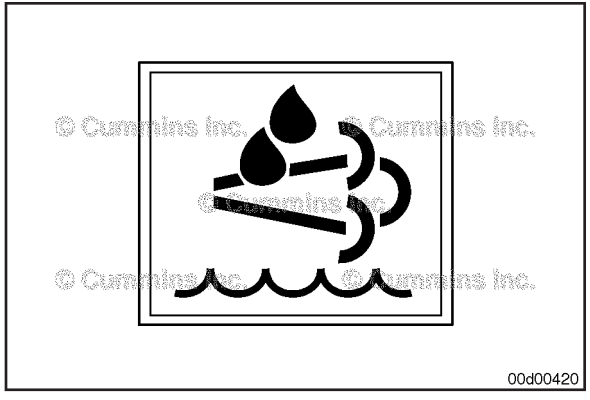
NOTE: The OEM determines whether or **not** the HIGH EXHAUST SYSTEM TEMPERATURE lamp is installed on the vehicle. The OEM also specifies the temperatures, vehicle speeds, and other conditions at which the lamp illuminates. Refer to the OEM service manual for additional information regarding this lamp.

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 SCR/exhaust system cleaning.





Aftertreatment Diesel Exhaust Fluid Lamp

The AFTERTREATMENT DIESEL EXHAUST FLUID lamp indicates, when illuminated or flashing, that the diesel exhaust fluid (DEF) level is low.

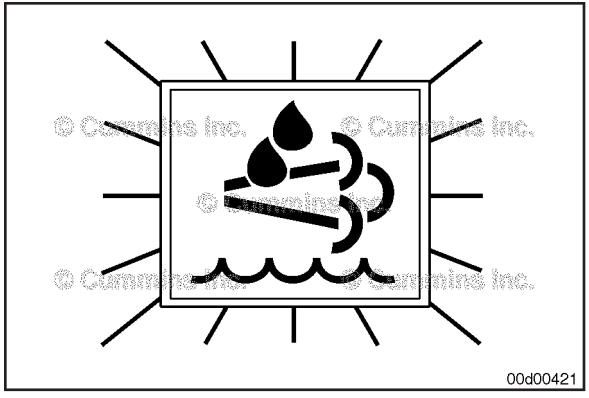
NOTE: The OEM determines whether or not the AFTERTREATMENT DIESEL EXHAUST FLUID lamp is installed on the vehicle. The OEM also specifies the level at which the lamp will illuminate or blink. Refer to the OEM service manual for additional information regarding this lamp.

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.

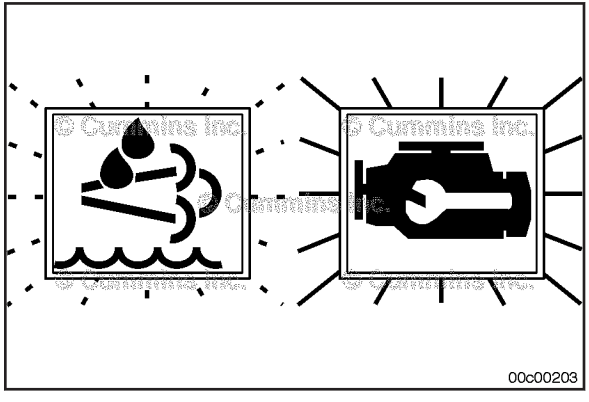
NOTE: It is recommended that the DEF tank be filled completely full of DEF in order to correct any fault conditions.

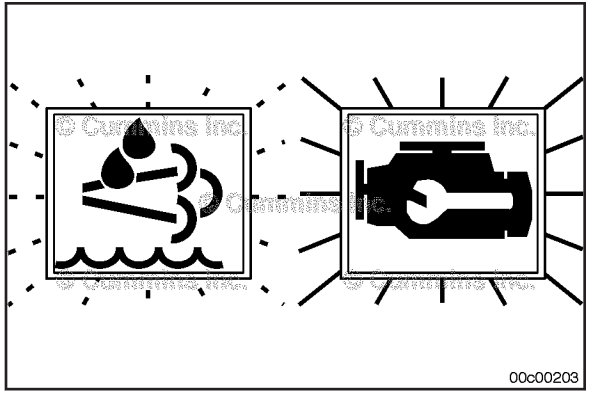


A flashing AFTERTREATMENT DIESEL EXHAUST FLUID lamp combined with an illuminated WARNING or CHECK ENGINE lamp indicates that the DEF level has fallen below the initial derate level. The engine power will be limited automatically. This can be corrected by filling the DEF tank with DEF.

If corrective action is **not** taken, engine power will be further limited to the secondary derate level.

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.

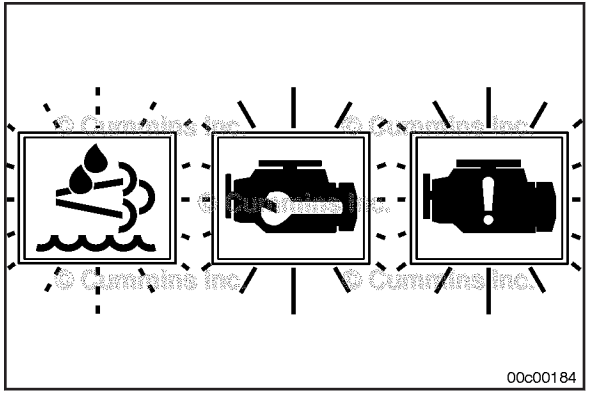
NOTE: It is recommended that the DEF tank be filled completely full of DEF in order to correct any fault conditions.

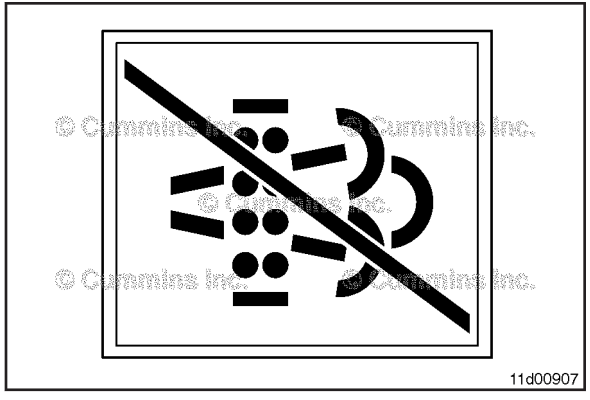
If the engine has been shut down or has idled for an extended period of time after the DEF gauge indicates empty, the STOP ENGINE lamp will also be illuminated along with the flashing AFTERTREATMENT DIESEL EXHAUST FLUID lamp and illuminated CHECK ENGINE lamp. The engine will enter the final derate level 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 CLEANING DISABLED (INHIBIT) lamp indicates that the inhibit switch is active and automatic or manual (non-mission) SCR/exhaust system cleaning will **not** occur. This can be corrected by switching the inhibit switch to permit mode. Refer to Procedure 101-050 in Section 1.

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

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

General Information

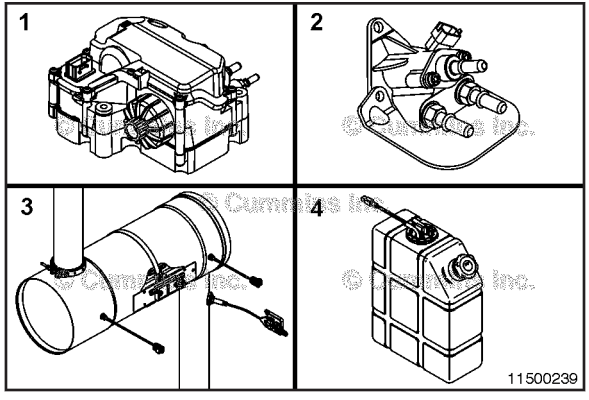
The SCR system is used to decrease the mono-nitrogen oxides (NOx) emissions from the vehicle tailpipe. The system is composed of several main components:

1 Aftertreatment diesel exhaust fluid (DEF) dosing unit

2 Aftertreatment DEF dosing valve

3 Aftertreatment SCR catalyst

4 Aftertreatment DEF tank and header assembly.



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:

- Can have a slight ammonia smell
- Is colorless
- Is non-toxic and non-polluting
- Is non-flammable
- 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 and level sensor, the DEF quality sensor, and all wiring between the components, unless labeled with a Cummins® part number.

NOTE: If the aftertreatment DEF components do **not** have a Cummins® part number, see equipment manufacturer service information.

The aftertreatment DEF dosing unit pumps DEF from the DEF tank to the aftertreatment DEF dosing valve. The aftertreatment DEF dosing unit and header unit is electrically heated and contains a filters that are maintenance items.

NOTE: See the Maintenance Schedule for the aftertreatment DEF dosing unit and DEF tank header filter maintenance interval.

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

The engine control module controls the amount of DEF sprayed into the exhaust. It also controls the DEF tank heater and DEF line heaters.

The aftertreatment SCR catalyst uses DEF to reduce the NOx emissions by converting the engine out NOx into nitrogen and water. The aftertreatment SCR catalyst itself requires no maintenance.

A vehicle with SCR will be equipped with an additional lamp on the dashboard, 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 will illuminate and engine power will be reduced. Attempting to operate the vehicle with no DEF in the tank will result in the vehicle speed being limited to 8 km/h [5 mph].

NOTE: See Section 1 for additional information on the aftertreatment diesel fluid lamp and associated engine derates.

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 will differ 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 engine control module (ECM).

After turning the keyswitch OFF on a vehicle with SCR, a pumping sound may be heard from underneath 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 100 seconds to complete. Do **not** disconnect the vehicle batteries during this process to avoid 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.

Selective Catalytic Reduction (SCR) System Cleaning

SCR system cleaning (also referred to as Aftertreatment Regeneration) occurs to diminish DEF deposits and condition the aftertreatment system. SCR system cleaning utilizes the diesel oxidation catalyst (DOC) to build heat in the aftertreatment system.

The cleaning process requires heat to occur, and can be classified into two different types: passive SCR system cleaning and active SCR system cleaning.

Passive Selective Catalytic Reduction (SCR) System Cleaning

Passive SCR system cleaning occurs when the exhaust temperatures are naturally high enough to meet cleaning requirements. This occurs during high engine duty cycles.

Since passive SCR system cleaning occurs naturally, it is considered to be normal engine operation. No fuel is added to the exhaust stream during passive cleaning.

Active Selective Catalytic Reduction (SCR) System Cleaning

⚠ WARNING ⚠

During Selective Catalytic Reduction (SCR) system cleaning, exhaust gas temperature can reach 800°C [1500°F], and exhaust system surface temperature can exceed 700°C [1300°F], which is hot enough to ignite or melt common materials and to burn people. The exhaust and exhaust components can remain hot after the vehicle has stopped moving. To avoid the risk of fire, property damage, burns, or other serious personal injury, allow the exhaust system to cool before beginning this procedure or repair. Make sure that no combustible materials are located where they are likely to come in contact with hot exhaust or exhaust components.

Active SCR system cleaning occurs when the exhaust temperatures are **not** naturally high enough to meet cleaning requirements.

Active SCR system cleaning requires assistance from the engine in order to increase the exhaust temperature. This is typically done by injecting a small amount of diesel fuel into the exhaust stream (called aftertreatment injection) which is then oxidized by the aftertreatment DOC. The oxidation of this additional fuel creates the heat needed to condition the aftertreatment system.

For active SCR system cleaning to occur, the ECM **must** determine that the aftertreatment timer or duty cycle-based algorithms have reached a specified limit. Once this limit is reached, the engine will alter its operation in order to create exhaust temperatures high enough to actively regenerate the aftertreatment system.

Active SCR system cleaning will occur more frequently in equipment with low load, or stop-and-go duty cycles.

Active SCR system cleaning is largely transparent to the equipment operator. The equipment operator may notice an increase in turbocharger noise during an active SCR system cleaning event, and may notice that the high exhaust temperature lamp is illuminated, if the exhaust temperature is greater than the high exhaust system temperature threshold set by the equipment original equipment manufacturer (OEM).

During active SCR system cleaning, the exhaust temperature can be hotter than when the engine is operating at full load. The exhaust temperature during a normal active SCR/exhaust system cleaning event could reach 650°C [1202°F].

NOTE: Use the following procedure for additional information about the engine indicator lamps. Refer to Procedure 101-048 in Section 1.

Manual (Non-Mission) Selective Catalytic Reduction (SCR) System Cleaning

Under some operating conditions, such as low speed, low load, or stop-and-go duty cycles, the engine may **not** have enough opportunity to regenerate the aftertreatment system during normal operation. When this occurs, the engine will illuminate the SCR cleaning lamp to inform the operator that assistance is required, typically in the form of a manual (non-mission) SCR system cleaning.

Manual (non-mission) SCR system cleaning is a form of active cleaning that is initiated by the equipment operator when **not** in operation.

Manual (non-mission) SCR system cleaning requires an elevated engine speed of approximately 1000 rpm. The length of a manual (non-mission) SCR system cleaning will vary depending on ECM algorithms, but will typically take anywhere from 20 to 60 minutes to complete.

A manual (non-mission) SCR system cleaning can be initiated one of several ways:

- An equipment mounted manual (non-mission) SCR system cleaning switch: Use the owner's manual for the location and operation of this switch. This switch may also be called a "parked SCR system cleaning" switch or start switch. The mounted manual (non-mission) SCR system cleaning switch will **only** initiate a manual (non-mission) SCR system cleaning when the SCR system cleaning lamp is illuminated.
- INSITE™ electronic service tool can initiate a manual (non-mission) SCR system cleaning by starting the "SCR Performance Test".

NOTE: The start and permit switches as well as the aftertreatment lamp are common with other Cummins systems utilizing a Diesel Particulate Filter. Some OEMs, documentation, and tools may reference these as Aftertreatment Diesel Particulate Filter Regeneration or Aftertreatment Regeneration parameters.

To perform a manual (non-mission) SCR system cleaning, follow the steps listed:

- Select an appropriate location to park the equipment.
- Choose a surface that will **not** burn or melt under high exhaust temperatures (such as clean concrete or gravel, **not** grass or asphalt).
- Make sure there are no items within 0.6 m [2 ft] of the exhaust outlet.
- Items that can burn, melt, or explode **must** be kept at least 1.5 m [5 ft] from the exhaust outlet (such as gasoline, paper, plastics, fabrics, compressed gas containers, hydraulic lines).
- Make sure that there are no gases or vapors nearby that could burn, explode, or contribute to a fire (such as LP gas, gasoline vapors, oxygen, nitrous oxide).

- Park the vehicle securely. Place the transmission in park, if provided, otherwise in neutral. Set wheel chocks at the front and rear of at least one tire.
- Set up a safe exhaust area. If bystanders might enter the area, set up barriers to keep people at least 1.5 m [5 ft] from the exhaust outlet during the manual (non-mission) SCR system cleaning. When indoors, attach an exhaust discharge pipe rated for at least 816°C [1500°F].
- Keep a fire extinguisher nearby.
- Check the exhaust system surfaces. Confirm that nothing is on or near the exhaust system surfaces (such as tools, rags, grease, or debris).
- The clutch pedal is released.
- The brake pedal is released.
- The transmission is in neutral or park.
- Power takeoff (PTO) or Remote PTO is off.
- The vehicle speed is 0 mph.
- The throttle pedal is released.
- Initiate the manual (non-mission) SCR system cleaning by toggling the equipment mounted manual (non-mission) SCR system cleaning switch or by using INSITE™ electronic service tool.
- Once the manual (non-mission) SCR system cleaning is initiated, the engine speed may increase, the turbocharger noise will increase, the high exhaust system temperature lamp may illuminate, and the SCR system cleaning lamp will blink.
- When the engine ECM detects that the cleaning has been completed, the engine will automatically return to normal idle speed, if increased.

- Monitor the vehicle and surrounding area during the stationary (parked) SCR system cleaning. If any unsafe condition occurs, shut off the engine immediately.

To stop a manual (non-mission) SCR system cleaning before it has completed, depress the clutch, brake, or throttle pedal, set the SCR system cleaning permit switch to the inhibit position, or turn off the engine.

Once the manual (non-mission) SCR system cleaning is complete, exhaust gas and surface temperatures will remain elevated for 3 to 5 minutes.

NOTE: If the low idle engine speed is 1000 rpm or greater, the engine speed will not increase when a manual (non-mission) SCR system cleaning is initiated.

Aftertreatment Switches

The vehicle manufacturer can install three switches that interact with the aftertreatment system:

- A stationary (parked) SCR system cleaning switch (can also be called a "start" switch or "parked SCR system cleaning" switch)
- An active SCR system cleaning permit switch (can also be called an "inhibit" switch, "disable" switch, or "stop" switch).
- An SCR operator inducement override switch (can also be called an "engine protection override" switch or "derate override" switch.

Refer to the vehicle owner’s manual for the location and presence of these switches.

The stationary (parked) SCR system cleaning switch is used to initiate a stationary (or parked) SCR system cleaning. See the following procedure for further information on aftertreatment SCR system cleaning. Refer to Procedure 101-050 in Section 1. The active SCR system cleaning permit switch is used to disable active SCR system cleaning.

The permit switch **must only** be used for special circumstances where it is desirable to **not** allow an active SCR system cleaning event. Prolonged engine operation with this switch engaged may result in illumination of the SCR system cleaning lamp.

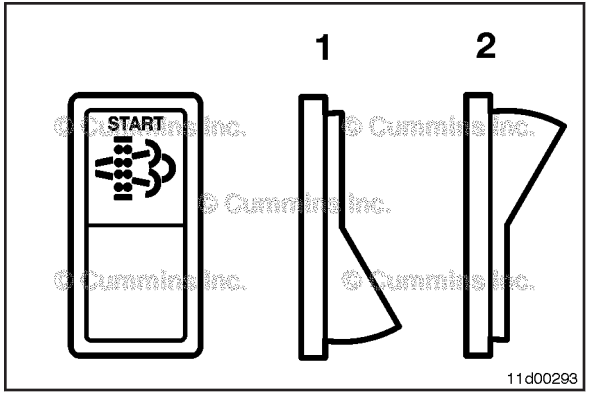
The aftertreatment cleaning switches are typically used in two configurations:

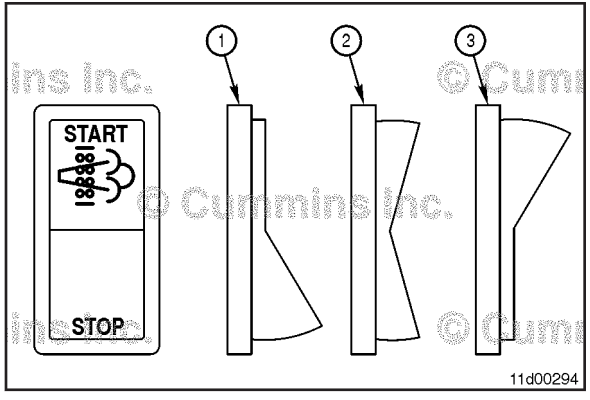
- A two position switch that is used to activate stationary (parked) SCR system cleaning
- A three position switch that is used to activate stationary (parked) SCR system cleaning and also disable active SCR system cleaning.

The examples below are generic and show two typical switch configurations. Use the vehicle owner's manual for the location and presence of these switches.

A two position switch (ON and OFF positions) will, when in the ON position (1), activate a stationary (or parked) SCR system cleaning.

The switch should be left in the OFF position (2) when the switch is **not** being used.





A three position switch (ON, NEUTRAL, and OFF positions) will typically have both "start" and "permit" functions.

In the ON position (1), the "start" switch is depressed, which will activate a stationary (or parked) SCR system cleaning.

In NEUTRAL position (2), neither the "start" switch or "permit" switch is depressed as the switch is in the neutral position. This position is recommended for normal engine operation.

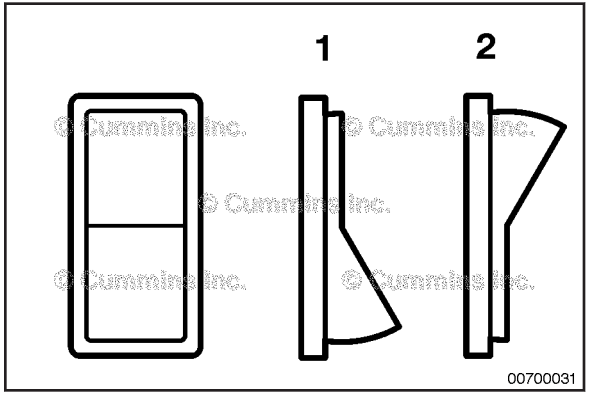
In OFF position (3), the "permit" switch is depressed. When the switch is in this position, active cleaning of the aftertreatment will **not** be allowed.

The vehicle manufacturer can install an SCR operator inducement override switch (also called an "engine protection override" switch or "derate override" switch). The derate override switch allows a driver to abort a pending aftertreatment derate or shutdown. The switch can be used up to three times consecutively to abort the derate for up to thirty minutes at a time. After the third consecutive use of the switch, the engine will be forced into the aftertreatment derate condition.

The switch is **only** active when it is properly wired by the OEM and the feature is enabled in the calibration.

When in the ON position, with the feature enabled in the calibration and less than three consecutive uses of the switch have been triggered, aftertreatment derate will be disabled for up to thirty minutes.

The switch should be left in the OFF position (2) when the switch is **not** being used.



Aftertreatment Derates

The engines supported by this manual are required to meet Tier 4 Final/Stage IV Midrange Aftertreatment regulations. These regulations exist to make sure the engine is operated within emissions limits. The ECM continuously monitors the engine and aftertreatment system to detect malfunctions that adversely affect emissions. Once a malfunction is detected, the operator is alerted by one of the engine indicator lamps and a fault code, which identifies the likely

malfunction, is stored in the ECM. For more information on the engine indicator lamps. Refer to Procedure 101-048 in Section 1.

If the malfunction is not resolved within the allotted time, the engine will not respond to the throttle or it will shut down. The operator will be alerted that there is a need for corrective action through a series of derates prior to the regulated final derate is applied. For more information on the derate strategy see equipment manufacturer service information. Some OEMs will install an SCR operator inducement override switch. See the Aftertreatment Switches step in this procedure.

The following are some of the aftertreatment components that can cause derates:

- DEF level below operating condition or malfunction
- DEF quality outside of operating condition or malfunction
- NOx sensor tampering or malfunction
- Exhaust gas temperature sensor tampering or malfunction
- DEF dosing unit tampering or malfunction
- DEF dosing valve tampering or malfunction
- EGR valve tampering or malfunction.

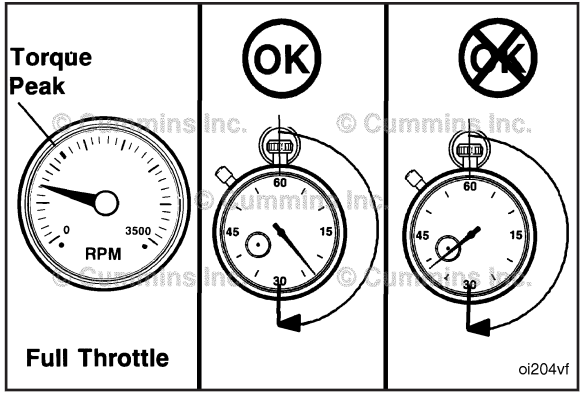
Engine Operating Range

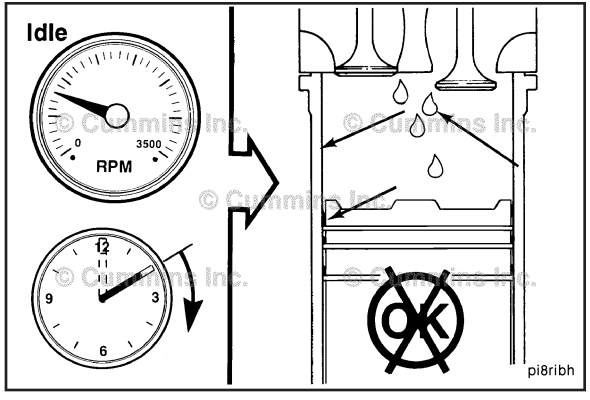
General Information

⚠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.

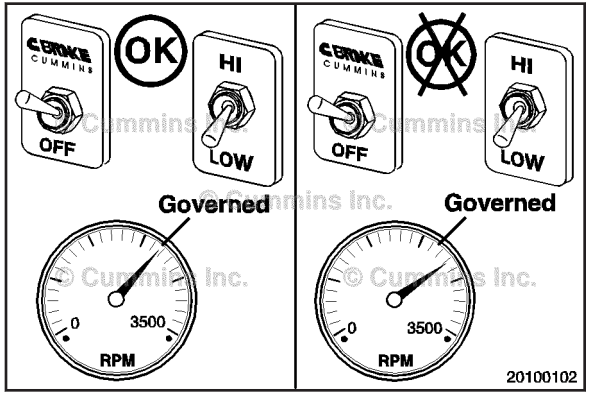
⚠CAUTION⚠
Do not operate the engine beyond the maximum engine speed. Operating the engine beyond the maximum engine speed can cause severe engine damage. Use proper operating techniques for the vehicle, vessel, or equipment to prevent engine overspeed. The maximum engine speed specification is listed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

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 idle the engine for excessively long periods. Long periods of idling, more than 10 minutes, can cause poor engine performance.



Engine Braking System

General Information

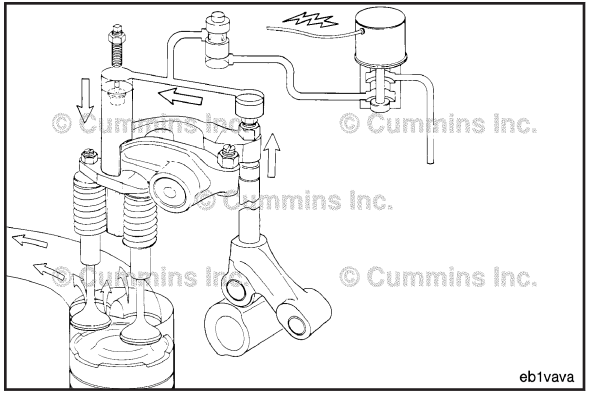
⚠CAUTION⚠
Do not exceed governed engine speed when operating engine brakes. Engine damage can occur. The engine brakes are designed to assist the vehicle's service brakes to slow the vehicle down. Never use only the engine brakes to stop the vehicle. If other engine brakes are used, see the component manufacturer's manual.

Some engines are equipped with engine brakes.

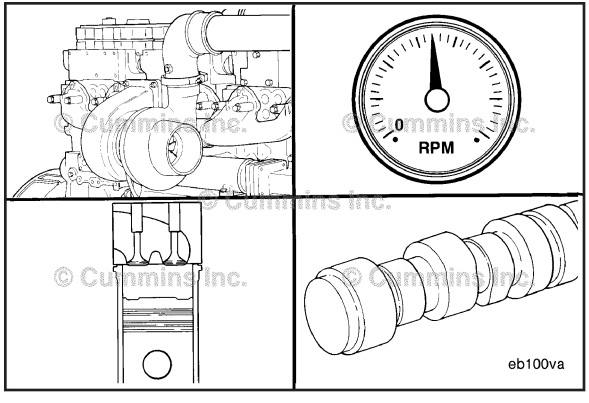
Engine brakes are devices that use the energy of engine compression to provide vehicle retardation. Engine brakes provide the maximum retarding power at rated speed; therefore, gear selection is important.

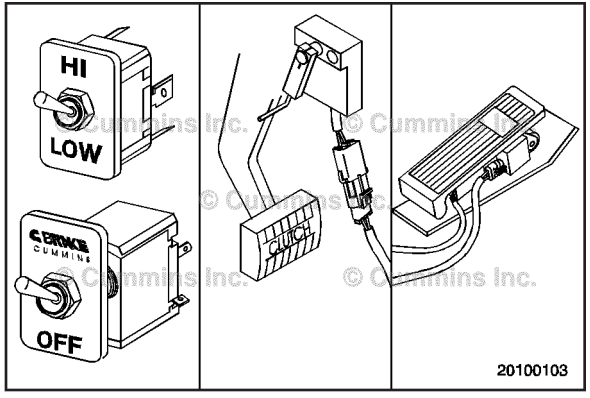
The engine brakes convert the engine to an energy-absorbing device to reduce vehicle speed.

This is accomplished by a hydraulic circuit that opens the exhaust valves near the end of the compression stroke.



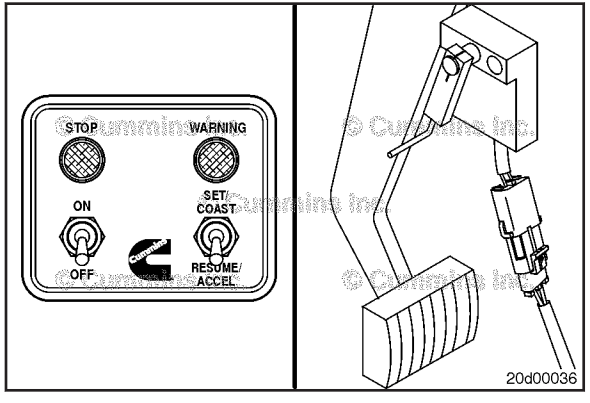
The amount of braking power available in a given engine series varies. Braking power depends on turbocharger boost pressure, engine speed, compression ratio, injector timing, and when the engine brakes open the exhaust valves.





Engine brake controls, with the fuel system, consists of the following:

- A two-position selector switch
- An ON/OFFf switch
- A clutch switch
- A throttle sensor.



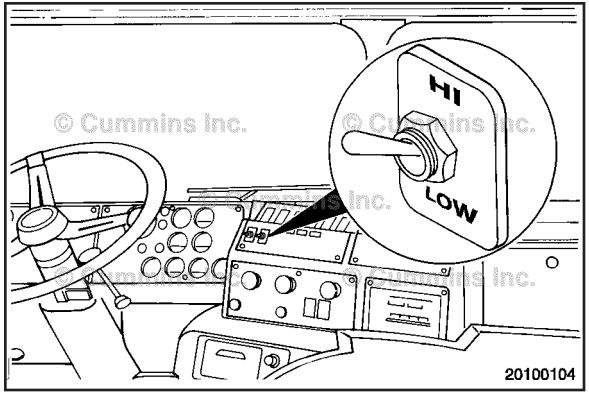
Other switches for cruise control that affect engine brake operations are:

- Cruise control ON/OFF switch (if Cruise Control actuator feature is selected).
- Service brake switch (if service brake actuator feature is selected).

The engine control module (ECM) allows the engine brakes to operate while the cruise control is turned ON.

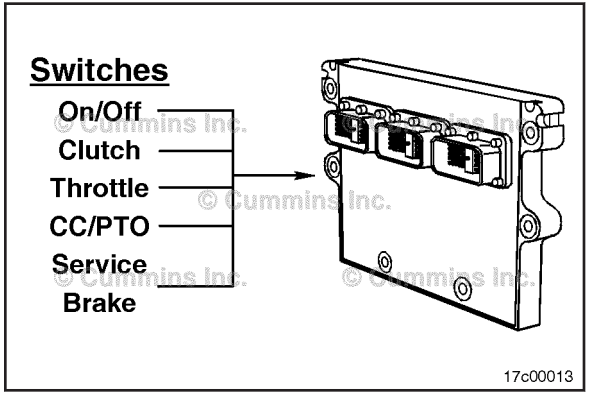
The two-position selector switch is located next to the ON/OFF switch in the cab, and allows you to select the retarding power of one or two brakes.

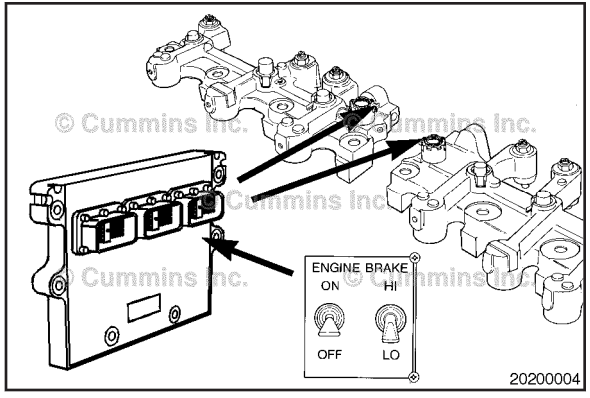
LOW activates the engine brake on three cylinders, and HI activates the engine brake on six cylinders.



Signals from the ON/OFF switch, clutch switch, throttle sensor, and the cruise/PTO switches are fed into the ECM.

NOTE: Any one of these switches can de-activate the engine brakes.

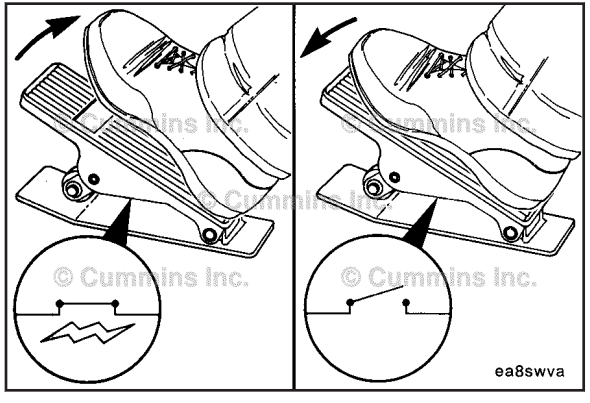




The ECM then electronically enables or disables the engine brakes.

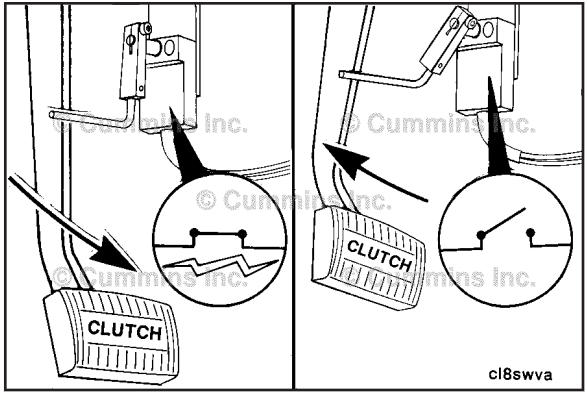
NOTE: Engine brakes can **not** be enabled:

- When cruise control is active and the engine brakes in cruise control feature is turned off
- When engine speed goes below 850 rpm
- When an electronic fault code is active.



The throttle sensor is part of the accelerator pedal assembly located in the cab and will deactivate the engine brakes when the acceleration pedal is depressed.

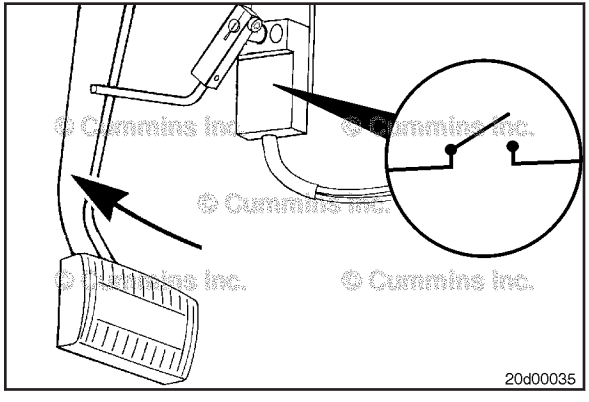
The clutch switch uses the motion of the clutch linkage to deactivate the engine brakes when the clutch pedal is depressed.

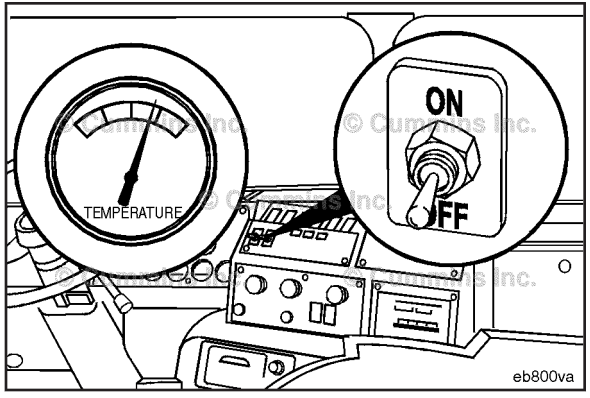


The service brake switch is attached to the service brake.

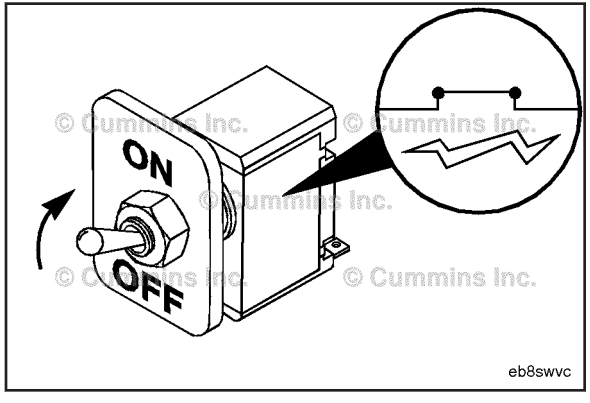
Applying the service brakes while in cruise control will disengage the cruise control and enable the engine brakes.

If the pedal-activated engine brake feature is enabled, the service brake pedal **must** be tapped before the engine brakes will be activated.





Idle the engine 3 to 5 minutes at approximately 1000 rpm to warm the engine before activating the engine brakes. Do **not** operate the engine brake until the engine oil temperature is above 30°C [86°F].



To activate the engine brakes, switch the ON/OFF switch to the ON position. Once activated, the operation of the engine brake is fully automatic.

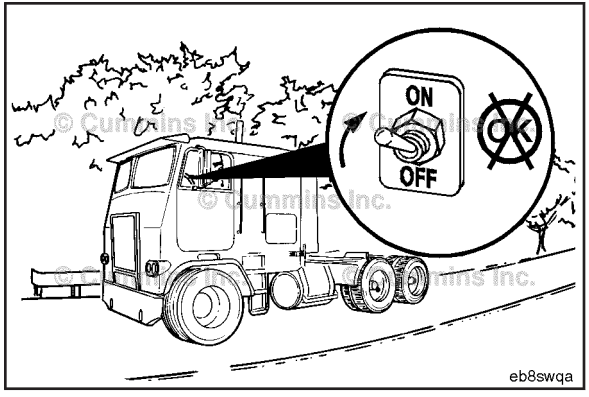
NOTE: See the “Tips for Operation” steps in this section for specific information about engine brake operation under certain road conditions.

NOTE: Some vehicles have an additional pedal that **must** be pressed for the engine brakes to activate. It is **not** fully automatic.

⚠WARNING⚠

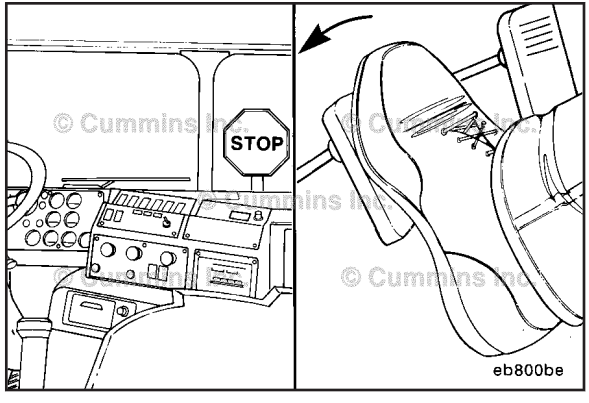
Do not use engine brakes while bobtailing or pulling an empty trailer. With the engine brakes in operation, wheel lockup can occur more quickly when the service brakes are applied, especially on vehicles with single-drive axles.

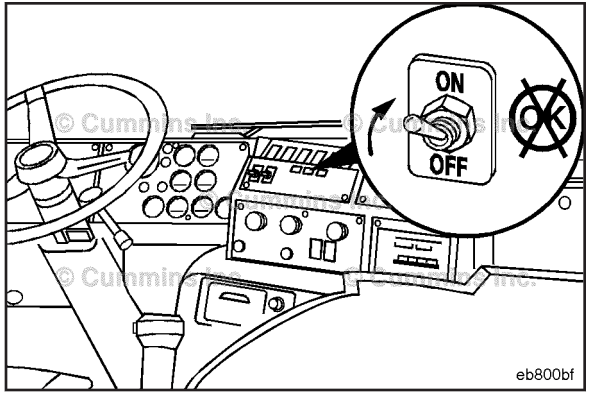
Make sure the engine brakes are switched to the OFF position when bobtailing or pulling an empty trailer.



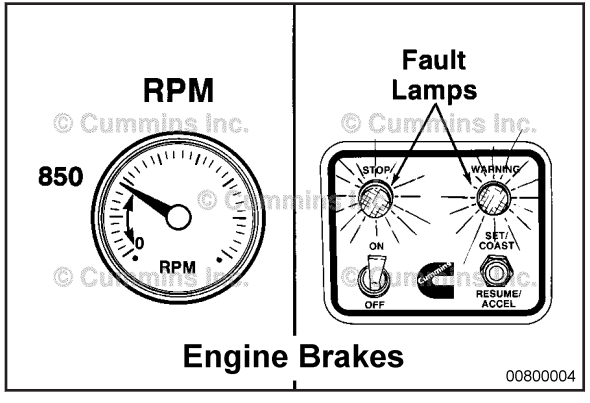
NOTE: The engine brakes are designed to assist the vehicle's service brakes when slowing the vehicle to a stop.

Remember, service brakes will be required to bring the vehicle to a stop.





⚠CAUTION⚠
Do not use the engine brakes to aid in clutchless gear shifting. This can cause the engine to stall or lead to engine damage.

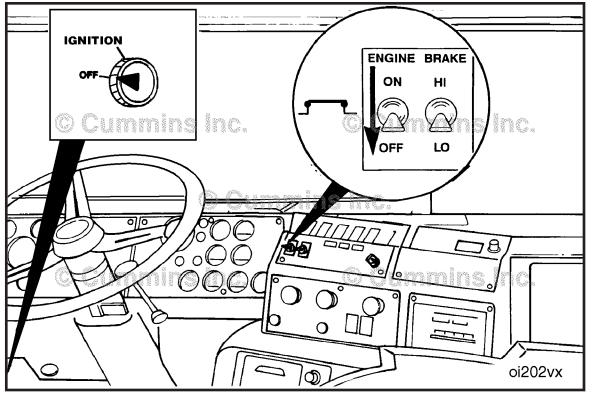


The ECM will disable the engine brakes when engine speed is below 850 rpm or when an electronic fault code is active.

⚠CAUTION⚠

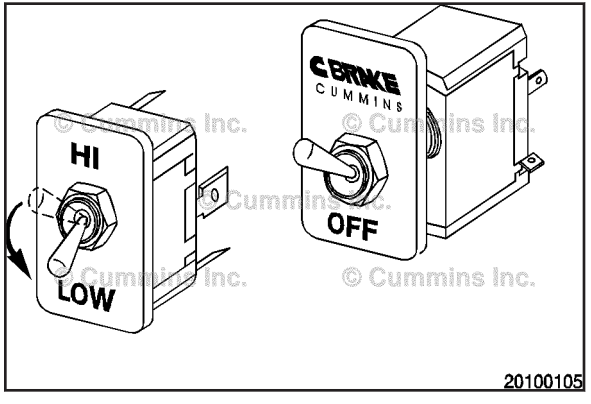
Do not operate the engine if the engine brake will not deactivate. To do so will cause severe engine damage.

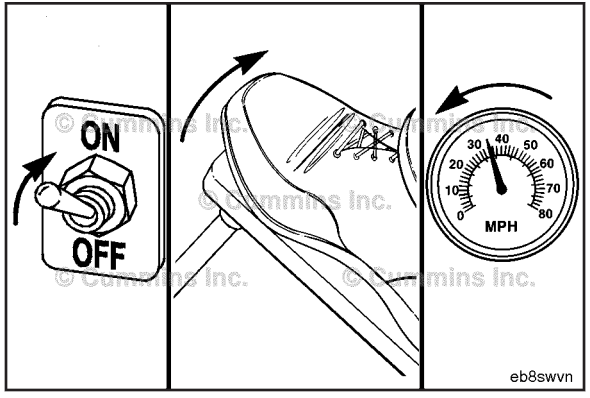
If the engine brakes will **not** shut off, shut off the engine immediately, and contact a Cummins® Authorized Repair Location.



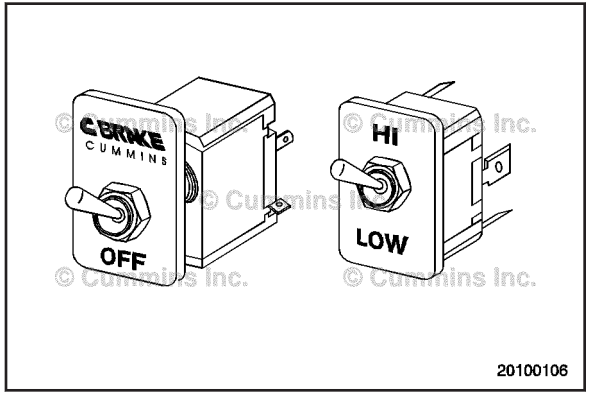
Tips for Operation on Level and Dry Pavement

For operation on dry and relatively flat surfaces, when greater retarding power is **not** required, put the two-position selector switch in the LOW position.





To reduce vehicle speed, put the engine brake ON/OFF switch in the ON position. Remove your foot from the accelerator pedal and clutch pedal. The engine brakes will immediately begin to operate, slowing the vehicle.



For operation on dry pavement when maximum retarding power is required, put the two-position selector switch in the HI position.

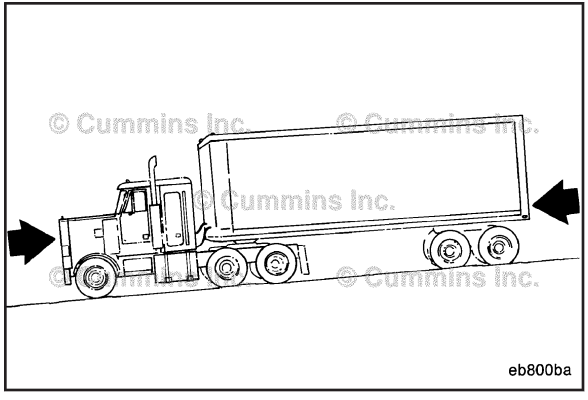
Tips for Operation on Grades with Dry Pavement

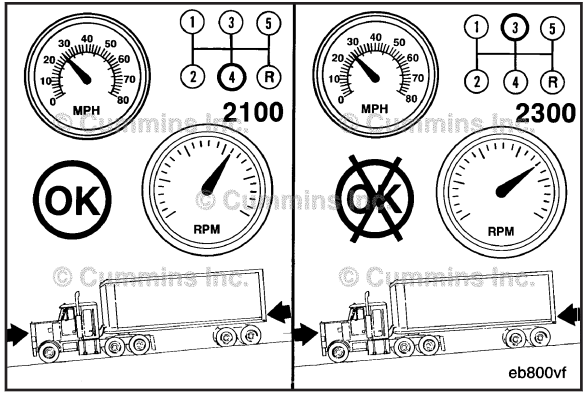
⚠WARNING⚠
To reduce the possibility of personal injury or property damage, always be prepared to use the vehicle service brakes for emergency stopping. The safe control speed of a vehicle will vary with the size of the load, the type of load, the grade, and the road conditions.

Control speed is the speed at which the forces pushing a vehicle down a grade are equal to the forces holding it back.

Vehicles equipped with properly operated engine brakes are often capable of traveling downhill at slightly higher control speeds than vehicles **not** equipped with engine brakes.

NOTE: Always be prepared to use the vehicle service brakes for emergency stopping.

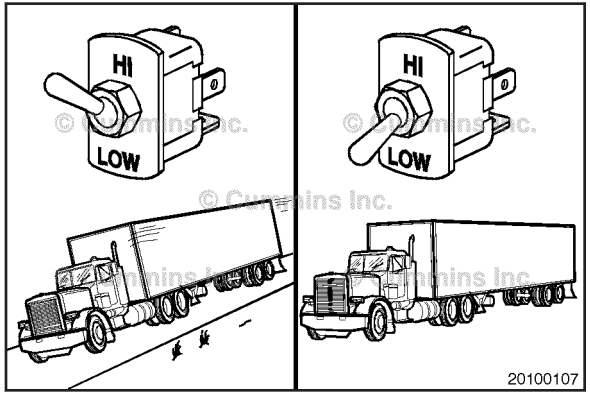




⚠CAUTION⚠
Never exceed governed engine speed because engine damage can occur.

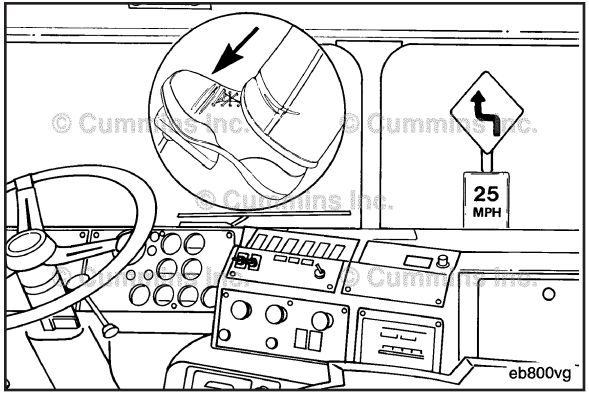
Once you have determined what the safe speed is for your vehicle, operate the engine brakes with the transmission in the lowest gear that will **not** cause the engine speed to exceed the rated engine speed.

NOTE: The optimum braking power of the engine brakes is reached at rated engine speed. Correct gear selection, therefore, is critical.

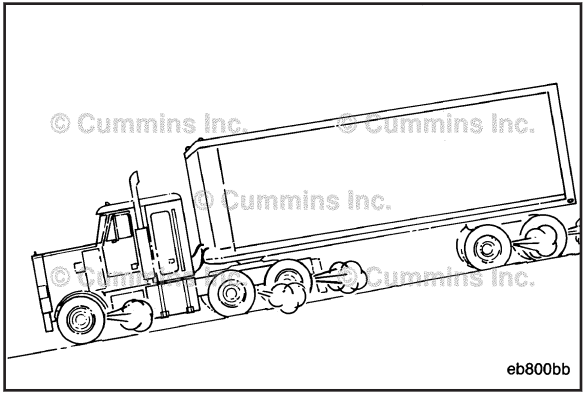


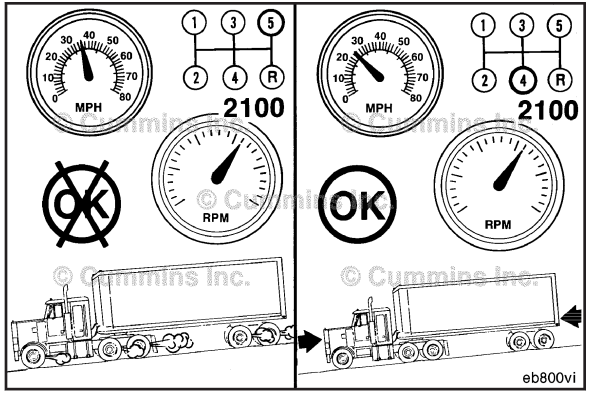
The two-position selector switch can be used to vary braking power as road conditions change.

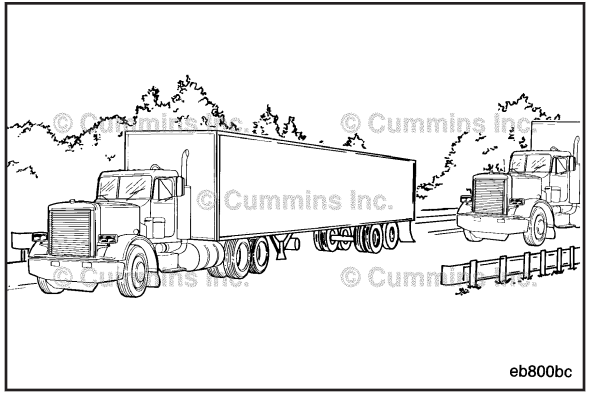
Vehicle service brakes **must** be used when additional braking power is required.



⚠WARNING⚠
Frequent use of the service brakes will cause them to heat up, reducing their ability to slow or stop the vehicle.







If frequent use of the vehicle service brakes is required, it is recommended that a slower control speed be used by selecting a lower transmission gear.

NOTE: The longer or steeper the hill, the more important it is to use your engine brakes. Make maximum use of your engine brakes by gearing down and letting the engine brakes do the work.

Tips for Operation on Slick Roads

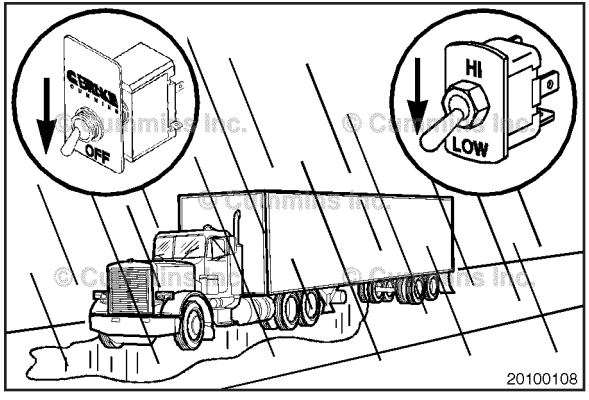
⚠WARNING⚠

To reduce the possibility of personal injury or property damage, always allow for extra distance between your vehicle and other objects when using the service brakes or engine brakes on slick roads.

The operation of any vehicle is difficult to predict on slick roads. The first 10 to 15 minutes of rainfall are the most dangerous, as road dirt and oil mixed with rain create a very slippery surface.

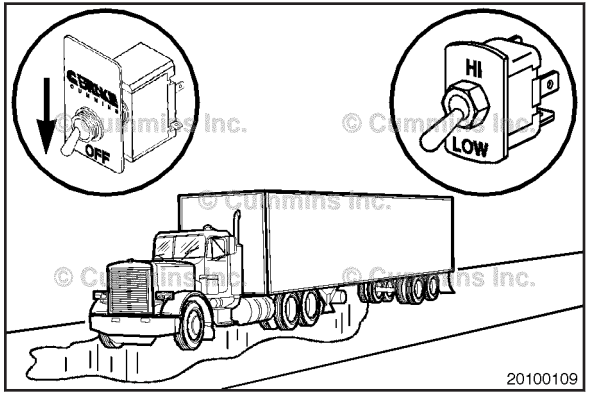
⚠WARNING⚠

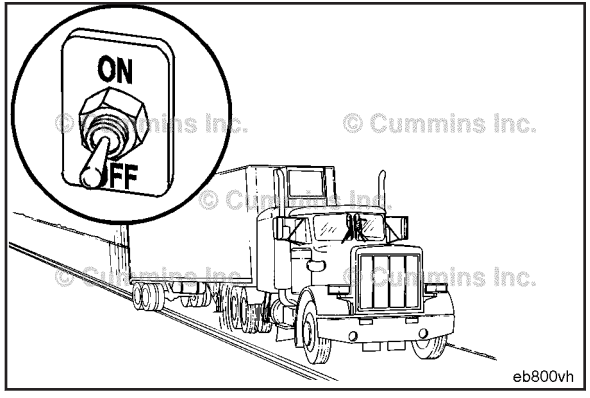
To reduce the possibility of personal injury or property damage, reduce the retarding power or turn "OFF" the engine brakes on slick roads. Using engine brakes on wet or slippery roads can cause overbraking, especially on vehicles with light loads or single-drive axles. Stopping distance can actually increase, or the vehicle can skid or jackknife.



When driving on slick roads, start with the ON/OFF switch in the "OFF" position and the two-position selector switch in the LOW position.

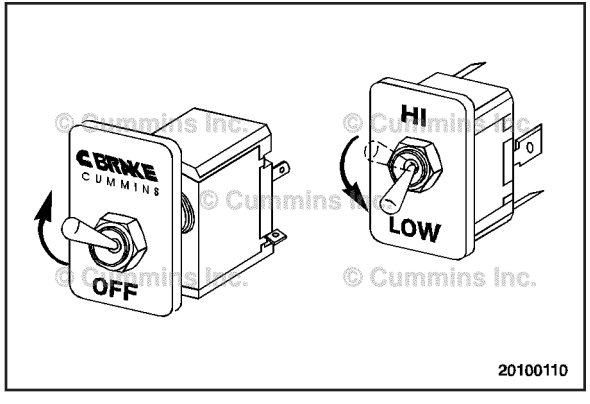
If your tractor is equipped with a twin-screw rear axle, position the power divider switch in the unlocked position.





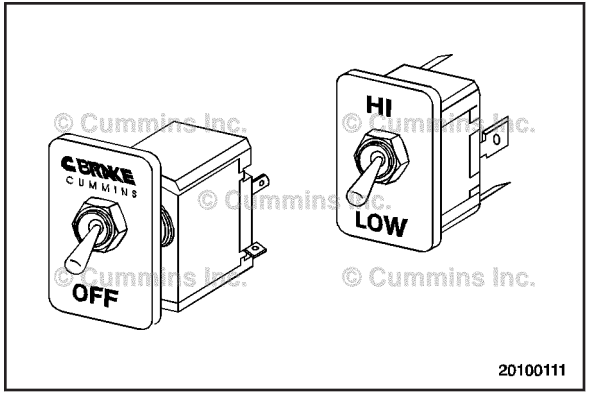
Remove your foot from the accelerator pedal to make sure the vehicle will maintain traction with the retarding power of the engine alone.

If the vehicle drive wheels begin to skid or if there is a fishtailing motion, do **not** activate the engine brakes.

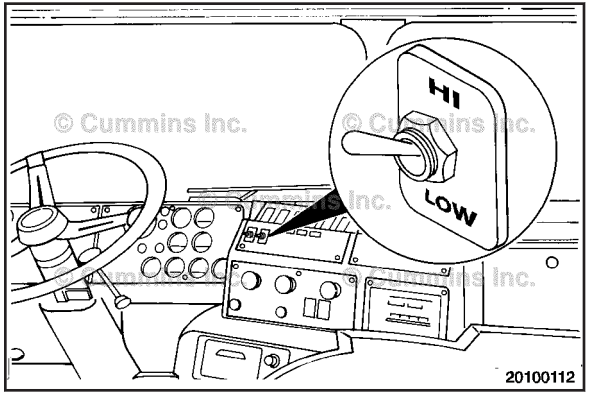


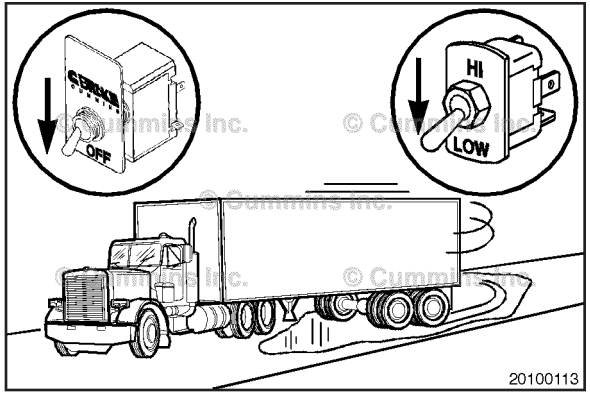
If traction is maintained using the retarding power of the engine alone and more braking power is required, switch the two-position selector switch to the LOW position and activate the engine brakes by switching the ON/OFF switch to the ON position.

If the vehicle's drive wheels begin to skid or there is a fishtailing motion, switch the ON/OFF switch to the OFF position.



If traction is maintained when the engine brakes are activated and more braking power is required, move the two-position selector switch to the HI position.





Again, if the vehicle has lost traction or if there is a fishtailing motion, switch the ON/OFF switch to the OFF position. Do **not** attempt to use the engine brakes in the HI position.

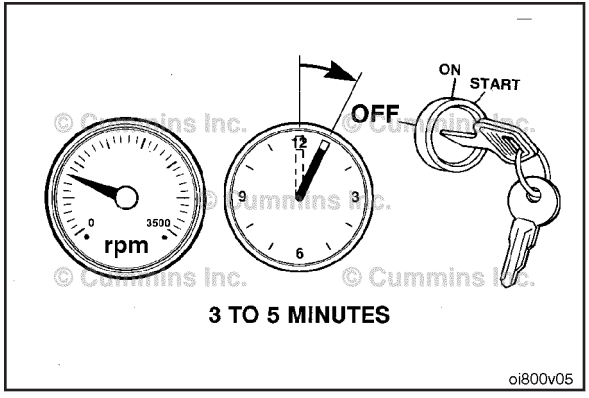
Engine Shutdown

General Information

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

NOTE: For engines equipped with an electronic control module (ECM) ensure the keyswitch is turned off for a minimum of 100 seconds prior to disconnecting the continuous (unswitched) battery power supply. If the unswitched battery power supply is disconnected in less than 100 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.



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

Section 2 - Maintenance Guidelines

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Maintenance Data 2-6
Maintenance Schedule 2-2
Maintenance Check 2-2

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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.

Maintenance Schedule

Maintenance Check

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

Maintenance Procedures at Daily Interval

- Air Intake Piping - Check
- Fan, Cooling - Inspect for Reuse
- Crankcase Breather Tube - Check
- Air Tanks and Reservoirs - Drain
- Coolant Level - Check
- Fuel-Water Separator - Drain
- Lubricating Oil Level - Check
- Aftertreatment Exhaust Piping - Check
- Dust Ejection Valve - Check
- Diesel Exhaust Fluid (DEF) Level - Check

Maintenance Procedures at 250 Hours or 3 Months

- Air Cleaner Restriction - Check
- Charge-Air Piping - Check
- Charge-Air Cooler - Check

- Radiator Hoses - Check
- Air Intake Piping - Check
- Radiator - Check

Maintenance Procedures at 500 Hours or 6 Months

- Fuel Filter (Spin-On Type) - Change[6]
- Lubricating Oil System - Change[1, 7]
- Lubricating Oil Filter (Spin-On) - Change[1]
- Supplemental Coolant Additive (SCA) and Antifreeze Concentration - Check[2]
- Coolant Filter - Change
- Batteries - Check[4]
- Battery Cables and Connections - Check[4]
- Radiator Pressure Cap - Inspect for Reuse

Maintenance Procedures at 1000 Hours or 1 Year

- Drive Belt, Cooling Fan - Check
- Belt Tensioner, Automatic (Water Pump) - Check
- Aftertreatment DEF Tank Filter - Inspect for Reuse[(9)]

Maintenance Procedures at 2000 Hours

- Crankcase Breather Element - Change

Maintenance Procedures at 2000 Hours or 2 Years

- Cooling System - Flush[8]
- Vibration Damper, Rubber - Inspect for Reuse
- Vibration Damper, Viscous - Check[3]
- Engine Steam Cleaning - Clean
- Air Compressor Discharge Lines - Check

Maintenance Procedures at 4500 Hours or 3 Years

- Aftertreatment DEF Dosing Unit Filter - Change

Maintenance Procedures at 5000 Hours or 4 Years

- Overhead Set - Adjust[5]
- Engine Brake - Adjust[4]

1 Cummins Inc. requires the use of a high quality, heavy duty engine oil. Use the following procedure for lubrication oil and recomendations. Refer to Procedure 018-003 in Section V.

2 Service interval is every oil change or 500 hours, or 6 months, whichever occurs first. Use the following procedure for coolant specifications and recommendations. Refer to Procedure 018-004 in Section V. The change interval is 2 years. Antifreeze is essential for freeze, overheat, and corrosion protection. SCA is essential for liner pitting and scaling protection.

3 The service interval is 2 years.

4 Follow the manufacturers' recommended maintenance procedures for the starter, alternator, batteries, electrical components, engine brake, exhaust brake, charge-air cooler, radiator, air compressor, air cleaner, refrigerant compressor, and fan clutch.

5 Reset valve lash, if needed, to nominal specifications. Refer to Procedure 018-015 in Section V.

6 Replace the suction-side and the pressure-side fuel filters at the same time.

7 For standby generator sets, the recommended change interval is 250 hours or every 12 months, whichever occurs first. For primary or continuous rated generator sets the interval is 500 hours or every 12 months, whichever occurs first.

8 This cooling system requirement to Flush at this scheduled maintenance includes: Drain, Flush, and Fill.

9 See equipment manufacturer service information for DEF tank filter service interval. For Cummins® provided DEF tanks, filter replacement is recommended every 2000 hours or one year, whichever occurs first. For low dust environments (such as paved road or indoor equipment), the recommended interval is 4500 hours or three years, whichever occurs first.

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

Maintain the correct oil and filter change intervals. It is a vital factor in preserving the integrity of an engine. Filters **must** be changed when the oil is changed.

Maintenance Record Form

Maintenance Data

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

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

A	B	C	D	E	F

Notes

Section L - Service Literature

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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

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Additional Service Literature

General Information

The following publications can be purchased.

Bulletin Number	Title or Publication
4332796	QSL9 CM2350 L102 Service Manual
4332795	QSL9 CM2350 L102 Fault Code Troubleshooting Manual
4332794	QSL9 CM2350 L102 Wiring Diagram
4332797	QSL9 CM2350 L102 Operation and Maintenance Manual
4332798	QSL9 CM2350 L102 Owners Manual
3379000	Air for Your Engine
3379001	Fuels for Cummins® Engines
3379009	Operation of Diesel Engines in Cold Climates
3666132	Cummins® Coolant Requirements and Maintenance
3810303	Parts Reuse Guidelines
3810340	Cummins® Engine Oil and Oil Analysis Recommendations

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

Section V - Maintenance Specifications

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General Engine

Specifications

Listed below are the general specifications for the engines covered in this manual:

Horsepower.....See engine dataplate
Firing Order.....1-5-3-6-2-4
Crankshaft Rotation (viewed from front of engine)..... **Clockwise**
Displacement.....8.9 liters [543 in^3]
Bore and Stroke.....114 mm [4.49 in] x 145 mm [5.71 in]
Wet Weight.....708 kg [1561 lb]
Overhead Adjustment
Intake Valve Adjustment.....0.305 mm [0.012 in]
Exhaust Valve Adjustment.....0.559 mm [0.022 in]
Engine Brake Adjustment.....2.286 mm [0.090 in]
Maximum Overspeed Capability (15 seconds maximum).....2550 rpm
Minimum Ambient Air Temperature for Unaided Cold Start[1] .....-23°C [-10°F]
Minimum Ambient Air Temperature with Cold Starting Aid[2] .....-40°C [-40°F]
Minimum Engine Cranking Speed.....120 rpm
Engine Idle Speed.....700 to 1200 rpm
Altitude Limit Before Derate is Applied.....3658 m [12,000 ft]

1. Engines covered by this manual meeting regulations for Tier 4 Final/Stage IV **must** be equipped with an intake air grid heater. Refer to Procedure 010-029 in Section 10.

2. Available cold starting aids include a block heater and an oil pan heater.

Lubricating Oil System

Specifications

Oil Pressure
- At Low Idle (minimum allowable)....69 kPa [10 psi]
- At Rated Speed (minimum allowable)....207 kPa [30 psi]

Regulated Oil Pressure....517 kPa [75 psi]
Lubricating Oil Filter Capacity....3.78 liters [4 qt]

Oil Pan Capacity, Low to High (ISC)
- Standard Oil Pan....15.1 to 18.9 liters [16 to 20 qt]
- Standard Oil Pan with Cylinder Block Stiffener Plate....16.1 to 19.9 liters [17 to 21 qt]

Total System Capacity (Oil Pan and New Oil Filter) (ISC)
- Standard Oil Pan....22.7 liters [24 qt]
- Standard Oil Pan with Cylinder Block Stiffener Plate....23.7 liters [25 qt]

Oil Pan Capacity, Low to High (ISL)
- Standard Oil Pan....18.9 to 22.7 liters [20 to 24 qt]
- Standard Oil Pan with Cylinder Block Stiffener Plate....19.9 to 23.7 liters [21 to 25 qt]

Total System Capacity (Oil Pan and New Oil Filter) (ISL)
- Standard Oil Pan....26.5 liters [28 qt]
- Standard Oil Pan with Cylinder Block Stiffener Plate....27.4 liters [29 qt]

Cooling System

Specifications

Coolant Capacity (engine **only**).....12.4 liters [13.1 qt]
Standard Modulating Thermostat Range.....82 to 93°C [180 to 200°F]
Minimum Recommended Pressure Cap.....90 kPa [13 psi]
Minimum Fill Rate (without low-level alarm).....11.4 liters/min [3 gpm]
Maximum Deaeration Time.....25 minutes
Maximum Top Tank Coolant Temperature.....107°C [225°F]
Winterfronts
Minimum allowed air passage area.....774 cm^2 [120 in^2]

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 Cummins Filtration™ Fleetguard® filters 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 should 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.

Lubricating Oil Filter (1)	
Cummins® Part Number	3401544
Cummins Filtration™ Part Number	LF9009

Fuel Filter (Pressure-Side) Hex Drive Base (2) (3)	
Cummins® Part Number	5303743
Cummins Filtration™ Part Number	FF63009

Fuel Filter (Suction-Side, with Water-In-Fuel Sensor)(2)	
Cummins® Part Number	5308722
Cummins Filtration™ Part Number	FS20038

Crankcase Breather Element	
Cummins® Part Number	4939749
Cummins Filtration™ Part Number	CV5060300

Air Filter (Primary)	
127 x 381 x 203 mm [5 x 15 x 8 in]	
Cummins® Part Number	5261248
Fleetguard® Part Number	AF55005
127 x 381 x 305 mm [5 x 15 x 12 in]	
Cummins® Part Number	5261249
Fleetguard® Part Number	AF55014
254 x 254 x 305 mm [10 x 10 x 12 in]	
Cummins® Part Number	5261250
Fleetguard® Part Number	AF55015

Air Filter (Secondary)	
127 x 381 x 203 mm [5 x 15 x 8 in]	
Cummins® Part Number	5261251
Fleetguard® Part Number	AF55308
127 x 381 x 305 mm [5 x 15 x 12 in]	
Cummins® Part Number	5261251
Fleetguard® Part Number	AF55308
254 x 254 x 305 mm [10 x 10 x 12 in]	

Air Filter (Secondary)	
Cummins® Part Number	5261252
Fleetguard® Part Number	AF55309

Aftertreatment Diesel Exhaust Fluid (DEF) Dosing Unit Filter	
Cummins® Part Number	5303604

(1)An LF9009 lubricating oil filter **must** be used. A venturi type lubricating oil filter **must** be used in order to benefit from the bypass filtration section of the lubricating oil filter. Do **not** use an LF3000 lubricating oil filter. Engine durability will be reduced by the use of the incorrect lubricating oil filter

(2)The fuel system requires the use of two fuel filters.

The suction-side filter must have the following characteristics:

- Water separating
- 8-micron rating
- Water-in-fuel sensor with shunt resistor
- Water drain valve
- Engine mounted or chassis mounted.

The pressure-side filter **must** have the following characteristics:

- 5-micron rating
- Engine mounted or chassis mounted.

(3)Early production pressure-side fuel filters were built with a square drive feature for installation and removal. Later built pressure-side fuel filters transitioned to a hex drive feature. The drive feature is the **only** difference between the pressure-side fuel filters.

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.

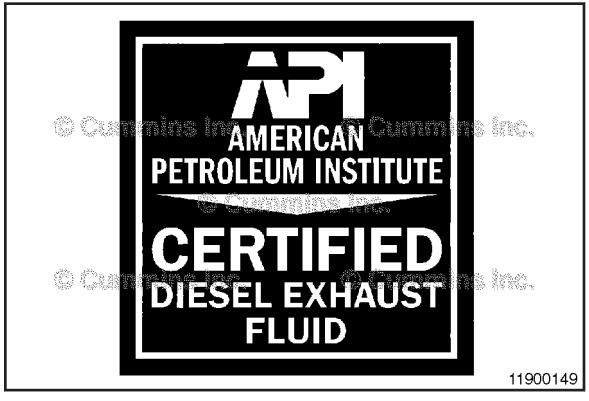
Cummins Inc. requires the use of Diesel Exhaust Fluid meeting ISO 22241-1. There is NO acceptable substitute.

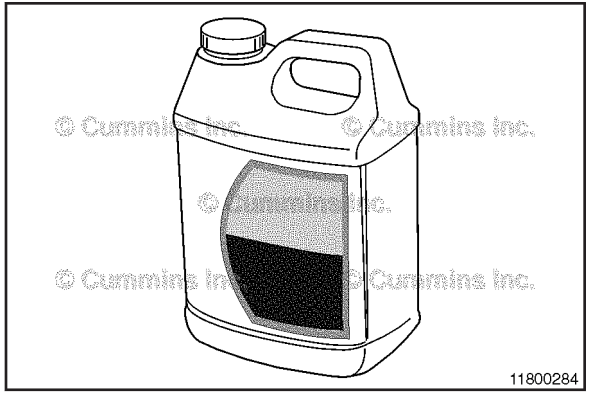
NOTE: Some locations may reference the DIN 70070 standard. Diesel Exhaust Fluid specification limits of this standard are identical to ISO 22241-1.

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 you 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.

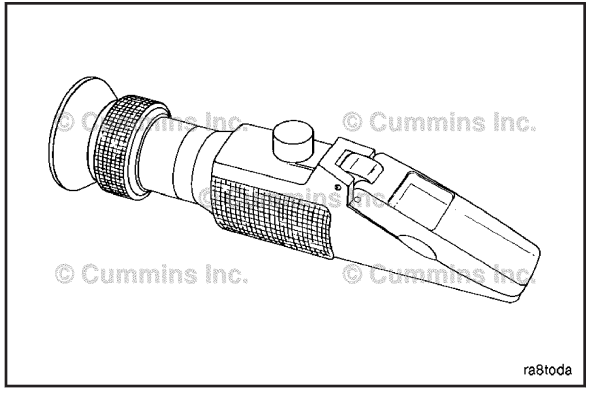
NOTE: Spilled Diesel Exhaust Fluid if left to dry or wiped away with a cloth only will leave a white residue. Failure to clean the spilled Diesel Exhaust Fluid may result in an incorrectly diagnosed leak of the Diesel Exhaust Fluid Dosing system.

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, varibility, 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

⚠CAUTION⚠

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

⚠CAUTION⚠

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

⚠WARNING⚠

Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can cause an explosion.

⚠CAUTION⚠

Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the fuel pump and the fuel injectors.

⚠CAUTION⚠

Lighter fuels can reduce fuel economy or possibly damage fuel system components.

⚠CAUTION⚠

Do not use diesel fuel blended with lubricating oil in engines equipped with an aftertreatment system. Service intervals for aftertreatment systems will be reduced.

⚠CAUTION⚠

Ultra-low sulfur diesel fuel is required for correct operation of the aftertreatment system. If ultra-low sulfur diesel fuel is not used, the aftertreatment system could possibly be damaged.

Cummins Inc. recommends the use of ASTM number 2D fuel. The use of number 2D diesel fuel will result in optimum engine performance.

The engine has been optimized for use with an exhaust aftertreatment to meet the Tier 4 Final/Stage IV off-highway emissions regulations. It **must** operate on ultra-low sulfur diesel (ULSD) with a maximum sulfur content of 15 ppm in the United States and 10 ppm in the European Union. Failure to do so can permanently damage engine and

aftertreatment systems within a short period of time. This damage could cause the engine to become inoperable and affect the warranty coverage on the engine.

Ultra-low sulfur diesel fuel, also defined by ASTM S-15, is defined as diesel fuel **not** exceeding 0.0015 (15 ppm) mass percent sulfur content. There is no acceptable substitute.

At operating temperatures below 0°C [32°F], acceptable performance can be obtained by using blends of number 2D and number 1D.

The following chart lists acceptable types of fuels for this engine.

Acceptable Types of Fuels									
Number 1D Diesel(1) (2)	**Number 2D Diesel(2)**	**Number 1K Kerosene**	**Jet-A**	**Jet-A1**	**JP-5**	**JP-8**	**Jet-B**	**JP-4**	**CITE**
OK	OK	NOT OK	NOT OK	NOT OK	NOT OK	NOT OK	NOT OK	NOT OK	NOT OK
48-34(3)	40-24(3)	50-35(3)	51-37(3)	51-37(3)	48-36(3)	51-37(3)	57-45(3)	57-45(3)	57-45(3)

1 Any adjustment to compensate for reduced performance with a fuel system using alternate fuel is **not** warrantable.

2 Winter blend fuels, such as those found at commercial fuel dispensing outlets, are combinations of number 1D and number 2D diesel fuel, and are acceptable.

3 BTU Content/Degree API Gravity - Low API gravity fuels have a higher thermal energy content (BTU). As a general rule, there is a 3 to 5 percent decrease in BTU content for every 10 degree increase in API gravity; there is also a 0.7 degree API gravity increase with an increase in fuel temperature. This decrease in energy content equates roughly to the same percentage of power loss. Use of fuels with higher API gravity will cause higher than normal fuel consumption.

NOTE: Cummins Inc. recommends that the cetane number of diesel fuel be a minimum of 45 for engines that are expected to operate at temperatures below 0°C [32°F] and a minimum of 42 for engines that are operated at temperatures above 0°C [32°F].

NOTE: The use of diesel fuel with a lower than recommended cetane number can cause hard starting, instability, and excessive white smoke. To maintain satisfactory operation at low ambient temperatures, it is important to specify diesel fuel of the correct cetane number.

NOTE: Cummins Inc. requires all permissible fuels to have adequate fuel lubricity. This means the BOCLE number is 3100 or greater as measured by ASTM specification D6078, Scuffing Load Ball On Cylinder Evaluator (SLBOCLE). Lubricity can also be measured by ASTM, specification D6079, ISO 12156, High Frequency Reciprocating Rig (HFRR), in which the fuel **must** have a wear scar diameter of 0.45 mm [0.02 in] or less.

The equipment original equipment manufacturer (OEM) is required to display readily visible labels on the dashboard (or instrument panel) and near all fuel fill inlets that state "Use Ultra Low-Sulfur Diesel Fuel Only" or "Ultra Low-Sulfur Diesel Fuel Only"

ULSD/Biodiesel blends up to B20 (20 percent biodiesel) supplied by a BQ9000 certified supplier are acceptable.

For information on alternative fuels, such as biodiesel, and additional information for fuel recommendations and specifications, reference the Fuels for Cummins® Engines, Bulletin 3379001.

Lubricating Oil Recommendations and Specifications

General Information

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.

Cummins Inc. requires the use of a high-quality SAE 15W-40 heavy-duty engine oil, such as Valvoline Premium Blue™ (USA) or Valvoline Premium Blue™ Extra (International), which meets or exceeds the American Petroleum Institute (API) performance classification CJ-4.

A sulfated ash limit of 1.0 mass percent is suggested for optimum valve and piston deposit, diesel particulate filter life, and oil consumption control.

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 **must** be applied to synthetic oils that are applied to petroleum (mineral) based engine oils.

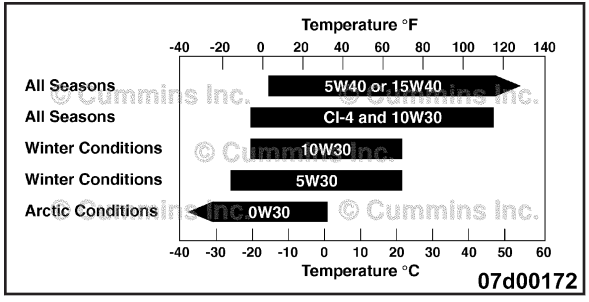
For further details and discussion of engine lubricating oils for Cummins® engines, refer to the latest revision of Cummins® Engine Oil Recommendations, Bulletin 3810340.

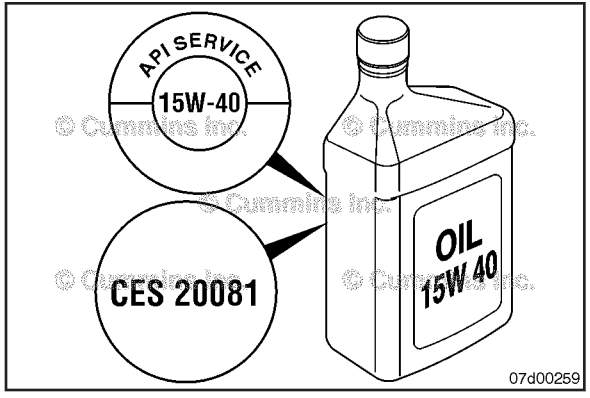
CAUTION

An SAE 10W-30 designation on a product is a viscosity designation only. This designation alone does not imply that the product meets Cummins® requirements. Only 10W-30 oils with diesel performance credentials listed in table above can be used in Cummins® Engines if the reduced ambient temperature indicated in chart above is observed. Only 10W-30 oils meeting CES 20081 (API CJ-4) can be used in the ambient temperature range similar to 15W-40 oils.

Cummins Inc. primary recommendation is for the use of 15W-40 multigrade for normal operation at ambient temperatures above -15°C [5°F]. The use of multigrade oil reduces deposit formation, improves engine cranking in low temperature conditions, and increases engine durability by maintaining lubrication during high temperature operating conditions. Since multigrade oils have been shown to provide approximately 30 percent lower oil consumption than monograde oils, it is important to use multigrade oils, to be certain the engine will meet applicable emissions requirements. While the preferred viscosity grade is 15W-40, lower viscosity multigrades can be used in colder climates. See the accompanying chart.

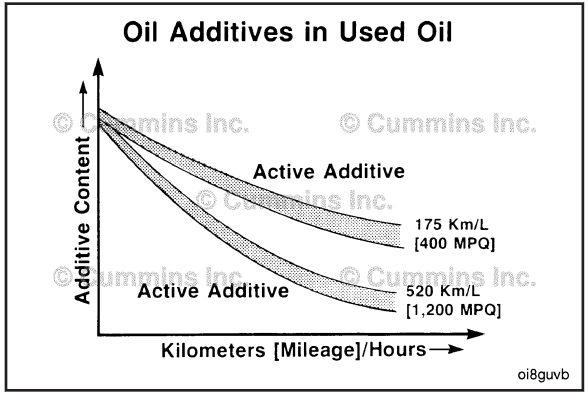
Oils meeting API CJ-4 and a 10W-30 viscosity grade, **must** meet a minimum high/temperature/high shear viscosity of 3.5 cP and ring wear / liner wear requirements of Cummins® and Mack™ tests. Thus, they can by used over a wider temperature range than 10W-30 oils meeting older API performance classifications. As these oils will 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 oil supplier. Obtain the oil supplier's commitment that the oil will give satisfactory performance in Cummins® engines, or do **not** use the oil.





An example of the API service symbols are shown in the accompanying illustration. The upper half of the symbol displays the appropriate oil categories.

The center section identifies the SAE oil viscosity grade.



As the engine oil becomes contaminated, essential oil additives are depleted. Lubricating oils protect the engine as long as these additives are functioning properly. Progressive contamination of the oil between oil and filter change intervals is normal. The amount of contamination will vary, depending on the operation of the engine, hours on the oil, fuel consumed, and new oil added.

Extending oil and filter change intervals beyond the recommendations will decrease engine life due to factors such as corrosion, deposits, and wear.

See the oil drain chart in Section 2 to determine which oil drain interval to use for the application.

NOTE: The responsibility is with the owner. If recommendations are ignored, warranty could be affected.

Any warranty claims that could be oil quality related **must** be accompanied by complete service history details of the following, prior to any warranty assessment being undertaken:

- Oil type, specifications and supplier
- Oil drain intervals
- Injector, valves and engine brake lash adjustments
- Oil filter type and supplier
- Application duty cycle.

NOTE: A.C.E.A. = Association des Constructeurs Européen d'Automobiles, A.P.I. =American Petroleum Institute and C.E.S. = Cummins® Engineering Standard.

⚠CAUTION⚠

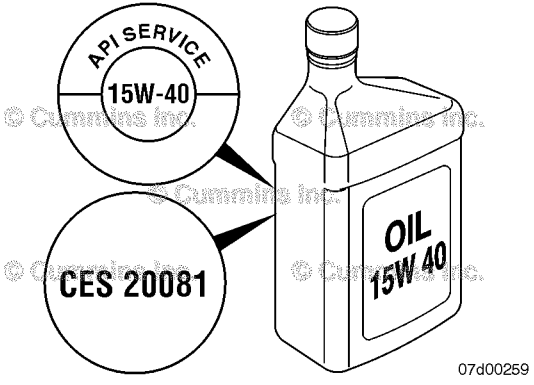
Extending the oil and filter change interval beyond the recommendations will decrease the engine life due to factors such as corrosion, deposits, and wear.

The 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 for the maintenance schedule. Refer to Procedure 102-002 in Section 2.

NOTE: The responsibility is with the owner. If recommendations are ignored, warranty could be affected.

API: American Petroleum Institute

CES: Cummins® Engineering Standard



To determine if the lubricating oil meets CES 20081, review the label on the back of the lubricating oil bottle for the CES 20081 reference. If acquiring the lubricating oil in bulk, contact the supplier for the lubricating oil specifications and confirm that the oil meets CES 20081.

Also located on the lubricating oil bottle is the API service symbol, which is shown in the accompanying illustration. The upper half of the symbol displays the appropriate oil categories. The center section identifies the SAE oil viscosity grade. The table below shows how the Cummins® Engineering Standard (CES) compares to the American Petroleum Institute (API) classification.

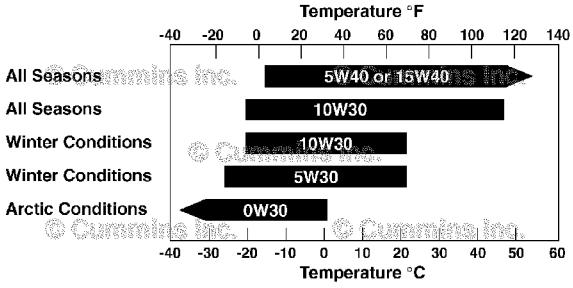
Cummins® Engine Standard Classification (CES)	American Petroleum Institute Classification (API)	Comments
CES20081	CJ-4/SL	Minimum oil classification required

NOTE: A lubricating oil that meets the American Petroleum Institute (API) performance classification CJ-4/SL may **not** meet the CES 20081 requirement. **Always** make sure the lubricating oil used meets the CES 20081 requirement, in addition to the API performance classification CJ-4/SL.

The primary Cummins Inc. recommendation is for the use of 15W-40 multigrade lubricating oil for normal operation at ambient temperatures above -15°C [5°F]. The use of multigrade oil reduces deposit formation, improves engine cranking in low temperature conditions, and increases engine durability by maintaining lubrication during high temperature operating conditions. Since multigrade oils have been shown to provide approximately 30 percent lower oil consumption than monograde oils, it is important to use multigrade oils, to be certain the engine will meet applicable emissions requirements.

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 **must** be applied to synthetic oils that are applied to petroleum (mineral) based engine oils.

For further details and discussion of engine lubricating oils for Cummins® engines, reference Cummins® Engine Oil Recommendations, Bulletin 3810340.



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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 than15W-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 GroupIV 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.

New Engine Break-in Oils

Additional information regarding lubricating oil availability throughout the world is available in the EMA Lubricating Oils Data Book for Heavy-Duty Automotive and Industrial Engines. The data book can be ordered from: Engine Manufacturers Association, Two North LaSalle Street, Chicago, IL 60602; (312) 827-8733, (www.engine-manufacturers.org).

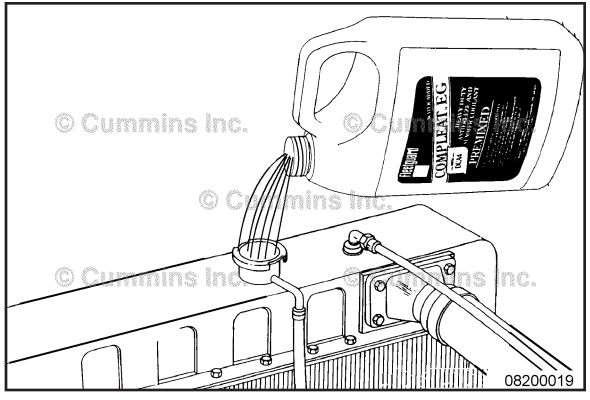
⚠CAUTION⚠

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

Special “break-in” engine lubricating oils are not recommended for new or rebuilt Cummins® engines. Use the same lubricating oil that will be used during normal operation.

AfterMarket Oil Additive Usage

Cummins Inc. does **not** recommend the use of aftermarket oil additives. The 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 furnished 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 furnished oil's capability 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 Standard (C.E.S.) 14603. For further details and discussion of coolant for Cummins® engines, refer to Coolant Requirements and Maintenance, Bulletin 3666132.

Cummins Inc. recommends using either a 50/50 mixture of good-quality water and fully formulated antifreeze, or fully formulated coolant when filling the cooling system.

Good-quality water is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

Water Quality	
Calcium Magnesium (hardness)	**Maximum 170 ppm as ($CaCO_3$ + $MgCO^3$)**
Chloride	40 ppm as (Cl)
Sulfur	100 ppm as (SO_4)

Cummins Inc. recommends Cummins Filtration™ antifreeze coolants including Compleat ES™ containing DCA4 Plus, Fleetcool™ EX containing DCA2 Plus, and ES Optimax™ Organic Acid Technology (OAT), which meet the requirements of Cummins® Engineering Standard 14603. However, Cummins Inc., Chevron Corporation and Shell have agreed that Chevron Texaco™, Shell Rotella™ and their private label counterpart Extended Life OAT coolants, which do **not** meet the elastomer compatibility section of Cummins® Engineering Standard 14603, are acceptable for extended service interval use, assuming the initial coolant fill requirements were met from the vehicle's original equipment manufacturer (OEM).

MidRange, Heavy Duty and High Horsepower engine overhauls, or repairs involving the replacement of the following components, using this Extended Life OAT coolant, **must** discard the coolant and replace it with new coolant.

- Rocker lever housing gasket
- Lubricating oil cooler housing gasket
- Cylinder head gasket
- Thermostat housing gasket

If the replacement coolant is Chevron Texaco™, Shell Rotella™ or their private label counterpart Extended Life OAT coolants, which do **not** meet the elastomer compatibility section of Cummins® Engineering Standard 14603, the coolant **must** be treated by adding 0.24 liters [8 oz] of liquid silicate fluid for every 45.5 liters [12 gal] of total coolant system volume. It is critical to **not** overtreat the coolant with silicate fluid.

To obtain order forms or ask questions relative to ordering the silicate fluid, contact:

- Silicate Fluid Order Program
- P.O. Box 27388
- Houston, TX
- 77277-7388
- Phone: 800-346-9041
- Fax: 800-876-5317

For further details and discussion of engine coolant for Cummins® engines, refer to Cummins® Coolant Requirements and Maintenance, Bulletin 3666132.

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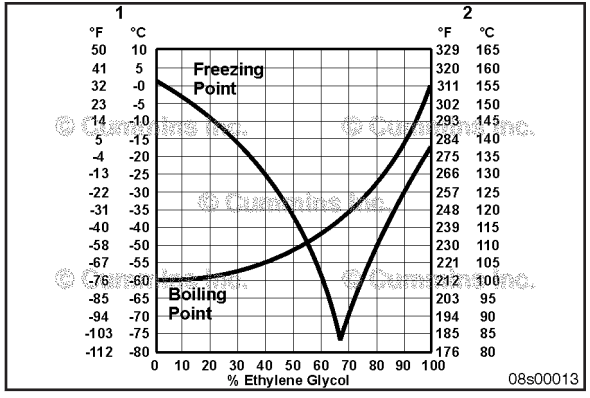
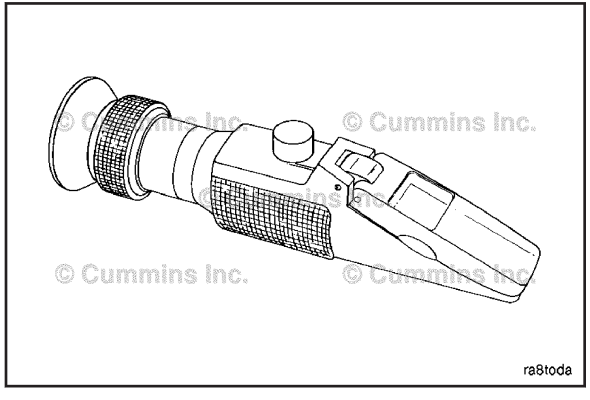




Fully formulated antifreeze **must** be mixed with good-quality water at a 50/50 ratio (40- to 60-percent working range). A 50/50 mixture of antifreeze and water gives a -36°C [-33°F] freezing point and a 108°C [226°F] boiling point, which is adequate for locations in North America. The actual lowest freezing point of ethylene glycol antifreeze is at 68 percent. Using higher concentrations of antifreeze will raise the freezing point of the solution and increase the possibility of a silica gel problem.

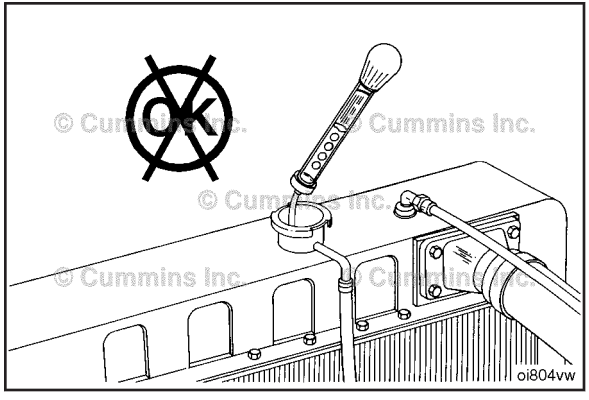
Legend

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 Cummins Filtration™ refractometer, Part Number CC2800 or CC2806.

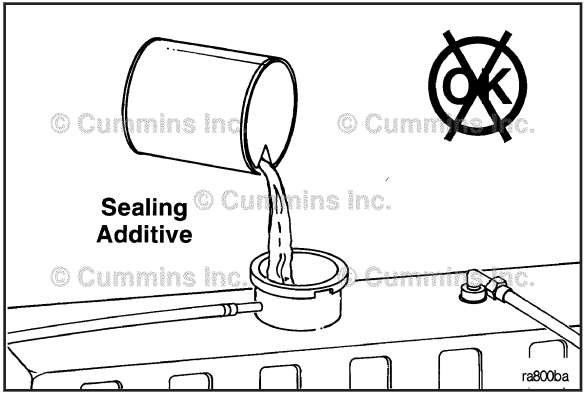
Do **not** use a floating ball hydrometer. Floating ball hydrometers can give incorrect readings.

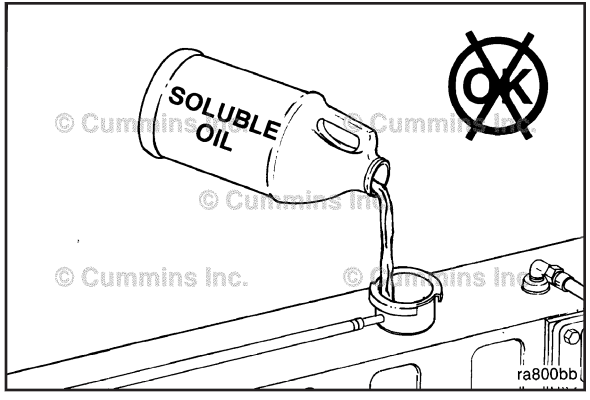


Cooling System Sealing Additives

Do **not** use sealing additives in the cooling system. The use of sealing additives will:

- Build up 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.

Section W - Warranty

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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.

CMD Quantum Commercial Marine Propulsion (QSB5.9/QSB6.7/QSC8.3/QSL9/QSM11/SDI/TDI)

Coverage

Engines Included in this Coverage

Marine Propulsion

QSB5.9/QSB6.7/QSC8.3/QSL9/QSM11/SDI/TDI

Products Warranted

This Warranty applies to new Product sold by Cummins MerCruiser Diesel, herein after “CMD”, that is branded as Cummins MerCruiser Diesel product and used in Commercial and Government Marine Propulsion applications anywhere in the world as permitted by US ITAR and Export Compliance regulations where CMD approved service is available* and delivered to the first user on or after May 1, 2011.

This Warranty covers any failures of the Product, under normal use and service, which results from a defect in CMD material or workmanship (Warrantable Failure). The (Product) includes the Engine, controls and other components other than pods or sterndrives as delivered from the CMD factory and accessories with a CMD part number that are added by a CMD approved distributor or OEM. Pods and sterndrives are covered under a separate CMD Warranty.

COMMERCIAL USE

Commercial use is defined as any work or employment related use of the product, or any use of the product which generates income, or any part of the warranty period, even if the product is only occasionally used for such purposes.

GOVERNMENT USE

Government use is defined as use by Federal, State, and Local agencies in non-revenue producing applications.

MARINE PROPULSION RATINGS

Government Service (GS) Rating

Intended for use in variable load applications where full power is limited to one hour out of every eight hours of operation.

Reduced power operation must be at or below cruise speed (rpm). Cruise speed (rpm) is dependent on the engine rated speed (rpm):

Rated Speed (rpm)	Cruise Speed (Reduction from rated speed, rpm)
2,000 to 2,800 rpm	200 rpm below rated
2,801 to 3,500 rpm	300 rpm below rated
3,501 to 4,500 rpm	400 rpm below rated

Government Service (GS)
The Government Service Rating applies to Government use in variable load applications where annual use is less than 500 hours and full power is one (1) out of every eight (8) hours of operation. Reduced power operation must be at or below cruise speed.

Light Commercial (LC)
The Light Commercial Rating applies to Commercial use in variable load applications where annual use is less than 500 hours and full power is one (1) out of every eight (8) hours of operation. Reduced power operation must be at or below cruise speed.

Intermittent Duty (ID)
This power rating is intended for intermittent use in variable load applications where full power is limited to two hours out of every eight hours of operation. Also, reduced power operations must be at or below 200 rpm of the maximum rated rpm. This rating is an ISO3046 Fuel Stop Power Rating and is for applications that operate less than 1,500 hours per year.

Medium Duty (MD)
This power rating is intended for continuous use in variable load applications where full power is limited to six hours out of every twelve hours of operation. Also, reduced power operations must be at or below 200 rpm of the maximum rated rpm. This rating is an ISO3046 Fuel Stop Power Rating and is for applications that operate less than 3,000 hours per year.

Heavy Duty (HD)
This power rating is intended for continuous use in variable load applications where full power is limited to eight hours out of every ten hours of operation. Also, reduced power must be at least 200 rpm below the maximum rated rpm. This rating is an ISO3046 Fuel Stop Power Rating and is for applications that operate less than 5,000 hours per year.

Continuous Duty (CD)
This power rating is intended for continuous use in applications requiring uninterrupted service at full power. This rating is an ISO3046 Standard Power Rating.

Base Engine Warranty
This warranty covers any failures of the Product, under normal use and service, which result from a defect in CMD material or factory workmanship (Warrantable Failure). Coverage begins with the sale of the Engine by CMD and continues for the Duration stated in the following table. The Duration commences on either the date of delivery of the Product to the first end-user, or the date the unit is first leased, rented or loaned, or when the Product has been operated for 50 hours, whichever occurs first. The Base Coverage duration ends two (2) years after the in-service date or allowed hours of total operation, whichever occurs first.

Warranty Coverage Periods				
Rating	**QSB, QSC, QSL, SDI, TDI**		**QSM11**	
	Coverage ends at whichever occurs first, months or hours of usage.		Coverage ends at whichever occurs first, months or hours of usage.	
	Months	Hours	Months	Hours
Government Service (GS)	24	1,000	24	1,000

Warranty Coverage Periods				
Rating	QSB, QSC, QSL, SDI, TDI		QSM11	
Light Commercial (LC)	24	1,000	NA	NA
Intermittent Duty (ID)	24	3,000	24	3,000
Medium Duty (MD)	24	5,000	24	6,000
Heavy Duty (HD)	24	5,500	24	8,000
Continuous Duty (CD)	24	6,500	24	9,000

Cummins MerCruiser Diesel Responsibilities

During Engine Warranty

CMD will pay for all parts and labor needed to repair the damage to the Product resulting from a Warrantable Failure when performed during normal business hours. All labor costs will be paid in accordance with Cummins published Standard Repair Time guidelines.

When it is necessary for mechanics to make on-site warranty repairs CMD will pay reasonable travel expenses, including meals, mileage and lodging, for mechanics to travel to and from the repair dock. Labor must be performed by an authorized CMD Repair Facility.

CMD will pay for the lubricating oil, antifreeze, filter elements, and other maintenance items that are not reusable due to the Warrantable Failure.

CMD will pay for reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

Owner Responsibilities

During the Engine Warranty

Owner is responsible for the operation and maintenance of the Product as specified in the applicable CMD Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed. This warranty does not cover normal wear and tear of covered parts. Exceeding the operational parameters of the rating will void this Warranty. The Owner of the boat is ultimately responsible for ensuring the Engine is properly operated and maintained. The Warranty will be void on any Engines that are misapplied, not maintained properly or misused.

Before the expiration of the applicable warranty, Owner must notify a CMD service provider, distributor, authorized dealer, or other repair location approved by CMD of any Warrantable Failure and make the Engine available for repair by such facility. Locations in the United States and Canada are listed in the Cummins U.S. and Canada Sales and Service Directory; other locations are listed in the CMD International Sales and Service Directory.

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.

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.

In the event of any Product failure, Owner is responsible for the cost of towing the boat to the repair dock and for all associated docking and harbor charges.

Owner is responsible for maintaining the Engine hourmeter in good working order at all times and to ensure that the hourmeter accurately reflects the total hours of operation of the Product.

Owner is responsible for the costs to investigate complaints, unless the problem is caused by a defect in CMD material or factory workmanship.

Limitations

1. Maintenance Component Limitations

CMD will replace certain maintenance components if they fail within 90 days or less after the base coverage starts. Maintenance components include but are not limited to: sea water pump impellers, zinc plugs, oil filters, fuel filters, air filters, water filters, fuel/water separator filters, expansion tank pressure caps, belts, hoses.

2. Other Component Limitations

CMD does not warrant components that are not supplied by CMD factory.

3. CMD supplied alternators and starters limitation

Warranty coverage is limited to 2 years or 2,000 hours, whichever expires first for rating other than Government Service.

Warranty coverage is limited to 2 years or 1,000 hours, whichever expires first for the Government Service rating.

Consumer Products

The warranty on Consumer Products in the United States is a limited warranty. **CMD IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.** Any implied warranties applicable to Consumer Products terminate concurrently with the expiration of the express warranties applicable to the Product. In the United States, some states do not allow the exclusion of incidental or consequential damages, or limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you.

CMD is not responsible for failures or damage resulting from what CMD determines to be abuse or neglect, including, but not limited to: operation without adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of cooling, lubricating or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications to the engine; improper propping that does not allow the engine to run at its maximum rated speed; submersion, freezing temperatures, improper service, removal of parts, or running the engine out of water; water

ingestion, unless caused by a Warrantable failure. CMD is also not responsible for failures caused by incorrect oil or fuel or by water, dirt or other contaminants in the fuel or oil.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that oil consumption exceeds CMD published standards.

CMD is not responsible for failures of maintenance components supplied by CMD beyond 90 days after the coverage duration start date. Maintenance components include, but are not limited to: sea water pump impellers; zinc plugs; oil filters; fuel filters; air filters; water filters; fuel/water separator filters.

Parts used in warranty repairs may be new CMD parts, CMD approved rebuilt parts, or repaired parts. CMD is not responsible for failures resulting from the use of parts not supplied by CMD.

A new CMD or CMD approved rebuilt part used to replace a Warranted Part assumes the identity of the Warranted Part it replaced and is entitled to the remaining coverage hereunder.

CMD DOES NOT COVER WEAR OR WEAROUT OF COVERED PARTS.

CMD IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

THESE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CMD IN REGARD TO THESE ENGINES. CMD MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Emission Warranty

Products Warranted

This Emission Warranty applies to new Engines certified to United States EPA 40 CFR 94 sold by CMD that are installed in vessels flagged or registered in the United States**.

Coverage

CMD warrants to the first user and each subsequent purchaser that the Engine is designed, built, and equipped so as to conform at the time of sale by CMD 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 5,000 hours of operation, whichever occurs first. The Emissions Warranty starts from the date of delivery of the Engine to the first user, or the date the unit is first leased, rented, or loaned, or when the Engine has been operated for 50 hours, whichever occurs first, or (B) The Base Engine Warranty.

Limitations

The owner may elect to have maintenance, replacement, or repair of the emission control parts performed by a facility other than a CMD distributor, an authorized dealer or a repair location approved by CMD, and may elect to use parts other than new genuine CMD or CMD approved rebuilt parts and assemblies for such maintenance, replacement or repair; however, the cost of such service or parts and subsequent failures resulting from such service or parts will not be covered under this emission control system warranty.

Failures, except those resulting from a defect in materials, or factory workmanship, are not covered by this WARRANTY.

CMD IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

In the United States** and Canada, this warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Outside the United States** and Canada, in case of consumer sales, in some countries the Owner has statutory rights which cannot be affected or limited by the terms of this warranty.

Nothing in this warranty excludes or restricts any contractual rights the Owner may have against third parties.

* Locations in the United States and Canada are listed in the Cummins United States and Canada Sales and Service Directory; other locations are listed in the Cummins International Sales and Service Directory.

** United States includes American Samoa, the Commonwealth of Northern Mariana Islands, Guam, Puerto Rico, and the U.S. Virgin Islands.

California Emission Control Warranty Statement, Off-Highway
Your Warranty Rights and Obligations

The California Air Resources Board and Cummins Inc., are pleased to explain the emission control system warranty on your 2015 and 2016 model year engine. In California, new heavy-duty off-road diesel engines must be designed, built and equipped to meet the State's stringent anti-smog standards. Cummins Inc. 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 Inc. will repair your heavy-duty off-road diesel engine at no cost to you including diagnosis, parts and labor.

Manufacturer's Warranty Coverage

This warranty coverage for 2015 and 2016 model year heavy-duty off-road engines 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 Inc.

Owner's Warranty Responsibilities

As the engine owner, you are responsible for the performance of the required maintenance listed in your Cummins® Owners and/or Operation and Maintenance Manual. Cummins Inc. recommends that you retain all receipts covering maintenance on your engine, but Cummins Inc. cannot deny warranty solely for the lack of receipts or for your failure to substantiate the performance of all scheduled maintenance.

You are responsible for presenting your engine to a Cummins® dealer as soon as a problem exists. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

As an engine owner, you should also be aware that Cummins Inc. may deny you warranty coverage if your engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

If you have any questions regarding your warranty rights and responsibilities, you should contact Cummins® Customer Relation Department at 1-800-343-7357 or the California Air Resources Board at 9528 Telstar Avenue, El Monte, CA 91731.

A warranted part which is scheduled for replacement as required maintenance is warranted up to the first schedule replacement point.

Prior to the expiration of the applicable warranty, Owner must give notice of any warranted emission control failure to a Cummins® distributor, authorized dealer or other repair location approved by Cummins Inc. and deliver the engine to such facility for repair. Repair locations are listed in Cummins® United States and Canada Service Directory.

Owner is responsible for incidental costs such as: communication expenses, meals, lodging incurred by Owner or employees of Owner as a result of a Warrantable Condition.

Owner is responsible for "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs, and other losses resulting from a Warrantable Condition.

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

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

EPA Diesel

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

EGR Differential Pressure Sensor
EGR Mixer/Venturi
EGR Temperature Sensor
EGR Valve

Air Handling Component
Barometric Air Pressure Sensor
Exhaust Gas Pressure Sensor
Exhaust Manifold
Grid Heater
Humidity Sensor
Intake Air Throttle Actuator

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

EPA Diesel

Air Handling (cont')
Component
Intake Manifold
Intake Manifold Air Temperature Sensor
Intake Manifold Temperature/Pressure Sensor
Turbocharger Actuator
Turbocharger Assembly
Turbocharger Compressor Inlet Air Temperature Sensor
Turbocharger Speed Sensor

Ignition System
Component
Ignition Coils
Ignition Control Module

Fuel System
Component
Fuel Control Valve
Fuel Lines
Fuel Pressure Sensor
Fuel Pump
Fueling/Timing Actuators

Fuel System (cont')
Component
Injector
Secondary Fuel Pressure/Temperature Sensor

California Emission Control System Warranty

Replacement Parts

Cummins Inc. recommends that any service parts used for maintenance, repair or replacement of emission control systems be new, genuine Cummins® or Cummins® approved rebuilt parts and assemblies, and that the engine be serviced by a Cummins® distributor, authorized dealer or the repair location approved by Cummins Inc. The owner may elect to have maintenance, replacement or repair of the emission control parts performed by a facility other than a Cummins® distributor, an authorized dealer or a repair location approved by Cummins Inc., and may elect to use parts other than new genuine Cummins® or Cummins® approved rebuilt parts and assemblies for such maintenance, replacement or repair; however, the cost of such service or parts and subsequent failures resulting from such service or parts will not be covered under this emission control system warranty, except for Emergency Repairs as described below.

Cummins Responsibilities

The warranty coverage begins when the engine is delivered to the ultimate purchaser.

Repairs and service will be performed by any Cummins® distributor, authorized dealer or other repair locations approved by Cummins Inc. using new, genuine Cummins® or Cummins® approved rebuilt parts and assemblies. Cummins Inc. will repair any of the emission control parts found by Cummins Inc. to be defective without charge for parts or labor (including diagnosis which results in determination that there has been a failure of a warranted emission control part).

Emergency Repairs

In the case of an emergency where a Cummins® distributor, authorized dealer, or other repair location approved by Cummins Inc. is not available, repairs may be performed by any available repair location or by any individual using any replacement parts. A part not being available within 30 days or a repair not being complete within 30 days constitutes an emergency. Cummins Inc. will reimburse the Owner for expenses (including diagnosis), not to exceed the manufacturer's suggested retail price for all warranted parts replaced and labor charges based on the manufacturer's recommended time allowance for the warranty repair and the geographically appropriate hourly labor

rate. Replaced parts and paid invoices must be presented at a Cummins® authorized repair facility as a condition of reimbursement for emergency repairs not performed by a Cummins® distributor, authorized dealer, or other repair location approved by Cummins Inc.

Warranty Limitations

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 adequate coolants or lubricants; overfueling; overspeeding; lack of maintenance of cooling, lubricating or intake systems; improper storage, starting, warm-up, run-in or shutdown practices; unauthorized modifications to the engine. Cummins Inc. is also not responsible for failures caused by incorrect oil, fuel, or coolant or by water, dirt or other contaminants in the fuel or oil or contaminants in the coolant.

Cummins Inc. is not responsible for failures resulting from improper repair or the use of parts which are not genuine Cummins® or Cummins® approved parts.

Cummins Inc. is not responsible for the material and labor costs of emission control parts and assemblies replaced during Scheduled Maintenance of the engine as specified in Cummins® Owners and/or Operation and Maintenance Manuals.

THIS WARRANTY, TOGETHER WITH THE EXPRESS COMMERCIAL WARRANTIES ARE THE SOLE WARRANTIES MADE BY CUMMINS INC. THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

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CALIFORNIA
Proposition 65 Warning

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

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