Troubleshooting and Repair Manual ISB and QSB5.9 Engines

U.S.A., Canada, Australia, New Zealand, and Puerto Rico

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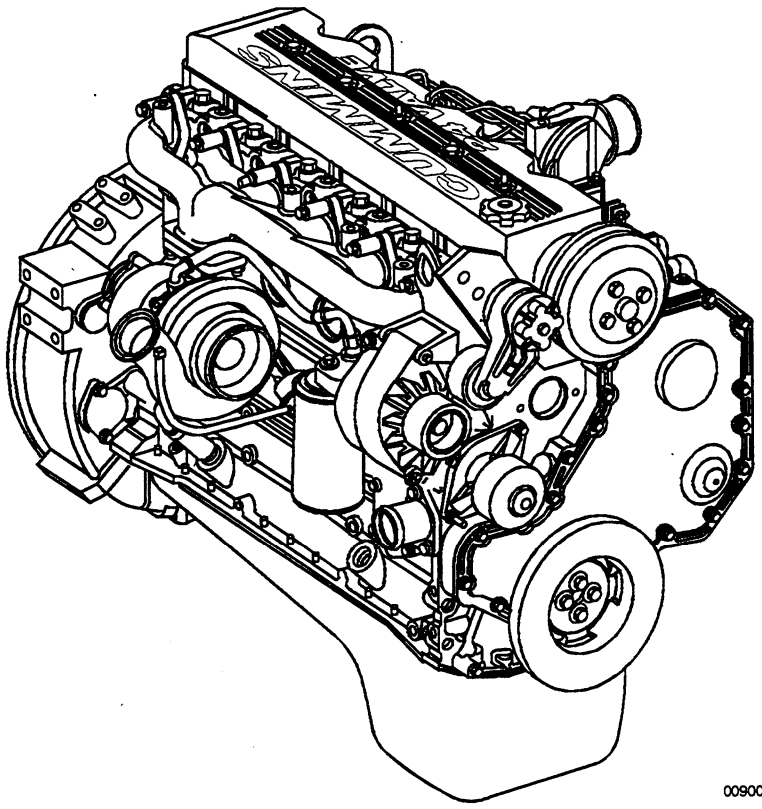

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Foreword

This manual provides instructions for troubleshooting and repairing this engine in the chassis. Component and assembly rebuild procedures are provided in the engine shop manual. Refer to Section i - Introduction for instructions on how to use this manual.

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

The manual is organized to guide a service technician through the logical steps of identifying and correcting problems related to the engine. This manual does not cover vehicle or equipment problems. Consult the vehicle or equipment manufacturer for repair procedures.

A series of specific service manuals (for example: Shop, Specifications, and Alternative Repair) are available and can be ordered by filling out and mailing the Literature Order Form located in Section L - Service Literature.

The repair procedures used in this manual are recommended by Cummins Engine Co., Inc. Some service procedures require the use of special service tools. Use the correct tools as described.

Cummins Engine Company, Inc. encourages the user of this manual to report errors, omissions, and recommendations for improvement. Please use the postage paid, pre-addressed Literature Survey Form in the back of this manual for communicating your comments.

The specifications and rebuild information in this manual are based on the information in effect at the time of printing. Cummins Engine Company, Inc. reserves the right to make any changes at any time without obligation. If differences are found between your engine and the information in this manual, contact a 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 are used to manufacture Cummins engines. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts. These parts can be identified by the following trademarks:

Cummins® Cummins ReCon® HOLSET® Fleetguard® Premium Blue

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Section i - Introduction

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About the Manual

This ISB Engine Troubleshooting and Repair Manual is intended to aid in determining the cause of engine-related problems and to provide recommended repair procedures. The manual is divided into sections by system. Each section provides general information, specifications, diagrams, and service tools where applicable. The specific repair procedures are referenced in the Troubleshooting Symptoms Charts.

How to Use the Manual

The manual is organized to provide an easy flow from problem identification to problem correction. A list of troubleshooting symptoms containing the most common engine problems begins on Page T-a in Section TS - Troubleshooting Symptoms. Complete the following steps to locate and correct the problem.

(Step 1.) Locate the symptom on the list.

Refer to the procedure number where the Troubleshooting Symptoms Chart is found.

(Step 2.) The left column of the Troubleshooting Symptoms Chart indicates a problem cause, starting at the top with the simplest and easiest to repair, and continuing downward to the most difficult.

The right column provides a brief description of the corrective action, with the reference number, for the repair.

(Step 3.) Locate the probable cause in the left column, and then turn to the procedure number in the right column.

The repair procedures are listed by system (Cooling, Lubricating Oil, Combustion Air, Compressed Air, Fuel, Electrical, and Base Engine Components).

(Step 4.) The Troubleshooting Symptoms Charts are based on the following assumptions:

1. The engine has been installed according to the manufacturer's specifications.
2. The easiest repairs are done first.
3. "Generic" solutions cover problems with the most common applications and original equipment manufacturers (OEM).

Symbols

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

WARNING - Provides a warning to take precaution to avoid bodily injury from electrical shock or electrocution. There is in the vicinity uninsulated high A.C. voltage.

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

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

Indicates a **REMOVAL or DISASSEMBLY** step.

Indicates an **INSTALLATION or ASSEMBLY** step.

INSPECTION is required.

CLEAN the part or assembly.

PERFORM a mechanical or time **MEASUREMENT**.

LUBRICATE the part or assembly.

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

TIGHTEN to a specific torque.

PERFORM an electrical **MEASUREMENT**.

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

The main circuit breaker is closed and normal power is being supplied to the equipment.

The main circuit breaker must be open so that normal power is **not** being supplied to the equipment.

The generator set is on and supplying power to the equipment.

The generator set **must** be off and **not** supplying power to the equipment.

The wiring harness disconnect plug **must** be disconnected.

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

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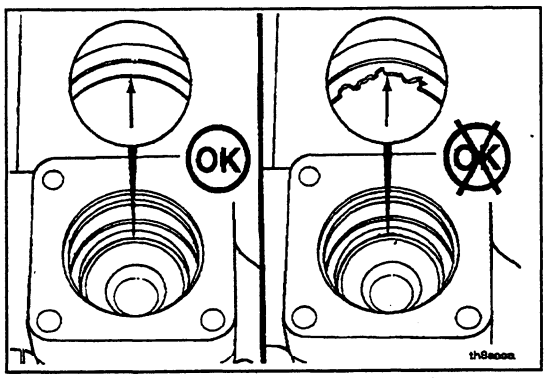
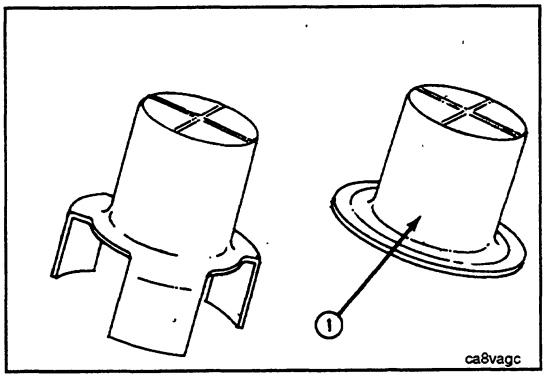
Illustrations

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 or carelessness can cause burns, cuts, mutilation, asphyxiation or other bodily 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.

- Make sure the work area surrounding the product 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 you slowly loosen the filler cap and relieve the pressure from the cooling system.
- Do **not** work on anything that is supported ONLY by lifting jacks or a hoist. **Always** use blocks or proper stands to support the product before performing any service work.
- Relieve all pressure in the air, oil, fuel and the 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 prevent suffocation and frostbite, wear protective clothing and ONLY disconnect fuel and 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 avoid 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 your 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 avoid burns, be alert for hot parts on products that have just been turned off, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use them before performing any service work. Use ONLY genuine Cummins or Cummins ReCon® replacement parts.
- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lesser quality if replacements are necessary.
- Do **not** perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.

General Repair Instructions

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

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

Air Compressor
Air Controls
Air Shutoff Assemblies
Balance Weights
Cooling Fan
Fan Hub Assembly
Fan Mounting Bracket(s)
Fan Mounting Capscrews
Fan Hub Spindle
Flywheel
Flywheel Crankshaft Adapter
Flywheel Mounting Capscrews
Fuel Shutoff Assemblies
Fuel Supply Tubes
Lifting Brackets
Throttle Controls
Turbocharger Compressor Casing
Turbocharger Oil Drain Line(s)
Turbocharger Oil Supply Line(s)
Turbocharger Turbine Casing
Vibration Damper Mounting Capscrews

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

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

General Cleaning Instructions

Solvent and Acid Cleaning

Several solvent and acid-type cleaners can be used to clean the engine parts. Experience has shown that the best results can be obtained using a cleaner that can be heated to 90 to 95 degrees Celsius [180 to 200 degrees Fahrenheit]. A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results. **Cummins Engine Company, Inc. does not recommend any specific cleaners. Always** follow the cleaner manufacturer's instructions.

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

⚠ WARNING ⚠

Acid is extremely dangerous and can cause personal injury and damage the machinery. Always provide a tank of strong soda water as a neutralizing agent.

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

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

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good way to clean the oil drillings.

⚠ WARNING ⚠

Wear protective clothing to prevent personal injury from the high pressure and extreme heat.

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

1. Electrical Components
2. Wiring
3. Injectors
4. Fuel Pump
5. Belts and Hoses
6. Bearings

Glass or Plastic Bead Cleaning

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

⚠ CAUTION ⚠

Do not use glass or plastic bead cleaning on aluminum piston skirts. Do not use glass bead cleaning on aluminum ring grooves. Small particles of glass or plastic will embed in the aluminum and result in premature wear. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.

NOTE: Plastic bead blasting media, Part No. 3822735, can be used to clean aluminum ring grooves. Do **not** use any bead blasting media on pin bores or aluminum skirts.

Follow the equipment manufacturer's cleaning instructions. The following guidelines can be used to adapt to manufacturer's instructions:

1. Bead size:
   a. Use U.S. size No. 16-20 for piston cleaning with plastic bead media, Part No. 3822735.
   b. Use U.S. size No. 70 for piston domes with glass media.
   c. Use U.S. size No. 60 for general purpose cleaning with glass media.
2. Operating Pressure:
   a. Glass: Use 620 kPa [90 psi] for general purpose cleaning.
   b. Plastic: Use 270 kPa [40 psi] for piston cleaning.
3. Steam clean or wash the parts with solvent to remove all of the foreign material and glass or plastic beads after cleaning. Rinse with hot water. Dry with compressed air.
4. Do **not** contaminate the wash tanks with glass or plastic beads.

Acronyms and Abbreviations

AFC	Air Fuel Control
API	American Petroleum Institute
ASA	Air Signal Attenuator
ASTM	American Society of Testing and Materials
°C	Celsius
CARB	California Air Resources Board
C.I.D.	Cubic Inch Displacement
CNG	Compressed Natural Gas
CPL	Control Parts List
cSt	Centistokes
ECM	Electronic Control Module
ECS	Emission Control System
EPA	Environmental Protection Agency
EPS	Engine Position Sensor
°F	Fahrenheit
GVW	Gross Vehicle Weight
Hg	Mercury
hp	Horsepower
H_2O	Water
ICM	Ignition Control Module
km/l	Kilometers per Liter
kPa	Kilopascal
LNG	Liquid Natural Gas
LTA	Low Temperature Aftercooling
MIP	Mixer Inlet Pressure
MPa	Megapascal
mph	Miles Per Hour
mpq	Miles Per Quart
N•m	Newton-meter
NG	Natural Gas
OEM	Original Equipment Manufacturer
ppm	Parts Per Million
psi	Pounds Per Square Inch
PTO	Power Takeoff
rpm	Revolutions Per Minute
SAE	Society of Automotive Engineers
SCA	Supplemental Coolant Additive
STC	Step Timing Control
VS	Variable Speed
VSS	Vehicle Speed Sensor

NOTES

Section E - Engine Identification

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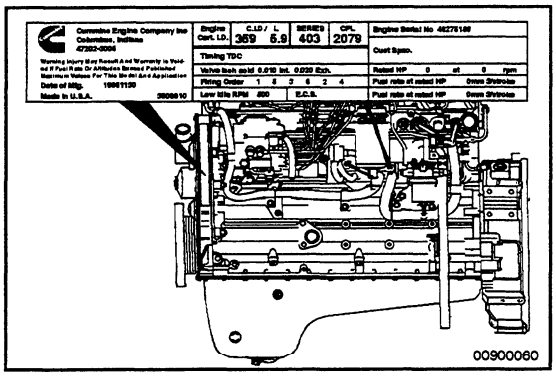
Engine Identification

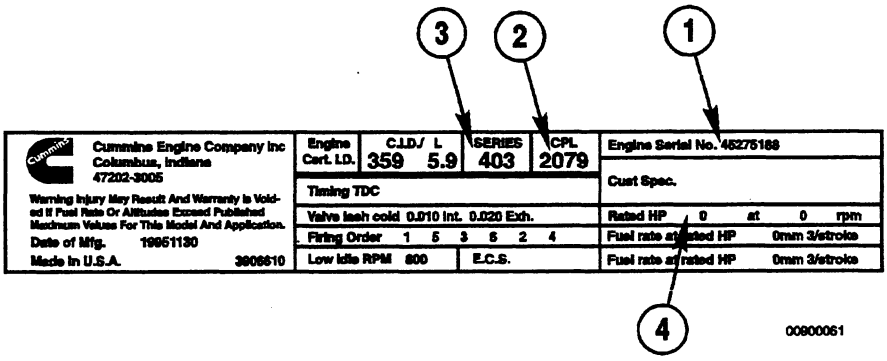
Engine Dataplate

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

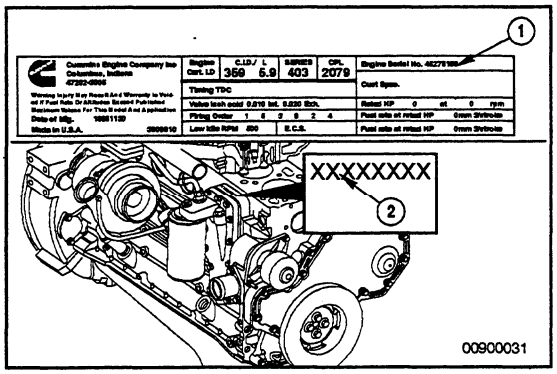


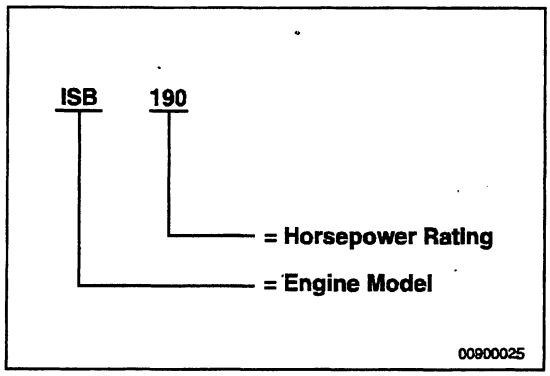
Have the following engine data available when communicating with a Cummins Authorized Repair Location. The information on the dataplate is **mandatory** when sourcing service parts.

1. Engine serial number
2. Control parts list (CPL)
3. Model
4. Horsepower and rpm rating.



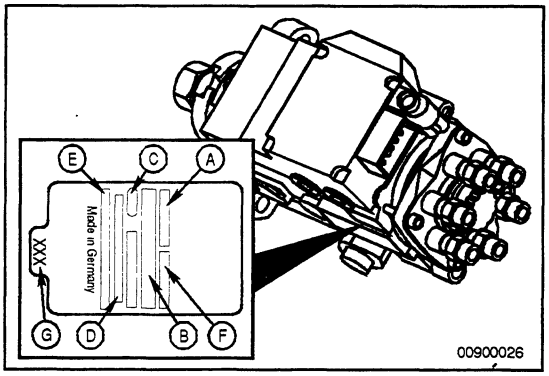
NOTE: If the engine dataplate (1) is **not** readable, the engine serial number (2) can be identified on the engine block on top of the lubricating oil cooler housing. Additional engine information is available by reading the ECM dataplate.





Cummins Engine Nomenclature

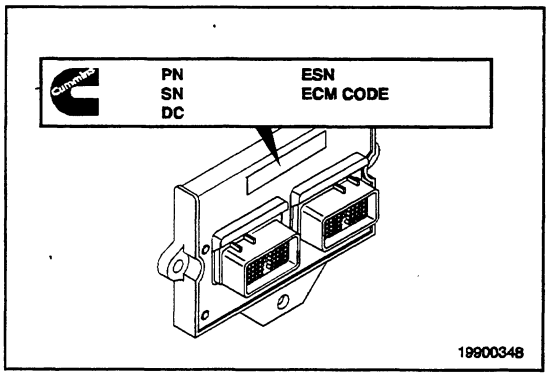
The Cummins engine nomenclature provides the data as illustrated in the graphic.



Fuel Injection Pump Dataplate

The VP44 fuel injection pump dataplate is located on the side of the fuel pump. The dataplate contains the following information:

- Order number (A)
- Bosch® part number (B)
- Factory code (C)
- Cummins part number (D)
- Manufacture date (E)
- Pump serial number (F)
- Last three digits of the key part number (G).



ECM Dataplate

The ECM dataplate shows information about your ECM and how the ECM was programmed. The dataplate is located on the ECM, above the ECM connectors.

The following information is available on the ECM dataplate:

- ECM part number
- ECM serial number
- ECM date code
- Engine serial number
- ECM code: Software number.

NOTE: Have the ECM code for your engine available when communicating with a Cummins Authorized Repair Location.

Specifications

General Specifications

Horsepower (refer to engine dataplate)

Bore and Stroke ..... 102 mm [4.02 in] X 120 mm [4.72 in]

Displacement ..... 5.9 liters [359 C.I.D.]

Compression Ratio 16.5:1

Firing Order 1-5-3-6-2-4

Engine Weight (with standard accessories):
- Dry Weight ..... 458 kg [1010 lb]

Crankshaft Rotation (viewed from the front of the engine) ..... **Clockwise**

Valve Clearance:
- Intake ..... 0.025 mm [0.010 in]
- Exhaust ..... 0.051 mm [0.020 in]

NOTE: The ISB engine features a no-adjust overhead. The ISB valve train is designed such that adjustment of the valve lash is **not** required for normal service during the first 241,402 km [150,000 mi]. The valve train operates acceptably within the limits of 0.152- to 0.381-mm [0.006- to 0.015-in] intake valve lash and 0.381- to 0.762-mm [0.015- to 0.030-in] exhaust valve lash.

Fuel System

For performance and fuel rate values, refer to the Engine Data Sheet or the fuel injection pump for the particular model involved.

Engine Idle Speed ..... 700 to 1000 rpm

Maximum Fuel Inlet Restriction to Lift Pump ..... 20 kPa [6 in Hg]

Maximum Fuel Pressure at Fuel Filter Outlet (engine cranking) ..... 28 to 55 kPa [4 to 8 psi]

Minimum Fuel Pressure at Fuel Filter Inlet (engine running) ..... 55 to 117 kPa [8 to 17 psi]

Maximum Pressure Drop Across Fuel Filter ..... 34 kPa [5 psi]

Fuel Drain Line Maximum Restriction ..... 69 kPa [10 psi]

Fuel Inlet Maximum Temperature ..... 74°C [165°F]

Engine Minimum Cranking Speed ..... 150 rpm

Lubricating Oil System

Oil Pressure:
- Low Idle (minimum allowed) ..... 103 kPa [15 psi]
- At Rated Speed (minimum allowed) ..... 310 kPa [45 psi]

Regulated Pressure ..... 414 kPa [60 psi]

Oil Capacity of Standard Engine:
- Standard
  - Pan **Only** ..... 14.2 liters [15 qt]
  - Total System ..... 16.4 liters [17 qt]
- Deep Sump
  - Pan **Only** ..... 16.1 liters [17 qt]
  - Total System ..... 18.3 liters [19 qt]
- Oil Pan High - Low
  - Standard Pan ..... 12 to 14.2 liters [13 to 15 qt]
  - Deep Sump Pan ..... 14.2 to 16.1 liters [15 to 17 qt]

NOTE: Some applications use a slightly different lubricating oil pan capacity. Contact your local Cummins Distributor if you have questions.

Cooling System

Coolant Capacity (engine **only**) ..... 9.0 liters [9.5 qt]

Standard Modulating Thermostat - Range ..... 84 to 91°C [184 to 195°F]

Maximum Allowed Operating Temperature ..... 100°C [212°F]

Minimum Recommended Operating Temperature ..... 71°C [160°F]

Minimum Recommended Pressure Cap ..... 48 kPa [7 psi]

Air Intake System

Maximum Intake Restriction (clean air filter element) ..... 254 mm H_2O [10.0 in H_2O]

Maximum Intake Restriction (dirty air filter element) ..... 635 mm H_2O [25.0 in H_2O]

Exhaust System

Maximum Back Pressure from Piping and Silencer (combined):

Hg ..... 76 mm Hg [3 in Hg]

H_2O ..... 1016 mm H_2O [40 in H_2O]

Exhaust Pipe Size (normally acceptable inside diameter) ..... 76 mm [3 in]

Electrical System

Minimum Recommended Battery Capacity

System Voltage	Ambient Temperature -18°C [0°F]		Ambient Temperature 0°C [32°F]	
	Cold Cranking Amperes	Reserve Capacity [1] Amperes	Cold Cranking Amperes	Reserve Capacity [1] Amperes
12 VDC	1800	640	1280	480
24 VDC[2]	900	320	640	240

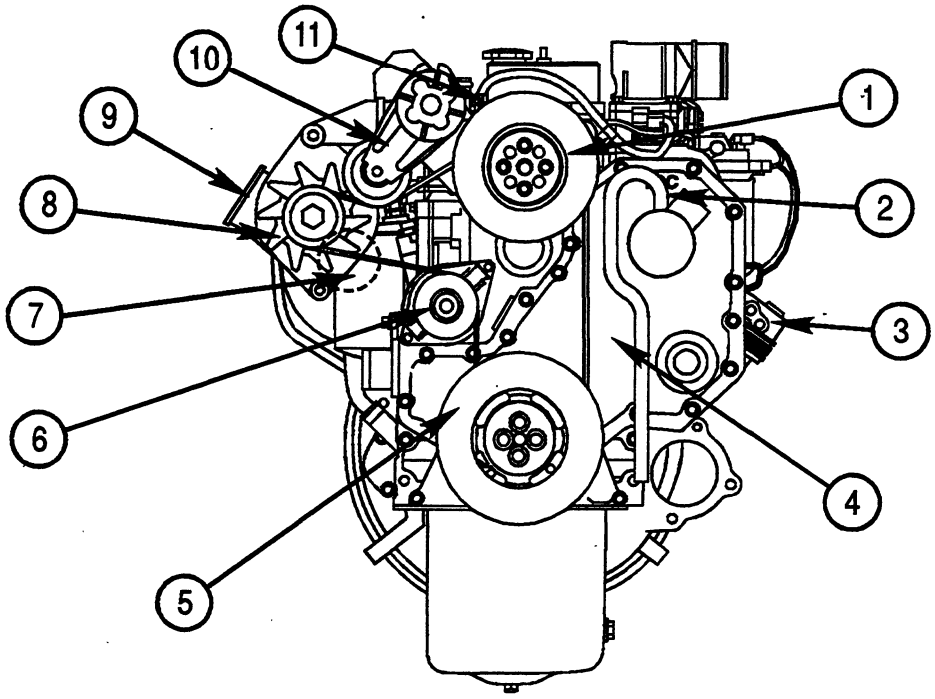
1. The number of plates within a given battery size determines reserve capacity. Reserve capacity determines the length of time in which sustained cranking can occur.
2. Cold cranking amps (CCA) ratings are based on two 12-VDC batteries in series.

Engine Diagrams

Engine Views

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

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



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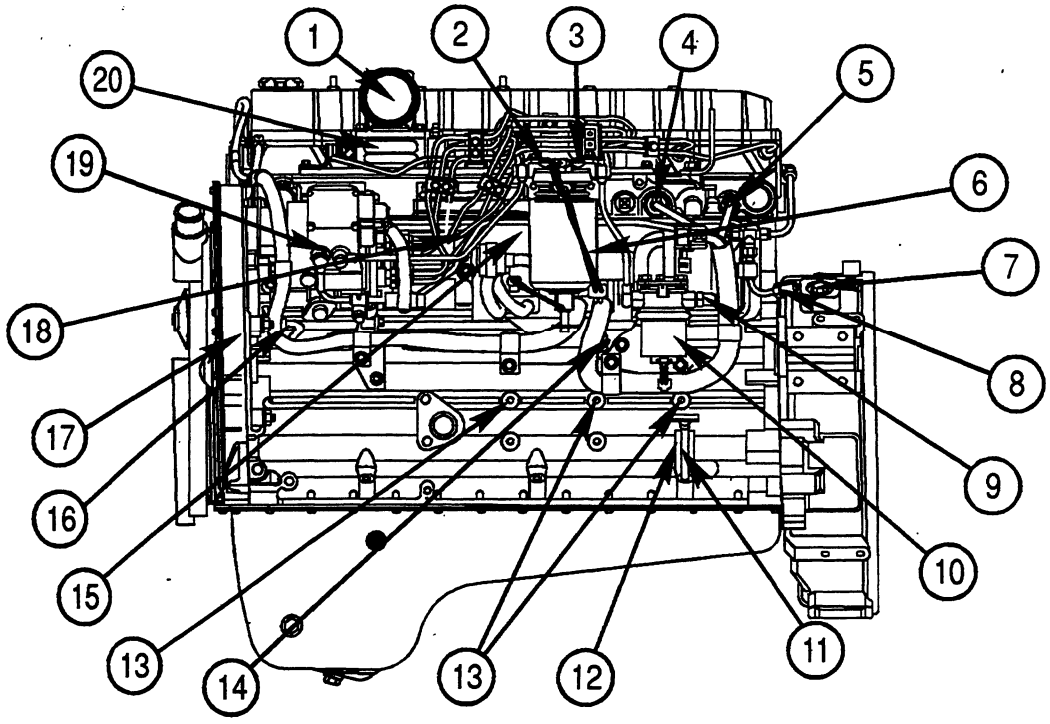
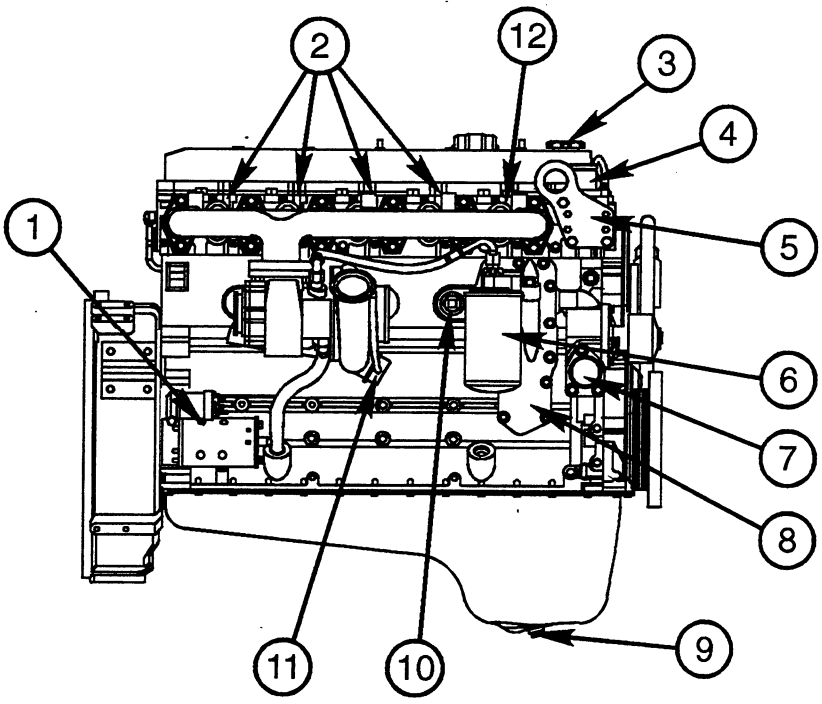
Front View

1. Fan pulley
2. Top dead center indication
3. Air compressor
4. Front gear cover
5. Vibration damper
6. Water pump
7. Turbocharger air inlet
8. Alternator
9. Turbocharger air outlet
10. Automatic belt tensioner
11. Coolant temperature sensor.



Air Intake Side View

1. Engine air inlet
2. M10 (STOR) fuel pressure after filter
3. M10 (STOR) fuel pressure before filter
4. Intake manifold pressure sensor
5. Intake manifold temperature sensor
6. Fuel filter/water separator
7. Magnetic pickup location (3/4-inch-16 UNF)
8. Fuel return connection
9. Fuel inlet connection
10. Fuel lift pump
11. Dipstick
12. Engine position sensor (EPS)
13. M10 (STOR) oil pressure
14. Oil pressure sensor
15. Electronic control module (ECM)
16. Engine diagnostic sensor
17. Engine dataplate
18. High-pressure fuel lines
19. Fuel injection pump
20. Intake air preheater.



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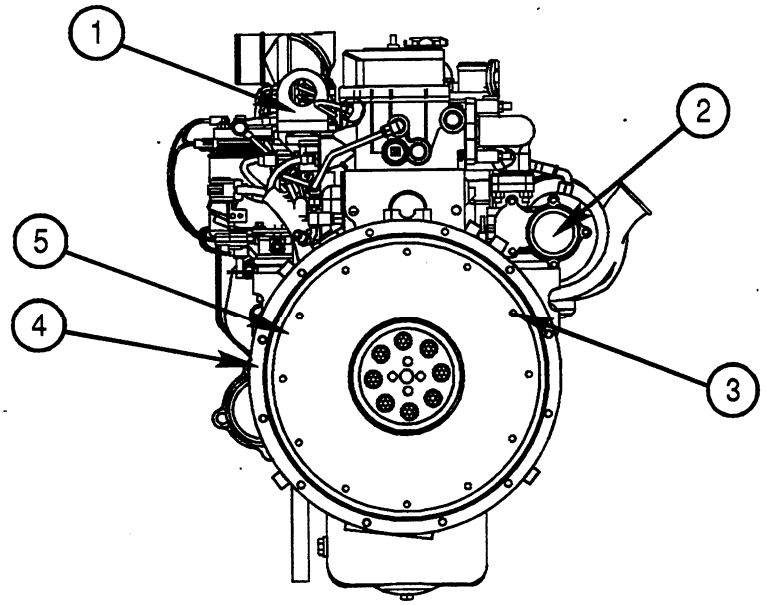
Exhaust Side View

1. Starter motor and solenoid
2. 1/2-inch (NPTF) coolant taps
3. Oil fill
4. Water outlet
5. Front engine lifting bracket
6. Lubricating oil filter
7. Water inlet
8. Lubricating oil cooler
9. Oil drain
10. Provision for coolant heater
11. Turbocharger wastegate actuator
12. Coolant vent fitting.



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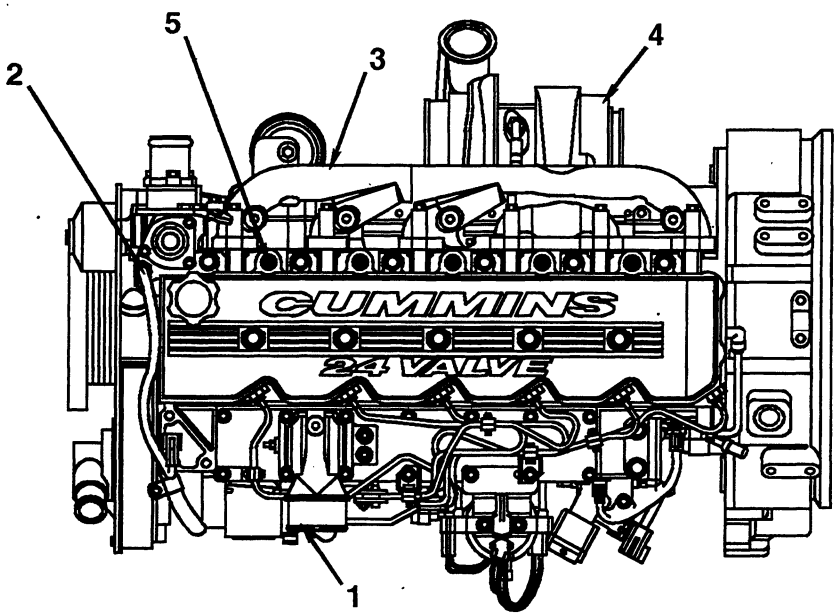
Rear View

1. Rear engine lifting bracket
2. Turbocharger exhaust outlet
3. Clutch mounting holes
4. Flywheel housing
5. Flywheel/flexplate.



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Top View

1. Engine air inlet
2. Coolant temperature sensor
3. Exhaust manifold
4. Turbocharger
5. Coolant vent fitting.

NOTES

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