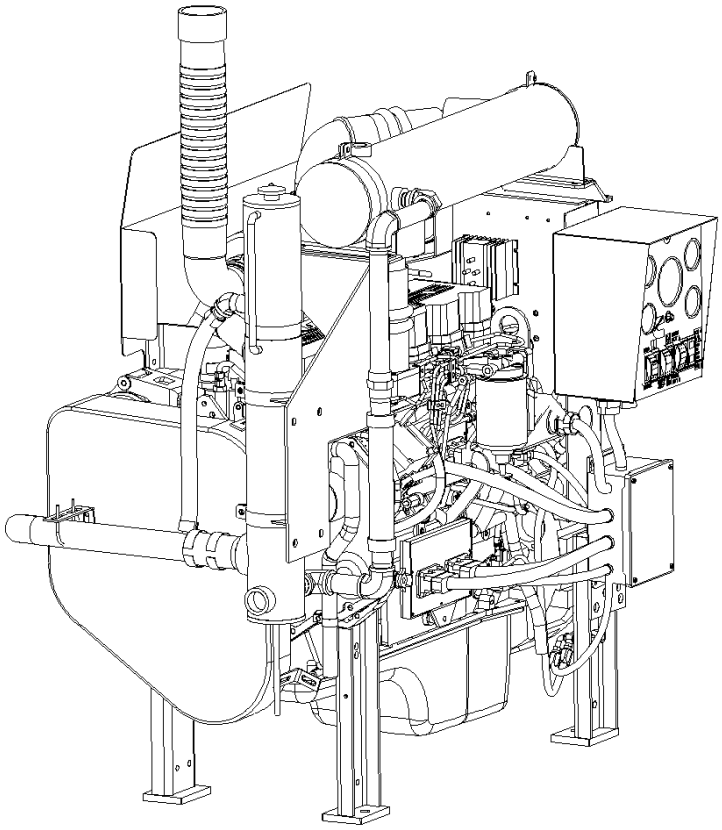
CFP6E SERIES

Operation & Maintenance Manual

Fire Pump Drive Engines



www.cumminsfirepower.com

Foreword

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

Read and follow all safety instructions. Refer to the General Safety Instructions in Section 1.

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 Fire Power, Cummins NPower and Cummins Engine Company, Inc. reserve the right to make changes at any time without obligation. If any differences are found between an engine and the information in this manual, contact the local Cummins Authorized Repair Location.

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

NOTE: Warranty information is located in Section 11. Make sure you are familiar with the warranty or warranties applicable to your engine.

Index of Sections

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Section 1 – Introduction

Section Contents

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To the Owner and Operator

Preventative maintenance is the easiest and least expensive type of maintenance. Follow the maintenance schedule recommendations outlined in Maintenance Guidelines in Section 4.

Keep records of regularly scheduled maintenance.

Use the correct fuel, oil, coolant, and filters in the engine as specified in Maintenance Specifications in Section 10.

Cummins Fire Power, Cummins NPower and Cummins Engine Company, Inc use the latest technology and the highest quality components to produce its engines. Cummins recommends using only genuine Cummins parts.

Personnel at Cummins Authorized Repair Locations have been trained to provide expert service and parts support. If a problem that can not be resolved by a Cummins Authorized Repair Location occurs, follow the steps outlined in the Service Assistance in Section 9.

About the Manual

This manual contains information needed to operate and maintain an engine correctly as recommended by Cummins Fire Power, Cummins NPower and Cummins Engine Company, Inc. Additional service literature (troubleshooting and repair manual) can be ordered by filling out and mailing the Literature Order Form located in Service Literature in Section 8.

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

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

Each section is preceded by a Section Contents to aid in locating information more quickly.

How to Use the Manual

This manual is organized according to intervals at which maintenance on the engine is to be performed. A table that states the required intervals and the checks to be made is located in Section 4. Locate the interval at which maintenance will be performed, then follow the steps given in the referenced section for all the procedures to be performed. All the procedures done under previous maintenance intervals must be performed, also.

Keep a record of all the checks and inspections made. A record form for recording date, mileage/kilometer or hours, and which maintenance checks were performed is located in Section 4.

Refer to the Maintenance Specifications in Section 10 for specifications recommended by Cummins Engine Company, Inc., for your engine. Specifications and torque values for each engine system are given in that section.

Symbols

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

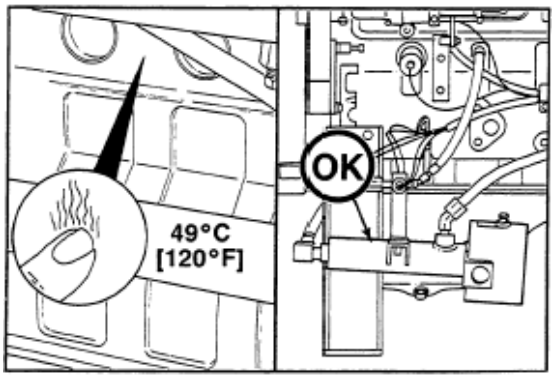
	**WARNING**. Serious personal injury or extensive property damage can result if the warning instructions are not followed.
	**CAUTION**. Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are not followed.
	**INSPECTION** is required.
	Refer to another location in this manual or another publication for additional information.
	Indicates a **REMOVAL** or **DISASSEMBLY** step.
	**LUBRICATE** the part or assembly.
	**CLEAN** the part or assembly.
	**TIGHTEN** to a specific torque.
	Indicates an **INSTALLATION** or an **ASSEMBLY** step.
	**PERFORM** a mechanical or time **MEASUREMENT**.
	**PERFORM** an electrical **MEASUREMENT**.

Illustrations

The illustrations used in this manual are intended to give an example of a problem, and to show what to look for and where the problem can be found.

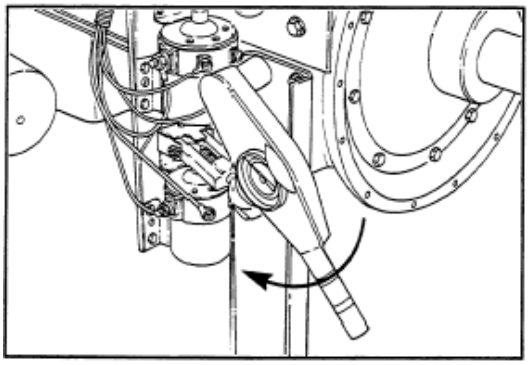
Some of the illustrations are “generic” and might not look exactly like the engine or parts used in your application.

The illustrations can contain symbols to indicate an action required, and an acceptable or not acceptable condition.



The illustrations are also intended to show repair or replacement procedures.

The illustration can differ from your application, but the procedure given will be the same.



General Safety Instructions

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. Put a "**Do Not Operate**" tag 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, 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 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 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**.

General Safety Instructions (Cont.)

- Naphtha 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. Dispose of waste oil in accordance with applicable requirements.

General Cleaning Instructions

WARNING

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

WARNING

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

WARNING

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

WARNING

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

CAUTION

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

CAUTION

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

CAUTION

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

Definition of Clean

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

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

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

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

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

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

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

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

Using Abrasive Pads and Abrasive Paper

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

WARNING

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

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

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

If particles that are smaller than the clearance between the parts while they are at rest (engine stopped), but larger than the running clearance then damage will occur when the parts move relative to each other (engine started). While the engine is running and there is oil pressure, particles that are smaller than the bearing clearance are likely to pass between the parts without damage and be trapped in the oil filter. However, particles larger than the bearing clearance will remove material from one part and can become embedded in one of the parts. Once embedded in one part it will abrade the other part until contact is no longer being made between the two parts. If the damage sufficiently degrades the oil film, the two parts will come into contact resulting in early wear-out or failure from lack of effective lubrication.

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

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

WARNING

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

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

Cleaning Gasket Surfaces

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

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

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

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

Solvent and Acid Cleaning

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

WARNING

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

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

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

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

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

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful to not damage any gasket surfaces. When possible use hot high pressure water or steam clean the parts before putting them in the cleaning tank. Removing the heaviest dirt before placing in the tank will allow the cleaner to work more effectively and the cleaning agent will last longer.

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

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

Steam Cleaning

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

WARNING

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

Do not steam clean the following components:

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

Plastic Bead Cleaning

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

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

CAUTION

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

CAUTION

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

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

Plastic Bead Cleaning (Cont)

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

Bead size: U.S. size Number 16 — 20 for piston cleaning with plastic bead media, Part Number 3822735

Operating Pressure — 270 kPa (40 psi) for piston cleaning. Pressure should not cause beads to break.

Steam clean or wash the parts with solvent to remove all of the foreign material and plastic beads after cleaning. Rinse with hot water. Dry with compressed air.

CAUTION

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

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

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

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

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

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

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

Acronyms and Abbreviations

AFC	Air Fuel Control	in.	Inch
Amp	Ampere	in-lb	Inch Pound
API	American Petroleum Institute	kg	Kilograms
ASA	Air Signal Attenuator	kPa	Kilopascal
ASTM	American Society of Testing and Materials	l	Liter
AWG	American Wire Gauge	lb.	pound
C	Celsius	lbf.	Pound force
C.I.D.	Cubic Inch Displacement	m	Meter
CAC	Charge Air Cooler	ml	Milliliter
CARB	California Air Resources Board	mm	Millimeter
cc	Cubic Centimeter	MPa	Megapascal
cm	Centimeter	MPH	Miles Per Hour
CPL	Control Parts List	MPQ	Miles Per Quart
cSt	Centistokes	N	Newton
D.	Diameter	N•m	Newton-meter
DCA	Diesel Coolant Additive	OEM	Original Equipment Manufacturer
E.C.S.	Emission Control System	oz.	Ounce
ECM	Electronic Control Module	ppm	Parts Per Million
EPA	Environmental Protection Agency	psi	Pounds Per Square Inch
EPS	Engine Position Sensor	PTO	Power Takeoff
F	Fahrenheit	qt	Quart
FSO	Fuel Shut-Off	RPM	Revolutions Per Minute
FSOS	Fuel Shut-Off Switch	S.A.E.	Society of Automotive Engineers
ft-lb	Foot-Pound	STC	Step Timing Control
GAL	Gallon (US)	TDC	Top Dead Center
H_2O	Water	US	United States of America
Hg	Mercury	V	Volt
HP	Horsepower	VS	Variable Speed

Section 2 - Engine Identification

Section Contents

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Fire Pump Engines

Cummins' complete line of fire pump engines have been approved as packaged units (engine and all accessories) by Factory Mutual Research and listed by Underwriter's Laboratories, Inc. and Underwriter's Laboratories of Canada. Because of the lengthy and expensive process to design and produce a fire pump engine that meets these requirements, no deviations are permitted without approval. These engines are to be used only for fire protection applications.

Overspeed Switches

Each engine is equipped with an overspeed switch which will activate the fuel pump solenoid valve and shut off the engine when the RPM exceeds a present limit. The overspeed switch senses engine speed during the start cycle and stops the starting motor cranking cycle. The overspeed switch must be adjusted to the required speed limit during the in-service inspection.

Operating Speed

All Cummins fire pump engines are shipped from the factory with the operating speed adjusted to the lowest approved operating speed. Final operating speed adjustment must be made at the time of the in-service inspection to obtain the required fire pump operating speed specified by the pump manufacturer.

Control System

The function of a fire pump controller is to start the engine. These controllers are more sophisticated than standard industrial controllers because they include special items for fire pumps. Several options are available:

The automatic start controller can be used for either automatic or manual stop after the fire demand signal is removed.

Pressure recorders are available to provide a permanent record of water pressure fluctuations and engine starts.

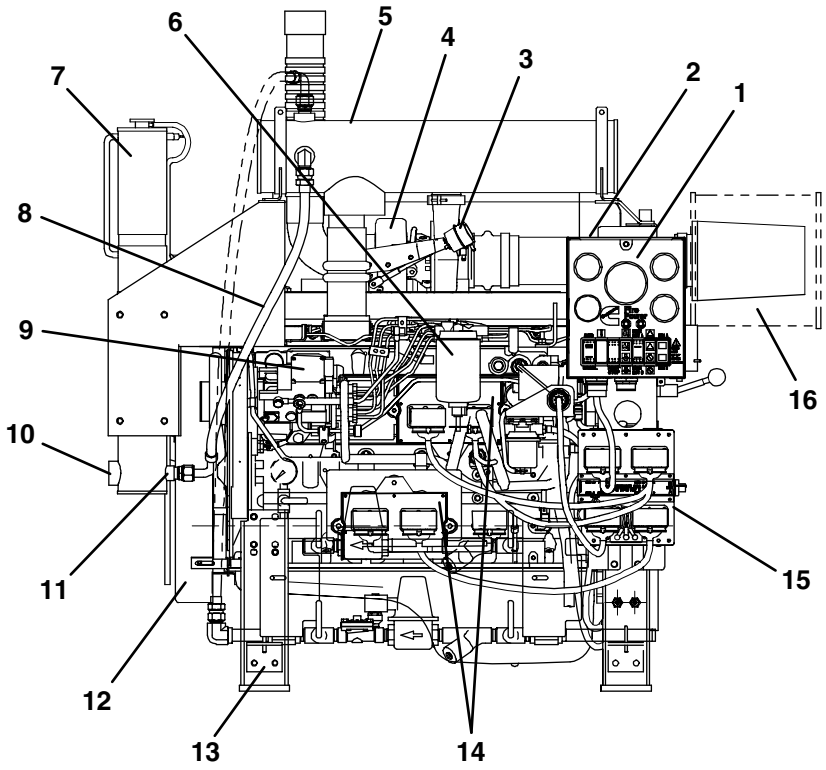
Sequential starting is available for multiple-pump installations to keep all pumps from starting simultaneously.

NOTE: Fire pump controllers are not supplied by Cummins Fire Power, or Cummins Engine Company, Inc.

External Engine Components and Views

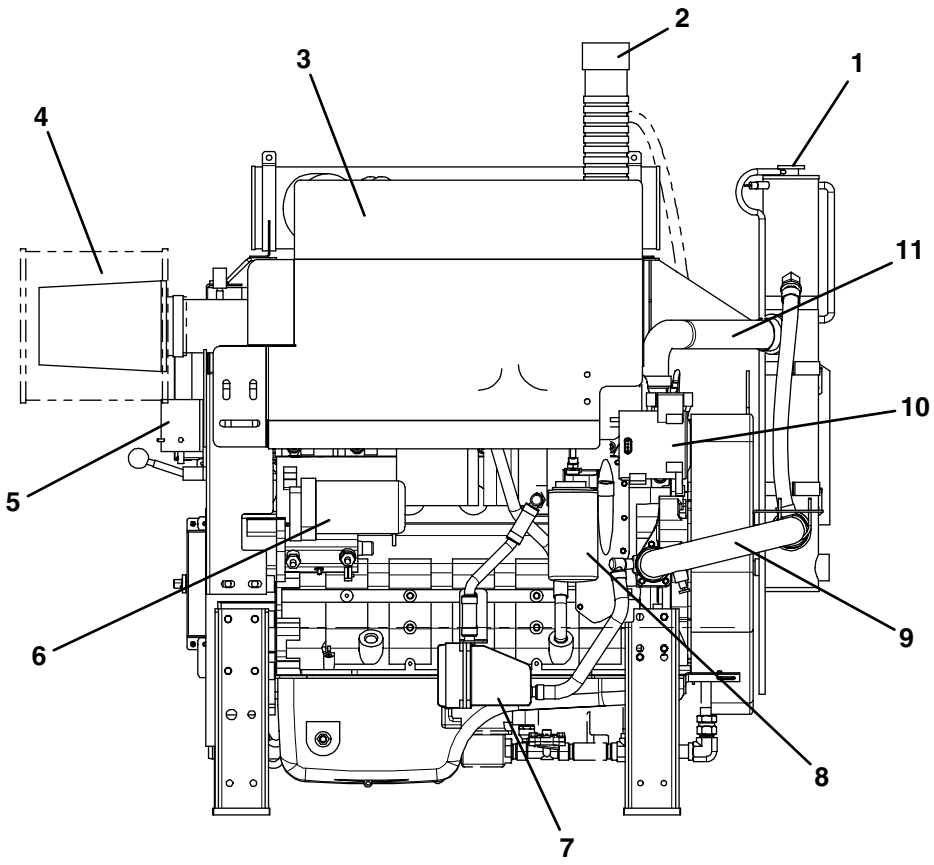
The following illustrations show the locations of the major external engine components, and other service and maintenance points. Some external components will be at different locations for different engine models.

Instrument Panel Side



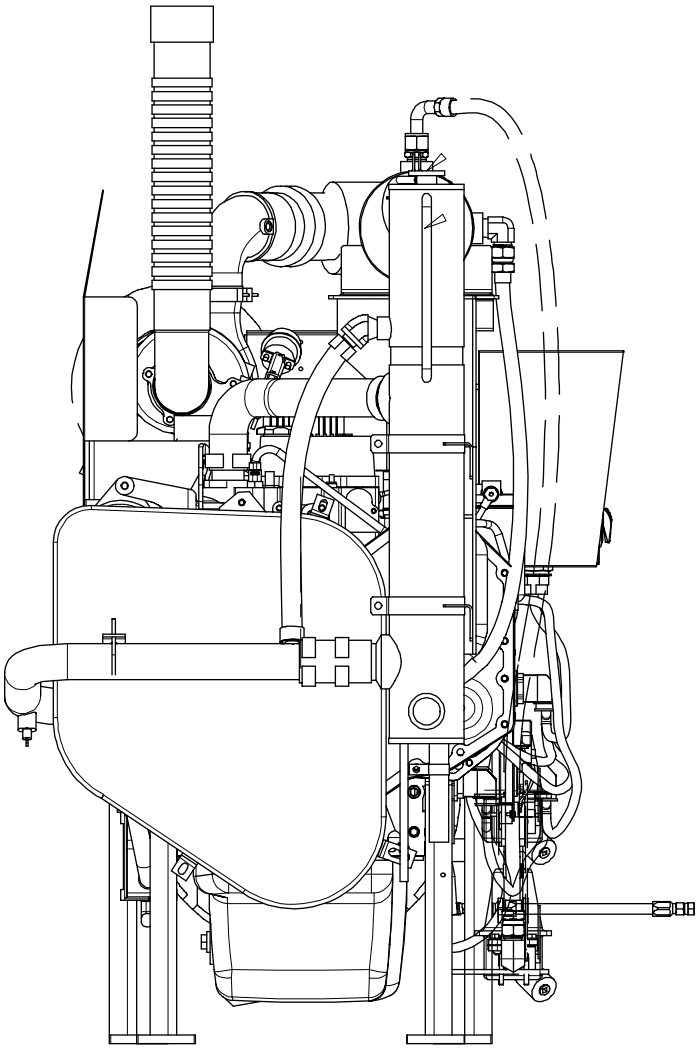
1. Instrument Panel
2. Terminal Box
3. Turbo-boost limiter
4. Turbocharger
5. Charge Air Cooler
6. Fuel Filter
7. Heat Exchanger
8. Water Piping for Charge Air Cooler
9. Fuel Pump
10. Raw Water Outlet
11. Raw Water Inlet
12. Pulley Guard
13. Engine Support
14. Electronic Control Module (ECM)
15. ECM Switch Holder Box
16. Air Cleaner Element

Turbocharger Side

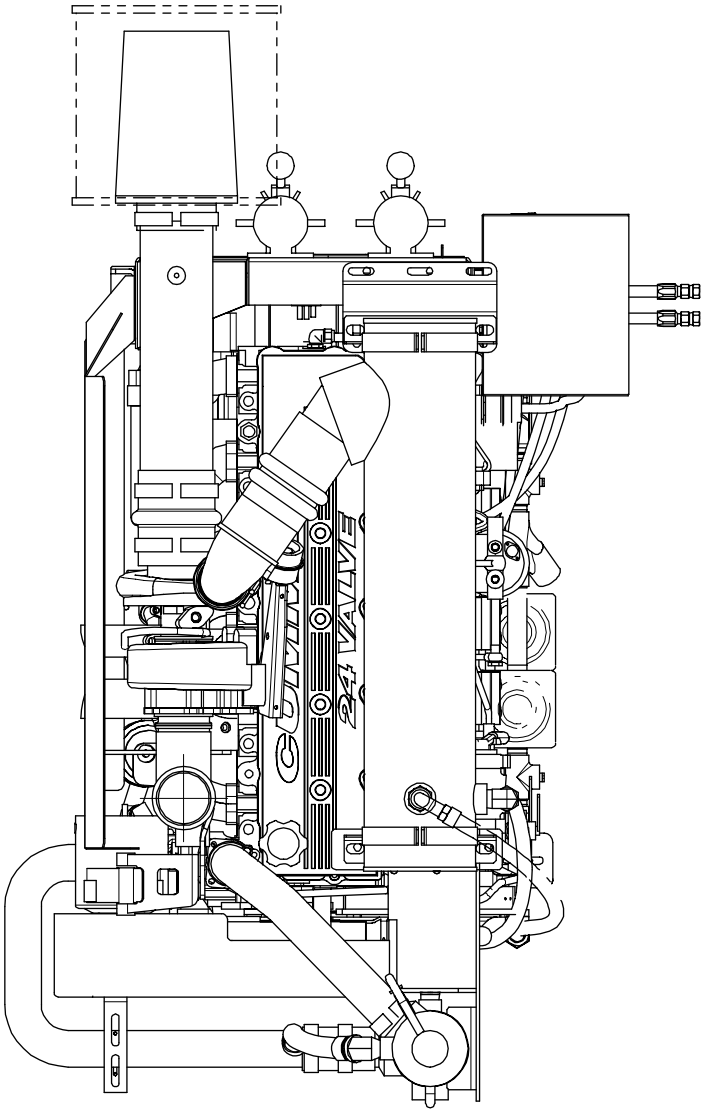


1. Top Tank Fill
2. Exhaust
3. Turbocharger and Exhaust Shield
4. Air Cleaner Element
5. Manual Start Lever
6. Starter Motor
7. Coolant Heater
8. Lubricating Oil Filter
9. Lower Water Hose/Tube
10. Alternator
11. Upper Water Hose/Tube

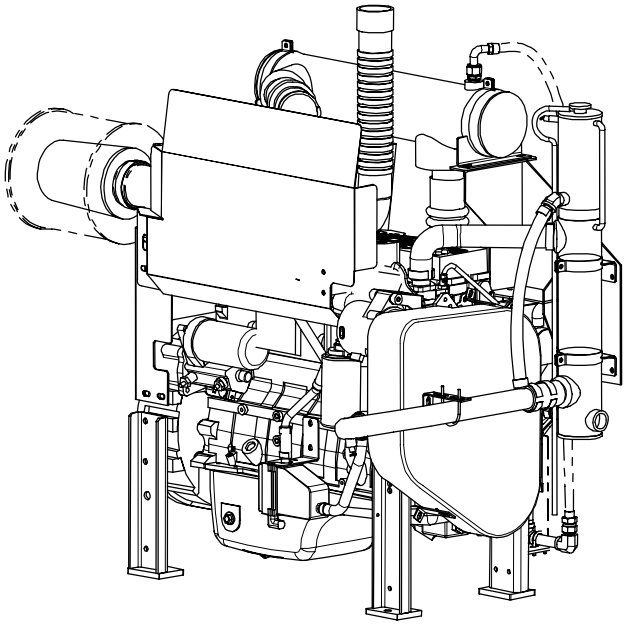
Front View

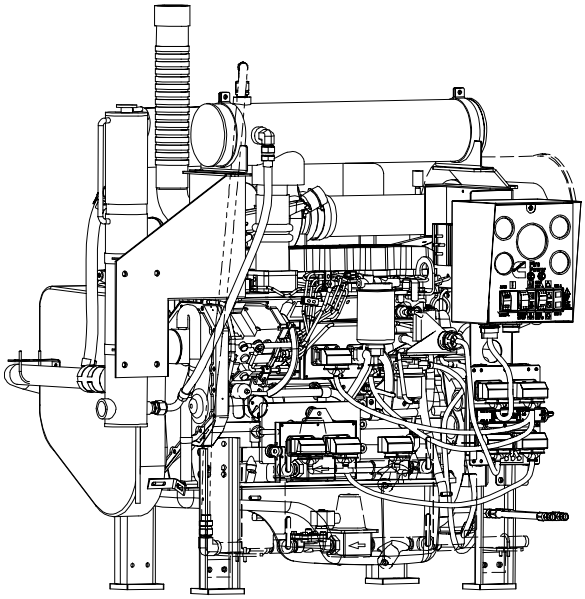


Top View

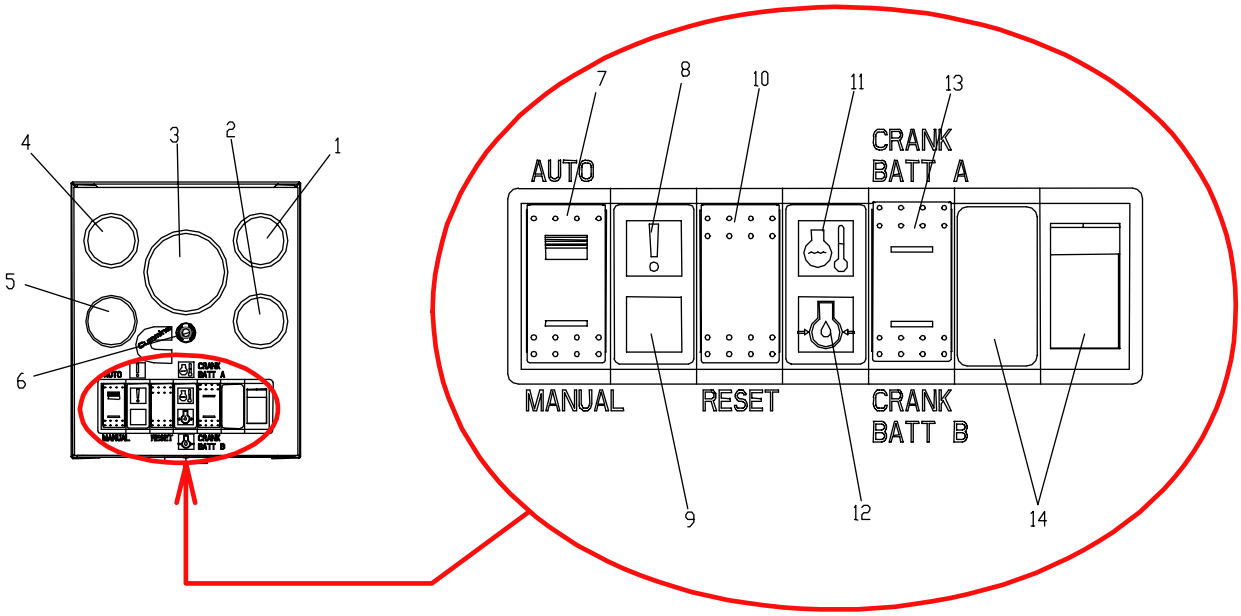


Isometric Views



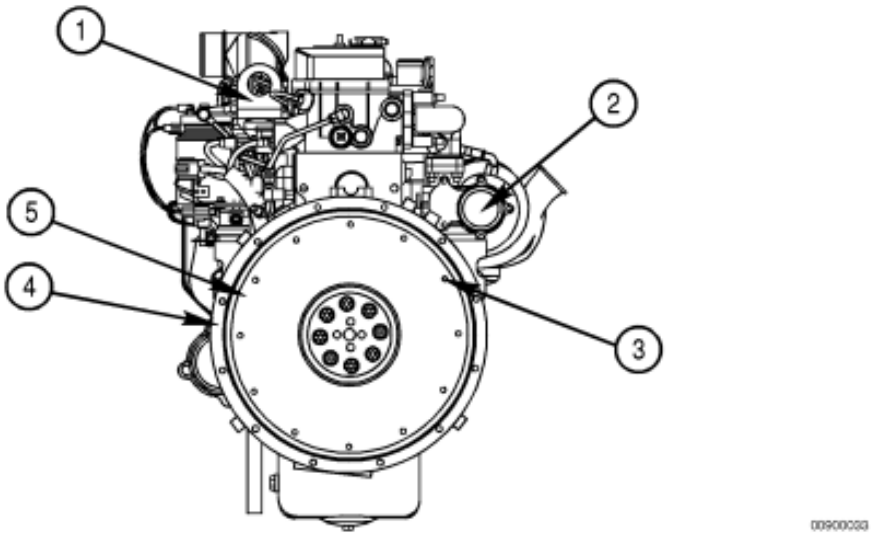


Instrument Panel



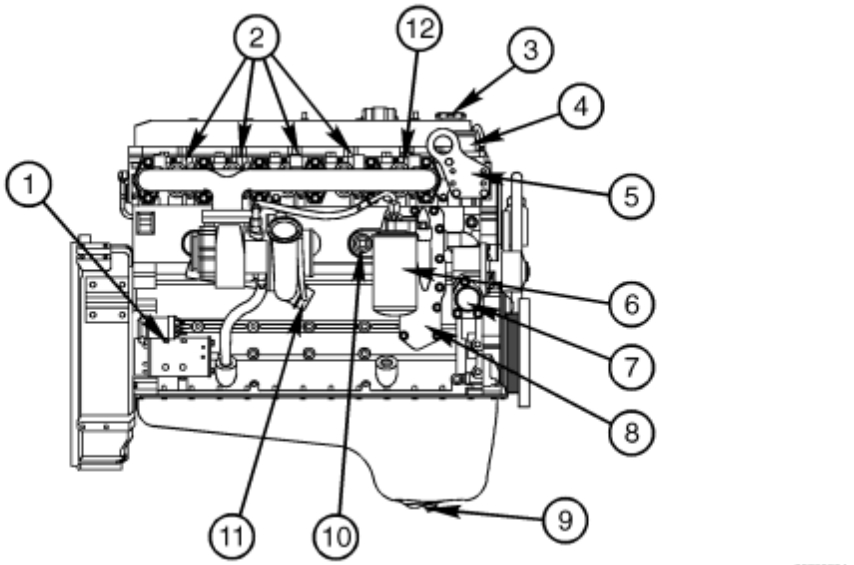
1. Battery “A” Voltmeter
2. Battery “B” Voltmeter
3. Tachometer (with hour-meter)
4. Water Temperature Gauge
5. Lubricating Oil Pressure Gauge
6. Circuit Breaker
7. ON/OFF Switch (AUTO/MANUAL)
8. Overspeed Warning Light
9. Not used
10. Overspeed Reset Switch
11. High Water Temperature Warning Light
12. Low Oil Pressure Warning Light
13. Battery A/B Switch
14. ECM indicators –
    Yellow (Warning)
    Red (Fuel)

Rear View



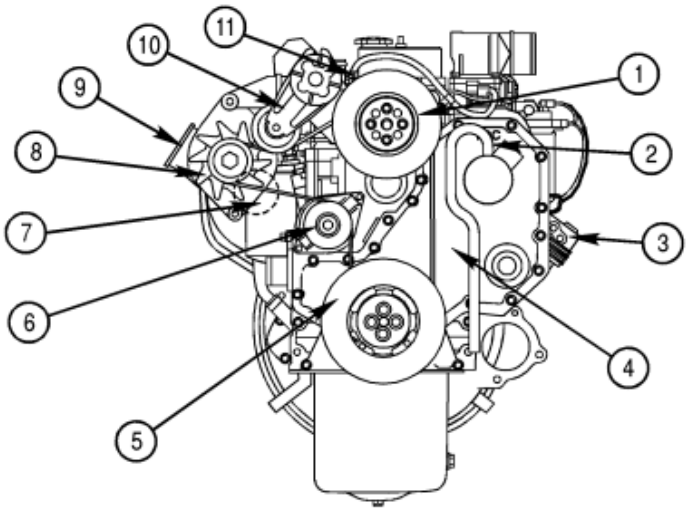
1.	Rear engine lifting bracket	4.	Flywheel housing
2.	Turbocharger exhaust outlet	5.	Flywheel/flexplate
3.	Clutch mounting holes		

Exhaust Side View



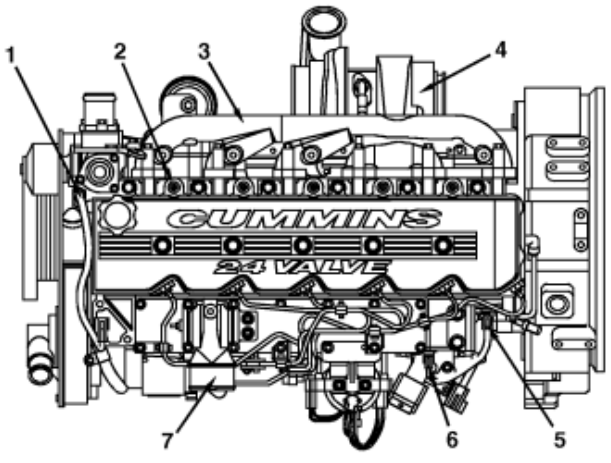
1.	Starter motor and solenoid	7.	Water inlet
2.	1/2-inch (NPTF) coolant taps	8.	Lubricating oil cooler
3.	Oil fill	9.	Oil drain
4.	Water outlet	10.	Provision for coolant heater
5.	Front engine-lifting bracket	11.	Turbocharger wastegate actuator
6.	Lubricating oil filter	12.	Coolant vent fitting

Front View



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

Top View



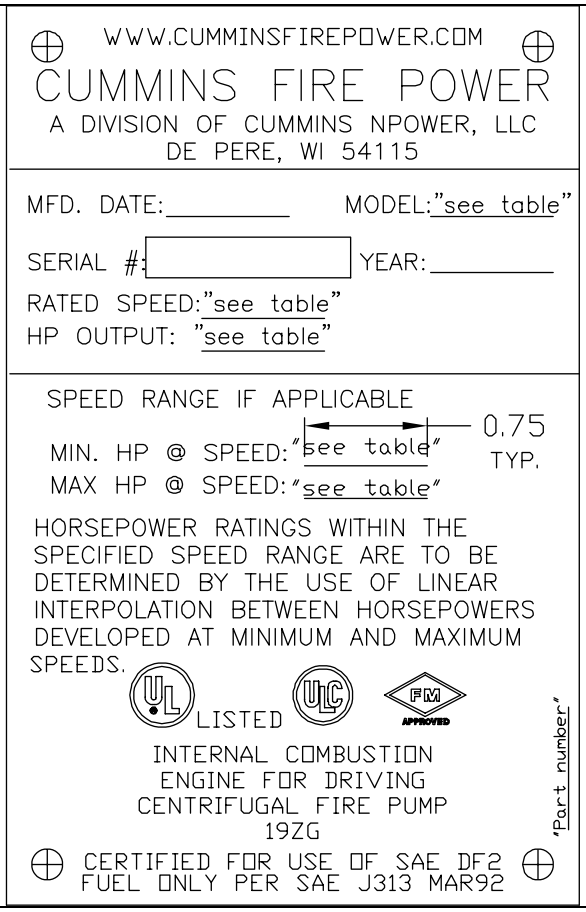
1.	Coolant temperature sensor	5.	Intake manifold pressure sensor
2.	Coolant vent fitting	6.	Intake manifold temperature sensor
3.	Exhaust manifold	7.	Engine air inlet
4.	Turbocharger		

Fire Pump Engine Data Tag

The Fire Pump Engine Data Tag is located at the pump end of the engine just above the redundant starter solenoids. Refer to Drawing 8707 in Section 13 for location details.

This tag shows specific information about your engine. The engine serial number provides information for ordering parts and service needs.

NOTE: The fire pump dataplate **must not** be changed unless approved by Cummins Fire Power.

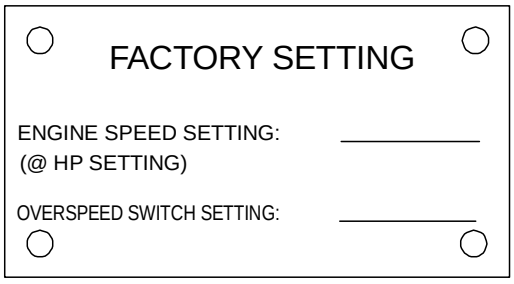


Factory Setting Tag

The Factory Setting Tag is located at the pump end of the engine just above the redundant starter solenoids. Refer to Drawing 8707 in Section 13 for location details.

This tag identifies to rated operating speed at the rated horsepower. It also provides the over speed switch setpoint. Both values are set at the factory.

Refer to Installation Instructions in Section 3 for procedures to verify or adjust either setpoint.



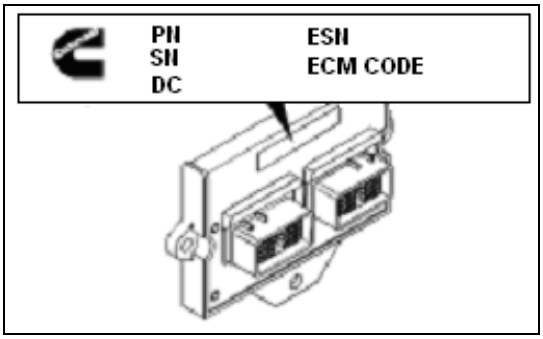
ECM Dataplate

The electronic control module (ECM) dataplate shows information about the 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 (PN)
- ECM serial number (SN)
- ECM date code (DC)
- Engine serial number (ESN)
- ECM code: Identifies the software in the ECM

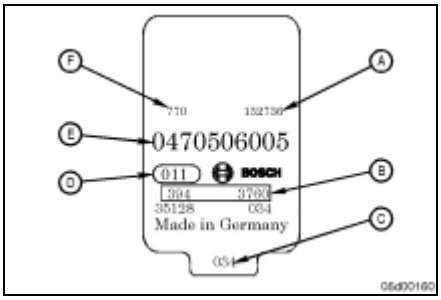
NOTE: Have the ECM code for your engine available when communicating with a Cummins Authorized Repair Location.



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:

- Pump serial number
- Cummins part number
- Key identifier
- Factory code
- Bosch® part number
- Date code



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Section 3 – Installation and Operation

Section Contents

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Installation Overview

The first part of this section provides instructions for the initial installation, adjustment, and testing of the Cummins NPower FirePump engine. Appropriate portions of this section should also be used when returning the engine to operation after overhaul or major maintenance. The second parts details normal operations.

Physical Engine Installation

Location

Refer to Drawing CFP6E GEN in Section 13 for the general fire pump and engine layout.

Refer to Drawing 8707 in Section 13 for the general fire pump engine power module assembly.

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 overspeeding, which can result in a fire, an explosion, and extensive property damage. Numerous safety devices are available, such as air intake shutoff devices, to minimize the risk of overspeeding in which an engine, because of application, might operate in a combustible environment (from a fuel spill or gas leak, for example). Cummins Engine Company, Inc., does not know how you will use your engine. The equipment owner and operator, therefore, is responsible for safe operation in a hostile environment. Consult your Cummins Authorized Repair Location for further information.

Install the fire pump engine in a sheltered environment protected from extremes of weather. Any enclosure must protect the water supply from freezing. Ensure that the engine and electrical components are not exposed to significant water dripping or sprays. Avoid installation in a dusty or dirty environment. Provide adequate physical protection from other physical damage as may be present in the specific location. (Refer to National Fire Protection Association NFPA20-2003 Chapter 11 for additional installation requirements for installations in the USA.)

Design the installation to meet the engine's mounting requirements. Refer to General Engine Data in Section 10.

Install the engine on a stable level foundation that is designed for the load and vibration of pump operation.

Install the engine with ample room for servicing of the engine, the pump, fuel supply, and support systems.

Ensure that the engine location is free of any risk of exposure to combustible vapors.

Physical Installation

Use the supplied lifting hooks on the engine to position the engine.

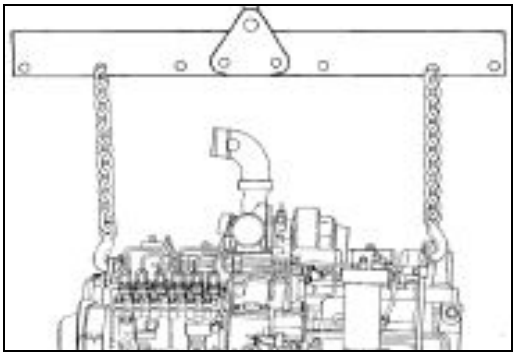
Provide engine support as required to support the wet weight specified in General Engine Data in Section 10.

Position the engine as required for the interface with the pump, piping, and electrical connections.

Level the installation with shims as required.

Secure the engine to the support or floor.

Connect the exhaust piping.



Fuel Supply Installation

NOTE: Refer to National Fire Protection Association NFPA20-2003 Chapter 11 for additional installation requirements for installations in the USA. Ensure that the fuel system is installed in a safe and an effective manner.

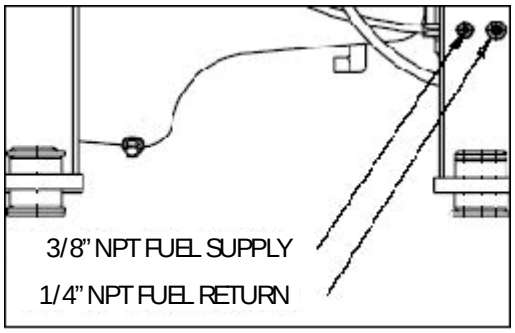
Install an elevated Diesel # 2 fuel tank or other fuel supply arrangement that meets the specifications listed in Fuel System Specifications in Section 10.

Size the fuel tank for the maximum expected full-load engine operation period with the initial fuel level at the minimum level for refueling.

Install a 3/8" NPT (minimum) fuel supply line to the fire pump engine.

Install a 1/4" NPT (minimum) fuel return line. Route this line to the bottom of the fuel tank in order to minimize the return head.

Provide a pre-filter on the fuel line to the fire pump engine.



Fire Pump Installation

Install the customer supplied fire pump as per the pump manufacturer's instructions and applicable code requirements. Refer to National Fire Protection Association NFPA20-2003 Chapter 11 for requirements for installations in the USA. Ensure that the engine and pump are correctly aligned.

Raw Water Supply Installation

Overview

Raw water is used to cool the engine cooling fluid. Raw water is supplied from the fire pump prior to the pump discharge flange. It is forced through a cooling loop by fire pump pressure to the heat exchanger. In the heat exchanger, it flows through the tubes in the bundle and is discharged to an open waste cone. The raw water supply must be immediately available when the engine is started.

Refer to the Cooling System Flow Diagrams in Section 6 for a simplified block diagram of the cooling weater system. Refer to Cooling System Specifications in Section 10 for pipe size requirements.

Refer to Drawing 8682 in Section 13 for the optional raw water piping manifold that is available from Cummins Fire Power.

If the piping supplied by the customer, provide raw water supply piping and components equivalent to that can be supplied by Cummins Fire Power and as shown in Assembly Diagram, Raw Water Piping in Section 6. Refer to National Fire Protection Association NFPA20-2003 Chapter 11 for installation requirements for installations in the USA. When choosing the components for the raw water supply and by-pass, care must be taken to ensure that the internal cross sectional area of the component is at least as large as the recommended pipe size.

When the raw water piping is installed, adjust both pressure regulator setpoints before operating the pump. Damage to the heat exchanger may occur from improperly regulated raw water supply pressure.

Raw Water Supply and Drain without Cummins Raw Water Manifold

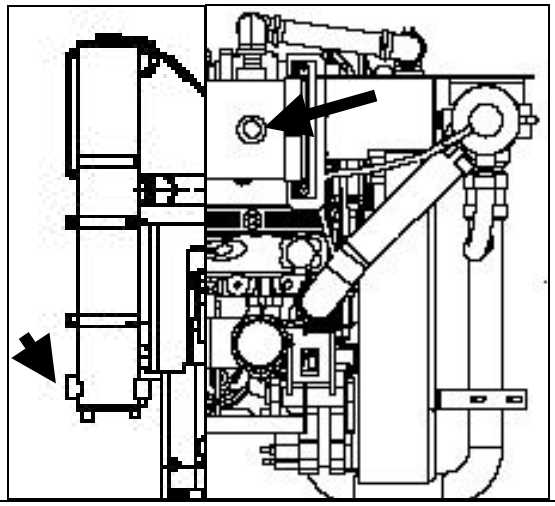
NOTE: Raw water outlet piping from the heat exchanger should be one pipe size larger than the supply piping.

NOTE: The velocity of raw water should be as great as possible without exceeding the maximum shown on the appropriate engine data sheet.

NOTE: Failure to comply will result in engine overheat and failure.

Provide raw water supply to the charge air cooler.

Provide an open waste cone raw water drain at the outlet from the heat exchanger.



Raw Water Supply and Drain with Cummins Raw Water Manifold

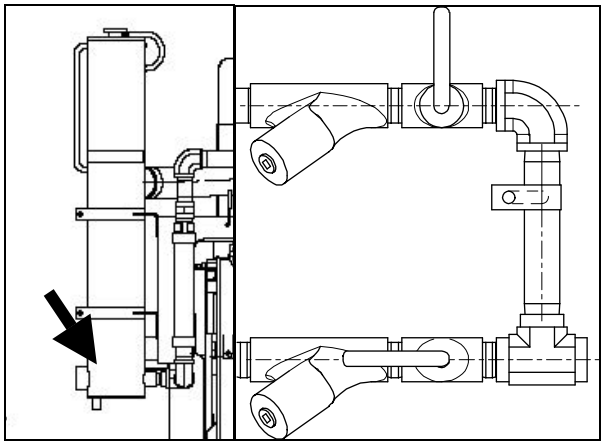
NOTE: Raw water outlet piping from the heat exchanger should be one pipe size larger than the supply piping.

NOTE: The velocity of raw water should be as great as possible without exceeding the maximum shown on the appropriate engine data sheet.

NOTE: Failure to comply will result in engine overheat and failure.

Provide raw water supply to the raw water manifold inlet.

Provide an open waste cone raw water drain at the outside of the heat exchanger.



Check Raw Water Pressure Regulator Setpoints

NOTE: Adapt this procedure to the actual installation if a Cummins raw water manifold is not supplied.

Temporarily remove raw water inlet piping at the charge air cooler. Refer to Drawing 11148 in Section 13.

Provide temporary drain piping at the raw water manifold outlet.

If closed, open the pressure gauge isolation valve.

NOTE: The normal line has the solenoid valve. The bypass line does not.

If open, close the normal line inlet valve.

Open the bypass line inlet and outlet valves.

NOTE: Temporary water supply pressure should exceed 414 kPa [60 psig].

Provide temporary water supply piping to the raw water manifold.

Adjust the bypass pressure regulator for 414 kPa [60 psig] or slightly less.

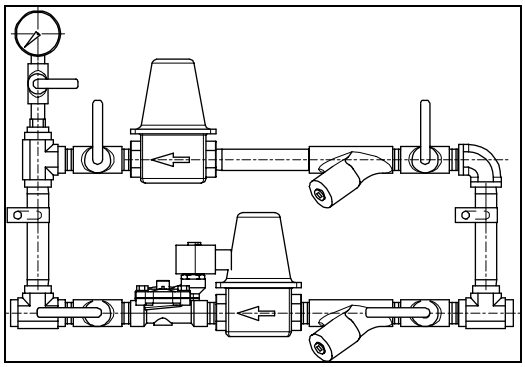
Close the bypass line inlet valve.

NOTE: Use the correct voltage for unit.

Provide a temporary 12 VDC standard (24 VDC optional) power source for the solenoid valve at Pin 13 and Pin 17.

Open the normal line inlet and outlet valves.

Adjust the normal pressure regulator for 414 kPa [60 psig] or slightly less.



Remove the power jumper and reconnect the wiring.

Re-install the raw water piping from the manifold to the charge air cooler. Refer to Drawing 11148 in Section 13.

Test the pressure regulator setpoints with water flowing through the heat exchanger. Trim the setpoints if required.

Remove the temporary water supply to the manifold.

Re-install the raw water piping at the pump.

Battery and Electrical Installation

Overview

Two redundant sets of batteries must be supplied for the selected operating voltage 12 VDC standard (24 VDC optional).

Batteries must meet the requirement listed in Electrical System Specifications in Section 10.

Batteries may be supplied by Cummins Fire Power as an option or may be supplied by the customer.

Refer to National Fire Protection Association NFPA20-2003 Chapter 11 for battery and battery charger requirements for installations in the USA.

Battery Installation

Install the redundant sets of batteries in a well ventilated or otherwise protected location. Provide adequate room for servicing or replacing the batteries. Provide protection from extremes of temperature and weather.

Locate the batteries near the engine or increase the size of the conductors as required by applicable codes.

Ensure that the batteries are configured properly for either 12 VDC standard (24 VDC optional) operations as appropriate.

Battery Wiring Installation

NOTE: Install the wiring in accordance with applicable codes and specifications.

Install the Loose Wire Kit wires. Refer to Drawing 9767 in Section 13.

If purchased, install the optional battery cable kit (Cummins FirePower Part No. 9609). Otherwise, install equivalent customer supplied wiring.

Signal and Control Installation

NOTE: Install signal and control wiring at Terminal Board. Refer to Drawing 10423 Sheet 1 in Section 13. .

Ensure that the fire control system is properly installed and configured as per the manufacturer's instructions.

Complete the customer-supplied fire pump controller wiring as per the manufacturer's instructions.

NOTE: Do not connect more than two wires at any point on the fire pump engine control panel terminal board. If necessary, add a grounding terminal board at the fire control system.

Connect the control power from the fire pump controller at TB-1 (+) and TB-11 (-). This power source is necessary for fire pump operations while in the AUTO mode.

Connect the two redundant crank signals from the fire pump controller to TB-9 (Crank Battery A) and to TB-10 (Crank Battery B). Connect the signal ground to TB-11.

Connect the Crank Terminate input to the fire pump controller from TB-2 with signal ground at TB-11. This 12 or 24 VDC signal is present when the engine is running. This signal indicates that the engine has started and that the crank command from the fire pump controller should stop immediately.

Connect the remote overspeed alarm input to the fire pump controller from TB-3. This 12 or 24 VDC signal is present when the overspeed switch has operated. If this event occurs, the fire pump engine will stop. The local RESET button must be pressed in order to restart the engine.

Connect the Low Oil Pressure alarm input to the fire pump controller from TB-5. This 0 VDC grounded signal is present when the oil pressure has dropped below the 110 kPa [16 PSIG] setpoint. The engine will continue to operate but immediate attention is necessary in order to prevent excessive damage to the engine or catastrophic engine failure.

Connect the High Water Temperature alarm input to the fire pump controller from TB-5. This 0 VDC grounded signal is present when the engine is running and the coolant temperature has risen above the 93 ^{o}C [200 ^{o}F] setpoint. The engine will continue to operate but immediate attention is necessary in order to prevent excessive damage to the engine or catastrophic engine failure.

If used, provide permanently installed redundant battery charging systems with connections at TB 6 and TB-8 (+) and TB-11 (-). TB-6 (+) and TB-8 (+) and TB-11 (-) should also be used for remote battery voltage indications at the fire control system or elsewhere.

Ensure electrical continuity and adequate insulation resistance for the installed wiring.

Provide the initial charge on the redundant batteries as per the battery charger's instructions.

Check that both voltmeters on the local control panel indicate the approximate battery voltage.

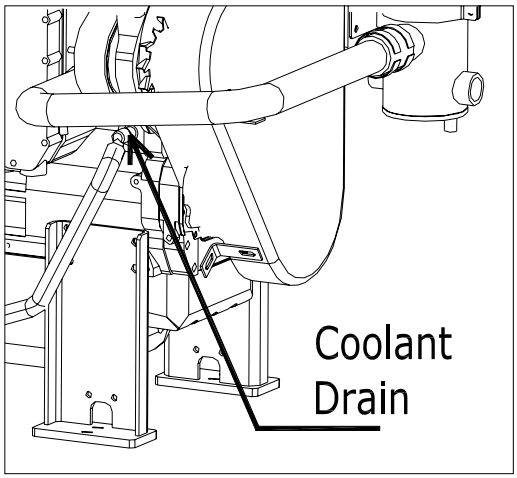
Coolant System Preparation

Check Cooling System Integrity

NOTE: Refer to Drawing 8707 in Section 13 for hose arrangement.

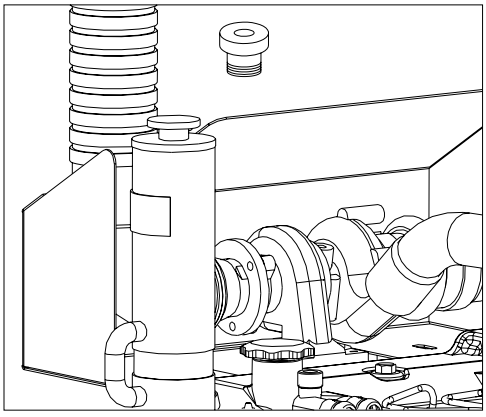
Check that all coolant hoses are properly installed and that the clamps are tight.

Check that the coolant drain petcock is closed.



Add Coolant

Remove the pressure cap (Cummins Fire Power Part No. 11407) from the heat exchanger.



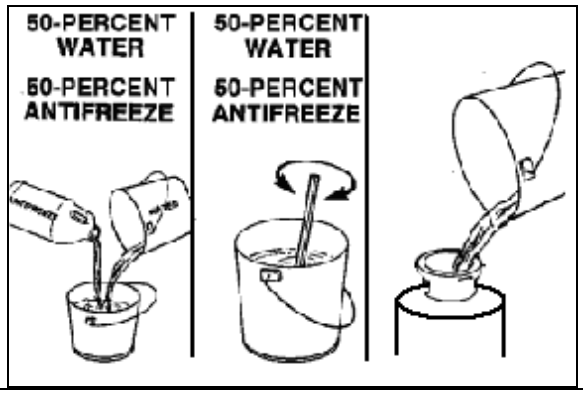
Refer to Cooling System Specifications and Coolant Recommendations and Specifications in Section 10.

NOTE: Use a mixture of at least 50 percent antifreeze and 50 percent water.

Add coolant until the coolant level is just below the fill tube in the coolant heat exchanger.

Check for leaks. Correct any leaks.

Install the pressure cap (Cummins Fire Power Part No. 11407) on the heat exchanger.



Coolant System Preparation (Cont)

Check Raw Water Supply Lineup

CAUTION

The raw water lines to and from the fire pump must be open, and there must be sufficient water to the heat exchanger when the engine has started. Insufficient water supply will cause overheating, resulting in engine failure.

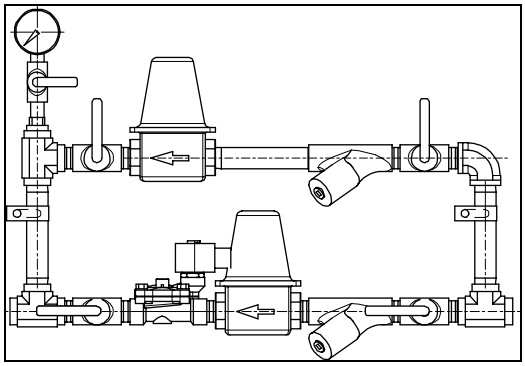
Check that the pressure gauge isolation valve is open.

NOTE: The upper line is the bypass line. The lower line with the solenoid valve is the normal line.

Check that the bypass line outlet valve is closed.

Check that the normal line inlet valve is open.

Check that the normal line outlet valve is open.

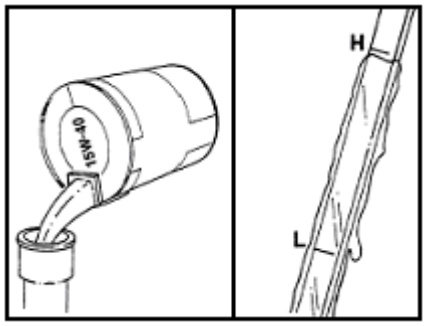


Lubricating Oil System Preparation

Add Lubricating Oil

NOTE: For oil requirements, refer to Lubricating Oil System Specifications and Lubricating Oil Recommendations and Specifications in Section 10. No change in oil viscosity or type is needed for new or newly rebuilt engines.

Fill the crankcase with lubricating oil to the “H” (high) mark on the dipstick.



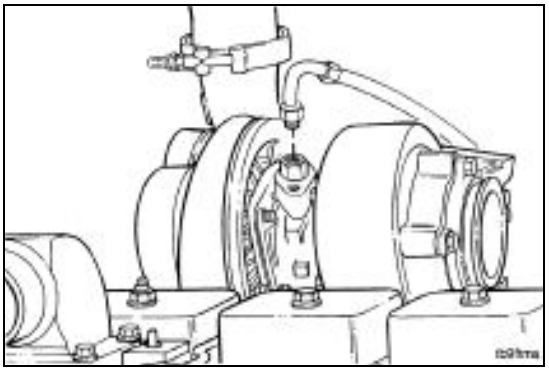
Prime the Turbocharger

CAUTION

New turbochargers must be pre-lubricated before startup. Failure to pre-lube the turbochargers will result in turbocharger bearing failure.

Remove the air intake filter assembly. Refer to Intake Air Filter Removal/Installation in Section 7.

Remove the turbocharger oil inlet line from the turbocharger bearing housing.



NOTE: Rotate the turbine wheel to allow oil to enter the bearing housing. Any excess oil will drain through the oil drain line.

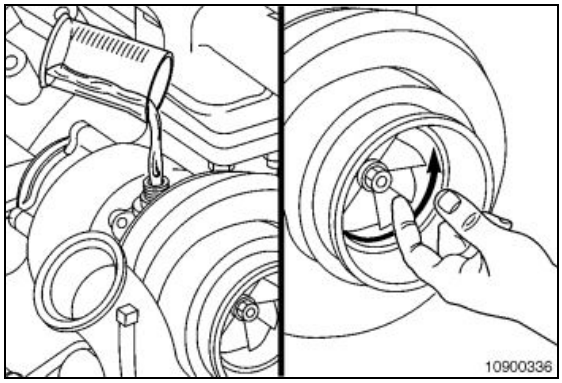
Lubricate the bearings by pouring 59 to 89 ml [2 to 3 oz] of clean engine lubricating oil into the turbocharger oil supply line fitting.

Reconnect the turbocharger oil inlet line.

Tighten the oil supply line.

Torque Value: 24 N•m [18 ft-lb]

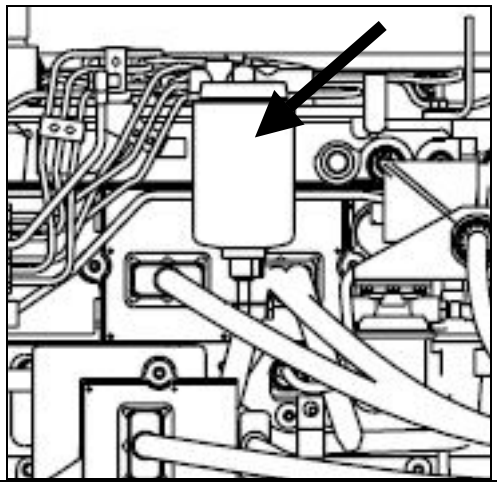
Install the air intake filter assembly. Refer to Intake Air Filter Removal/Installation in Section 7.



Fuel System Preparation

Fill the Fuel Filter

Unscrew the combination fuel filter assembly and remove it from the engine.

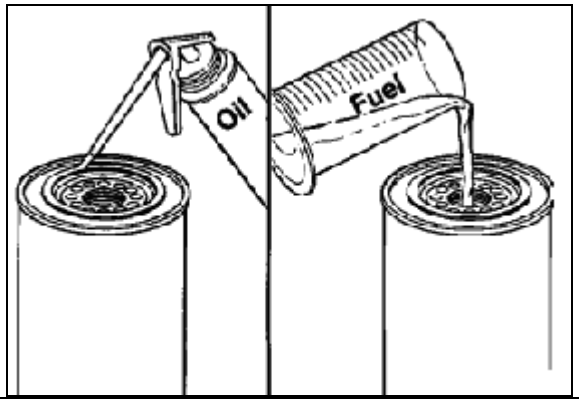


If open, close the water separator drain cock. Refer to Drain Fuel-Water Separator in Section 7.

Lubricate the o-ring seal with clean lubricating oil.

NOTE: Refer to Fuel Recommendations and Specifications in Section 10 for fuel requirements.

Fill the fuel element with fuel.



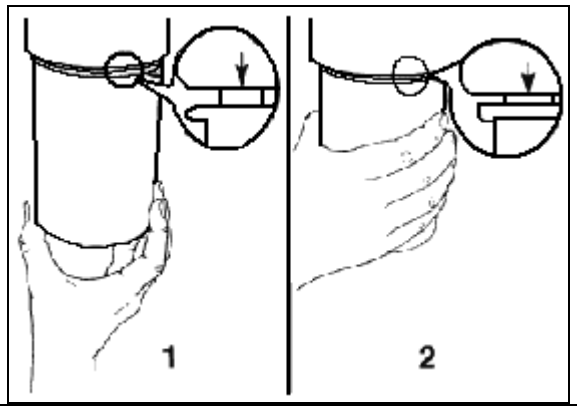
CAUTION

Mechanical over-tightening will distort the threads, filter element seal or filter can.

Install the filter on the filter head.

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

Tighten the filter an additional one-half to three-fourths of a turn, or as specified by the filter manufacturer.



Fuel System Preparation (Cont)

Fill the Fuel Tank

NOTE: Refer to Fuel Recommendations and Specifications in Section 10 for fuel requirements.

Ensure that the fuel tank and piping is clean.

Fill the fuel tank with fuel.

Fill the fuel lines to the engine and fill the fuel pre-filter.

Tighten all fuel supply line fittings to stop possible suction leaks.

Bleed the Fuel Lines

Open any fuel isolation valves and bleed any air from the customer-supplied fuel supply line to the fire pump engine.

Bleed the fuel pre-filter of any air.

Tighten the fuel supply line connections in order to avoid air leakage when the lift pump draws suction.

Pre-Start Inspections

Perform a visual inspection as follows:

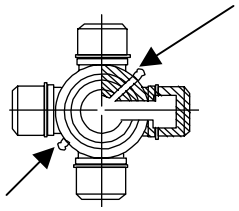
- Check that there is no apparent damage and that all components are installed.
- Check that the drive belt is properly installed.
- Check that all hoses and tubes are properly installed.
- Check that all electrical connections are properly installed.
- Check that the fire pump is properly installed as per the pump manufacturer's instructions, is correctly aligned, and is free to rotate.

Lubricate Zerk Fittings on Auxiliary Drive Shaft

Some lubrication loss may occur during transport and storage. It is recommended that all drive shafts be re-lubricated upon installation.

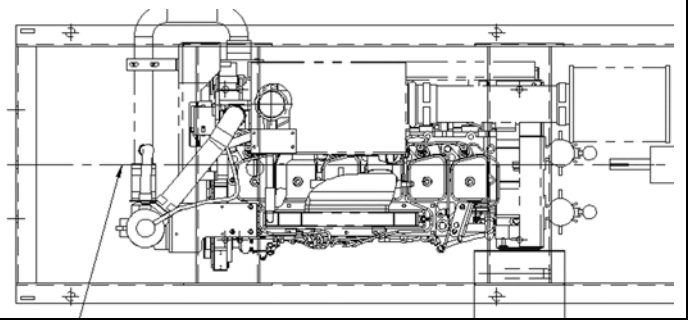
Grease zerk fittings as shown.

See Lubricating Oil Recommendations and Specifications in Section 10 for grease specifications.



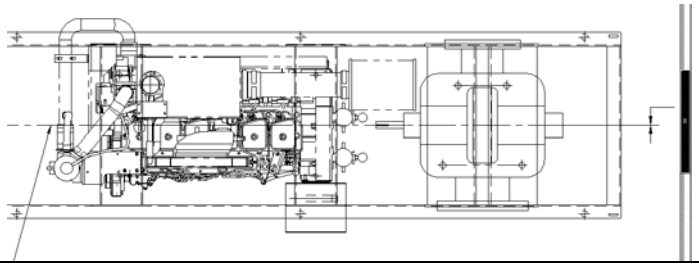
Check Engine to Pump Alignment

Ensure engine position is centered on Frame side to side within +-1/32", by measuring outside of frame side to engine support leg mounting pad. (Compare two front engine supports and two back engine supports.)

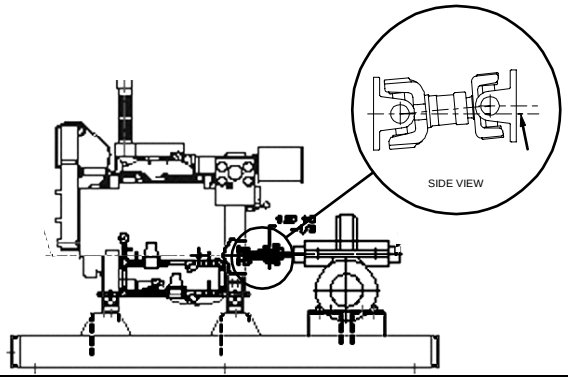


Check Engine to Pump Alignment (Cont)

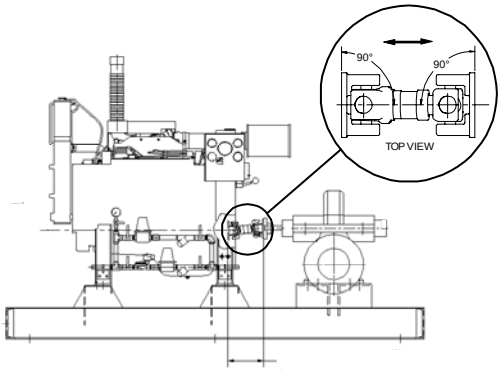
Align engine centerline to pump centerline within +-1/32”.



The pump centerline to the engine crank centerline (in vertical plane) is to be ½” +0, -1/4” offset.



Auxiliary Drive shaft mounting flanges must be parallel within 1.5 degrees.

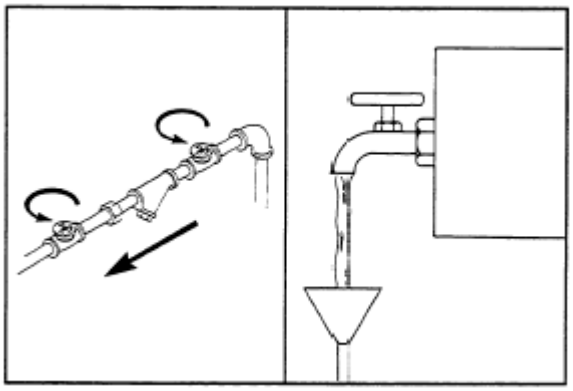


Initial Start-Up

NOTE: Contact personnel responsible for the fire protection system before starting and to obtain approval to service or repair the system.

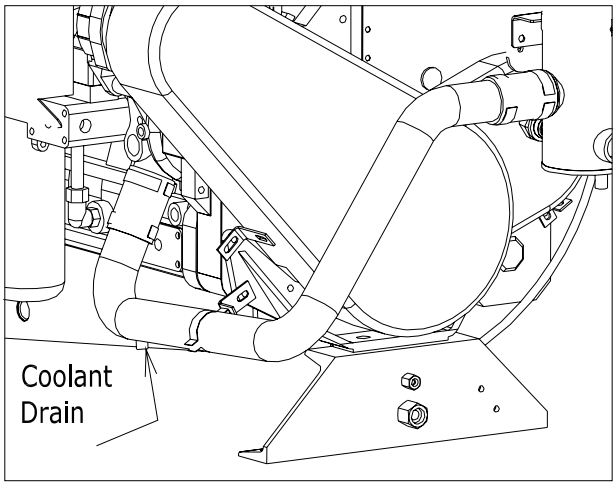
CAUTION

The raw water lines to and from the fire pump must be open, and there must be sufficient water to the heat exchanger when the engine has started. Insufficient water supply will cause overheating, resulting in engine failure.

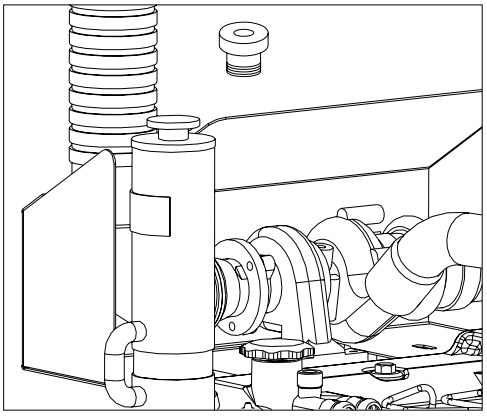


Close all cooling system drains.

Verify that the vents are opened, and the drain plug is installed in the coolant connection.



Remove the coolant tank cap.



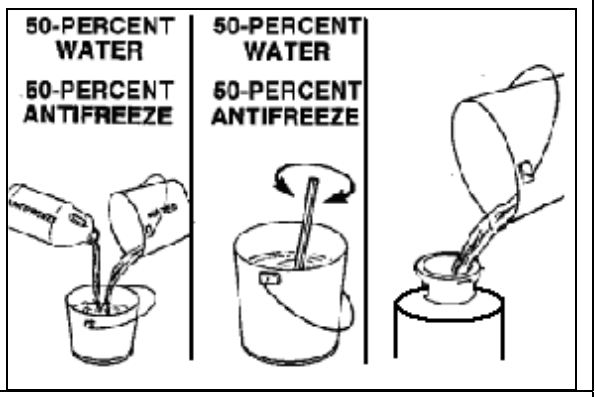
Initial Start-Up (Cont)

Check the engine coolant supply.

Add coolant if necessary.

Use a mixture of at least 50 percent antifreeze and 50 percent water.

Make a visual check for leaks and open the water filter shut-off valves.



Prime the fuel system.

Fill fuel filter (see specifications in Section 3).

Remove the fuel pump suction line and wet the gear pump gears with clean lubricating oil.

Check and fill the fuel tanks.

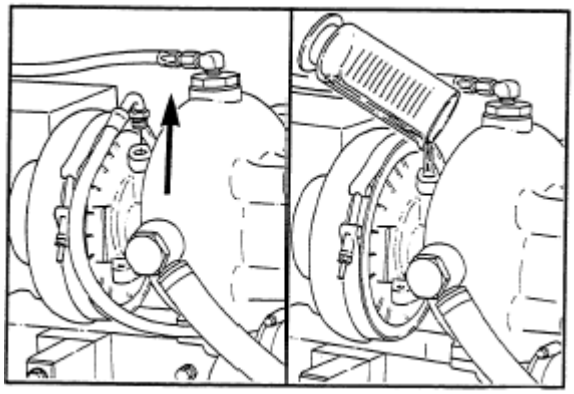
Check the injectors to be sure they are properly adjusted.

Prime the lubricating system:

Fill the crankcase to the “L” (low) mark on the dipstick. See Lubricating Oil Specifications in Section 3.

Remove the turbocharger oil inlet line to pre-lubricate the housing by adding 50 to 60 CC (2 to 3 oz.) of clean engine lubricating oil.

Replace the line.



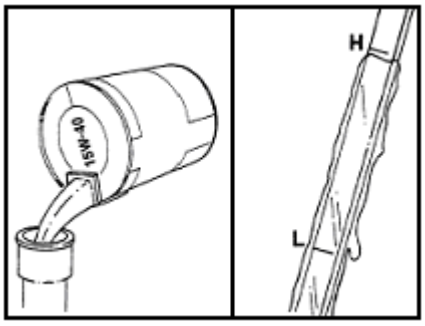
CAUTION

New turbochargers must be pre-lubricated before startup. Failure to pre-lube the turbochargers will result in turbocharger bearing failure.

Prime the engine lubricating system until a 30 psi [207 kPa] minimum pressure is obtained.

Do not prime the engine lubricating system from the by-pass filter.

Crank the engine at least 15 seconds, while maintaining the external oil pressure at a minimum of 15 psi [103kPa].



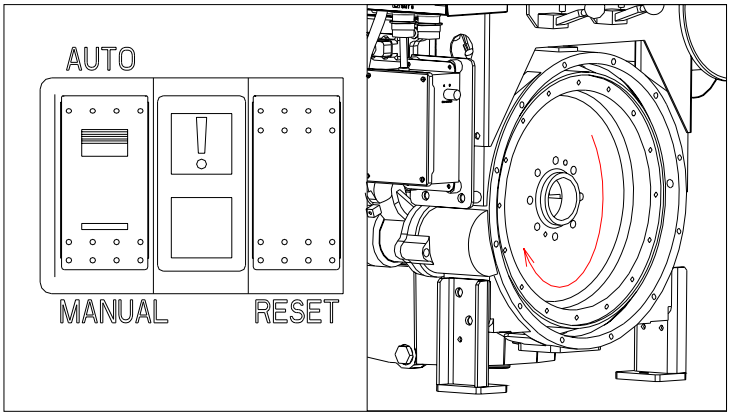
Initial Start-Up (Cont)

Check and/or fill the crankcase to the “H” (high) mark on the dipstick with oil meeting specifications, listed in Section 3.

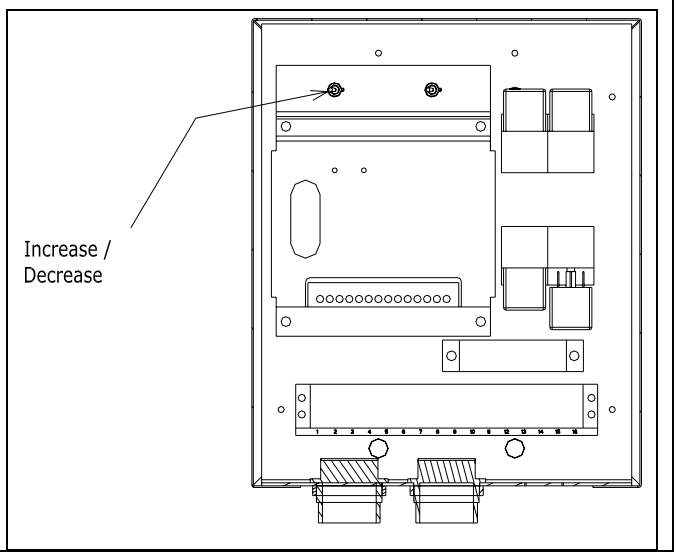
No change in oil viscosity or type is needed for new or newly rebuilt engines.

Pre-lubricate the Engine as follows:

Use the fire pump controller or manual setting from the gauge panel to crank the engine through two cranking cycles.



Inside the Control Panel, turn the screw shown to half of speed.



Initial Start-Up (Cont)

Start the engine.

Immediately turn the screw at low speed.

Allow the engine to operate at low idle speed (700 RPM).

Check the lubricating oil pressure within 15 seconds after the engine starts.

Operate the engine at set point for 8 to 10 minutes.

Check for leaks, unusual noises, or other indications of incorrect operation.

Correct any problems found during the inspection before proceeding.

Shut off the engine.

Overspeed is already set at factory.

Stop the engine and check the engine oil and expansion tank coolant levels. Top off if necessary.

Clean the raw water strainer.

Start the engine and bring it to the fire pump required operating speed.

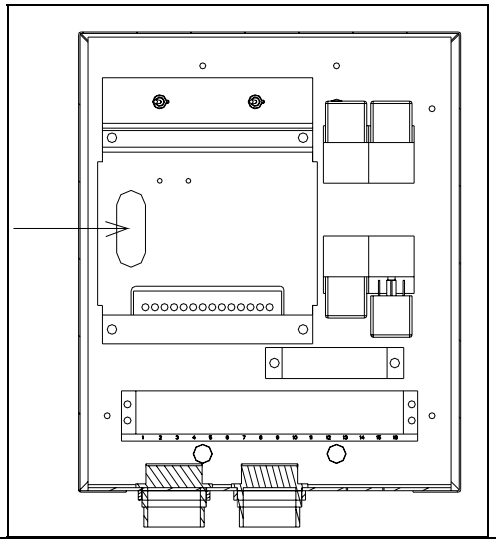
Adjust the raw water pressure regulator to obtain the required pressure.

Readjust the engine speed if necessary.

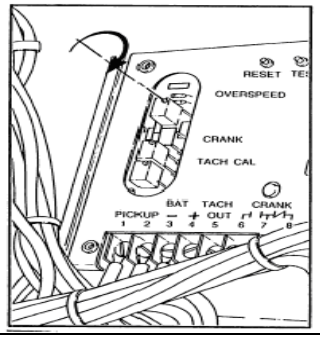
Initial Start-Up (Cont)

Adjustment procedure:

Remove the calibrating screw cover from the electronic overspeed switch.

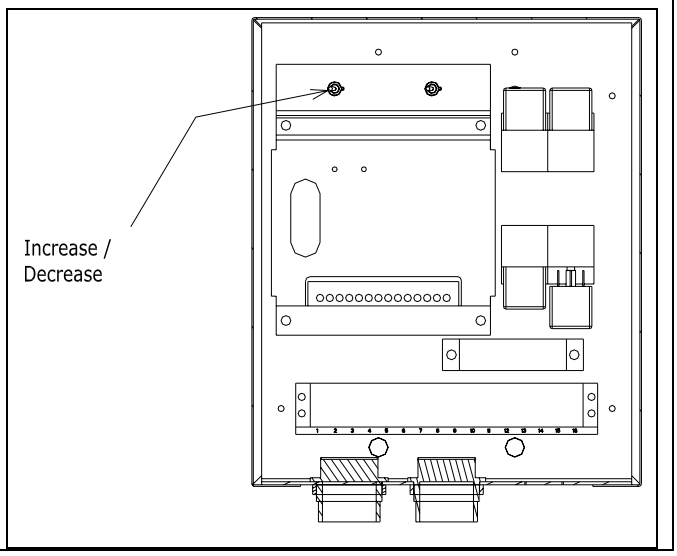


Turn the small screw on the potentiometer near the word “OVERSPEED” clockwise to increase trip speed.



Turn the screw shown to half of speed.

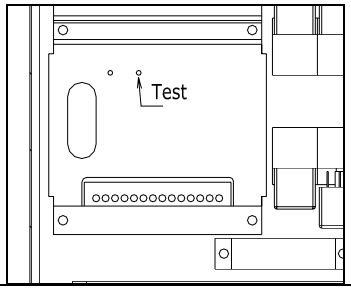
Start the engine and turn the screw to the lowest position.



Initial Start-Up (Cont)

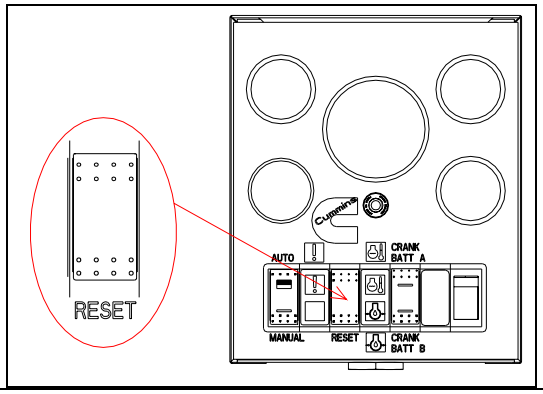
Depress the “TEST” button push-button on the back of the panel. Turn the screw to increase speed.

NOTE: Test button triggers overspeed at 10% below normal.



Operate the “OVERSPEED RESET” switch on the front of the engine control panel.

Repeat if necessary to further adjust the overspeed stop setting.

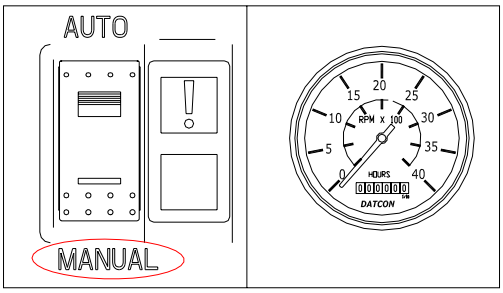


Start the engine.

Check operation at rated speed.

Shut off the engine.

Turn the controller switch to “MANUAL” so it will be ready to start if necessary.



Shut off the engine.

Contact operating personnel responsible for fire protection system that engine is ready for service. Obtain authorized signature of acceptance.

Initial Start

NOTE: Pre-lubrication of the engine is not required. 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.

NOTE: The object of this test is to check that the engine starts and operates normally with oil pressure being displayed and raw water flow being established to the coolant heat exchanger. Operation at the factory-adjusted rated speed is also checked.

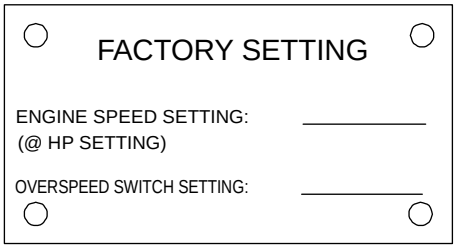
NOTE: If the engine still will not start, troubleshoot as per Engine Cranks But Will Not Start (No Exhaust Smoke) or Engine Difficult to Start or Will Not Start - Exhaust Smoke Present in Section 12.

NOTE: When the engine starts, immediately check that oil pressure is displayed. It should be on-scale within a few seconds. Stop the engine if oil pressure is not displayed within about 15 seconds.

NOTE: When the engine starts, immediately check that raw water flow is established through the coolant heat exchanger. Raw water flow should be established immediately but some delay may occur before the flow exits the heat exchanger drain connection.

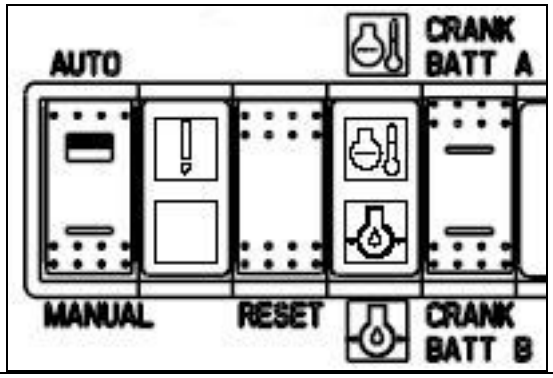
NOTE: Rated speed is displayed on the Factory Setting Tag described in Section 2.

NOTE: Electronically controlled engines should operate within a few RPM of the rated speed whether the engine is fully loaded or unloaded. If it becomes necessary to adjust the engine's actual speed to match the rated value, refer to Rated Speed Setpoint Adjustment in this section.



Start the engine using either the CRANK BATT A or the CRANK BATT B switch positions.

Check that the engine starts and operates at about rated speed.



Initial Start (Cont)

NOTE: If oil pressure is not present or if the Low Oil Pressure Light does not go out, stop the engine and troubleshoot as per Lubricating Oil Pressure Low in Section 12.

Check that lubricating oil pressure is displayed within 15 seconds after the engine starts.

NOTE: Raw water should be flowing through the heat exchanger and water pressure shown on the local pressure gauge should be no more than 414 kPa (60 psig).

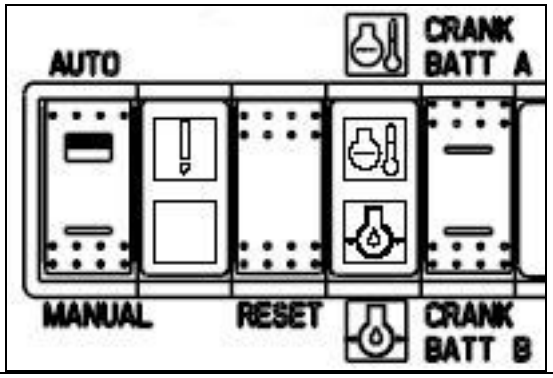
Check that raw water is flowing through the heat exchanger.

Check that raw water supply pressure is correctly adjusted.

Operate the engine for 8 to 10 minutes.

Check for leaks, unusual noises, or other indications of incorrect operation.

Shut off the engine by pressing the AUTO position on the AUTO/MANUAL rocker switch and by momentarily pressing the RESET switch.



Check that raw water flow stops automatically shortly after the engine stops.

Correct any problems found during the inspection before proceeding.

Check the engine lubricating oil level. Refer to Check Lubricating Oil Level in Section 5. Top off if necessary.

Check the coolant heat exchanger's coolant level. Refer to Check Coolant Level in Section 5. Top off if necessary.

Check the raw water strainer. Clean the strainer if necessary.

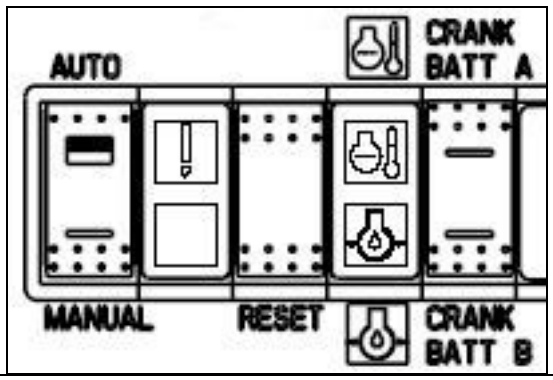
Second Start

NOTE: The object of this test is to check that the engine operates normally with coolant temperature being maintained. Oil pressure is again checked at rated speed.

NOTE: If required, adjust engine operating speed as per Rated Speed Setpoint Adjustment below.

Start the engine using either the CRANK BATT A or the CRANK BATT B switch positions.

Check that the engine starts and operates at about rated speed.



Check that the oil pressure is as specified in Lubricating Oil System Specifications (276-414 **[**kPa 40-60 psi**])** in Section 10.

NOTE: If oil pressure is not within the rated range, troubleshoot as per Lubricating Oil Pressure High or Lubricating Oil Pressure Low in Section 12.

NOTE: If temperature does not stabilize, stop the engine and refer to Coolant Temperature Above Normal or Coolant Temperature Below Normal (Engine Running) in Troubleshooting Section 12.

Check that engine operating temperature stabilizes between about 82 and 95 ^{o}C [180 and 203 ^{o}F].

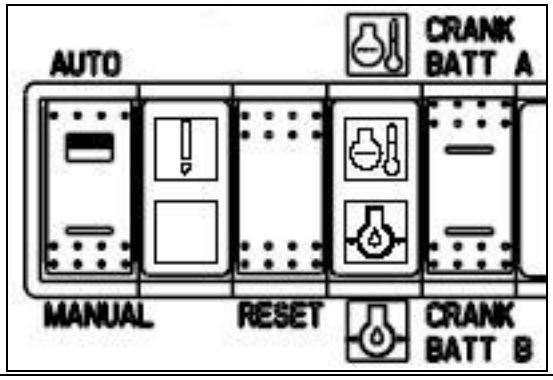
Stop the engine by pressing the RESET button.

Correct any problems found before proceeding.

Check the engine lubricating oil level. Refer to Check Lubricating Oil Level in Section 5. Top off if necessary.

Check the coolant heat exchanger's coolant level. Refer to Check Coolant Level in Section 5. Top off if necessary.

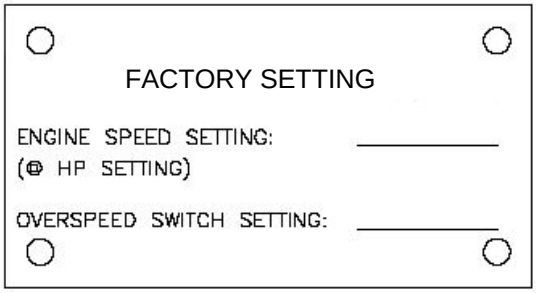
Check the raw water strainer. Clean the strainer if necessary.



Rated Speed Setpoint Adjustment

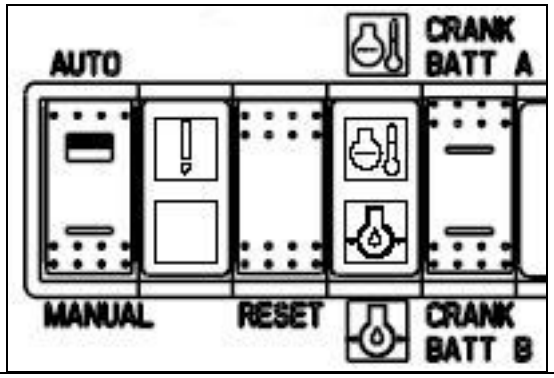
NOTE: If required, use this section to adjust the normal operating speed to the nameplate value.

NOTE: Rated speed is displayed on the Factory Setting Tag described in Section 2.



Start the engine.

Observe that the engine starts and accelerates to the currently adjusted speed setpoint.



Adjust the speed setpoint to rated speed.

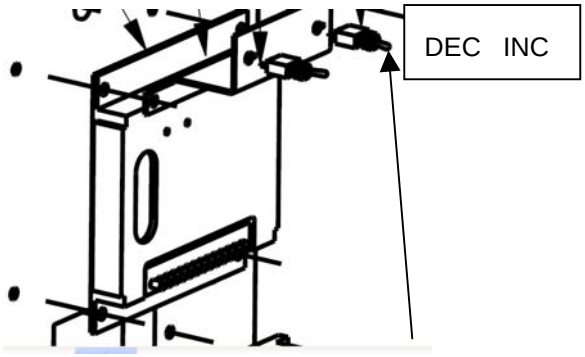
NOTE: Rated speed is adjusted by locating the increment and decrement switch inside the electrical control panel.

Open electrical panel by removing the bolt on the face of the panel. Allow the face panel to gently drop down supported by the hinge.

To increase the speed, toggle the switch to the right until the rated speed is desired.

To decrease the speed, toggle the switch to the left until the rated speed is desired.

Close the panel and tighten bolt to secure panel face.



Rated Speed Setpoint Adjustment (Cont)

Stop the engine.
Start the engine. Observe that the engine starts and accelerates to the rated speed setpoint.
Stop the engine. Repeat the above adjustment until the desired speed is attained.

Overspeed Setpoint Adjustment and Testing

Overview

Overspeed setpoint adjustment and testing is a repetitive process. Use the Adjustment Procedure to change the setpoint. Use the Test Procedure to check the setpoint. Repeat the adjustments and checks until the desired setpoint is demonstrated. When the overspeed setpoint is successfully demonstrated, then check that the engine operates normally while not being tested.

NOTE: The overspeed trip setpoint is displayed on the Factory Setting Tag described in Section 2.

NOTE: The overspeed setpoint must be set at between 115 and 120% of the engine's rated speed.

The speed switch located on the engine's local control panel has a TEST button which lowers the currently adjusted overspeed by 10%. Thus, an overspeed setpoint of 2112 rpm would be reduced to (2112 * 0.9 =) 1901 RPM when the test button is pressed.

FACTORY SETTING

ENGINE SPEED SETTING: _____
(@ HP SETTING)

OVERSPEED SWITCH SETTING: _____

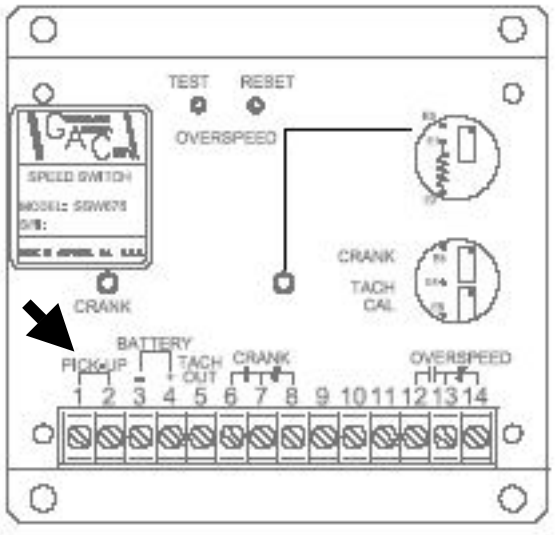
Adjust the Speed Switch:

Lower the cover on the engine's local control panel.

Disconnect the engine speed sensor signal from PICK-UP terminals 1 and 2.

Connect a signal generator capable of providing between 0.25 to 120 VAC RMS signal to the switch. The signal must be proportional to the engine's rated speed.

Provide an overspeed signal at the specified overspeed switch setting frequency.



Overspeed Setpoint Adjustment and Testing (Cont)

Remove the calibrating screw cover from the electronic overspeed switch.

NOTE: Turn the small screw on the potentiometer near the word “OVERSPEED” clockwise to increase trip speed. Turn it counter-clockwise to reduce trip speed.

If the OVERSPEED light is illuminated with the signal present, perform the following steps:

Reduce the signal frequency.

Press the RESET button.

Turn the potentiometer clockwise to raise the setpoint.

Increase the signal frequency to setpoint.

With the OVERSPEED light off, slowly turn the potentiometer counter-clockwise until the light is just illuminated.

NOTE: Repeat the adjustments as required to make the finest adjustment practical.

When the setpoint is adjusted, perform the following steps:

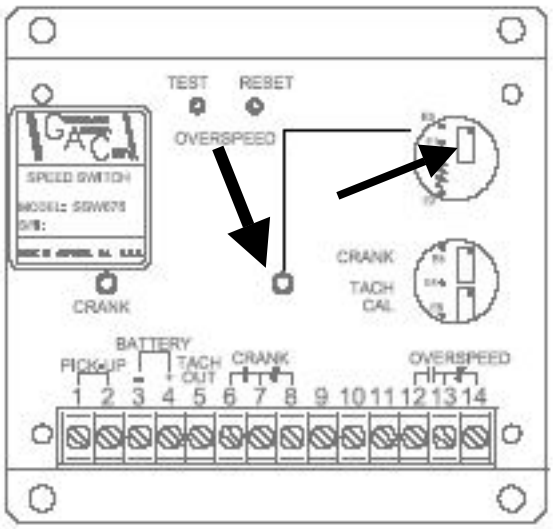
Replace the screw cover at the potentiometer.

Disconnect the signal generator.

Reset the light.

Reconnect the speed sensor input.

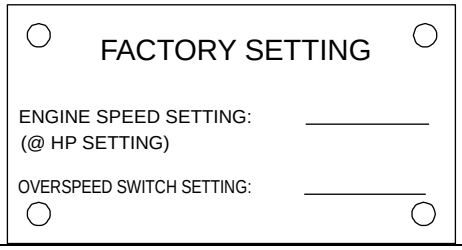
Perform the Test Procedure to check the effect of the adjustment.



Overspeed Setpoint Adjustment and Testing (Cont)

Test Procedure

NOTE: The overspeed trip setpoint is displayed on the Factory Setting Tag described in Section 2.



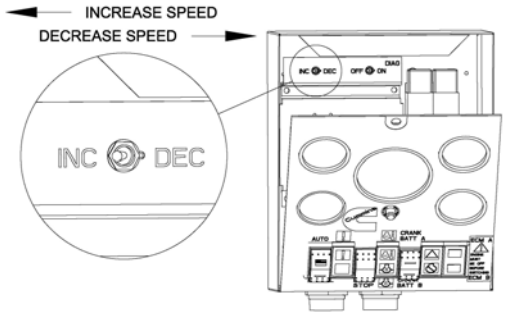
Start the engine.

Observe that the engine starts and operates at about rated speed.

NOTE: Monitor engine speed on the tachometer. Record the observed engine speed when it trips. It must trip between 115 and 120% of rated speed.

NOTE: Do not exceed 120% of rated speed. If the engine does not trip at or below 120%, stop the engine and Adjust the Speed Switch.

Adjust the speed setpoint to rated speed by means of the INC/DEC toggle located in the control panel.



Observe that the engine stops automatically and that the overspeed trip light is illuminated.

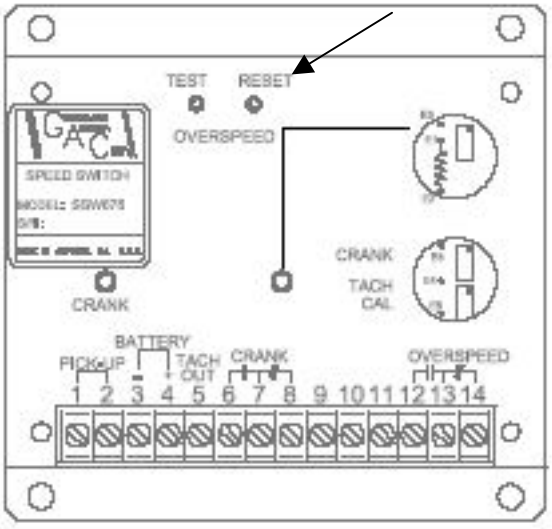
Verify that the engine tripped at a speed between 115 and 120% of rated speed.

Press the RESET button on the speed switch.

Press the RESET switch on the front of the engine control panel.

Observe that the overspeed light has extinguished.

NOTE: If required by the local authority, restart the engine at the current mechanical throttle setpoint to demonstrate a run-away overspeed shutdown as specified by Underwriter's Laboratory UL 1247.



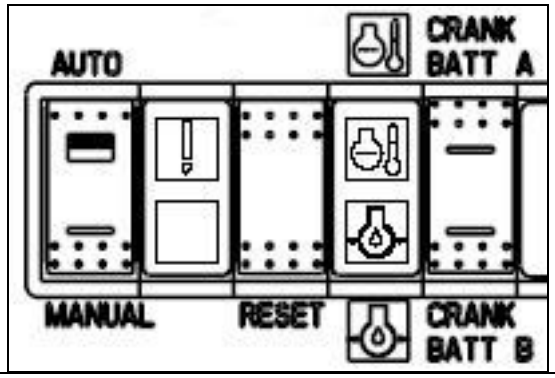
Overspeed Setpoint Adjustment and Testing (Cont)

Set/Check Normal Operation

Start the engine.

Adjust engine speed for rated value. Refer to Rated Speed Setpoint Adjustment in this section.

Stop the engine.



Crank Terminate Adjustment and Testing

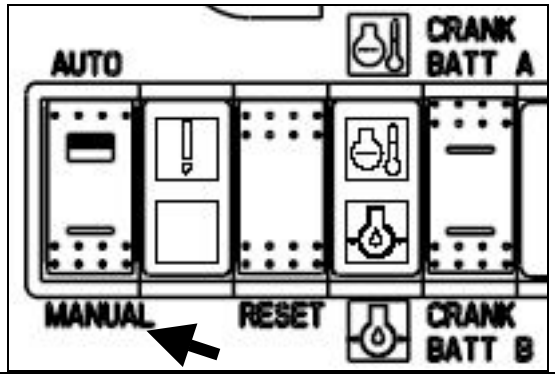
NOTE: The crank terminate signal to the remote fire pump controller informs the controller that the engine has started. This allows the controller to terminate the selected crank signal to the engine. This crank terminate signal is produced by the overspeed switch in the engine's local control panel. The setpoint for the crank terminate signal is adjusted at the factory to a value above normal idling speeds but less than the rated speed. The setpoint should not require adjustment unless it is necessary to test the switch operation or to replace the overspeed speed switch.

NOTE: If using this procedure for troubleshooting, perform the test portion prior to making any adjustments.

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

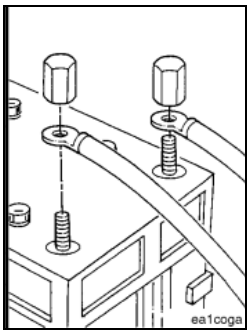


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a "Battery Failure" alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Crank Terminate Adjustment and Testing (Cont)

Adjust

NOTE: Refer to Drawing 10423 Sheet 1 in Section 13.

Open the engine's local control panel cover.

Disconnect the GRAY/RED (MPU +) wire from PICK-UP terminal 1 at the speed switch.

Disconnect the GRAY/BLK (MPU -) wire from PICK-UP terminal 1 at the speed switch.

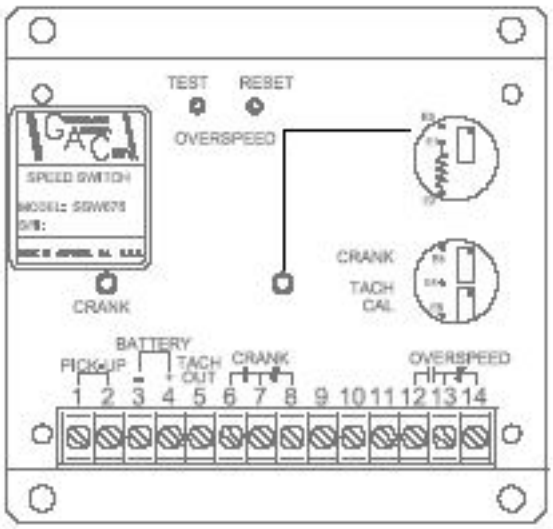
Connect a signal or pulse generator to the switch inputs with the same signal polarity.

Adjust the pulse generator to about 1100 cycles or pulses per second.

Remove the cover from the speed switch CRANK/TACH CAL potentiometers.

If, with this signal, the CRANK LED is illuminated on the speed switch, turn the CRANK potentiometer E5 clockwise until the LED extinguishes.

Then, turn the CRANK potentiometer E5 slowly counterclockwise until the CRANK LED illuminates.

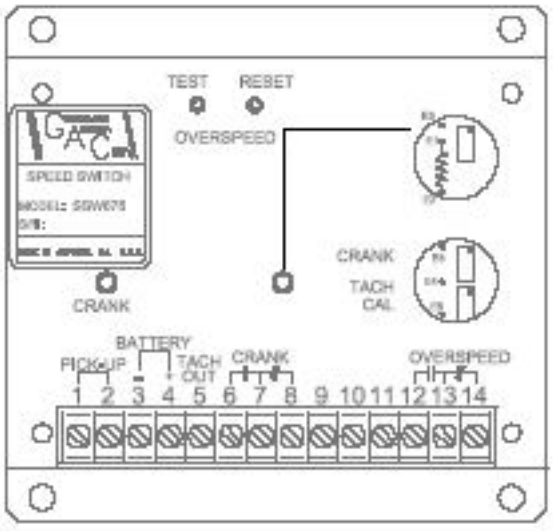


Replace the cover on the speed switch.

Remove the signal generator.

Connect the GRAY/RED (MPU +) wire at PICK-UP terminal 1 at the speed switch.

Connect the GRAY/BLK (MPU -) wire at PICK-UP terminal 1 at the speed switch.

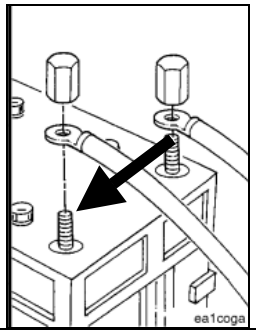


Crank Terminate Adjustment and Testing (Cont)

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

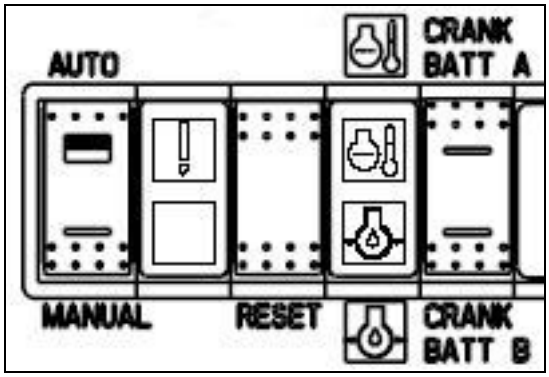
Reconnect the batteries at their terminals after all service work has been completed.



Test

NOTE: Monitor fire pump controller operations from the controller. Check for the crank terminate signal at the input terminals and observe that the controller removes the crank output to the engine.

Connect a digital voltmeter at crank terminate output of the local control panel between TB2 (+) and TB11 (-). Refer to Drawing 10423 Sheet 1 in Section 13.



NOTE: The engine's rated speed is displayed on the Factory Setting Tag described in Section 2.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Start the engine from the fire pump controller.

Observe that the engine starts and accelerates to about rated speed.

Observe that the CRANK terminal LED on the speed switch is illuminated.

Check that the local digital voltmeter indicates the 12 VDC standard (24 VDC optional) signal output voltage.

When testing is done, stop the engine.

Remove the digital voltmeter.

Close the cover on the engine control panel.

Isolated Acceptance Testing

Demonstrate the manual local start, operation, and shutdown of the fire pump from the engine's local starter-solenoid controls. Demonstrate that the engine will operate in the event of blown fuses or other faults in the local control panel. Demonstrate manual engine speed control. Manual raw water valve operations are required.

Demonstrate the manual local start, operation, and shutdown of the fire pump from the engine's control panel. Demonstrate that the engine starts, operates at speed, and stops in the event that the fire pump controller is not functioning.

Demonstrate the start of the fire pump engine using each battery set separately.

Demonstrate that the fire pump engine alternator operates while the engine is running. Demonstrate that any customer supplied battery charging systems operate when the engine is not running.

Demonstrate engine startup, operation, and shutdown of the engine with each of the redundant ECM.

Check that engine fault codes are not being set during normal operations.

Integrated Acceptance Testing

Demonstrate the start-up, operation, and shutdown of the fire pump engine in response to operations of the customer-installed fire pump controller. Perform this testing with the testing of the fire pump controller.

Demonstrate that the fire pump controller provides design indications and/or alarms for simulated engine oil pressure, water temperature, and overspeed faults.

Demonstrate the actual operation of the crank terminate output from the overspeed switch.

Participate in any flushing, pressure testing, flow testing, or capacity testing required for the fire protection system.

Complete the Cummins Fire Power Start-Up Inspection (SUI) Checklist. This is available on the Cummins Fire Power web site (www.cumminsfirepower.com/startup).

When these items have been demonstrated, contact operating personnel responsible for fire protection system that engine is ready for service.

Normal Remote Starting Procedure

The fire pump engine starts automatically upon receipt of the start command from the customer installed fire control panel. The remote command starts the engine when the AUTO/MANUAL rocker switch at the local; control panel is in the AUTO position. The remote start command consists of either the Crank A or the Crank B signal. Only one should be selected.

The engine continues to operate as long as the run signal is present. When the run signal is lost, the engine promptly stops.

When the engine starts, the crank terminate signal is sent to the fire control panel to indicate that the engine is running. How this is displayed depends upon the fire control panel manufacturer. This indication should be checked in the event that an automatic start is initiated. If the signal is not present, the engine can be started locally by using the Emergency Starting Procedure in this section.

The engine may be stopped locally by selecting the manual position on the AUTO/MANUAL rocker switch and by pressing the local RESET switch.

Normal Local Starting Procedure

Overview

The fire pump engine is started locally for testing and maintenance. Local starts for testing will be performed at rated speed. That is, the engine starts and promptly ramps up to operating speed. If it is necessary to operate the engine at idle speed for maintenance or troubleshooting, the engine speed must be manually reduced. After maintenance or troubleshooting, the speed must be manually reset to the rated value shown on the Factory Setting Tag in see Section 2.

Local Starting Procedure for Testing

CAUTION

To prevent damage to the starter, do not engage the starting motor more than 15 seconds. Wait 15 seconds between each attempt to start (electrical starting motors only).

Start the Engine

Press the MANUAL position on the AUTO/MANUAL rocker switch.

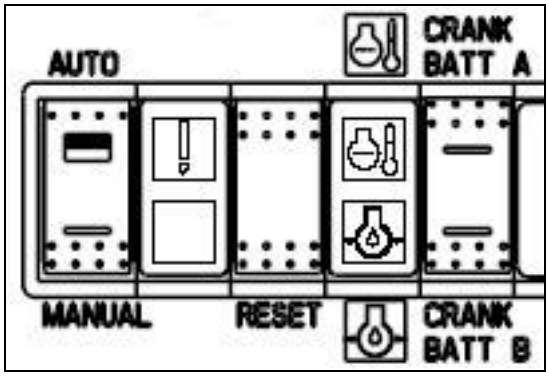
Observe the battery voltages displayed on the engine control panel. Use the battery with the highest indicated voltage.

NOTE: Depress the selected switch until the engine starts, but no longer than 15 seconds. Repeat up to three times if necessary after waiting 15 seconds between each attempt.

Start the engine using either the CRANK BATT A or the CRANK BATT B rocker switch positions.

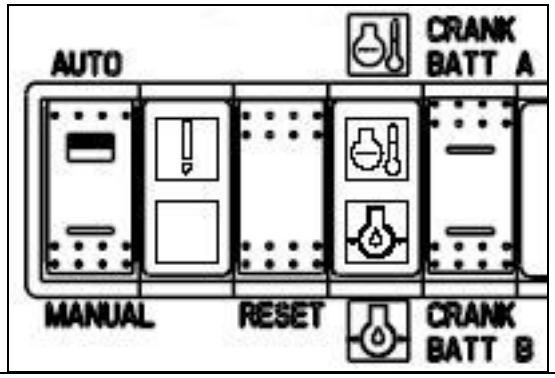
NOTE: If the engine does not start after three attempts, check the fuel supply system. Absence of blue or white exhaust smoke during cranking indicates no fuel is being delivered.

Engine oil pressure must be indicated on the gauge within 15 seconds after starting.



Stop the Engine

To stop the engine, select the AUTO position on the AUTO/MANUAL rocker switch and press the RESET switch.



Normal Local Starting Procedure (Cont)

Local Starting Procedure for Maintenance or Troubleshooting

Engines used in fire pumps or standby service are expected to transition from crank to full load within a short period of time.

CAUTION

Do not idle the engine for excessively long periods. Long periods of idling (more than 10 minutes) can damage an engine because combustion chamber temperatures drop so low the fuel will not burn completely. This will cause carbon to clog the injector spray holes and piston rings, and can cause the valves to stick. If the engine coolant temperature becomes too low (60°C [140°F]), raw fuel will wash the lubricating oil off the cylinder walls and dilute the crankcase oil; therefore, all moving parts of the engine will not receive the correct amount of lubrication.

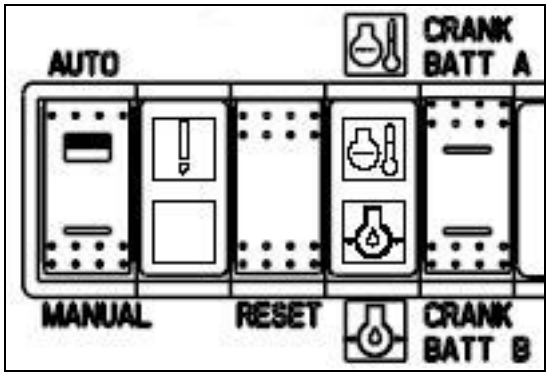
Adjust the fuel pump as per instructions to get idle speed.

Manually position the fuel pump at mid throttle position.

Press the MANUAL position on the AUTO/MANUAL rocker switch.

CAUTION

To prevent damage to the starter, do not engage the starting motor more than 15 seconds. Wait 15 seconds between each attempt to start (electrical starting motors only).



Start the engine using either the CRANK BATT A or the CRANK BATT B switch positions.

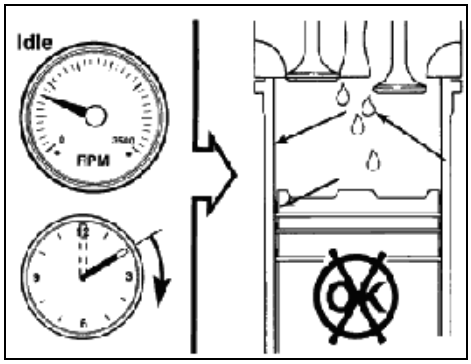
NOTE: If the engine does not start after three attempts, check the fuel supply system. Absence of blue or white exhaust smoke during cranking indicates no fuel is being delivered.

Engine oil pressure must be indicated on the gauge within 15 seconds after starting.

Normal Local Starting Procedure (Cont)

CAUTION

Do not operate the engine at low idle for long periods. Long periods at low idle, more than 10 minutes, can damage an engine because combustion chamber temperatures will decrease and the fuel will not completely burn. This will cause carbon to build up around the injector spray holes and piston rings, which can cause the valves to stick. To avoid damage, operate the engine at higher idle.



When the engine starts, immediately position the throttle linkage to an idle speed setting of about 700 RPM.

To stop the engine, select the AUTO position on the AUTO/MANUAL rocker switch and press the RESET switch.

Adjust the engine to operate at rated speed as per later in this section.

Jumpering the Batteries

NOTE: If a battery charging system is not provided, the engine can be started using known good batteries to provide a temporary power source. Once the engine is started, disconnect the added batteries and allow the engine's alternator to charge the existing batteries. It may take some time to charge the batteries with this method.

NOTE: For maintainable lead acid batteries as supplied by Cummins NPower, check the state of charge by the measurement of battery cell specific gravity. Refer to Battery Testing in Section 7 for more information.

WARNING

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

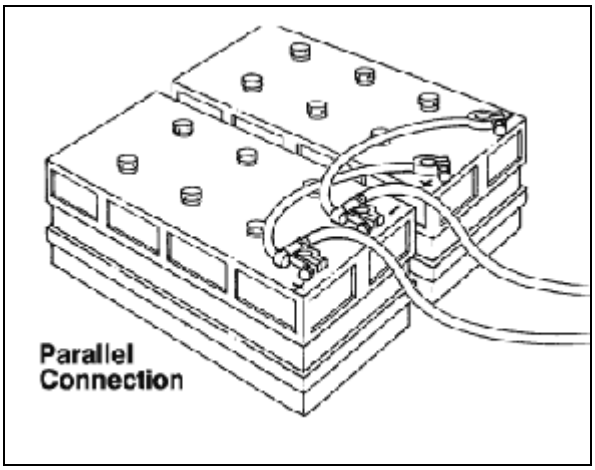
CAUTION

When using jumper cables to start the engine, make sure to connect the cables in parallel: Positive (+) to positive (+) and ground (-) to ground (-).

The accompanying illustration shows a typical parallel battery connection. This arrangement, positive (+) to positive (+), doubles the cranking amperage.

Use this type of connection to jump start the engine.

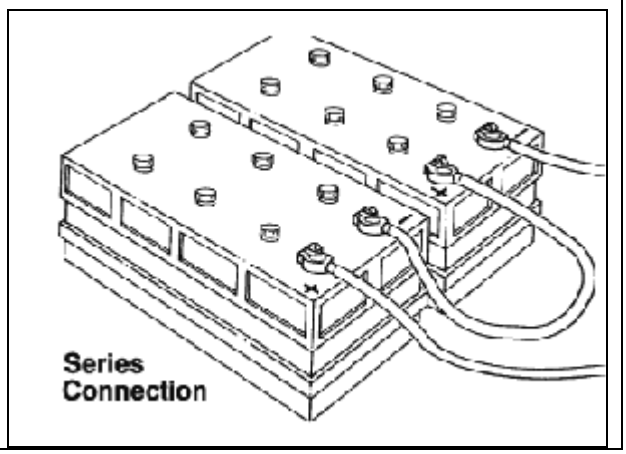
For a 24 VDC system, two or more 12 VDC batteries are connected in the parallel connection as shown. If jumpering a 24 VDC battery setup, another 24 VDC battery pair is required as the source.



The accompanying illustration shows a typical series battery connection.

This arrangement, positive (+) to negative (-), doubles the voltage.

Do not use this type of connection to jump start the engine using a second 12 VDC battery.



Operating the Engine

Monitor Operating Values Frequently

Monitor the oil pressure and coolant temperature gauges frequently. Refer to Lubricating Oil System Specifications or Cooling System Specifications in Section 10 for recommended operating pressures and temperatures. Shut off the engine if any pressure or temperature does not meet the specifications.

Do not exceed a maximum coolant temperature (93°C [220°F]). The pressure cap (Cummins Fire Power Part No. 11407) (or radiator cap) must meet the minimum pressure of 48 kPa [7 psi].

CAUTION

Continuous operation with low coolant temperature (below 60°C [140°F]) or high coolant temperature (above 100°C [212°F]) can damage the engine.

Verify raw water coolant pressure and flow.

Monitor Engine Condition Periodically

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

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

Emergency Manual Starting Procedures

Overview

The engine starts automatically in the event of a fire emergency. However, if it fails to start automatically, the engine can be started locally by either of two means. The Normal Local Starting Procedure in this section can be used to start the engine if it fails to start because of a failure in the remote fire control system. Operating the engine with this procedure will automatically control raw water flow.

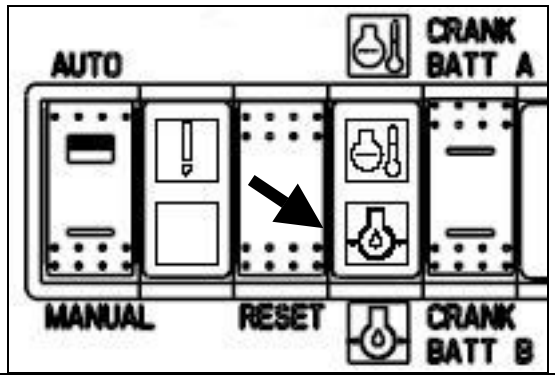
Additionally, manual means are available to start the engine in the event of some local failures. This procedure requires the manual operation of the raw water valves and the use of the manual starting lever on either of the two starting solenoids.

Use the following procedures as specified:

If the red low lube oil pressure light is illuminated, attempt an Emergency Manual Mode Electrical Start.

If the red low lube oil pressure light is not illuminated, attempt an Emergency Manual Mode Non-Electrical Start.

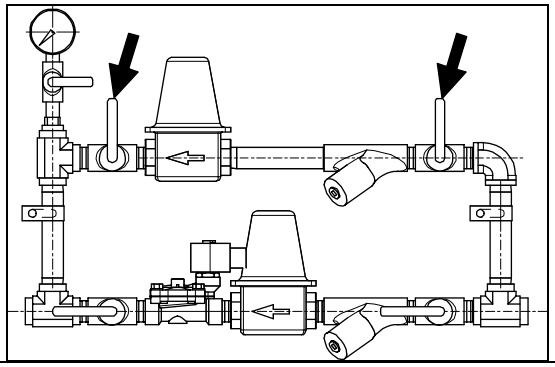
Also, if the fuel shutoff valve is known to be faulted, attempt an Emergency Manual Mode Non-Electrical Start.



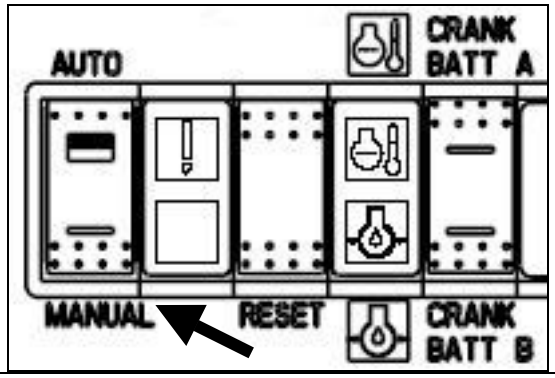
Emergency Manual Mode Electrical Start

Starting the Engine

Open both manual valves in the raw water bypass supply piping.



Press the MANUAL position on the AUTO/MANUAL rocker switch.



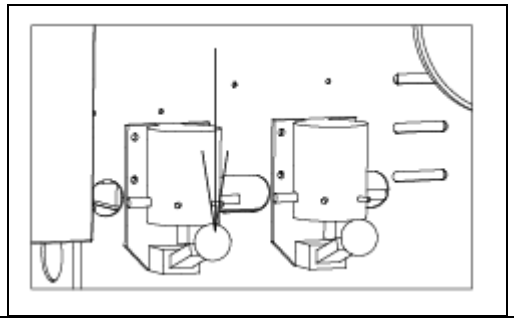
Emergency Manual Mode Electrical Start (Cont)

NOTE: Use the lever on either solenoid. If one does not crank the engine, then use the other.

Depress the lever on the selected solenoid to start the engine.

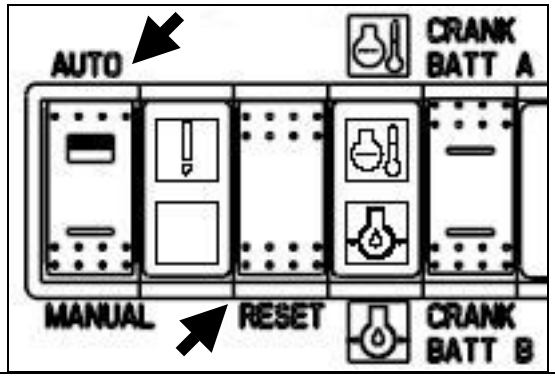
When the engine starts, release the lever.

If the engine cranks but does not start, try the Manual Mode Non-Electrical Start procedure in this section.



Stopping the Engine

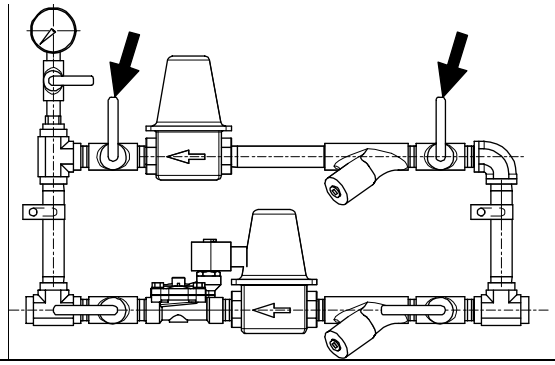
When emergency operation is done, stop the engine by pressing the AUTO position on the AUTO/MANUAL rocker switch and then press the RESET switch.



Emergency Manual Mode Non-Electrical Start

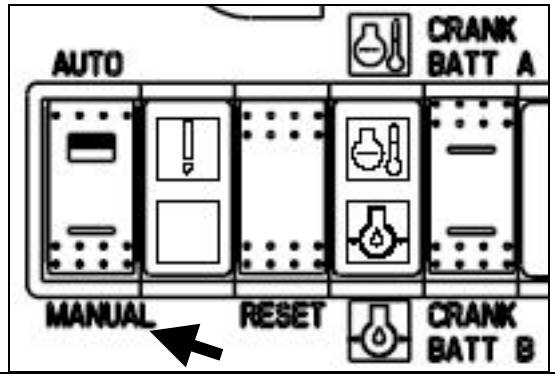
Starting the Engine

Open both manual valves in the raw water bypass supply piping.



Prepare: Place the fire protection system in a safe mode for engine service.

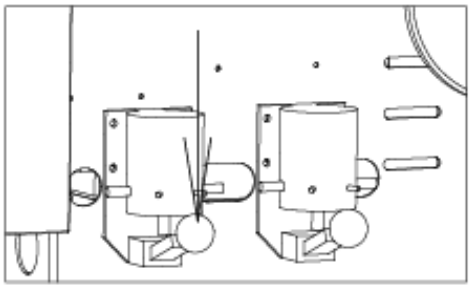
Place the AUTO/MANUAL rocker switch in the MANUAL position.



Emergency Manual Mode Non-Electrical Start (Cont)

Press down on the crank solenoid lever to engage the starter while in manual mode. Depress until engine starts.

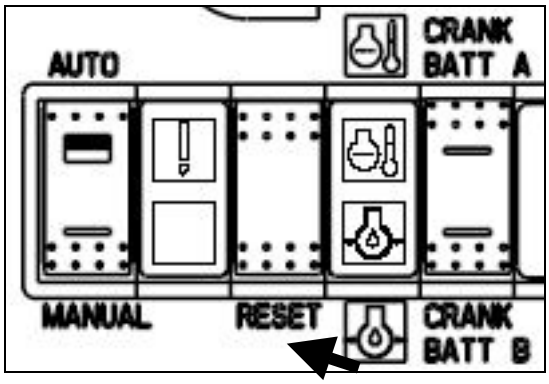
NOTE: If first crank solenoid lever does not engage the starter, repeat on second crank solenoid lever.



Stopping the Engine

Once engine is operational in manual mode, be sure to press and hold the stop/reset button until the engine comes to a complete stop.

You may now switch the engine to automatic mode and engine can be restarted when required.



Starting Procedure - After Extended Shutdown or Oil Change

Complete the following steps after each oil change, or after the engine has been shut off for more than 30 days to make sure the engine receives the correct oil flow through the lubricating oil system:

Bump the engine. Refer to Pre-Lubricate the Engine in this section.

Depending upon the nature of the shutdown, perform other installation checks in this section as appropriate.

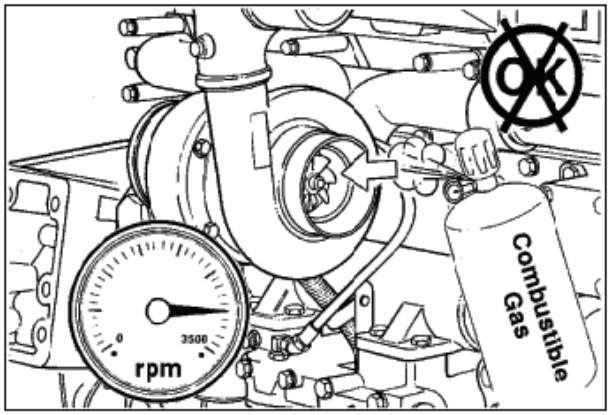
Start the engine. Refer to Normal Local Starting Procedure in this section.

If required, vent the fuel system. Refer to Air in Fuel in Section 7.

Follow the Normal Starting Procedure in this section. The engine will run at idle **only** until the minimum oil pressure is detected by the ECM.

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 overspeeding that can result in a fire, an explosion, and extensive property damage. Numerous safety devices are available, such as air intake shutoff devices, to minimize the risk of overspeeding where an engine, due to its application, might operate in a combustible environment, such as due to a fuel spill or gas leak. Remember, Cummins has no way of knowing the use you have for your engine. THE EQUIPMENT OWNER AND OPERATOR ARE RESPONSIBLE FOR SAFE OPERATION IN A HOSTILE ENVIRONMENT. CONSULT YOUR CUMMINS AUTHORIZED REPAIR LOCATION FOR FURTHER INFORMATION.



Electronic Controlled Fuel System

The engine control system is an electronically operated fuel control system that also provides many operator and engine or equipment features.

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

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

The electronic control module (ECM) is the control center of the system. It processes all of the inputs and sends commands to the fuel system and engine control devices.

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

Some fault codes will cause a diagnostic lamp to activate to signal the driver.

The ECM communicates with service tools through an SAE J1939 datalink.

Some engines and equipment will have J1939 networks on them that link many of the "smart" controllers together. Engine control devices can temporarily command engine speed or torque to perform one of the devices' functions.

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

- Coolant temperature sensor
- Intake air temperature sensor
- Intake manifold pressure sensor
- Oil pressure switch
- Engine speed/position sensor

Engine Protection System

The engines are equipped with an engine protection system. The system monitors critical engine temperatures and pressures and will log diagnostic faults when an over or under normal operation condition occurs.

If an out-of-range condition exists and engine de-rate action is to be initiated, the operator will be alerted by an in-cab WARNING lamp. The WARNING lamp will blink or flash when out-of-range conditions continue to worsen.

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

Diagnostic Fault Codes

The control system can show and record operation anomalies that present themselves as fault codes. These codes will make troubleshooting easier. The fault codes are recorded in the ECM. They can be read using the fault lamps in the dash or with the INSITE™ service tool.

NOTE: Not all engine or control system anomalies are shown as fault codes.

There are three types of system codes:

- Engine electronic control system fault codes
- Engine protection system fault codes
- Engine maintenance indicator codes

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

Most of the electronic fault codes will light a lamp when they are active. There are three possible lamps that can be lit when a fault is active:

The WARNING or CHECK ENGINE lamp is yellow and indicates the need to repair the fault at the first available opportunity.

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

The MAINTENANCE lamp will illuminate when an engine maintenance function needs to be performed.

NOTE: The names and colors of these lamps can vary by equipment manufacturer.

The fault code will flash in the following sequence: First, a WARNING (yellow) lamp will flash. Then there will be a short 1- or 2-second pause, after which the number of the recorded fault code will flash in STOP (red) lamp. There will be a 1- or 2-second pause between each number. When the number has finished flashing in red, a yellow lamp will appear again. The three-digit code will repeat in the same sequence.

The lights flash each fault code out two times before advancing to the next code. To skip to the next fault code sooner, move the idle speed adjust switch (if equipped) momentarily to the "(+)" position. You can go back to the previous fault code by momentarily moving the idle speed adjust switch (if equipped) to the "(-)" position. If only one active fault is recorded, the control system will continuously display the same fault code, even when either "(+)" or "(-)" switch is depressed.

The explanation and correction of the fault codes are explained in the Troubleshooting and Repair Manual, Electronic Control System, ISB and QSB5.9 Engines, Bulletin 3666194.

When not using the diagnostic system, turn off the diagnostic switch, or remove the shorting plug. If the diagnostic switch is left on or the shorting plug in, the electronic control module will not log some faults.

Fault Code Snapshot Data

This data makes up additional fault code information that can be obtained by using the INSITE service tool. The snapshot data records the value or state of the control system sensors and switches at the time a fault occurred. This data is stored for the first occurrence of the fault, since it was last cleared, and for the most recent occurrence. This data can be very valuable when trying to re-create or determine engine operating conditions at the time of a fault.

Electromagnetic Interference (EMI)

General Information

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

System EMI Susceptibility

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

System EMI Radiation Levels

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

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

Locate the receiving antenna as far away from the engine and as high as possible.

Locate the receiving antenna as far away as possible from all metal obstructions (e.g., exhaust stacks).

Consult a representative of the accessory supplier in your area to:

Calibrate accurately the device for proper frequency, power output, and sensitivity (both base and remote site devices must be properly calibrated).

Obtain antenna reflective energy data measurements to determine the optimum antenna location.

Obtain optimum antenna type and mounting arrangement for your application.

Make sure your accessory equipment model is built for maximum filtering to reject incoming electromagnetic noise.

Emergency Starting With Failed ECM

NOTE: This fire pump engine is supplied with two Electronic Control Modules (ECM). Either one can be selected when the engine is not running. Do not switch between ECM while the engine is running.

If the AUTO/MANUAL switch is in the AUTO position

Place the AUTO/MANUAL Switch in the MANUAL Position. This will stop the engine if running in the automatic mode.

Switch between ECM “A” and ECM “B”. Switch from the one to the other.

Start the engine locally by pressing either the CRANK BATT A Switch or the CRANK BATT B Switch.

Alternatively, manually start the engine at either of the levers provided on the crank solenoids.

When practical, troubleshoot the failed ECM. Refer to Engine Stops During Operation in Section 12.

Section 4 - Maintenance Guidelines

Section Contents

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Overview

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

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

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

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

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

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

Tool Requirements

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

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

Tool Part Number	Description
CC-2802	Coolant test kit
CC-2800	Refractometer
ST-1273	Pressure gauge
3375045	Torque wrench (0 to 175 ft-lb)
3375049	Oil filter wrench
3376807	Engine coolant and fuel filter wrench
3377161	Digital multimeter
3822524	Belt tension gauge, click type (v-belts and ribbed with 4 or 5 ribs)
3822525	Belt Tension Gauge, Click-type (for V-ribbed with 6 to 12 ribs)
3824556	Charge air cooler (CAC) pressure kit
3824591	Engine barring gear
3824783	Torque wrench (0 to 300 in-lb)
3824842	M10 Compuchek® fitting
3825157	Fuel Injector Connector Puller
3825156	Fuel Injector Puller

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

Sockets	Wrenches	Other
10 mm	8 mm	Engine Barring Gear, Part No. 3377371
12 mm	13 mm	Allen Wrench (8 mm)
13 mm	15 mm	Breaker Bar (3/8-in drive)
15 mm	19 mm	Flat Screwdriver
17 mm	22 mm	Ratchet (3/8-in drive)
18 mm	24 mm	Ratchet (1/2-in drive)
19 mm	17 mm (open end)	Filter Wrenches (75 to 80 mm, 90 to 95 mm, and 118 to 131 mm)
22 mm		Pliers
27 mm		Torque Wrench
		T-Bar Puller (75 mm)

Maintenance Schedule

Activity (as per engine specifications)			Trimonthly													
	Daily	Weekly	1	2	3	4	5	6	7	8	9	10	11	12	Procedure #	Page #
Check Air Intake Filter and Piping.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1	5-4
Check Coolant Level	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	5-4
Check Crankcase Breather Tube	x	x	x	x	x	x	x	x	x	x	x	x	x	x	3	5-5
Check Lubricating Oil Level	x	x	x	x	x	x	x	x	x	x	x	x	x	x	4	5-6
Drain Fuel-Water Separator	x	x	x	x	x	x	x	x	x	x	x	x	x	x	5	5-6
Inspect Charge Air Cooler Piping	x	x	x	x	x	x	x	x	x	x	x	x	x	x	6	5-7
Check Coolant Heat Exchanger Piping	x	x	x	x	x	x	x	x	x	x	x	x	x	x	7	5-8
Check Coolant Heater Piping	x	x	x	x	x	x	x	x	x	x	x	x	x	x	8	5-8
Bleed Fuel Tanks		x	x	x	x	x	x	x	x	x	x	x	x	x	9	5-9
Clean Raw Water Strainers		x	x	x	x	x	x	x	x	x	x	x	x	x	10	5-9
Check Battery Condition		x	x	x	x	x	x	x	x	x	x	x	x	x	11	5-9
Test Run Engine		x	x	x	x	x	x	x	x	x	x	x	x	x	12	5-10
Check Hose Condition			x	x	x	x	x	x	x	x	x	x	x	x	13	5-12
Check Engine Coolant Heater			x	x	x	x	x	x	x	x	x	x	x	x	14	5-12
Inspect Heat Exchanger Zinc Plug			x	x	x	x	x	x	x	x	x	x	x	x	15	5-12
Inspect Electrical Components			x	x	x	x	x	x	x	x	x	x	x	x	16	5-13
Check Turbochargers Mounting Nuts			x	x	x	x	x	x	x	x	x	x	x	x	17	5-13
Check Engine Mounting Bolts			x	x	x	x	x	x	x	x	x	x	x	x	18	5-13
Check Cooling System Condition			x	x	x	x	x	x	x	x	x	x	x	x	19	5-14
Check Air Cleaner Service Indicator			x	x	x	x	x	x	x	x	x	x	x	x	20	5-14
Inspect Air Intake System Piping			x	x	x	x	x	x	x	x	x	x	x	x	21	5-15
Check Fuel Pump			x	x	x	x	x	x	x	x	x	x	x	x	22	5-15
Change Lubricating Oil and Filters			x	x	x	x	x	x	x	x	x	x	x	x	23	5-16
Change Fuel Filter (Spin-on Type)			x	x	x	x	x	x	x	x	x	x	x	x	24	5-20
Clean Charge Air Cooler			x	x	x	x	x	x	x	x	x	x	x	x	25	5-21
Lubrication of Output Shafts			x	x	x	x	x	x	x	x	x	x	x	x	26	5-22
Drain and Flush Cooling System				x		x		x		x		x		x	27	5-23
Change Coolant Filter				x		x		x		x		x		x	28	5-27
Vent Fuel Supply Lines				x		x		x		x		x		x	29	5-29
Vent Injection Pump				x		x		x		x		x		x	30	5-30
Check Overspeed Switch Operation						x				x				x	31	5-31
Check Drive Belt, Tensioner Bearing and Belt Tension						x				x				x	32	5-31
Check Valve Lash Clearance						x				x				x	33	5-37
Inspect Turbocharger										x					34	5-40
Inspect Viscous Damper										x					35	5-42
Inspect Water Pump										x					36	5-42
Engine Steam Cleaning										x					37	5-42
Inspect Overhead Set														x	38	5-43

Refer to Maintenance Procedures in Section 5 for instructions.

Maintenance Record Form

Engine Serial No.			Engine Model		
Owner's Name			Equipment Name/Number		
Date	**Hours or Time Interval**	**Actual Hours**	**Check Performed**	**Performed By**	**Comments**

Section 5 - Maintenance Procedures

Section Contents

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DAILY

General Information

Preventative maintenance begins with day-to-day awareness of the engine and its system.

On a daily basis, inspect the engine for the following issues:

- Leaks
- Loose or damaged parts
- Worn or damaged belts
- Any change in engine appearance
- Odor of fuel
- Correct any problems as per the instructions in this manual.
- Perform the specific checks in this section only after the engine has been stopped. Do not perform this section if the fire pump is in operation.

Engine Operation Report

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

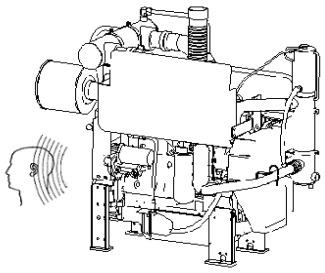
Comparison and intelligent interpretation of the daily report, along with a practical follow-up action, will eliminate most failures and emergency repairs.

Report to the maintenance department any of the following conditions:

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

Unusual Engine Noise

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



Procedure 1 — Check Air Intake Filter and Piping

Visually inspect the air intake filter and piping daily for wear points and damage to piping, loose clamps, or punctures.

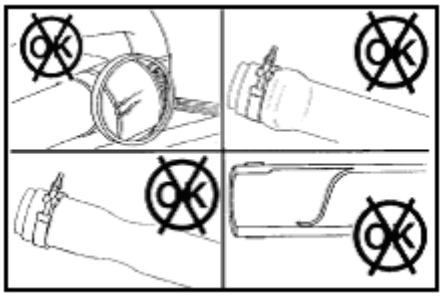
Replace damaged air filter or pipes, and tighten loose clamps, as necessary, to prevent the air system from leaking. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.

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

Disassemble and clean, as required. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.

Torque loosened clamps.

Torque Value: 8 N•m [72 in-lb]



Procedure 2 — Check Coolant Level

WARNING

Do not remove a pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

CAUTION

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

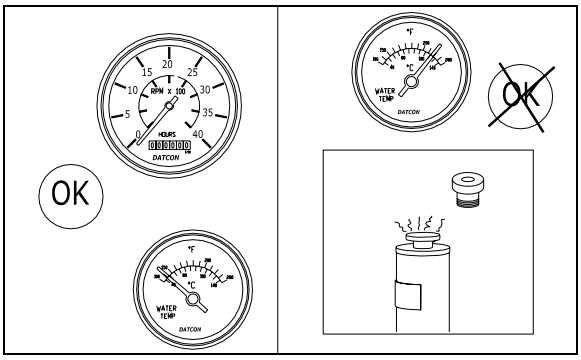
CAUTION

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

Press down, unscrew and remove the pressure cap, (Cummins Fire Power Part No. 11407).

NOTE: Coolant level should be at the bottom of the fill neck. It must be above the raw water tubes.

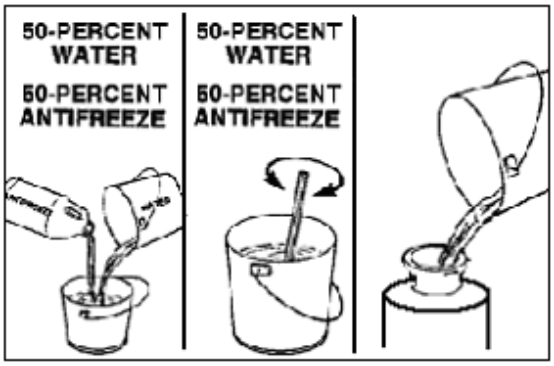
Check coolant level.



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

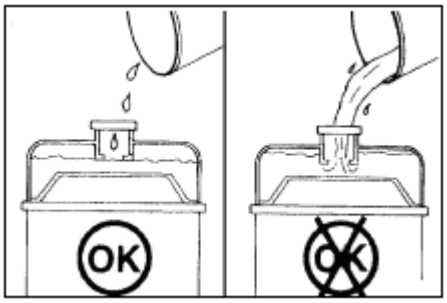
Coolant specifications can be found in Coolant Recommendations and Specifications in Section 7.

If required, prepare a coolant solution.



Fill the cooling system with coolant to the bottom of the fill neck in the coolant heat exchanger.

When done, press down and screw in the pressure cap, (Cummins Fire Power Part No. 11407).

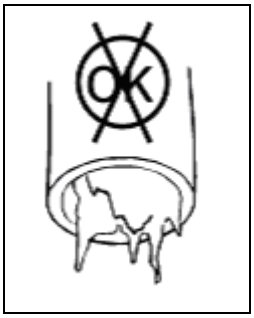


Procedure 3 **Check Crankcase Breather Tube**

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

If the breather tube is obstructed or blocked, clean it.

Inspect the tube more frequently in icy conditions.



Procedure 4 **Check Lubricating Oil Level**

CAUTION

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

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

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

Check the oil level on the dipstick.

NOTE: If the lube oil is excessively high, troubleshoot as per Oil Level Rises in Section 7.

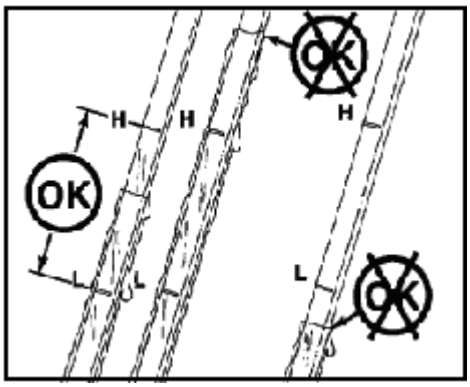
If the lube oil level is greater than the high mark, drain the excessive oil. Refer to Drain Oil in Change Lubricating Oil and Filters in Section 7.

If the lube oil level is below the low mark, add oil. Refer to Fill Oil in Change Lubricating Oil and Filters later in this Section.

NOTE: If the lube oil is excessively low, troubleshoot as per Lubricating Oil Consumption Excessive in Section 12.

Oil Capacity (Low to High Mark Oil): 3.8 liters [4 U.S. qt]

For additional lubricating oil recommendations and oil pan capacity information, refer to Lubricating Oil Recommendations and Specifications and Lubricating Oil System Specifications in Section 7.



Procedure 5 **Drain Fuel-Water Separator**

Cummins Inc. requires a fuel-water separator or fuel filter be installed in the fuel supply system. Drain the water and sediment from the separator daily.

WARNING

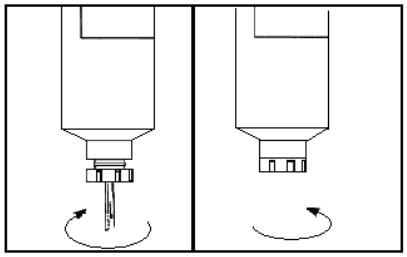
Drain the water-fuel separator into a container and dispose of in accordance with local environmental regulations.

Spin-on Type

NOTE: If more than 59 ml (2 oz) is drained, refilling of the filter is required to prevent hard starting.

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

Drain the filter sump until clear fuel is visible.



CAUTION

When closing the drain valve, do not over-tighten the valve. Over-tightening can damage the threads.

Close the valve by lifting the valve and turning it clockwise until it is hand-tight.

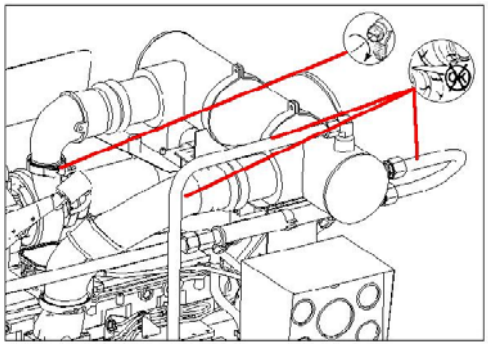
If required, refill the filter. Refer to Change Fuel Filter later in this Section for removal and installation instructions.

Procedure 6 Inspect Charge Air Cooler Piping

Inspect the charge air cooler piping and hoses daily for holes, cracks, or loose connections.

Tighten the hose clamps, if necessary.

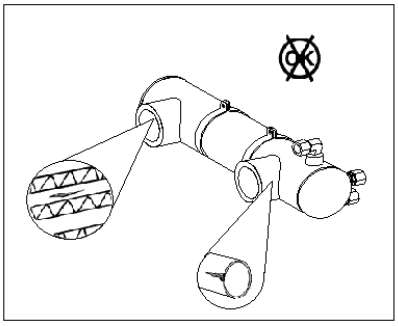
Torque Value: 8 N•m [72 in-lb]



Inspect the charge air cooler for dirt and debris blocking the fins.

Check for cracks, holes, or other damage.

If damage is found, refer to Charge Air Cooler (CAC) Removal and Installation instructions in Section 7.

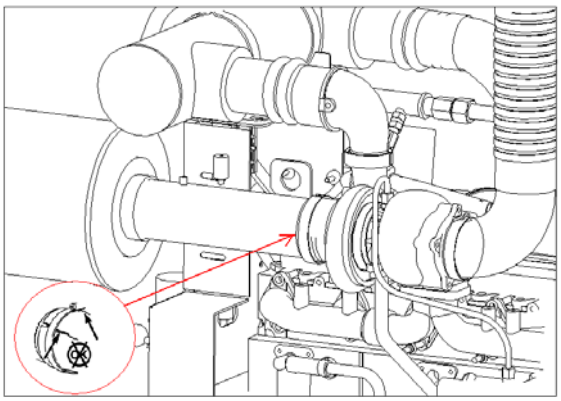


Inspect the intake piping daily for wear points and damage to piping, loose clamps, or punctures that can damage the engine.

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

Torque Value: 8 N•m [72 in-lb]

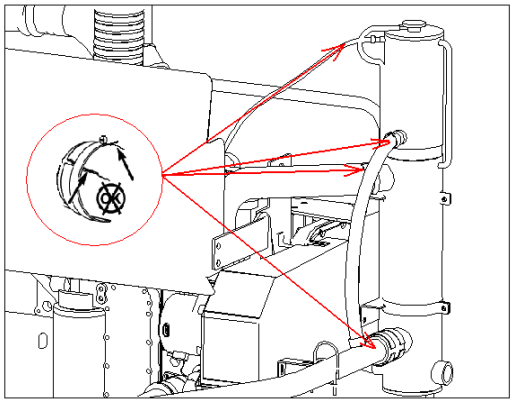
Check for corrosion under the clamps and hoses of the intake system piping. Corrosion can allow corrosive products and dirt to enter the intake system. Disassemble and clean as required.



Procedure 7 **Check Coolant Heat Exchanger Piping**

Visually inspect the coolant heat exchanger and piping daily for wear points and damage to piping, loose clamps, or punctures.

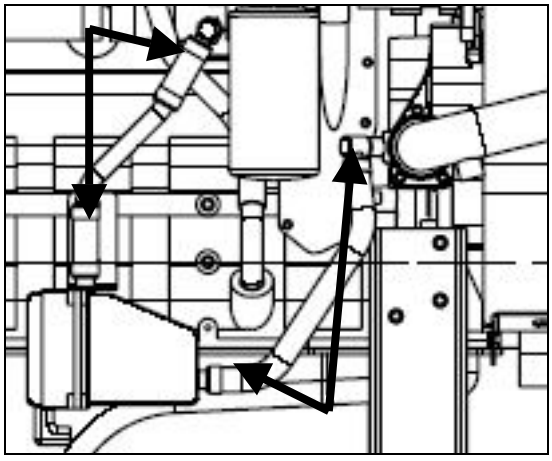
Replace damaged tubes, clamps, or pipes, and tighten loose clamps, as necessary, to prevent the coolant system from leaking. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.



Procedure 8 **Check Coolant Heater Piping**

Visually inspect the engine coolant heater hoses and piping daily for wear points and damage to piping, loose clamps, or punctures.

Replace damaged tubes, clamps, or pipes, and tighten loose clamps, as necessary, to prevent the coolant system from leaking. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.



WEEKLY

General Information

With the engine not running, perform the daily maintenance checks plus the following:

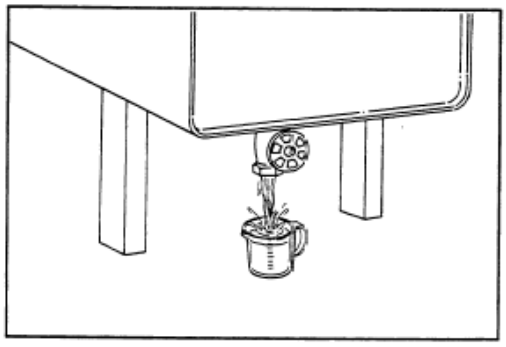
Procedure 9 Bleed Fuel Tanks

Loosen the fuel tank drain plug or open the drain valve.

Drain approximately 1 cup of fuel to remove water and sediment.

Close the drain valve or tighten the drain plug.

Dispose of the waste fuel in accordance with applicable requirements.



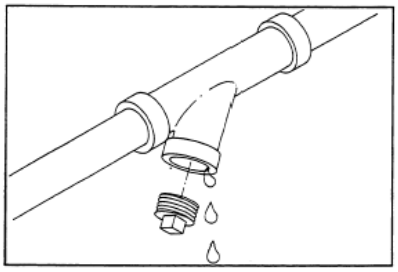
Procedure 10 Clean Raw Water Strainers

For each raw water strainer, remove the plug.

Inspect and remove any debris.

Install the strainer plugs.

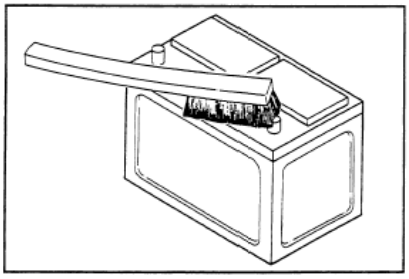
Unless otherwise directed, ensure that the bypass line valves are closed and the normal line valves are open.



Procedure 11 Check Battery Condition

Inspect the condition of the batteries.

Refer to Section 7 for inspection and maintenance procedures.

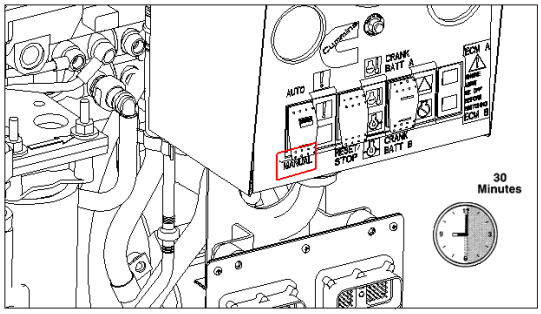


Procedure 12 **Test Run Engine**

Start Test Run

Select the **MANUAL** position on the AUTO/MANUAL Switch.

Press the **CRANK A** or **CRANK B** switch.

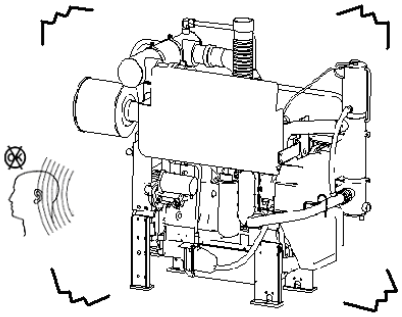


Check Unusual Engine Noise

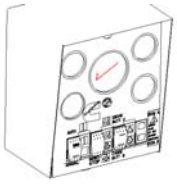
Run the engine no less than 30 minutes to attain normal running temperature.

During the weekly maintenance check, listen for any unusual engine noise which can indicate that service is required.

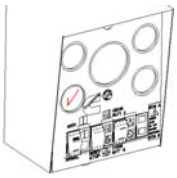
Check running indications.



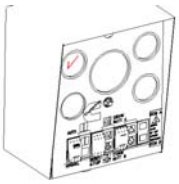
Observe that the engine is operating at test speed as follows:



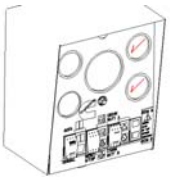
Check oil pressure greater than 10 PSI.



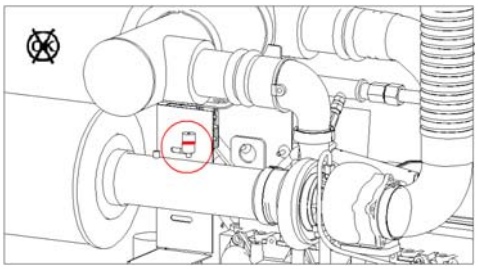
Check coolant temperature between 140°F and 212°F.



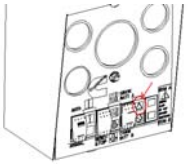
Check that both battery voltmeters indicate 12 VDC standard (24 VDC optional) depending upon the application.



Check that the inlet air restriction indicator has not popped-up. Red plunger would be popped as shown.

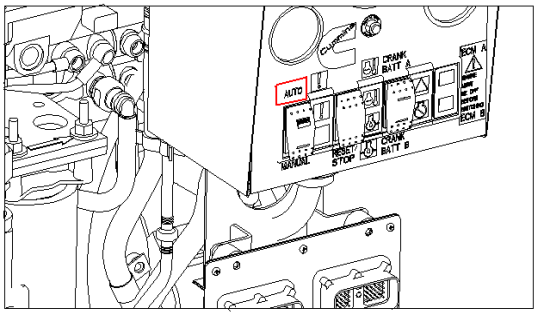


Check that the Fuel Injection Failure (F.I.F.) light is not turned on.



End Test Run

Select the **AUTO** position on the AUTO/MANUAL Switch.



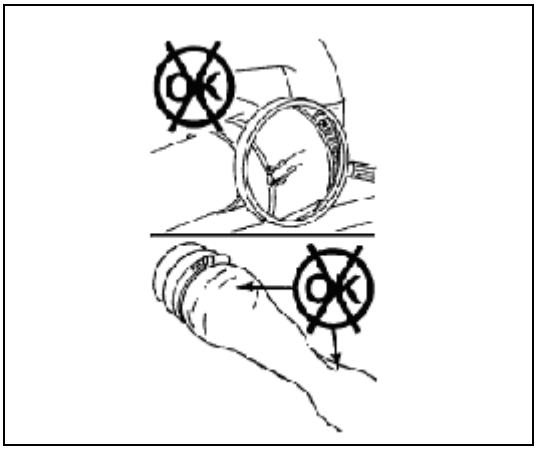
Every Three Months or 250 Hours

General Information

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

Procedure 13 Check Hose Condition

Inspect the lubricating, fuel, and cooling system hoses and hose connection for leaks or deterioration. Particles of deteriorated hose can be carried through the cooling system and slow or partially stop circulation.

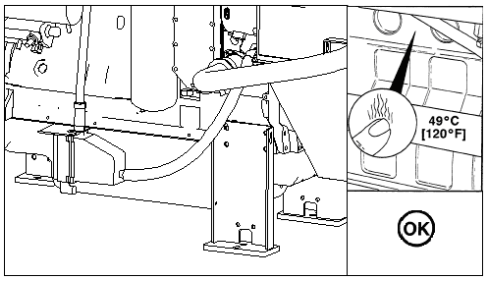


Procedure 14 Check Engine Coolant Heater

NOTE: Do not perform this inspection procedure until 24 hours after shutting off the engine.

The engine coolant heater must maintain an engine coolant temperature of 49 °C (120 °F) or above. The engine block must be warm to the touch in the water jacket areas.

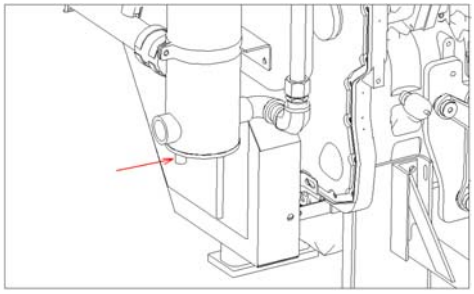
If the heater does not appear to be working correctly, contact a Cummins Authorized Repair Location.



Procedure 15 Inspect Heat Exchanger Zinc Plug

Remove the zinc plug.

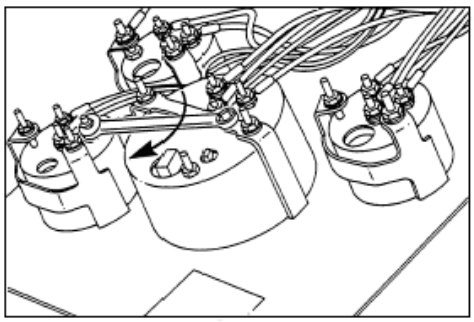
Inspect the plug. If it has eroded over 50 percent, replace the plug (Cummins Fire Power Part No. 9750), and brass fitting (Cummins Fire Power Part No. 9751).



Procedure 16 Inspect Electrical Components

Clean and tighten any loose electrical connections.

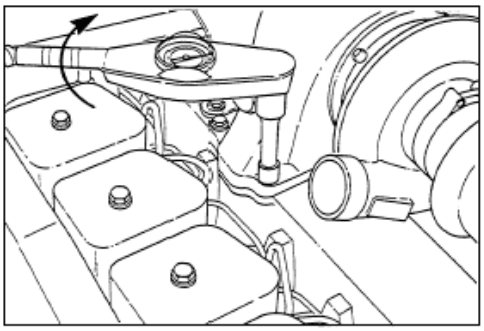
Follow the manufacturer's recommended procedures for servicing the electrical components and batteries.



Procedure 17 Check Turbocharger Mounting Nuts

Check the turbocharger mounting nuts. Tighten the mounting nuts.

Torque Value: 65 N•m (50 ft-lb)



Procedure 18 Check Engine Mounting Bolts

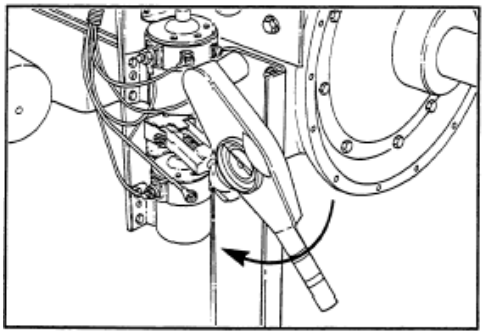
CAUTION

Damaged engine mounts and brackets can cause engine misalignment. Driveline component damage can result in vibration complaints.

Inspect all rubber-cushioned mounts for cracks or damage.

Inspect all mounting brackets for cracks or damaged bolt holes.

Check the torque on the engine mounting nuts and bolts. Tighten any that are loose.



Procedure 19 **Check Cooling System Condition**

WARNING

Check the coolant level only when the engine is stopped. Wait until the coolant temperature is below 50 °C (120 °F) before removing the pressure cap (Cummins Fire Power Part No. 11407). Failure to do so can cause personal injury from heated coolant spray.

Supplemental Coolant Additive(SCA)

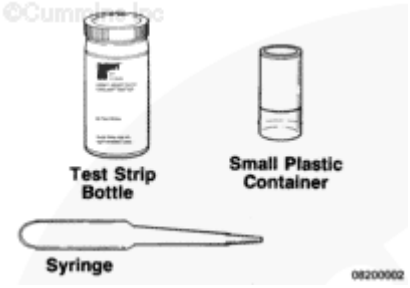
Check the SCA concentration level:

~At least twice a year

~At every subsequent oil drain interval if the concentration is above 3 units

~Whenever coolant is added to the cooling system between filter changes.

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



Antifreeze

CAUTION

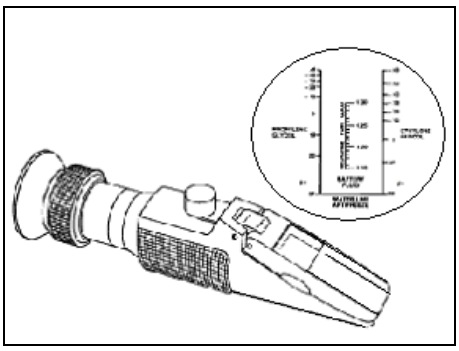
Over concentration of antifreeze or use of high-silicate antifreeze can damage the engine.

Check the antifreeze concentration.

Use a mixture of 50-percent water and 50-percent ethylene glycol-base antifreeze to protect the engine to -37°C [-34°F] year-around.

Antifreeze is essential in any climate. It broadens the operating temperature range by lowering the coolant freezing point and raising its boiling point.

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



Procedure 20 **Check Air Cleaner Service Indicator**

CAUTION

Never operate the engine without an air cleaner. Unfiltered foreign objects could cause engine damage.

Maximum intake air restriction is 762 mm H2O [30.0 in H2O] for turbocharged engines.

Turbocharged engines must be operated at rated RPM and full load to check maximum intake air restriction. Replace the air cleaner element when the restriction reaches the maximum allowable limit, or clean according to the manufacturer's recommendations.

NOTE: Follow the manufacturer's instructions when cleaning or replacing the air cleaner element.

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

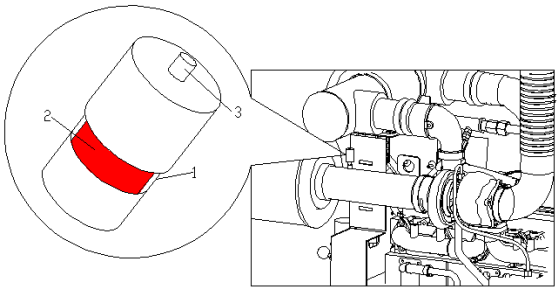
Check the air cleaner service indicator, if equipped.

A mechanical restriction indicator is available to indicate excessive air restriction through a dry-type air cleaner. This instrument can be mounted in the air cleaner outlet or on the instrument panel

Change the filter element when the red indicator flag (2) is at the raised position in the window (1).

After the air cleaner has been serviced, push the button (3) to reset the service indicator.

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



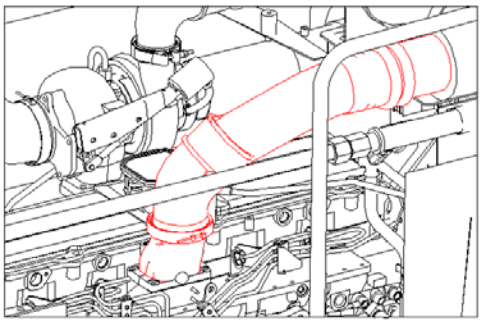
Procedure 21 Inspect Air Intake System Piping

Inspect the intake piping for cracked hoses, loose clamps, or punctures that can allow dirt and debris to enter the engine.

Tighten or replace parts as necessary to make sure the air intake system does not leak.

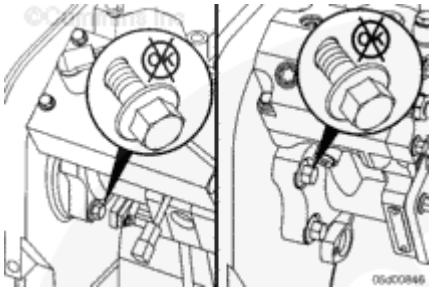
Check for corrosion of the intake system piping under the clamps and hoses. Corrosion can allow corrosive products and dirt to enter the intake system.

Disassemble and clean as required.



Procedure 22 Check Fuel Pump

Inspect the fuel injection pump mounting nuts, including the support bracket, for loose or damaged hardware.



Procedure 23 **Change Lubricating Oil and Filters**

WARNING

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

WARNING

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

WARNING

If no oil pressure is noted within 15 seconds after the engine is started, shut down the engine to reduce the possibility of internal damage.

CAUTION

For composite oil pans, always use a new sealing washer on the oil drain plug. Hold the external locking nut in place while tightening the oil drain plug.

Lubricating Oil and Filter Change Interval

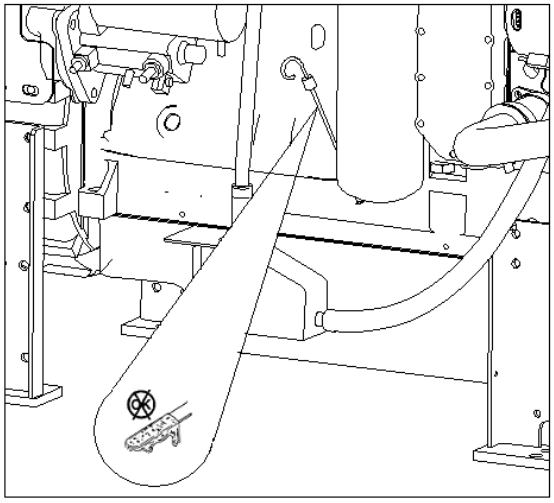
Engine oil becomes contaminated and essential oil additives are depleted with use. The amount of contamination is related to the total amount of fuel and oil consumed.

The oil change interval for turbocharged engines is every 3 months or 250 hours. Change the oil and the filters to remove the contaminants suspended in the oil.

NOTE: If the lubricating oil is drained from the oil pan to make an engine repair, new oil must be used. Do not use oil after it has been drained from the oil pan.

Laboratory and field tests have determined that, when using the recommended quality oils and filters, a turbocharged engine in good condition and equipped with a by-pass oil filter can consume 255 U.S. gallons of fuel for each U.S. gallon of oil in the oil system before the maximum level of oil contamination is reached.

NOTE: Cummins Engine Co. Inc, does not recommend exceeding 25,000 miles and/or 600 hours on oil change intervals.



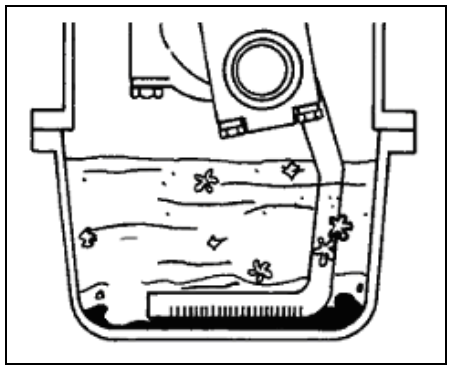
Drain

CAUTION

Avoid prolonged and repeated skin contact with used engine oils. Such prolonged and repeated contact can cause skin disorders or other bodily injury. Wash thoroughly after contact. Keep out of reach of children.

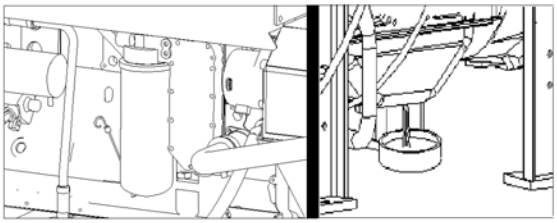
NOTE: If the engine is in service, the oil drain interval of 250 hours or 3 months must be observed.

PROTECT THE ENVIRONMENT: Handling and disposal of used engine oil is subject to federal, state, and local laws and regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for receipt of used oil. If in doubt, contact state and local environmental authorities or the Environmental Protection Agency for guidance as to proper handling and disposal of used engine oil.



Change the oil and filters to remove the contaminants suspended in the oil.

NOTE: Drain the oil only when it is hot and the contaminants are in suspension.



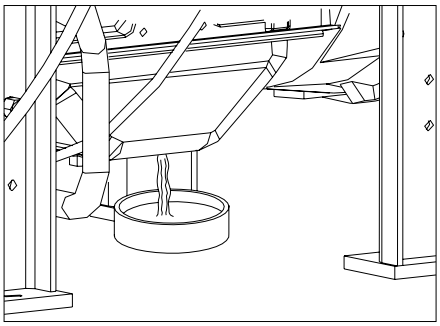
CAUTION

Hot oil can cause personal injury.

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

Shut the engine off.

NOTE: Use a container that can hold at least 20 liters [21.1 qt] of oil.



NOTE: For composite oil pans, hold the external locking nut in position with a separate wrench while removing the drain plug. This will prevent the bulkhead from loosening during drain plug removal.

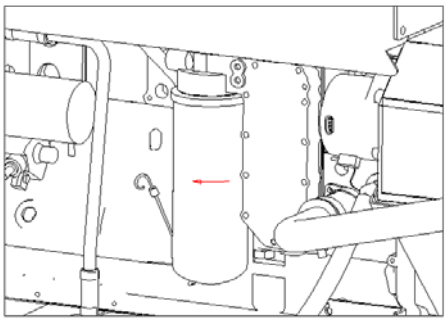
Remove the oil drain plug.

Drain the oil immediately to make sure all the oil and suspended contaminates are removed from the engine.

Remove

Clean the area around the lubricating oil filter head. Using an oil filter wrench, remove the filter. Clean the gasket surface of the filter head with a clean lint-free cloth.

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



Install

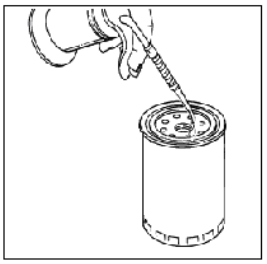
CAUTION

The lubricating oil filter should be full of oil at start-up to prevent engine damage.

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

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

Fill the filter with clean 15W-40 oil.

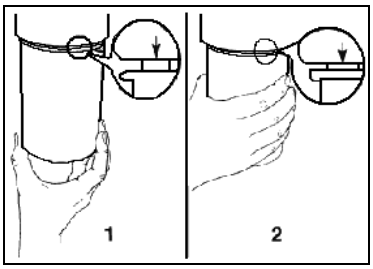


CAUTION

Mechanical over tightening can distort the threads or damage the filter element seal.

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

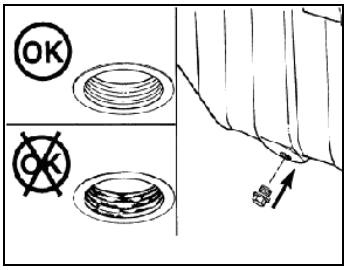
Install the filter as specified by the filter manufacturer.



Check and clean the oil drain plug threads and sealing surface.

Install the oil drain plug.

Torque Value: 50 N•m [37 ft-lb]

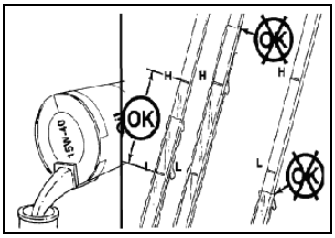


NOTE: Use a high-quality 15W-40 multiviscosity lubricating oil, such as Cummins Premium Blue®, or its equivalent, in Cummins engines. Choose the correct lubricating oil for your operating climate as outlined in Section 5.

Fill the engine with clean oil to the proper level.

NOTE: Capacities assume standard pan. Total system assumes standard pan plus filter.

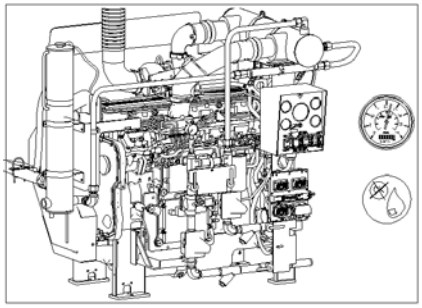
NOTE: When filling the oil pan, use the fill tube on the side of the engine rather than on top of the rocker lever cover.



WARNING

If no oil pressure is noted within 15 seconds after the engine is started, shut down the engine to reduce the possibility of internal damage

Operate the engine at idle to inspect for leaks at the filters and the drain plug.

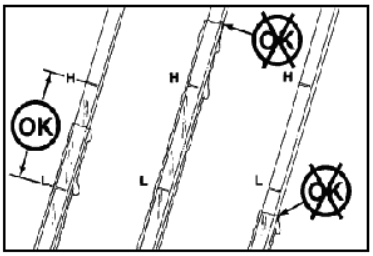


Stop the engine.

Wait approximately 15 minutes to let the oil drain from the upper parts of the engine.

Check the oil level again.

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



Procedure 24 **Change Fuel Filter (Spin-on Type)**

WARNING

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

CAUTION

Use caution when disconnecting or removing fuel lines, replacing filters and priming the fuel system that fuel is not spilled or drained into the bilge area. Do not drop or throw filter elements into the bilge area. The fuel and fuel filters must be discarded in accordance with local environmental regulations.

CAUTION

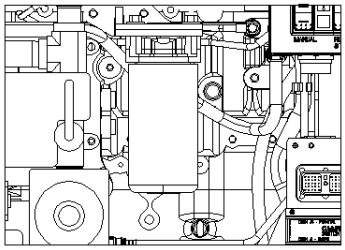
Mechanical overtightening can distort the threads as well as damage the filter element seal or filter canister.

Remove

NOTE: Close any OEM fuel valves (if equipped) to prevent fuel from draining or siphoning.

Clean the area around the fuel filter head. Remove the filters. Clean the gasket surface of the filter head.

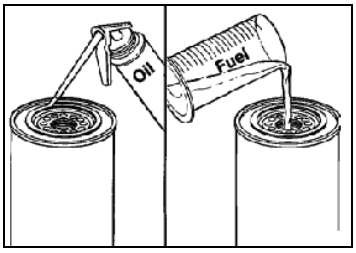
Replace the o-ring.



Install

Fill the new filter(s) with clean fuel, and lubricate the o-ring seal with clean lubricating oil.

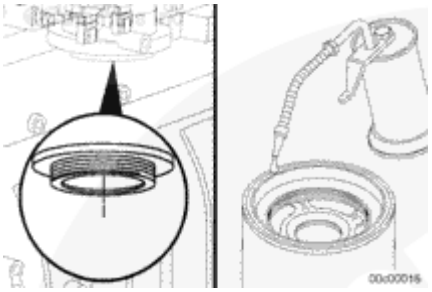
Fuel-water separator – used in single-filter applications.



It will be necessary to fill the 10-micron water stripping (suction side) fuel filter with fuel.

Do **not** fill the 10-micron (pressure side) fuel filter with fuel before installation; instead, prime the fuel system using the fuel lift pump.

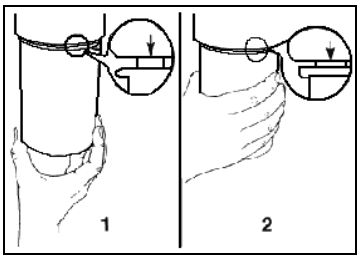
Be sure the center seal ring is installed onto the filter spud.



CAUTION

Mechanical over-tightening will distort the threads, filter element seal or filter can.

Install the filter as specified by the filter manufacturer.

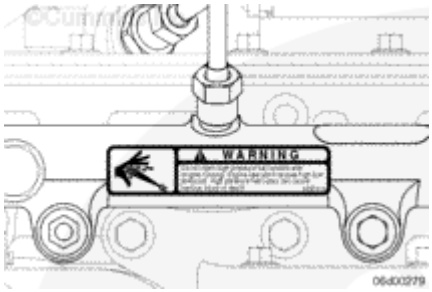


Prime

WARNING

Do not open the high-pressure fuel system with the engine running. Engine operation causes high fuel pressure. High-pressure fuel spray can cause serious injury or death.

Open the fuel supply and return valves, if equipped.



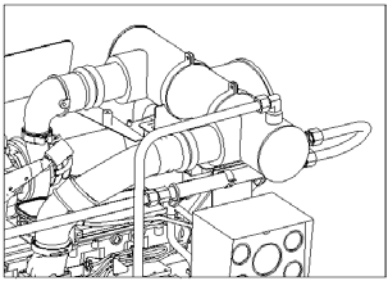
Finishing Steps

Once the engine is started, slowly increase the engine speed while air is purged from the fuel plumbing.

Procedure 25 Clean Charge Air Cooler

If the engine experiences a turbocharger failure or any other occasion where oil or debris is put into the charge air cooler, the charge air cooler must be cleaned.

Remove charge air cooler from the engine. Refer to Section 4.



WARNING

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

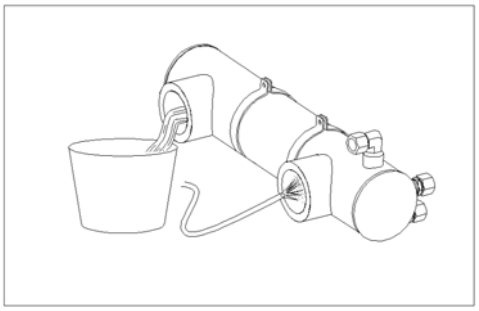
CAUTION

Do not use caustic cleaners to clean the charge air cooler. Damage to the charge air cooler will result.

Flush the charge air cooler internally with solvent in the opposite direction of normal airflow.

Shake the charge air cooler and lightly tap on the end tanks with a rubber mallet to dislodge trapped debris.

Continue flushing until all debris or oil is removed.



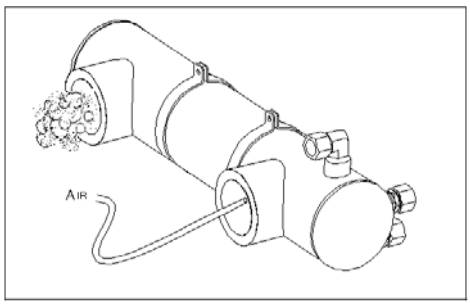
WARNING

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

After the charge air cooler has been thoroughly cleaned of all oil and debris with solvent, wash the charge air cooler internally with hot, soapy water to remove the remaining solvent.

Rinse thoroughly with clean water.

Blow compressed air into the charge air cooler in the opposite direction of normal airflow until the charge air cooler is dry internally.
Refer to Section 4 for installation procedures.

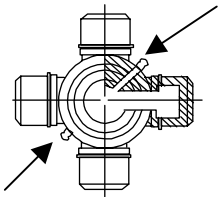


Procedure 26 **Lubrication of Output Shafts**

It is recommended that proper lubrication to drive shafts and output shafts is to be completed on a regular schedule.

Grease zerk fittings as shown.

See Section 10 for grease specifications and lubricating oil recommendations.



Every Six Months or 500 Hours

General Information

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

Procedure 27 Drain and Flush Cooling System

The cooling system must be clean to work correctly.

Drain the system and flush with clean water.

If the system shows mineral buildup, scale, rust or oil, clean with a heavy duty engine coolant cleaner and follow the manufacturer's directions.

Drain

CAUTION

Avoid prolonged and repeated skin contact with used antifreeze. Such prolonged, repeated contact can cause skin disorders or other bodily injury.

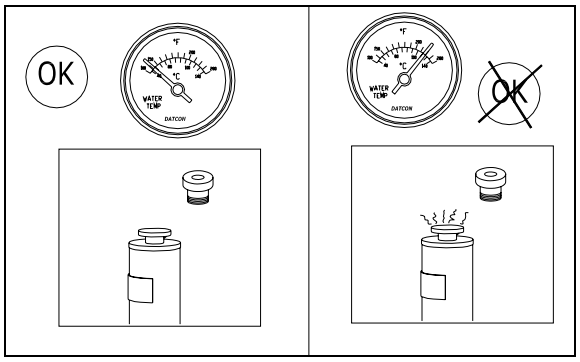
CAUTION

Wait until the temperature is below 50°C [120°F] before removing the coolant system pressure cap, (Cummins Fire Power Part No. 11407). Failure to do so can cause personal injury from heated coolant spray.

Avoid excessive contact - wash thoroughly after contact.

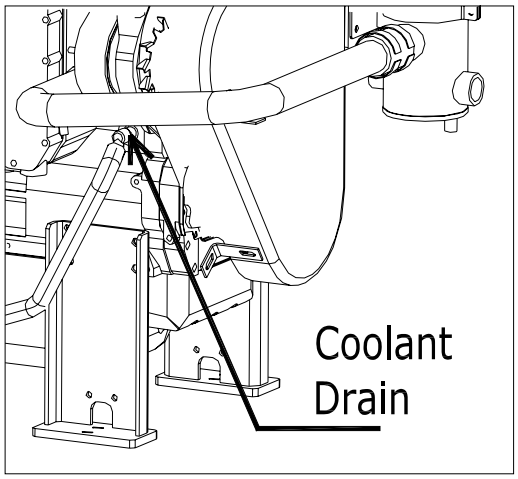
Keep out of reach of children.

Protect the environment: Handling and disposing of used antifreeze can be subject to federal, state, and local laws and regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for the receipt of used antifreeze. If in doubt, contact local authorities or the EPA for guidance as to proper handling of used antifreeze.



Drain the cooling system by opening the drain valve on the heat exchanger and removing the plug in the bottom of the water inlet.

A drain pan with a capacity of 20 liters [5 gal] will be adequate in most applications.

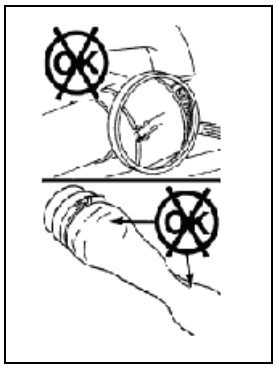


Check for damaged hoses and loose or damaged hose clamps.

Replace as required.

Check the heat exchanger for leaks, damage, and buildup of dirt.

Clean and repair as required.

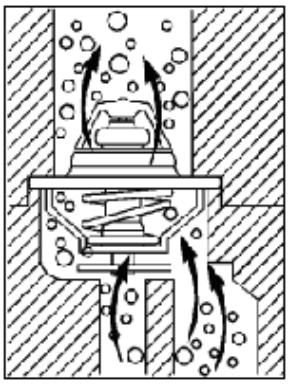


Flush

CAUTION

During filling, air must be vented from the engine coolant passages. The air vents through the "jiggle pin" openings to the top heat exchanger hose and out the fill opening. Additional venting is provided for engines equipped with an after cooler. Open the petcock during filling.

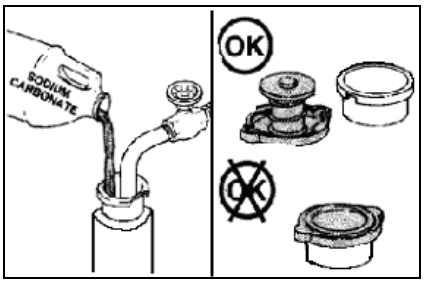
NOTE: Adequate venting is provided for a fill rate of 10 liters/minute [2.6 gal/min].



NOTE: Do not install the heat exchanger cap. The engine is to be operated without the cap for this process.

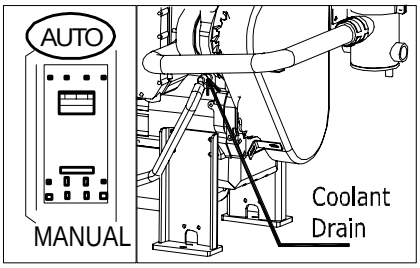
Fill the system with a mixture of sodium carbonate and water (or a commercially available equivalent).

NOTE: Use 0.5 kg [1.0 lb] of sodium carbonate for every 23 liters [6 gal] of water.



Operate the engine for 5 minutes with the coolant temperature above 82°C [180°F].

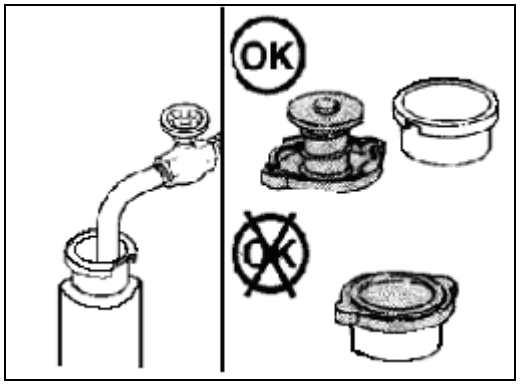
Shut the engine off, and drain the cooling system.



Fill the cooling system with clean water.

NOTE: Be sure to vent the engine and aftercooler for complete filling.

NOTE: Do not install the radiator cap or the new coolant filter.

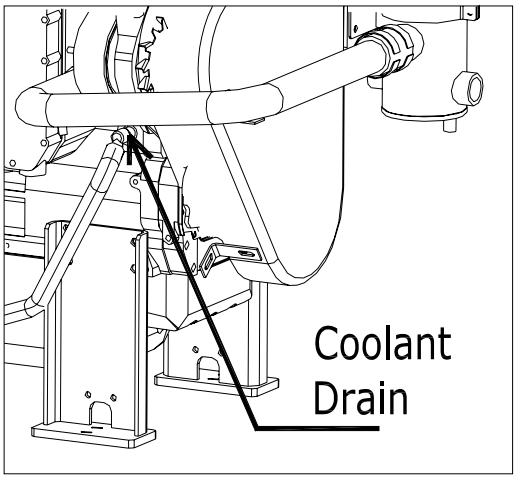


Operate the engine for 5 minutes with the coolant temperature above 82°C [180°F].

Shut the engine off.

Drain the cooling system.

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

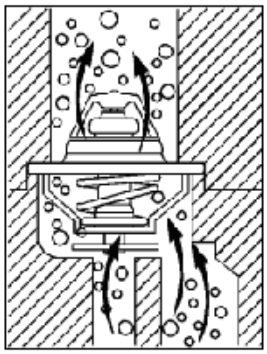


Fill

CAUTION

The system must be filled properly to prevent air locks. During filling, air must be vented from the engine coolant passages.

The system has a design fill rate of 10 liters/minute [2.8 gal/min].

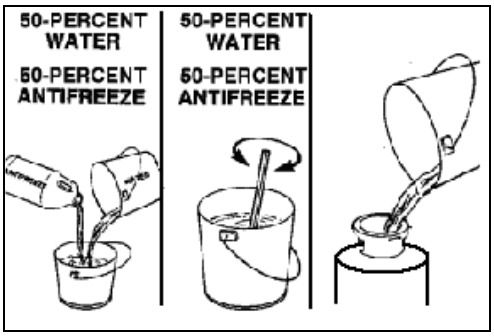


CAUTION

Never use water alone for coolant. Damage from corrosion can be the result of using water alone for coolant.

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

Coolant Capacity (Engine Only): 4.50 liters [1.19 US Gal]



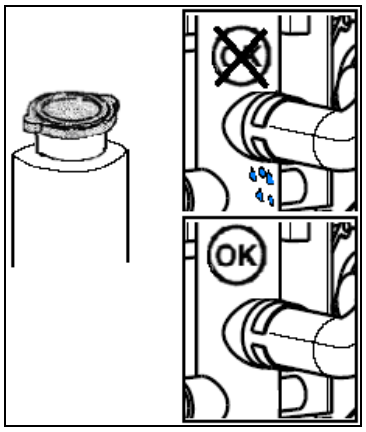
WARNING

Before removing the pressure cap, wait until the coolant temperature is below 50°C [120°F]. Failure to do so can cause personal injury from heated coolant spray.

Install the pressure cap (Cummins Fire Power Part No 11407.).

Operate the engine until it reaches a temperature of 82°C [180°F], and check for coolant leaks.

Check the coolant level again to make sure the system is full of coolant, or that the coolant level has risen to the hot level in the recovery bottle on the system, if so equipped.



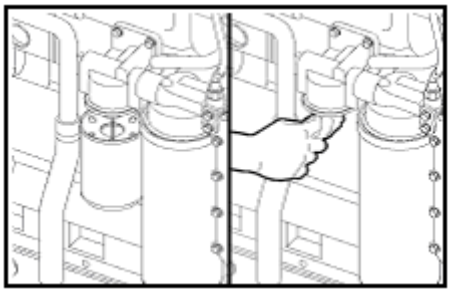
Procedure 28 **Change Coolant Filter**

WARNING

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

WARNING

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



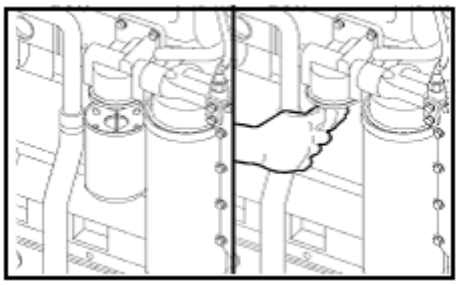
CAUTION

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

Remove and discard the coolant filter.

Clean

Clean the gasket surface.



Install

CAUTION

Do not allow oil to get into the filter. Oil will damage the DCA.

CAUTION

Mechanical over-tightening can distort the threads or damage the filter head.

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

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

Tighten the coolant filter an additional 1/2 to 3/4 of a turn, or as specified by the filter manufacturer.

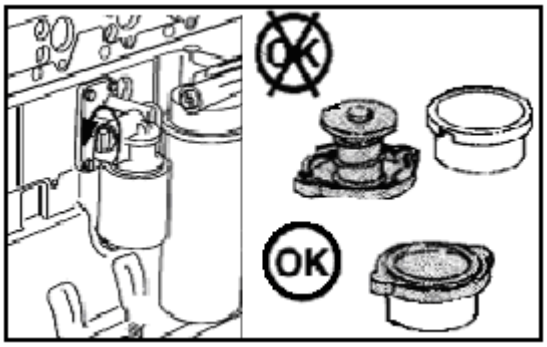
Test Run

Install the coolant system pressure cap (Cummins Fire Power Part No. 11407).

Operate the engine.

Check for coolant leaks.

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



Procedure 29 **Vent Fuel Supply Lines**

General Information

Controlled venting is provided at the injection pump through the fuel drain manifold. Small amounts of air introduced by changing the filters or injection pump supply line will be vented automatically if the fuel filter is changed in accordance with the instructions. No manual bleeding of fuel lines is required.

NOTE: Manual bleeding is required if any of the following is true:

- The fuel filter is not filled prior to installation.
- The injection pump is replaced.
- High-pressure fuel line connections are loosened or lines replaced.
- Engine is initially started or started after an extended period of no engine operation.
- Vehicle fuel tank has run empty.

Low Pressure Fuel Line(s)

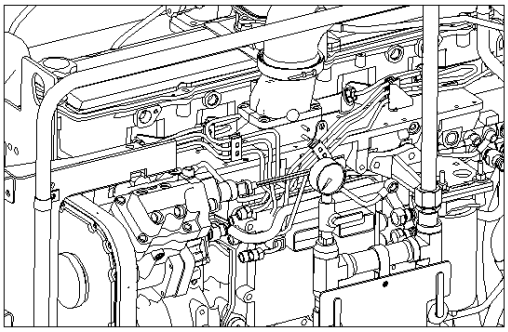
Open the vent screw.

Allow fuel to drain until the fuel flowing from the fitting is free of air.

Tighten the vent screw.

Torque value: 8 N•m (6ft-lb).

The low pressure fuel lines are bled by pumping the hand lever on the filter head.

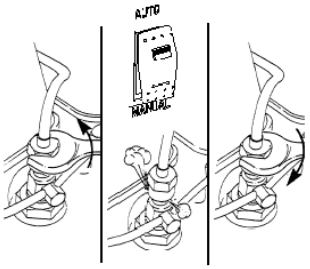


High Pressure Fuel Line(s)

WARNING

The pressure of the fuel in the line is sufficient to penetrate the skin and cause serious bodily harm.

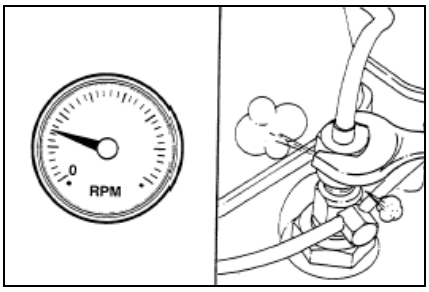
Venting is accomplished by loosening one or more fittings at the injectors and cranking the engine to allow entrapped air to bleed from the lines.



WARNING

Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.

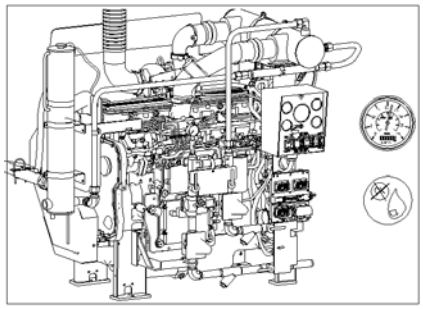
With the engine at idle, vent one line at the time until the engine runs smoothly.



Retighten Line Fittings

Tighten the line fittings and check for leaks.

Torque Value: 22 N•m [16 ft-lb]



Procedure 30 **Vent Injection Pump**

WARNING

The pressure of the fuel in the line is sufficient to penetrate the skin and cause serious personal injury. Wear gloves and protective clothing.

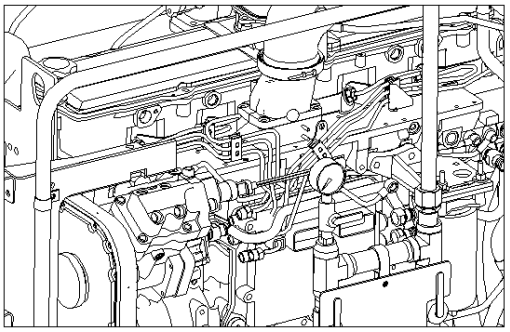
Loosen the fittings at the injectors, and crank the engine to allow entrapped air to bleed from the lines. Tighten the fittings.

WARNING

It is necessary to put the engine in the run position. Because the engine could start, be sure to follow all the safety precautions. Use the normal engine starting procedure.

Start the engine and vent one line at a time until the engine runs smoothly.

NOTE: Do not engage the starter for more than 30 seconds each time when it is used to vent the system: Wait 2 minutes between engagements.



Every Year or 1000 Hours

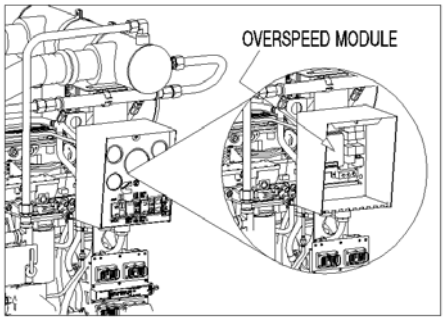
General Information

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time, in addition to those listed under this maintenance interval, except for valve lash adjustment.

Procedure 31 Check Overspeed Switch Operation

Check the overspeed switch for operation.

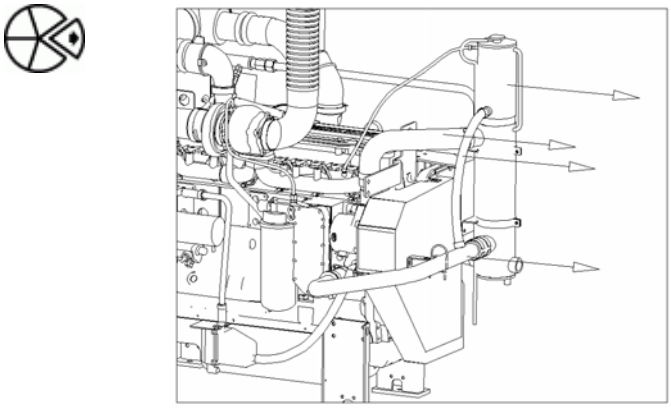
Refer to Operating Instructions in Section 3 of the Operational Manual for settings.



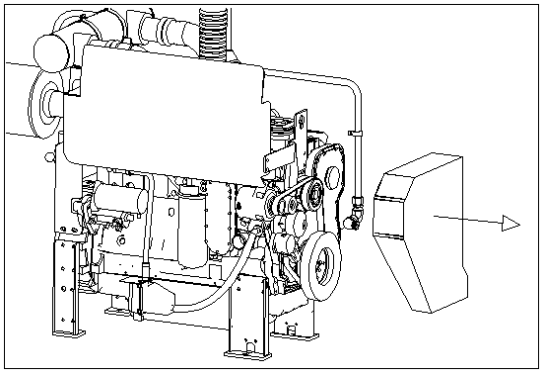
Procedure 32 Check Drive Belt, Tensioner Bearing and Belt Tension

Inspect

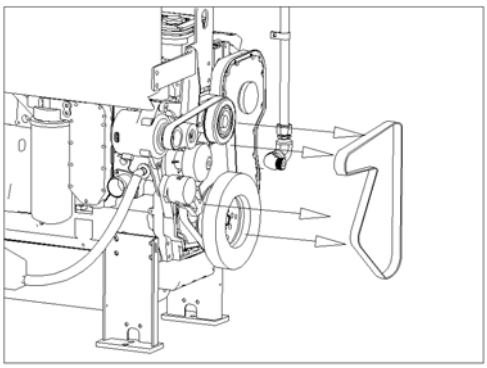
Remove heat exchanger, piping and hoses.



Remove the belt guard.



Remove the drive belt.

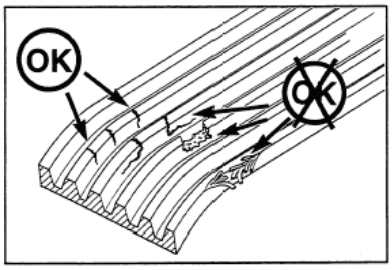


Poly-Vee Belt

Visually inspect the belt.

Check the belt for intersecting cracks. Transverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are not acceptable.

Replace the belt if it is frayed or has pieces of material missing.

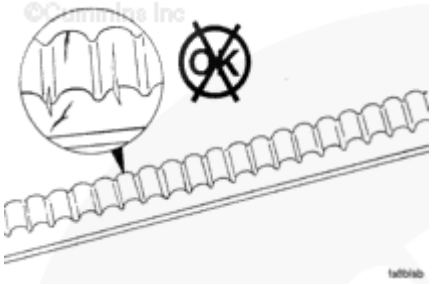


Belt damage can be caused by:

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

Cogged Belt

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

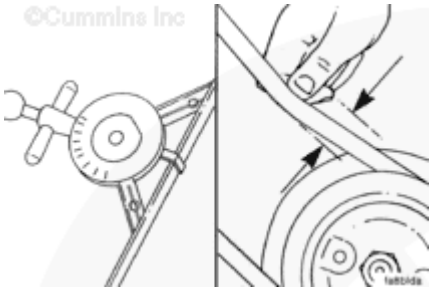


Adjust the belts that have a glazed or shiny surface, which indicates belt slippage. Correctly installed and tensioned belts will show even pulley and belt wear. Refer to Section A for belt adjustment and replacement procedures.

Belt damage can be caused by:

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

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

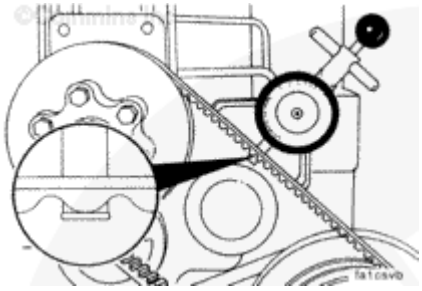


Refer to the Belt Tension Chart in Section V for the correct gauge and tension value for the belt width used.

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

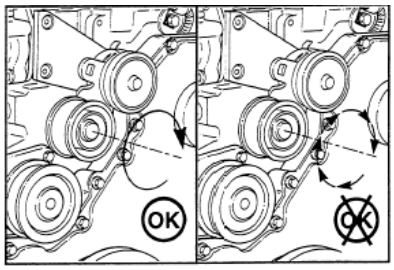
Refer to Section A for adjustment.

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



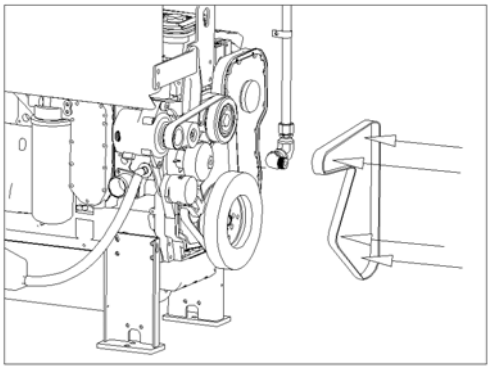
Check the tensioner bearing.

The tensioner pulley should spin freely with no rough spots detected under hand pressure.

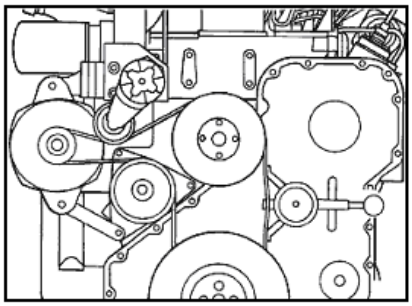


Replace tensioner or bearing if defective.

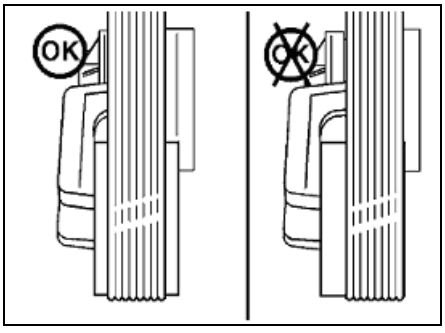
Install the drive belt.



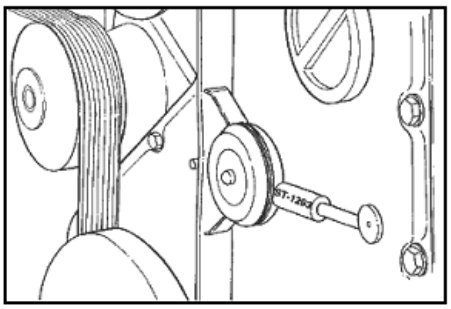
Torque Value: Tension Limit: 360 to 490 N•m [266 to 361 ft-lb]



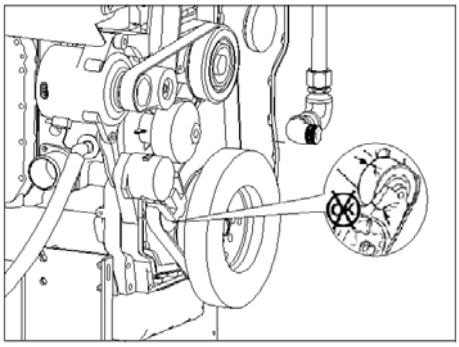
Check the location of the drive belt on the belt tensioner pulley. The belt should be centered on, or centered close to the middle of, the pulley. Unaligned belts, either too far forward or backward, can cause belt wear, belt roll-off failures, or increase uneven tensioner bushing wear.



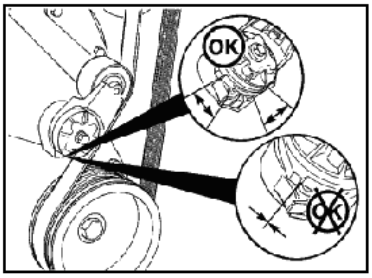
Use the Cummins belt tensioner gauge, Part No. 3822524, to measure the tension in the drive belt. This needs to be in the range of 360 to 490 N•m [266 to 361 ft-lb].



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

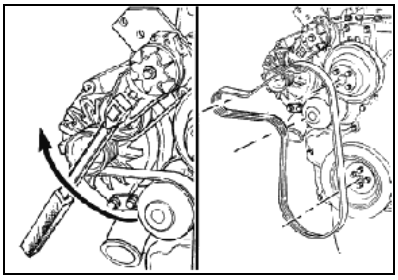


With the belt on, verify that neither tensioner arm stops are in contact with the spring casing stop. If either stop is touching, the drive belt must be replaced. After replacing the belt, if the tensioner arm stops are still in contact with the spring casing stop, replace the tensioner.



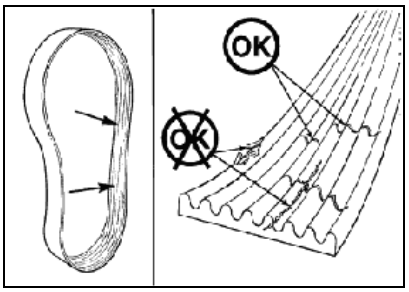
Remove the drive belt, and check the torque of the tensioner capscrew. After checking the torque, use a breaker bar with a 3/8-inch ratchet to rotate the tensioner slowly away from the area of belt contact. If the arm rotates with any roughness or hesitancy, replace the tensioner.

Torque Value: 43 N•m [32 ft-lb]



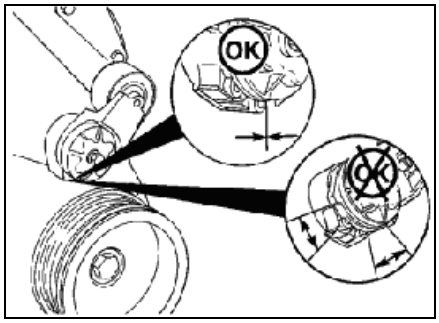
Check the belt for damage. Transverse (across the belt width) cracks are acceptable. Longitudinal (direction of the belt length) cracks that intersect with transverse cracks are not acceptable.

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



With the belt removed, verify that the tensioner arm stop is in contact with the spring case stop.

If these two are not touching, the tensioner must be replaced.



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

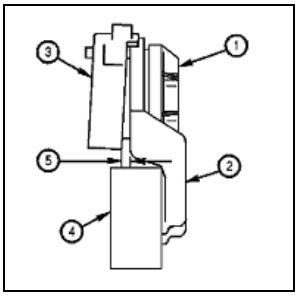
Measure the clearance between the tensioner spring case and the tensioner arm to verify tensioner wear-out and uneven bearing wear.

If the clearance exceeds 3 mm [0.12 in] at any point, the tensioner failed and must be replaced as a complete assembly.

Experience has revealed that tensioners generally will show a larger clearance gap near the lower portion of the spring case, resulting in the upper portion rubbing against the tensioner arm.

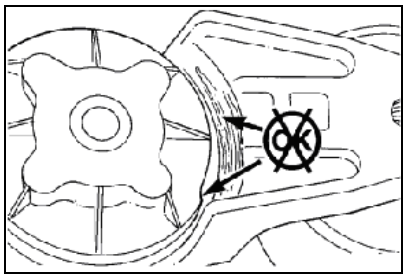
Always replace the belt when a tensioner is replaced.

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



Inspect the tensioner for evidence of the tensioner arm contacting the tensioner cap.

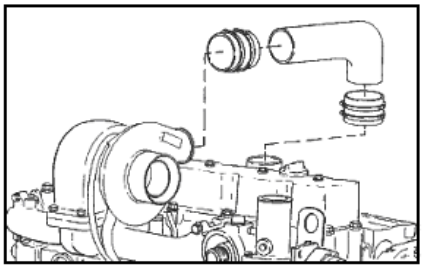
If there is evidence of the two areas making contact, the pivot tube bushing has failed and the tensioner must be replaced.



Procedure 33 **Check Valve Lash Clearance**

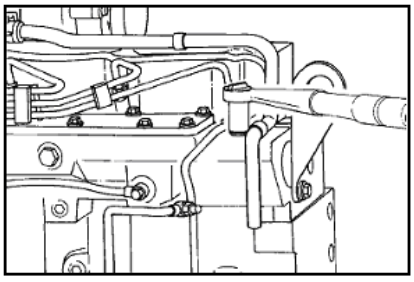
Adjust

Remove the air crossover tube from the engine if equipped.

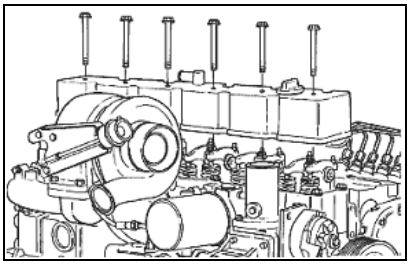


Disconnect the support clamps, hose clamp, and wastegate sensing line.

Remove the crankcase vent tube and any other parts that would prevent removal of the valve cover.

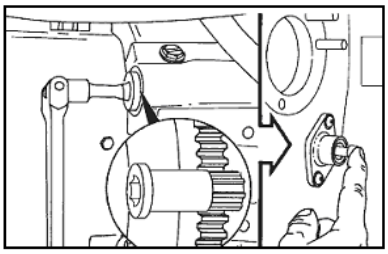


Remove valve cover.

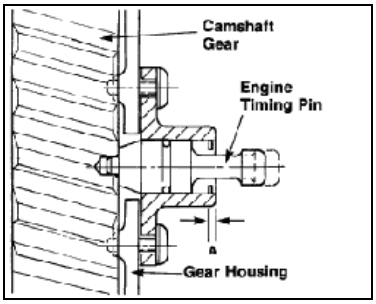


Locate top dead center for cylinder No. 1 by rotating the crankshaft slowly while pressing on the engine timing pin.

The barring gear inserts into the flywheel housing and engages the flywheel ring gear. The engine can then be rotated by hand using a 1/2-inch ratchet or breaker bar.

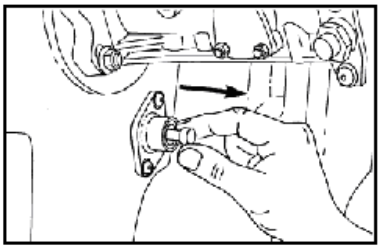


When the engine timing pin engages the hole in the camshaft gear, cylinder No. 1 is at top dead center on the compression stroke.



⚠CAUTION⚠

Be sure to disengage the engine timing pin after locating top dead center to prevent damage to the engine timing pin.

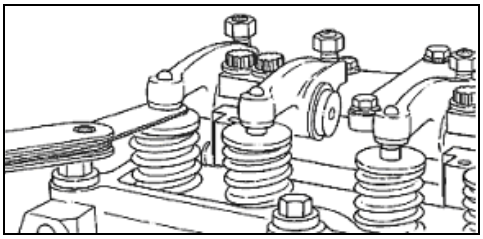


Intake clearance: 0.30 mm [0.012 in]

Exhaust clearance: 0.61 mm [0.024 in]

Check/set valves with engine cold - below 60°C [140°F].

NOTE: The clearance is correct when some resistance is “felt” when the feeler gauge is slipped between the valve stem and the rocker lever.

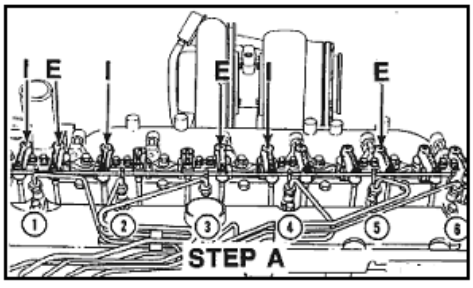


Locate top dead center for cylinder No. 1.

Check/adjust the valves indicated for STEP A (I = intake; E = exhaust).

After tightening the rocker lever locknut, check the valve clearance to make sure the valve clearance has not changed.

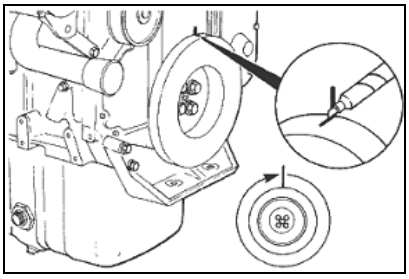
Torque Value: 24 N•m [212 in-lb]



CAUTION

Be sure the engine timing pin is disengaged to prevent damage to the engine timing pin.

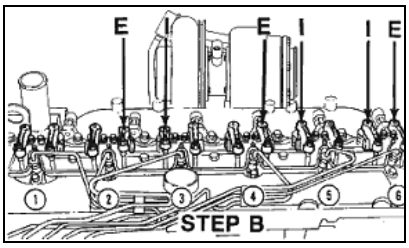
Mark vibration damper and rotate the crankshaft 360 degrees.



Set the valves indicated for STEP B.

After tightening the rocker lever locknut, check the valve clearance to make sure the valve clearance has not changed.

Torque Value: 24 N•m [212 in-lb]



NOTE: If the seal is not damaged, it can be used again.

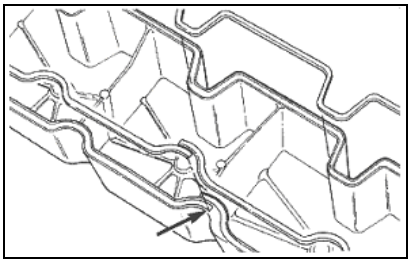
If the seal is damaged, install a new seal.

Install the rubber seal into the groove in the valve cover.

Start the installation at the overlap area shown in the illustration.

Do not stretch the rubber seal.

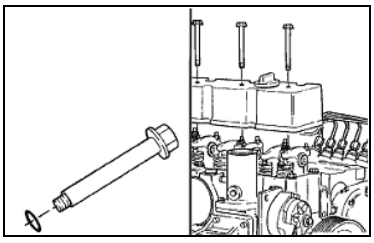
If the seal has more overlap than shown in the illustration, trim the length to provide the correct overlap.



Install new sealing o-rings on the capscrews.

Install the valve cover and wastegate sensing tube.

Torque Value: 24 N•m [212 in-lb]

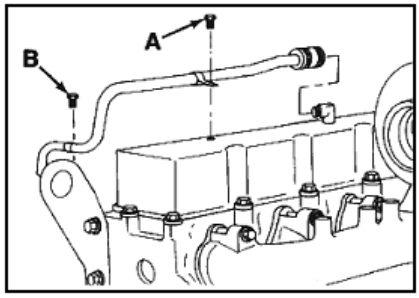


Install the crankcase vent tube, and secure with the support clamps and hose clamp.

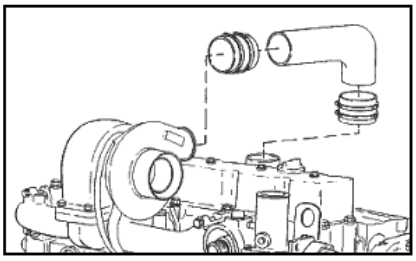
Torque Values:

A = 24 N•m [212 in-lb]

B = 43 N•m [32 in-lb]



Install the air crossover tube and any other parts previously removed to gain access to the valve cover.

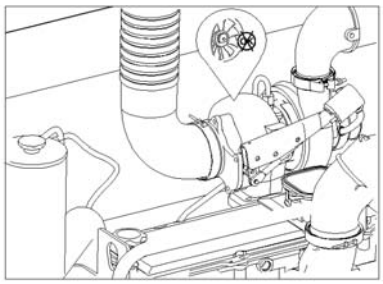


Procedure 34 **Inspect Turbocharger**

Remove the air intake and the exhaust piping.

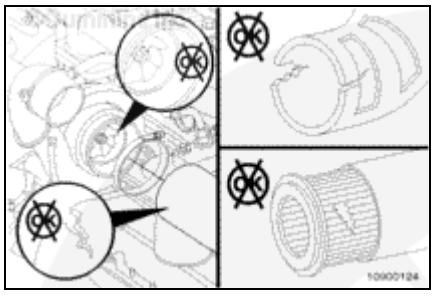
Look for damaged or cracked compressor or turbine blades.

Check to see that the turbocharger shaft spins freely.



If the compressor impeller is damaged, inspect the intake piping and filter element for damage.

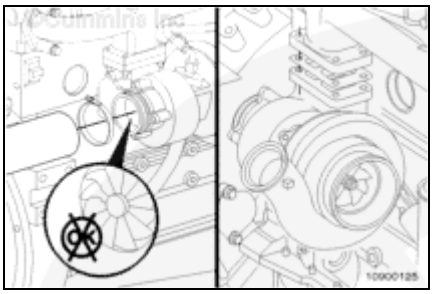
Repair any damage before operating the engine.



Remove the exhaust pipe from the turbocharger.

Inspect the turbine wheel for damage.

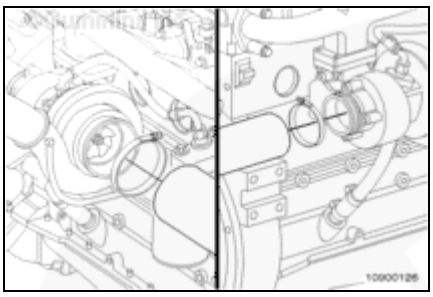
Replace the turbocharger if damage is found. Contact a Cummins Authorized Repair Location for replacement.



NOTE: If visual inspections or dimensional checks indicate a problem, contact a Cummins Authorized Location for Assistance.

The turbocharger must be removed for replacement or rebuild if the clearances are beyond the limits.

Install the air intake and the exhaust piping and tighten the clamps.



Every Two Years or 2000 Hours

General Information

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

Procedure 35 Inspect Viscous Damper

CAUTION

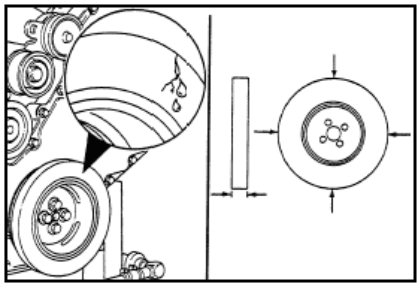
The silicone fluid in the vibration damper will become solid after extended service and will make the damper inoperative. An inoperative vibration damper can cause major engine or drivetrain failures.

Check the damper for evidence of fluid loss, dents, and wobble.

Visually inspect the vibration damper thickness for any deformation or raising of the damper front cover plate.

If any variations or deformations are detected, refer to the Troubleshooting and Repair Manual for detailed inspection procedures.

Viscous dampers have a limited lift. The maximum damper life specifications are located in Maintenance Specifications.

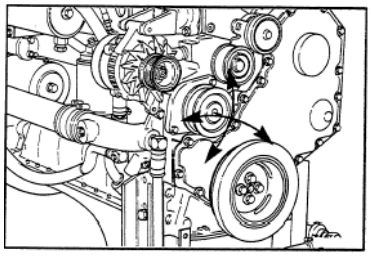


Procedure 36 Inspect Water Pump

Inspect the water pump for drive pulley wobble and grease or water leakage around the water pump shaft.

Replace with a new or rebuilt, pre-lubricated unit as necessary.

Refer to the Troubleshooting and Repair Manual for more information.



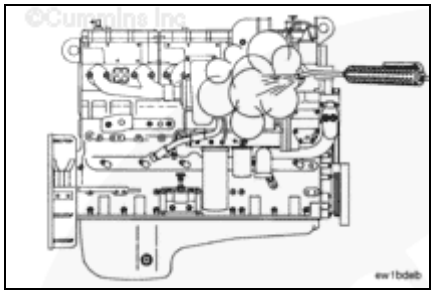
Procedure 37 Engine Steam Cleaning

WARNING

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

Steam is the best method of cleaning a dirty engine or a piece of equipment. If steam is **not** available, use a solvent to wash the engine.

Protect all electrical components, openings, and wiring from the full force of the cleaner spray nozzle.



Every Four Years or 5000 Hours

General Information

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

Procedure 38 **Inspect Overhead Set**

Preparatory Steps

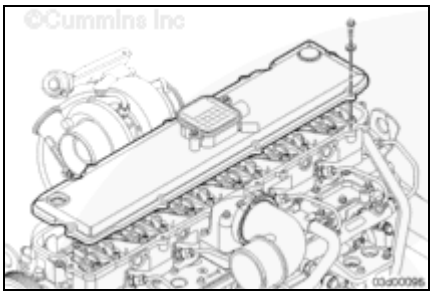
Remove the crankcase breather tube, rocker lever cover mounted breather only.

Remove the variable geometry turbocharger actuator air supply line, if equipped.

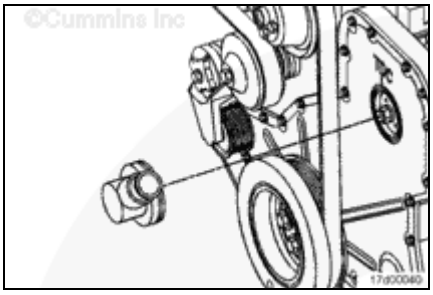
Remove the capscrews.

Remove the rocker lever cover and gasket.

NOTE: Rocker lever cover configurations will be different based upon if the cover is center bolted or perimeter bolted.



Remove the plastic fuel pump drive cover located on the front of the engine.

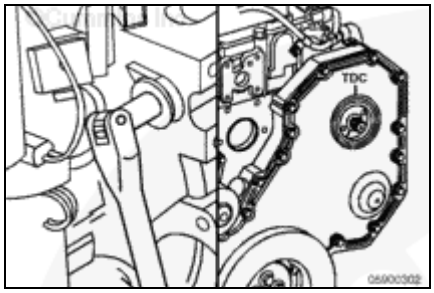


Adjust

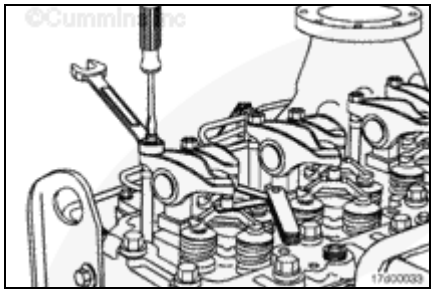
CAUTION

Engine coolant temperature should be less than 60°C [140°F].

Use the barring tool, Part Number 3824591, or equivalent, and rotate the crankshaft to align the top dead center marks on the gear cover and the fuel pump gear.



With the engine in this position, lash can be checked on the following rocker arms: 1I, 1E, 2I, 3E, 4I, and 5E.

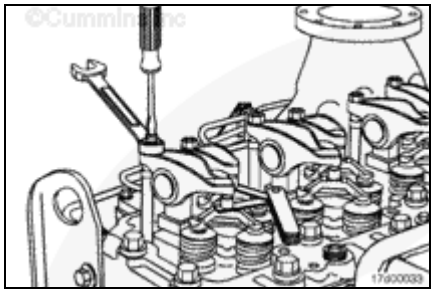


Lash Check Limits

	mm		in
Intake	0.152	MIN	0.006
	0.559	MAX	0.022
Exhaust	0.381	MIN	0.015
	0.813	MAX	0.032

NOTE: Lash checks are performed as part of a troubleshooting procedure, and resetting is not required during checks as long as the lash measurements are within the above limits.

Measure lash by inserting a feeler gauge between the crosshead and the rocker lever ball insert and socket while lifting up on the end of the rocker arm. If the lash measurement is out of specification, loosen the locknut and adjust the lash to the nominal specification.



Lash Reset Specifications

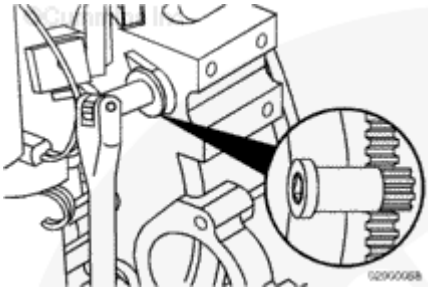
	mm		in
Intake	0.305	NOM	0.012
Exhaust	0.559	NOM	0.022

NOTE: Lash resets are only required at the interval specified in the Maintenance Schedule, when lash is measured and found out of specification, or when engine repairs cause removal of the rocker arms and/or loosening of the adjusting screws.

Tighten the locknut and measure again.

Torque Value: 24 N•m [18 ft-lb]

Use the barring tool, Part Number 3824591, or equivalent, and rotate the crankshaft 360 degrees and measure lash for rocker arms 2E, 3I, 4E, 5I, 6I, and 6E. Reset the lash, if out of specification.

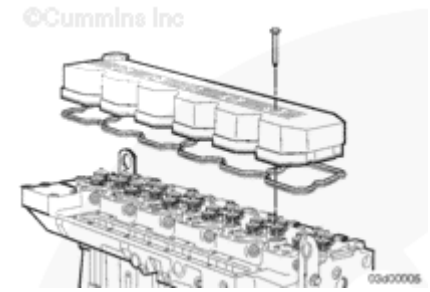


Finishing Steps

Center Bolted Rocket Lever Cover

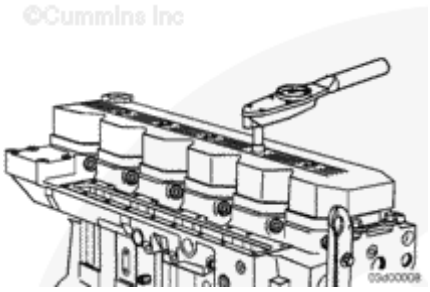
Place the gasket on the cylinder head. Be sure the gasket is properly aligned around the cylinder head capscrews.

Install the rocker lever cover and capscrews.



Tighten the capscrews.

Torque Value: 12 N•m [106 in-lb]

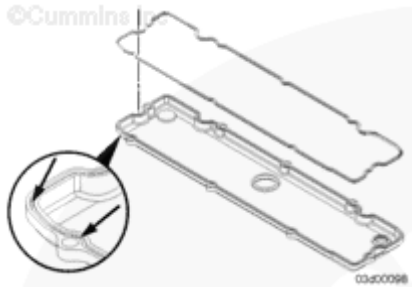


Perimeter Bolted Rocker Lever Cover

NOTE: If the gasket has been removed from the rocker lever cover, a new gasket must be used.

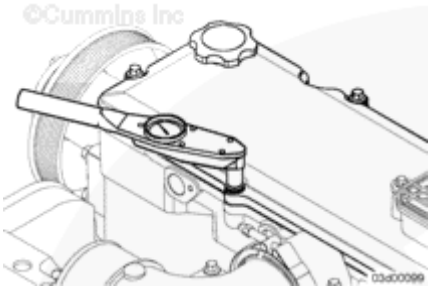
The following installation procedure must be used when installing the press-in gasket:

1. Press the molded gasket into the corners of the rocker lever cover.
2. Press the gasket around the capscrew mounting holes.
3. Press the remaining gasket into the rocker lever cover.



Install the rocker lever cover and capscrews.

Torque Value: 12 N•m [106 in-lb]



Install the crankcase breather tube, rocker lever cover mounted breather only.

Install the variable geometry turbocharger actuator air supply line, if equipped.

Section 6 - System Diagrams

Section Contents

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Overview

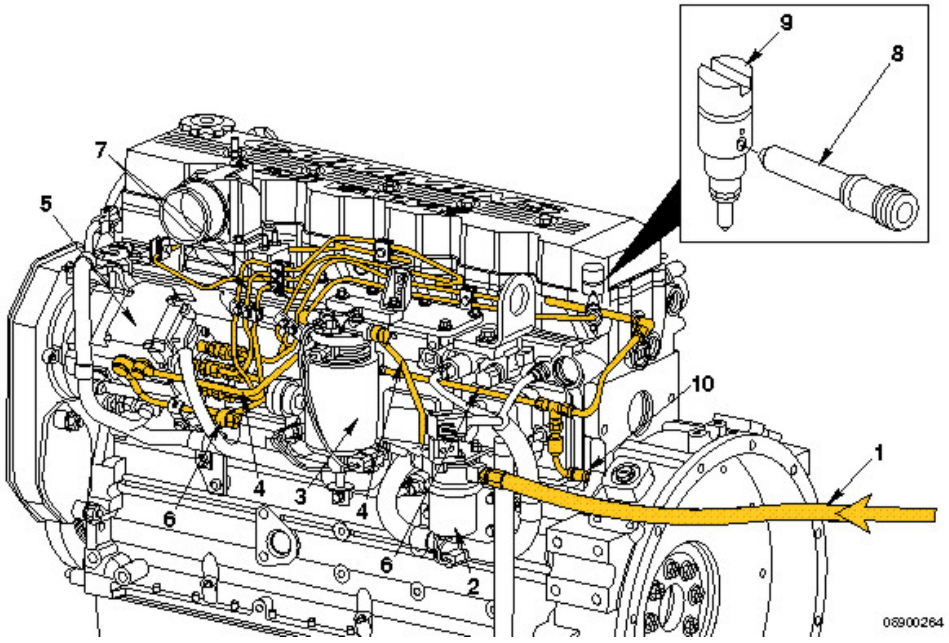
General Information

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

- Fuel System
- Lubricating Oil System
- Coolant System
- Intake Air System
- Exhaust System
- Raw Water System

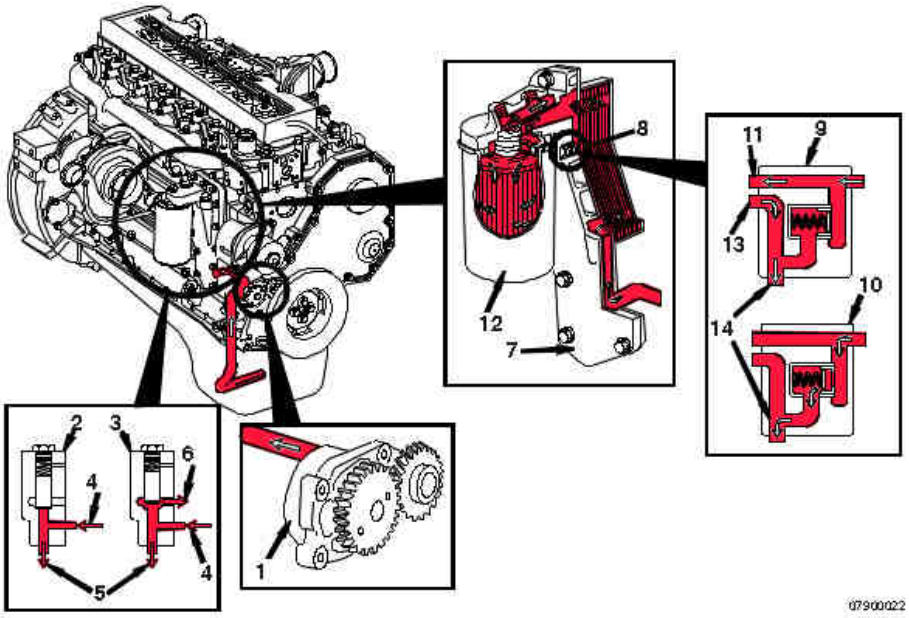
Knowledge of the engine systems can help you in troubleshooting, service, and general maintenance of your engine.

Flow Diagram, Fuel System



1. Fuel from Supply Tank
2. Electronic Lift Pump
3. Fuel Filter/Water Separator
4. Low-Pressure Supply Lines
5. Robert Bosch® VP44 Injection Pump
6. Fuel Drain Line
7. High-Pressure Supply Line
8. Fuel Connector
9. Robert Bosch® Closed Nozzle Injectors
10. Fuel Return to Supply Tank

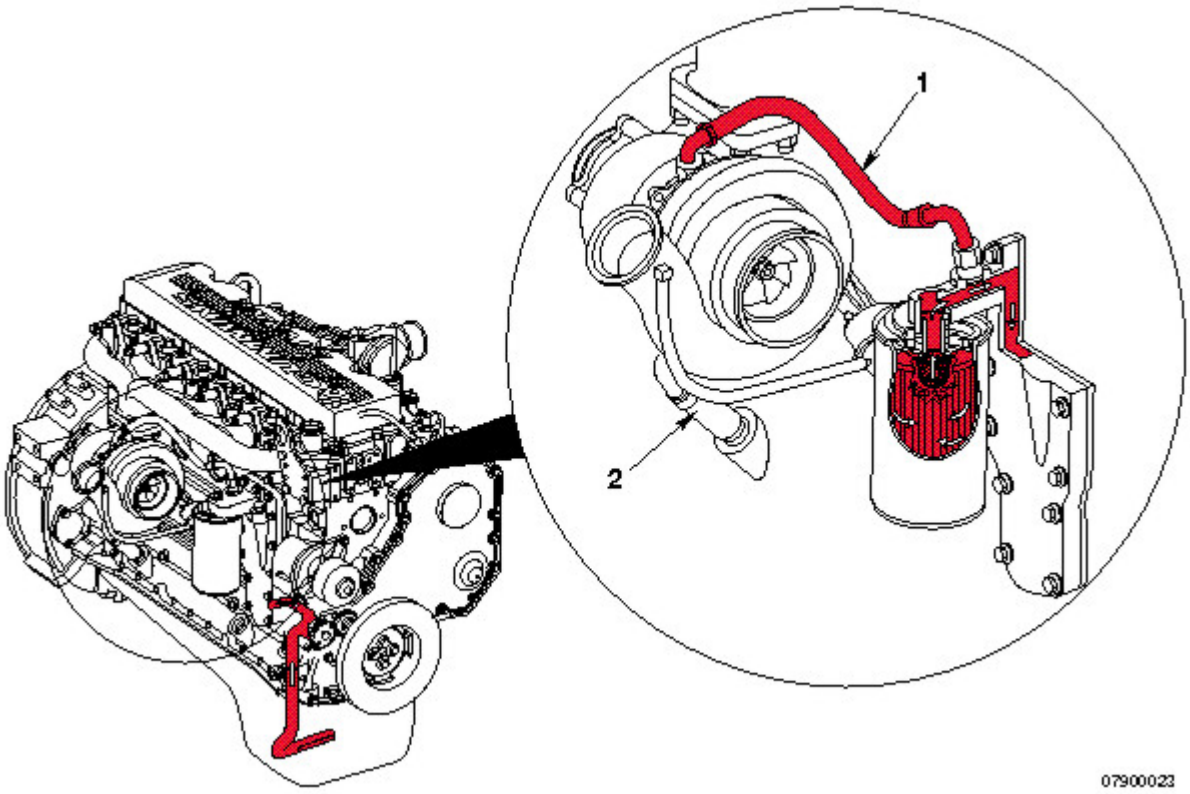
Flow Diagram, Lubricating Oil System



1. Gerotor Lubricating Oil Pump
2. Pressure Regulating Valve Closed
3. Pressure Regulating Valve Open
4. From Lubricating Oil Pump
5. To Lubricating Oil Cooler
6. To Lubricating Oil Pan
7. Lubricating Oil Cooler
8. Filter Bypass Valve
9. Filter Bypass Valve Closed
10. Filter Bypass Valve Open
11. To Lubricating Oil Filter
12. Full-Flow Lubricating Oil Filter
13. From Lubricating Oil Filter
14. Main Lubricating Oil Rifle

Flow Diagram, Lubricating Oil System (Cont)

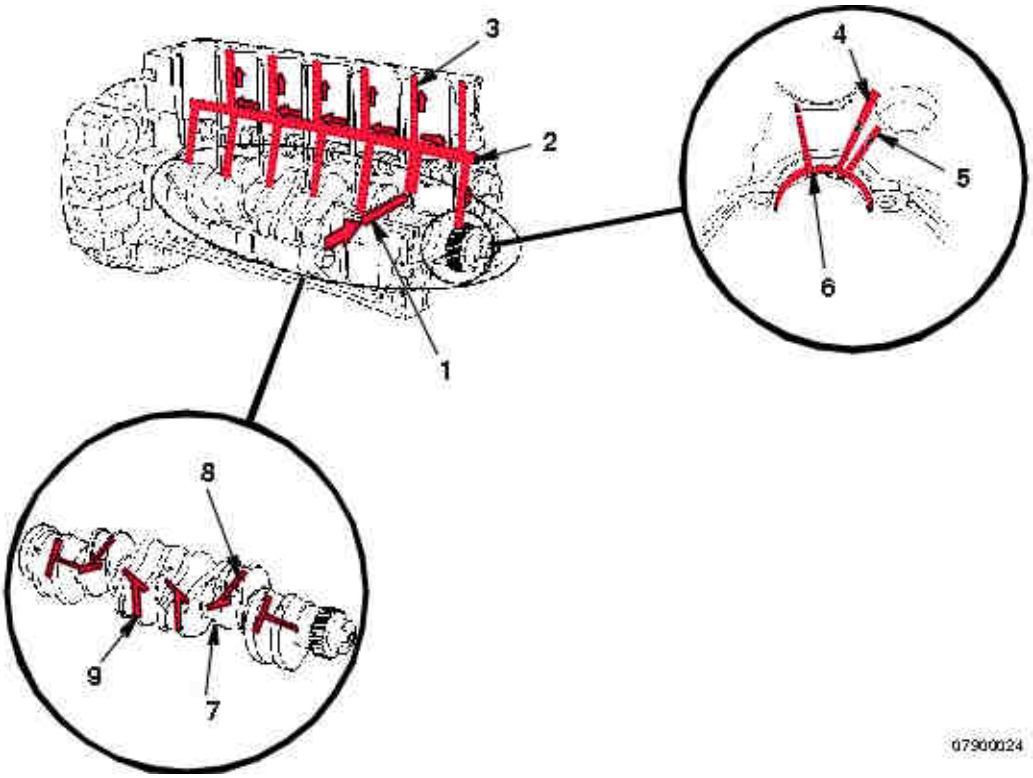
Lubrication for the Turbocharger



1. Lubricating Oil Supply
2. Lubricating Oil Drain

Flow Diagram, Lubricating Oil System (Cont)

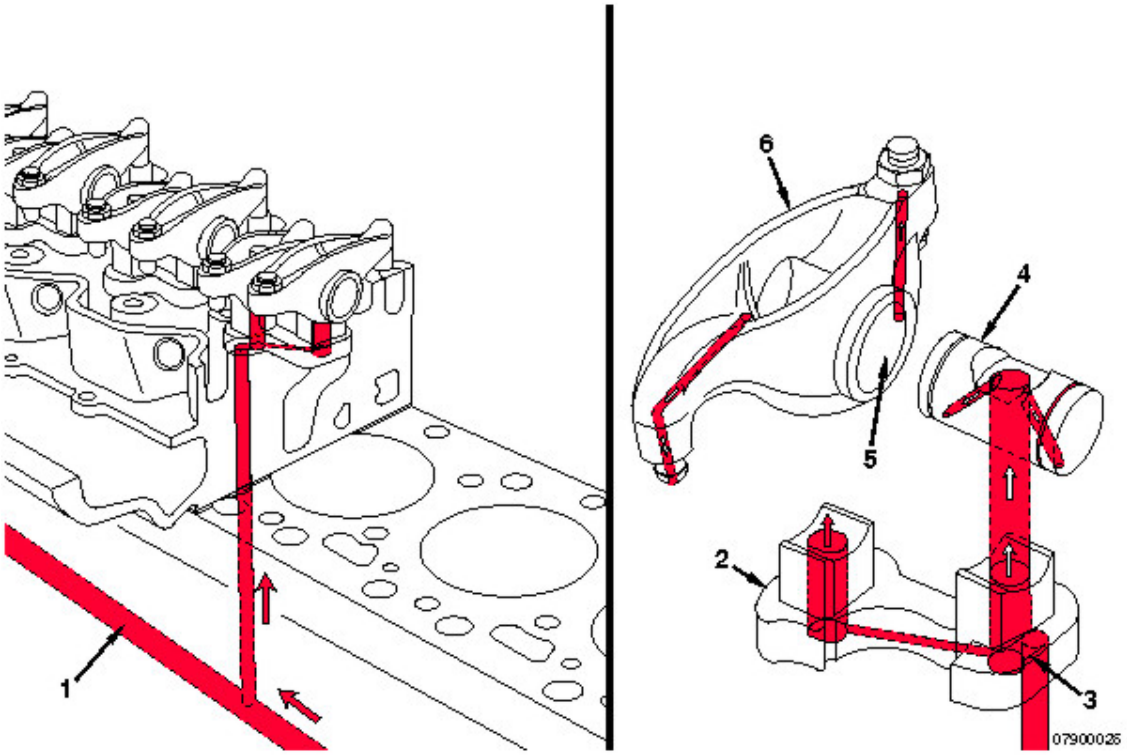
Lubrication for the Power Components



1. From Lubricating Oil Cooler
2. Main Lubricating Oil Rifle
3. To Valve Train
4. From Main Lubricating Oil Rifle
5. To Camshaft
6. To Piston Cooling Nozzle
7. Crankshaft Main Journal
8. To Connecting Rod Bearing
9. Connecting Rod Journal

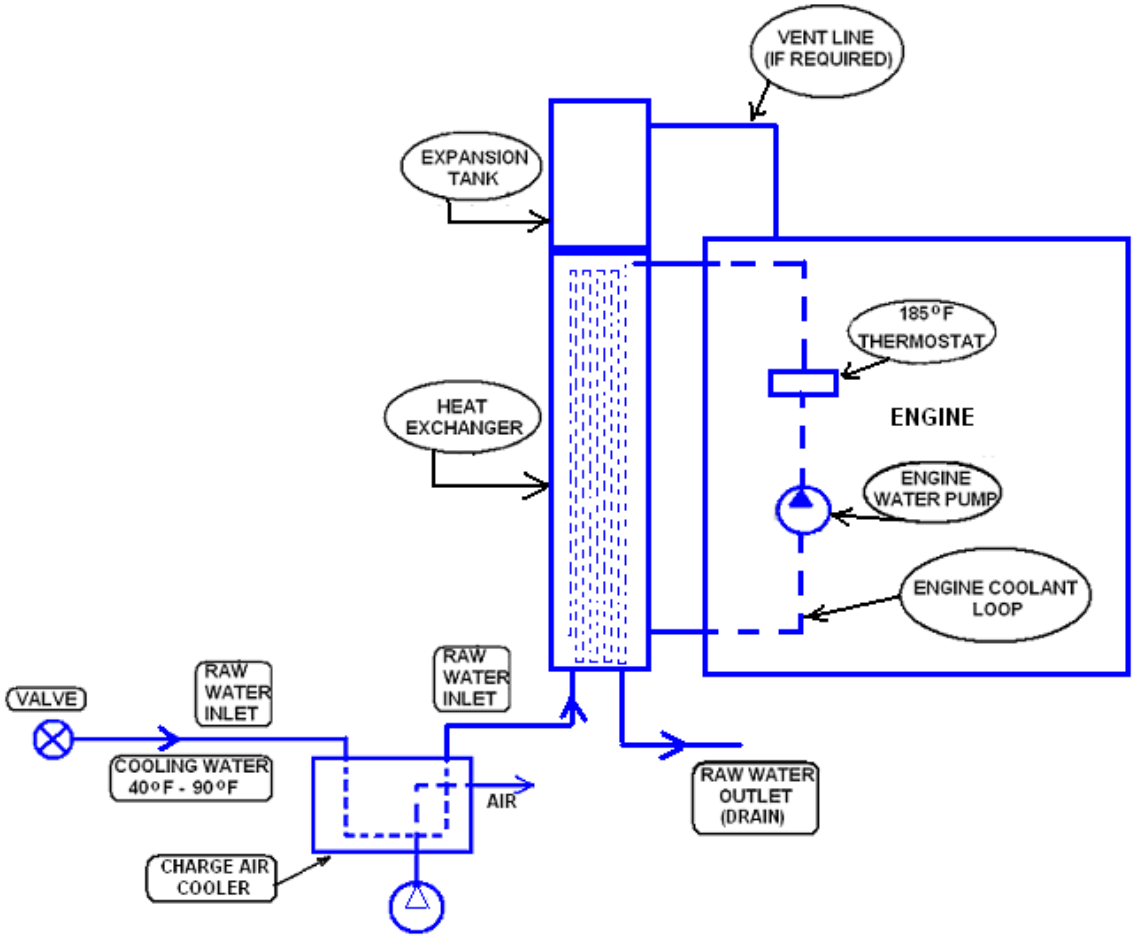
Flow Diagram, Lubricating Oil System (Cont)

Lubrication for the Overhead

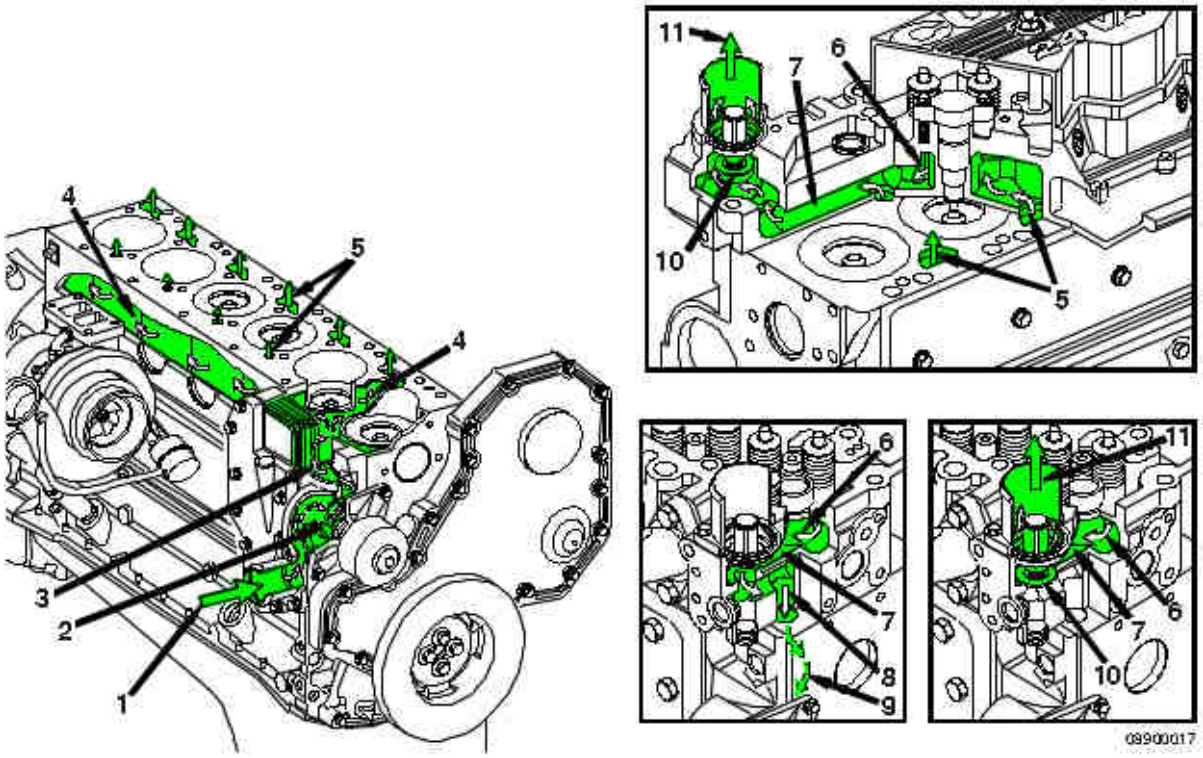


1. Main Lubricating Oil Rifle
2. Rocker Lever Support
3. Transfer Slot
4. Rocker Lever Shaft
5. Rocker Lever Bore
6. Rocker Lever

Flow Diagram, Cooling System

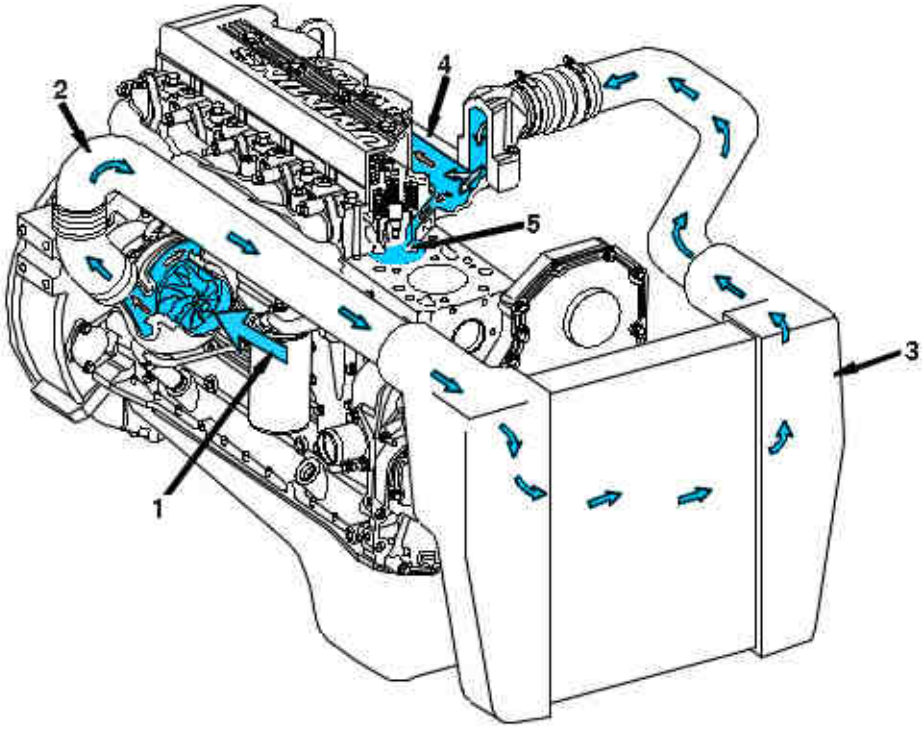


Flow Diagram, Cooling System (Cont)



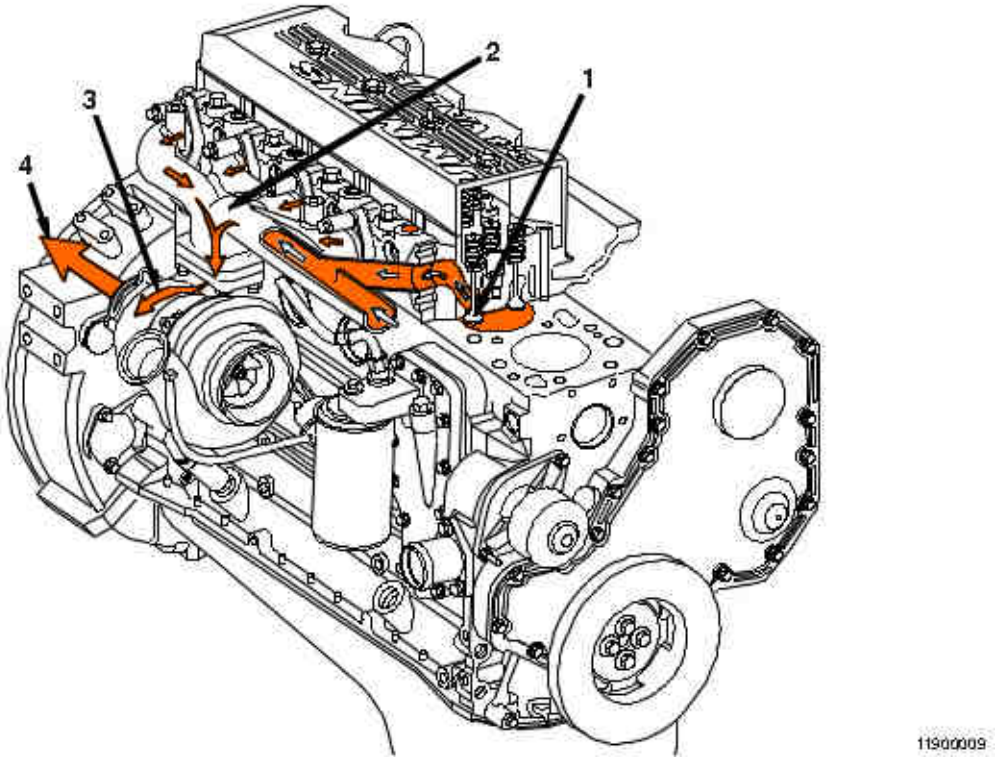
1. Coolant Inlet
2. Pump Impeller
3. Coolant Flow Past Lubricating Oil Cooler
4. Coolant Flow Past Cylinders
5. Coolant Flow from Cylinder Block to Cylinder Head
6. Coolant Flow Past Injector
7. Coolant Flow to Thermostat Housing
8. Coolant Bypass Passage
9. Coolant Flow to Pump Inlet
10. Bypass Closed
11. Coolant Flow Back to Radiator

Flow Diagram, Air Intake System



1. Intake Air Inlet to Turbocharger
2. Turbocharger Air to Charge Air Cooler
3. Charge Air Cooler (shown in diagram for flow purposes only) Mounted in horizontal plane on Fire Pump applications.
4. Intake Manifold (Integral Part of Cylinder Head)
5. Intake Valve

Flow Diagram, Exhaust System

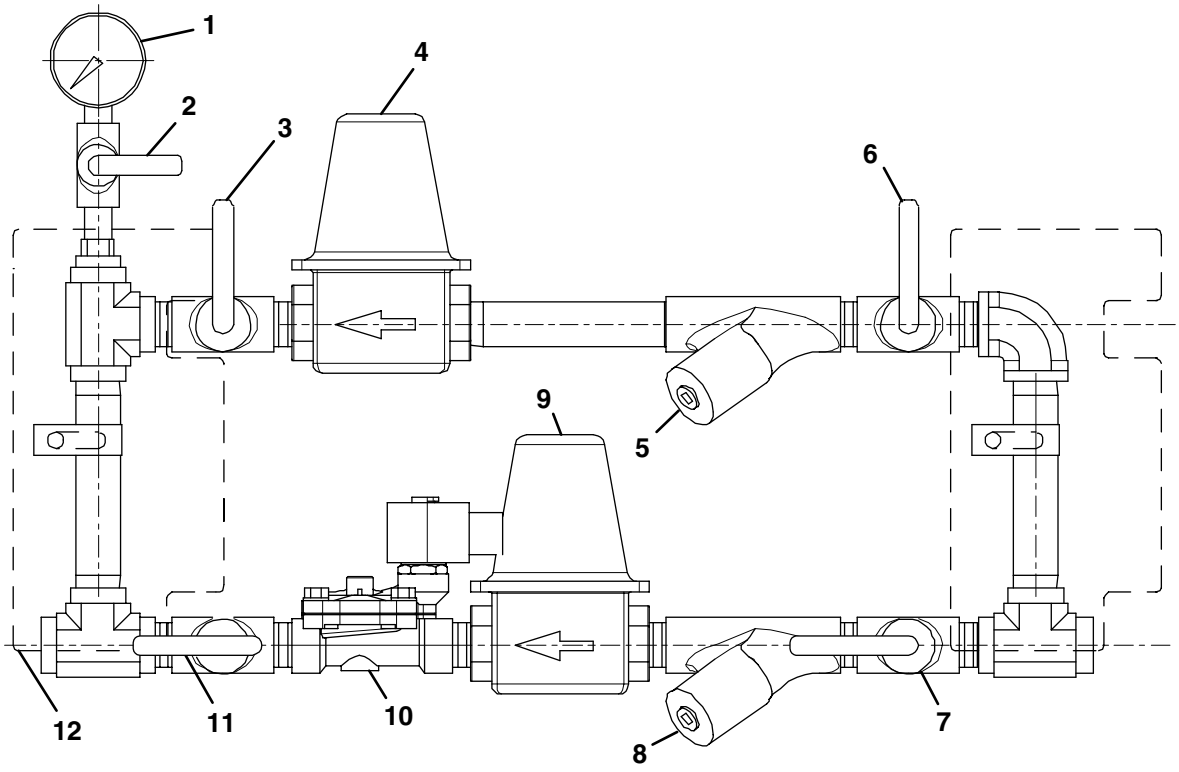


1. Exhaust Valve
2. Exhaust Manifold (Pulse Type)
3. Dual-Entry Turbocharger
4. Turbocharger Exhaust Outlet

Assembly Diagram, Raw Water Piping

Raw water is used to cool the engine coolant and is supplied from the fire pump prior to the pump discharge flange. It is forced through a cooling loop by fire pump pressure to the engine heat exchanger. Then it is discharged to an open waste cone.

The following raw water manifold is available as an option (Cummins N Power Part No. 8682). If supplied by the customer, National Fire Protection Association (NFPA) Pamphlet No. 20 lists the components that are required. Refer to the Cooling System Specifications in Section 10 for process requirements. Refer to Raw Water Piping, Lineup, and Configuration in Section 3.



1.	Supply Pressure Gauge	7.	Normal Inlet Valve
2.	Supply Pressure Gauge Isolation Valve	8.	Normal Strainer
3.	Bypass Outlet Valve	9.	Normal Pressure Regulator
4.	Bypass Pressure Regulator	10.	Solenoid Operated Valve
5.	Bypass Strainer	11.	Normal Outlet Valve
6.	Bypass Inlet Valve	12.	3/4” supply to the heat exchanger

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Section 7 – Adjustment, Repair and Replacement

Section Contents

Section Contents (Cont)

Section Contents (Cont)

Section Contents (Cont)

Overview

Coverage

This section of this manual addresses the Adjustment, Repair, and Replacement of Cummins NPower Fire Pump Engine components. Work this manual with the associated base engine troubleshooting and repair manuals.

Base engine components are addressed in Cummins Manual No. 4021398-00, QSB3.9-30, QSB4.5-30, and QSB5.9-30 Industrial Engine Troubleshooting & Repair Manual.

The electronic engine control module and associated components are addressed in Cummins Manual No. 3666194-01, ISB/QSB and QSB Fuel System Troubleshooting and Repair Manual.
Refer to Service Literature in Section 8 for additional information about these manuals.

Requirements

Satisfy all code requirements or local regulations necessary to remove the fire pump from service. This may require contacting the local fire department or other authority.

Obtain the required tools and supplies for the intended service. If fluids are to be drained, get appropriate containers. Dispose of any waste fluids or removed components in accordance with applicable environmental requirements.

Ensure that the area is prepared for the intended service.

When work is completed, ensure that the fire pump is operational and correctly aligned for service. As required, notify the local fire department or other authority.

Maintenance must be performed by trained, experienced technicians. Refer to Service Assistance in Section 9 for qualified service assistance.

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Belt Guard Removal/Installation

Prepare

WARNING

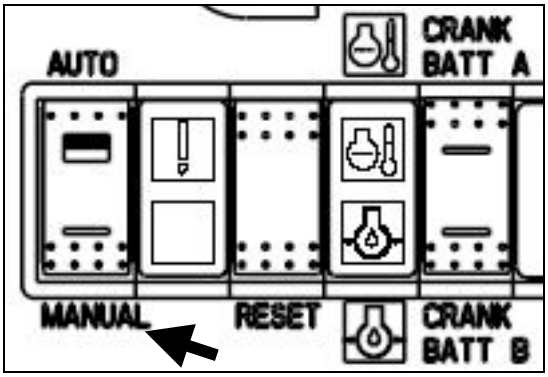
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING

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

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



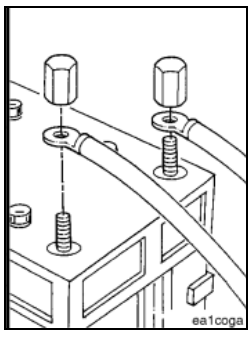
Disconnect or isolate the coolant heater power supply.

REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.

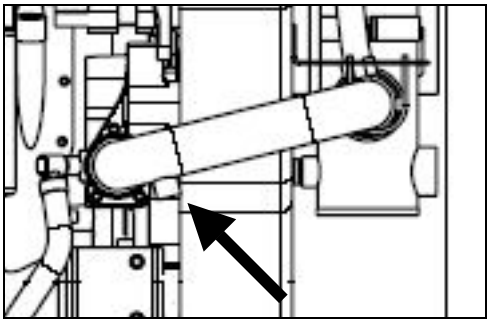


Belt Guard Removal/Installation ((Cont))

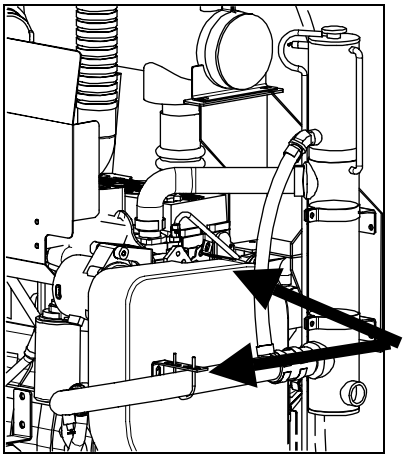
Ensure that the engine and engine coolant is cool in order to avoid burns.

Remove the engine coolant pressure cap.

Drain the engine coolant system. Refer to Drain and Flush Coolant System in Section 8.

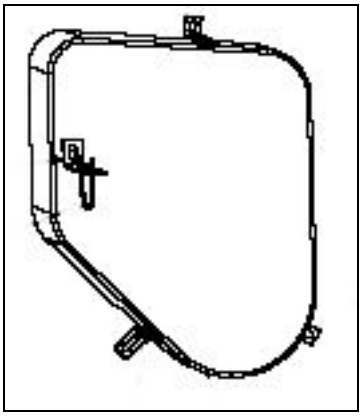


Remove the Lower Engine Coolant and Fill Hose from the heat exchanger.



Remove

Remove the three bolts and the belt guard.



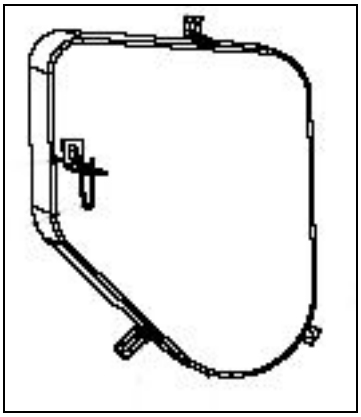
Belt Guard Removal/Installation ((Cont))

Install

NOTE: Install only Cummins approved replacement belt guard (Cummins Fire Power Part No. 9820) or equivalent.

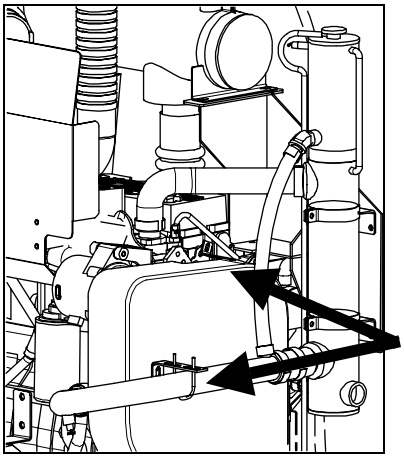
When other work is completed, install the belt guard using the three bolts.

Torque as per Capscrew Markings and Torque Values in Section 10.

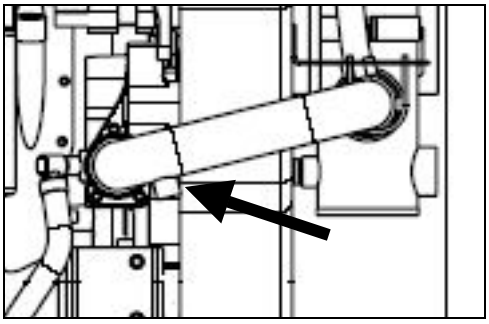


Follow-Up

Install the Lower Engine Coolant and Fill Hose at the heat exchanger.



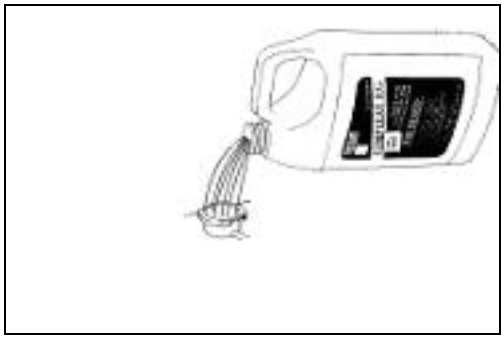
Close the coolant drain valve.



Belt Guard Removal/Installation (Cont)

Refill engine coolant. Refer to Drain and Flush Coolant System in Section 8.

Install the coolant system pressure cap.

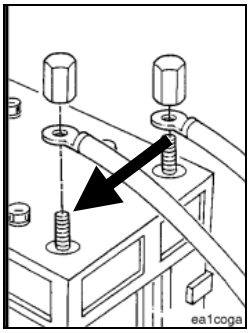


Reconnect the coolant heater power supply.

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



NOTE: Start the engine and do a quick check for leaks. If any coolant leaks are observed, stop the engine, repair the leak, check coolant level, then restart the engine.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

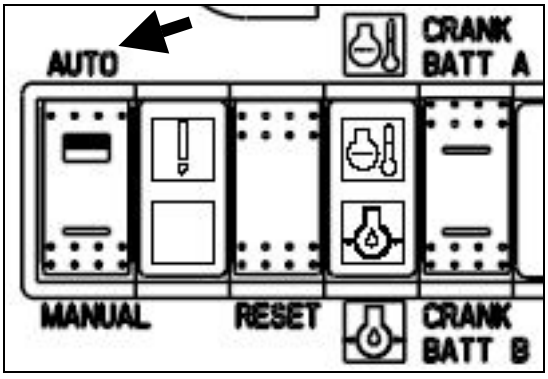
Check for and repair any coolant leaks.

Ensure that repairs are completed satisfactorily.

Stop the engine.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Belt Removal/Installation

Prepare

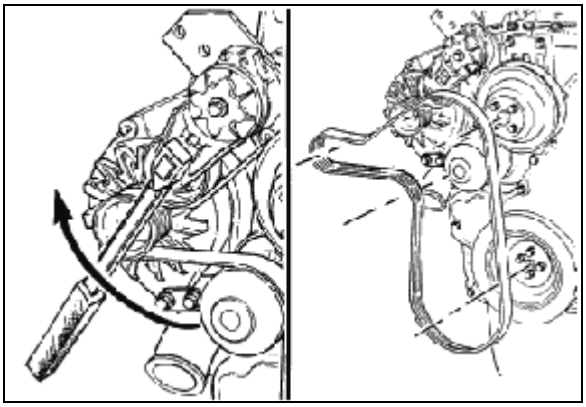
Do the preparatory steps and remove the Belt Guard. Refer to Belt Guard Removal / Installation in this section.

Remove

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

Lift belt tensioner to relieve tension in the belt, and remove the belt.

Allow the belt tensioner to relax.

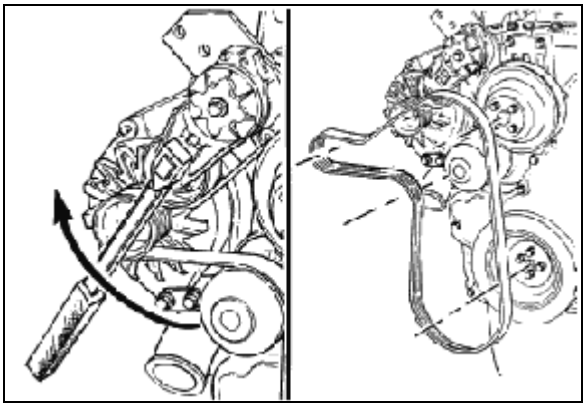


Install

Service Tip: If difficulty is experienced installing the drive belt; for example, the belt seems too short; position the belt over the grooved pulleys first; then, while holding the tensioner up, slide the belt over the water pump pulley.

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

NOTE: Install only Cummins approved replacement v-ribbed belts (Cummins Part No. 3289157) or equivalent.



Lift belt tensioner to relieve tension in the belt, and install the belt.

Allow the belt tensioner to relax.

Ensure that the belt tensioner supplies tension to the belt without being at a mechanical limit stop.

Follow-Up

When work is completed, install the Belt Guard and do the listed follow up steps. Refer to Belt Guard Removal/Installation in this section.

Check that the drive belt operates without unusual noises.

Automatic Belt Tensioner Removal/Installation

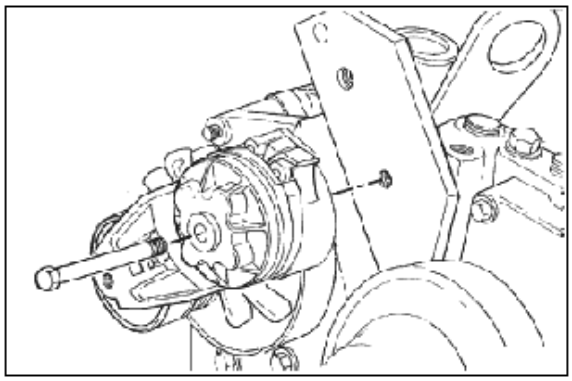
Prepare

Do the preparatory steps and remove the Belt Guard. Refer to Belt Guard Removal/Installation in this section.

Remove the Drive Belt. Refer to Belt Removal/ Installation in this section.

Remove

Remove the capscrew and belt tensioner.

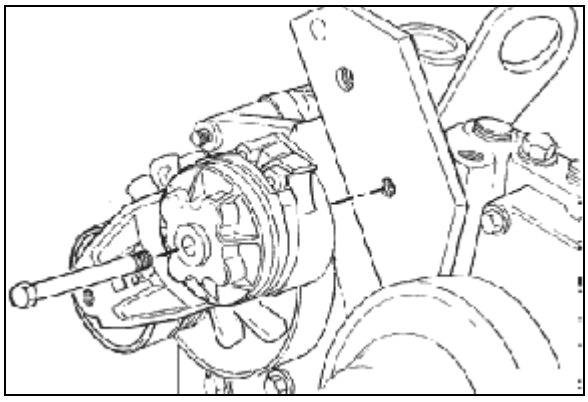


Install

NOTE: Install only Cummins approved replacement belt tensioner (Cummins Part No. 3926056) or equivalent.

Install the belt tensioner and tighten the capscrew.

Torque Value: 43 N•m [32 ft-lb]



Follow-Up

When work is completed, install the Drive Belt. Refer to Belt Removal/Installation in this section.

When work is completed, install the Belt Guard and do the listed follow up steps. Refer to Belt Guard Removal/Installation in this section.

Check that the drive belt operates without unusual noises.

Coolant Heat Exchanger Removal/Installation

Prepare

WARNING

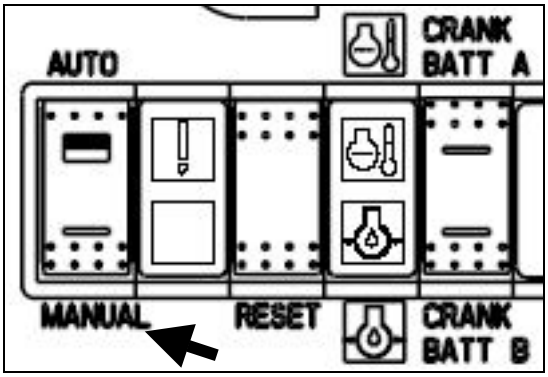
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING

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

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



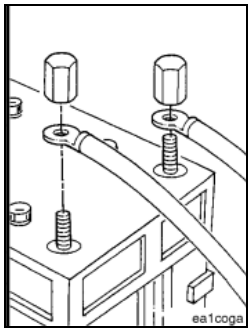
Disconnect or isolate the coolant heater power supply.

REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.

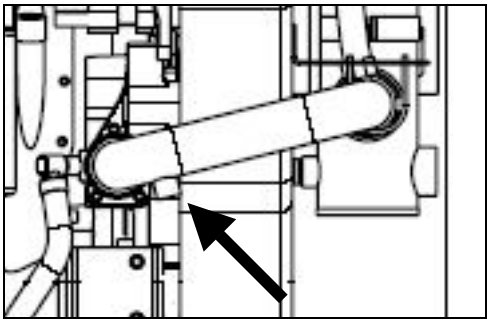


Coolant Heat Exchanger Removal/Installation (Cont)

Ensure that the engine and engine coolant is cool in order to avoid burns.

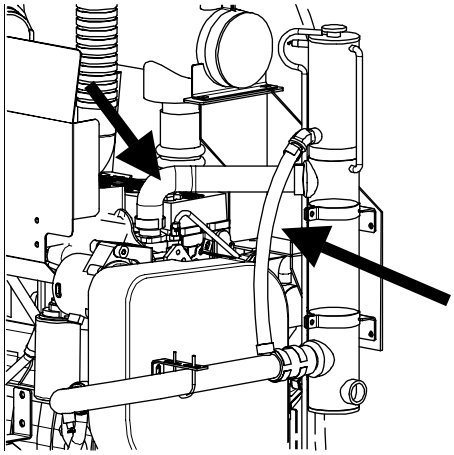
Remove the engine coolant pressure cap.

Drain the engine coolant system. Refer to Drain and Flush Coolant System in Section 5.



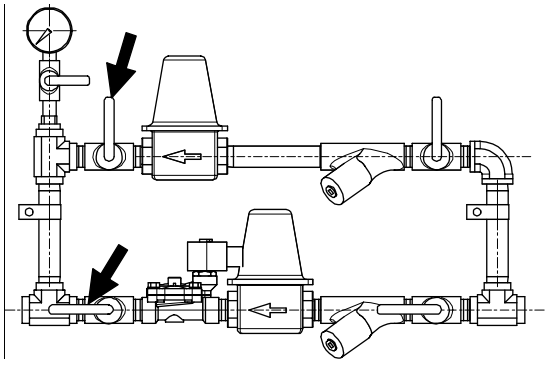
Remove the Upper Engine Coolant Hose from the heat exchanger.

Remove the Lower Engine Coolant and Fill Hose from the heat exchanger.



Close the Raw Water Manifold Bypass Line Outlet Isolation Valve.

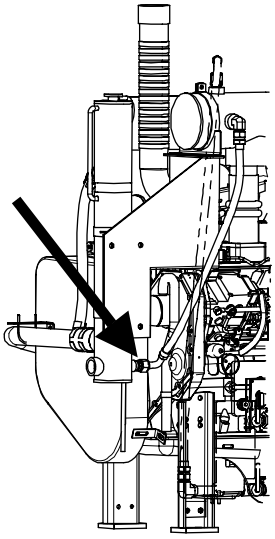
Close the Raw Water Manifold Normal Line Outlet Isolation Valve.



Coolant Heat Exchanger Removal/Installation (Cont)

Remove the raw water inlet piping from the charge air cooler to the heat exchanger. (Refer to Drawing 11148 in Section 13 for raw water supply piping details.)

Also, remove any customer-supplied raw water outlet fittings. Save these components for reuse.



Pressure Test

NOTE: This test is required if internal leakage in the heat exchanger is suspected. It may be performed prior to the removal from the engine.

NOTE: Use teflon tape or other pipe sealant when installing the test setup to prevent leaks.

Install a 1” NPT pipe plug at the raw water outlet of the heat exchanger.

Install a pressure test setup with 700 kPa [100 psi] pressure gauge at the 3/4” NPT raw water inlet to the heat exchanger.

NOTE: There should be no detectable decrease in the pressure reading for the duration of the test.

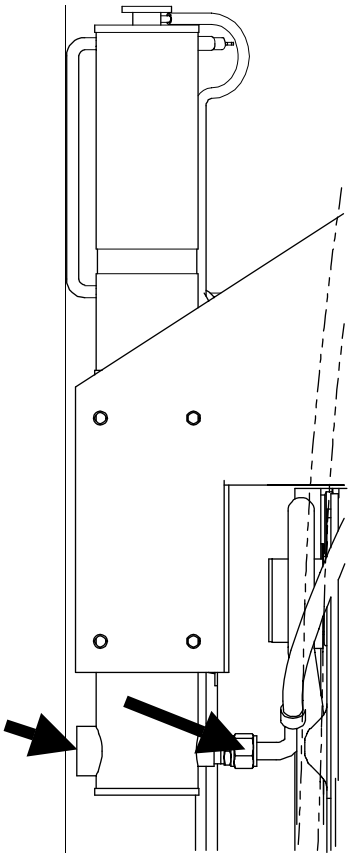
Apply air pressure at 621 kPa [90 psig].

Isolate the pressure source and monitor the pressure gauge for 5 minutes.

After testing, release the pressure.

Remove the pipe plug and the test setup.

If leakage is detected, the heat exchanger must be replaced.



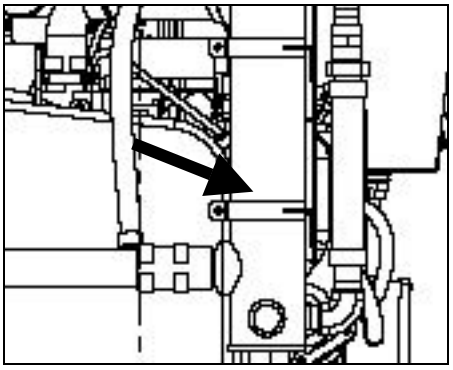
Coolant Heat Exchanger Removal/Installation (Cont)

Remove

Provide temporary support for the coolant heat exchanger in order to avoid dropping it.

Remove the four back sets of nuts, washers, and bolts at the heat exchanger mounting clamps.

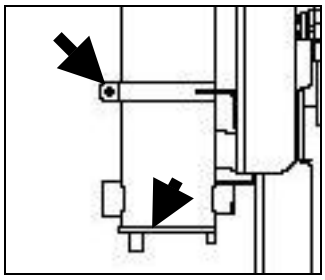
Remove the heat exchanger and clamps from the engine.



Disassemble

If required for replacement, remove the two front sets of nuts and bolts at the coolant heat exchanger clamps.

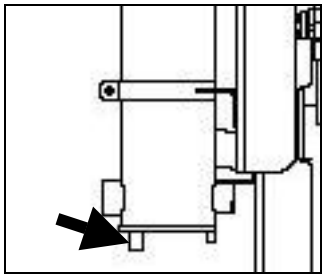
If required for replacement, remove the zinc plug and other pipe fittings from the heat exchanger.



Assemble

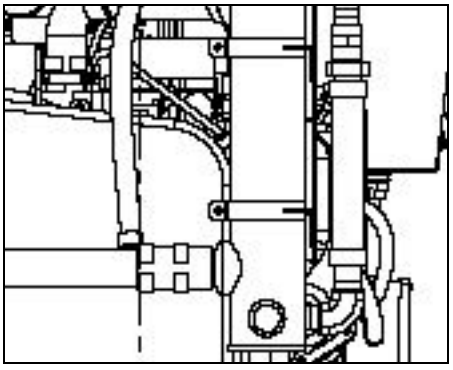
NOTE: Use teflon or other pipe sealant when installing threaded pipe fittings.

If missing, install the zinc plug (Cummins Fire Power Part No. 9750) and brass fitting (Cummins Fire Power Part No. 9751) in the bottom of the heat exchanger.



If missing, install the pipe fittings removed from the original heat exchanger. Refer to Drawing 8665 in Section 13 for component information.

If removed, position the two clamps on the heat exchanger and install the two front sets of nuts and bolts at the coolant heat exchanger clamps. Do not tighten at this time. Refer to Drawing 8665 in Section 13 for component information.



Coolant Heat Exchanger Removal/Installation (Cont)

Install

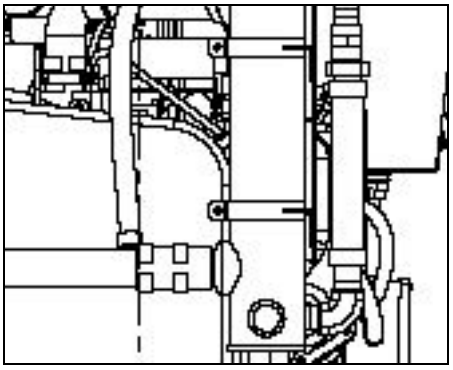
Provide support for the coolant heat exchanger in order to avoid dropping it.

Position the heat exchanger and clamps on the engine's mounting bracket and start the four bolts.

Start the nut and washers on the four bolts.

Align the heat exchanger with the required hose connections and tighten the four back sets of clamp fasteners.

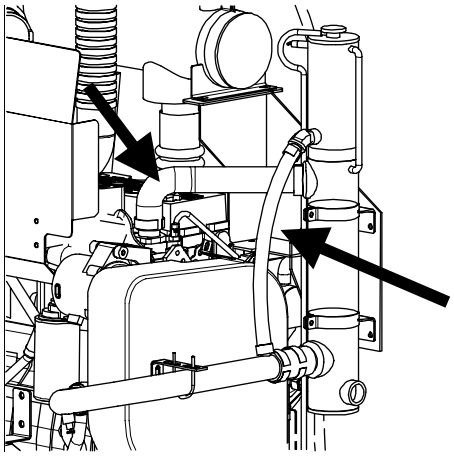
Tighten the two front sets of clamp fasteners.



Follow-Up

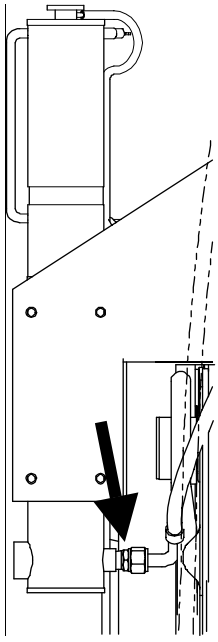
Install the Upper Engine Coolant Hose at the heat exchanger.

Install the Lower Engine Coolant and Fill Hose at the heat exchanger.



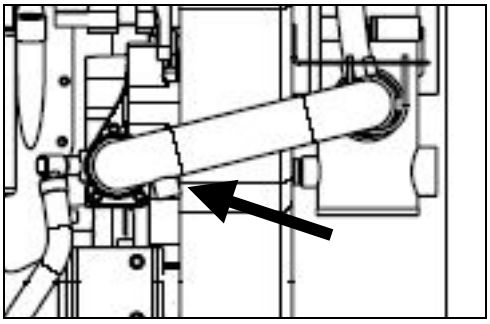
Install the raw water inlet piping from the charge air cooler to the heat exchanger. (Refer to Drawing 11148 in Section 13 for raw water supply piping details.)

Also, install any customer-supplied raw water outlet fittings.



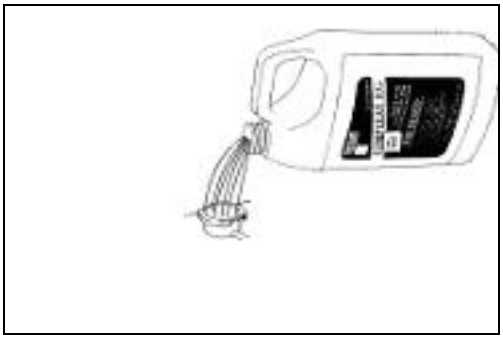
Coolant Heat Exchanger Removal/Installation (Cont)

Close the coolant drain valve.



Refill engine coolant. Refer to Drain and Flush Coolant System in Section 5.

Install the coolant system pressure cap.

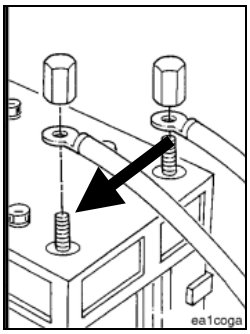


Reconnect the coolant heater power supply.

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



NOTE: Start the engine and do a quick check for leaks. If any coolant leaks are observed, stop the engine, repair the leak, check coolant level, then restart the engine. If no leaks are present, promptly establish raw water flow through the heat exchanger.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

Check for and repair any coolant leaks.

Coolant Heat Exchanger Removal/Installation (Cont)

CAUTION

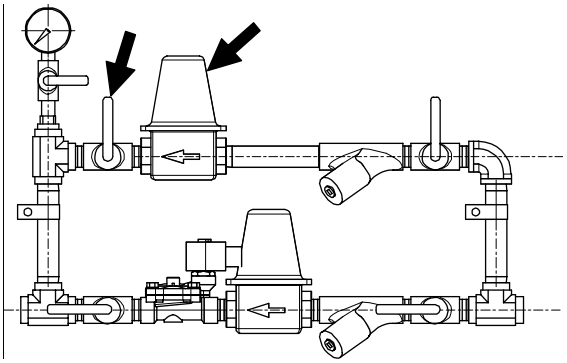
When establishing raw water flow, ensure that the raw water pressure does not exceed 414 kPa (60 psig) at the heat exchanger. Adjust the pressure regulators as required.

Slowly open the Raw Water Manifold Bypass Line Outlet Isolation Valve.

Observe raw water flow through the heat exchanger.

Adjust the bypass pressure regulator if required.

Close the Raw Water Manifold Bypass Line Outlet Isolation Valve.



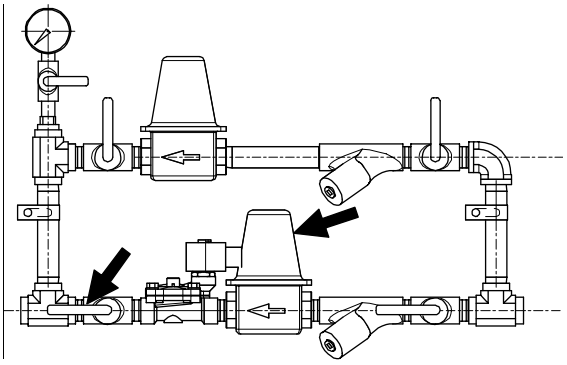
CAUTION

When establishing raw water flow, ensure that the raw water pressure does not exceed 414 kPa (60 psig) at the heat exchanger. Adjust the pressure regulators as required.

Slowly open the Raw Water Manifold Normal Line Outlet Isolation Valve.

Observe raw water flow through the heat exchanger.

Adjust the normal pressure regulator if required.



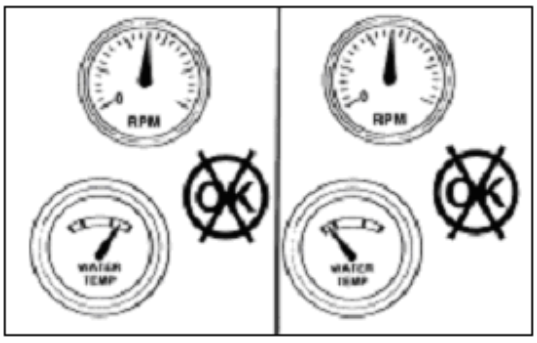
NOTE: If temperature does not stabilize, stop the engine and refer to Coolant Temperature Above Normal or Coolant Temperature Below Normal (Engine Running) in Troubleshooting, Section 12.

Check that engine operating temperature stabilizes between about 82 and 93 °C [180 and 200 °F].

Check that no coolant hoses are collapsed.

When temperature has stabilized, stop the engine.

Ensure that repairs are completed satisfactorily.

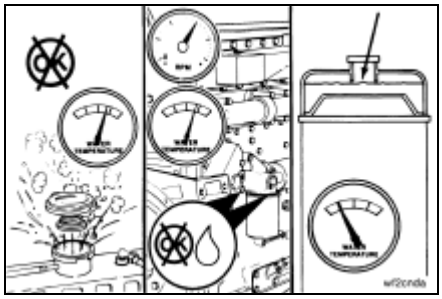


Coolant Heat Exchanger Removal/Installation (Cont)

WARNING

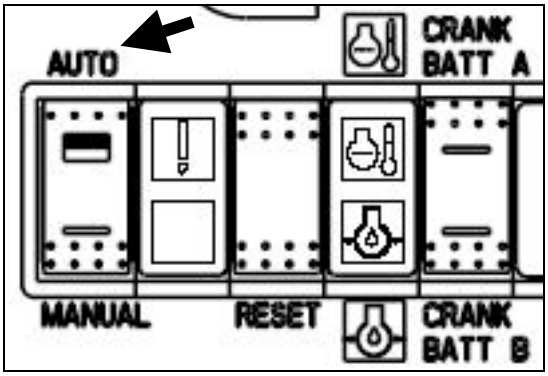
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant if necessary.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Coolant Heater Removal/Installation

Prepare

WARNING

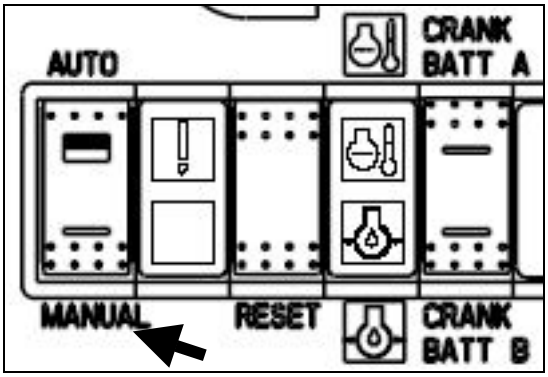
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING

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

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



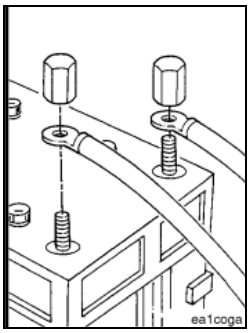
Disconnect or isolate the coolant heater power supply.

REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.

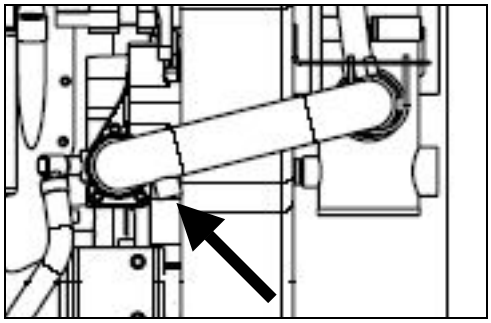


Coolant Heater Removal/Installation (Cont)

Ensure that the engine and engine coolant is cool in order to avoid burns.

Remove the engine coolant pressure cap.

Drain the engine coolant system. Refer to Drain and Flush Coolant System in Section 5.

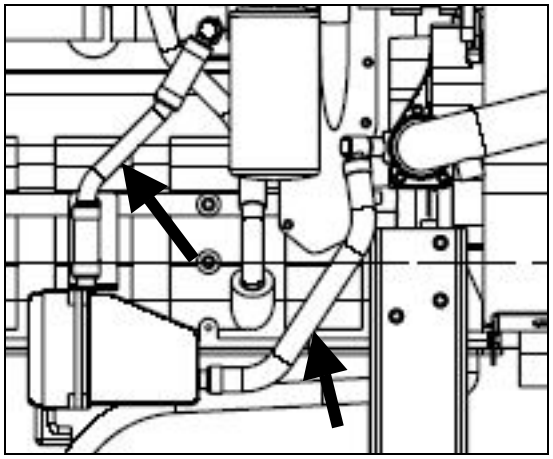


NOTE: Collect the remainder of the coolant in the heater hoses.

NOTE: Refer to Drawing 8556 in Section 13 for detailed component information.

Remove the Upper Coolant Heater Hose.

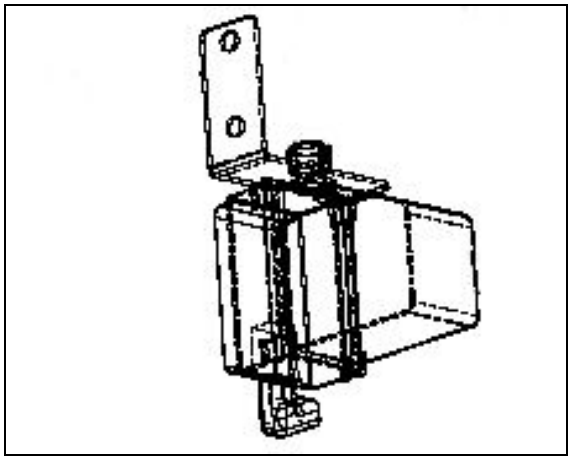
Remove the Lower Coolant Heater Hose.



Remove

Remove the two capscrews, washers, bracket, and coolant heater.

If required, remove the nuts, bolts, washers and mounting bracket from the coolant heater.



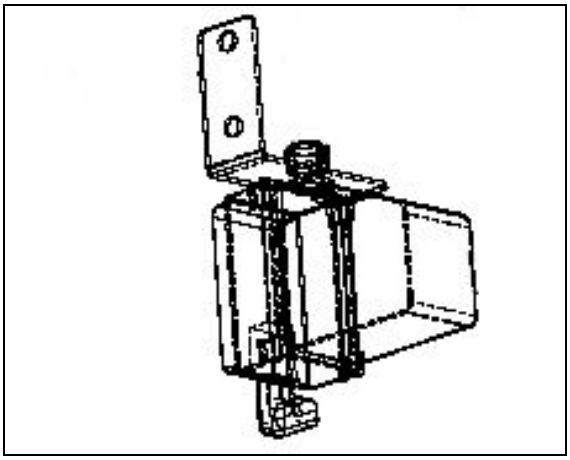
Coolant Heater Removal/Installation (Cont)

Install

If missing, install the nuts, bolts, washers and mounting bracket on the coolant heater.

Position the coolant heater and mounting bracket and start the two bolts with washers.

Torque the two bolts on the mounting bracket as per Capscrew Markings and Torque Values in Section 10.

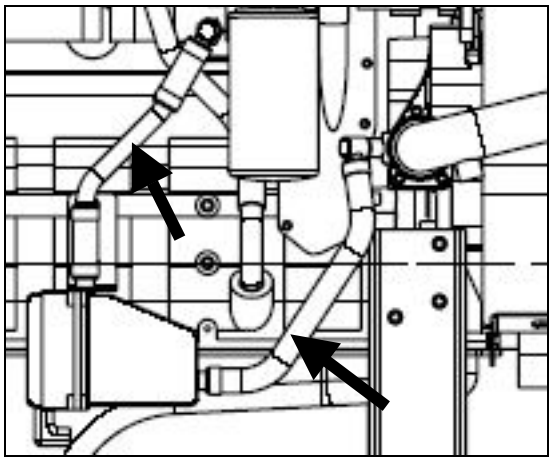


Follow-Up

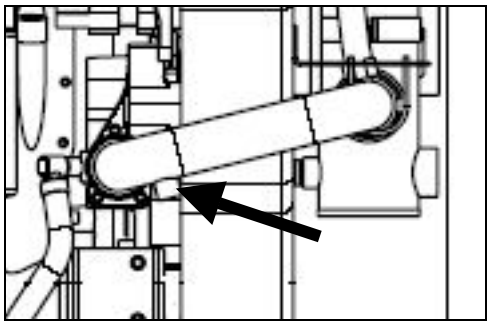
NOTE: Refer to Drawing 8556 in Section 13 for detailed component information.

Install the Upper Coolant Heater Hose.

Install the Lower Coolant Heater Hose.



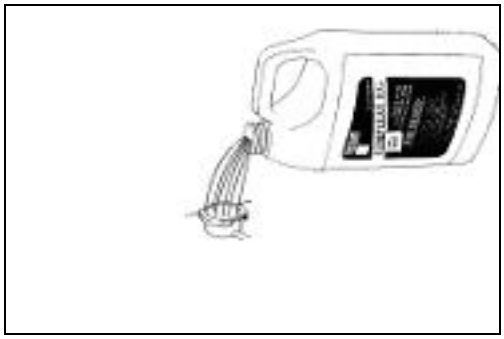
Close the coolant drain valve.



Coolant Heater Removal/Installation (Cont)

Refill engine coolant. Refer to Drain and Flush Coolant System in Section 5.

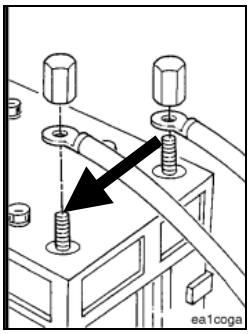
Install the coolant system pressure cap.



For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



NOTE: Start the engine and do a quick check for leaks. If any coolant leaks are observed, stop the engine, repair the leak, check coolant level, then restart the engine.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

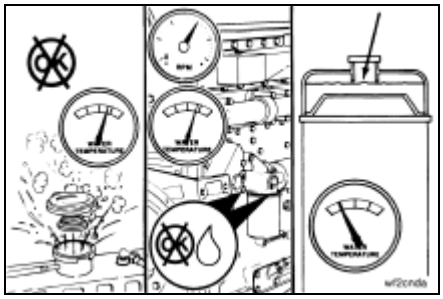
Check for and repair any coolant leaks.

Stop the engine.

WARNING

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

Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant if necessary.



Reconnect the coolant heater power supply.

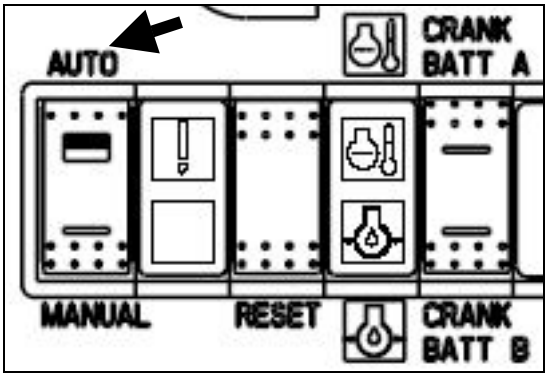
Observe that the coolant temperature cools down but stabilizes.

Check that the engine block remains warm to the touch.

Coolant Heater Removal/Installation (Cont)

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Coolant Hose Removal/Installation

NOTE: This section addresses all coolant tubes and hoses. Only remove those coolant hoses that are necessary. It is not required to remove both ends of the hose for the replacement of other components. Use the following sections as applicable:

Prepare

WARNING

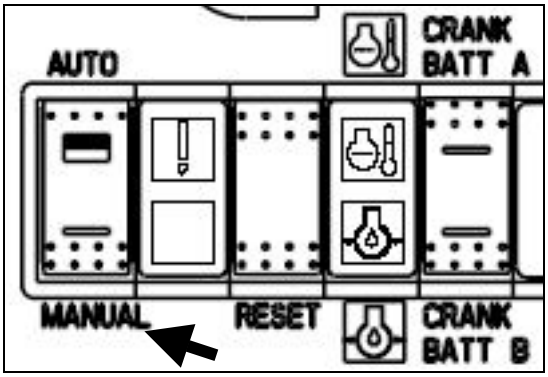
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING

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

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



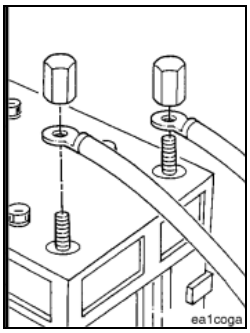
Disconnect or isolate the coolant heater power supply.

REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.

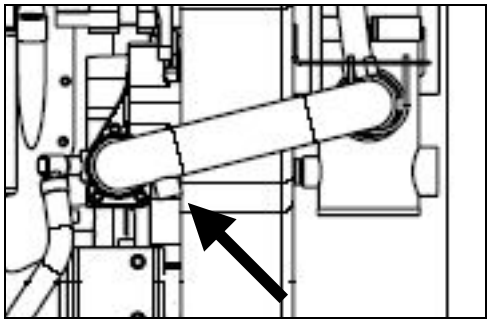


Coolant Hose Removal/Installation (Cont)

Ensure that the engine and engine coolant is cool in order to avoid burns.

Remove the engine coolant pressure cap.

Drain the engine coolant system. Refer to Drain and Flush Coolant System in Section 5.



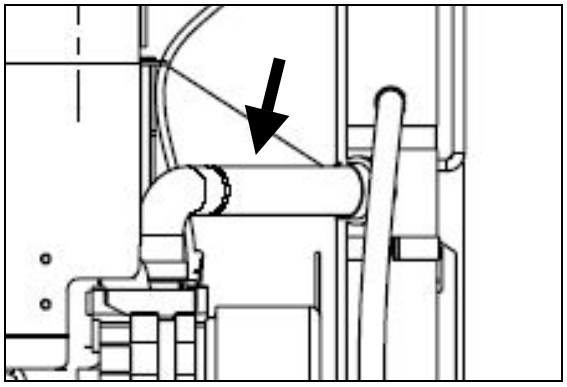
Remove the Upper Engine Coolant Hose

NOTE: Refer to Assembly Drawing 8665 in Section 13 for detailed construction.

Loosen the hose clamp at the heat exchanger.

Loosen the hose clamp at the engine.

Pull the hose from the heat exchanger and engine.



Remove the Lower Engine Coolant and Fill Hoses

NOTE: Refer to Assembly Drawing 8665 in Section 13 for detailed construction.

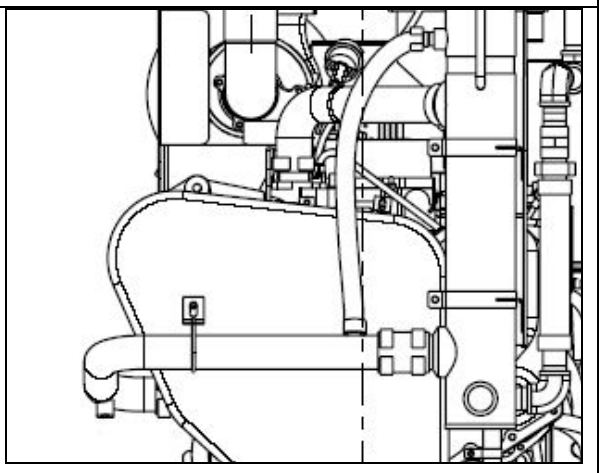
Remove the nuts and U-bolt supporting the lower hose.

Loosen the upper fill hose clamp at the heat exchanger.

Loosen the lower engine coolant hose clamp at the heat exchanger.

Loosen the lower engine coolant hose clamp at the engine.

Pull the hoses from the heat exchanger and engine.



Coolant Hose Removal/Installation (Cont)

Remove the Upper Coolant Heater Hose

NOTE: Refer to Assembly Drawing 8556 in Section 13 for detailed construction.

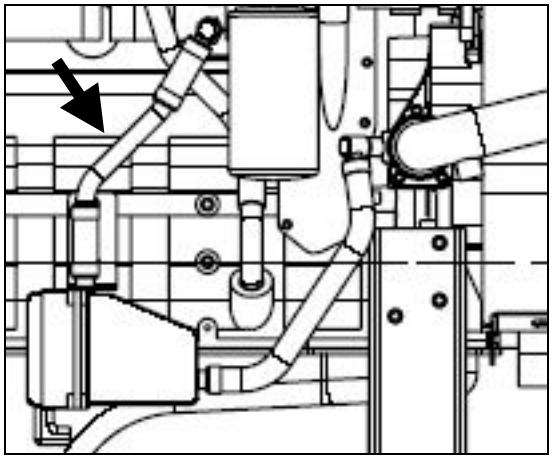
NOTE: Be ready to collect the residual coolant that remains in the hose.

Loosen the hose clamp at the coolant heater.

Loosen the hose clamp at the engine.

Pull the hoses from the coolant heater and engine.

Disassemble additional components if this is required for inspection or repairs.



Remove the Lower Coolant Heater Hose

NOTE: Refer to Assembly Drawing 8556 in Section 13 for detailed construction.

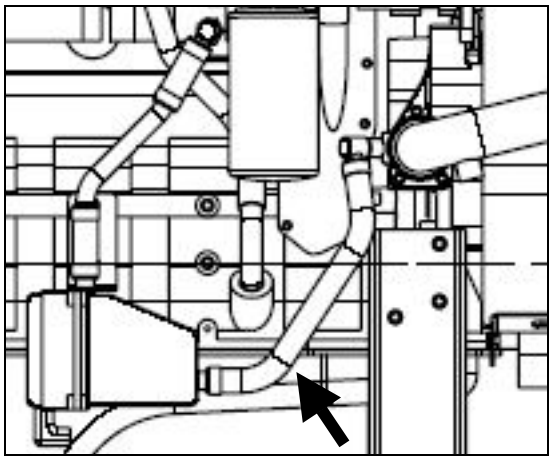
NOTE: Be ready to collect the residual coolant that remains in the hose.

Loosen the hose clamp at the coolant heater.

Loosen the hose clamp at the engine.

Pull the hoses from the coolant heater and engine.

Disassemble additional components if this is required for inspection or repairs.

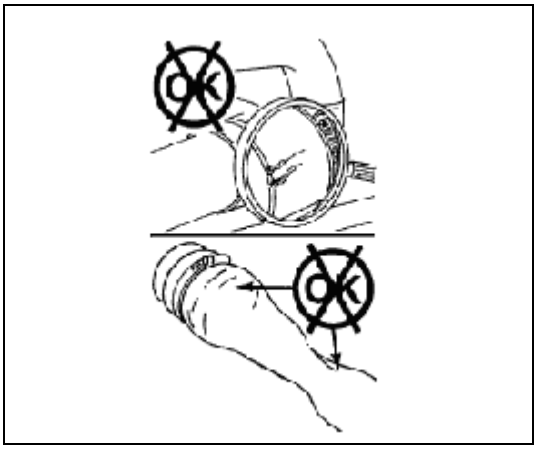


Inspect

NOTE: Inspect the cooling system hoses and hose connection for leaks or deterioration. Particles of deteriorated hose can be carried through the cooling system and slow or partially stop circulation.

Inspect the hoses and hose connections.

Replace any hoses or clamps that are damaged.



Coolant Hose Removal/Installation (Cont)

Install the Upper Engine Coolant Hose

CAUTION

Do not re-install worn or damaged hoses or corroded clamps.

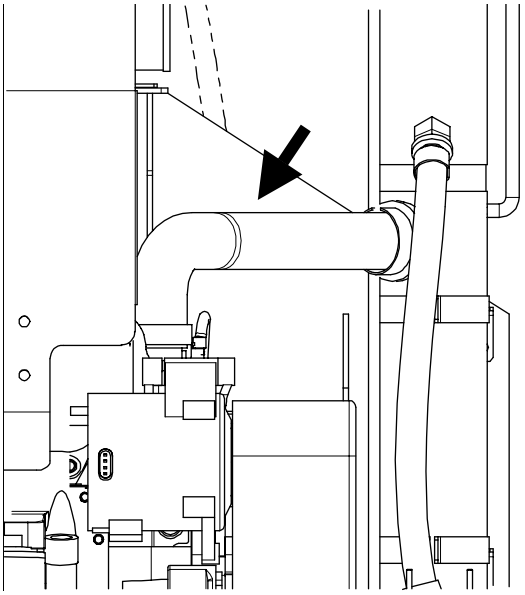
NOTE: Refer to Assembly Drawing 8665 in Section 13 for detailed construction.

Position the hose clamps on the hose.

Push the hose onto the heat exchanger and engine.

Tighten the hose clamp at the heat exchanger.

Tighten the hose clamp at the engine.



Install the Lower Engine Coolant and Fill Hoses

CAUTION

Do not re-install worn or damaged hoses or corroded clamps.

NOTE: Refer to Assembly Drawing 8665 in Section 13 for detailed construction.

Position the hose clamps on the hose.

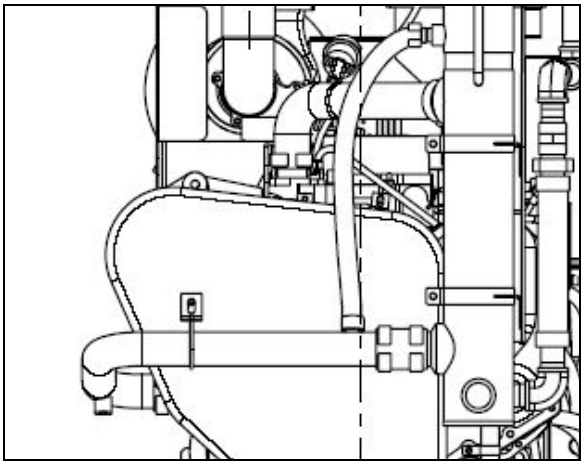
Position the hoses at the heat exchanger and engine.

Position and tighten the lower engine coolant hose clamp at the engine.

Position and tighten the lower engine coolant hose clamp at the heat exchanger.

Position and tighten the upper fill hose clamp at the heat exchanger.

Install the nuts and U-bolt supporting the lower hose.



Coolant Hose Removal/Installation (Cont)

Install the Upper Coolant Heater Hose

CAUTION

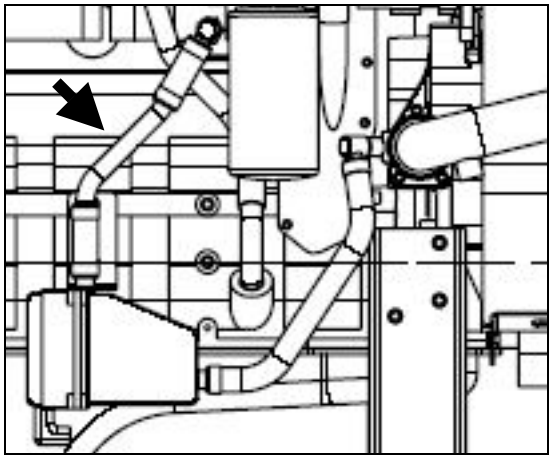
Do not re-install worn or damaged hoses or corroded clamps.

NOTE: Refer to Assembly Drawing 8556 in Section 13 for detailed construction.

Position the hose clamps on the hose.

Position the hose on the fittings at the heater and at the engine connection.

Position and tighten the hose clamps.



Install the Lower Coolant Heater Hose

CAUTION

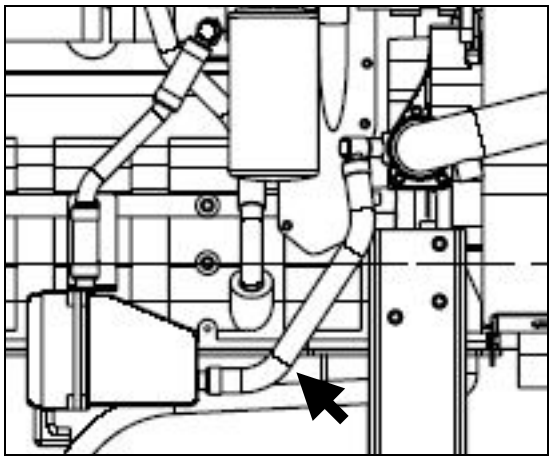
Do not re-install worn or damaged hoses or corroded clamps.

NOTE: Refer to Assembly Drawing 8556 in Section 13 for detailed construction.

Position the hose clamps on the hose.

Push the hose on the fittings at the heater and at the water inlet connection.

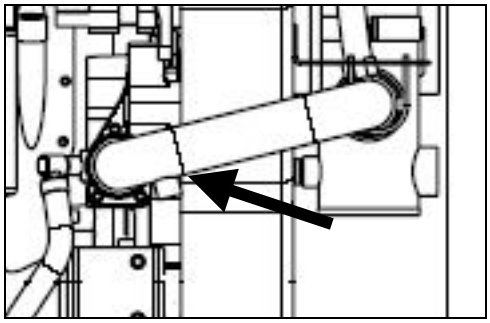
Position and tighten the hose clamps.



Coolant Hose Removal/Installation (Cont)

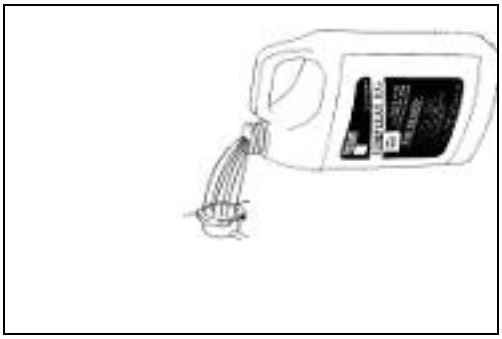
Follow-Up

Close the coolant drain valve.



Refill engine coolant. Refer to Drain and Flush Coolant System in Section 5.

Install the coolant system pressure cap.

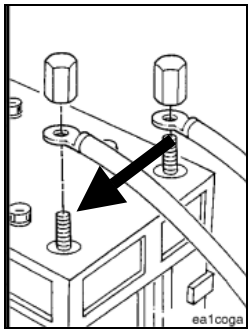


Reconnect the coolant heater power supply.

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



NOTE: Start the engine and do a quick check for leaks. If any coolant leaks are observed, stop the engine, repair the leak, check coolant level, then restart the engine.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

Check for and repair any coolant leaks.

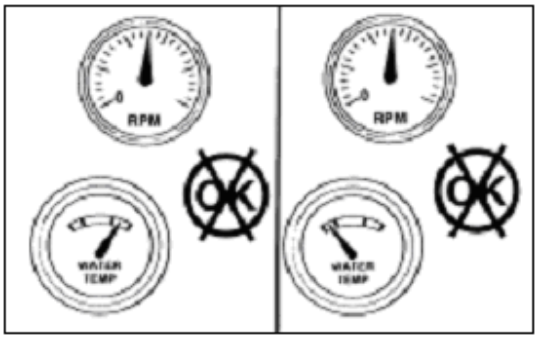
Coolant Hose Removal/Installation (Cont)

Check that engine operating temperature stabilizes between about 82 and 93 °C [180 and 200 °F].

Check that no coolant hoses are collapsed.

When temperature has stabilized, stop the engine.

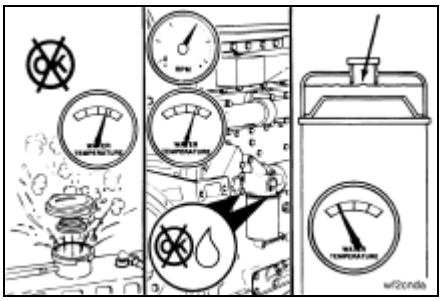
Ensure that repairs are completed satisfactorily.



WARNING

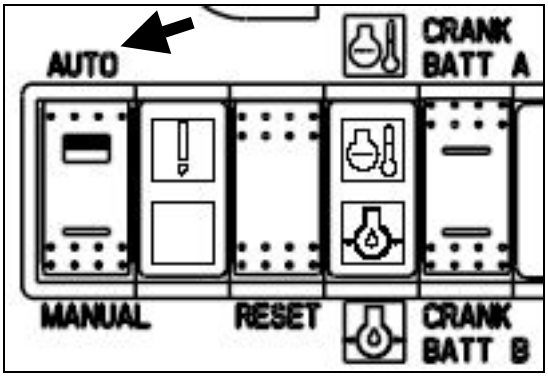
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant if necessary.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Raw Water Pressure Regulator Removal/Installation

NOTE: This section applies only to pressure regulators supplied by Cummins Fire Power. These procedures should be modified for alternative piping or components as supplied by the customer.

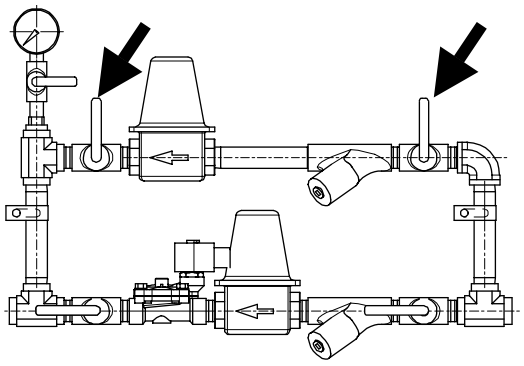
NOTE: This section applies to both the normal and bypass lines.

Prepare (Bypass Line)

Place the AUTO/MANUAL Switch at the local panel in the MANUAL position.

Close the Raw Water Manifold Bypass Line Inlet Isolation Valve.

Close the Raw Water Manifold Bypass Line Outlet Isolation Valve.

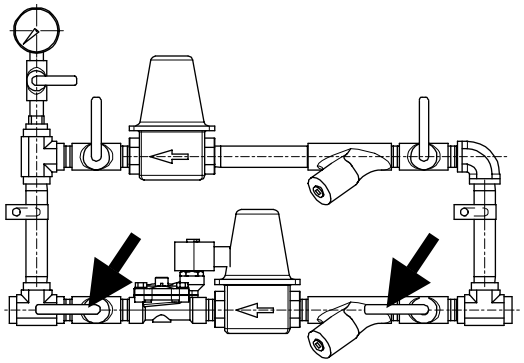


Prepare (Normal Line)

Place the AUTO/MANUAL Switch at the local panel in the MANUAL position.

Close the Raw Water Manifold Normal Line Inlet Isolation Valve

Close the Raw Water Manifold Normal Line Outlet Isolation Valve.

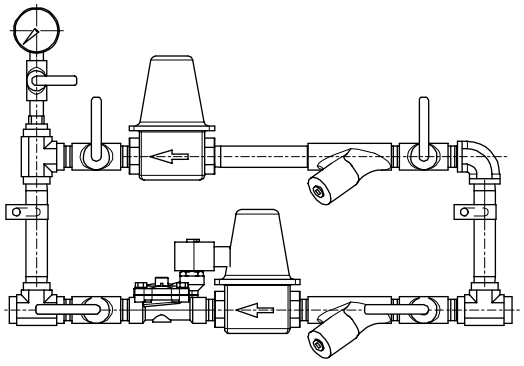


Remove (Bypass Line)

Loosen the pipe union upstream of the pressure regulator.

Unscrew the pressure regulator from the outlet isolation valve.

As required, remove the pipe nipples from the pressure regulator.



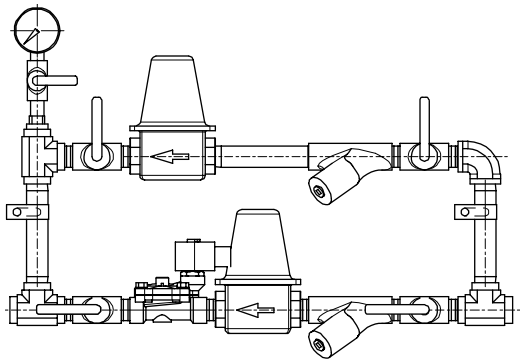
Raw Water Pressure Regulator Removal/Installation (Cont)

Remove (Normal Line)

Loosen the pipe union downstream of the pressure regulator.

Unscrew the pressure regulator from the solenoid valve.

As required, remove the pipe nipples from the pressure regulator.



Install (Bypass Line)

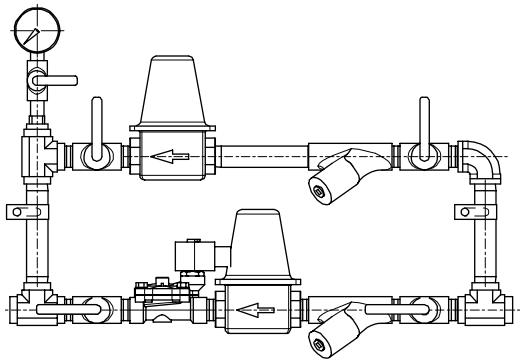
When the pressure regulator is repaired or replaced, prepare it for installation.

NOTE: Use pipe dope or silicon sealant on threaded fittings.

As required, install the pipe nipples on the pressure regulator. Tighten with a pipe wrench or equivalent.

Screw the pressure regulator onto the outlet isolation valve.

Align and connect the pipe union. Tighten with a pipe wrench or equivalent.



Install (Normal Line)

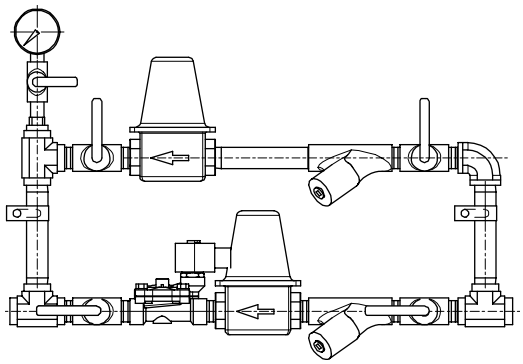
When the pressure regulator is repaired or replaced, prepare it for installation.

NOTE: Use pipe dope or silicon sealant on threaded fittings.

As required, install the pipe nipples on the pressure regulator. Tighten with a pipe wrench or equivalent.

Screw the pressure regulator onto the solenoid valve.

Align and connect the pipe union. Tighten with a pipe wrench or equivalent.



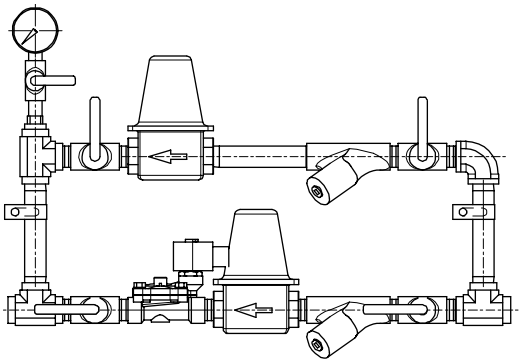
Raw Water Pressure Regulator Removal/Installation (Cont)

Follow-Up (Bypass Line)

Check the pressure regulator setpoint (refer to Section 3).

If required, open the Raw Water Manifold Bypass Line Inlet Isolation Valve.

If required, open the Raw Water Manifold Bypass Line Outlet Isolation Valve.



Verify that raw water flow is established through the heat exchanger.

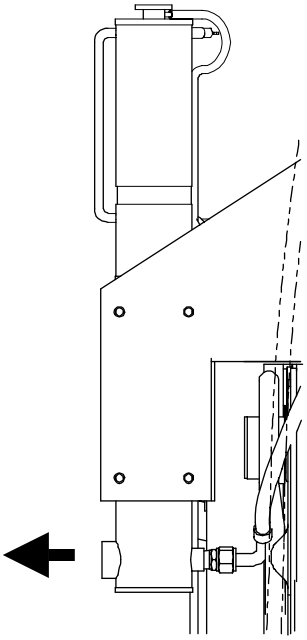
When flow is verified, close the bypass line outlet valve.

Ensure that the normal line inlet and outlet valves are both open.

Ensure that the pressure gauge isolation valve is open.

Ensure that repairs are completed satisfactorily.

Place the AUTO/MANUAL Switch at the local panel in the AUTO position.



Raw Water Pressure Regulator Removal/Installation (Cont)

Follow-Up (Normal Line)

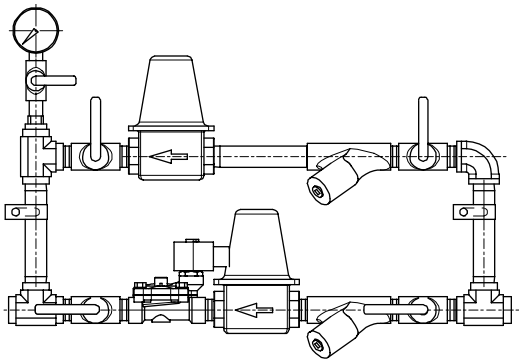
Check the pressure regulator setpoint.

If required, open the Raw Water Manifold Normal Line Inlet Isolation Valve.

If required, open the Raw Water Manifold Normal Line Outlet Isolation Valve.

As required, close the bypass line outlet valve.

Ensure that the pressure gauge isolation valve is open.



Start the engine to operate the raw water solenoid valve. .

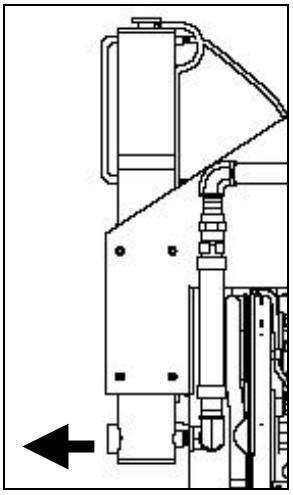
Verify that raw water flow is established through the heat exchanger.

When flow is verified, stop the engine.

Observe that raw water flow stops.

Ensure that repairs are completed satisfactorily.

Place the AUTO/MANUAL Switch at the local panel in the AUTO position.



Raw Water Solenoid Valve Removal/Installation

NOTE: This section applies to solenoid valves supplied by Cummins Fire Power.

Prepare

Place the AUTO/MANUAL Switch at the local panel in the MANUAL position.

WARNING

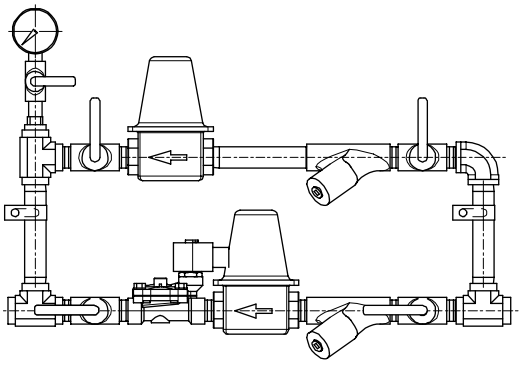
Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

Disconnect the positive battery cables from both batteries.

Disconnect any customer supplied battery chargers.

Close the Raw Water Manifold Normal Line Inlet Isolation Valve.

Close the Raw Water Manifold Normal Line Outlet Isolation Valve.



Remove

NOTE: Minimize the loss of wire when cutting the splices.

NOTE: Tag each end of the wire before making the cut.

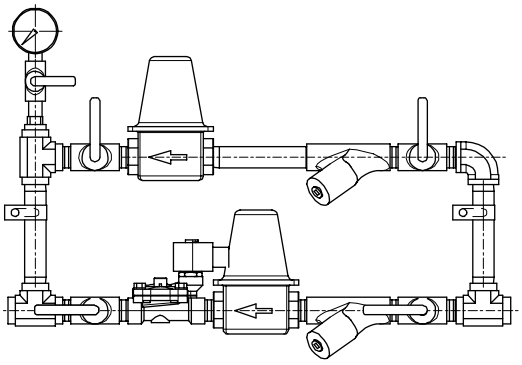
Cut the butt-splices at the connection between the two solenoid valve pigtail wires and the fire pump electrical harness.

Loosen the union fitting between the solenoid valve and the pressure regulator.

Unscrew the solenoid valve from the outlet isolation valve or inlet nipple.

Remove the solenoid valve.

If appropriate for replacement, remove the pipe fittings from the solenoid valve.



Raw Water Solenoid Valve Removal/Installation (Cont)

Install

NOTE: Install only Cummins approved replacement solenoid valves [Cummins Fire Power Part No. 8210G003-12VDC (12 VDC) or 8210G3-24VDC (24 VDC)].

NOTE: Use thread sealant when making threaded plumbing connections.

If removed, install the inlet and outlet fittings on the solenoid valve.

Position the solenoid valve and start threading it into the outlet valve or onto the outlet valve nipple.

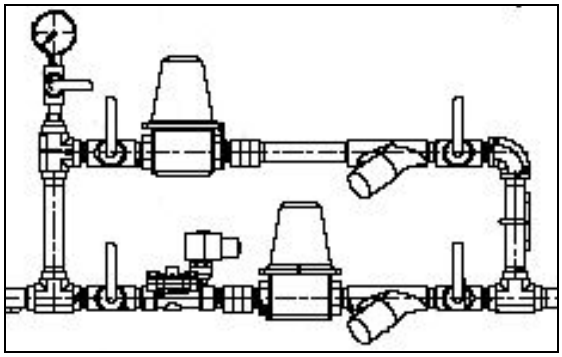
Thread the valve until it is tight and so that the electrical housing is facing up.

Align and tighten the union connection.

NOTE: Use termination techniques that meet all local requirements. Cummins recommends crimped and insulated butt splices.

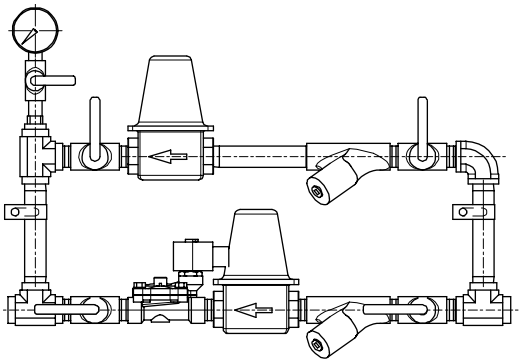
NOTE: The solenoid valve's green pigtail lead is not used. The other two leads are not polarity dependent.

Splice the two solenoid pigtail leads to the fire pump harness solenoid leads.



Raw Water Solenoid Valve Removal/Installation (Cont)

Follow-Up



WARNING

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

Connect the positive battery cables at both batteries,

Open the Raw Water Manifold Normal Line Inlet Isolation Valve.

Open the Raw Water Manifold Normal Line Outlet Isolation Valve.

Place the AUTO/MANUAL Switch at the local panel in the MANUAL position.

Operate the engine. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

Check that raw water flow starts when the engine starts.

Stop the engine.

Check that raw water flow stops shortly after the engine stops.

If raw water flow does not start when the engine starts, refer to Coolant Temperature Above Normal in Troubleshooting, Section 12.

If raw water flow does not stop shortly after the engine stops, refer to Raw Water Solenoid Valve Fails to Operate in Troubleshooting, Section 12.

Water Temperature Gauge Removal/Installation

Prepare

Place the AUTO/MANUAL Switch at the local panel in the MANUAL position.

WARNING

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

Disconnect the positive battery cables from both batteries.

Disconnect any customer supplied battery chargers.

Remove

Use a nut driver or equivalent to remove the control panel's mounting bolt.

Pull the control panel out from the enclosure so that it is supported by the piano hinge on the bottom.

NOTE: Check and tag all wires with location tags prior to removal.

Remove the two dark blue [METER +] wires from the [I] terminal on the gauge.

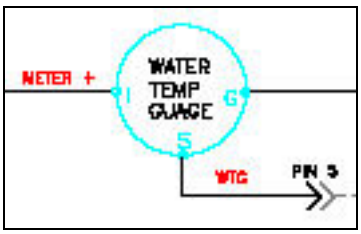
Remove the single black ground wire from the [G] terminal on the gauge.

Remove the single [WTG] wire from the [S] terminal on the gauge.

NOTE: Catch the gauge as the meter bracket is removed.

Remove the two nuts and the meter bracket from the back of the panel.

Remove the gauge from the panel.



Water Temperature Gauge Removal/Installation (Cont)

Install

Position the gauge in the panel. Orient it for ease of reading.

Position the meter bracket on the gauge's mounting studs. Start the nuts.

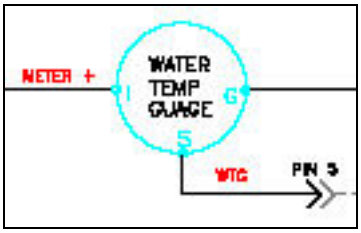
Tighten the nuts hand tight plus a full turn.

Connect the two dark blue [METER +] wires on the [I] terminal on the gauge.

Connect the single black ground wire on the [G] terminal on the gauge.

Connect the single [WTG] wire on the [S] terminal on the gauge.

Raise the control panel and install the panel mounting bolt.



Follow-Up

Reconnect the batteries and any battery chargers.

Observe that the [WATER TEMP] gauge indicates a reasonable value for cooling water temperature.

If the gauge does not indicate correctly, refer to Troubleshooting in Section 7.

If the gauge does indicate correctly, place the AUTO/MANUAL Switch at the local panel in the MANUAL position.

Coolant Temperature Sender Removal/Installation

Prepare

WARNING

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

WARNING

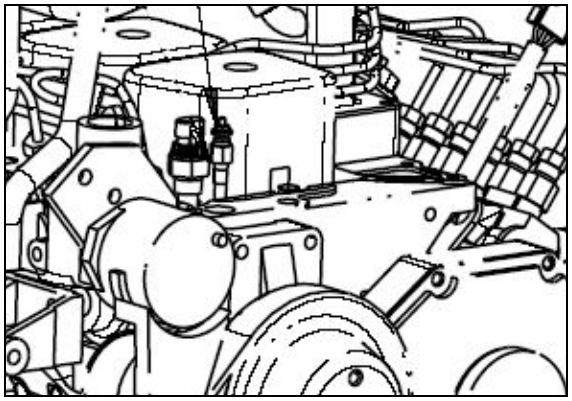
Do not remove the pressure cap from a hot engine. Wait until the temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Drain the coolant. Refer to Drain and Flush Cooling System in Section 5.

Remove

Disconnect the temperature sensor wiring.

Remove the temperature sensor.



Install

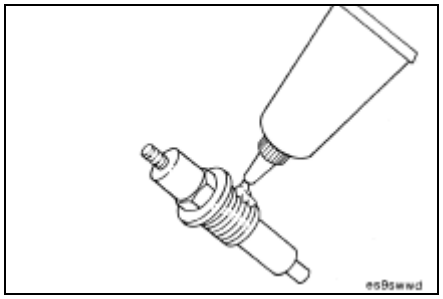
NOTE: Apply liquid teflon sealant to the threads when installing the temperature sensor.

Install the temperature sensor.

Torque Value:

- **(Cast Iron) 50 N•m [37 ft-lb]**
- **(Aluminum) 30 N•m [22 ft-lb]**

Reconnect the wiring.



Coolant Temperature Sender Removal/Installation (Cont)

Follow-Up

Fill coolant to proper level. Refer to Drain and Flush Cooling System in Section 5.

Operate the engine. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

Check that engine operating temperature stabilizes between 83 and 91 ^{o}C [181 and 196 ^{o}F]. If temperature does not stabilize, stop the engine and refer to Troubleshooting in Section 12.

Coolant Temperature Switch Removal/Installation

Prepare

WARNING

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

WARNING

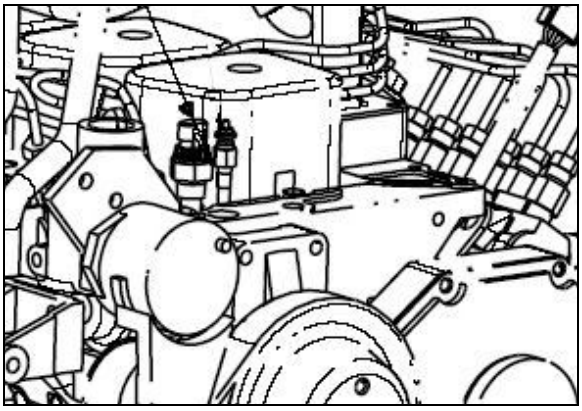
Do not remove the pressure cap from a hot engine. Wait until the temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Drain the coolant. Refer to Drain and Flush Cooling System in Section 5.

Remove

Disconnect the temperature switch wiring.

Remove the temperature switch.



Install

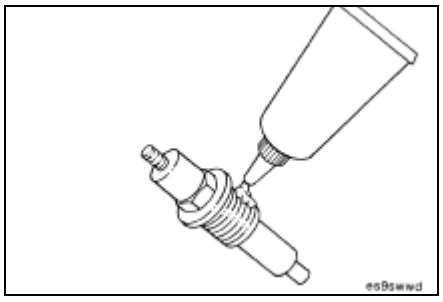
Apply liquid teflon sealant to the threads when installing the temperature switch.

Install the temperature switch.

Torque Value:

- **(Cast Iron) 50 N•m [37 ft-lb]**
- **(Aluminum) 30 N•m [22 ft-lb]**

Reconnect the wiring.



Coolant Temperature Switch Removal/Installation (Cont)

Follow-Up

Fill coolant to proper level. Refer to Drain and Flush Cooling System in Section 5.

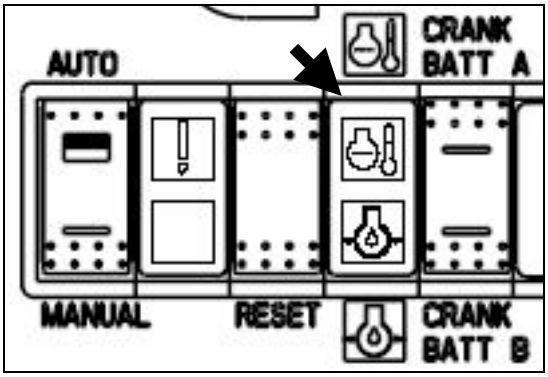
Operate the engine. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

Observe that engine operating temperature stabilizes between 83 and 91 °C [181 and 196 °F].

Check that the High Water Temperature Light on the control panel does not illuminate.

Stop the engine.



Coolant Thermostat Removal/Installation

Prepare

WARNING

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

WARNING

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

CAUTION

Always use the correct thermostat, and never operate the engine without a thermostat installed. The engine can overheat if operated without a thermostat because the path of least resistance for the coolant is through the bypass to the pump inlet. An incorrect thermostat can cause the engine to overheat or run too cold.

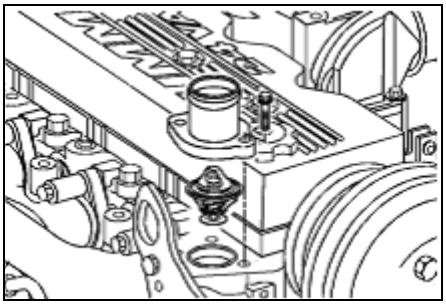
Drain the coolant. Refer to Drain and Flush Cooling System in Section 5.

Disconnect the coolant hose. Refer to Remove Upper Engine Coolant Hose in this section.

Remove

Remove the three mounting capscrews and the water outlet connection.

Remove the thermostat and seal.

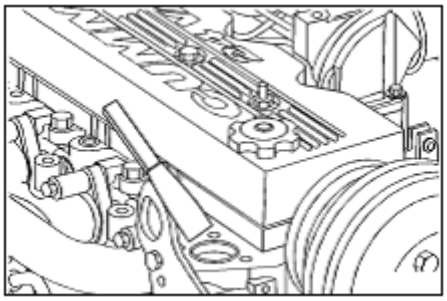


Coolant Thermostat Removal/Installation (Cont)

Clean

NOTE: Do not let any debris fall into the thermostat cavity when cleaning the gasket surfaces. Stuff a clean rag in the hole.

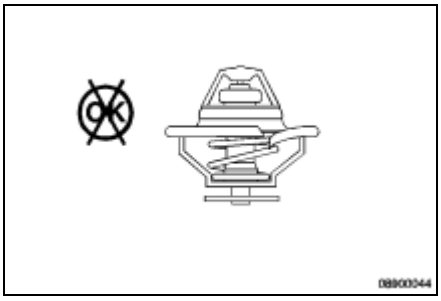
Clean the mating surfaces with a putty knife and clean cloth.



Inspect for Reuse

Inspect the thermostat for obvious damage such as obstructions caused by debris, broken springs, or stuck or missing vent pins.

Make sure the thermostat is clean and free from corrosion.



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

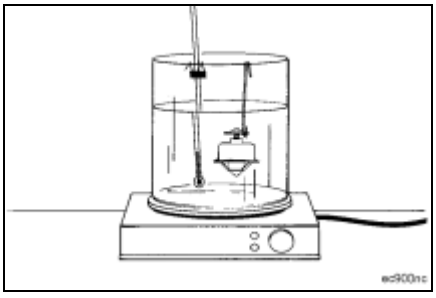
Suspend the thermostat and a 100°C [212°F] thermometer in a container of water.

Heat the water slowly so the wax element in the thermostat has sufficient time to react to the rising water temperature.

Check the thermostat as follows:

Requirements

- **Starts to open within ±1°C [±2°F] of 83°C [181°F].**
- **Fully open within ±1°C [±2°F] of 95°C [203°F].**



Coolant Thermostat Removal/Installation (Cont)

Install

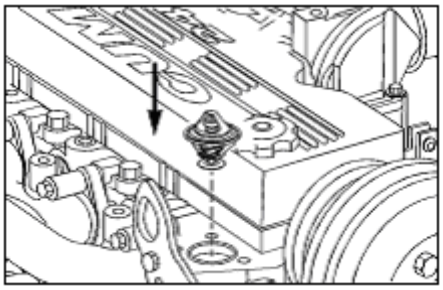
CAUTION

Always use the correct thermostat, and never operate the engine without a thermostat installed. The engine can overheat if operated without a thermostat because the path of least resistance for the coolant is through the bypass to the pump inlet. An incorrect thermostat can cause the engine to overheat or run too cold.

If used, remove the rag from the hole in the engine block.

NOTE: Make certain the thermostat seal is installed on the outer lip of the thermostat flange.

Install the thermostat (Cummins Part No. 3967195) and new thermostat seal (Cummins Part No. 3954829) into the thermostat housing.

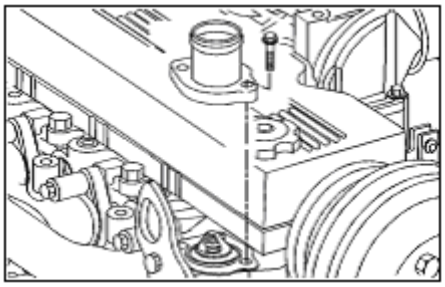


Install the water outlet connection (thermostat housing).

Install the three capscrews.

Torque Value: 10 N•m [89 in-lb]

Install the water outlet hose. Refer to Install Upper Engine Coolant Hose in this section.



Follow-Up

Fill the cooling system. Refer to Drain and Flush Cooling System in Section 5.

Operate the engine. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

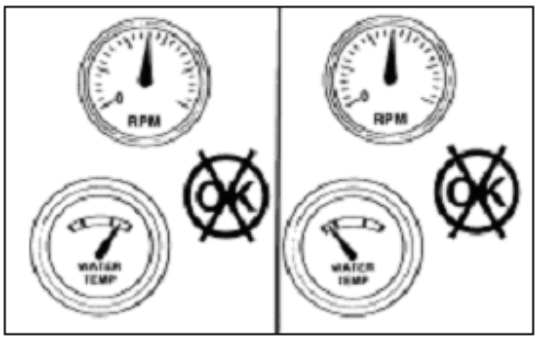
Check that engine operating temperature stabilizes between 83 and 91 °C [181 and 196 °F]. If temperature does not stabilize, stop the engine and refer to Troubleshooting in Section 12.

Coolant Thermostat Tests

Coolant Thermostat Leak Test

CAUTION

The engine thermostat must operate properly in order for the engine to operate in the most efficient heat range. Overheating or overcooling will shorten engine life.

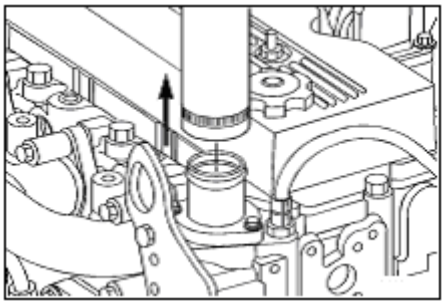


WARNING

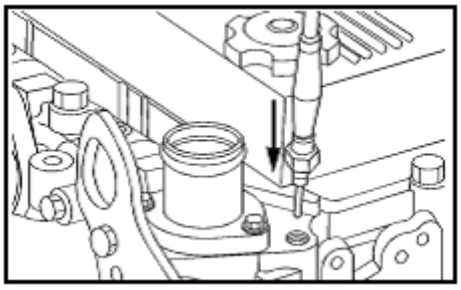
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Allow the engine to cool well below 83 °C [181 °F].

Loosen the hose clamp on the Upper Engine Coolant Hose. Remove the hose from the thermostat housing.



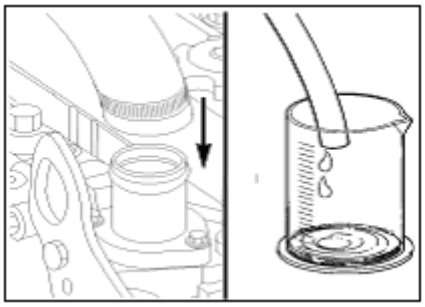
If desired, use an electronic service tool to monitor the coolant temperature, or install a thermocouple or temperature gauge, which is known to be accurate, in the water header plate on the engine side or the water outlet connection.



Install a hose of the same size on the thermostat housing outlet long enough to reach a remote, dry container used to collect coolant.

Install and tighten a hose clamp on the housing outlet.

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

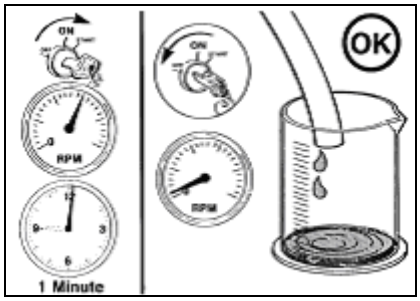


Coolant Thermostat Tests (Cont)

Operate the engine at rated rpm for 1 minute. Refer to Operating Instructions in Section 3.

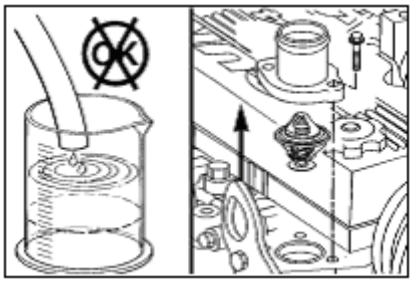
Shut off the engine and measure the amount of coolant collected in the container.

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



If more than 100 cc [3.3 fl oz] of coolant is collected, the thermostat is leaking and must be replaced. Refer to Coolant Thermostat Removal/Installation in this section.

If leakage is not present, then continue to perform the Coolant Thermostat Function Test below.



Coolant Thermostat Function Test

Start the engine and allow the engine to approach operating temperature.

Monitor the water temperature with an electronic service tool or a gauge.

Monitor the operation of the thermostat.

Thermostat Initial Opening Temperature

- **MIN: 82 °C [179 °F]**
- **MAX: 84 °C [183 °F]**

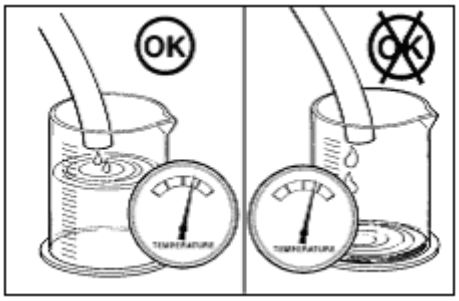
Stop the engine when the coolant starts to flow.

If the coolant does not start flowing into the container during the initial opening temperature range, the thermostat must be replaced. Refer to Coolant Thermostat Removal/Installation in this section.

Remove any test instruments.

Install the heat exchanger hose and tighten hose clamp.

Return any coolant to the engine.



Coolant Water Pump Removal/Installation

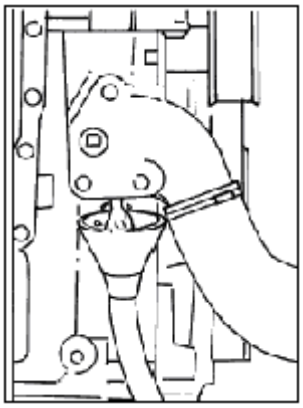
Prepare

WARNING

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

WARNING

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



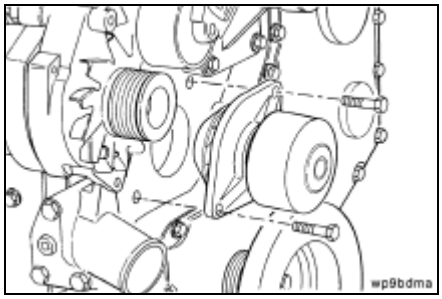
Drain engine coolant as required for the intended service. (Refer to Drain and Flush Coolant System in Section 5.)

If installed, remove the Belt Guard. Refer to Belt Guard Removal/Installation in this section.

If installed, remove the Drive Belt. Refer to Belt Removal/Installation in this section.

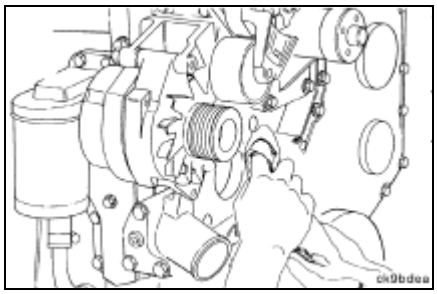
Remove

Remove the two capscrews and water pump.



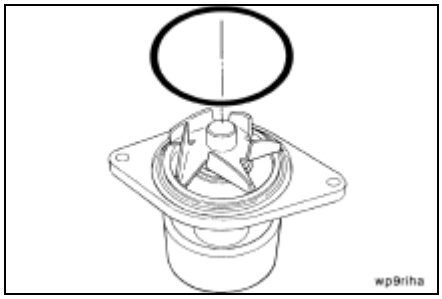
Clean

Clean the sealing surface on the cylinder block.



Coolant Water Pump Removal/Installation (Cont)

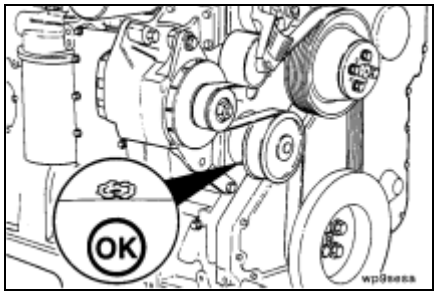
Clean o-ring sealing surface on the water pump housing.



Inspect for Reuse

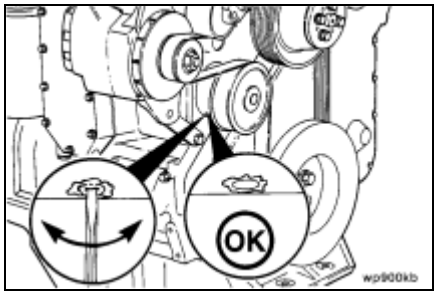
Inspect the water pump body for indications of water leakage at the weep hole.

A streak or chemical buildup at the weep hole is not justification for water pump replacement. If a recurring drip of coolant is observed, replace the water pump with a new unit.



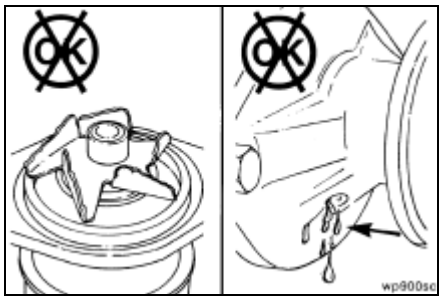
NOTE: A small screwdriver or a small tool can be used to remove any debris.

Inspect the weep hole to make sure it is open. A plugged weep hole can cause the water pump to fail.



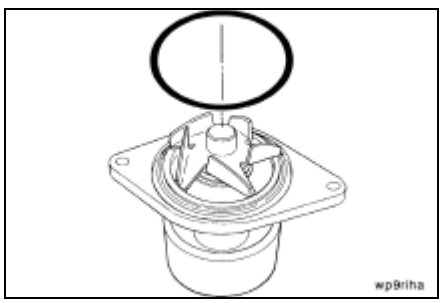
NOTE: Replace the water pump if it is damaged.

Inspect the water pump housing and impeller for any damage.



NOTE: Replace the water pump if it is damaged.

Inspect the o-ring sealing surface of housing.

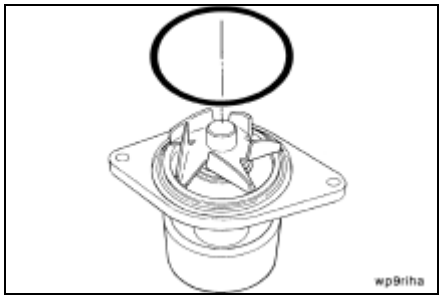


Coolant Water Pump Removal/Installation (Cont)

Install

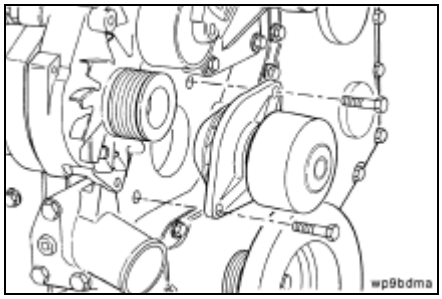
If reusing the original water pump, install a new water pump seal (Cummins Part No 3906698) onto the water pump housing.

Otherwise, install a new water pump kit (Cummins Part No 3286278)



Install the water pump and capscrews.

Torque Value: 24 N•m [18 ft-lb]



Follow-Up

Install the Drive Belt. Refer to Belt Removal/Installation in this section.

Install the Belt Guard. Refer to Belt Guard Removal/Installation in this section.

Refill engine coolant as required. Refer to Drain and Flush Coolant System in Section 5.

Coolant Water Pump Removal/Installation (Cont)

NOTE: Perform the appropriate actions in Initial Start-Up. See Section 3.

Perform a test run. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

Check that the alternator is charging.

Check that engine operating temperature stabilizes between 83 and 91 ^{o}C [181 and 196 ^{o}F]. If temperature does not stabilize, stop the engine and refer to Coolant Temperature Above Normal or Coolant Temperature Below Normal (Engine Running) in Troubleshooting, Section 12.

Stop the engine.

Ensure that repairs are completed satisfactorily.

Place the AUTO/MANUAL Switch at the local panel in the AUTO position.

Coolant Filter Assembly Removal/Installation

Prepare

WARNING

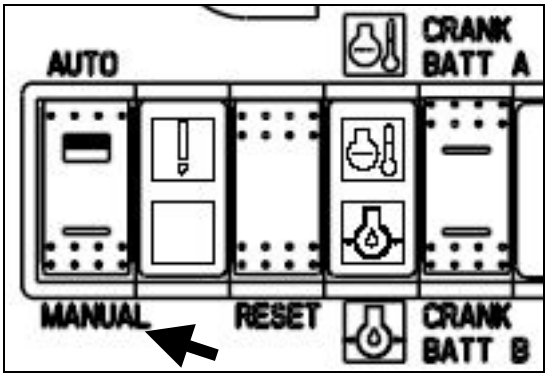
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

WARNING

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

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

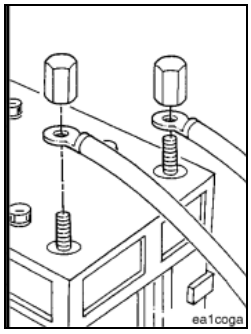


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

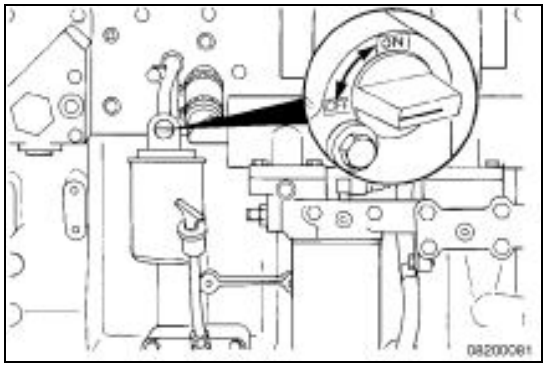
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Remove the coolant system pressure cap.

Turn the coolant filter shutoff valve to the OFF position by rotating the knob from vertical to horizontal in the direction shown.



Coolant Filter Assembly Removal/Installation (Cont)

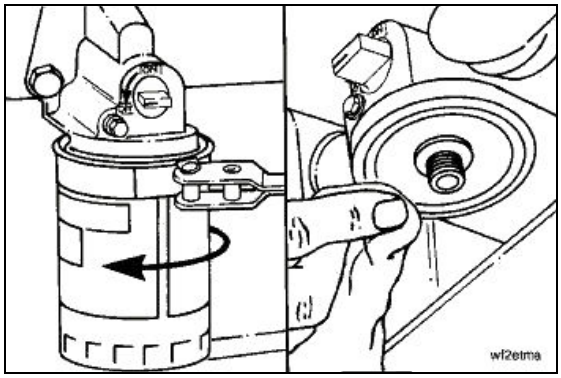
Remove

WARNING

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

Remove and discard the coolant filter.

Clean the filter housing with a dry clean rag.



Install

CAUTION

Do not allow oil to get into the filter.

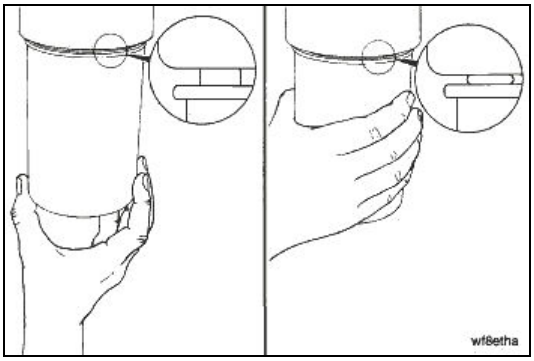
Apply a thin film of lubricating oil to the gasket sealing surface before installing the new coolant filter.

CAUTION

Mechanical over-tightening can distort the threads or damage the filter head.

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

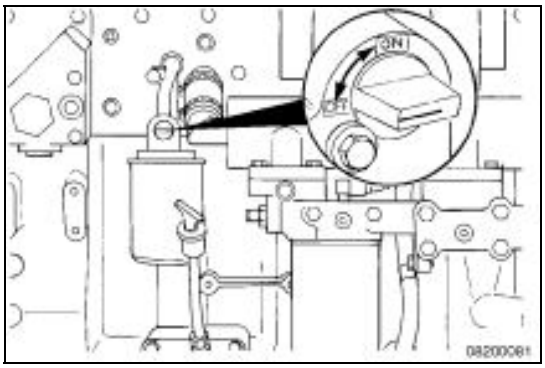
Tighten the coolant filter an additional 1/2 to 3/4 of a turn, or as specified by the filter manufacturer.



CAUTION

The valve must be in the ON position to prevent engine damage.

Turn the shutoff to the ON position by rotating the knob from horizontal to vertical.



Coolant Filter Assembly Removal/Installation (Cont)

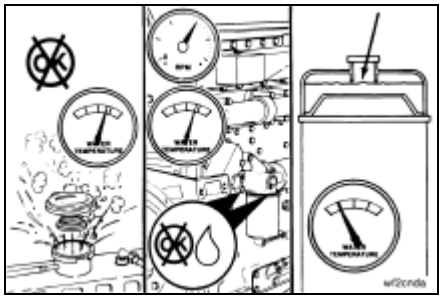
Follow-Up

Install the coolant system pressure cap.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

Check for and repair any coolant leaks.

After the air has been purged from the system, stop the engine.



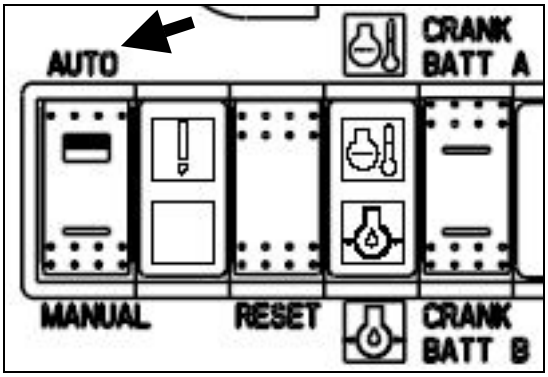
WARNING

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

Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant if necessary.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



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Alternator Checks and Testing

Alternator Wiring Integrity Check

NOTE: Refer to Drawing 10423 Sheet 1, Drawing 10423 Sheet 2, and Drawing 9767 in Section 13 for schematic details.

WARNING

Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the battery compartment before servicing the batteries.

WARNING

To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

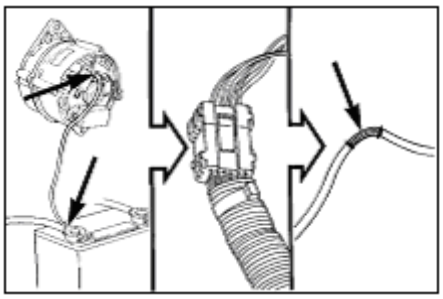
Check the battery and all wiring connections for damage. Refer to Battery Cables and Connections in this section.

Check all connections for tightness and cleanliness. Include both the slip connectors at the alternator and connections at the battery.

NOTE: Continuity should be in the single digit Ohms or less. Resistance to ground should be in the mega-Ohm range. Refer to any applicable customer criteria.

Using a digital multimeter or other test equipment, check for continuity between terminals. Check also the insulation resistance to ground.

Correct any electrical faults.



Alternator Mechanical Check

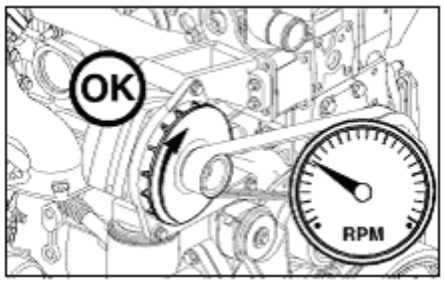
Start the engine. Refer to Normal Local Starting Procedure in Section 3.

Visually check the drive belt and alternator pulley to be sure the alternator is rotating.

Note any unusual noises such as from belt whine or alternator mechanical fault.

Stop the engine.

Correct any mechanical failures.



Alternator Checks and Testing (Cont)

Alternator Voltage Output Test

CAUTION

Batteries must have been satisfactorily load tested and must be charged with a resting voltage of more than 12.4 Volts for this testing.

CAUTION

Batteries must have been satisfactorily load tested and must be charged with a resting voltage of more than 12.4 Volts for this testing.

NOTE: Conduct this testing at normal shop temperature.

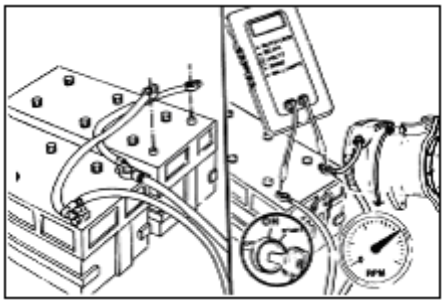
NOTE: Voltage should not exceed 15.5 V (for a 12 VDC system) or 31 V (for a 24 VDC system).

Start the engine and operate at rated speed. Refer to Normal Local Starting Procedure in Section 3.

Measure the alternator voltage output to the batteries with digital multimeter, Cummins Part Number 3377161.

Stop the engine.

Replace the alternator if the voltage exceeds specification. Refer to Alternator Removal/Installation in this section.



Alternator Checks and Testing (Cont)

Alternator Amperage Output Test

NOTE: Conduct this testing at normal shop temperature.

NOTE: Refer to Electrical Specifications in Section 10 for the minimum required alternator output. Use the value listed for the system voltage.

Connect a carbon pile load in parallel across the battery terminals. Refer to Jumpering the Batteries in Section 3 for how to make a parallel connection.

Connect a clamp-on (induction) ammeter across the alternator output cable.

Start the engine and operate at rated speed. Refer to Normal Local Starting Procedure in Section 3.

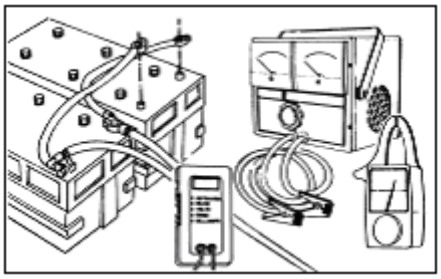
Adjust the carbon pile for maximum indication.

Note the amperage indicated on the ammeter.

Stop the engine.

Remove the test equipment.

Replace the alternator if the output is not 90% or more of the specification value. Refer to Alternator Removal/Installation in this section.



Alternator Removal/Installation

Prepare

Remove the belt guard. Refer to Belt Guard Removal/Installation in this section.

Remove the drive belt. Refer to Belt Removal/Installation in this section.

NOTE: Refer to Drawing 8513 Sheet 1 in Section 13 for wiring harness information.

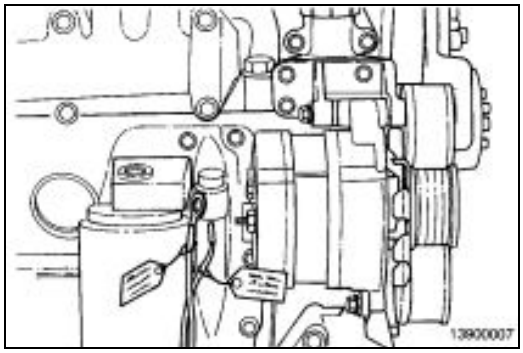
NOTE: Ensure that the connectors are clearly tagged for the correct reconnection.

Disconnect the engine wiring harness connectors from the alternator.

Remove

Remove the alternator. Refer to Alternator (53-013-001) in ISB/QSB and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

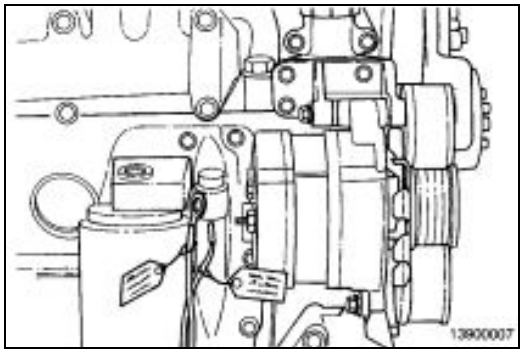
NOTE: If the alternator bracket must also be removed, go to Alternator Bracket Removal/Installation in this section.



Install

Ensure that the alternator bracket is installed. Refer to Alternator Bracket Removal/Installation in this section.

Install the alternator. Refer to Alternator (53-013-001) in ISB/QSB and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Follow-Up

NOTE: Refer to Drawing 8513 Sheet 1 in Section 13 for wiring harness information.

Connect the two engine wiring harness connectors to the alternator.

Install the drive belt. Refer to Belt Removal/Installation in this section.

Install the belt guard. Refer to Belt Guard Removal/Installation in this section.

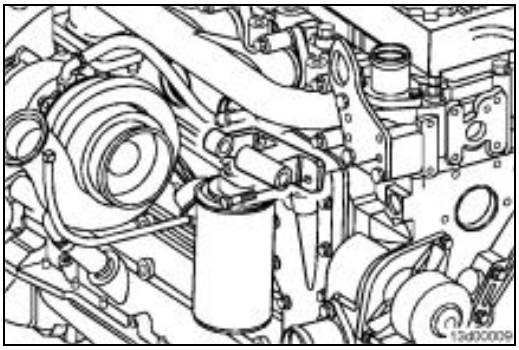
Alternator Bracket Removal/Installation

Prepare

Remove the alternator. Refer to Alternator Removal/Installation in this section.

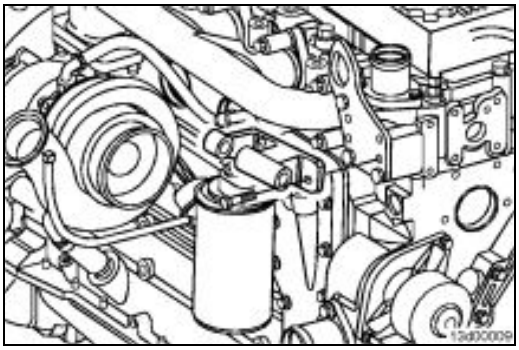
Remove

Remove the alternator bracket components. Refer to Alternator Bracket (53-013-003) in ISB/QSB and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Install

Install the alternator bracket components. Refer to Alternator Bracket (53-013-003) in ISB/QSB and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Follow-Up

Install the alternator. Refer to Alternator Removal/Installation in this section.

Alternator Pulley Removal/Installation

Prepare

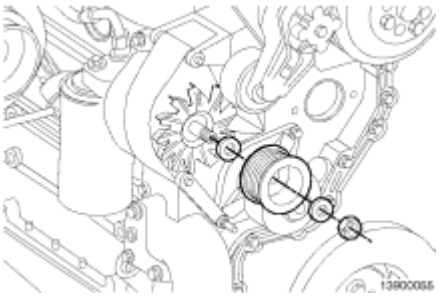
Remove the drive belt. Refer to the Procedure 008-002 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB Engines, Bulletin No. 3666193.

Hold the shaft or pulley to prevent turning.

Remove

Remove the alternator nut.

Remove the alternator pulley.

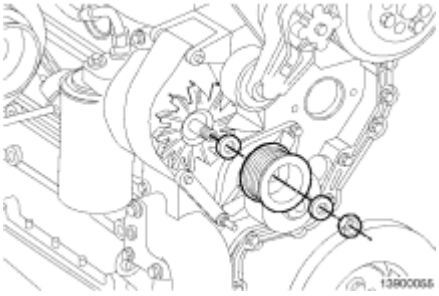


Install

Install the alternator pulley.

Install and tighten alternator pulley nut.

Torque Value: 80 N•m [59 ft-lb]



Follow Up

Install the drive belt. Refer to Procedure 008-002 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB Engines, Bulletin No. 3666193.

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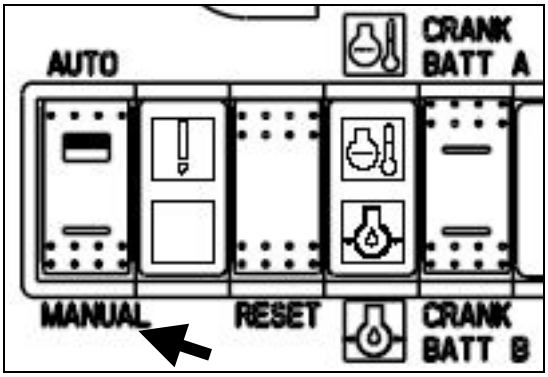
Battery Isolator Removal/Installation

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



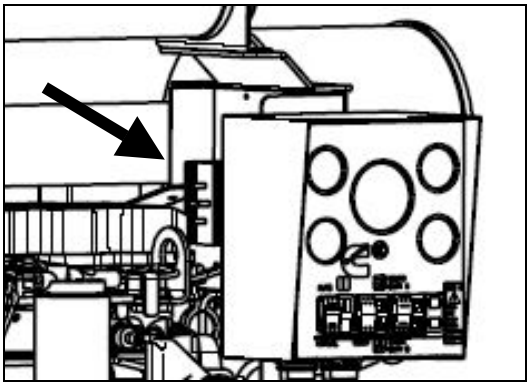
NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for disconnecting the battery cable clamps.

Disconnect the negative battery cable from Battery A.

Disconnect the negative battery cable from Battery B.

Remove

NOTE: Ensure that all battery isolator wires are clearly tagged for reconnection. Also note the orientation of the existing isolator.



Battery Isolator Removal/Installation (Cont)

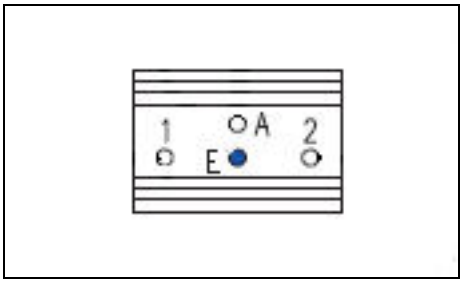
Disconnect the battery cable from terminal 1.

Disconnect the battery cable from terminal 2.

Disconnect the alternator cable from terminal A.

Disconnect the alternator excitation cable from terminal E.

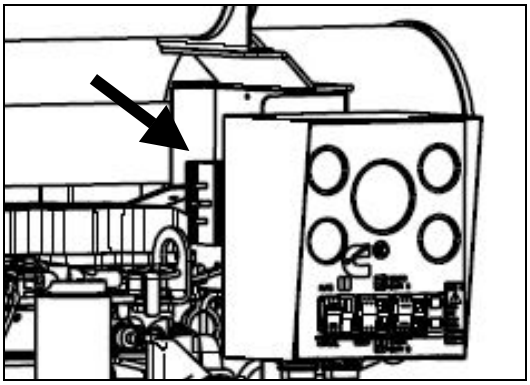
Remove the four mounting nuts and the battery isolator



Install

Align and position the battery isolator on the four mounting studs.

Install the four mounting nuts.



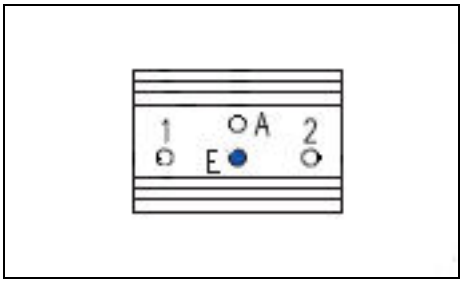
Connect the battery cable at terminal 1.

Connect the battery cable at terminal 2.

Connect the alternator cable at terminal A.

Connect the alternator excitation cable at terminal E.

Ensure that all four rubber caps are in position.



Follow-Up

NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for connecting the battery cable clamps.

Connect the negative battery cable at Battery A.

Connect the negative battery cable at Battery B.

Battery Isolator Removal/Installation (Cont)

NOTE: Refer to Drawing 10423 Sheet 2 for schematic details. Measure voltages at the most convenient location.

With the engine off, verify the following voltages at the battery isolator terminals to ground:

- Terminal 1 indicates battery voltage.
- Terminal 2 indicates the other battery voltage.
- Terminal E indicates no voltage.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

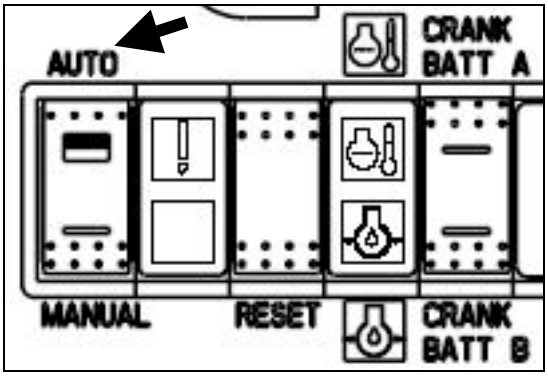
With the engine running, verify the following voltages at the battery isolator terminals to ground:

- Terminal 1 indicates battery voltage.
- Terminal 2 indicates the other battery voltage.
- Terminal E indicates battery voltage.
- Terminal A indicates about 1 volt higher than battery voltage.

Stop the engine.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



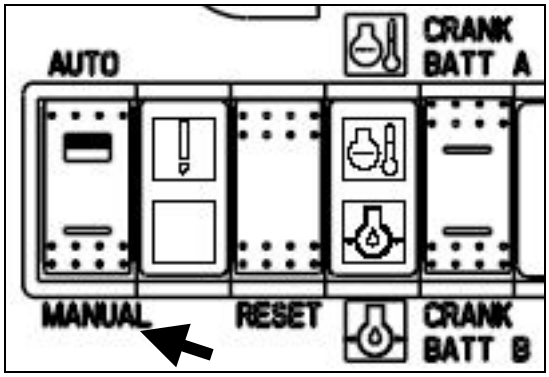
Engine Harness Removal/Installation

NOTE: There are two harness assemblies on this fire pump engine. This section addresses the engine harness connected to the control panel. The ECM harness is addressed in ECM Harness Removal/Installation also in this section.

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for disconnecting the battery cable clamps.

Disconnect the negative battery cable from Battery A.

Disconnect the negative battery cable from Battery B.

Remove

NOTE: Refer to Drawing 8513 Sheet 1 in Section 13 for a depiction of the engine wiring harness.

NOTE: Ensure that each terminal is properly labeled for ease of reconnection.

Disconnect the harness connection at each terminal.

Install

NOTE: Refer to Drawing 8513 Sheet 1 in Section 13 for a depiction of the engine wiring harness.

Connect the harness connection at each terminal.

Engine Harness Removal/Installation (Cont)

Follow-Up

NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for connecting the battery cable clamps.

Connect the negative battery cable at Battery A.

Connect the negative battery cable at Battery B.

NOTE: Refer to Second Start in Section 3 for the suggested checks.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

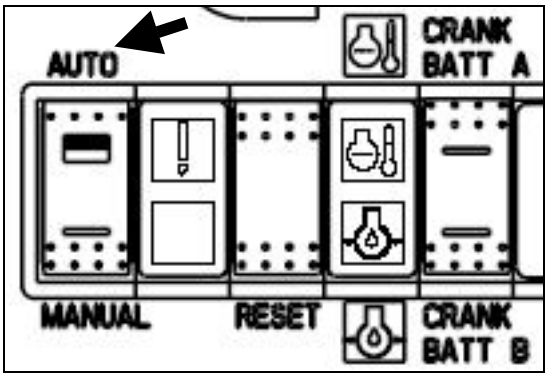
Observe that the engine starts with no unusual noises or vibrations.

Verify that the engine reaches operating temperature.

Stop the engine.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.

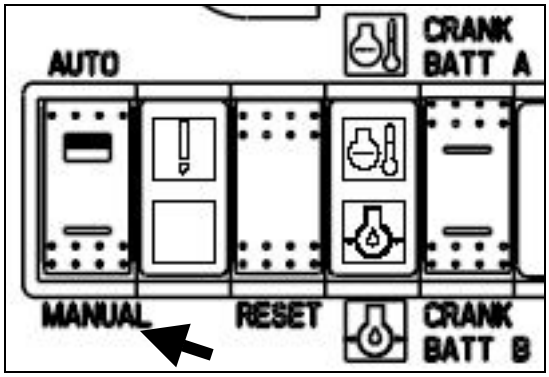


Voltmeter Removal/Installation

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

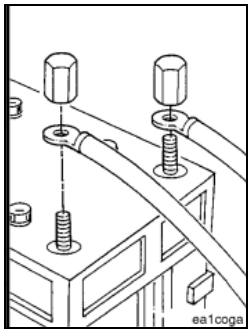
For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.

NOTE: Refer to Control Panel Fuse Replacement in this section for fuse location information.

Remove the electrical fuse from the fuse block as follows:



- For Voltmeter A, remove Fuse F1
- For Voltmeter B, remove Fuse F2

Remove

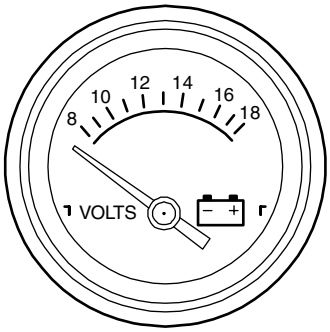
NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for electrical schematic details.

Open the local control panel.

NOTE: Ensure that the wires are clearly tagged for reconnection.

Loosen the nuts on the stud and remove the wires.

Remove the nuts on the mounting bracket and remove the voltmeter from the panel.



Voltmeter Removal/Installation (Cont)

Install

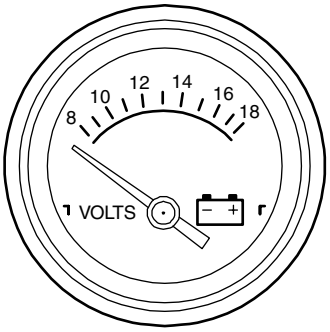
Orient the voltmeter in the cutout in the electrical panel.

Position the mounting bracket on the gauge.

Install the mounting nuts.

Reconnect the electrical wires on the studs in the same positions as they were originally installed.

Tighten the nuts on the studs.

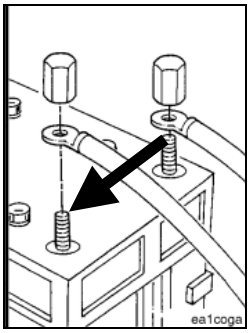


Reinstall the electrical fuse in the fuse block.

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

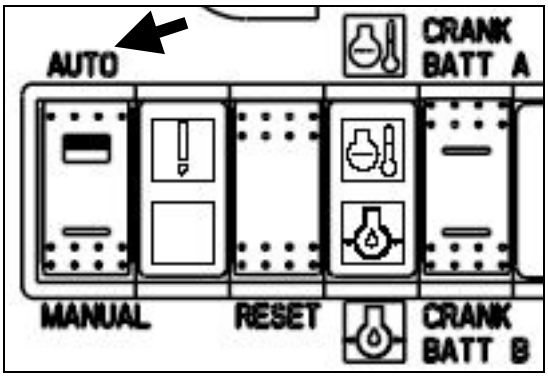
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Battery Testing

WARNING

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

WARNING

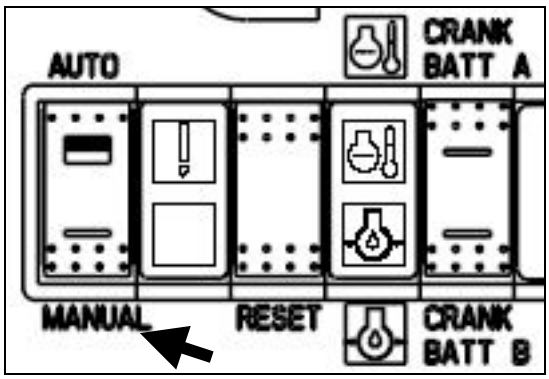
Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a strong tank of soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to avoid serious burns.

NOTE: This section is for conventional batteries only. Maintenance-free batteries may be supplied by the customer. These are sealed and do not require the addition of water. Also, specific gravity cannot be checked. If the batteries are not supplied by Cummins Fire Power, follow the battery manufacturer's recommendations for testing and servicing their batteries.

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

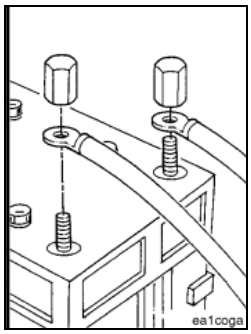


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a "Battery Failure" alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Battery Testing (Cont)

Check Electrolyte Level

Remove all cell covers for both sets of batteries.

Check the electrolyte level in each cell of each battery.

NOTE: Cummins recommends the use of a self-leveling filler. If a syringe type filler is used, use care to prevent overflow or splashing of acid from the cell.

CAUTION

Do not overfill the cell. Fill only to the level indication.

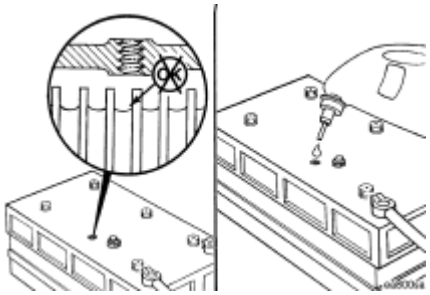
CAUTION

If a syringe type filler is used, use care to prevent overflow or splashing of acid from the cell.

As required, fill each battery cell with distilled water.

Install all cell covers for both sets of batteries.

If water was added, recharge the battery prior to checking specific gravity.



Battery Testing (Cont)

Check Specific Gravity

NOTE: If water has been added to a dry cell, recharge the battery to mix the added water with the existing battery electrolyte. This will prevent incorrect readings.

NOTE: The battery must be more than about ¼ charged before the hydrometer readings can be accurate. Accurate readings may require several hours of charging for a fully discharged battery.

Use a hydrometer to measure the specific gravity of each cell.

State of Charge and Specific Gravity*

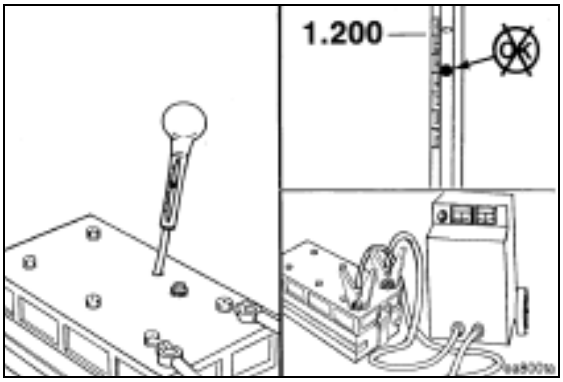
% Charged	Non-Tropical	Tropical
100%	1.265	1.225
75%	1.225	1.185
50%	1.190	1.150
25%	1.155	1.115
0%	1.120	1.080

* At 26.7 °C [80 °F]

Check the battery fluid column in the refractometer to determine the state of charge of each battery cell.

NOTE: Evaluate the state of charge in respect to the local requirements. A cold location will require a greater specific gravity than a hot climate for the necessary cranking amperes.

If charge is low, charge the batteries. Refer to Battery and Electrical Installation in Section 3.



Battery Testing (Cont)

Check Battery Output

CAUTION

Do not connect battery charging cables to any electronic control system part. This can damage the electronic control system parts.

NOTE: Use the inductive charging-cranking systems analyzer, Cummins Part Number 3377193, to test the output amperage of either maintenance-free or conventional vent cap batteries. Follow the instructions provided with the test equipment.

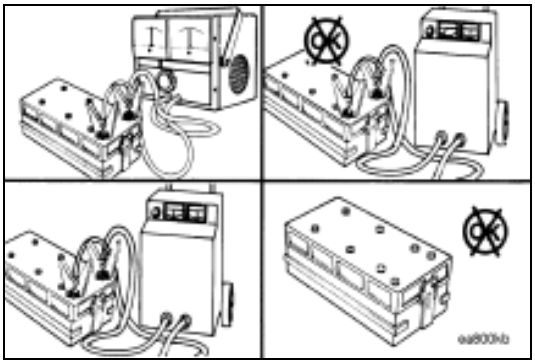
NOTE: The required battery output in cold cranking amperes is provided in Electrical System Specifications in Section 10. Use the listed value for the system voltage.

Test both sets of batteries.

NOTE: For customer supplied batteries, refer to the manufacturer's literature for charging instructions.

If the output amperage is low, charge the battery. Refer to Battery and Electrical Installation in Section 3.

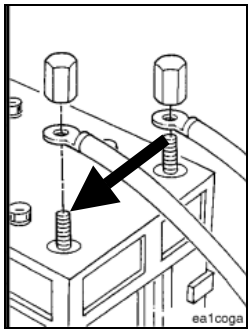
Replace the battery if it will not charge to the manufacturer's specifications or will not maintain a charge.



For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

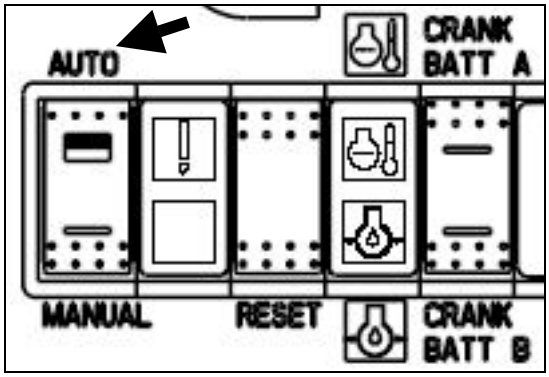
Reconnect the batteries at their terminals after all service work has been completed.



Battery Testing (Cont)

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Battery Removal/Installation

WARNING

Batteries can emit explosive gases. To avoid injury, always ventilate the compartment before servicing the batteries.

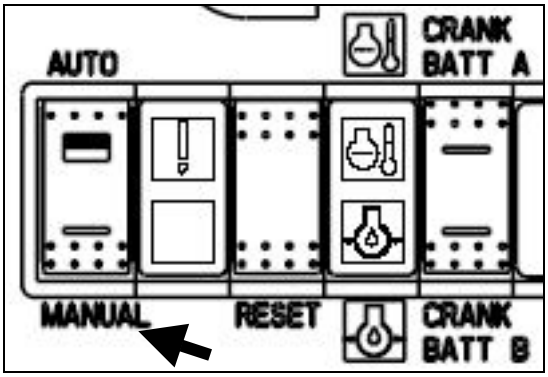
WARNING

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

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

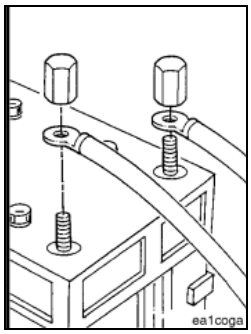


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Clear and ventilate the battery storage area.

Collect the necessary tools and safety equipment.

Battery Removal/Installation (Cont)

Remove

NOTE: Use the correct battery tools. Use end wrenches to loosen the battery clamps. Use a battery cable puller to remove tight cable clamps from the battery terminal. Use a battery carrier to lift and carry the battery.

Remove any battery support hardware.

WARNING

To reduce the possibility of arcing, remove the negative (-) battery cable first.

Loosen the battery cable clamps.

Remove the negative battery cable first.

Remove the positive battery cable last.

WARNING

Do not tip the battery and spill the acid.

Using a battery carrier, lift and remove the battery.

If disposing of the battery, dispose of it in accordance with all applicable environmental regulations.

Clean

NOTE: Use the correct battery tools. Use a terminal cleaning brush for the battery terminal. Use a putty knife and wire brush to remove dirt and corrosion from the battery body and any support.

Clean the battery posts to remove all corrosion and to expose the metal.

Remove any other corrosion or debris from the battery body or battery support.

Battery Removal/Installation (Cont)

Install

NOTE: Use the correct battery tools. Use a battery cable clamp spreader to install tight cable clamps on the battery terminal. Use end wrenches to tighten the battery clamps

WARNING

Do not tip the battery and spill the acid.

Using a battery carrier, carry and position the battery.

WARNING

To reduce the possibility of arcing, attach the negative (-) battery cable last.

Spread the positive cable clamp and position the clamp on the post.

Tighten the positive cable clamp.

Spread the negative cable clamp and position the clamp on the post.

Tighten the negative cable clamp.

Install any battery support hardware.

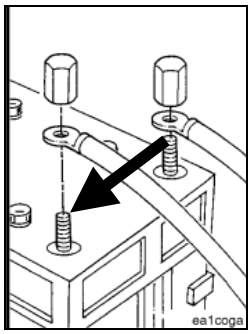
Follow-Up

If new batteries are installed, charge the batteries. Refer to Battery and Electrical Installation in Section 3.

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

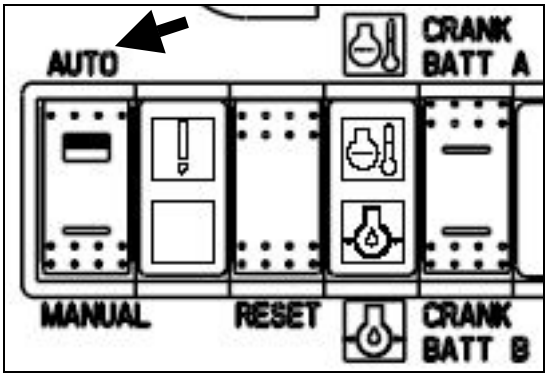
Reconnect the batteries at their terminals after all service work has been completed.



Battery Removal/Installation (Cont)

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Check Battery Cables and Connections

WARNING

Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries.

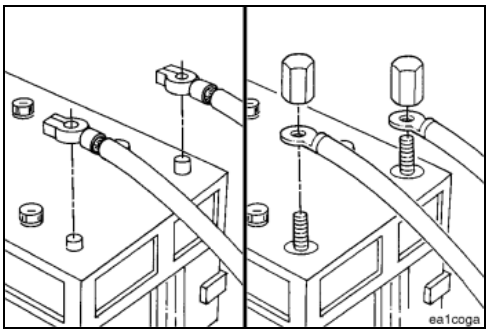
WARNING

To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

NOTE: There are two possible heavy-duty battery connections:

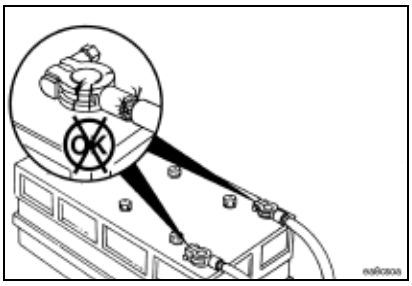
Battery terminal and clamp

Threaded battery terminal and nut



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

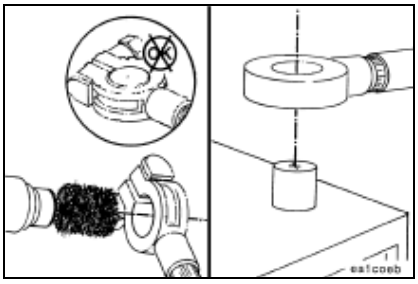
Replace broken terminals, connectors, or cables.



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

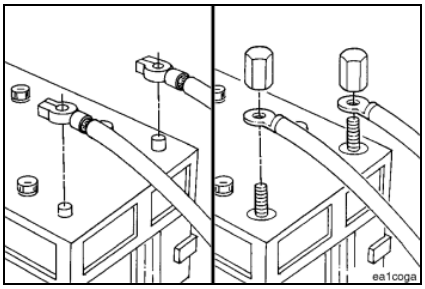
Alternatively, if a brush won't do the job, use an acid neutralizing solution to remove the corrosion.

Brush or wipe all residue or debris from the terminals.



NOTE: Coat the terminals with a high temperature grease to prevent corrosion.

Install the cables and tighten the battery connections.

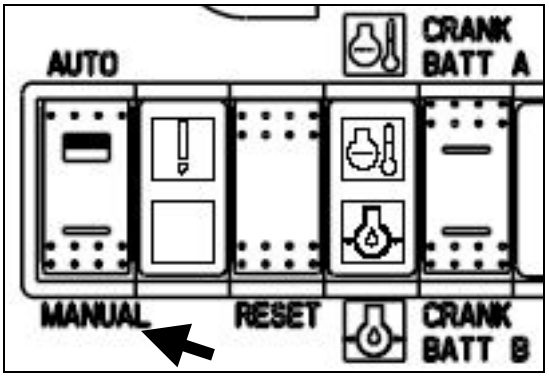


Starter Motor Assembly Removal/Installation

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



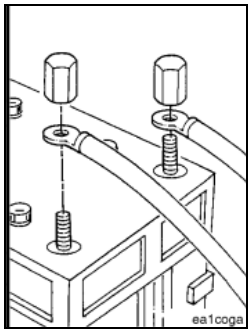
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.

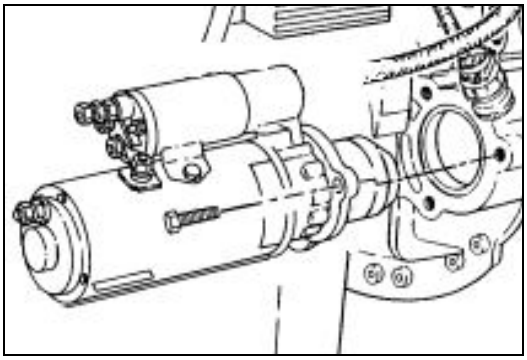
Remove the grounding strap from the starter if used.



Remove

Remove the three capscrews and starter motor.

Inspect the starter motor gears. If gear damage is present, check also the ring gear.



Starter Motor Removal/Installation (Cont)

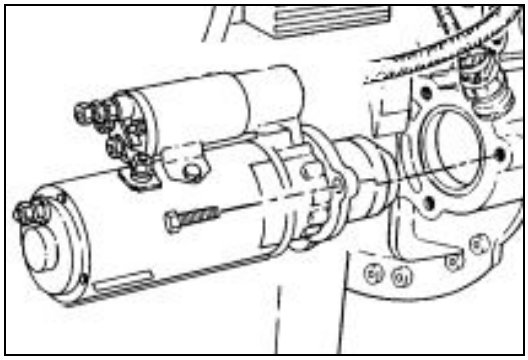
Install

NOTE: Use only the Delco 39MT replacement starter Cummins Part No. ST9370 / 3971603 (12 VDC) or Cummins Part No. ST9258 / 3957598 (24 VDC).

Align and install the starter motor.

Install and tighten the three mounting capscrews.

Torque Value: 43 N•m [32 ft-lb]

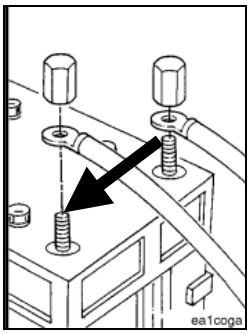


For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.

Install the grounding strap to the starter if used.



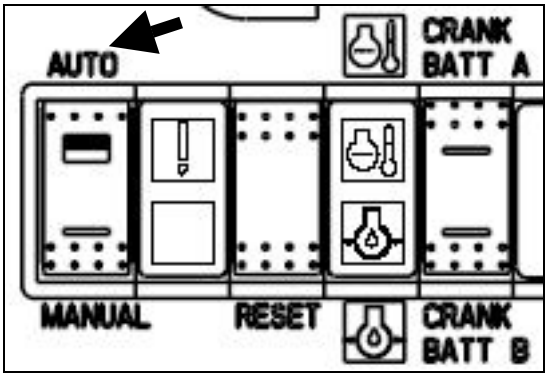
Start the engine. Refer to Normal Local Starting Procedure in Section 3.

Observe that the engine starts with no unusual noises or vibrations.

Stop the engine.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



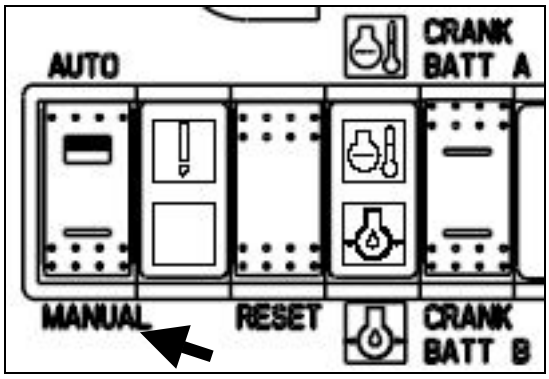
Crank Solenoid Assembly Removal/Installation

NOTE: Use this procedure to remove and install either or both of the crank solenoid assemblies. The crank solenoid assembly sub-components are not serviceable parts as supplied by Cummins Fire Power.

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.



NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for disconnecting the battery cable clamps.

Disconnect the negative battery cable from Battery A.

Disconnect the negative battery cable from Battery B.

Remove

NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for schematic information related to the crank solenoid assemblies.

NOTE: Ensure that the wires are clearly identified for ease of reconnection.

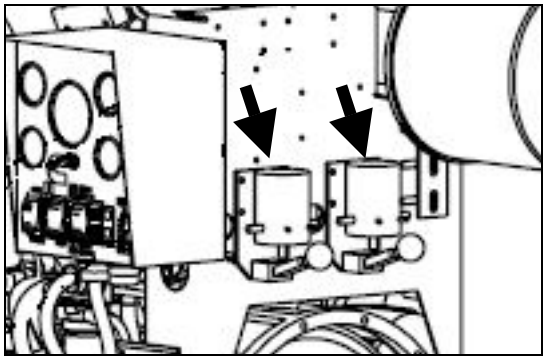
NOTE: Observe the location of flat and lock washers for ease of reconnection.

NOTE: Save the nuts, bolts, flat washers, and lock washers for reuse.

Disconnect all electrical connectors from the solenoid's four terminal studs.

Loosen the four sets of mounting nuts, bolts, and washers.

Remove the crank solenoid and fasteners from the engine.



Crank Solenoid Assembly Removal/Installation (Cont)

Install

NOTE: Install the correct component. For 12 VDC systems, use Cummins NPower Part No 8824. For 24 VDC systems, use Cummins NPower Part No 8846.

Position the four bolts through the mounting holes.

Position the crank solenoid on the bolts, add the lock washers, and start the nuts.

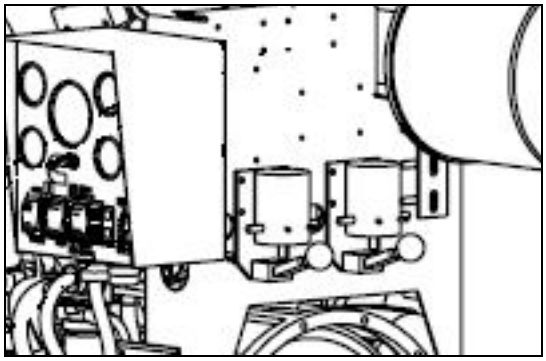
Tighten the four mounting nuts.

NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for crank solenoid schematic information.

Position the flat washers, cable lugs, lock washers, and nuts on the studs in the same order as was removed.

Tighten the nuts on the studs.

With power still disconnected, verify that the lever handle on the crank solenoid operates freely.



Follow-Up

NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for reconnecting the battery cable clamps.

Connect the negative battery cable from Battery A.

Connect the negative battery cable from Battery B.

Crank Solenoid Assembly Removal/Installation (Cont)

Demonstrate Local Electrical Start

NOTE: If Crank Solenoid A was replaced, start the engine using CRANK BATT A. Alternatively, use B if B was replaced.

Start the engine electrically from the local control panel. Refer to Normal Local Starting Procedure in Section 3.

Verify that the engine starts normally with no unusual indications.

Stop the engine.

Demonstrate Local Manual Start

NOTE: If Crank Solenoid A was replaced, start the engine using CRANK BATT A. Alternatively, use B if B was replaced.

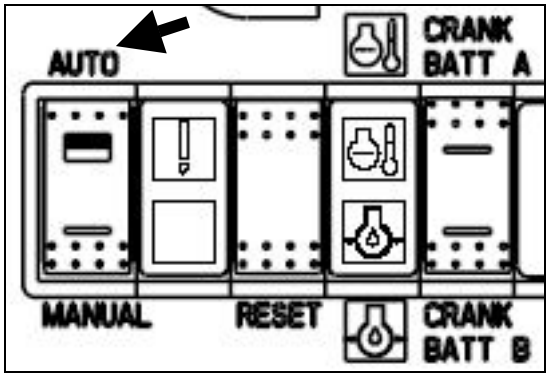
Start the engine manually from the crank solenoid lever handle. Refer to Normal Local Starting Procedure in Section 3.

Verify that the engine starts normally with no unusual indications.

Stop the engine.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.

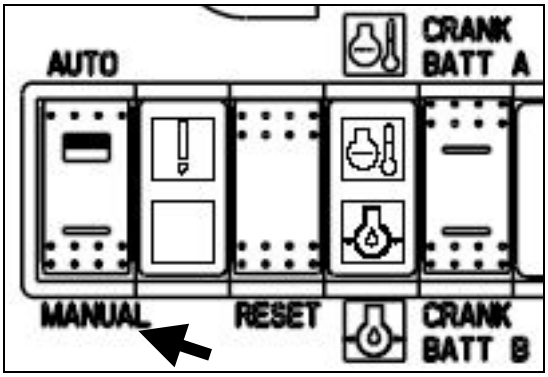


Control Panel Fuse Replacement

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

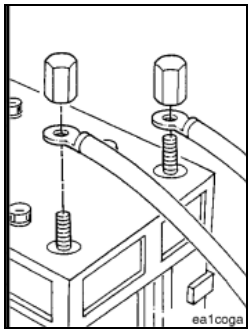


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

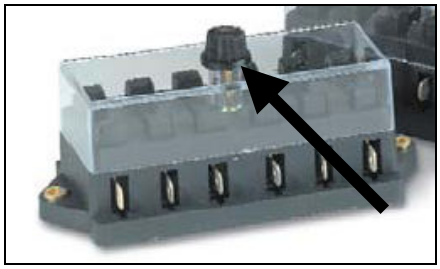
Next, disconnect both batteries at their terminals.



Remove

Open the fire pump engine’s local control panel.

Loosen the cover screw and remove the fuse block cover.



Control Panel Fuse Replacement (Cont)

NOTE: The fuses are ATO/ATC ¼" blade type automotive fuses. The 20 Amp fuses (Fuse 1, 2, and 3) are colored yellow. The five amp fuse is colored tan.

NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for schematic details.

NOTE: The fuses are ordered from top to bottom as follows:

- 5 A Fuse F4 (Control Panel Indications)
- 20 A Fuse F1 (Battery A)
- 20 A Fuse F2 (Battery B)
- 20 A Fuse F3 (Crank Circuit)

Select the fuse for testing or replacement.

Pull the fuse from the fuse block.

Check for continuity either visually or with an ohmmeter.

Check for short circuits to ground on any fuse circuit that had an open circuited fuse. Correct any faults.

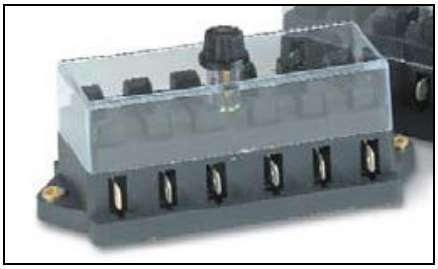
If necessary, remove, test, or replace the engine harness. Refer to Engine Harness Removal/Installation in this section.

Install

Replace any fuse with an open circuit. Place the new fuse into the fuse block and press it in until the fuse is properly inserted.

Install the fuse block cover and tighten the cover screw,

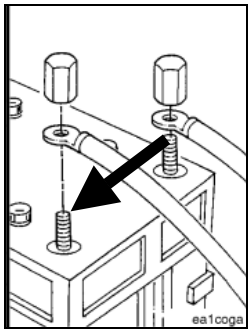
Close the control panel.



For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Control Panel Fuse Replacement (Cont)

NOTE: If Fuse 1 or Fuse 2 was replaced, start the engine using CRANK BATT A or CRANK BATT B respectively.

Start the engine. Refer to Normal Local Starting Procedure in Section 3.

Observe that the engine starts with no unusual indications.

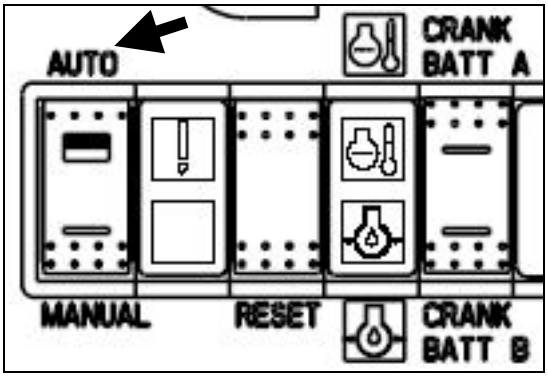
Observe that engine speed is indicated.

Observe that raw water flow has started.

Stop the engine.

Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



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Air in Fuel

General Information

WARNING

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

WARNING

Do not vent the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

The low-pressure fuel system for a Cummins engine consists of the fuel tank, lines between tank and engine, transfer pump and lines, and fuel filter and lines. Air or bubbles at the injection pump can cause no or erratic engine operation and/or subsequent malfunction of the fuel injection pump. Air can be introduced by leaks in the fuel system prior to the transfer pump since fuel pressure is a vacuum.

Bubbles can result from any number of restrictions in the system:

Plugged fuel filter

Crimped fuel line

Stopped-up tank module

Inoperative transfer pump

If sufficient fuel reaches the injection pump from the low-pressure system, then solutions to engine operational problems are elsewhere. The following steps will aid in evaluating low-pressure fuel system performance in absence of fault codes.

NOTE: For cold-start/performance problems, perform the following steps:

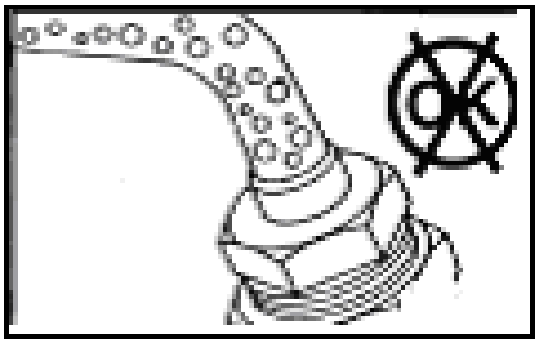
Leave engine outside in cold environment for at least 12 hours.

Perform outlined test.

If the system fails to meet test criteria, replace the fuel lift pump.

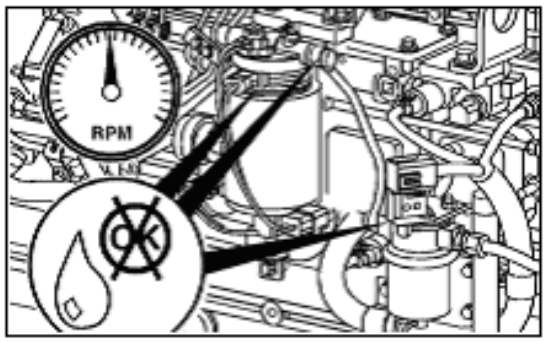
Discussion

A replacement of fuel supply lines, fuel filters, fuel injection pump, high-pressure fuel lines, and injectors will let air enter the fuel system. Air in the system will make the engine hard to start, run rough, misfire, produce low power, and can cause excessive smoke and a fuel knock.



Air in Fuel (Cont)

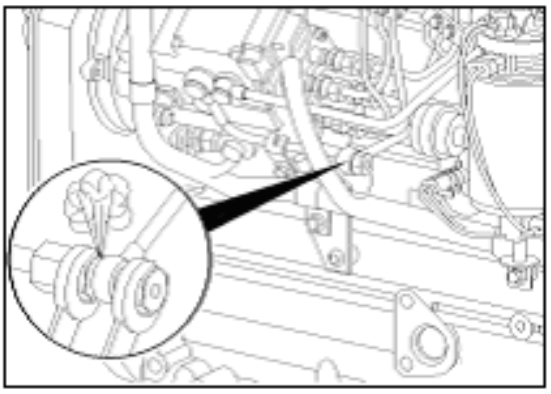
Since the fuel lift pump provides positive pressure through the fuel filter and supply line to the fuel injection pump, loose connections or defective seals can show as a fuel leak, not as an air leak.



NOTE: If an excessive amount of air has entered into the system, the system will need to be vented.

Loosen the return banjo fitting on the fuel lift pump. Run the fuel lift pump until all the air has been vented. When all the air has been vented, retighten the fitting.

NOTE: To run the fuel pump for 25 seconds, crank the engine for a split second, and leave the key in the ON position.

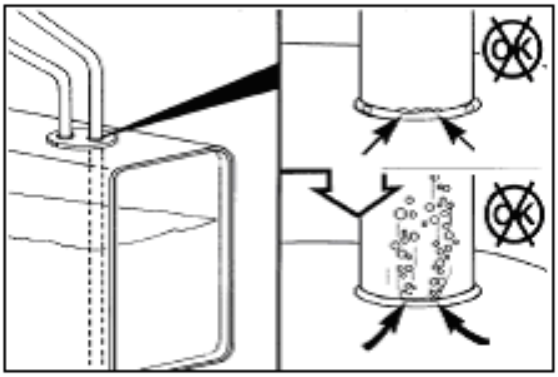


If air continues to bubble out of the system for several minutes, then an air leak is present.

An often overlooked source from which air can enter the fuel system is between the inlet of the fuel transfer pump and the suction tube in the tank. Fuel tanks that have the outlet fitting at the top will have a suction tube that extends to the bottom of the tank. Cracks or pin holes in the weld that join the tube to the fitting can let air enter the fuel system.

Also, check to make sure all the fittings from the fuel supply line on the tank to the inlet of the fuel transfer pump are tight.

Use a sight glass at the fuel lift pump inlet to check for air in the fuel supply lines.



Air in Fuel (Cont)

Check High Pressure Lines

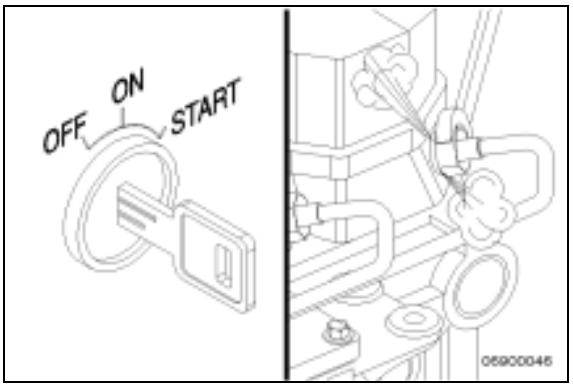
WARNING

Keep hands and body parts away from the high-pressure fuel lines. Fuel coming from the high-pressure fuel lines is under extreme pressure and can cause serious injury by penetrating the skin.

NOTE: Check for air in the high-pressure lines by loosening the fittings at the head.

Crank the engine to allow entrapped air to bleed from the line. Tighten the fittings.

Torque Value: 38 N•m [28 ft-lb]



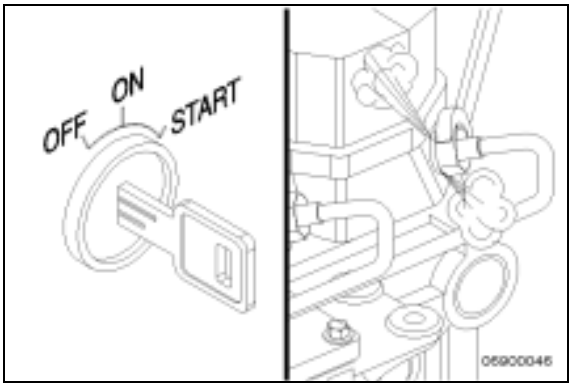
CAUTION

Do not bleed the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

Operate the engine.

Vent one line at a time until the engine runs smoothly.

Stop the engine.



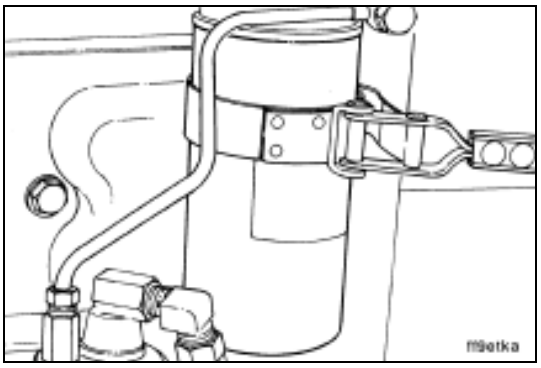
Fuel Filter Removal/Installation

Prepare

Remove

Disconnect the water-in-filter sensor connector from the base of the fuel filter.

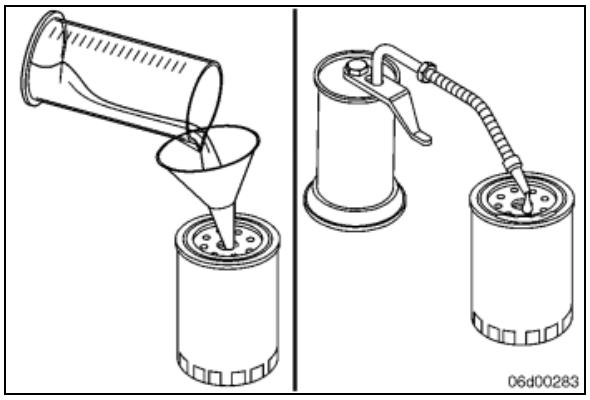
Remove the combination water separator and fuel filter.



Install

Fill the filter with clean fuel.

Lubricate the seal with clean lubricating engine oil.



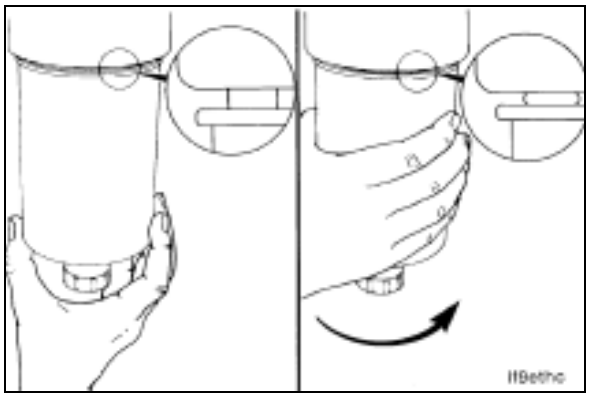
CAUTION

Mechanical over-tightening can distort the threads as well as damage the filter element seal or filter can.

Install the fuel filter on the fuel filter head.

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

Tighten the fuel filter an additional 1/2 to 34 of a turn after the gasket contacts the fuel filter head surface, or as specified by the fuel filter manufacturer.

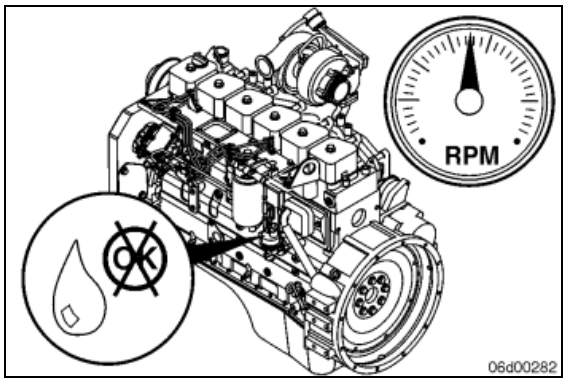


Fuel Filter Removal/Installation (Cont)

Follow-Up

Operate the engine and check for leaks.

NOTE: Air trapped in the system can lead to hard starts. Operating the lift pump priming lever will purge the low pressure fuel system of air. Refer to Procedure 006-003 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.



Fuel Filter Head Bracket Removal/Installation

Prepare

Remove the following:

Fuel filter (Procedure 006-015) in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

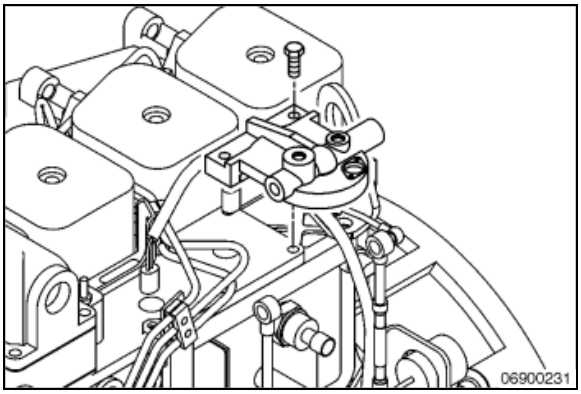
Fuel supply and return banjos (Procedure 006-024) in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Remove

Refer to Fuel Filter Head Bracket (53-006-018) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

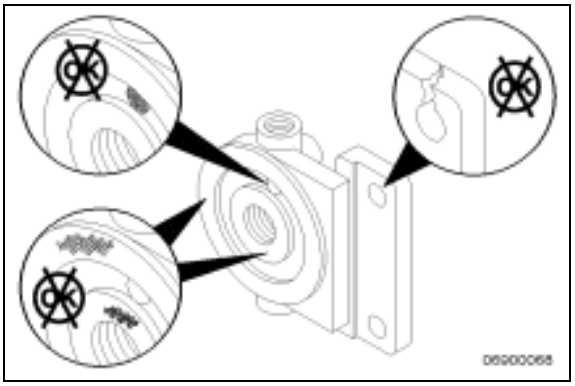
Remove the two capscrews retaining the filter head.

Remove the filter head from the engine.



Inspect for Reuse

Inspect the filter head for cracks, passage blockage, and material or debris on the sealing surfaces.



Fuel Filter Head Bracket Removal/Installation (Cont)

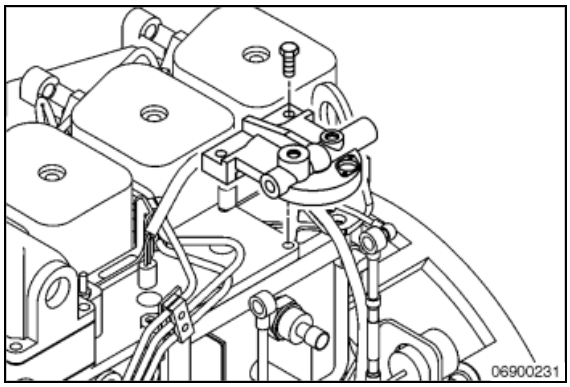
Install

Refer to Fuel Filter Head Bracket (53-006-018) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Install the filter head.

Tighten the two retaining capscrews.

Torque Value: 24 N•m [18 ft-lb]



Follow-Up

Install the following:

Fuel supply return banjos. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Fuel filter. Refer to Procedure 006-015 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193. Run the engine and check for leaks.

Fuel Pump Timing

Prepare

Adjust

Refer to Fuel Pump Timing (53-005-037) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

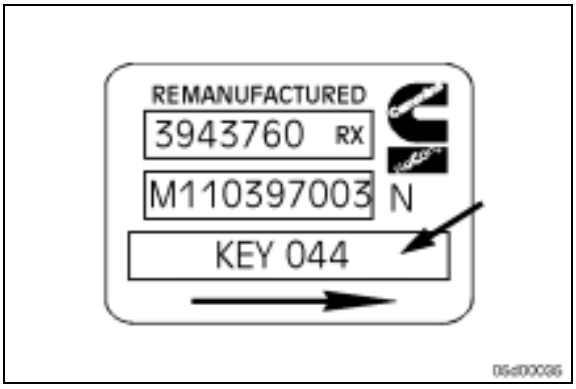
Test

The Bosch® dataplate shows a key number 034. These digits represent the last three digits of the full Bosch® part number for the correct key.

NOTE: The key part number is assigned to a specific fuel pump when the fuel pump is manufactured.

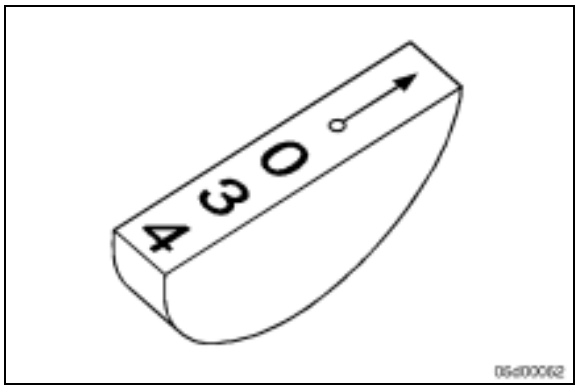
The ReCon® shows a key number 044. These digits represent the last three digits of the full Bosch® part number for the correct key.

NOTE: The key part number is assigned to a specific fuel pump when the fuel pump is manufactured.



Fuel Pump Timing (Cont)

Every VP44 pump key is marked with the last three digits of its Bosch® part number. In addition, each key has an installation arrow. The arrow must always point toward the pump.

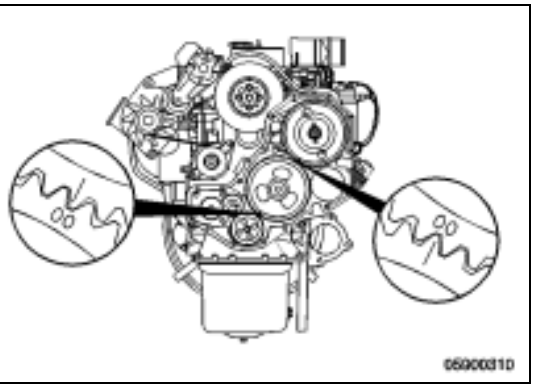


The following steps are for checking the static timing:

Remove the front cover, and verify that the timing marks on the gear train are aligned. Refer to Procedure 001-031 for front cover manual in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Verify that no gears have slipped on the shaft.

Verify the number on the fuel pump gear key matches the number stamped on the back of the fuel pump.



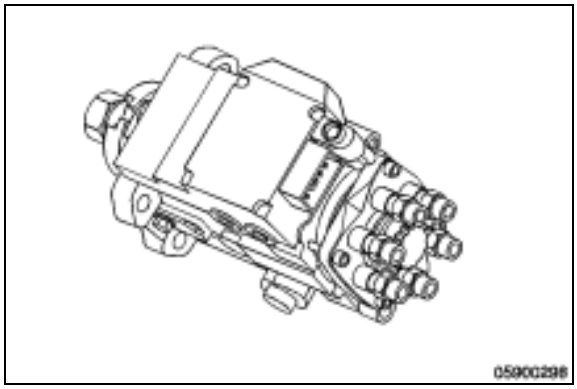
If the above checks are okay, remove the pump. Refer to Procedure 005-045 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Have the timing checked at an authorized Bosch® service shop.

Follow-Up

Fuel Injection Pump Initial Test

General Information



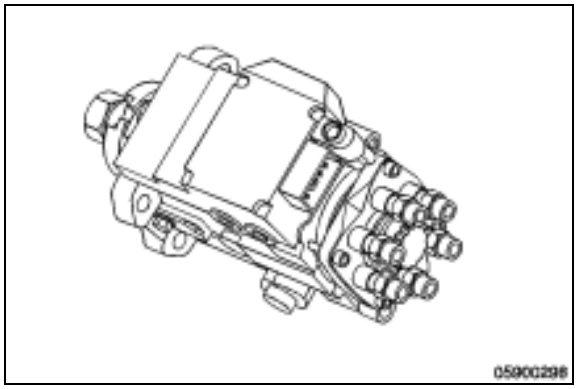
The fuel injection pump (VP44) is an electronic rotary distributor pump. The pump performs four basic functions:

- Producing the high fuel pressure required for injection
- Metering the exact amount of fuel for each injection cycle
- Distributing the high-pressure, metered fuel to each cylinder at the precise time
- Varying the timing relative to engine speed

A cam ring with three plungers, a rotor, and an electronically controlled fueling solenoid valve is used to develop and distribute the high pressure required for injection.

A worn or damaged internal transfer pump, plunger, or fueling valve can affect the pressure and amount of fuel injected, thus reducing the power from the engine. Generally, if the fuel injection pump is injecting fuel from one outlet, it will deliver from all outlets.

VP44 Timing Principles



Timing in the VP44 is controlled by an internal timing piston coupled to a cam ring inside the pump. The timing piston is moved by fuel pressure. The amount of fuel pressure in the timing piston assembly housing is controlled by an internal transfer pump and a pulsating timing solenoid valve.

As pump speed increases, the fuel pressure to the timing piston assembly also increases. Based on the inputs from the fuel pump control module (FPCM), the timing solenoid valve pulses to vary the pressure to move the timing piston, which results in the cam ring moving to the desired position to achieve the commanded timing.

The more pressure created by the internal transfer pump and timing solenoid valve, the more the timing will advance; therefore, timing range capability is increased at higher rpm.

Fuel Injection Pump Initial Test (Cont)

Initial Check

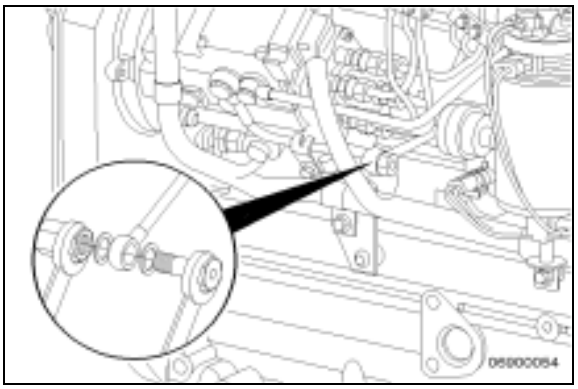
WARNING

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

WARNING

Do not vent the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

Disconnect the VP44 fuel pump drain line from the T-fitting and plug it.



Disconnect the vacuum gauge plastic tubing from the cylinder head's drain line and connect it to the VP44 fuel pump inlet line.

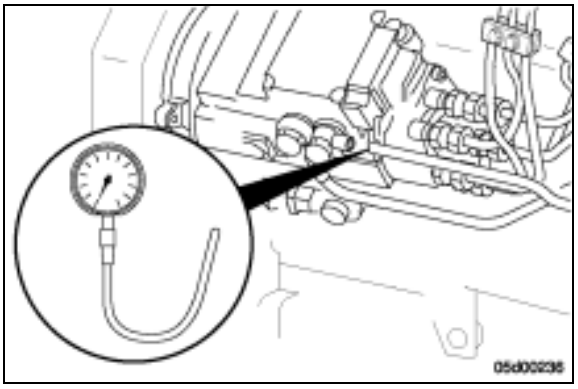
NOTE: All fuel must be drained from all fuel lines, if observed.

Apply the vacuum test to the fuel system and check the vacuum gauge. The vacuum can not exceed 381 to 508 mm Hg [15 to 20 in Hg].

If the system holds the vacuum (if the reading on the gauge does not reduce, the vacuum should not drop more than 2.54 mm Hg [0.1 in Hg] in a minute), then there is no leak in the fuel system.

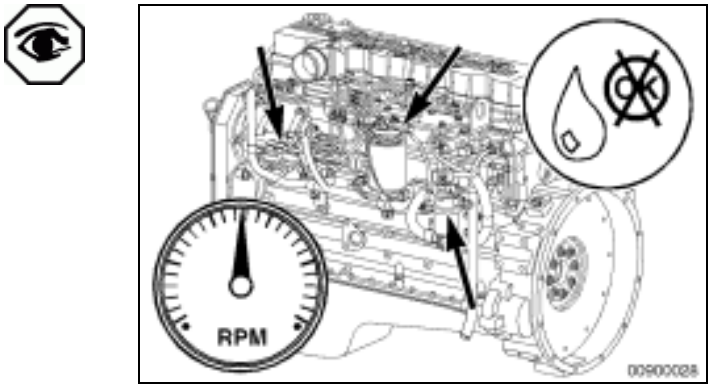
NOTE: The vacuum test is completed if the fuel system holds vacuum for at least 5 minutes.

If the system does not hold vacuum (the reading on the gauge does not hold and reduce to 0 mm Hg [0 in Hg], then there is a leak in the fuel system.



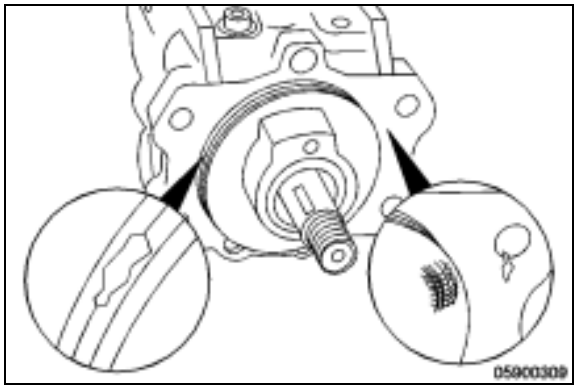
Fuel Injection Pump Initial Test (Cont)

If the system does not hold a vacuum, check for leaks at the VP44 fuel pump.



Inspect the lines, fittings, washers, and VP44 fuel pump for any damage. Replace and install parts that are damaged.

Contact an Authorized Cummins Repair Facility for replacement and installation of the VP44 fuel pump, if required.



Fuel Injection Pump Removal/Installation

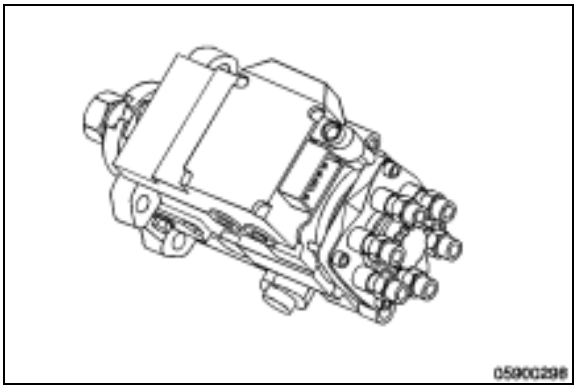
Prepare

Disconnect the battery cables, negative (-) cable first.

Remove

Remove, clean, and inspect the injection pump for reuse. Refer to Fuel Injection Pump, Rotary (53-005-014) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

General Information



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Fuel Injection Pump Removal/Installation (Cont)

VP44 Timing Principles

Timing in the VP44 is controlled by an internal timing piston coupled to a cam ring inside the pump. The timing piston is moved by fuel pressure. The amount of fuel pressure in the timing piston assembly housing is controlled by an internal transfer pump and a pulsating timing solenoid valve.

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The more pressure created by the internal transfer pump and timing solenoid valve, the more the timing will advance; therefore, timing range capability is increased at higher RPM.

Initial Check

WARNING

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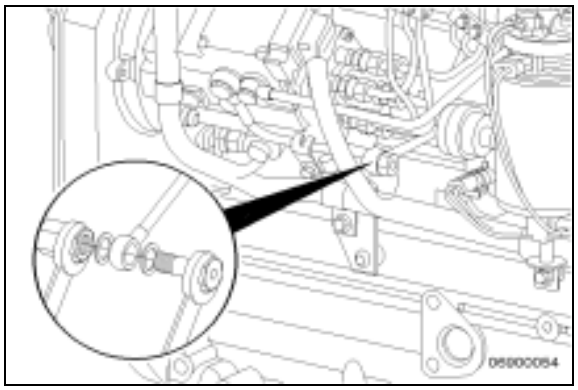
WARNING

Do not vent the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

Disconnect the VP44 fuel pump drain line from the T-fitting and plug it.



Fuel Injection Pump Removal/Installation (Cont)

Disconnect the vacuum gauge plastic tubing from the cylinder head's drain line and connect it to the VP44 fuel pump inlet line.

NOTE: All fuel must be drained from all fuel lines, if observed.

Apply the vacuum test to the fuel system and check the vacuum gauge. The vacuum can not exceed 381 to 508 mm Hg [15 to 20 in Hg].

If the system holds the vacuum (if the reading on the gauge does not reduce, the vacuum should not drop more than 2.54 mm Hg [0.1 in Hg] in a minute), then there is no leak in the fuel system.

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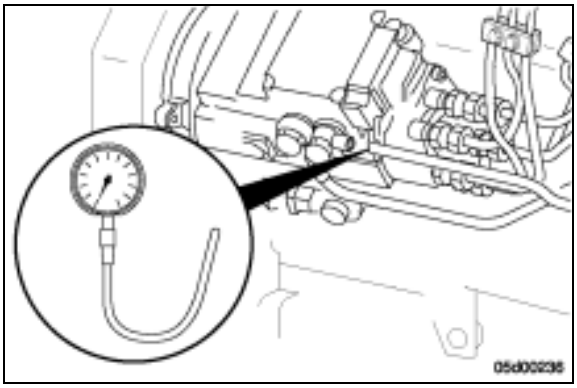
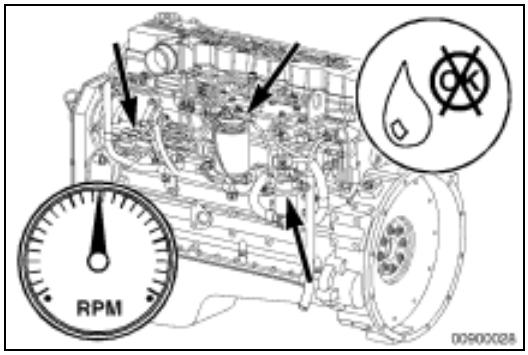
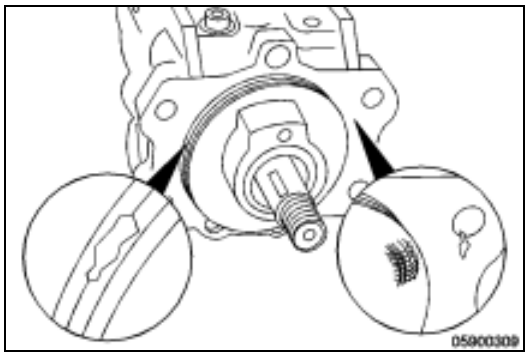


If the system does not hold a vacuum, check for leaks at the VP44 fuel pump.



Inspect the lines, fittings, washers, and VP44 fuel pump for any damage. Replace and install parts that are damaged.

Contact an Authorized Cummins Repair Facility for replacement and installation of the VP44 fuel pump, if required.



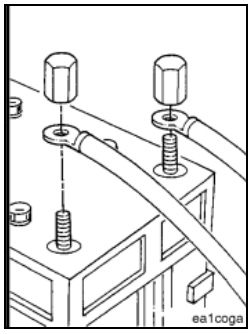
Fuel Injection Pump Removal/Installation (Cont)

REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

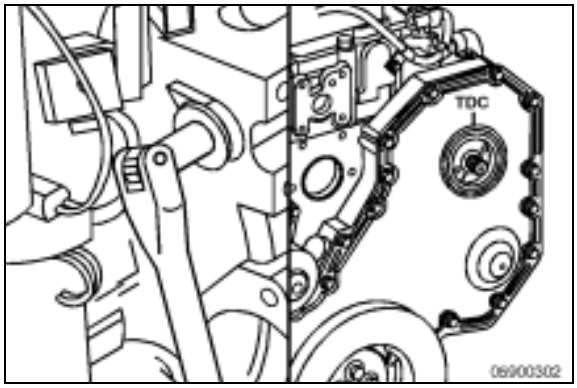
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



It is recommended to bar the engine over so that the keyway on the gear is at the 12-o'clock position when removing the fuel pump. This position can be found by taking the oil fill or fuel pump gear access cap off, whichever applies, and aligning the keyway in the fuel pump gear to the top dead center (TDC) position on the front cover. In this position the line on the fuel pump gear will approximately be in the 7-o'clock position.

NOTE: Doing the above will help prevent the fuel pump key from falling into the housing if it is loose.



Fuel Injection Pump Removal/Installation (Cont)

WARNING

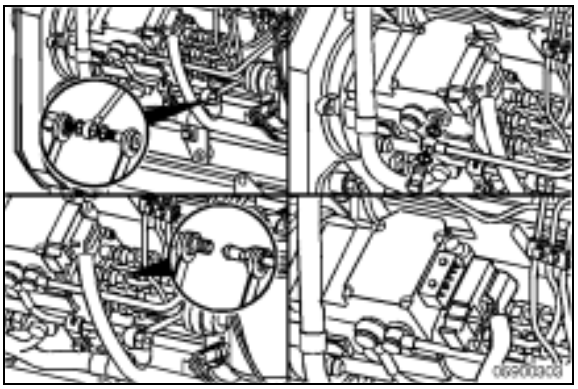
Fuel is flammable. Keep all cigarettes, flames, pilot lights, arcing equipment, and switches out of the work area and areas sharing ventilation to reduce the possibility of severe personal injury or death when working on the fuel system.

Disconnect the fuel return line. Refer to Procedure 006-013 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

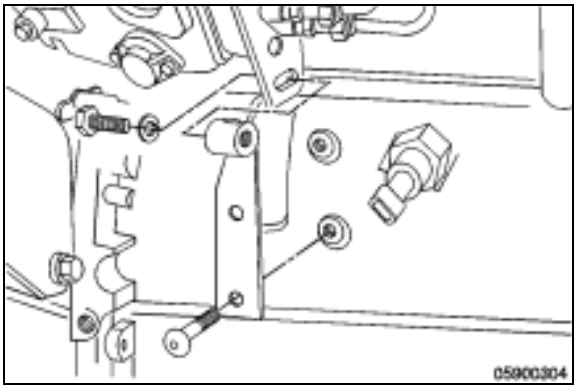
Disconnect the fuel pump supply line. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Remove the high-pressure lines. Refer to Procedure 006-051 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Remove the 9-pin electrical connector from the fuel pump control module (FPCM).

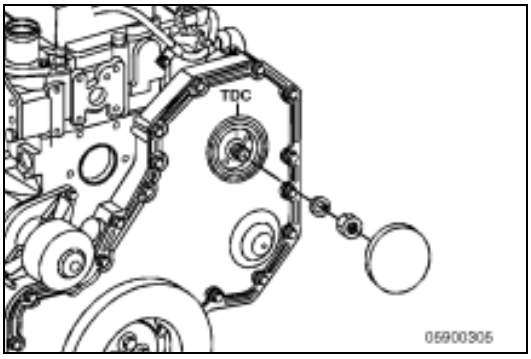


Remove the fuel pump support bracket.



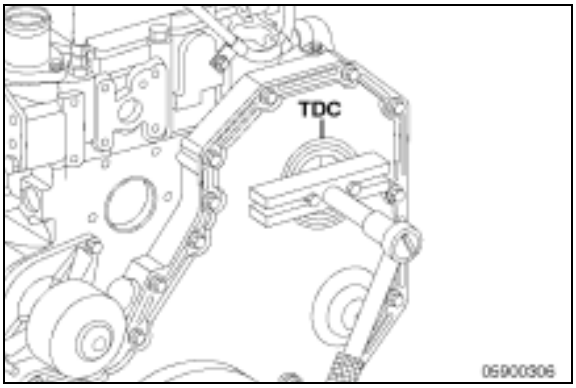
Fuel Injection Pump Removal/Installation (Cont)

Remove the crankcase breather and gear retaining nut and washer. Refer to Procedure 003-018 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.



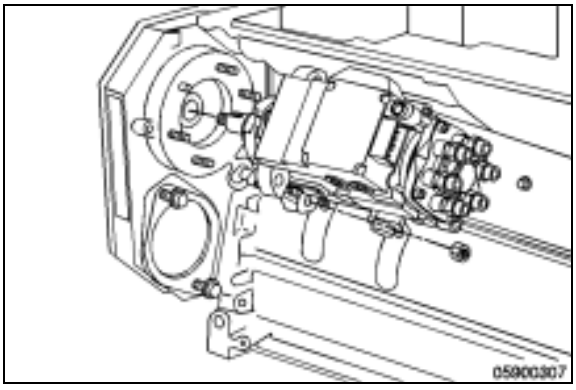
75-mm T-Bar

Pull the fuel injection pump drive gear loose from the pump driveshaft.



NOTE: Do not drop the drive gear key when removing the pump.

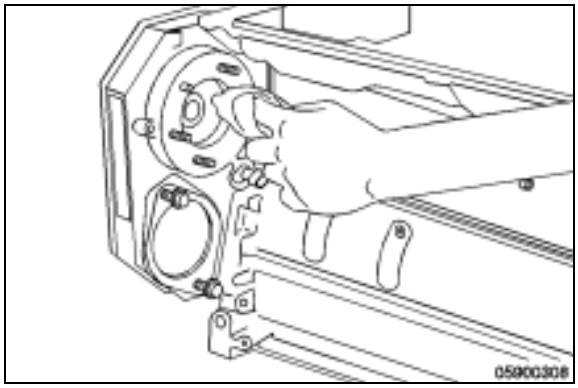
Remove the four mounting nuts, and remove the fuel injection pump.



Fuel Injection Pump Removal/Installation (Cont)

Clean

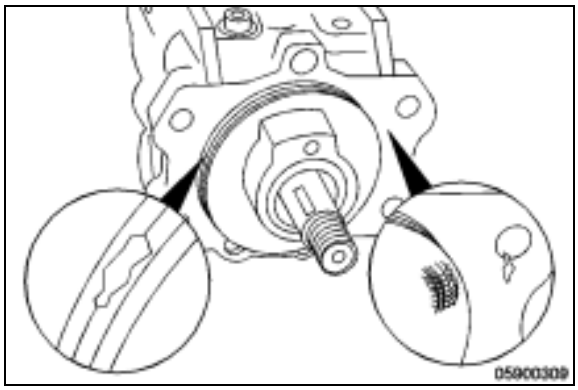
Use a clean, dry cloth to wipe all of the oil off the back of the gear housing mounting surface and pump housing.



Inspect for Reuse

Inspect the mounting surfaces for damage.

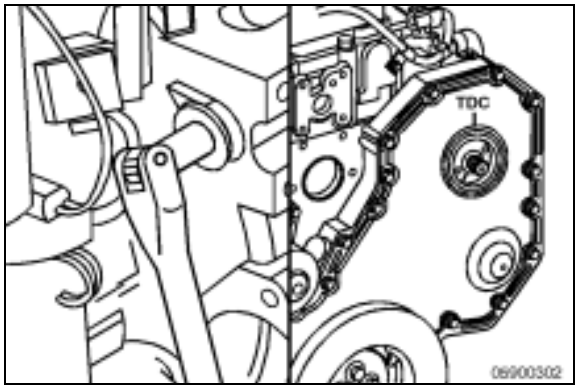
Inspect the fuel pump mounting o-ring for cuts or damage.



Install

It is recommended to bar the engine over so that the keyway on the gear is at the 12-o'clock position when installing the fuel pump. This position can be found by taking the oil fill or fuel pump gear access cap off, whichever applies, and aligning the keyway in the fuel pump gear to the top dead center (TDC) position on the front cover. In this position the line on the fuel pump gear will approximately be in the 7-o'clock position.

NOTE: Doing the above will help prevent the fuel pump key from falling into the gear housing if it is loose.



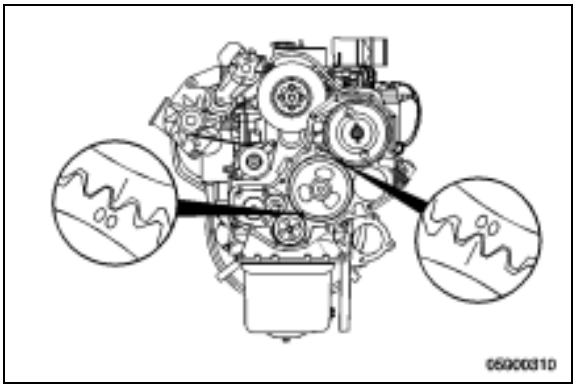
Fuel Injection Pump Removal/Installation (Cont)

CAUTION

The driveshaft must be clean and free of all oil before installation. Failure to do so can result in the drive gear slipping on the shaft.

The keyed gear and shaft allow for the fuel injection pump to be installed in any position, as long as the markings on the front gear train align and a gear has not slipped.

Use an evaporative cleanser (e.g., brake cleaner, isopropyl alcohol) to clean the pump shaft and gear bore.

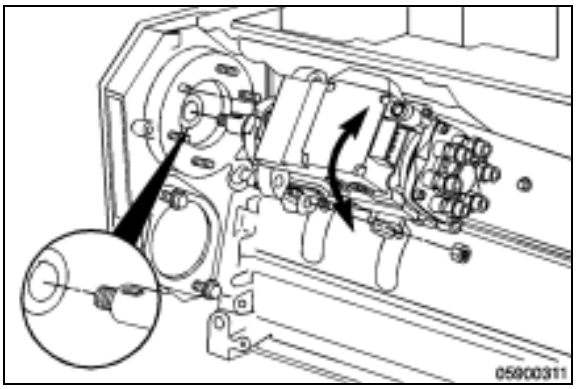


NOTE: The fuel injection pump shaft has to be rotated to align with the keyway in the gear.

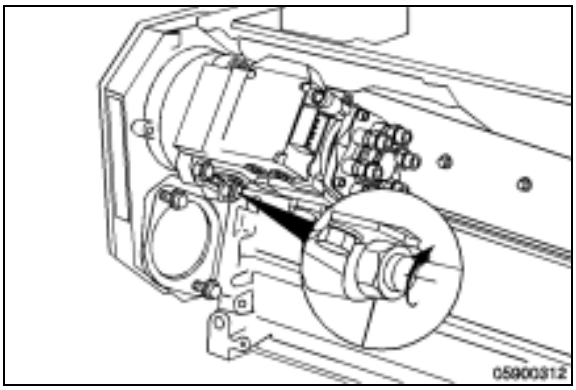
Install the pump. Make sure the key does not fall into the gear housing. Take care not to damage the pump mounting o-ring.

NOTE: When installing the fuel pump, the dowel in the back of the gear housing has to line up with the hole in the pump mounting flange, as well as the keyway in the gear.

NOTE: Barring the engine so the keyway is at the 12-o'clock position will aid in aligning the key into the keyway.



Hand-tighten the four mounting nuts.

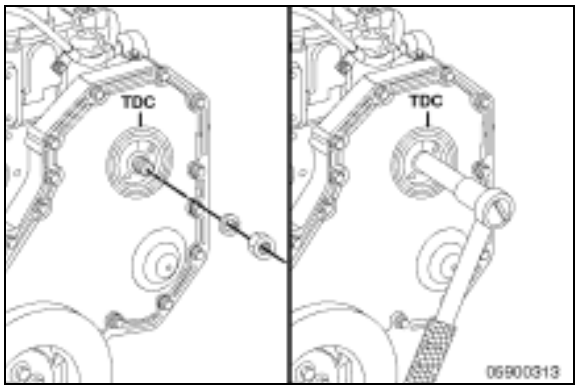


Fuel Injection Pump Removal/Installation (Cont)

Install the pump driveshaft nut and spring washer.

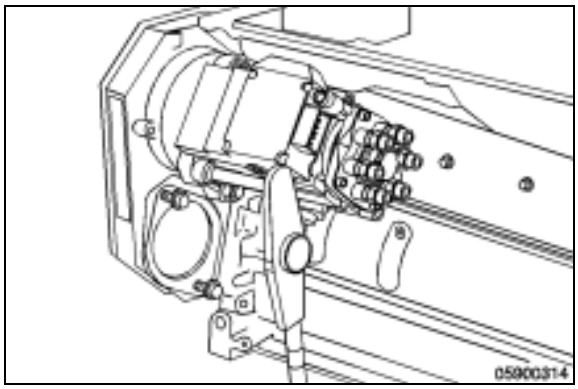
Torque Value: 30 N•m [22 ft-lb]

NOTE: Do not overtighten; this is not the final torque.



Tighten the fuel injection pump mounting nuts.

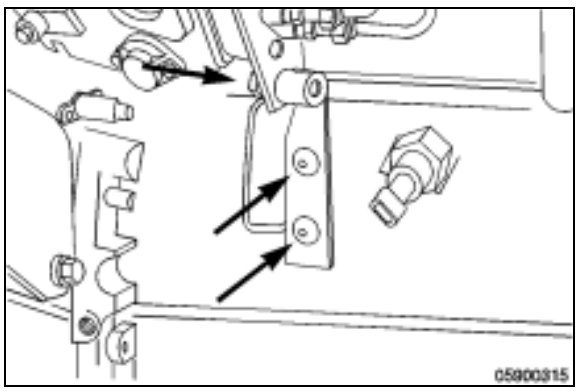
Torque Value: 43 N•m [32 ft-lb]



Install the injection pump support bracket. Finger-tighten all capscrews before final tightening.

Tighten the brackets in the following sequence:

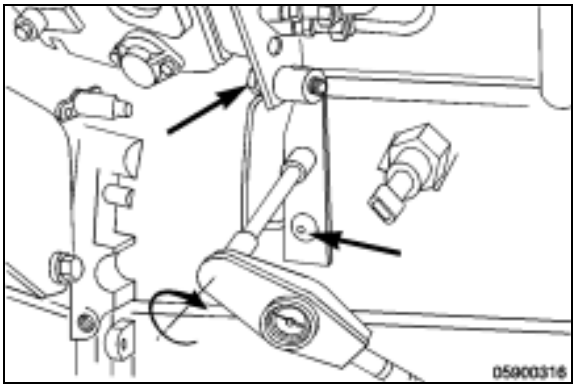
- Bracket-to-fuel pump capscrews
- Brace-to-block capscrews
- Bracket-to-fuel pump brace capscrews.



Fuel Injection Pump Removal/Installation (Cont)

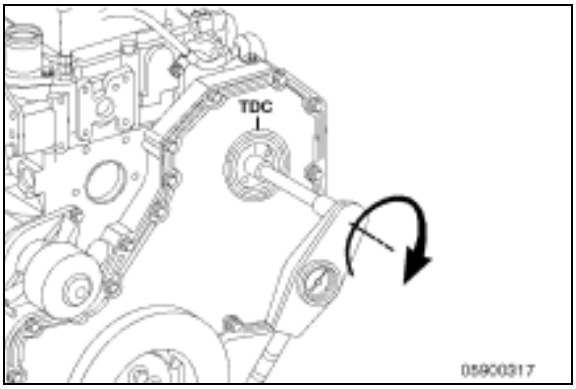
Tighten all capscrews on the support bracket.

Torque Value: 24 N•m [212 in-lb]

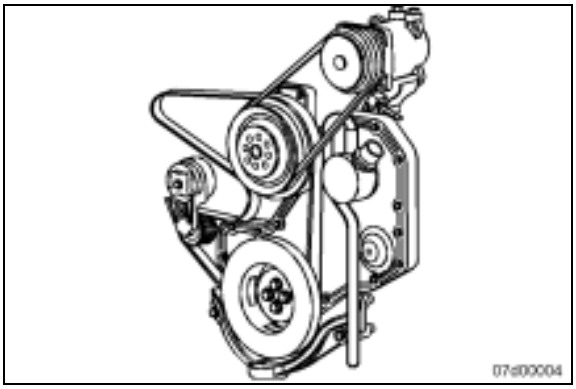


Tighten the pump driveshaft retaining nut.

Torque Value: 170 N•m [125 ft-lb]



Install the crankcase breather. Refer to Procedure 003-018 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.



Fuel Injection Pump Removal/Installation (Cont)

Install the low-pressure fuel lines. Refer to Procedure 006-024.

Install the fuel Inlet. Refer to Procedure 006-024.

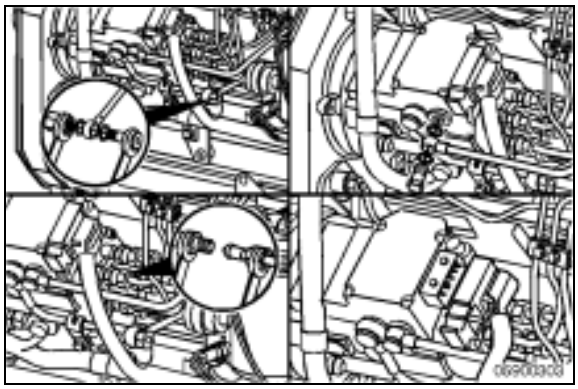
Install the fuel return lines. Refer to Procedure 006-013.

Install the high-pressure line at the fuel pump. Refer to Procedure 006-051.

Install a high-pressure line at the cylinder head. Refer to Procedure 006-051.

Connect the 9-pin connector to the VP44 fuel pump.

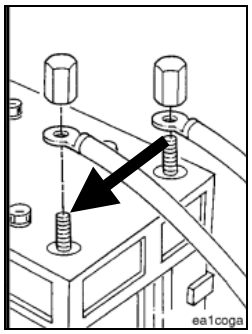
NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.



For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

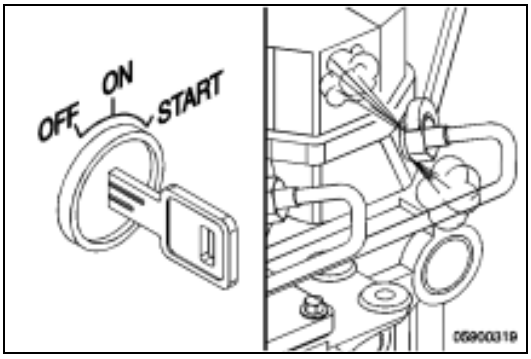
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Fuel Injection Pump Removal/Installation (Cont)

Vent all air from the fuel system, if needed. Refer to Procedure 006-003 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.



Install

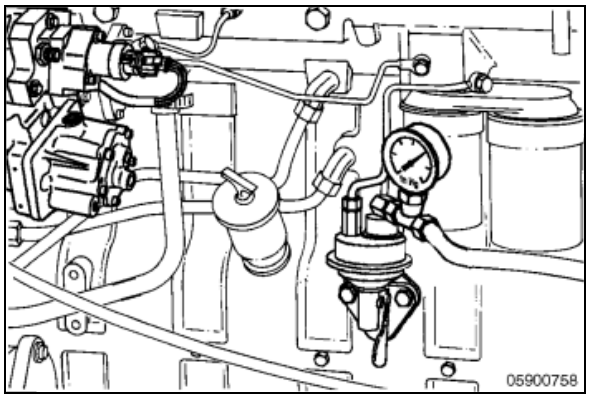
Install the fuel injection pump. Refer to Fule Injection Pump, Rotary (53-005-014) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Follow-Up

Fuel Lift Pump Initial Check

Initial Check

Perform the initial check. Refer to Fuel Lift Pump (53-005-045) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

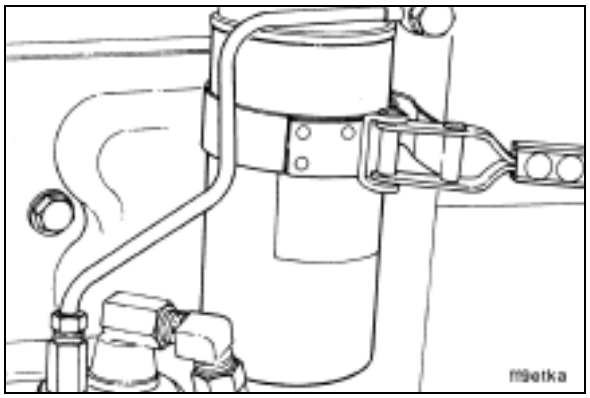


Initial Check

Measure the pressure drop across the fuel filter at low idle. If the filter restriction is above the maximum, it must be replaced.

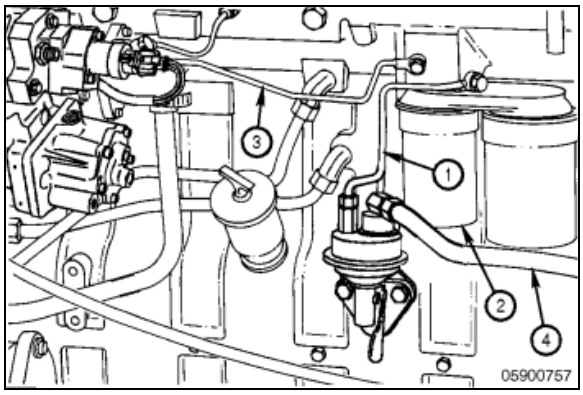
Pressure Drop Across Filter

MAX Diaphragm Lift Pump 21 kPa [3 psi]



Check for a restriction between the fuel lift pump and the fuel injection pump.

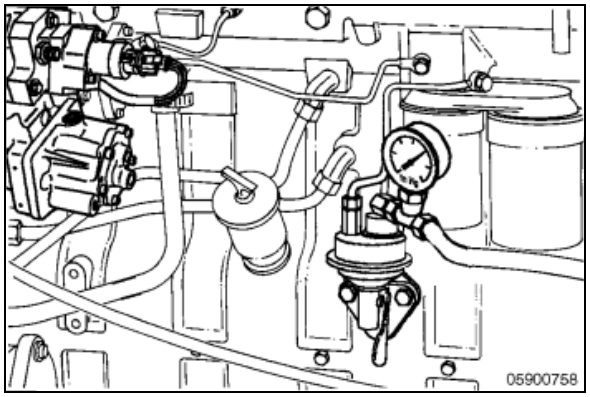
- Supply line to fuel filter
- Fuel filter
- Supply line to fuel injection pump
- Fuel inlet line from tank



Fuel Lift Pump Initial Check (Cont)

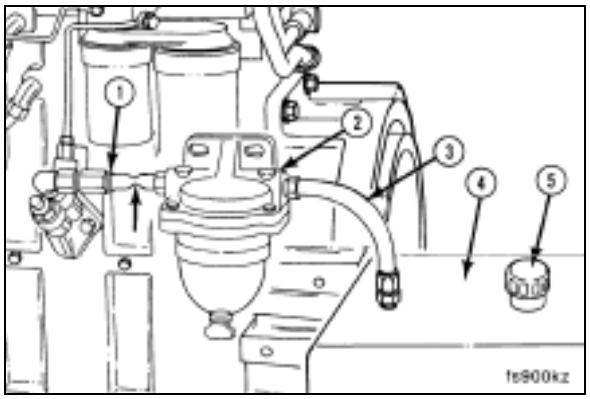
Measure the fuel lift pump inlet restriction with a vacuum gauge between the fuel lift pump inlet and the supply line (4) from the fuel tank.

Fuel Lift Pump Inlet Restriction MAX 27 kPa [8 in-hg]

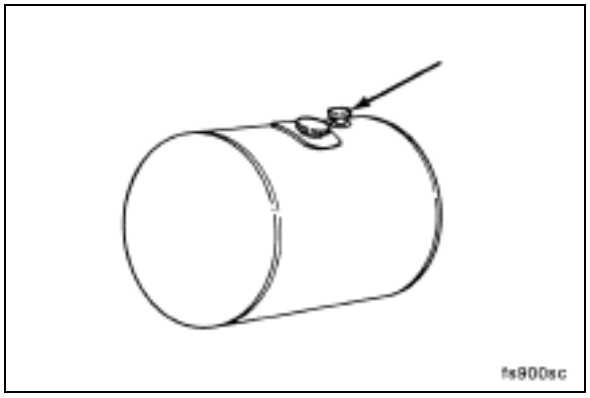


If the inlet restriction is above the maximum, check for restrictions or suction leaks in the fuel circuit to the fuel lift pump:

- Supply line
- Prefilter
- Supply line
- Supply tank
- Tank vent



Look for a plugged supply tank vent first.



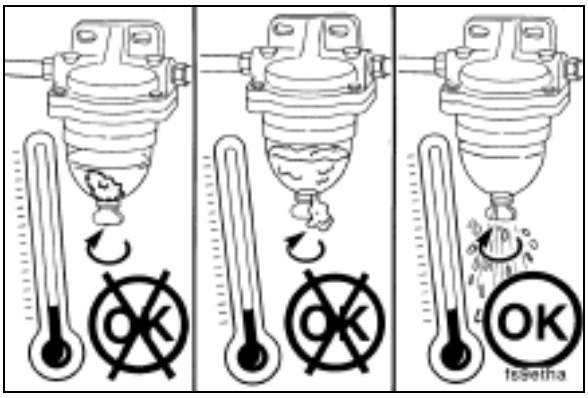
Fuel Lift Pump Initial Check (Cont)

Fuel prefilters, inline and water separator type, can become clogged and cause a loss of fuel flow.

Check the prefilter for clogs or restrictions.

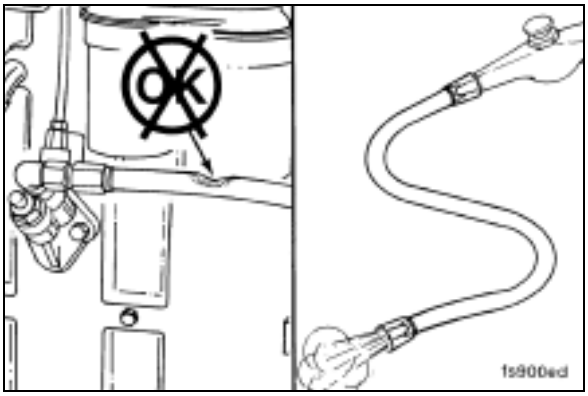
In cold weather, check the prefilter for gelled fuel.

Clean or replace the prefilter, if necessary.



Check for kinks or bends in the fuel supply line that can cause a restriction in the fuel flow.

Remove and blow out the fuel supply lines.



Fuel Lift Pump Removal/Installation

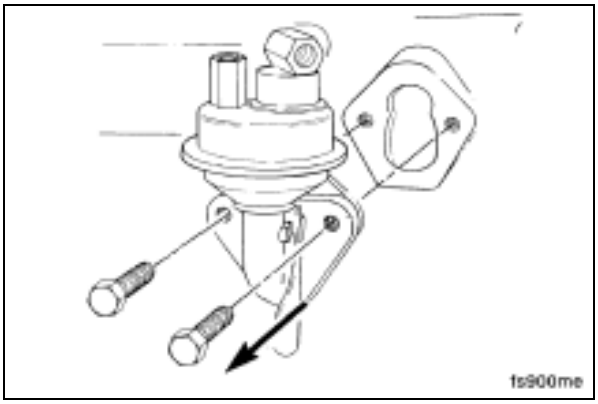
Prepare

Clean debris from the fuel line fittings and the fuel lift pump.

Disconnect the low-pressure fuel lines. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Remove

Remove the fuel lift pump. Refer to Fuel Lift Pump (53-005-045) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Preparatory Steps

WARNING

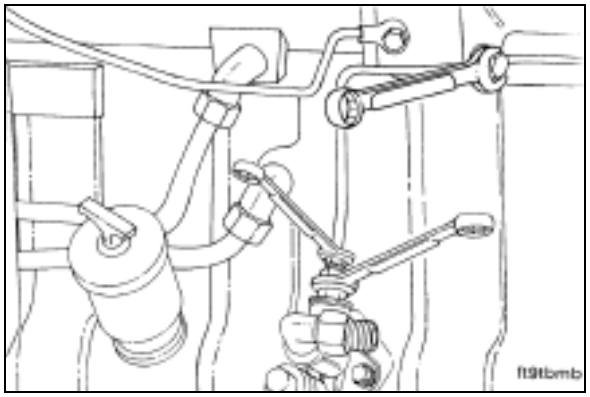
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

WARNING

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

Clean debris from the fuel line fittings and the fuel lift pump.

Disconnect the low-pressure fuel lines. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

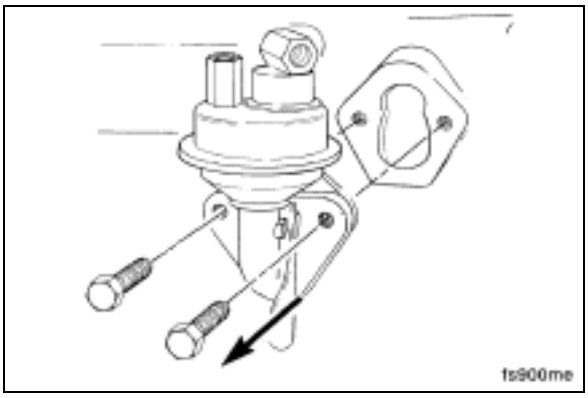


Fuel Lift Pump Removal/Installation (Cont)

Remove

Remove the two fuel lift pump mounting capscrews.

Remove the fuel lift pump.

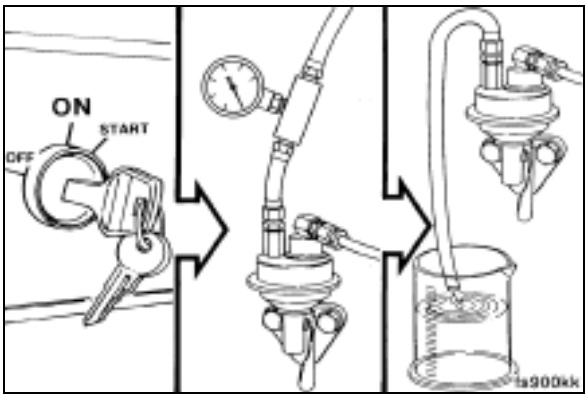


Test

The output of the fuel lift pump can be checked in two ways:

Test 1: Measure the output pressure using an in-line pressure gauge installed between the filter head and the fuel injection pump.

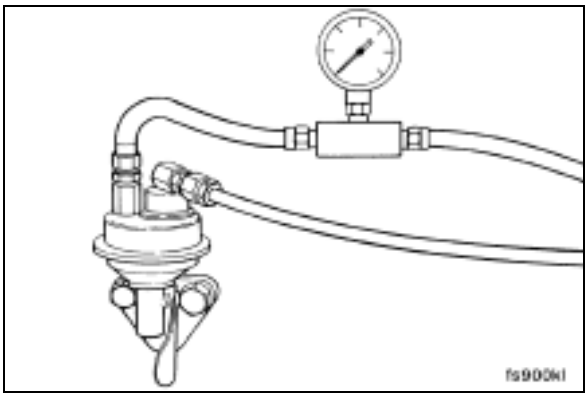
Test 2: Measure the flow volume.



Test 1: Output Pressure Test (Diaphragm Style)

Operate the engine and measure the output pressure of the fuel lift pump using an in-line pressure gauge at the inlet to the injection pump.

The minimum pressure at high idle is 21 kPa [3 psi].



Fuel Lift Pump Removal/Installation (Cont)

Test 2: Flow Volume Test (Diaphragm Style)

CAUTION

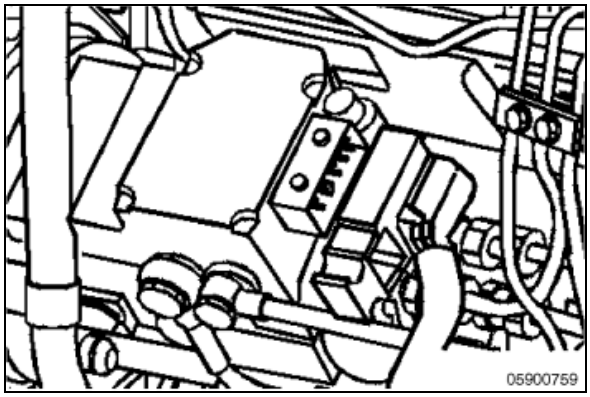
To prevent the engine from starting, disconnect the 9-pin connector.

CAUTION

Do not crank the starter for more than 30 seconds at a time. Doing so can result in starter damage. Also, high voltage during cranking can damage the shutdown solenoid.

Disconnect the 9-pin fuel pump connector, and measure the engine cranking speed with a handheld tachometer, Part Number 3377462.

The minimum cranking speed is 125 rpm.



CAUTION

Leave the 9-pin fuel pump connector disconnected for the following check.

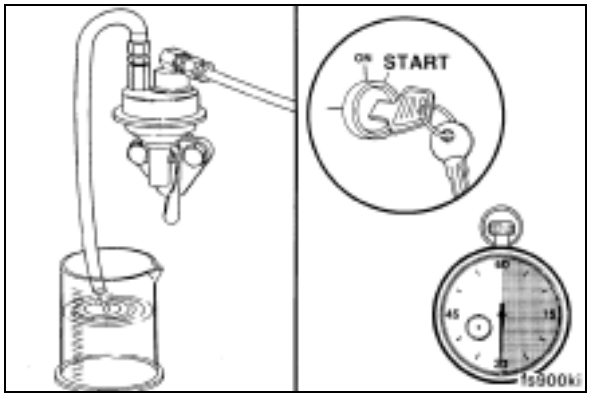
CAUTION

Do not crank the starter for more than 30 seconds at a time. Doing so can result in starter damage. Also, high voltage during cranking can damage the shutdown solenoid.

Disconnect the output pressure line from the fuel lift pump, and run it into a container.

Measure the fuel lift pump flow volume while cranking the engine with the starter for 30 seconds.

The minimum flow volume is 150 mL [5 oz].



Fuel Lift Pump Removal/Installation (Cont)

Install

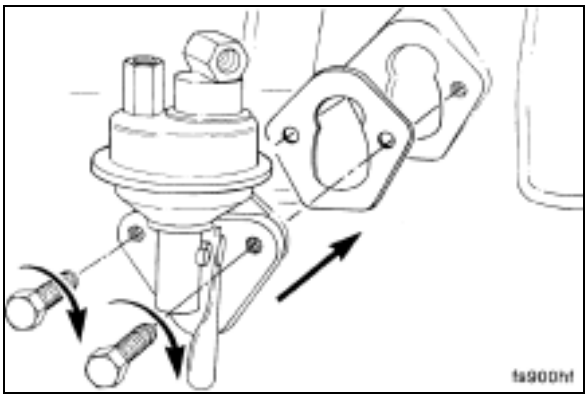
CAUTION

Alternately tighten the mounting capscrews. As the capscrews are tightened, the fuel lift pump lever arm is pushed into the pump. Failure to tighten the capscrews in an even manner can result in the lever arm being bent or broken, causing sticking and failure.

Diaphragm style

Install the pump.

Torque Value: 24 N•m [18 ft-lb]



Finishing Steps

Install the following:

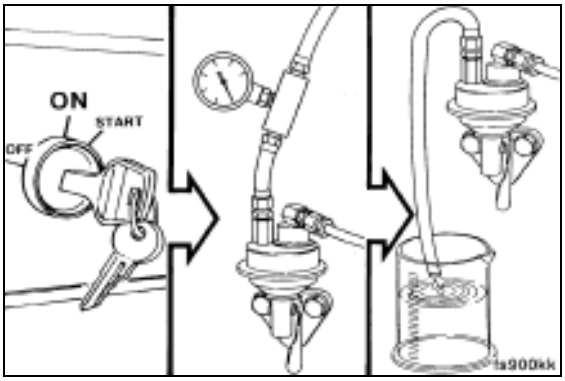
Fuel line to the fuel lift pump and fuel filter head. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Vent the low-pressure fuel lines. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Clear any fault codes generated during testing. Refer to the Electronic Control System Troubleshooting and Repair Manual, Bulletin 3666194.

Test

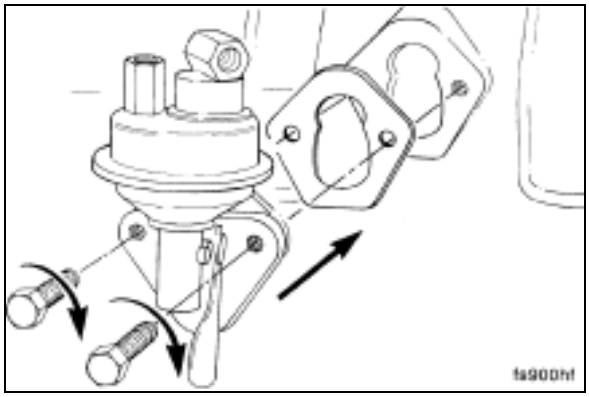
Bench test the fuel lift pump. Refer to Fuel Lift Pump (53-005-045) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Fuel Lift Pump Removal/Installation (Cont)

Install

Install the fuel lift pump. Refer to Fuel Lift Pump (53-005-045) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Follow-Up

Install the following:

Fuel line to the fuel lift pump and fuel filter head. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Vent the low-pressure fuel lines. Refer to Procedure 006-024 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.

Clear any fault codes generated during testing. Refer to the Electronic Control System Troubleshooting and Repair Manual, Bulletin 3666194.

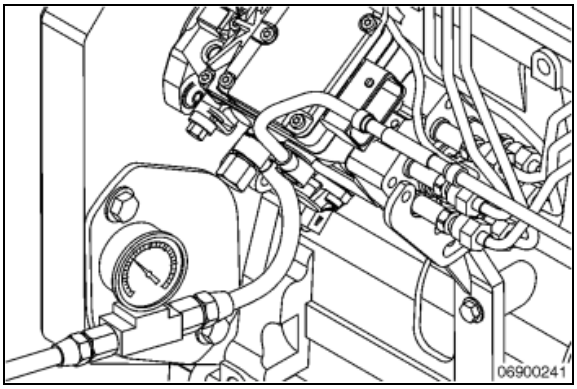
Measure Fuel Drain Line Restriction

Prepare

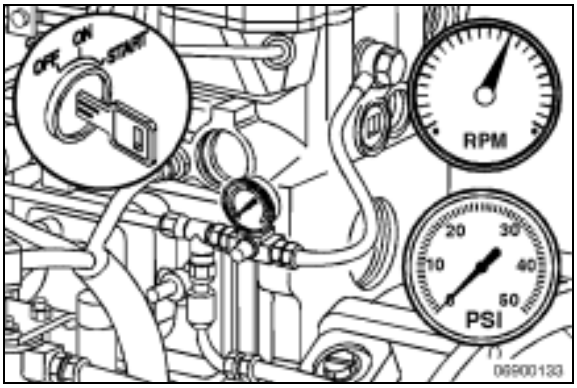
Measure

Remove the fuel drain line from the fitting at the injection pump.

Install the 0 to 207 kPa [0 to 30 psi] pressure gauge.



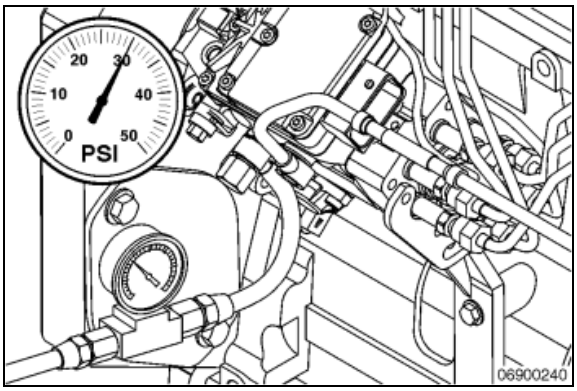
Operate the engine at rated speed and no load.



Observe the reading on the pressure gauge.

Maximum Fuel Drain Line Restriction: 69 kPa 10 psi

If the drain line pressure is out of specification, check for bends or kinks in the drain lines.



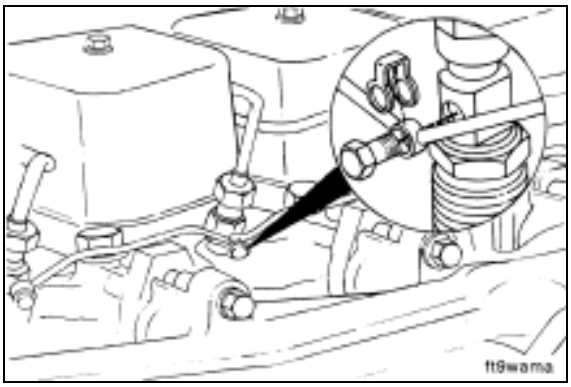
Follow-Up

Fuel Drain Lines Removal/Installation

Prepare

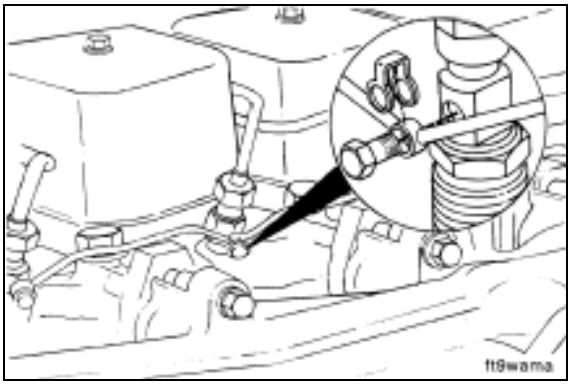
Remove

Remove, clean, and inspect the fuel drain lines for reuse. Refer to Fuel Drain Lines (53-006-013) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

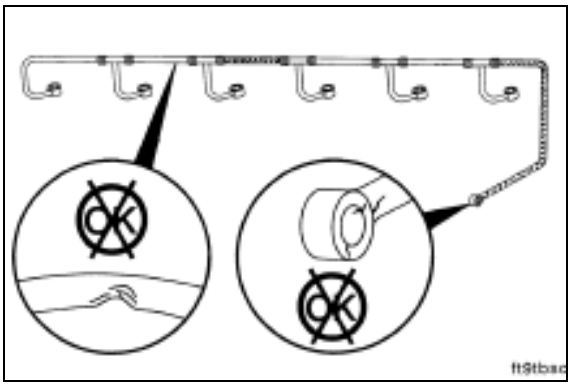


Remove

Remove the banjo fitting capscrews and washers.



Remove the banjo capscrew and sealing washers at the fuel filter head.



Fuel Drain Lines Removal/Installation (Cont)

Clean

WARNING

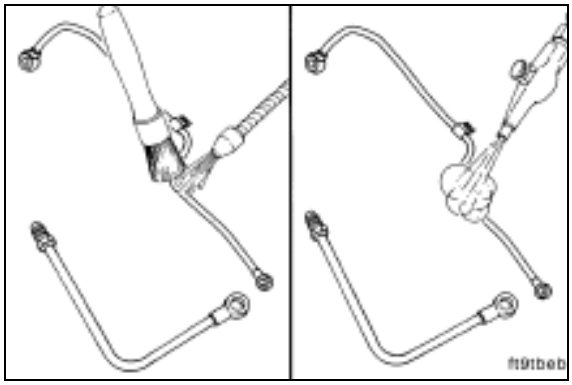
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to avoid personal injury.

WARNING

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

Wash the low-pressure fuel lines in solvent.

Dry the fuel lines with compressed air.

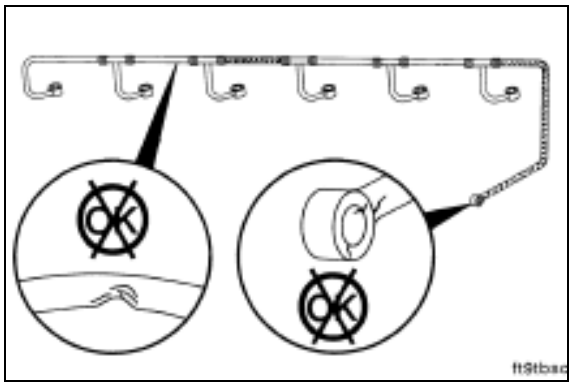


Inspect for Reuse

Inspect the fuel drain lines for cracks and other damage.

Inspect the fuel drain manifold banjo connections.

NOTE: The banjo connection seals must be discarded when removed.

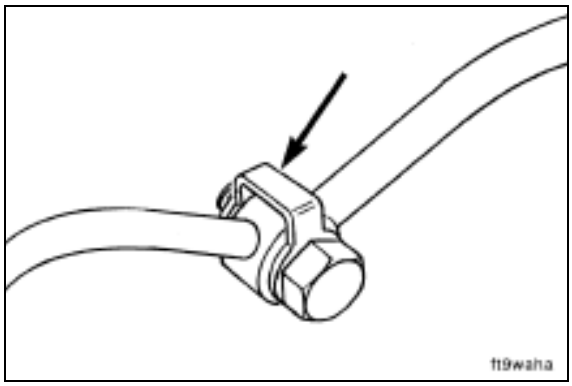


Install

Install the banjo capscrew and sealing washers at the fuel filter head.

Install the banjo fitting capscrews and washers.

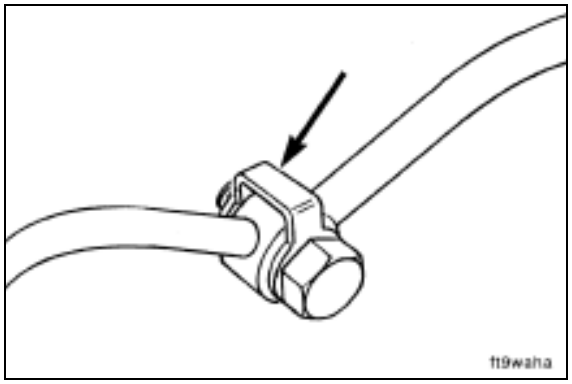
Torque Value: 9 N•m [80 in-lb]



Fuel Drain Lines Removal/Installation (Cont)

Install

Install the fuel drain lines. Refer to Fuel Drain Lines (53-006-013) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Follow-Up

Low Pressure Fuel Supply Lines Removal/Installation

Prepare

Thoroughly clean all fittings and components before removal. Make sure that the debris, water, steam, or cleaning solution does not reach the inside of the fuel system.

Remove

Refer to Fuel Supply Lines (53-006-024) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Vent

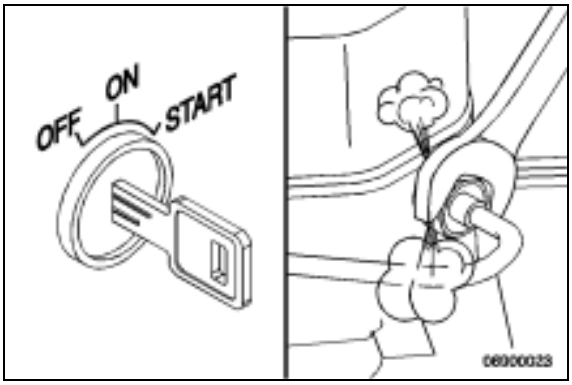
High Pressure Fuel Line(s)

WARNING

The pressure of the fuel in the line is sufficient to penetrate the skin and cause serious personal injury. Wear gloves and protective clothing.

Check for air in the high-pressure lines by loosening the fittings at the cylinder head, and crank the engine to allow entrapped air to vent from the line. Tighten the fittings.

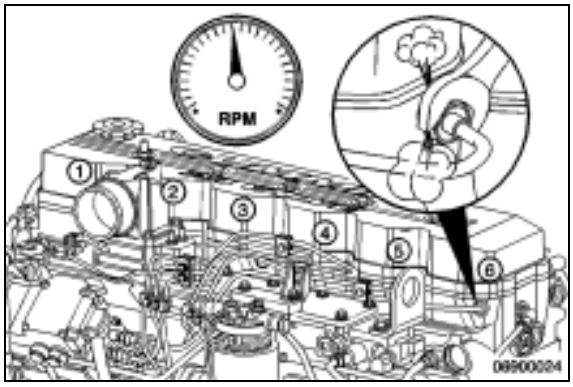
Torque Value: 40 N•m [30 ft-lb]



WARNING

Do not vent the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

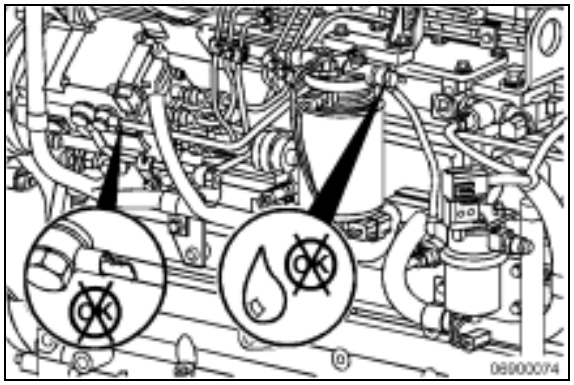
Operate the engine, and vent one line at a time until the engine runs smoothly.



Low Pressure Fuel Supply Lines Removal/Installation (Cont)

Initial Check

Inspect all fuel line fittings and lines. Look for cracks in the lines or leaky fittings.



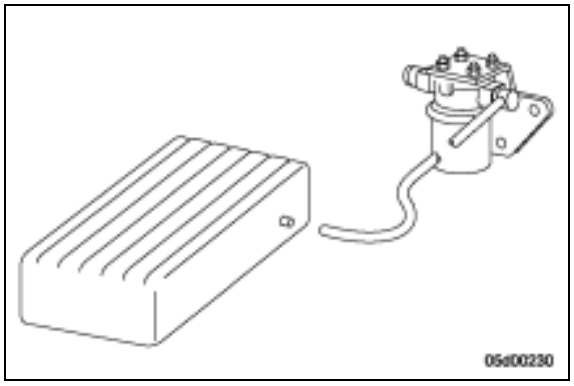
WARNING

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

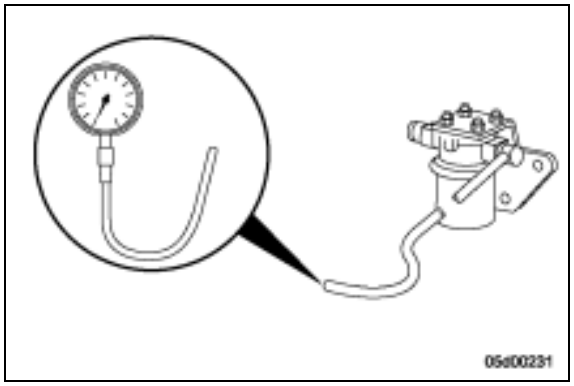
WARNING

Do not vent the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

Disconnect the fuel supply line as close to the fuel tank as possible.

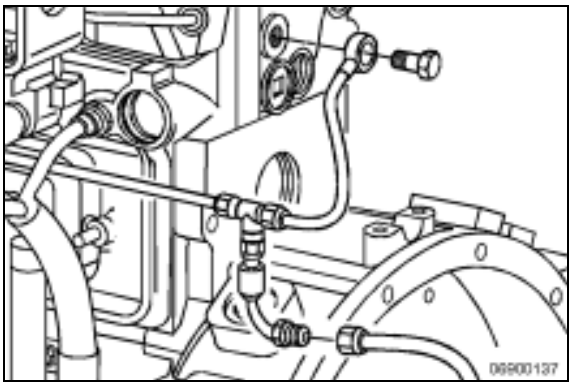


Connect the vacuum gauge plastic tubing to the fuel supply line.



Low Pressure Fuel Supply Lines Removal/Installation (Cont)

Disconnect the fuel return line from the tank (after the T-connector from the cylinder head return and the VP44 fuel pump return line and as close to the fuel tank as possible).



Plug the fuel drain return line.

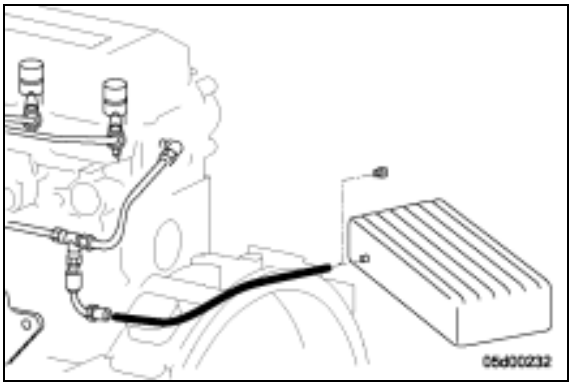
NOTE: All fuel must be drained from all fuel lines, if observed.

Apply the vacuum test to the fuel system and check the vacuum gauge. The vacuum can not exceed 381 to 508 mm Hg [15 to 20 in Hg].

If the system holds the vacuum (if the reading on the gauge does not reduce, the vacuum should not drop more than 2.54 mm Hg [0.1 in Hg] in a minute), then there is no leak in the fuel system.

NOTE: The vacuum test is completed if the fuel system holds vacuum for at least 5 minutes.

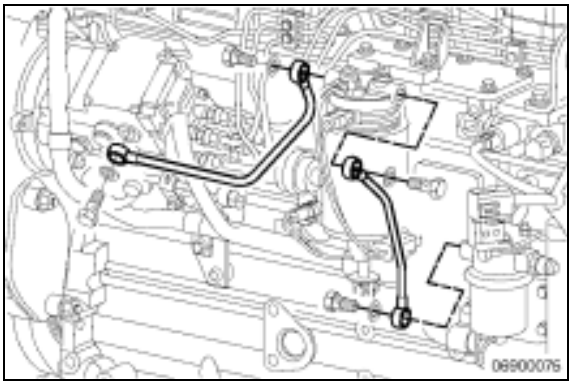
If the system does not hold vacuum (the reading on the gauge does not hold and reduce to 0 mm Hg [0 in Hg], then there is a leak in the fuel system.



Remove

Remove supply lines, banjo capscrews, and sealing washers.

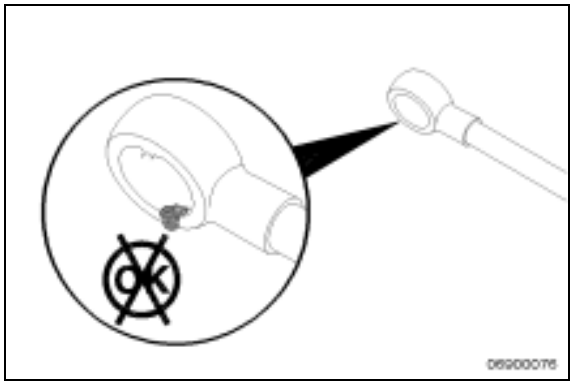
Discard sealing washers.



Low Pressure Fuel Supply Lines Removal/Installation (Cont)

Inspect for Reuse

Inspect for burrs or debris around the banjo fittings that can cause a leak.

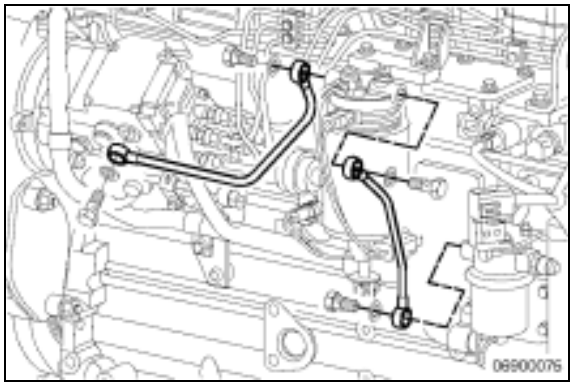


Install

Install new sealing washers.

Install fuel supply lines and banjo capscrews.

Torque Value: 24 N•m [212 in-lb]



Install

Refer to Fuel Supply Lines (53-006-024) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Follow-Up

Injector Supply Lines (High Pressure) Removal/Installation

Prepare

Clean all debris from around the fittings.

Remove

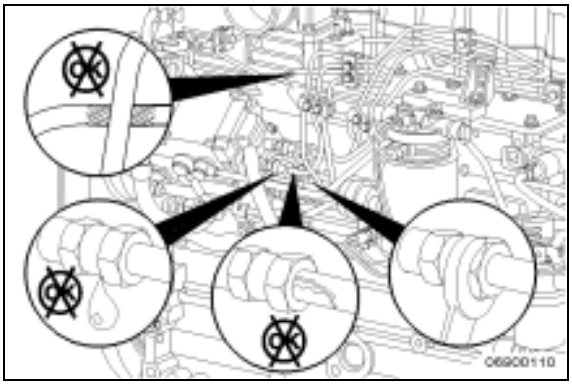
Refer to Injector Supply Lines (High Pressure) (53-006-051) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Initial Check

Inspect the lines for cracks, chafe, or leaks. Make sure the lines are tightened to the proper specification.

17 mm, Fuel Pump Connection
Torque Value: 24 N•m [212 in-lb]

19 mm, Cylinder Head Connection
Torque Value: 38 N•m [28 ft-lb]



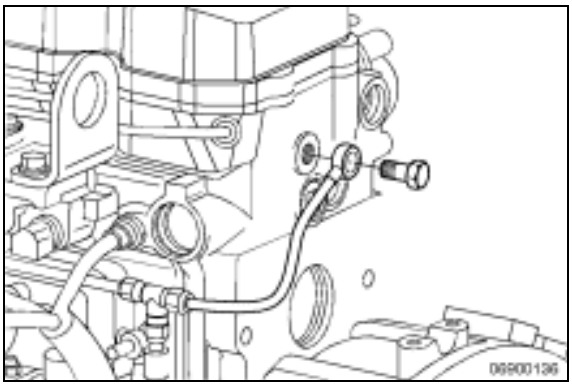
WARNING

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

WARNING

Do not vent the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

Disconnect the head's drain line from the T-fitting.



Injector Supply Lines (High Pressure) Removal/Installation (Cont)

Disconnect the vacuum gauge plastic tubing from the lift pump inlet line and connect it to the drain outlet line from the cylinder head.

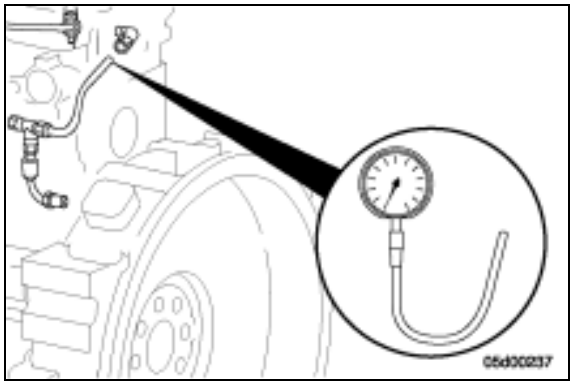
NOTE: All fuel must be drained from all fuel lines, if observed.

Apply the vacuum test to the fuel system and check the vacuum gauge. The vacuum can not exceed 381 to 508 mm Hg [15 to 20 in Hg].

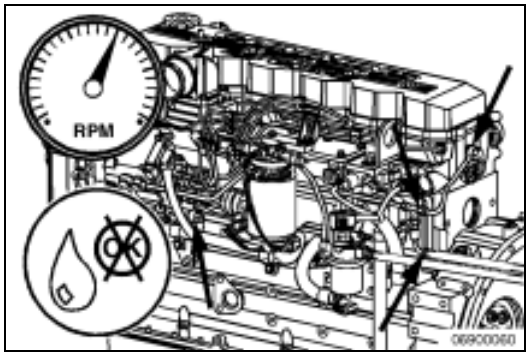
If the system holds the vacuum (if the reading on the gauge does not reduce, the vacuum should not drop more than 2.54 mm Hg [0.1 in Hg] in a minute), then there is no leak in the fuel system.

NOTE: The vacuum test is completed if the fuel system holds vacuum for at least 5 minutes.

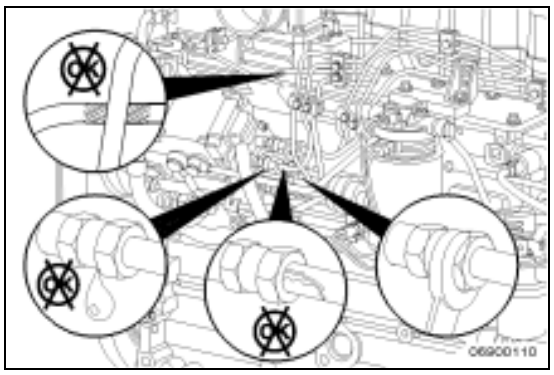
If the system does not hold vacuum (the reading on the gauge does not hold and reduce to 0 mm Hg [0 in Hg], then there is a leak in the fuel system.



If the system does not hold a vacuum, check for leaks at the cylinder head.



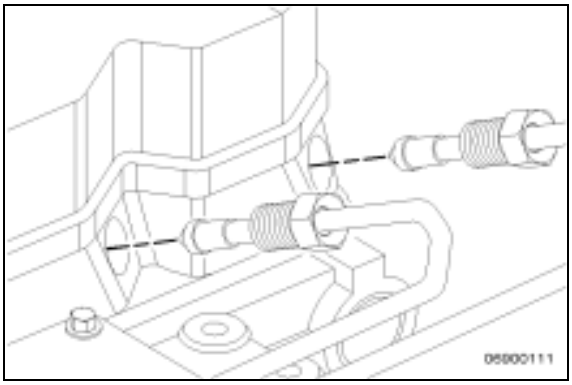
Disconnect the high-pressure fuel lines and inspect the O-rings on the connector tubes. If there is any damage to any one of them, replace the connector tubes.



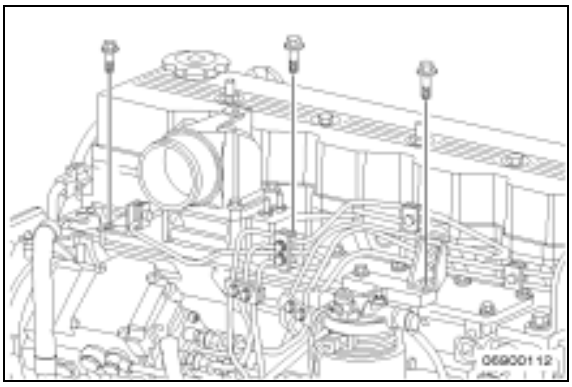
Injector Supply Lines (High Pressure) Removal/Installation (Cont)

Remove

Disconnect the high-pressure fuel lines from the cylinder head.

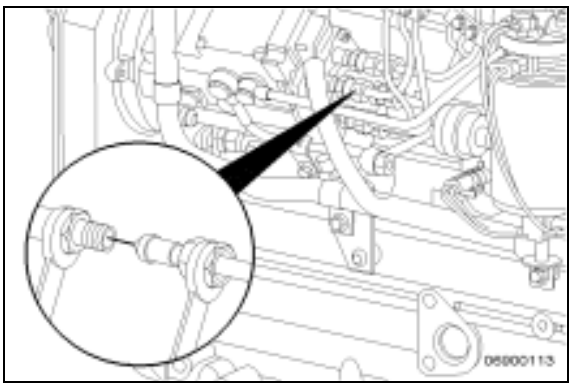


Remove the fuel line clamp capscrews from the intake cover.



Remove the fuel lines from the fuel injection pump.

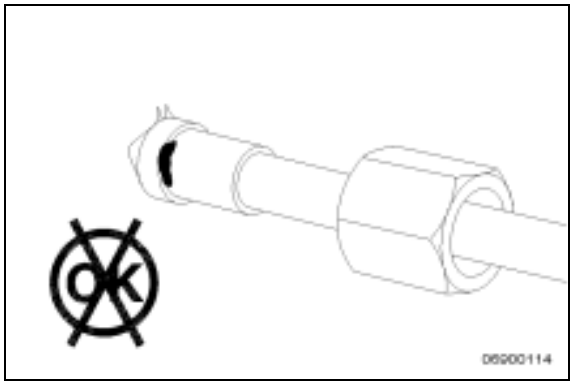
NOTE: Use two wrenches to prevent the delivery valve holder from turning.



Injector Supply Lines (High Pressure) Removal/Installation (Cont)

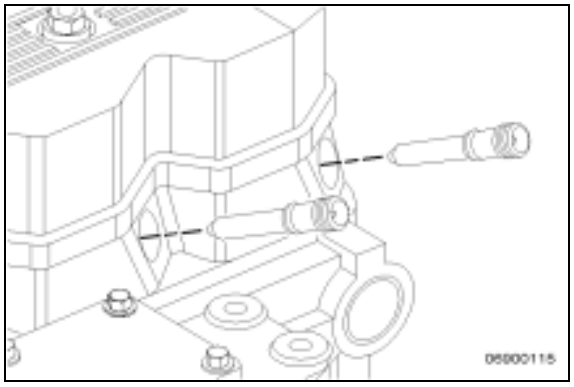
Inspect for Reuse

Inspect the ferrules of the lines for any signs of burrs or foreign material.



Install

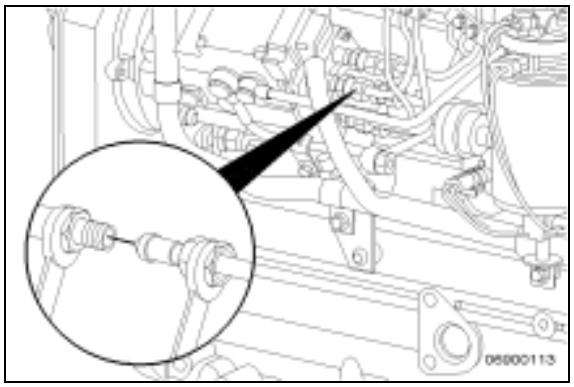
NOTE: Before installing the injector supply lines, make sure that the fuel connector is fully and properly seated against the injector.



Install the fuel lines in the reverse order of removal.

Fuel Pump Connection Torque Value:
24 N•m [212 in-lb]

Cylinder Head Connection Torque Value:
38 N•m [28 ft-lb]

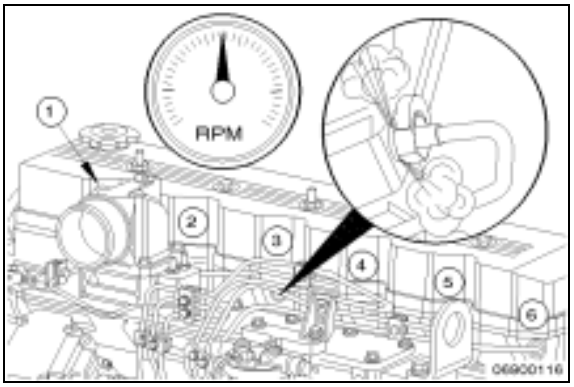


Injector Supply Lines (High Pressure) Removal/Installation (Cont)

WARNING

Do not vent the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

Operate the engine and vent one line at a time until the engine runs smoothly.



Install

Refer to Injector Supply Lines (High Pressure) (53-006-051) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Follow-Up

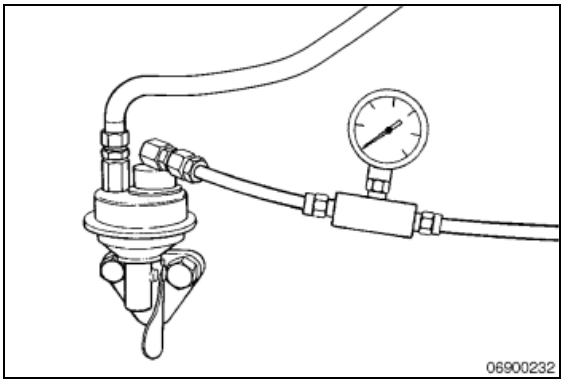
Measure Fuel Inlet Restriction

Prepare

Measure

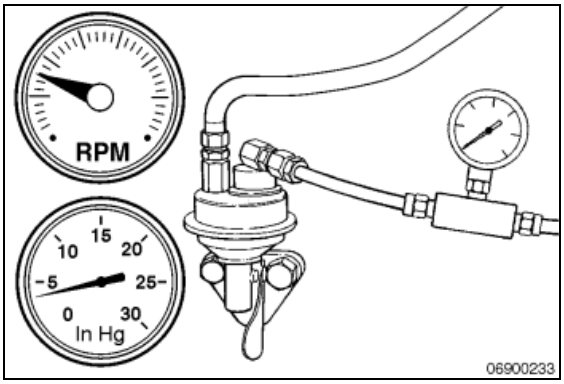
Install a fitting at the transfer pump fuel inlet

Install a vacuum gauge that has a range of at least 0 to 508 mm Hg [0 to 20 in Hg].



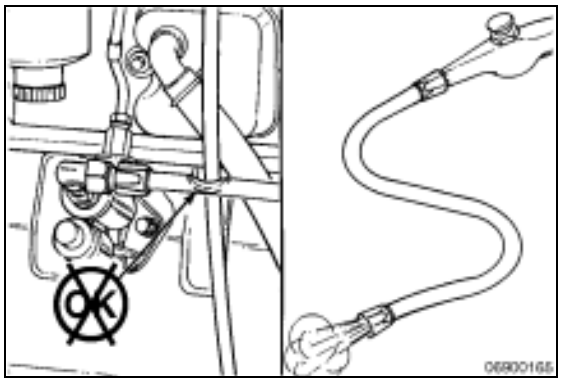
Start the engine, and run at low or high idle.

Maximum Allowable Inlet Restriction at Low/High Idle: 101.6 mm-hg [4.0 in-hg]



If the fuel inlet restriction is too high, check to make sure that the OEM lines from the tank are sized properly, there are no kinks or bends in the lines, and the lines are not clogged.

Make sure that there are no clogged fuel strainers or malfunctioning check valves.



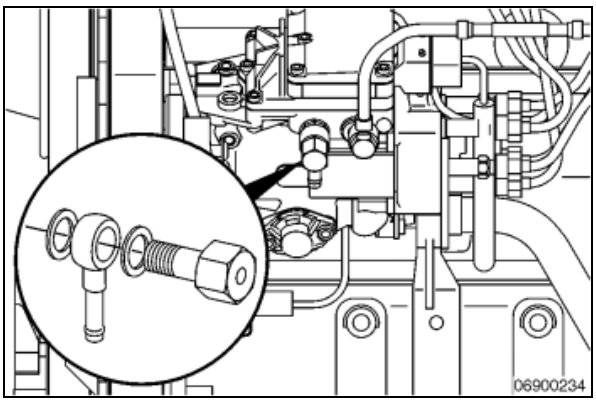
Follow-Up

Fuel Return Overflow Valve Removal/Installation

Prepare

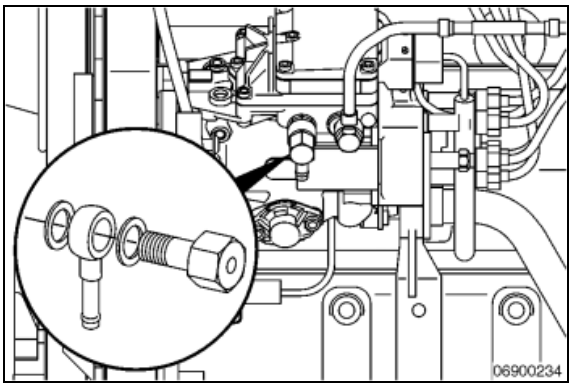
Remove

Remove, clean, and inspect the fuel return overflow valve for reuse. Refer to Fuel Return Overflow Valve (53-006-044) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



Remove

Remove the fuel return overflow valve and rubber-coated sealing washer.



Clean

WARNING

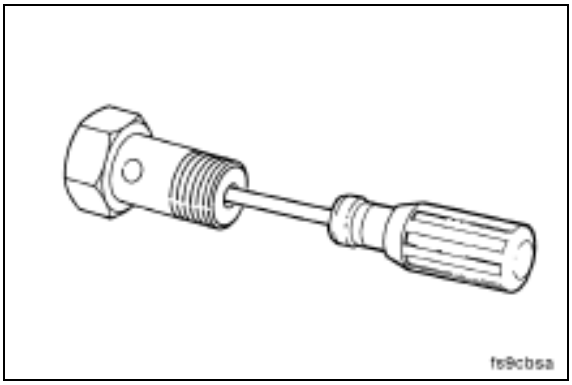
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to avoid personal injury.

Thoroughly flush the high-pressure relief valve with cleaning solution.

Fuel Return Overflow Valve Removal/Installation (Cont)

Inspect for Reuse

Use a small screwdriver to verify that the check ball is not sticking in the high-pressure relief valve assembly and that the spring is not broken.

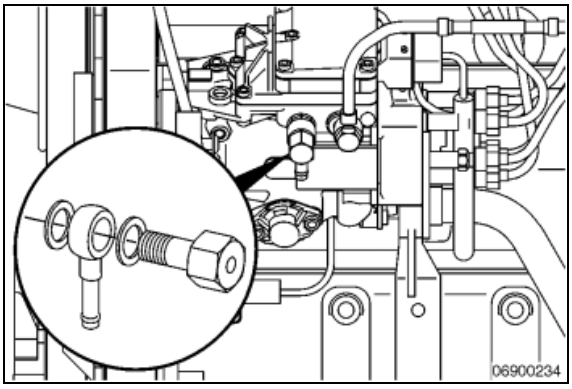


Install

Install new rubber-coated sealing washers and fuel return overflow valve.

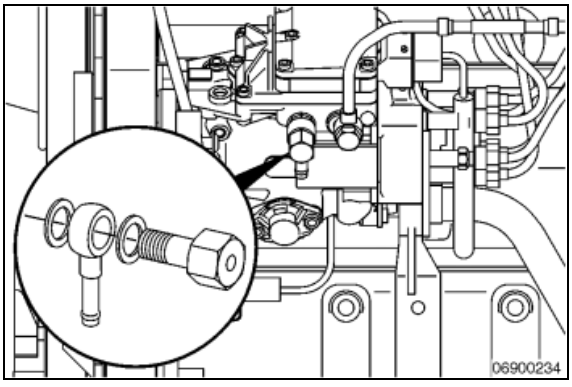
NOTE: Use two wrenches when installing the overflow valve.

Torque Value: 24 N•m [18 ft-lb]



Install

Install the fuel return overflow valve. Refer to Fuel Return Overflow Valve (53-006-044) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.



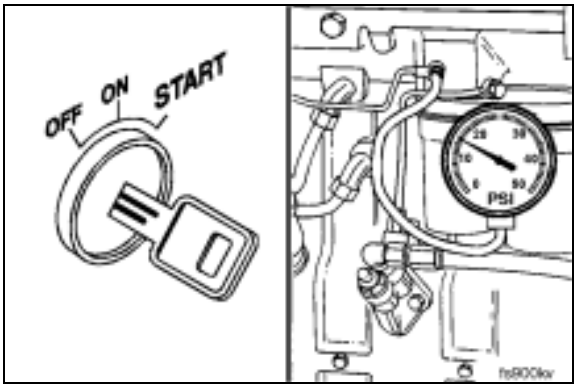
Follow-Up

Fuel Pressure Test

Prepare

Pressure Test

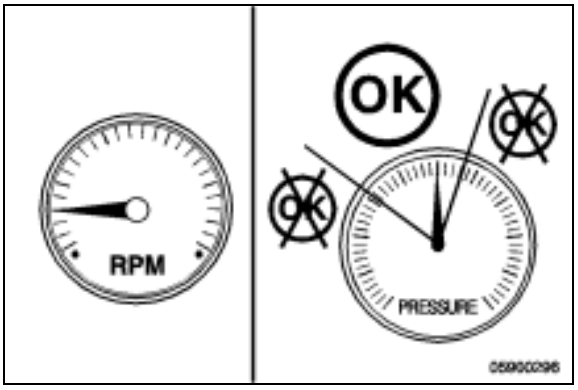
Install a pressure gauge that has a range of at least 0 to 138 kPa [0 to 20 psi], to the outlet side of the fuel filter head.



Run the engine at high-idle speed. Fuel supply pressure must read as follows:

Outlet side of the filter equals 21 kPa [3 psi] minimum

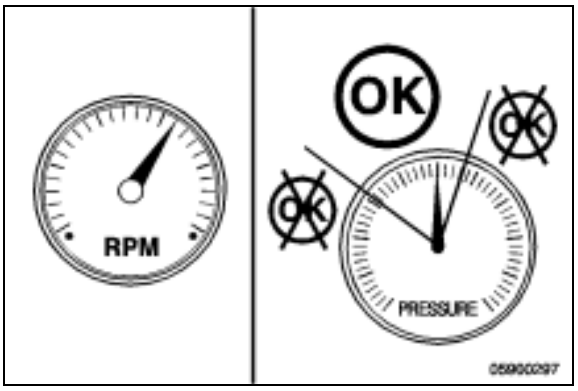
Pressure drop across the fuel filter equals 34 kPa [5 psi] maximum.



If the fuel pressure is below the minimum at the outlet side of the filter, the fuel filter may be plugged, or the fuel lift pump is possibly not operating properly. Refer to Procedures 006-015 and 005-045.

If the maximum fuel pressure drop across the fuel filter is greater than 34 kPa [5 psi], replace the fuel filter. Refer to Procedure 006-015.

NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB** Engines, Bulletin No. 3666193.



Fuel Connector (Head Mounted) Removal/Installation

Prepare

Remove

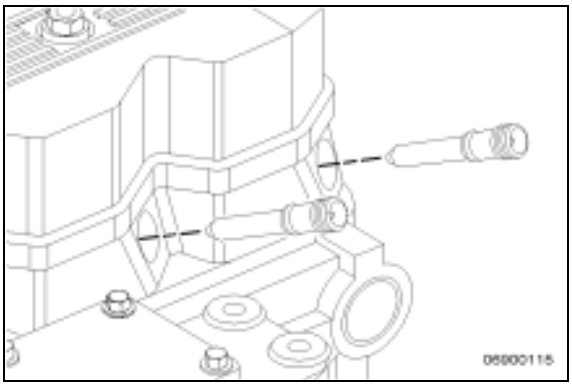
Refer to Fuel Connector (Head Mounted) (53-006-052) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Remove

Install the fuel connector puller, Part No. 3825157.

NOTE: When removing the fuel connector from the cylinder head, care must be taken to make sure the connector o-ring is not damaged.

Remove the fuel connector from the cylinder head.



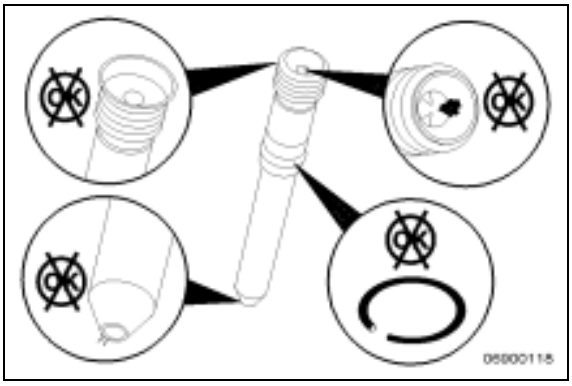
Inspect for Reuse

Inspect the fuel connector. Look for burrs or deformation around the inlet and outlet sides of the connector.

Check the edge filter for signs of plugging or material contamination.

Check the o-ring for tearing or deterioration.

NOTE: It is recommended that the o-ring on the high-pressure connector be replaced whenever the connector is removed and installed.

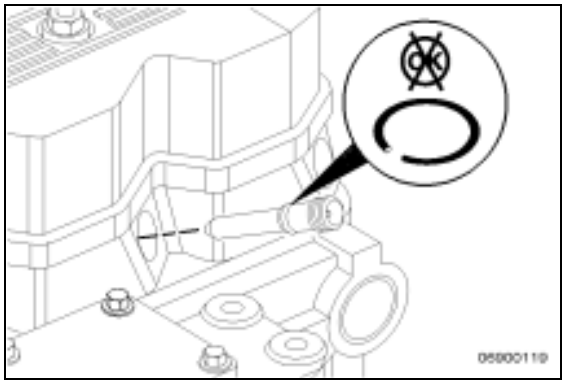


Fuel Connector (Head Mounted) Removal/Installation (Cont)

Install

Carefully push the fuel connector into the head until it stops against the injector.

NOTE: Make sure not to tear the o-ring as the connector is being installed.



Install

Refer to Fuel Connector (Head Mounted) (53-006-052) in **ISB/QSB** and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Follow-Up

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Air Leaks, Air Intake and Exhaust Systems Checks

Prepare

Initial Check

CAUTION

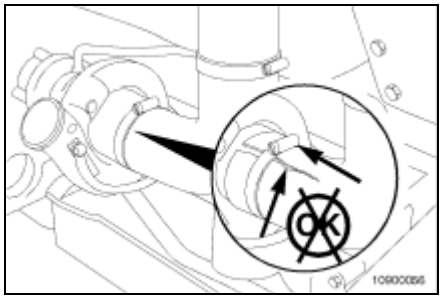
Engine intake air must be filtered to prevent dirt and debris from entering the engine. If intake air piping is damaged or loose, unfiltered air will enter the engine and cause premature wear.

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

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

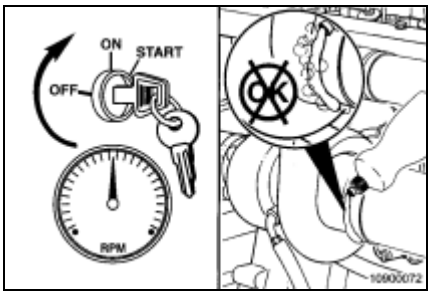
Torque Value: 8 N•m [71 in-lb]

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



Operate the engine at high idle, and use a solution of soapy water to spot intake air leaks.

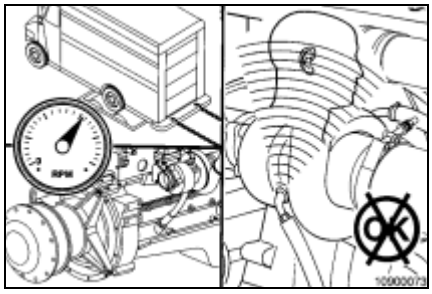
If an air leak exists, the soap bubbles will be drawn in with the air.



Air Leaks, Air Intake and Exhaust Systems Checks (Cont)

Operate the engine at full throttle and rated rpm with maximum load.

Listen for a high-pitched whistling noise from the turbocharger, nearby piping, and connections.

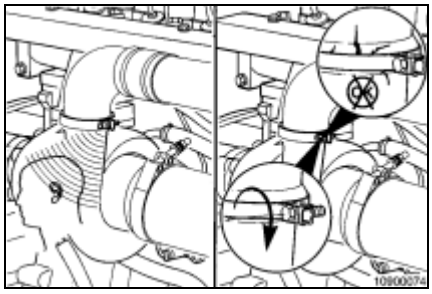


The noise can be caused by an air leak from the:

Turbocharger-to-discharge elbow connection.

Inspect for damage. Tighten loose clamps.

Torque Value: 8 N•m [71 in-lb]

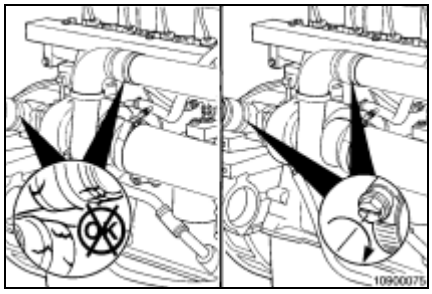


Any charge air cooler tubing or connecting hoses.

Inspect the hose and tubing for damage.

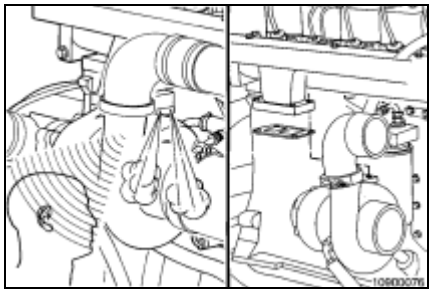
Tighten the hose clamps.

Refer to the manufacturer's specifications for the correct torque value.



Turbocharger-to-exhaust-manifold mounting gasket.

Replace the gasket. Refer to Procedure 010-033 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

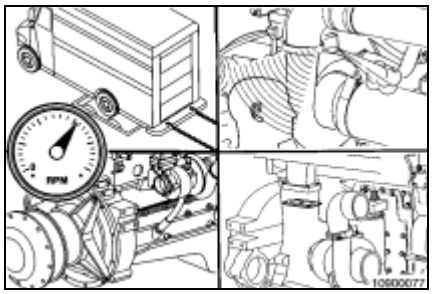


Air Leaks, Air Intake and Exhaust Systems Checks (Cont)

Operate the engine at full throttle and rated rpm with maximum load.

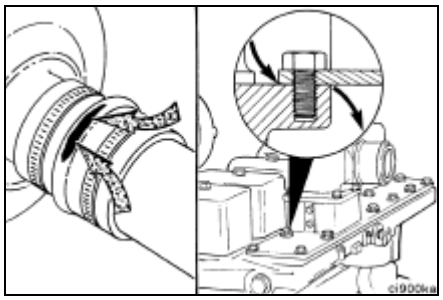
Listen again for leaks.

Replace the turbocharger if the air piping is not damaged and the noise can still be heard. Refer to Procedure 010-033 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.



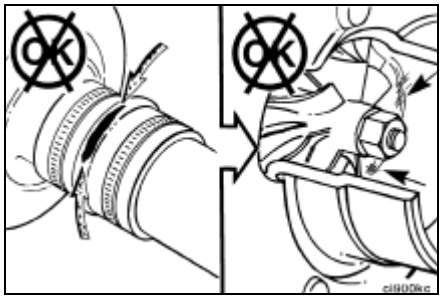
Loose connections or cracks in the suction side of the intake pipe and after the air filter can allow debris to be ingested by the engine, causing rapid wear in the cylinders.

Leaks at the intake manifold, unsealed bolt holes, or manifold cover gasket can also allow dust and dirt to be ingested into naturally aspirated engines.



Debris drawn into the air suction side can damage the compressor blades, causing an imbalance resulting in bearing failure.

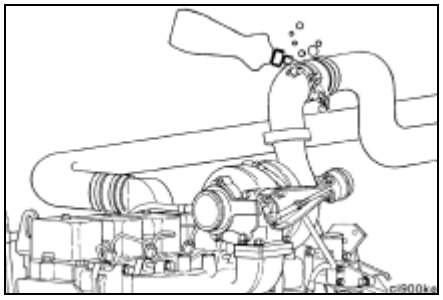
To verify a bearing failure or damaged compressor, remove the intake and exhaust piping, and check for contact. The rotor assembly must rotate freely and should not be damaged. Measurement of axial and radial clearance is described in this section.



Excessive smoke and low power from a turbocharged engine can be caused by pressurized air leaking from loose connections or cracks in the crossover tube or intake manifold. This can also cause a noise problem.

Air Leaks, Air Intake and Exhaust Systems Checks (Cont)

In addition to the inspection for cracks and loose fittings, liquid soap can be applied to the charge air cooler, connections, and the manifold cover sealing surfaces to find the leaks. The leaks will create bubbles that are easier to detect. Measurement of manifold pressure is described in this section.



Follow-Up

Air Inlet Connection

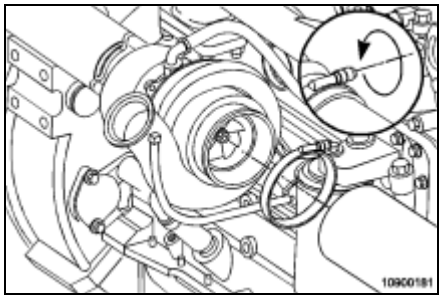
Refer to Air Inlet Connection (53-010-022) in **ISB/QSB/QSB/QSB**/QSB and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Prepare

Remove

Loosen air inlet clamps.

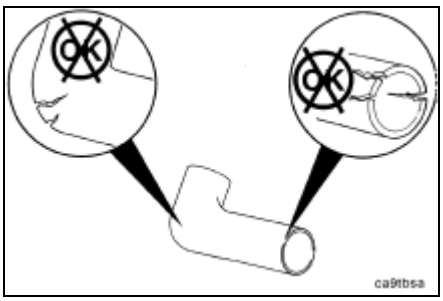
Remove the air inlet connection.



Clean and Inspect for Reuse

Inspect the air inlet connection for cuts, cracks, holes, or worn sections.

Replace if necessary.

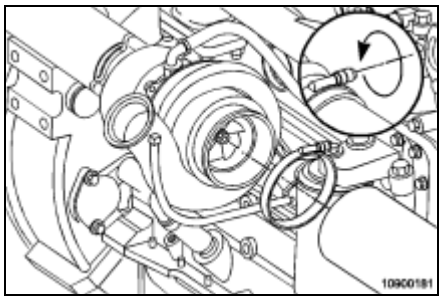


Install

Install the air inlet connection.

Tighten air inlet clamps.

Torque Value: 8 N•m [71 in-lb]

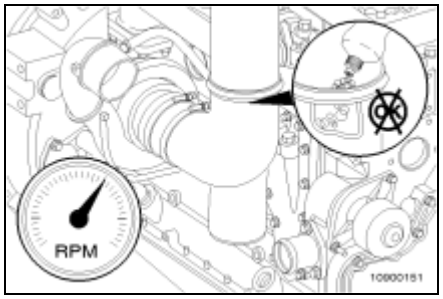


Air Inlet Connection (Cont)

Follow-Up

Operate the engine and check for leaks.

If an air leak exists, the soap bubbles will be drawn in with the air.



Intake Air Cleaner Element Removal/Installation

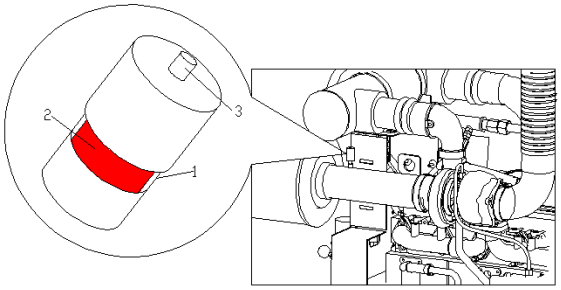
CAUTION

Never operate the engine without an air cleaner. Unfiltered foreign objects could cause engine damage.

Check Air Restriction Indicator. Replace the air cleaner element when the restriction reaches the maximum allowable limit, or clean according to the manufacturer's recommendations. See Air Cleaner Restriction Removal/Installation in this section.

Turbocharged engines must be operated at rated RPM and full load to check maximum intake air restriction.

Maximum intake air restriction is 762 mm H2O [30.0 in H2O] for turbocharged engines.



Loosen air cleaner clamp.

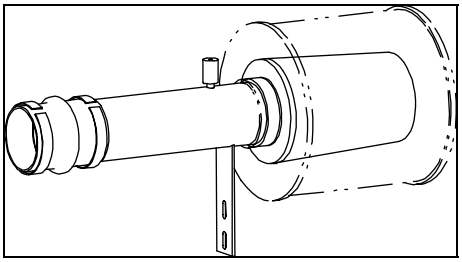
Remove the air cleaner element.

Clean and Inspect for Reuse

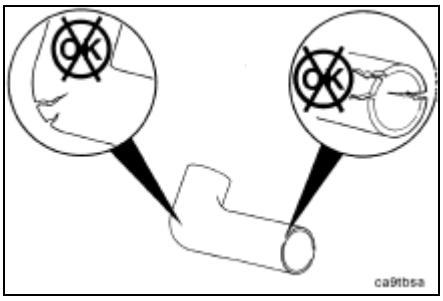
Inspect the air cleaner for cuts, cracks, holes, or excessive debris.

Clean or replace if necessary.

See Air Intake System Specifications in Section 10 for correct Cummins Fire Power replacement part number.



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



Intake Air Cleaner Element Removal/Installation (Cont)

Re-run engine at rated RPM at full load to check maximum intake restriction.

Maximum intake air restriction is 762 mm H2O [30.0 in H2O] for turbocharged engines.

Follow-Up

Air Intake Restriction Indicator Removal/Installation

A mechanical restriction indicator is available to indicate excessive air restriction through a dry-type air cleaner. This instrument is mounted on the air cleaner outlet tube.

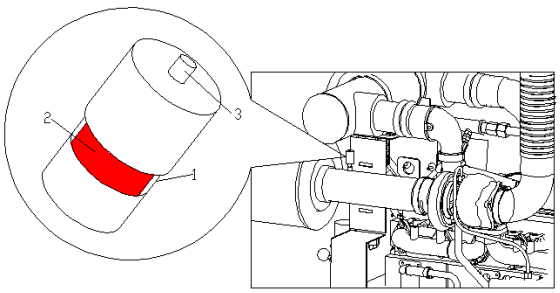
Refer to Air Filter Assembly Drawing in Section 13.

Change the filter element when the red indicator flag (2) is at the raised position in the window (1). See Air Cleaner Element Removal/Installation in this section.

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

After the air cleaner has been serviced, push the button (3) to reset the service indicator. If the indicator does not retract to the service position with new air cleaner element installed, the service indicator needs to be replaced.

Remove service indicator from Air Cleaner Element piping. Apply Teflon sealant to the threads on the indicator. Install new indicator on Intake pipe.



Follow-Up

Run engine to determine if new indicator is functioning.

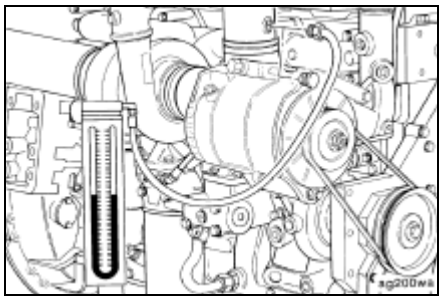
Air Intake Restriction Measurement

Prepare

Measure

Install a vacuum gauge or water manometer in the intake air piping.

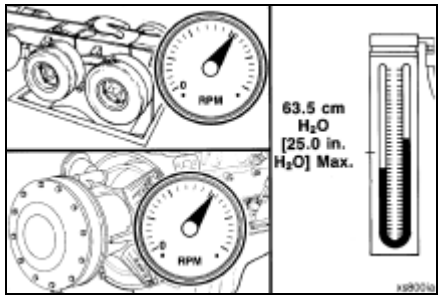
The gauge adapter must be installed at a 90-degree angle to the airflow in a straight section of pipe, one pipe diameter before the turbocharger.



Operate the engine at full throttle and rated rpm with maximum load.

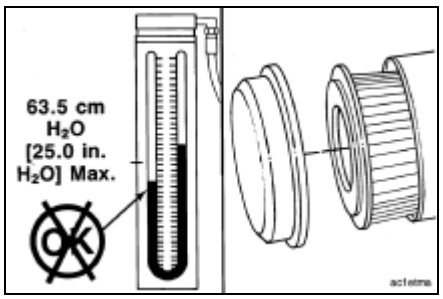
Record the data on the gauge or manometer.

Maximum Inlet Air Restriction 63.5 mm-H_2O [25.0 in- H_2O]



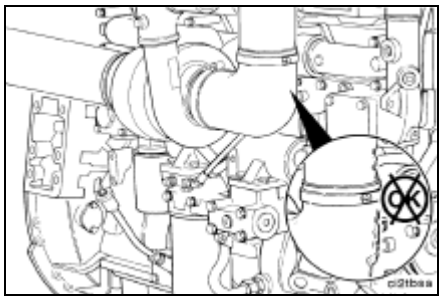
If restriction exceeds specifications:

Replace or clean the air filter element. Refer to the equipment manufacturer's instructions.

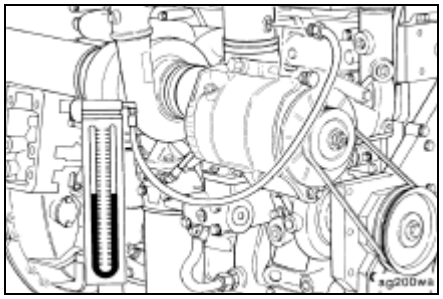


Air Intake Restriction Measurement (Cont)

Inspect the intake piping for damage. Refer to the equipment manufacturer's repair instructions.



Remove the test equipment.



Follow-Up

Air Intake Manifold Removal/Installation

Prepare

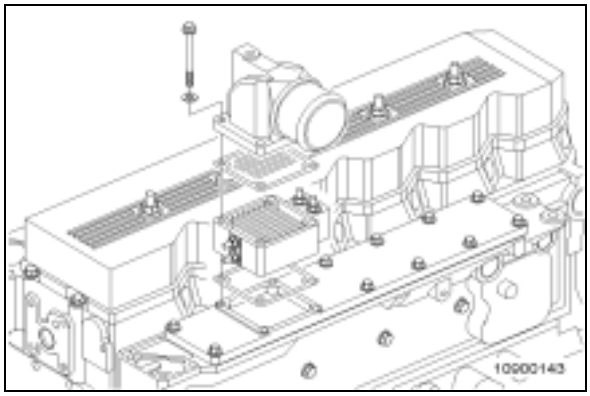
Disconnect the cold starting aid, if used. Refer to Procedure 010-029.

Remove the cooler air crossover tube, if used. Refer to Procedure 010-019.

Disconnect the charge air cooler hose, if used. Refer to Procedure 010-027.

Remove the air intake connection and grid heater, if equipped. Refer to Procedures 010-022 and 010-029.

NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

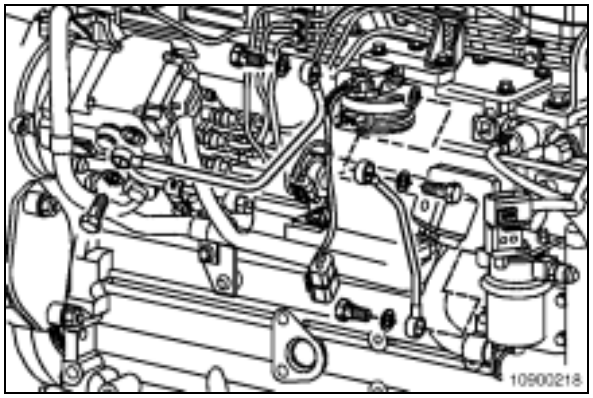


Remove

Remove the high- and low-pressure fuel lines. Refer to Procedure 006-051 .

Remove the fuel filter mount. Refer to Procedure 006-018.

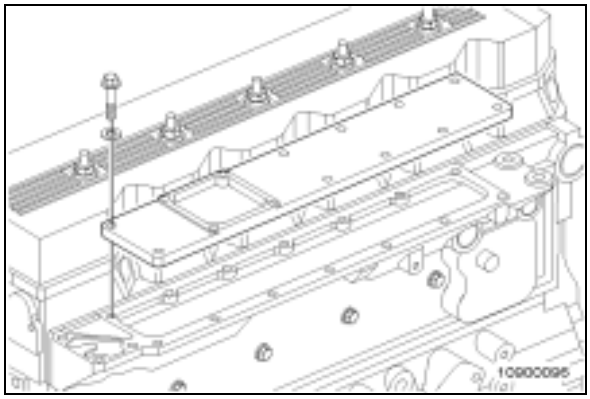
NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.



Remove the mounting capscrews and the intake cover.

Tape off the intake manifold opening to prevent debris from entering the intake system.

NOTE: Be sure not to tape over all manifold edges so that the surface can be cleaned.

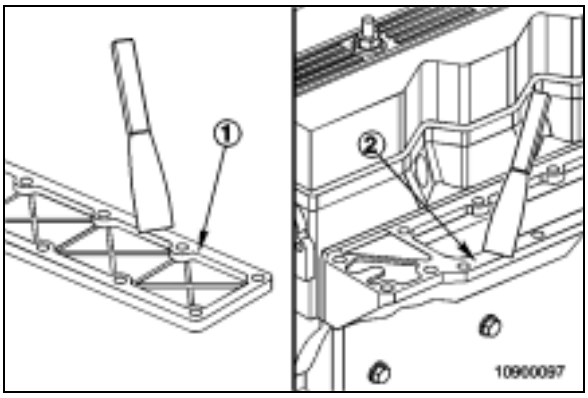


Air Intake Manifold Removal/Installation (Cont)

Clean

NOTE: Keep the gasket material and any other material out of the air intake.

Clean the sealing surfaces (1 and 2) with a putty knife and a clean rag.

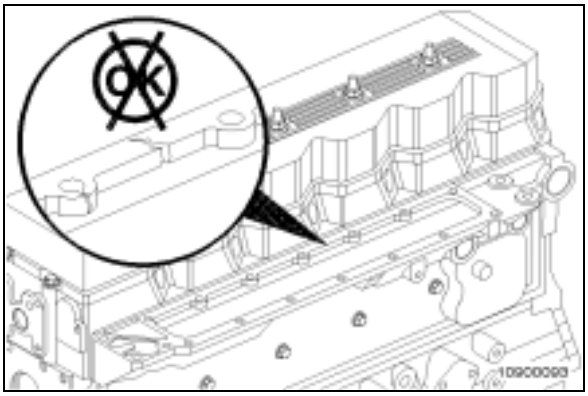


Inspect for Reuse

Remove the tape.

Inspect the intake manifold for cracks or other damage.

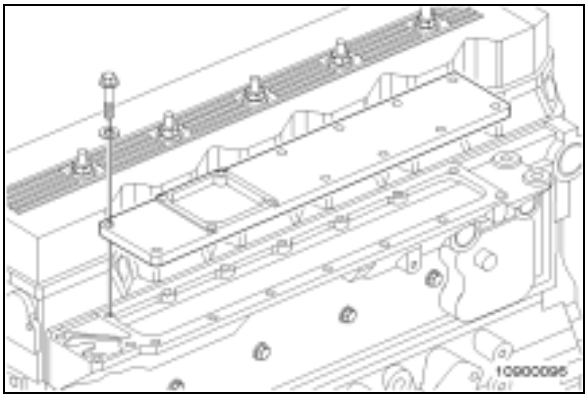
NOTE: When inspecting the intake manifold for oil or debris from an air system failure, also inspect the cylinder head for oil and debris.



Install

Install the cover and a new gasket.

Torque Value: 24 N•m [18 ft-lb]



Air Intake Manifold Removal/Installation (Cont)

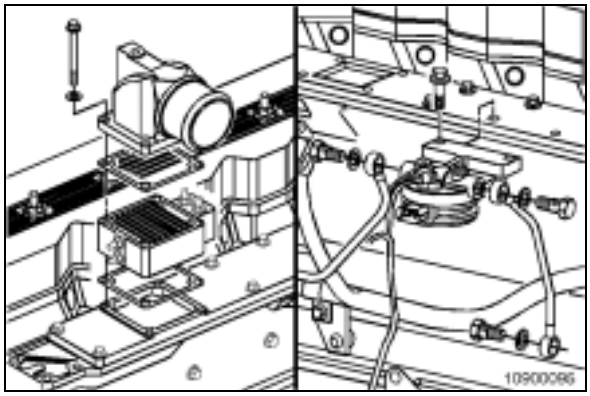
Install the fuel filter mount. Refer to Procedure 006-018.

Install the fuel filter head. Refer to Procedure 006-014 or Procedure 006-015.

Install the low-pressure fuel lines. Refer to Procedure 006-024.

Install the high-pressure fuel lines. Refer to Procedure 006-051.

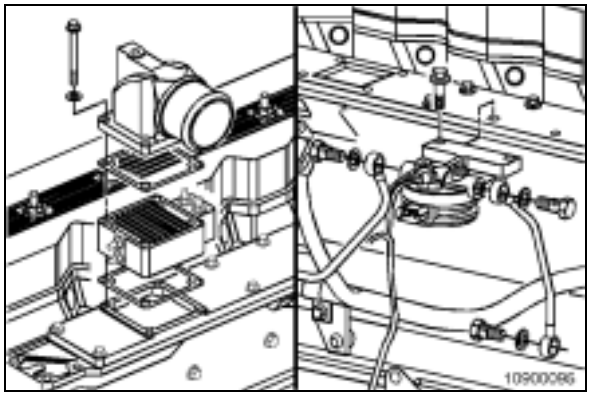
NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.



Install air intake connections, including new gaskets. Refer to Procedure 010-022.

Install grid heater, if equipped. Refer to Procedure 010-029.

NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

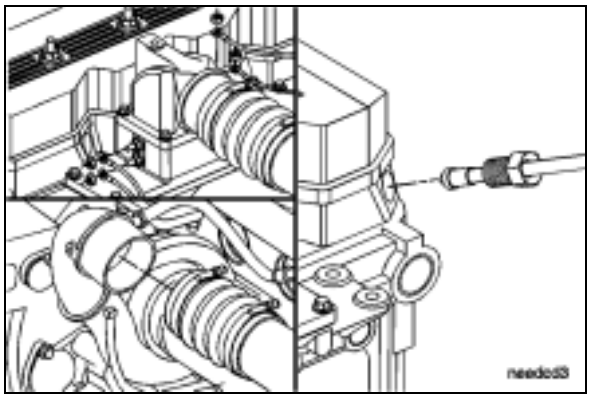


Follow-Up

Connect the charge air cooler hose, if used. Refer to Procedure 010-027

Install the air crossover tube, if used. Refer to Procedure 010-023.

NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.



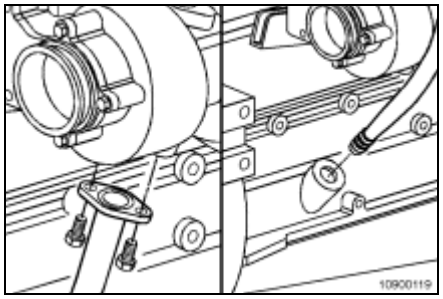
Turbocharger Oil Drain Line Removal/Installation

Prepare

Remove

Remove the capscrews from the turbocharger oil drain tube.

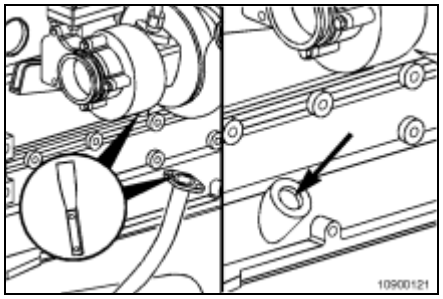
Pull the drain line out of the drain line boss.



Clean

Clean the gasket sealing surfaces (first frame).

Clean the o-ring seating bore, and make sure it is free of dirt and debris.

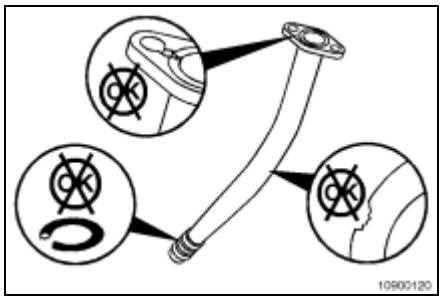


Inspect for Reuse

Inspect line for cracks, wear, and damage.

Inspect the o-ring for fretting and cracking, and replace as necessary.

Check the rubber section of the drain line for deterioration.



Turbocharger Oil Drain Line Removal/Installation (Cont)

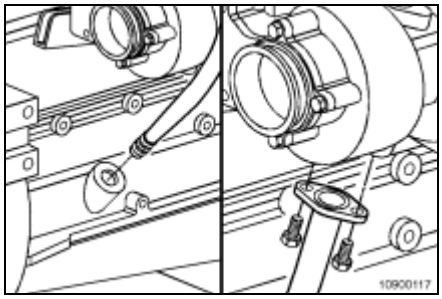
Install

Apply a thin film of oil to the drain line o-rings.

Push the drain line into the drain line boss. Be sure both o-rings are completely seated in the bore.

Install the drain line capscrews with a new gasket.

Torque Value: 24 N•m [18 ft-lb]



Follow Up

Operate the engine, and check for leaks.

Turbocharger Oil Supply Line Removal/Installation

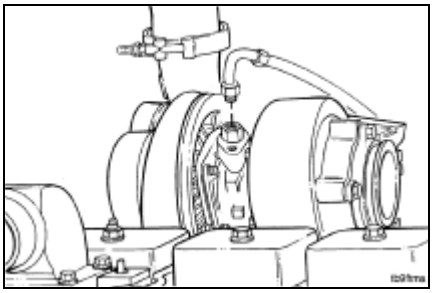
Prepare

Remove

Remove

Remove the oil supply line from the oil filter head (1).

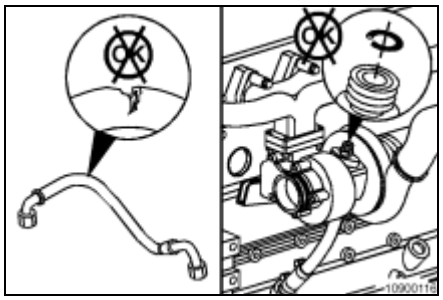
Remove the oil supply line from the turbocharger bearing housing (2).



Inspect for Reuse

Inspect the line for cracks, wear, and damage.

Inspect o-rings for cracking and fretting. Replace as necessary.



Install

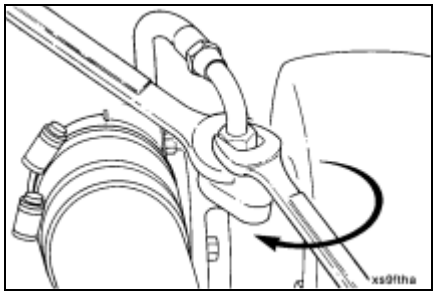
Apply a thin film of oil to the o-ring seals.

Fill the turbocharger oil inlet with clean oil.

Install the oil supply line at both the filter head and the turbo bearing housing.

Tighten the oil supply line to final torque.

Torque Value: 24 N•m [18 ft-lb]



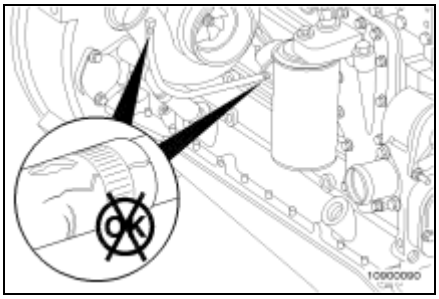
Follow-Up

Turbocharger Wastegate Actuator Removal/Installation

Initial Check

Inspect the integral wastegate actuator hose for cracks or holes.

Replace the hose if damaged.

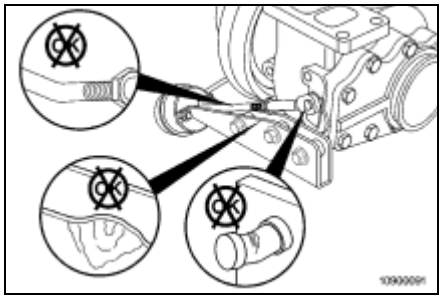


CAUTION

A bent wastegate mounting bracket, actuator rod, or lever can cause improper operation.

Inspect the wastegate mounting bracket, actuator rod, and lever for damage.

If the wastegate mounting bracket, actuator rod, or lever is bent, it must be replaced.



Prepare

Remove

Remove

NOTE: In some applications, the turbocharger must be removed in order to remove the wastegate actuator. Refer to Procedure 010-033 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

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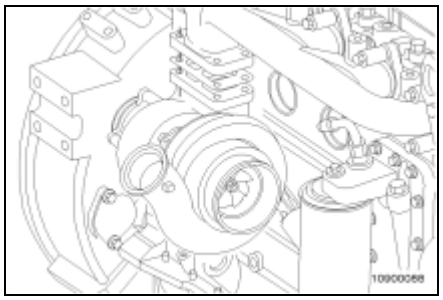
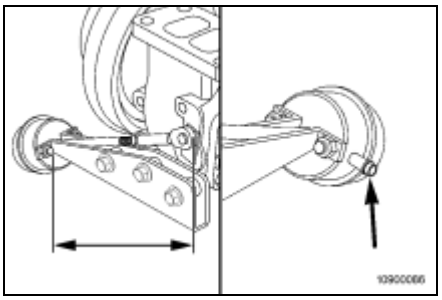


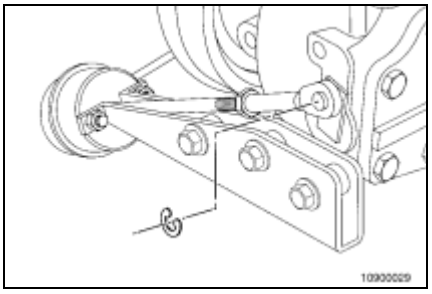
Turbocharger Wastegate Actuator Removal/Installation (Cont)

NOTE: Prior to removal, note position length of the control rod from the boost capsule housing and orientation of the boost capsule hose connector in relation to the mounting bracket.



Remove the retaining clip from the control lever.

Disconnect the integral boost line from the wastegate capsule.

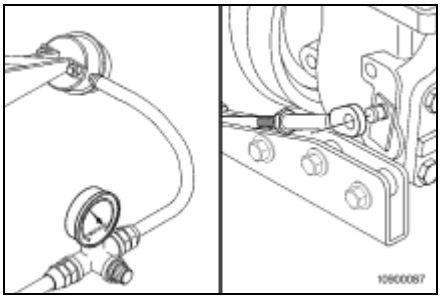


CAUTION

Be careful not to bend the control lever.

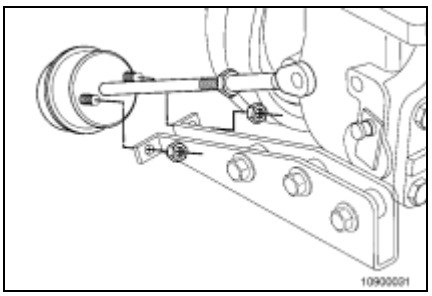
Disconnect the boost capsule actuator rod end from the turbocharger wastegate lever. This can be accomplished by slowly applying regulated air pressure to the boost capsule until the control rod is activated.

Disconnect the control rod from the turbocharger wastegate lever pin.



NOTE: If the boost capsule diaphragm material is ruptured and will not hold air pressure, manually pull the control rod outward in order to overcome boost capsule spring tension for removal of the control rod from the turbocharger wastegate lever pin.

Loosen the boost capsule mounting capscrews, disconnect the air supply hose, and remove assembly from the mounting bracket.



Turbocharger Wastegate Actuator Removal/Installation (Cont)

Test

NOTE: In some applications, the turbocharger must be removed in order to test the wastegate actuator. Refer to Procedure 010-033 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

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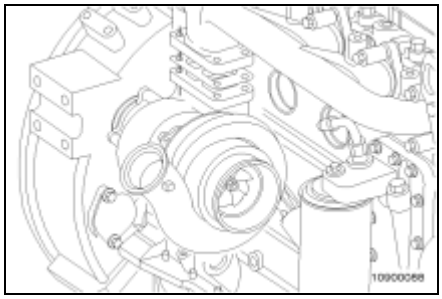


Disconnect the integral boost line from the wastegate capsule.

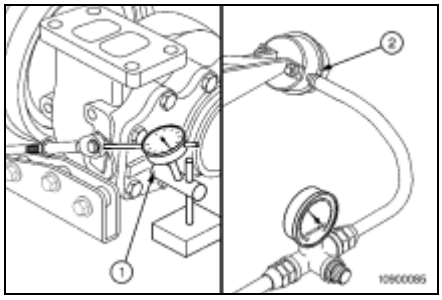
Attach a dial indicator (1) as shown, so that its shaft is in line with the wastegate actuator rod. Set the indicator to zero.

Connect clean, regulated air pressure and a pressure gauge to the capsule. Apply 200 kPa [29 psi] to make sure the wastegate is functioning properly.

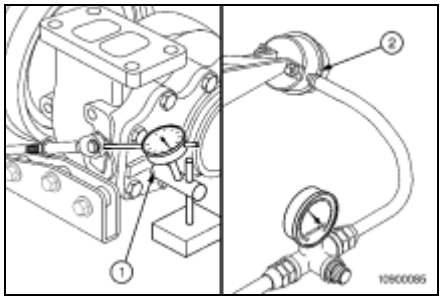
The rod should move approximately 0.33 to 1.27 mm [0.013 to 0.050 in] without any sticking or air leakage.

NOTE: No air should be heard (i.e., leaking noise) through a functional wastegate capsule.

NOTE: A small amount of travel when air pressure is first applied is normal; the tolerance is being removed from the system.



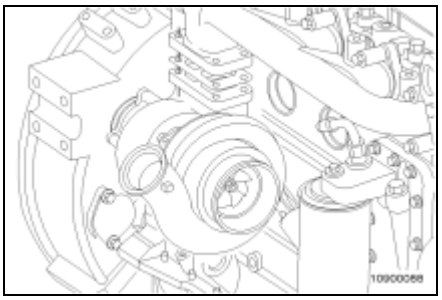
Replace the actuator if no movement of the actuator rod and lever is detected.



Turbocharger Wastegate Actuator Removal/Installation (Cont)

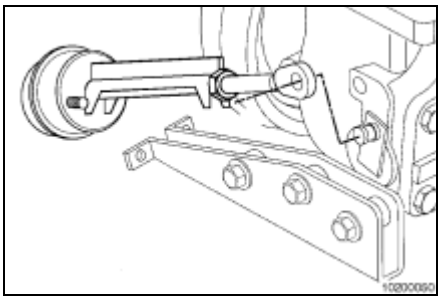
Install

NOTE: In some applications, the turbocharger must be removed in order to install a new wastegate actuator. Refer to Procedure 010-033 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

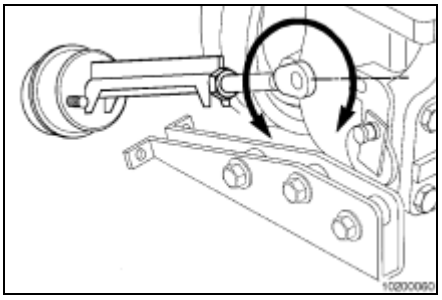


Fit the end-link over the turbocharger wastegate lever pin. With the spine of the spacer visible and the turbocharger wastegate lever pushed toward the rod, lay the actuator alongside the mounting bracket.

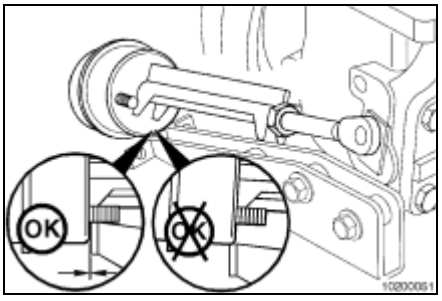
NOTE: Do not fit the two studs into the mounting holes at this time.



Adjust the length of the actuator assembly by removing from the turbocharger, rotating the end-link, and re-fitting the actuator until the underside of the actuator will just fit over the bracket mounting studs with less than 0.5-mm [0.20-in] gap.



The setting is correct when the underside of the actuator will just fit over the bracket with less than 0.5-mm [0.20-in] gap.

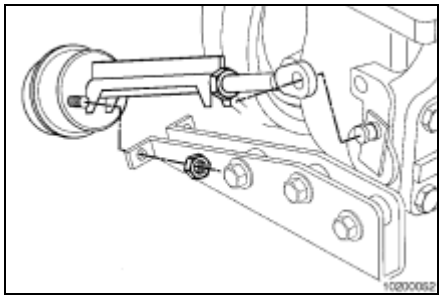


Turbocharger Wastegate Actuator Removal/Installation (Cont)

Fit the actuator mounting studs into the holes in the bracket, and fit both actuator mounting capscrews.

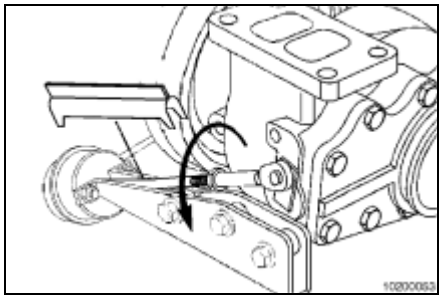
Refit the end-link onto the crank-pin. Install the control rod retaining clip.

Torque Value: 8 N•m [75 in-lb]

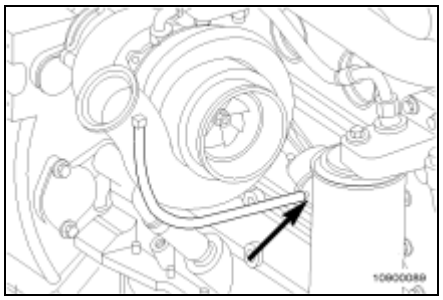


Tighten the control rod jam nut against the end-link. Cut the tie wrap and remove tie wrap and spacer piece. Discard tie wrap. Continue turning jam nut in the same direction, and tighten against end-link.

Torque Value: 8 N•m [75 in-lb]



Refit the air supply hose to the actuator using the new hose clamp provided.

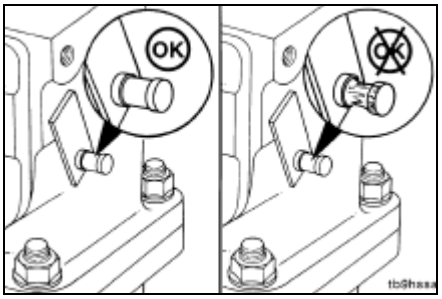


Follow-Up

Turbocharger Wastegate Valve Body Inspection

Prepare

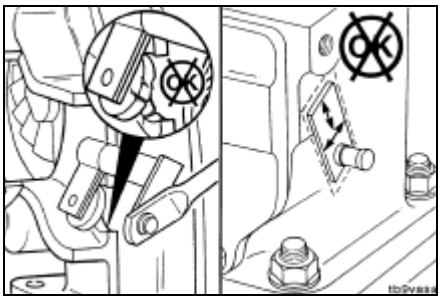
Inspect for Reuse



Inspect the lever pin.

Replace the turbine housing assembly if worn excessively.

Refer to the Turbocharger Master Repair Manual, Bulletin 3580555.



Inspect the valve and valve seat for cracks or erosion.

Replace the turbine housing assembly if worn excessively.

Refer to the Turbocharger Master Repair Manual, Bulletin 3580555.

Actuate the lever by hand to be sure that the shaft rotates freely and is not seized.

Check for excessive movement between the shaft and bushing.

Replace the turbine housing if the shaft and bushing are damaged or seized.

Refer to the Turbocharger Master Repair Manual, Bulletin 3580555.

Follow-Up

Turbocharger Wastegate Controller Removal/Installation

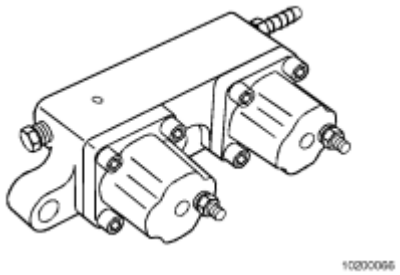
Prepare

Remove

Remove the electrical leads of each coil of the wastegate controller.

Remove the wastegate actuator hose from the wastegate controller.

Remove the wastegate controller capscrews.



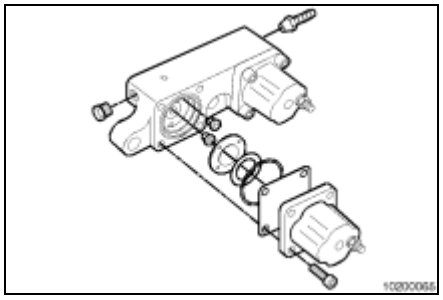
Disassemble

Remove the rectangular ring seal from the intake manifold inlet of the wastegate controller.

Remove the four capscrews for the coil.

Remove the coil and shutoff valve shield.

Remove the valve spring, valve disc, and rectangular ring seal from the controller housing.



Turbocharger Wastegate Controller Removal/Installation (Cont)

Inspect for Reuse

CAUTION

Controller orifices can not be removed from the controller housing. Attempting to remove orifices can result in damage to the housing or orifice.

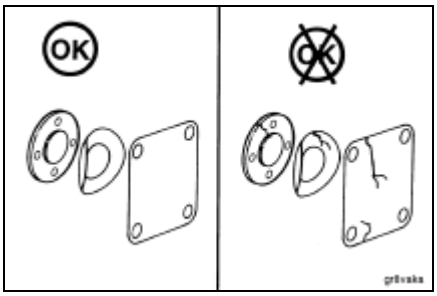
Check for plugged orifices in the controller housing. All of the parts except the coil assembly can be cleaned using mineral spirits.

NOTE: Do not get solvent on the coil. Clean the coil with a dry cloth. Use a 200 grit emery cloth and a flat surface to polish the coil surface.

A wire brush can only be used on the coil terminal.

Visually check the valve disc, valve spring, and shutoff valve shield for dirt, metal parts, bonding separation, corrosion, cracks, or wear. Replace if necessary.

Use a wire brush to clean any corrosion from the coil terminal.



Check the coil assembly with a multimeter.

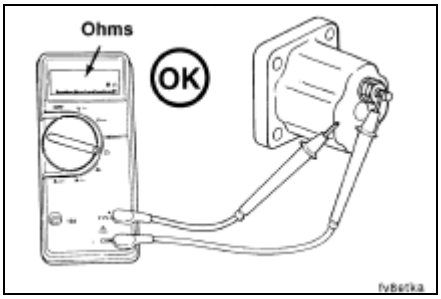
Replace the coil if not within specifications.

If the coil assembly shows zero ohms, there is an electrical short in the coil.

24 VDC solenoid	26-40 Ohms	18°C to 100°C [0°F to 212°F]
12 VDC solenoid	6-10 Ohms	18°C to 100°C [0°F to 212°F]

Tighten the nut that holds the electrical connection post on the coil.

Torque Value: 1.695 N•m [15 in-lb]



Turbocharger Wastegate Controller Removal/Installation (Cont)

Install

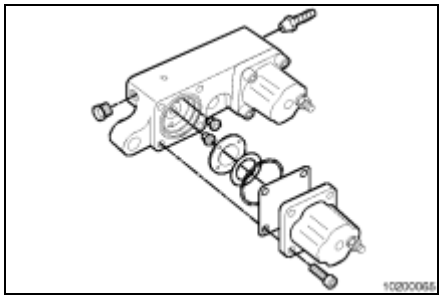
Assemble the valve as shown.

Install these parts as follows:

Install a new rectangular ring seal in the controller housing.

Install the valve disk with the rubber bulls-eye side down

Install the valve spring on the valve disc with the cavity side positioned upward.



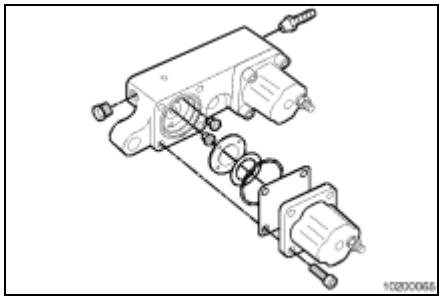
The coil must be orientated with the electrical connection post at the three o'clock position, when the controller is installed on the engine.

Make sure the coil is the correct voltage. The coil voltage and part number are cast into the terminal connection end of the coil.

Install the shutoff shield and coil on the control valve body.

Tighten the capscrews.

Torque Value: 8 N•m [72 in-lb]



Install a new rectangular ring seal around the intake manifold connection of the wastegate controller.

Place the wastegate controller on the intake manifold and tighten the capscrews.

Torque Value: 47 N•m [35 in-lb]

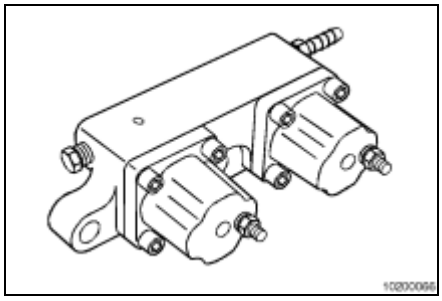
Refit the wastegate actuator hose to the wastegate controller.

Install the electrical connections on the coils.

Install the nut on the threaded post of the coils.

Use two wrenches to hold the post of the nut firmly while tightening the connection nut.

Torque Value: 1.695 N•m [15 in-lb]



Follow-Up

Turbocharger Checks

Prepare

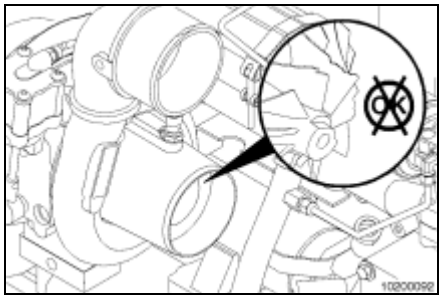
Initial Check

If turbocharger blade damage is suspected:

Remove the air intake pipe from the turbocharger.

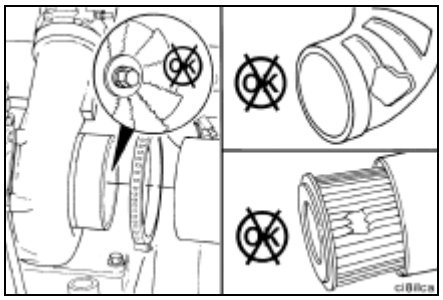
Inspect the turbocharger compressor impeller blades for damage.

Replace the turbocharger if damage is found.



If the compressor impeller is damaged, inspect the intake piping and filter element for damage.

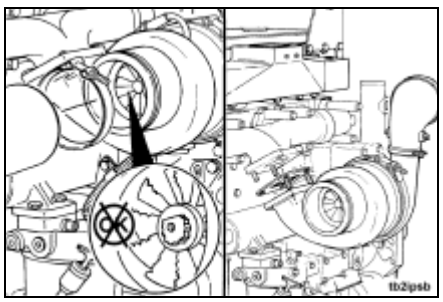
Repair any damage before operating the engine.



Remove the exhaust pipe from the turbocharger.

Inspect the turbine wheel for damage.

Replace the turbocharger if damage is found.

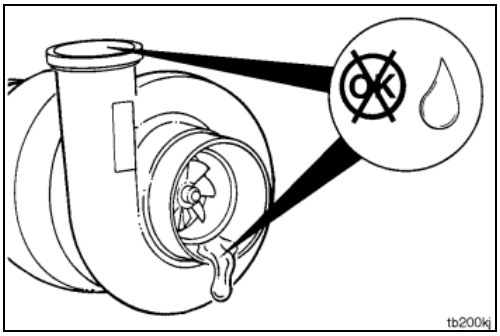


Turbocharger Checks (Cont)

If turbocharger compressor seal leak is suspected:

Inspect the compressor intake and discharge for oil.

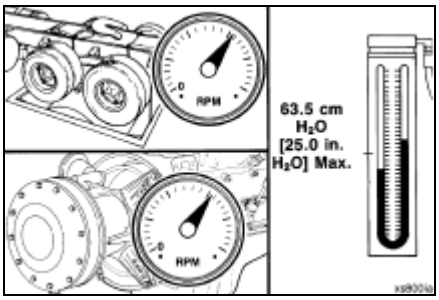
If oil is present in the compressor intake, as well as in the discharge, check upstream from the turbocharger for the source of the oil.



If oil is present only in the discharge side, install the air intake and charge air cooler piping.

Check for intake restriction. Refer to Procedure 010-031 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

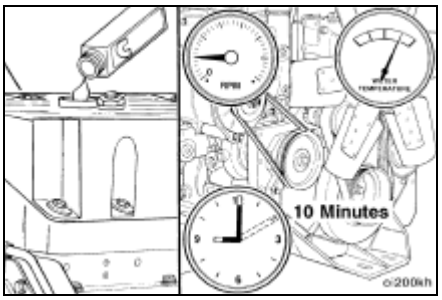
If no intake restriction is found, replace the turbocharger.



If turbocharger turbine seal leak is suspected:

Add one unit of fluorescent tracer, Part Number 3376891, to each 38 liters [10 gal] of engine lubricating oil.

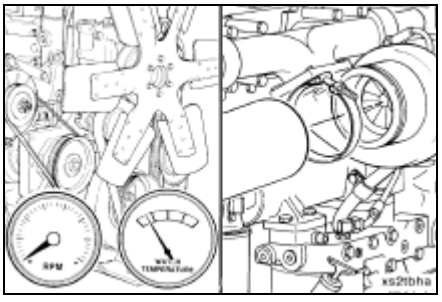
Operate the engine at low idle for 10 minutes.



Shut off the engine.

Allow the turbocharger to cool.

Remove the exhaust pipe from the turbine housing.

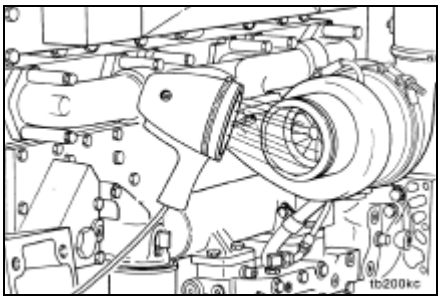


Turbocharger Checks (Cont)

Use a high-intensity black light, Part Number 3377253 or 3377394, to inspect the turbine outlet for leaks.

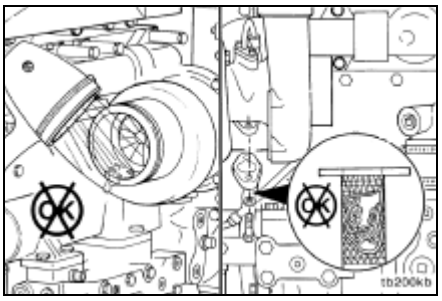
A dark blue glow indicates a fuel leak. Refer to Procedure 007-044 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

A yellow glow indicates an oil leak.

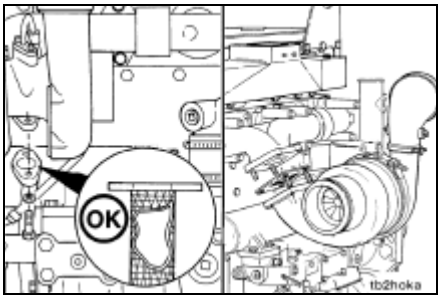


If oil is found on the turbine housing, remove the oil drain line and check for restrictions.

Clear any restrictions found or replace the damaged components, as required.



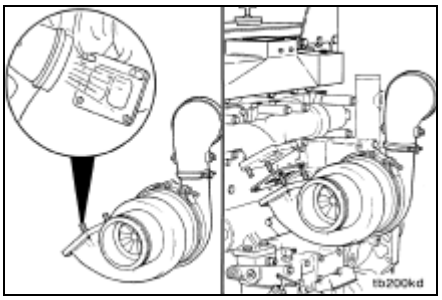
If the oil drain line is not restricted, remove the turbocharger.



Use a high-intensity black light, Part Number 3824524 or 3824754, to inspect the turbine inlet for leaks.

A yellow glow indicates an oil leak from the engine.

If a yellow glow is not seen in the turbine inlet, replace the turbocharger.

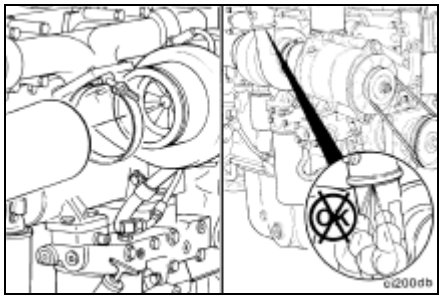


Turbocharger Checks (Cont)

Install the exhaust pipe to the turbocharger and tighten the clamp.

Torque Value: 8 N•m [71 in-lb]

Operate the engine and check for air leaks.



Follow-Up

Turbocharger Removal/Installation

Prepare

Remove the following:

- Remove the air crossover, if equipped. Refer to Procedure 010-019.
- Disconnect the charge air cooler hose. Refer to the OEM service manual.
- Oil supply line from the turbocharger. Refer to Procedure 010-046.
- Oil drain line from the turbocharger. Refer to Procedure 010-045.

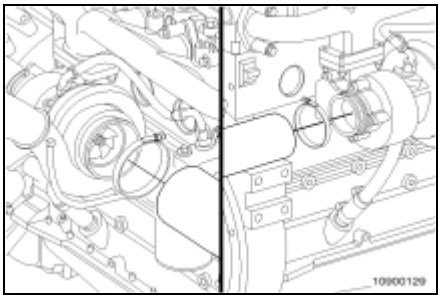
NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

Remove

Remove the exhaust piping.

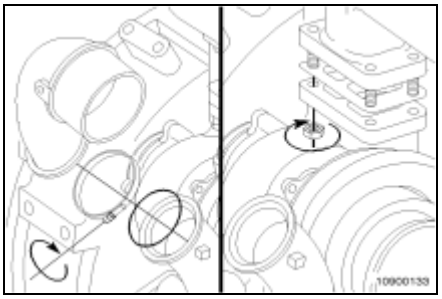
Remove the turbocharger compressor air inlet pipe.

Remove the turbocharger compressor outlet elbow, v-band clamp, and o-ring from the turbocharger compressor outlet.



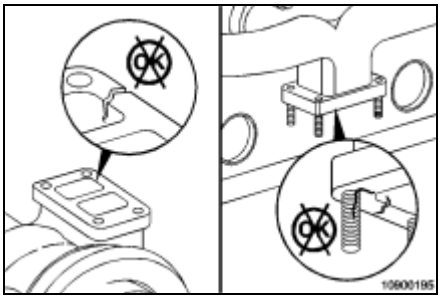
Remove the four turbocharger mounting nuts.

Remove the turbocharger and gasket.



Turbocharger Removal/Installation (Cont)

Clean and Inspect for Reuse



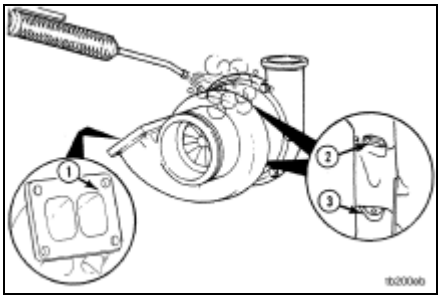
Clean the turbocharger and exhaust manifold gasket surfaces.

Inspect the turbocharger and exhaust manifold gasket surfaces, and mounting studs for cracks and damage.

Replace the turbocharger if any cracks are found in the mounting flange surfaces.

See the Remove and Install steps in this procedure.

Replace the exhaust manifold if any cracks are found in the mounting flange surfaces. Refer to Procedure 011-007 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.



WARNING

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

WARNING

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

WARNING

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

Remove all carbon deposits and gasket material from surfaces (1, 2, and 3).

Use solvent or steam to clean the exterior of the turbocharger.

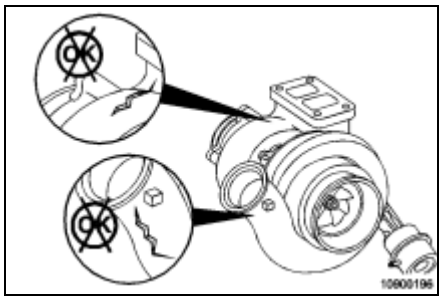
Dry with compressed air.

Turbocharger Removal/Installation (Cont)

Inspect the turbine and compressor housings.

If cracks are found which go all the way through the outer walls, the turbocharger must be replaced.

NOTE: A charge air cooler failure can cause progressive damage to the turbine housing. If the turbine housing is damaged, check the charge air cooler. Refer to Procedure 010-027 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.



NOTE: If the engine experiences a turbocharger failure or any other occasion in which oil or debris is put into the charge air system, the charge air system must be inspected and cleaned. Refer to Procedure 010-027 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

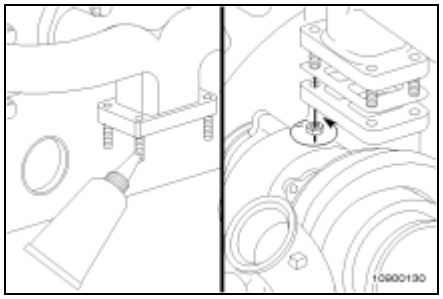
Install

Apply a film of high-temperature anti-seize compound to the turbocharger mounting studs.

Use a new gasket and install the turbocharger.

Install and tighten the four mounting nuts.

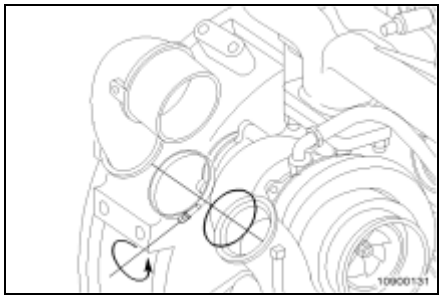
Torque Value: 45 N•m [33 ft-lb]



Install the turbocharger compressor outlet elbow, v-band clamp, and a new o-ring seal on the turbocharger compressor discharge outlet.

Tighten the clamp.

Torque Value: 8 N•m [71 in-lb]



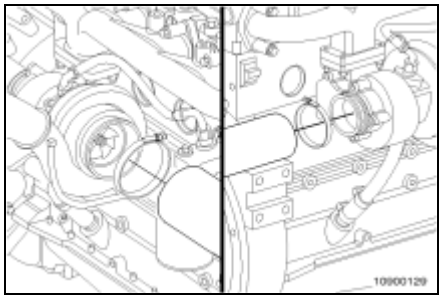
Turbocharger Removal/Installation (Cont)

Install the intake pipe to the turbocharger compressor inlet and tighten the clamp.

Torque Value: 8 N•m [71 in-lb]

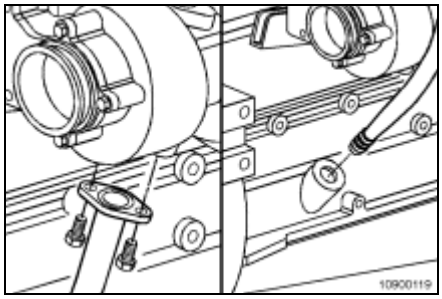
Install the exhaust pipe to the turbocharger turbine outlet and tighten the clamp.

Torque Value: 8 N•m [71 in-lb]



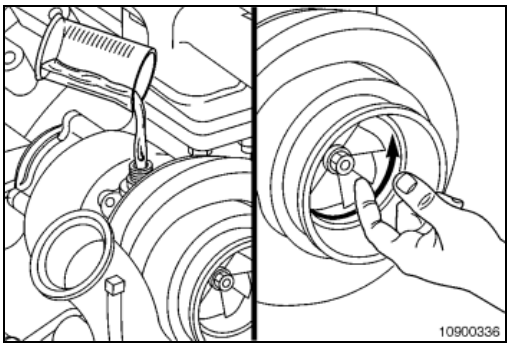
Prime

Install and tighten the turbocharger oil drain line. Refer to Procedure 010-045 in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.



Lubricate the bearings by pouring 0.25 to 0.38 [2 to 3 oz] of clean 15W40 engine oil in the turbocharger oil supply line fitting.

Rotate the turbine wheel to allow oil to enter the bearing housing.



Turbocharger Removal/Installation (Cont)

Follow Up

Install the air crossover, if equipped. Refer to Procedure 010-019.

Install the charge air cooler hose. Refer to the OEM service manual.

Install and tighten the turbocharger oil supply line. Refer to Procedure 010-046.

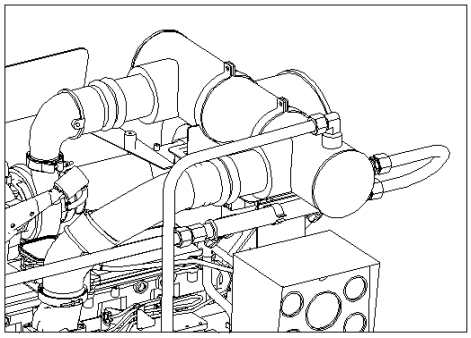
NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, **ISB/QSB/QSB/QSB**/QSB Engines, Bulletin No. 3666193.

Operate the engine and check for leaks.

Charge Air Cooler (CAC) Removal and Installation

If the engine experiences a turbocharger failure or any other occasion where oil or debris is put into the charge air cooler, the charge air cooler must be cleaned or replaced.

Remove charge air cooler from the engine.



Remove

Refer to Assembly Drawing 8676 in Section 13.

Disconnect the CAC Air Outlet Piping Assembly from the CAC.

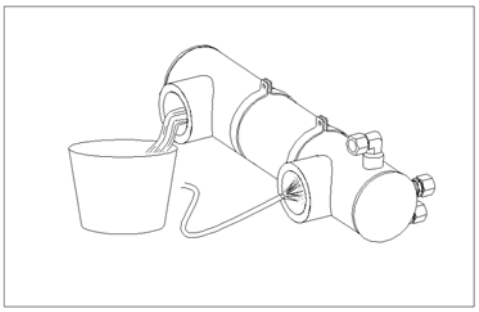
Disconnect the CAC Air Inlet Piping Assembly from the CAC.

Disconnect the CAC Raw Water Coolant Inlet Piping Assembly from the CAC.

Disconnect the CAC Raw Water Outlet Piping Assembly from the CAC.

Remove the bolts from mounting bracket and remove the cooler assembly.

Remove the two clamps from the cooler assembly



Charge Air Cooler (CAC) Removal and Installation (Cont)

Install

Install two clamps on the cooler assembly Install the cooler assembly and start the bolts on the mounting bracket.

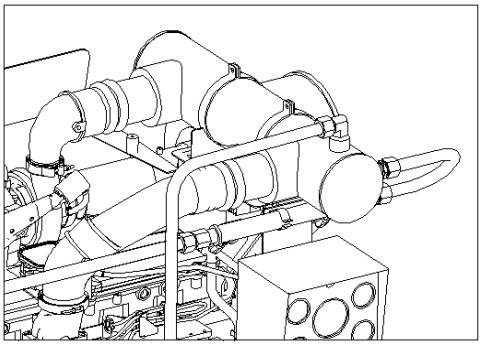
NOTE: Apply Teflon tape or pipe sealant to the threaded fittings as the raw water piping is reinstalled.

Re-connect the CAC Raw Water Coolant Outlet Piping Assembly to the CAC.

Re-connect the CAC Raw Water Coolant Inlet Piping Assembly to the CAC.

Connect the CAC Air Outlet Piping Assembly to the CAC.

Connect the CAC Air Inlet Piping Assembly to the CAC.



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Lubricating Oil Filter Assembly Removal/Installation

Prepare

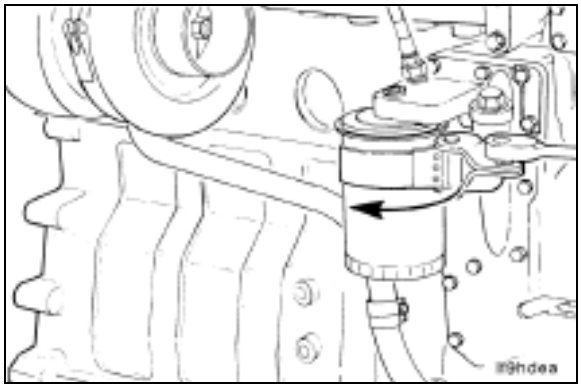
Remove

Oil Filter Wrench, Part No. 3375049

Clean the area around the lubricating oil filter head.

Use the oil filter wrench, Part No. 3375049, to remove the filter.

Clean the gasket surface of the filter head.



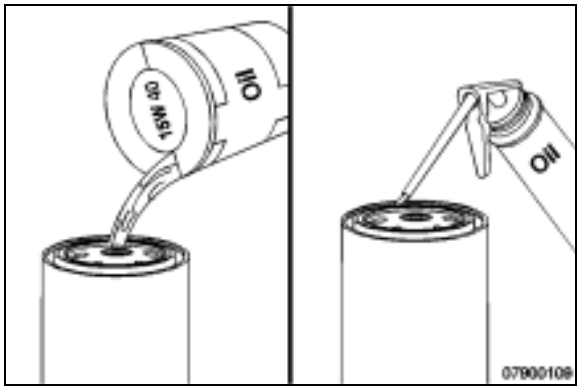
Install

CAUTION

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

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

Fill the filter with clean 15W-40 oil.



Lubricating Oil Filter Assembly Removal/Installation (Cont)

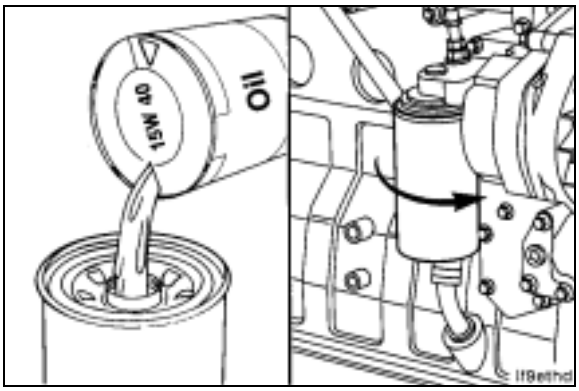
CAUTION

Mechanical over-tightening of the filter can distort the threads or damage the filter element seal.

Oil Filter Wrench, Part Number 3375049

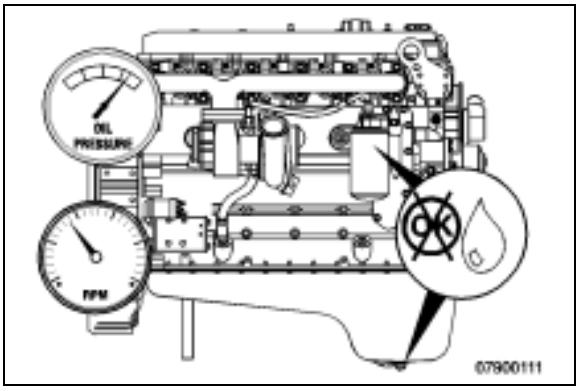
Install the filter on the oil filter head. Tighten the filter until the gasket contacts the filter head surface.

Use the oil filter wrench, Part Number 3375049, to tighten the filter. Read the instructions supplied with the filter.



Operate the engine and check for leaks.

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



Install

Refer to Lubricating Oil Filter (Spin-On) (53-007-013) in ISB/QSB/QSB and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Follow-Up

Lubricating Oil Filter Head Removal/Installation

Prepare

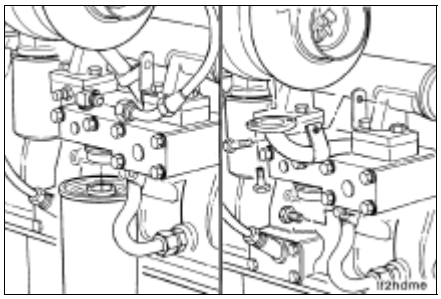
WARNING

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

Remove the oil filter. Refer to Procedure 007-013 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

Remove the turbocharger oil supply line from the oil filter head.

Remove the turbocharger oil drain from the turbocharger. Remove the two support brackets from the filter head.



WARNING

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

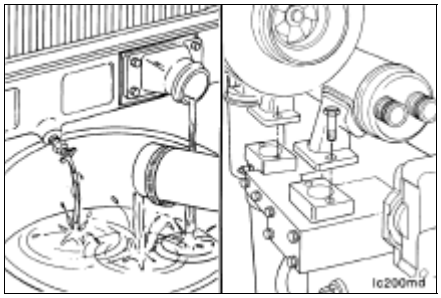
WARNING

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

Drain the cooling system. Refer to Procedure 008-018.

Remove the lubricating oil cooler. Refer to Procedure 007-003.

NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

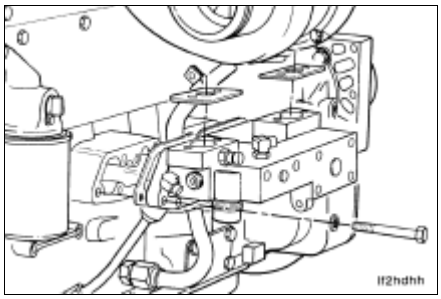


Lubricating Oil Filter Head Removal/Installation (Cont)

Remove

Remove the nine filter head capscrews and the filter head.

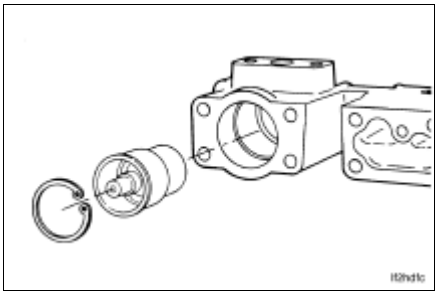
Remove and discard the gaskets.



Disassemble

Use snap ring pliers to remove the snap ring in the thermostat bore.

Remove the lubricating oil thermostat.



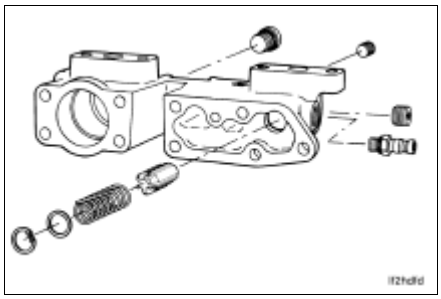
WARNING

The valve spring must be compressed to install the snap ring. To avoid personal injury, wear face and eye protection.

Remove the snap ring from the bypass valve bore.

Remove the washer, spring, and bypass valve.

Remove the remaining plugs and fittings from the filter head.



Lubricating Oil Filter Head Removal/Installation (Cont)

Clean

WARNING

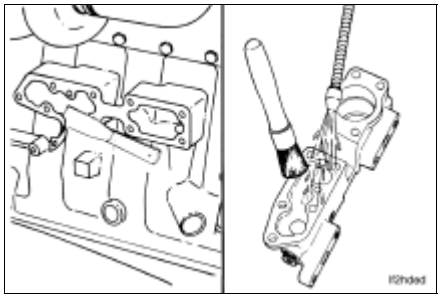
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

WARNING

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

Clean the filter head and cylinder block gasket surfaces.

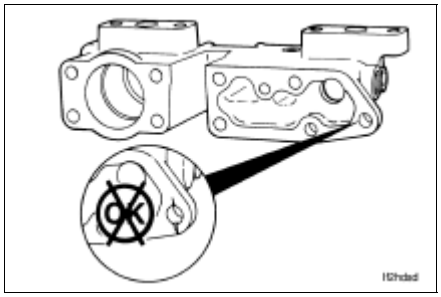
Use solvent to clean the filter head. Dry with compressed air.



Inspect for Reuse

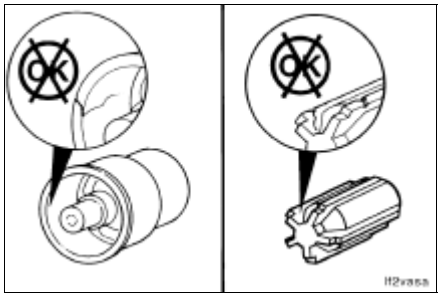
Inspect for cracks or other damage.

Inspect the lubricating oil thermostat. Refer to Procedure 007-039 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Inspect the thermostat and bypass valve for cracks or other damage.

If the bypass valve or thermostat is damaged, it must be replaced.

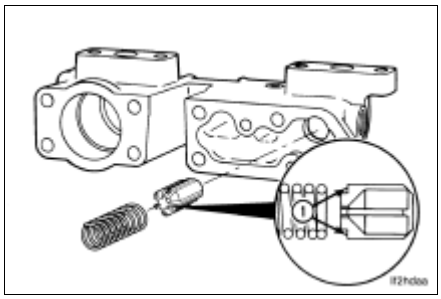


Lubricating Oil Filter Head Removal/Installation (Cont)

Assemble

Install the bypass valve into the filter head. The notched end of the valve (1) must face the engine side of the filter head.

Insert the spring into the bore. Check to be sure the spring is properly located over the notched end of the valve (1).

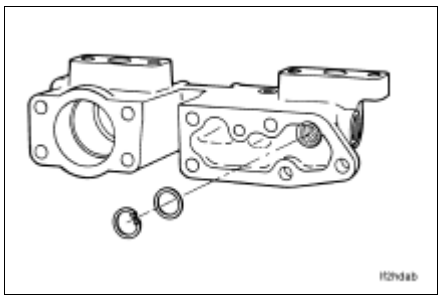


WARNING

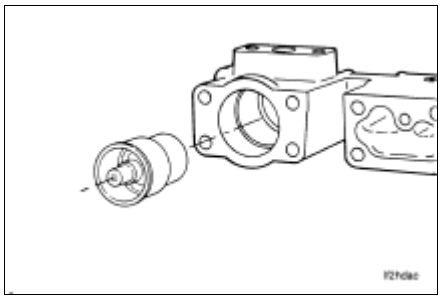
The valve spring must be compressed to install the snap ring. To avoid personal injury, wear face and eye protection.

Place the washer on top of the spring.

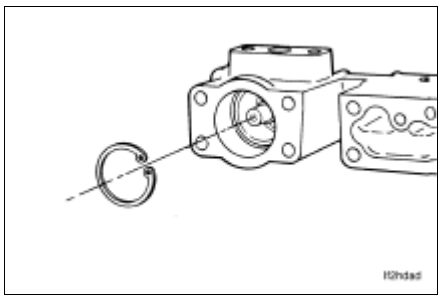
Using snap ring pliers, install the snap ring into the groove inside the bore.



Insert the oil thermostat into the filter head. The beveled end of the thermostat goes in first.



Install the snap ring into the groove using snap ring pliers.



Lubricating Oil Filter Head Removal/Installation (Cont)

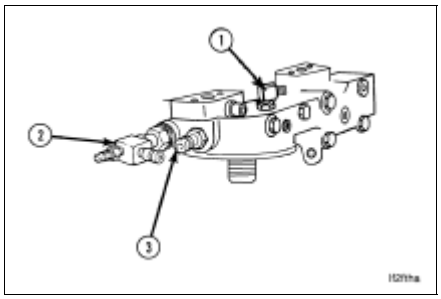
Install the following fittings into the filter head.

Turbocharger oil supply fitting: (1) 12 N•m [106 in-lb]

Engine brake supply fitting (2): 12 N•m [106 in-lb]

Compuchek® fitting (3): 25 N•m [18 ft-lb]

Remaining plugs: 25 N•m [18 ft-lb]

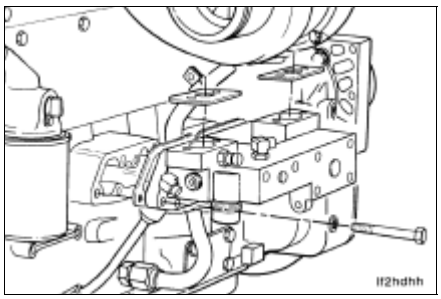


Install

Use a new gasket and install the filter head to the cylinder block.

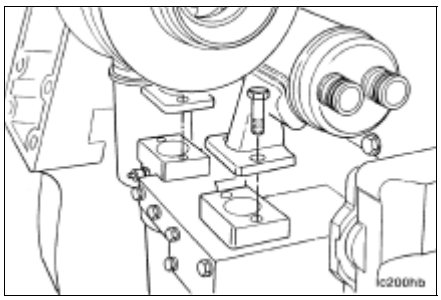
Install the nine capscrews and tighten.

Torque Value: 47 N•m [35 ft-lb]

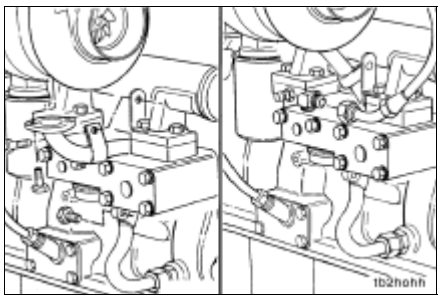


Follow-Up

Install the lubricating oil cooler. Refer to Procedure 007-003 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Install the turbocharger oil supply and drain lines and support brackets.

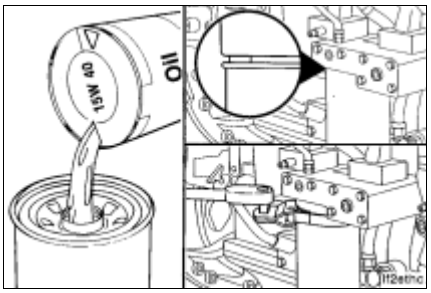


Lubricating Oil Filter Head Removal/Installation (Cont)

Install the lubricating oil filter. Refer to Procedure 007-013.

Filling the cooling system. Refer to Procedure 008-018.

NOTE: The procedures listed above are found in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

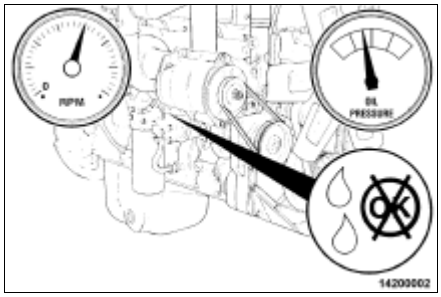


CAUTION

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

Operate the engine at idle speed for 3 minutes to inspect for leaks at the filter head.

Confirm the correct oil level in the oil pan.

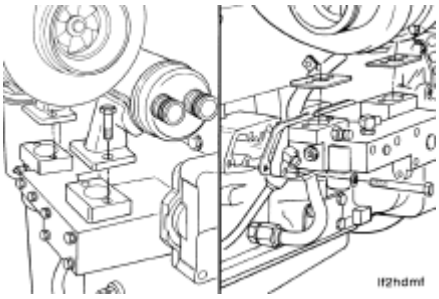


Lubricating Oil Thermostat Removal/Installation

Prepare

Remove

Remove the lubricating oil filter head. Refer to Procedure 007-015 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



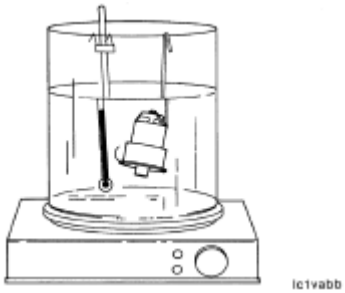
Inspect for Reuse

WARNING

The flash point of new lubricating oil is approximately 221°C [430°F]. Do not allow the oil temperature in the container to exceed 149°C [300°F]. Do not allow water droplets to enter the container of hot oil. Water droplets will cause a violent reaction, which can cause personal injury.

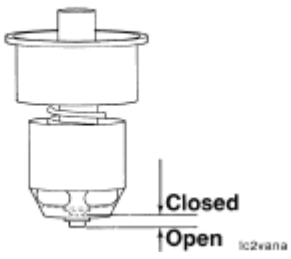
Suspend the thermostat and a 116°C [240°F] thermometer in a container of new lubricating oil. Do not allow the thermostat or the thermometer to touch the sides of the container.

Heat the lubricating oil.



Write down the temperature at which the valve is fully extended. The valve must be fully extended to at least 6 mm [0.250 in] from the closed position when the temperature reaches 116°C [240°F].

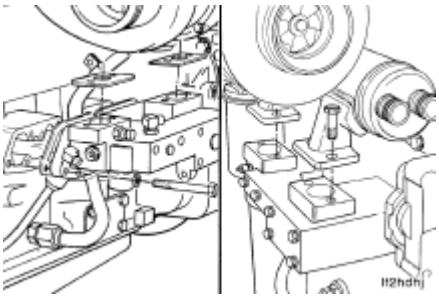
Replace the thermostat if it does not operate as described.



Lubricating Oil Thermostat Removal/Installation (Cont)

Install

Install the filter head onto the engine. Refer to Procedure 007-015 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

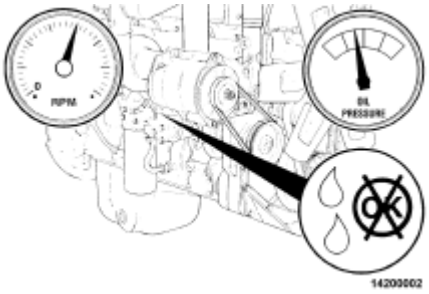


Follow-Up

CAUTION

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

Operate the engine at idle speed for 3 minutes to inspect for leaks at the filter head.



Lubricating Oil Pan Removal/Installation

Prepare

Drain

WARNING

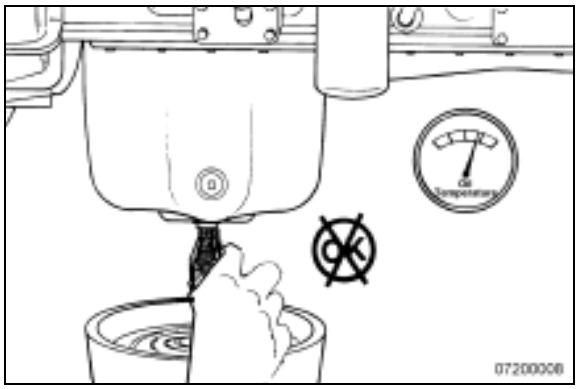
Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapor, ingestion, and prolonged contact with used engine oil.

WARNING

Hot oil can cause serious personal injury.

NOTE: Use a container that can hold at least 20 liters [15 qt] of lubricating oil.

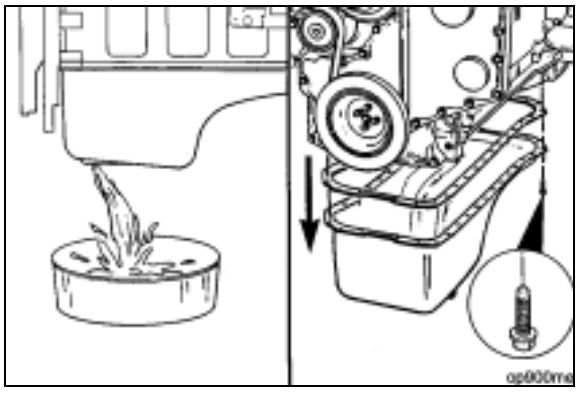
Operate the engine until the coolant temperature reaches 60°C [140°F]. Shut off the engine. Remove the oil drain plug. Drain the oil immediately to be sure all the oil and suspended contaminants are removed from the engine.



Remove

Remove the lubricating oil pan and gasket.

If the suction tube must be removed. Refer to Procedure 007-035 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Lubricating Oil Pan Removal/Installation (Cont)

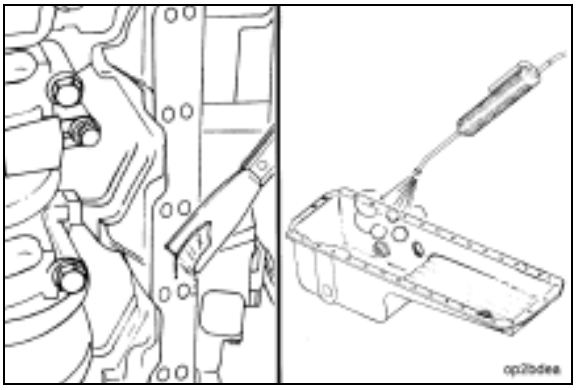
Clean

WARNING

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

Using a putty knife, remove all gasket material from the cylinder block and oil pan surface.

Steam-clean the oil pan. Dry the oil pan with compressed air.

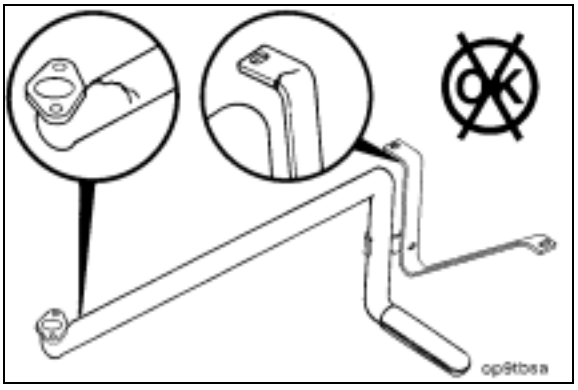


Inspect for Reuse

Inspect the oil pan, suction tube, and tube braces for damage.

NOTE: If cracks are found, replace the damaged part. Do not attempt to repair the oil pan by welding.

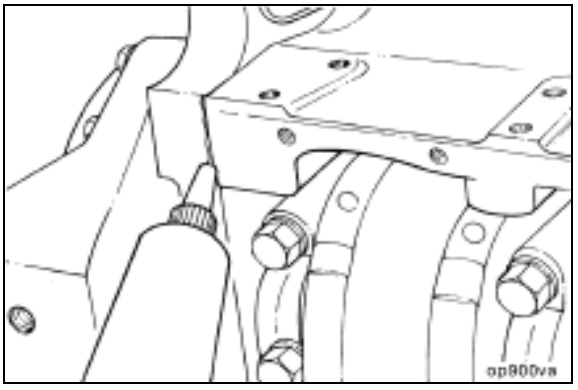
If the suction tube must be replaced. Refer to Procedure 007-035 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Install

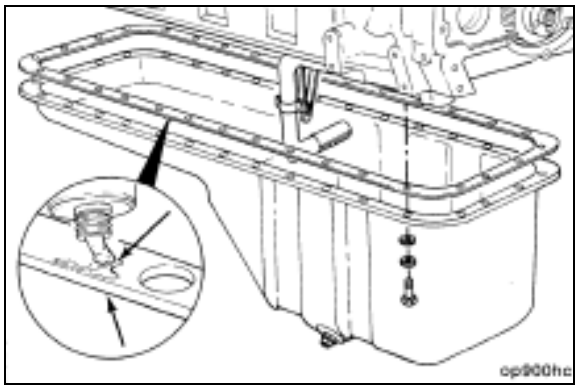
Use Three-Bond™ sealant, Part Number 3823494, or equivalent, to fill the joints between the oil pan rail, gear housing, and rear seal housing.

If the suction tube has been removed. Refer to Procedure 007-035 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193 for installation instructions.



Lubricating Oil Pan Removal/Installation (Cont)

Apply a 2-mm [0.063-in] bead of Three-Bond™ sealant, Part Number. 3823494, or equivalent, to both sides of the new oil pan gasket.

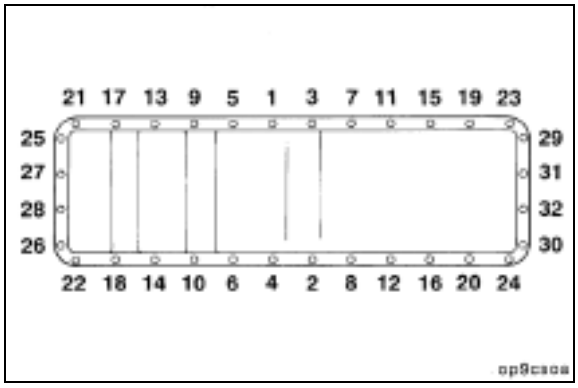


Assemble the washers and capscrews to secure the oil pan, as illustrated.

Install the gasket and lubricating oil pan.

Tighten all capscrews in the sequence shown in the accompanying chart.

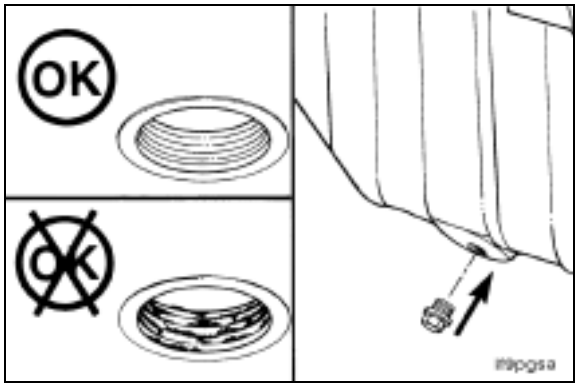
Torque Value: 24 N•m [18 ft-lb]



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

Install and tighten the oil pan drain plug.

Torque Value: 60 N•m [44 ft-lb]



Lubricating Oil Pan Removal/Installation (Cont)

Fill

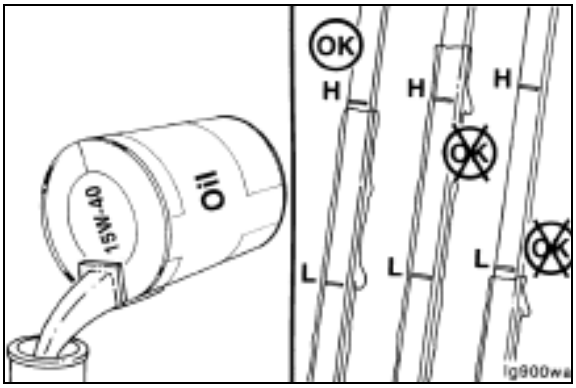
NOTE: Use a high-quality 15W-40 multiviscosity oil, such as Cummins Premium Blue®, or its equivalent, in Cummins engines. Choose the correct oil for your operating climate as outlined in the Operation and Maintenance Manual, ISB/QSB/QSB Engine, Bulletin No. 3666170.

Turbocharged engines: CF/SG

Fill the engine with clean 15W-40 lubricating oil to the proper level.

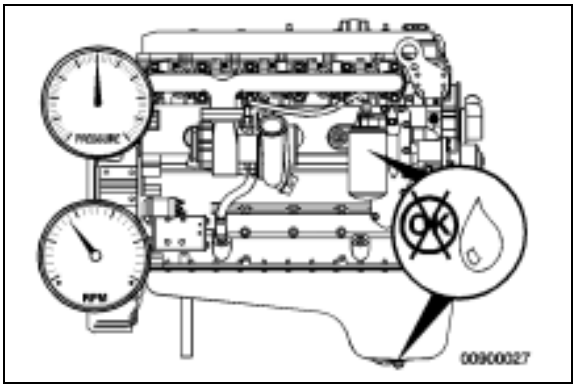
NOTE: When filling the oil pan, use the fill tube on the side of the engine rather than on top of the rocker lever cover.

NOTE: If the engine is not equipped with a side-fill, wait at least 3 minutes before measuring the oil level with the dipstick to allow the oil to drain to the pan.



Idle the engine to inspect for leaks at the drain plug.

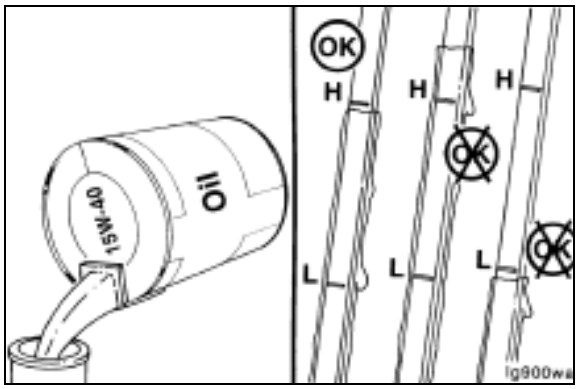
NOTE: Engine oil pressure must be indicated on the gauge within 15 seconds after starting. If oil pressure is not registered within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm that the correct oil level is in the oil pan.



Lubricating Oil Pan Removal/Installation (Cont)

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

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



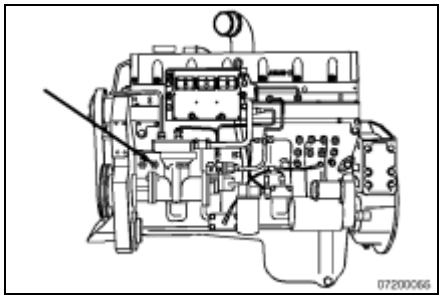
Follow-Up

Oil Pressure Gauge Test

Prepare

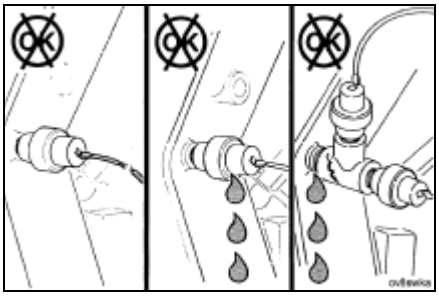
Remove

The combination oil pressure and oil temperature sensor is located on the engine block directly above the accessory drive.



Check the following for defects:

- Electrical wiring broken
- Sending unit malfunction
- Plumbing loose or broken



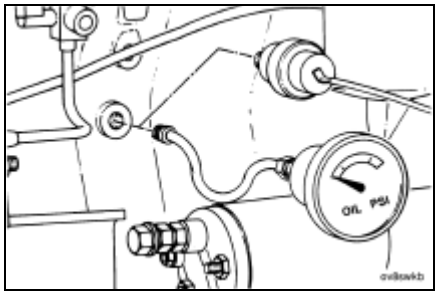
To check for a sending unit malfunction:

Use Compulink™ to verify the readings of the suspect gauge.

If readings from the engine sensors are suspected, use a master gauge of known accuracy to verify.

Connect the line from the master gauge to the main oil rifle on the fuel pump side of the engine.

Replace the sending unit or sensor if it is defective.



Follow-Up

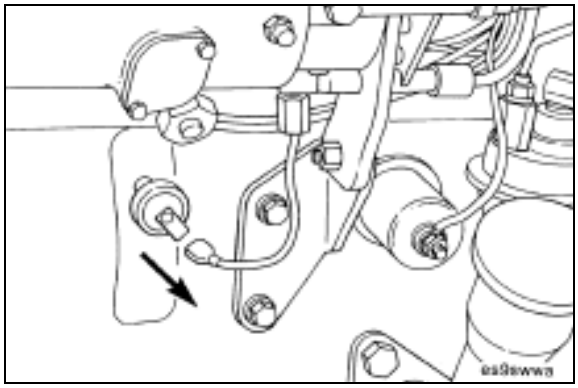
Oil Pressure Sender Removal/Installation

Prepare

Remove

Disconnect the wire from the sending unit.

NOTE: The sending units illustrated can differ from those installed by the original equipment manufacturer (OEM).



Inspect for Reuse

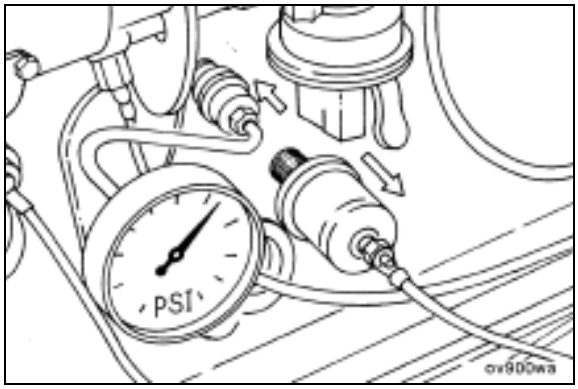
Remove the OEM oil pressure sensor, and install a pressure gauge.

Start the engine.

Measure the lubricating oil pressure.

Minimum lubricating oil pressure:

- **Low Idle (675 to 725 rpm): 69 kPa [10 psi]**
- **High Idle rpm: 207 kPa [30 psi]**



Install

Install the sending unit.

Connect the wire to the sending unit.

Torque Values:

- **Installed into Cast Iron 16 N•m [12 ft-lb]**
- **Installed into Aluminum 10 N•m [7 ft-lb]**

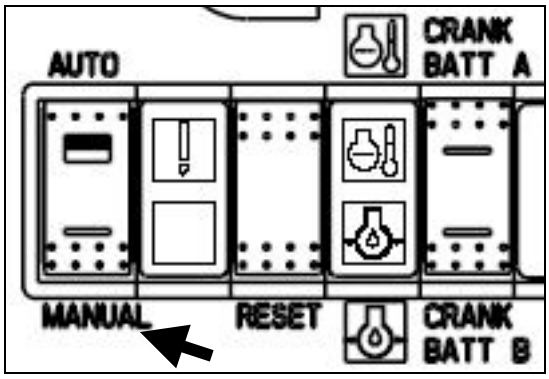
Follow-Up

Oil Pressure Gauge Removal/Installation

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

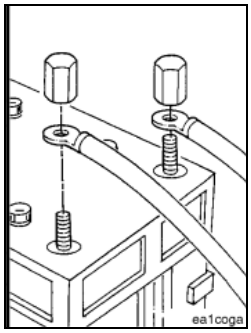


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Remove

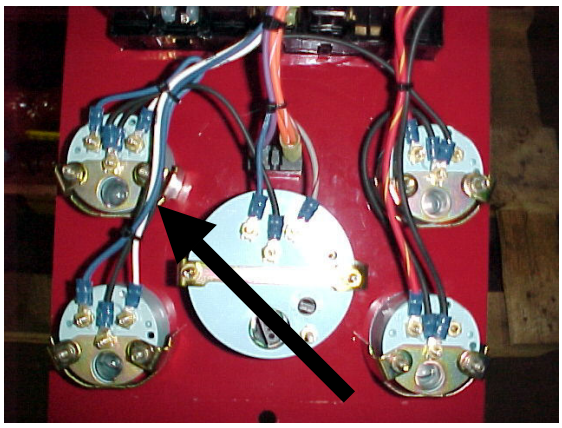
NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for electrical schematic details.

Open the local control panel.

NOTE: Ensure that the wires are clearly tagged for reconnection.

Loosen the nuts on the stud and remove the wires.

Remove the nuts on the mounting bracket and remove the gauge from the panel.



Oil Pressure Gauge Removal/Installation (Cont)

Install

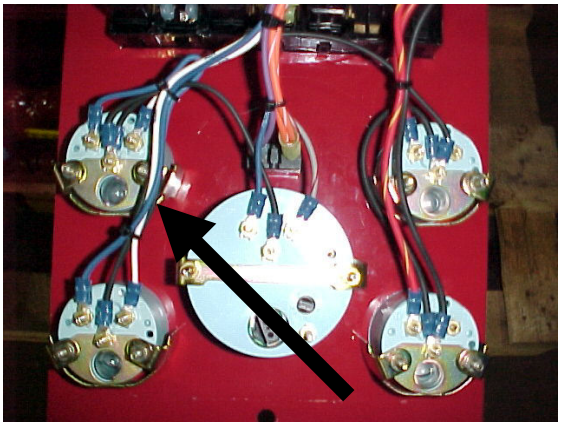
Orient the gauge in the cutout in the electrical panel.

Position the mounting bracket on the gauge.

Install the mounting nuts.

Reconnect the electrical wires on the studs in the same positions as they were originally installed.

Tighten the nuts on the studs.

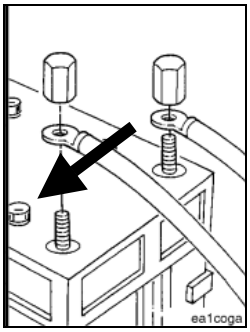


Follow-up

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

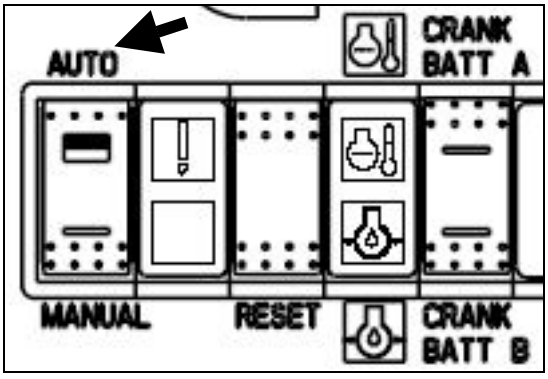
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Lubricating Oil Pressure Regulator Removal/Installation

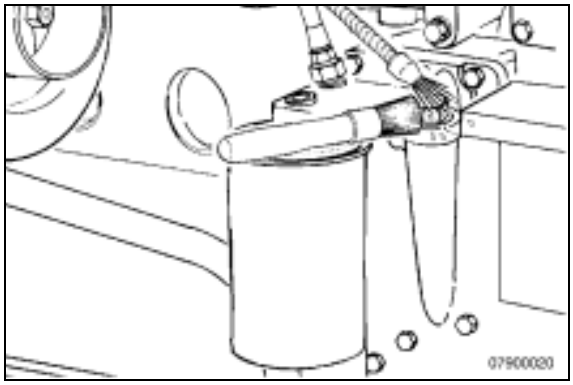
Prepare

Remove

WARNING

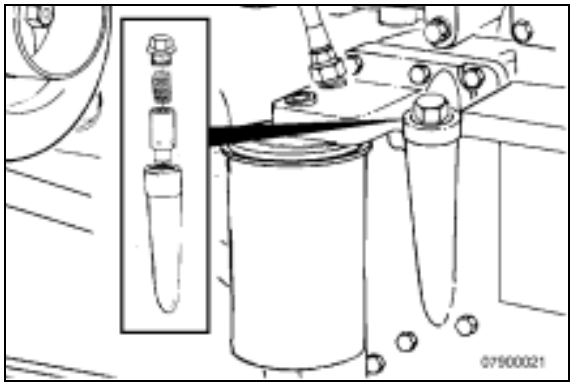
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to prevent personal injury.

Thoroughly clean the area around the pressure regulator plug with clean solvent to prevent debris from falling into the plunger bore when the plug is removed.



Remove the pressure regulator valve plug, spring, and plunger.

Service Tip: The plunger normally can be removed by inserting a finger into the plunger bore until snug and pulling up. If the plunger can not be removed in this manner, the plunger is probably stuck and will require removal of the housing.



Lubricating Oil Pressure Regulator Removal/Installation (Cont)

Clean

WARNING

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

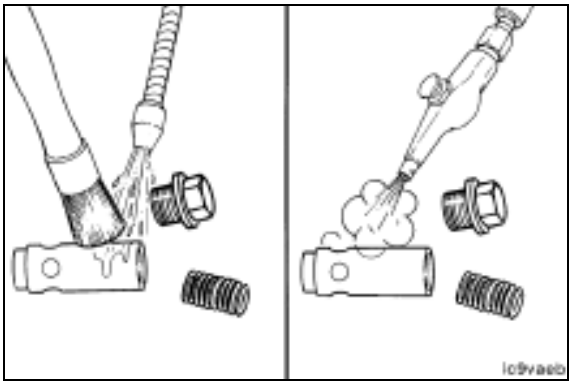
CAUTION

Compressed air used for cleaning/drying should not exceed 207 kPa [30 psi]. Use only with protective clothing and goggles.

Use solvent to clean the spring, plunger, plug, washer, and pressure regulator valve housing.

Dry the parts with compressed air.

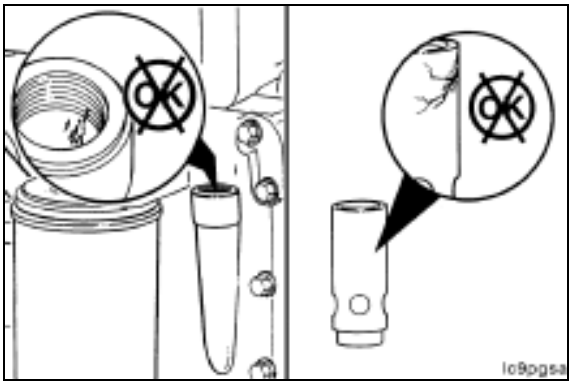
NOTE: If the plunger bore requires cleaning, remove the housing so as not to flush debris into the engine.



Inspect for Reuse

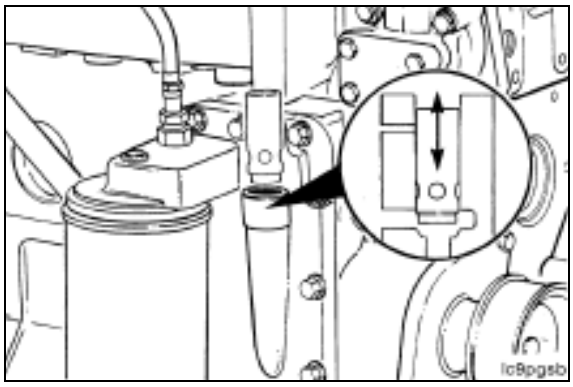
Inspect the plunger and plunger bore for nicks or scratches.

NOTE: Polished areas on the plunger and bore are acceptable.



Lubricating Oil Pressure Regulator Removal/Installation (Cont)

Verify that the plunger moves freely in the bore.

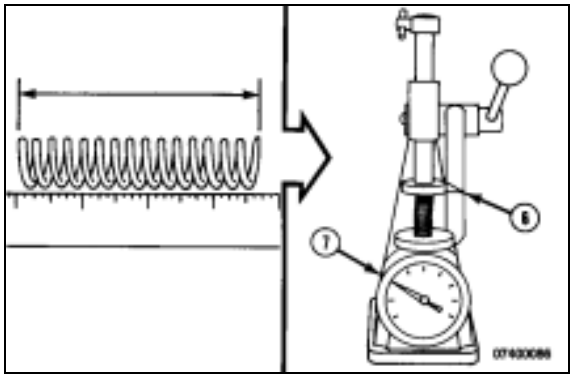


Measure the pressure regulator spring at the following heights.

Pressure Regulator Spring Pressure

- **MIN @ 41.25 mm [1.624 in] 127 n [28.6 lb]**
- **MIN @ 44.5 mm [1.752 in] 109 n [24.5 lb]**

NOTE: When the load is 105 N [23.6 lb], the regulator valve opens. When the load is 142 N [32 lb], the regulator valve is seated.



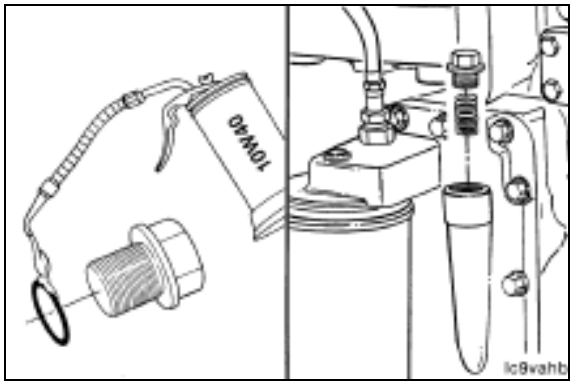
Install

Install a new sealing o-ring on the valve plug and lubricate with clean 15W-40 engine oil.

Assemble the valve plug, spring, and plunger.

Install the pressure regulator assembly and tighten.

Torque Value: 80 N•m [59 ft-lb]



Follow-Up

Oil Pressure Switch Removal/Installation

Prepare

Remove

Disconnect the oil pressure switch wiring.

Remove the oil pressure switch.

Install

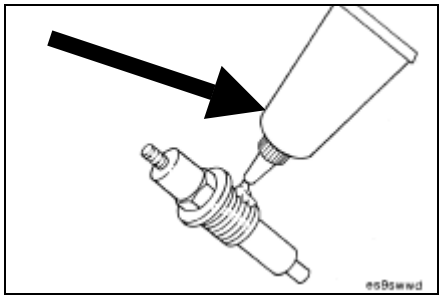
NOTE: Apply liquid teflon sealant to the threads when installing the temperature switch.

Install the temperature sensor.

Torque Value:

- **(Cast Iron) 50 N•m [37 ft-lb]**
- **(Aluminum) 30 N•m [22 ft-lb]**

Reconnect the wiring.



Follow-Up

Operate the engine. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

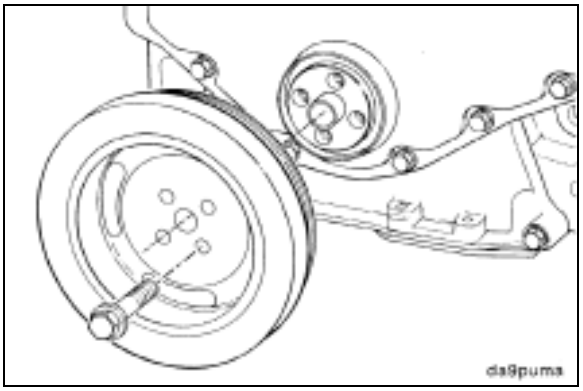
Lubricating Oil Pump Removal/Installation

Prepare

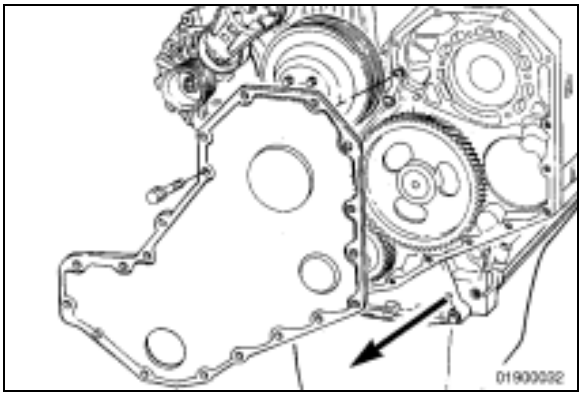
Remove the drive belt. Refer to Procedure 008-002 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

Remove

Remove the vibration damper. Refer to Procedure 001-051 or Procedure 001-052 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



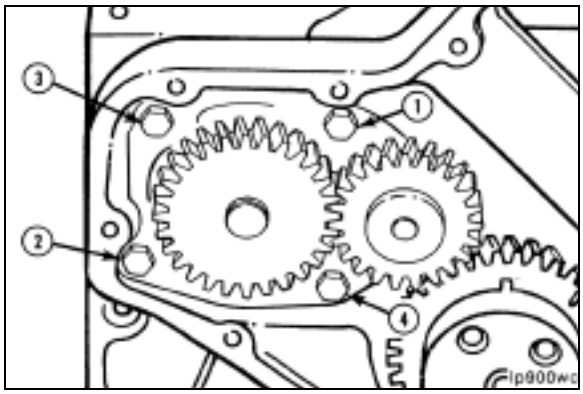
Remove the front gear cover. Refer to Procedure 001-031 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Lubricating Oil Pump Removal/Installation (Cont)

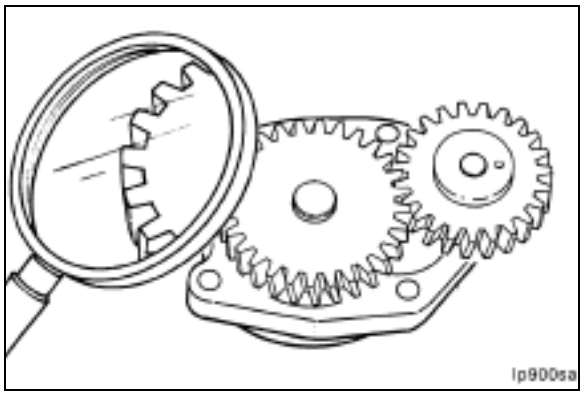
Remove the four mounting capscrews (1, 2, 3, and 4).

Remove the lube oil pump from the bore in the cylinder block.

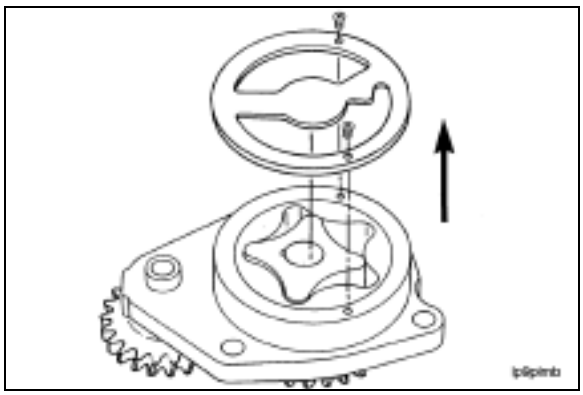


Inspect for Reuse

Inspect the lubricating oil pump gears for chips, cracks, or excessive wear.

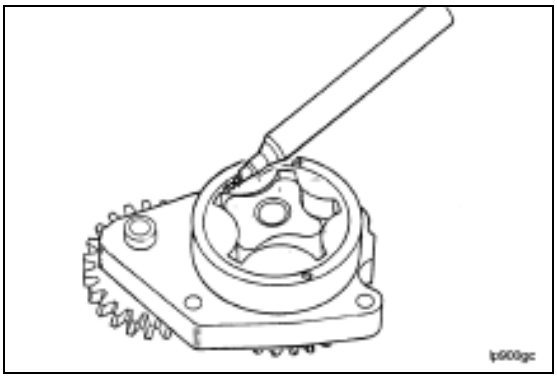


Remove the back plate.



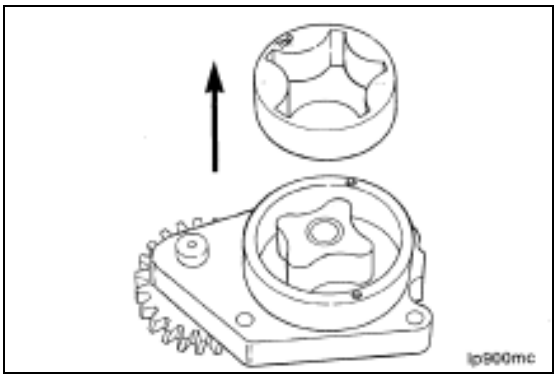
Lubricating Oil Pump Removal/Installation (Cont)

Mark “TOP” on the gerotor planetary.



Remove the gerotor planetary.

Inspect for excessive wear or damage.



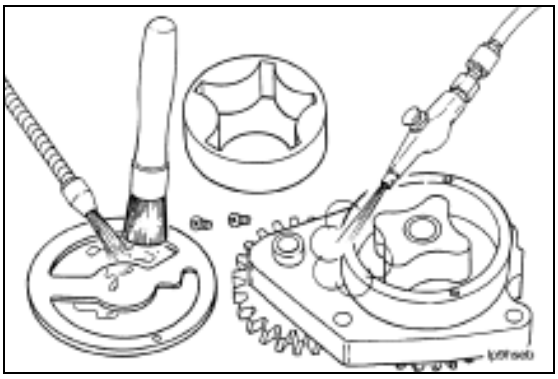
WARNING

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

WARNING

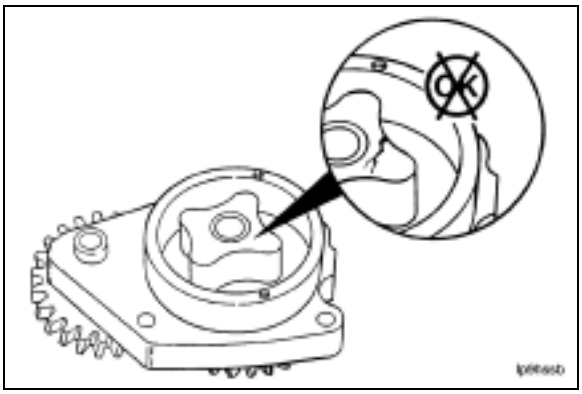
Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause bodily injury.

Clean all parts in solvent and dry with compressed air.



Lubricating Oil Pump Removal/Installation (Cont)

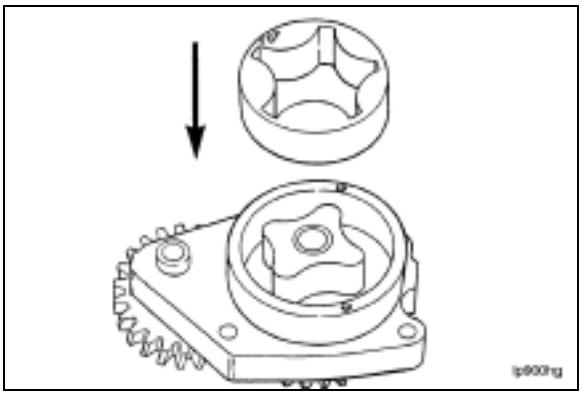
Inspect the lubricating oil pump housing and gerotor drive for damage and excessive wear.



CAUTION

Make sure the gerotor planetary is installed in the original position. Failure to do so can damage the oil pump.

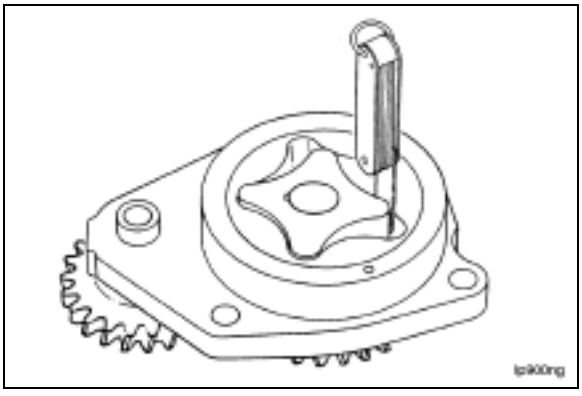
Install the gerotor planetary.



Measure

Measure the tip clearance.

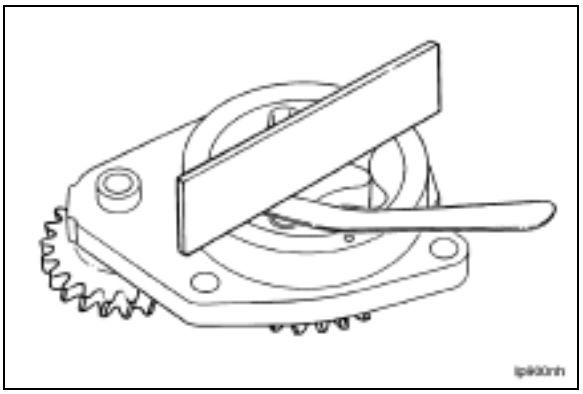
MAX Limit 0.1778 mm [0.007 in]



Lubricating Oil Pump Removal/Installation (Cont)

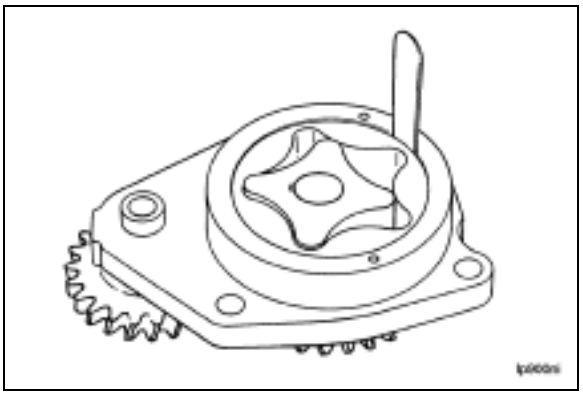
Measure the clearance of the gerotor drive/gerotor planetary to port plate.

MAX Limit 0.127 mm [0.005 in]



Measure the clearance of the gerotor planetary to the body bore.

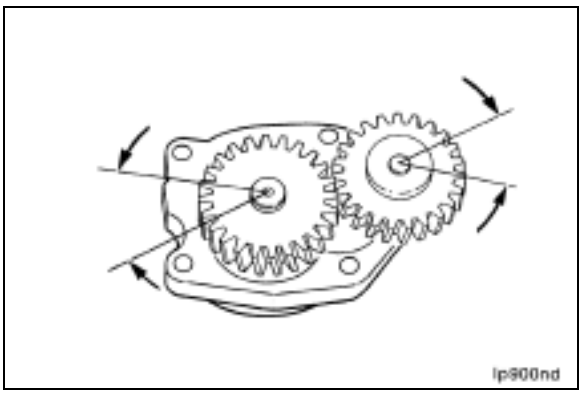
MAX Limit 0.381 mm [0.015 in]



Measure the gear backlash.

Limits (Used Pump)

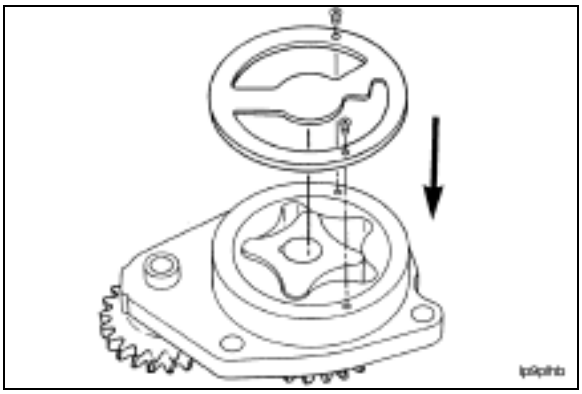
- **MIN 0.75 mm [0.030 in]**
- **MAX 0.85 mm [0.033 in]**



Lubricating Oil Pump Removal/Installation (Cont)

Install

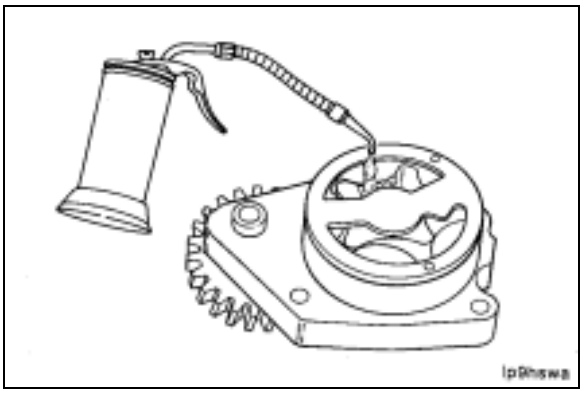
Install the back plate.



CAUTION

Failure to fill the pump with oil during installation can result in a slow prime at initial engine start-up, resulting in severe engine damage.

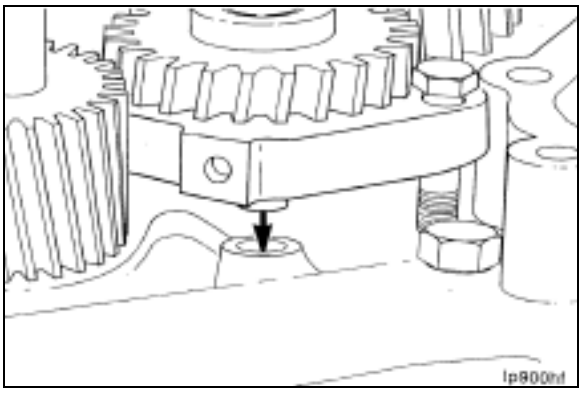
Lubricate the lubricating oil pump with clean 15W-40 engine oil.



CAUTION

Make sure the idler gear pin is installed in the locating bore in the cylinder block.

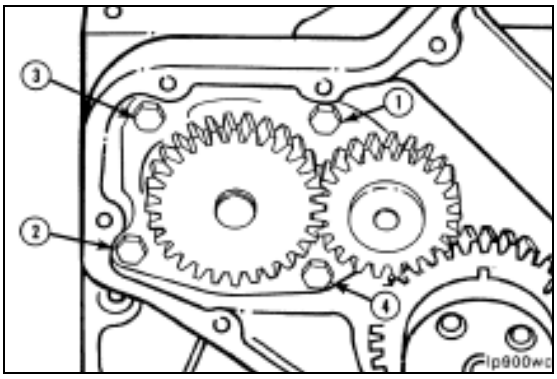
Install the lubricating oil pump.



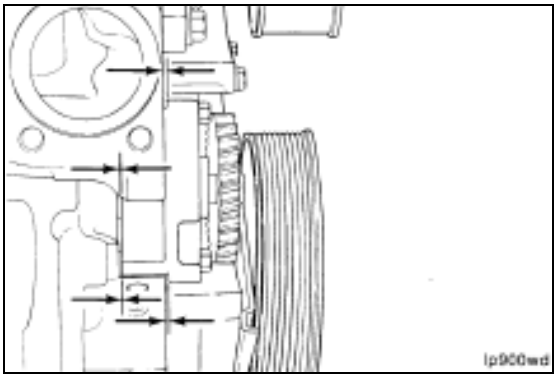
Lubricating Oil Pump Removal/Installation (Cont)

Tighten in the sequence shown.

Torque Value: 24 N•m [18 ft-lb]



NOTE: The back plate on the pump seats against the bottom of the bore in the cylinder block. When the lubricating oil pump is correctly installed, the flange on the lubricating oil pump will not touch the cylinder block.



NOTE: Be sure the gear backlash is correct if installing a new lubricating oil pump.

Measure the gear backlash.

Backlash Limits

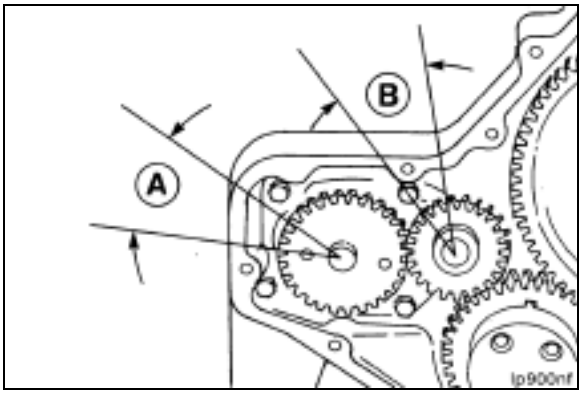
A

- **MIN 0.75 mm [0.030 in]**
- **MAX 0.85 mm [0.033 in]**

B

- **MIN 0.75 mm [0.030 in]**
- **MAX 0.85 mm [0.033 in]**

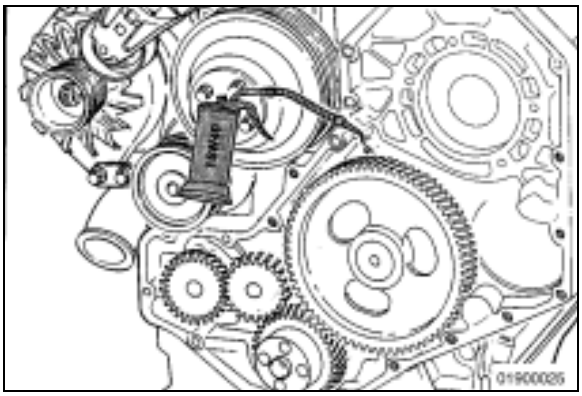
NOTE: If the adjoining gear moves when you measure the backlash, the reading will be incorrect.



Lubricating Oil Pump Removal/Installation (Cont)

Gear Cover - Installation

Lubricate the front gear train with clean 15W-40 engine oil.

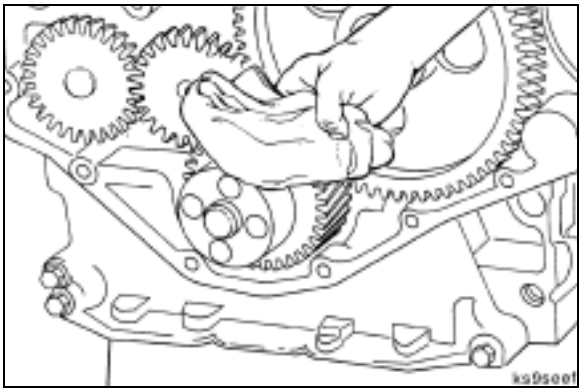


CAUTION

The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.

Thoroughly clean the front seal area of the crankshaft.

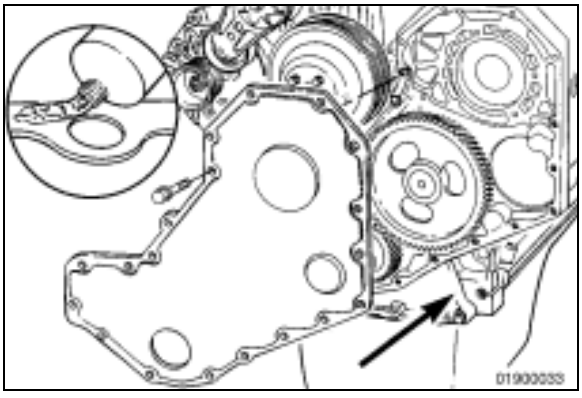
NOTE: Always replace the front seal when removing and installing the gear cover. Refer to Procedure 001-023 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Apply a thin bead of Three-Bond™, or equivalent, to the front cover side of the gasket only.

NOTE: Do not remove the plastic seal pilot tool from the lubricating oil seal at this time. Use the plastic seal pilot tool to guide the seal on the crankshaft.

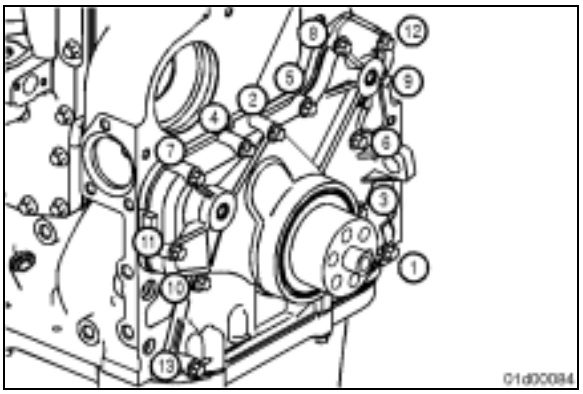
Install the gasket and front cover on the engine.



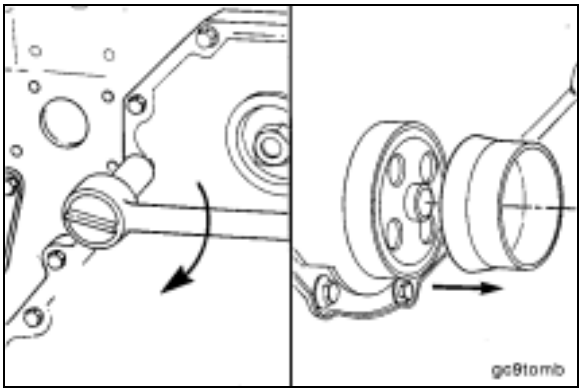
Lubricating Oil Pump Removal/Installation (Cont)

Tighten the front cover mounting capscrews in the indicated order.

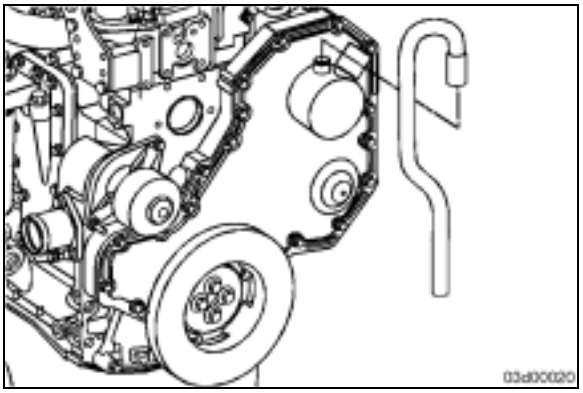
Torque Value: 24 N•m [18 ft-lb]



Remove the plastic pilot tool from the crankshaft.

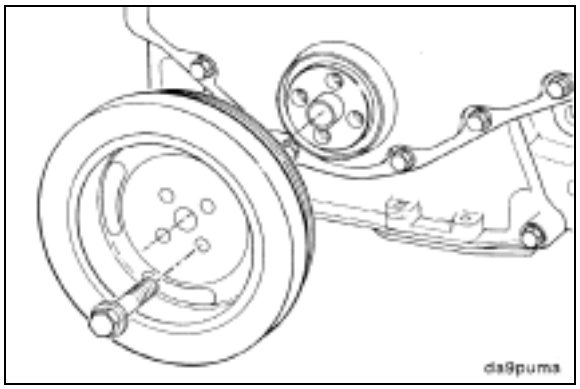


Install the front breather and tube. Refer to Procedure 003-018 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



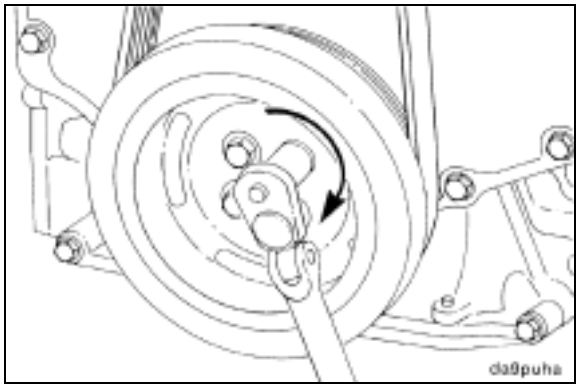
Lubricating Oil Pump Removal/Installation (Cont)

Install the vibration damper. Refer to Procedure 001-051 or Procedure 001-052 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Tighten the vibration damper. Refer to Procedure 001-051 or Procedure 001-052 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

Torque Value: 125 N•m [92 ft-lb]



Raise the belt tensioner to install the belt. Refer to Procedure 008-002 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

Follow-Up

Lubricating Oil and Filter Analysis

Inspect

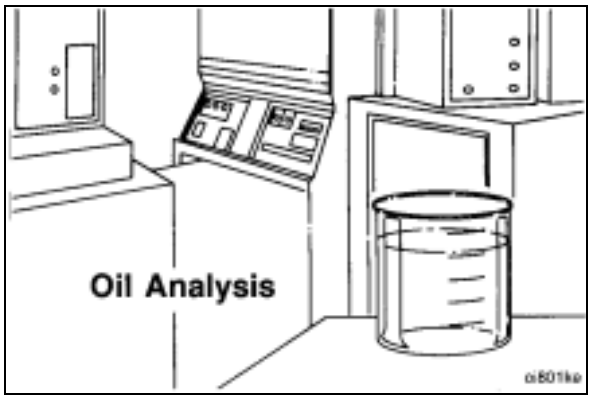
An analysis of used oil can help diagnose internal engine damage and determine if it was caused by one of the following:

Intake air filter malfunction

Coolant leaks

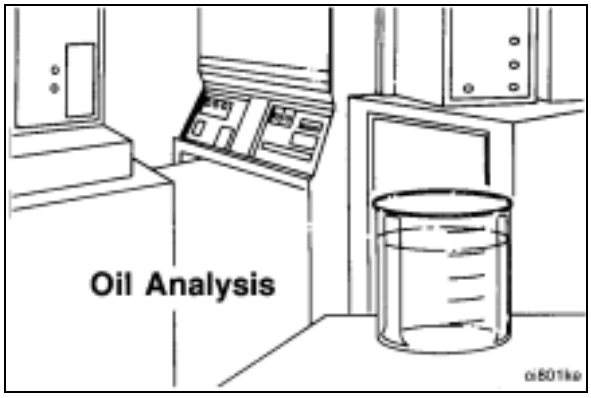
Oil diluted with fuel

Metal particles causing wear



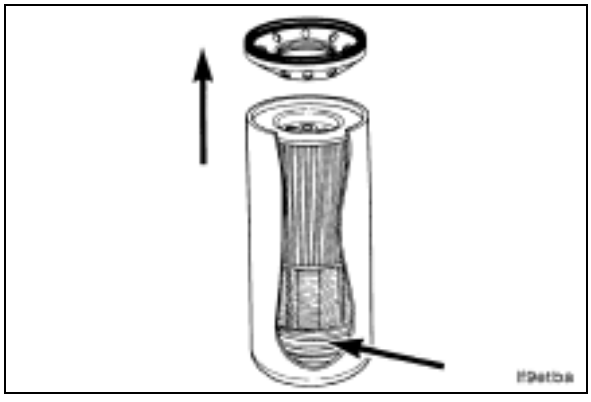
For additional oil analysis information, Refer to Cummins Engine Oil Recommendations, Bulletin 3810340 in the Cummins Engine Troubleshooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

NOTE: Do not take apart an engine for repair based solely on the results of an oil analysis. Inspect the oil filters. If the oil filter shows evidence of internal damage, find the source of the problem, and repair the damage. Refer to the appropriate procedure(s) based on the following oil filter inspection.



WARNING

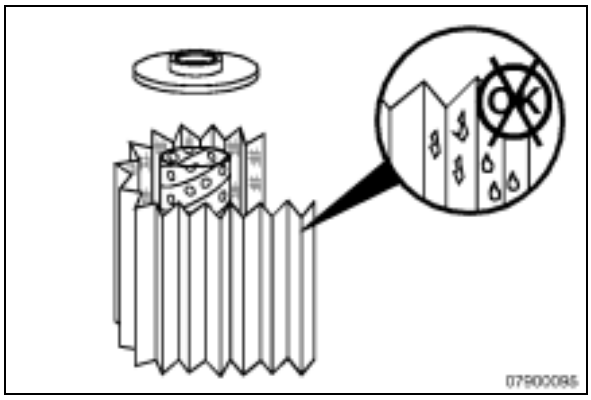
Restrain the full flow lubricating oil filter, and carefully cut the filter (upper section of combination filter) open. The filter element spring is under compression and can cause personal injury.



Lubricating Oil and Filter Analysis (Cont)

Use the tube cutter, Part No. 3376579, to open the full-flow oil filter (upper section of the bypass filter).

Inspect the filter element for evidence of moisture or metal particles.

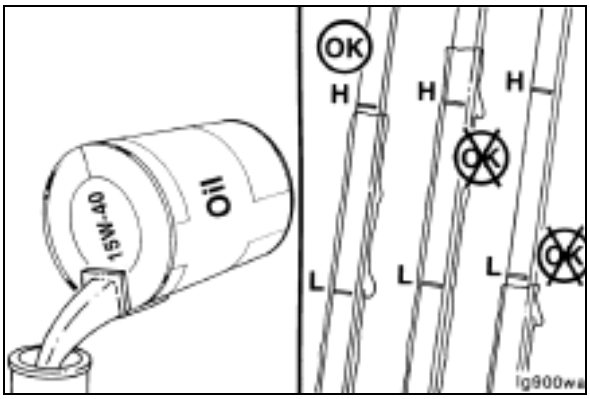


Metal	Possible Source
Copper	Bearings and Bushings
Chromium	Piston Rings
Iron	Cylinder Liners
Lead	Bearing Overlay Material
Aluminum	Piston Wear or Scuffing

Check Oil Level

Fill the engine with clean lubricating oil to the proper level.

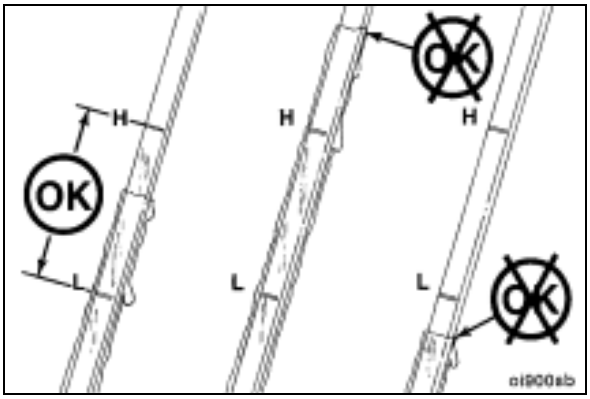
Idle the engine to inspect for leaks at the drain plug.



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

Check the oil level again.

Add oil a necessary to bring the oil level to the “H” (high) mark on the dipstick.



Drain and Fill Lubricating Oil

Drain

WARNING

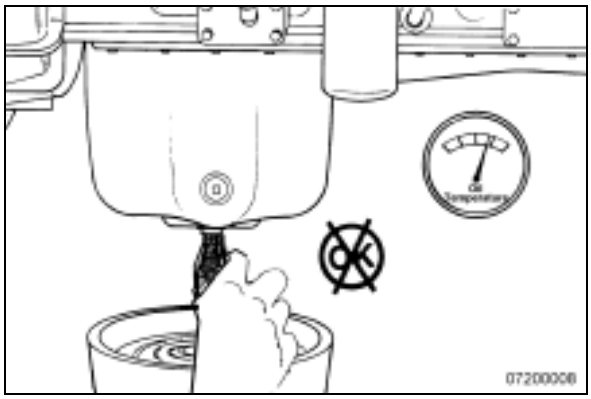
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

WARNING

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

NOTE: Use a container that can hold at least 20 liters [21 qt] of lubricating oil.

Operate the engine until the coolant temperature reaches 60°C [140°F]. Shut off the engine. Remove the oil drain plug. Drain the oil immediately to be sure all the oil and suspended contaminants are removed from the engine.



Fill

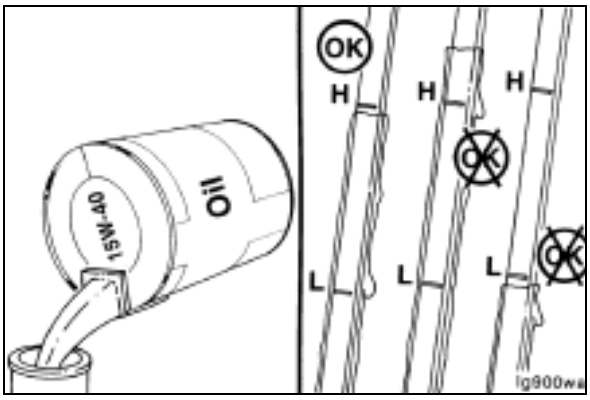
NOTE: Use a high-quality 15W-40 multiviscosity oil, such as Cummins Premium Blue®, or its equivalent, in Cummins engines. Choose the correct oil for your operating climate as outlined in the Section V.

Drain and Fill Lubricating Oil (Cont)

Fill the engine with clean 15W-40 lubricating oil to the proper level.

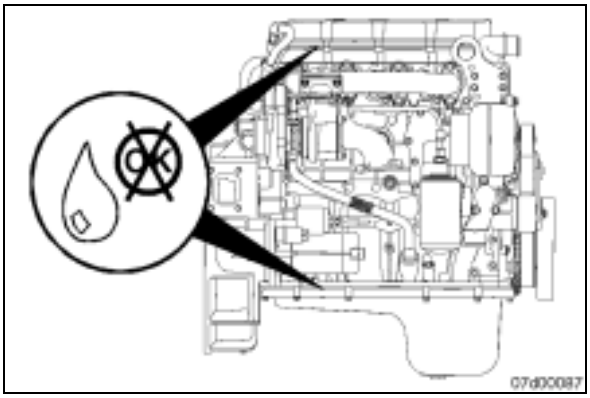
NOTE: When filling the oil pan, use the fill tube on the side of the engine rather than on top of the rocker lever cover.

NOTE: If the engine is not equipped with a side-fill, wait at least 3 minutes before measuring the oil level with the dipstick to allow the oil to drain to the pan.



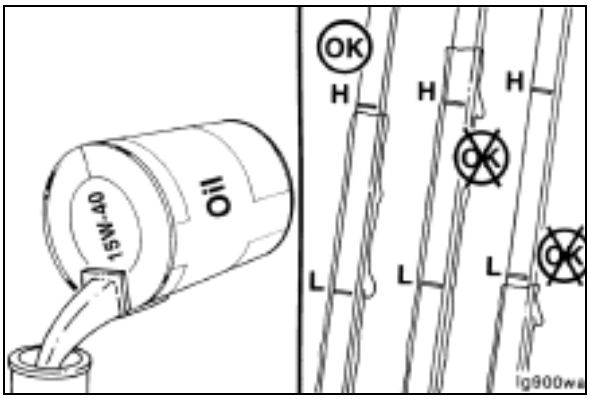
Idle the engine to inspect for leaks at the drain plug.

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



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

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



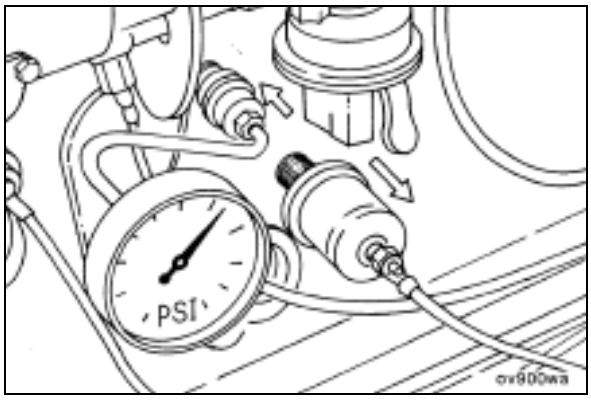
Drain and Fill Lubricating Oil (Cont)

Measure

Remove the plug in the main lubricating oil rifle. The plug is located midway up on the left side of the cylinder block.

Connect a pressure gauge.

NOTE: Remove the OEM pressure sensor, if equipped, to install the gauge.



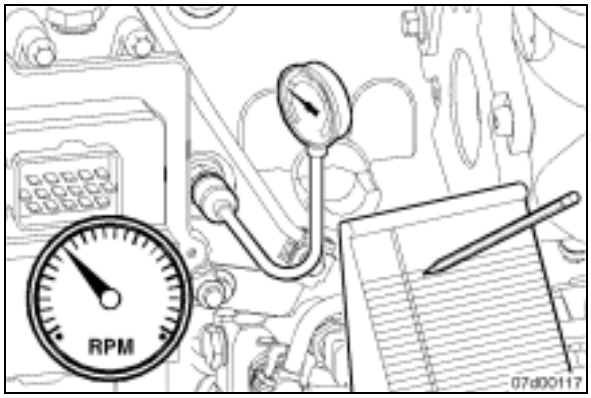
CAUTION

If the lubricating oil pressure does not develop within 15 seconds, shut off the engine to reduce the possibility of internal engine damage.

Start the engine.

Allow the engine to run and achieve operating temperature. Check for oil leaks.

Record the lubricating oil pressure readings at idle rpm.



Increase engine speed to rated speed and hold for 30 seconds.

Record the lubricating oil pressure readings at rated rpm.

Minimum oil pressure at low idle: 69 kPa [10 psi]

Minimum oil pressure at rated engine speed: 207 kPa [30 psi]

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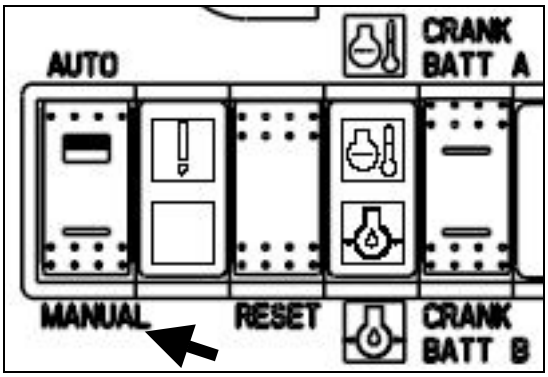
Speed Sensor or Mag Pick-Up Sensor Removal/Installation

Prepare: Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

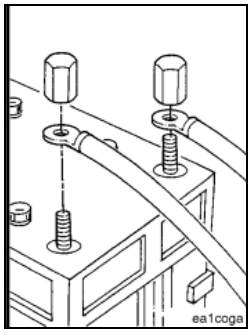


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Remove The Mag Pick-Up (Speed Sensor) which is mounted on the bell-housing and located over the flywheel teeth. Both the Speed Switch and the Tachometer (located in the Engine control Panel) use the Mag Pick-Up as the engine speed signal. The resistance on a good Mag Pick-Up should be approximately 265 Ohms.

Remove the 2-wire cable that is connected to it. (The cable wires are not polarity sensitive, so it makes no difference how the wires are connected to it). Remove the Mag Pick-Up by turning it out counter-clockwise.

Speed Sensor or Mag Pick-Up Sensor Removal/Installation (Cont)

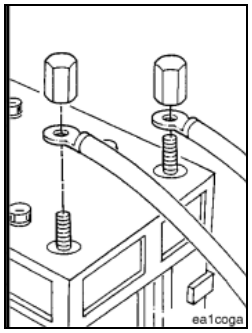
When installing a new Mag Pick-Up, first check that the threads in the bell-housing are clean. Any burrs may prevent proper installation.

Install the Mag Pick-Up by threading it into the bell-housing until its tip is bottomed out against the flywheel. Then back out the Mag Pick-Up ½ turn. Reconnect the 2-wire cable. Reconnect the batteries.

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

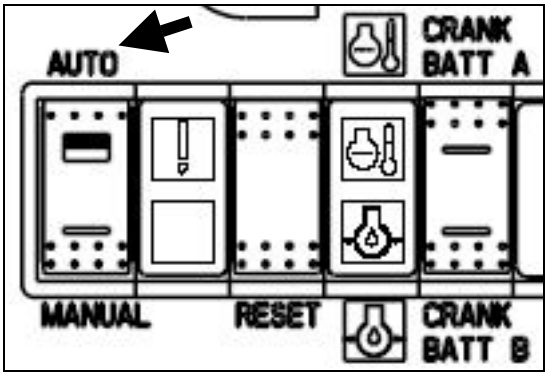
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Place the AUTO/MANUAL rocker switch in the AUTO position on the fire pump panel.

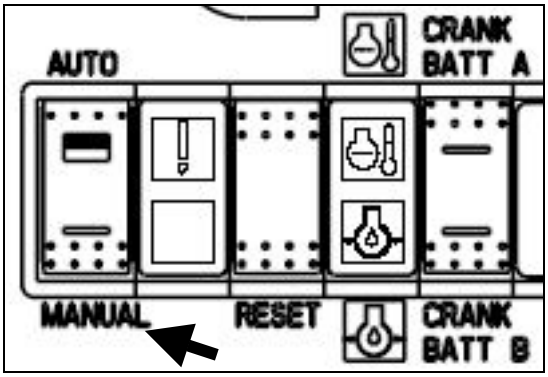
Return the fire protection system controller back to operating status.



Tachometer Removal/Installation

Prepare: Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

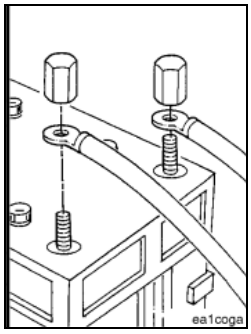


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



To remove the tachometer, open the cover of the Engine Control Panel. Disconnect the 3-wire connector that is plugged into the back of the tachometer. Next, remove the tachometer’s retaining bracket.

Install the new tachometer in reverse order.

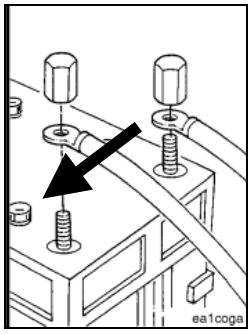
Refer to instructions for Tachometer Calibration in this section.

Tachometer Removal/Installation (Cont)

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

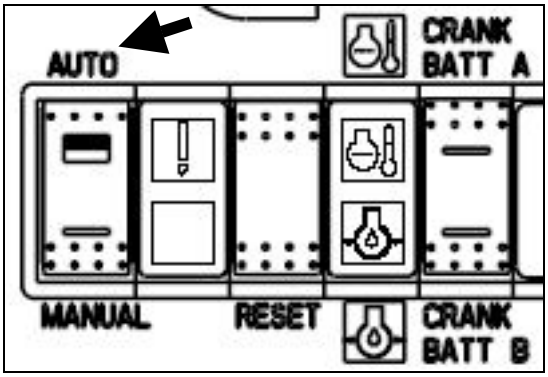
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



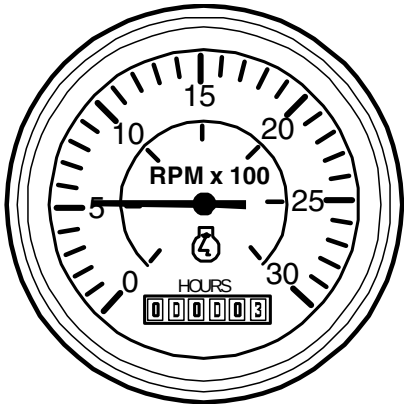
Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system controller back to operating status.

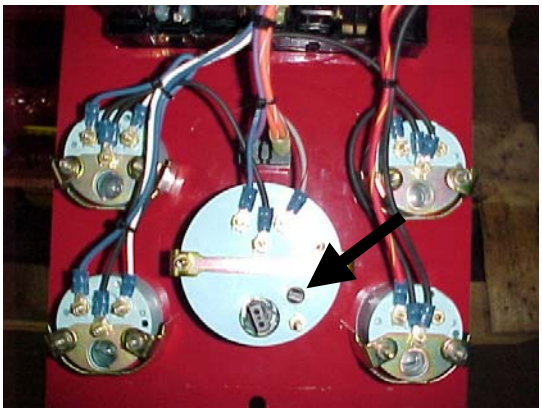


Tachometer Calibration

After a new tachometer has been installed, it will be necessary to calibrate it. In order to do this, the engine must be started and verified that it is operating at rated speed.



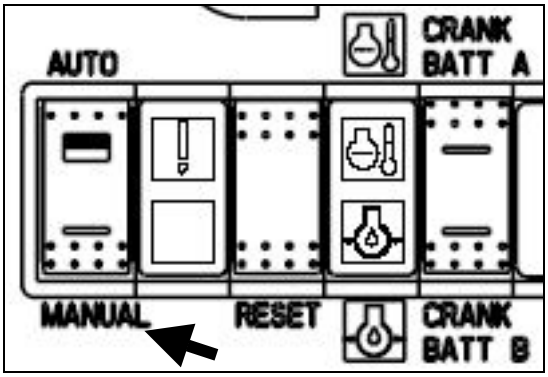
With a small flat-blade screwdriver, turn the trim pot, located on the back of the tachometer, until its indicator agrees with the engine speed.



Overspeed Switch Removal/Installation

Prepare: Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

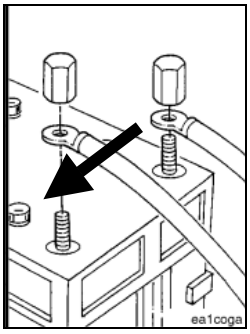


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

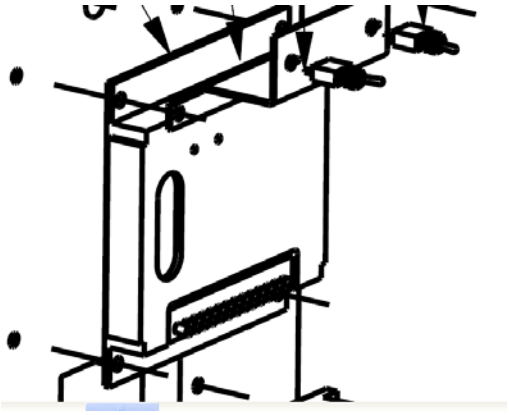
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



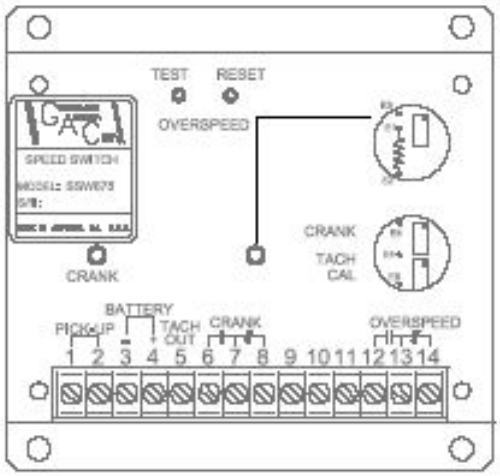
Begin removing the Speed Switch by first documenting the wires that are connected to its terminals. If necessary, place a piece of masking tape on each wire, noting the terminal number that it’s connected to.

Once all of the wires are removed, the Speed Switch can be removed from the Engine Control Panel by removing the four screws that are securing it to the panel. Each screw is nutted to the back of the Control Panel. In order to access the four retaining nuts, the Control Panel may have to be loosened from the engine frame to allow clearance for a wrench.



Overspeed Switch Removal/Installation (Cont)

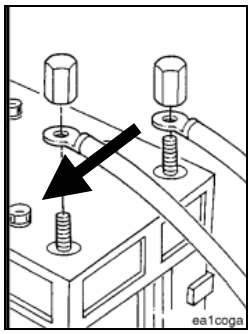
Once the Speed Switch is removed, install the new one in reverse order. All Speed Switches are factory calibrated for the specific Firepump Engine model that it's intended to be used with. No adjustments will be necessary.



For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

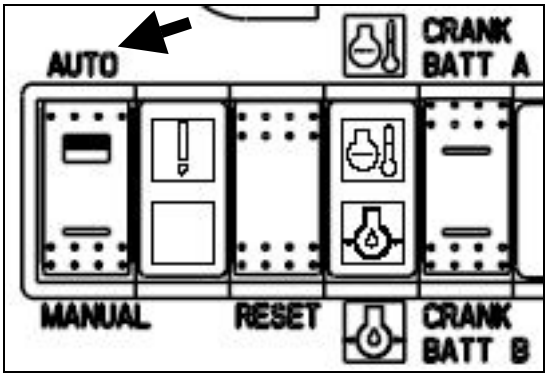
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system controller back to operating status.



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Electronic Controlled Fuel System Information

Base Control System Description

The engine control system is an electronically operated fuel control system that also provides many operator and vehicle or equipment features.

The base functions of the control system include:

Fueling and timing control

Limiting the engine speed operating range between the low- and high-idle set points

Reducing exhaust emissions while optimizing engine performance

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

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

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

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

The ECM can communicate with the INSITE™ service tool and some other vehicle controllers, such as transmissions, antilock braking system, automatic slip reduction, electronic dash displays, etc., through the new SAE J1939 datalink or the older SAE J1708 datalink.

Some vehicles and equipment will have J1939 networks on them that link many of the smart controllers together. Vehicle control devices can temporarily command engine speed or torque to perform one of its functions, such as transmission shifting, antilock braking, etc.

Electronic Controlled Fuel System Information (Cont)

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

Coolant temperature sensor

Intake air temperature sensor

Intake manifold pressure sensor

Oil pressure and temperature sensor

Crankshaft engine position sensor (Signature, ISX, QSX15 only)

Camshaft engine position sensor

Ambient air pressure sensor

Fuel supply pressure sensor (Signature, ISX, QSX15 only)

Front and rear rail pressure sensors (Signature, ISX, QSX15 only)

Fuel inlet restriction sensor

Water-in-fuel sensor

Wet tank pressure sensor

The following inputs are provided by OEM-selected devices:

Key switch enable

Engine speed Inc/Dec switch

ECM Diagnostic switch

Programmable Features

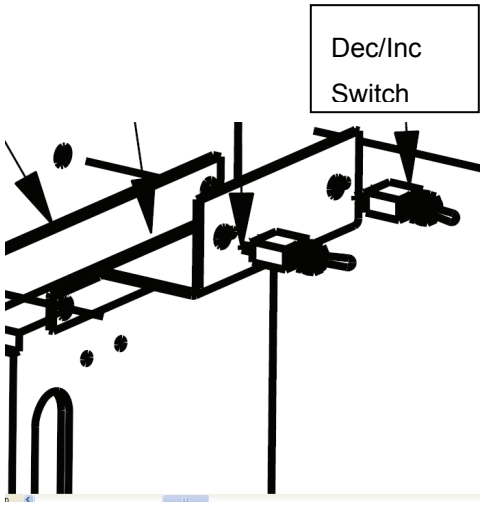
Electronic Controlled Fuel System Information (Cont)

Engine Speed Control

The engine speed can be increased or decreased with the “INC/DEC” switch, which is located inside the engine control panel.

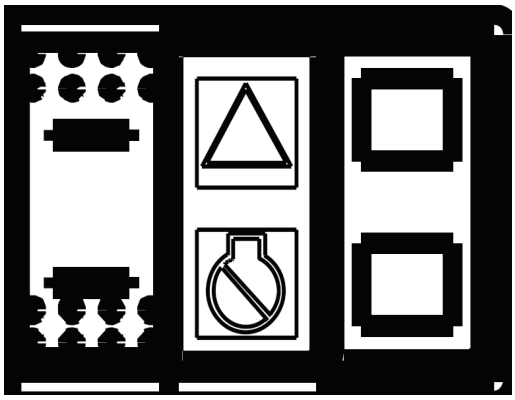
With the engine running, the engine speed can be increased by 25 rpm every time the INC/DEC switch is momentarily switched to the “INC” position. Likewise, the engine speed can be decreased by 25 rpm every time the INC/DEC switch is momentarily switched to the “DEC” position.

The engine ECM will remember the speed at the time of the engine shutdown, so it will start and run at this new speed.



Diagnostic Fault Codes

The engine ECM has a diagnostic mode that, when turned on, can blink out fault codes that may be present. A fault code is present if the yellow warning lamp or red shutdown lamp, which are located on the engine control panel, is illuminated.



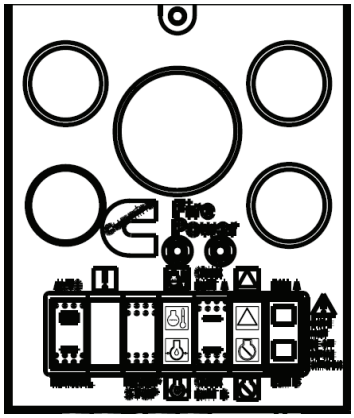
Electronic Controlled Fuel System Information (Cont)

To turn on diagnostics, the “Auto/Manual” switch on the engine control panel must be in the “Manual” position and the engine NOT running. Open the engine control panel and switch the “Diagnostic” switch to the ON position. The yellow and red engine lamps will then blink out a fault code as follows:

The yellow lamp will blink once to announce the beginning of the fault code. Then the red lamp will blink out a 3-digit code. For example, for a fault code of 241, the red lamp will blink 2 times, pause, blink 4 times, pause, then blink 1 time.

The yellow lamp will then blink once to announce then end of the code. The code will continue to blink again.

-



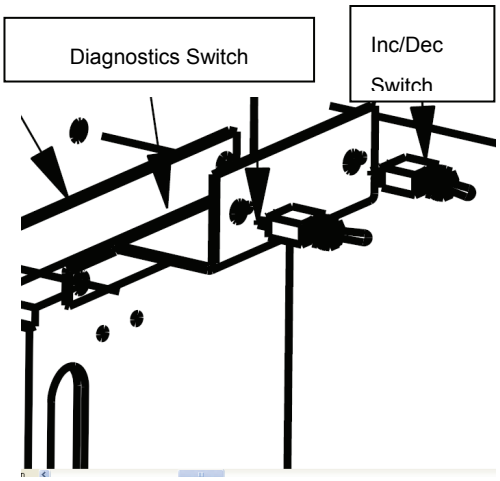
To increment to the next fault code, switch the “INC/DEC” switch to the “INC” position once. If there is another fault code present, then a new code will be blinked out.

If placed in diagnostic mode and the yellow and red lamps do not blink but remain lit, then there are no active faults present.

The Diagnostic switch must be returned to the OFF position before starting the engine.

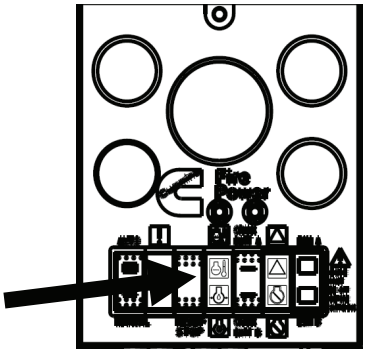
At engine start-up, the ECM conducts a diagnostic test. The yellow and red lamps will light sequentially, remain lit for about 1 second, then turn off.

-



Circuit Breakers

The engine control panel has two 30A circuit breakers that are of the manual-reset type. They are provided to protect against a catastrophic failure, such as a direct battery-terminal ground fault or a battery charger malfunction. One breaker is for Battery A, and the other breaker is for Battery B. If one of the circuit breakers trips, first locate the source of the fault before resetting.



Electronic Controlled Fuel System Information (Cont)

Engine Protection System

In addition to the engine diagnostic lamps (see "Diagnostic" Section), the engine control panel has annunciation for 5 critical engine conditions.

They are:

Engine Overspeed

Engine Low Oil Pressure

Engine High Water Temp

Alternate ECM

Fuel Injection Failure

All of the 5 critical conditions are annunciated at the engine control panel with indicator lamps, as well as to the Firepump Controller via the Engine Terminal Block, which is located inside the Engine Control Panel. Annunciation is as follows:

1. Engine Overspeed Annunciation AND Engine Shutdown

The engine overspeed signal is controlled by the speed switch, which is located inside the Engine Control Panel. The speed switch is factory programmed to alarm at 115% rated engine speed. If the engine RPM's exceed 115% rated speed, the engine will shut down, and annunciation will occur as follows:

The Overspeed Lamp on the Engine Control Panel will illuminate.

A HIGH signal (B+) will appear at Terminal #3 on the Engine Terminal Block.

Electronic Controlled Fuel System Information (Cont)

Engine Low Oil Pressure Annunciation

Low Oil Pressure Annunciation is controlled by a switch that is activated at a falling pressure of 16 psi, and deactivates at a rising pressure of 12 psi. (When the engine is not running, the Low Oil Pressure Lamp will be illuminated). When a Low Oil Pressure condition exists, annunciation will occur as follows:

The Low Oil Pressure Lamp on the Engine Control Panel will illuminate.

A LOW Signal (gnd) will appear at Terminal #4 on the Engine Terminal Block.

Engine High Water Temperature

Engine High Water Temperature Annunciation is controlled by a switch that is activated at a rising temperature of 200 degrees F, and deactivates at a falling temperature of 190 degrees F. When a High Temperature condition exists, annunciation will occur as follows:

The High Temperature Lamp on the Engine Control Panel will illuminate.

A LOW Signal (gnd) will appear at Terminal #5 on the Engine Terminal Block.

Electronic Controlled Fuel System Information (Cont)

4. Alternate ECM Annunciation

There are two lamps on the Engine Control Panel which indicate whether ECM A or ECM B is controlling the engine. ECM B is considered the Alternate ECM. When the ECM Selector Switch is in the ECM B position, annunciation will occur as follows:

The ECM B Lamp on the Engine Control Panel will illuminate.

A LOW Signal (gnd) will appear at Terminal # 301 on the Engine Terminal Block.

Fuel Injection Failure (FIF)

Fuel Injection Failure Annunciation is controlled by the engine ECM. When an FIF condition exists, annunciation will occur as follows:

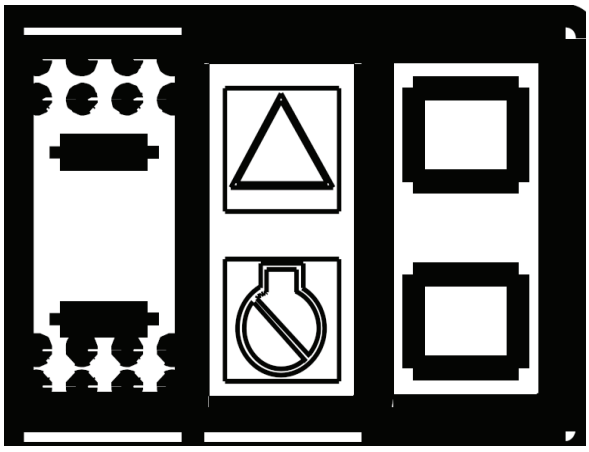
The ECM will illuminate the Red engine shutdown lamp on the Engine Control Panel.

A LOW Signal (gnd) will appear at Terminal #302 on the Engine Terminal Block.

Illuminated Indicator Symbols

The indicator symbols provide additional information on the type of fault that the ECM has detected. The codes will flash on the indicators as mentioned in the Diagnostic Fault Codes section in this section.

NOTE: Pressing the alarm cancel button when the switch is turned on will illuminate the symbols for a self-test.



Electronic Controlled Fuel System Information (Cont)

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

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

The water-in-fuel lamp interfaces with the optional water-in-fuel sensor in the primary fuel filter. It comes on when there is water in the fuel filter.

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

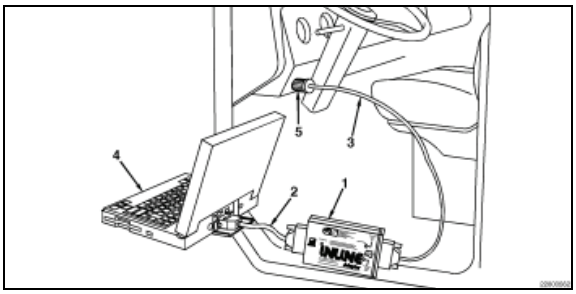
The low coolant level lamp comes on when the coolant level is below specification. Refer to Procedure 018-018 in the Troubleshooting and Repair Manual, this engine model for coolant specifications.

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

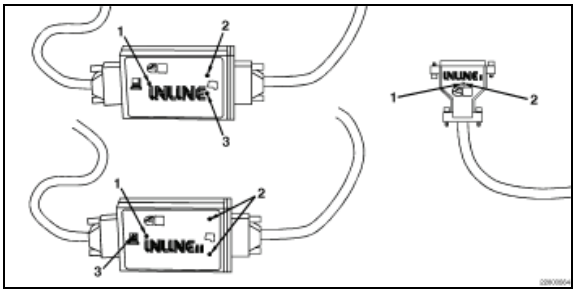
The low engine oil pressure lamp comes on when the engine oil pressure is below specification. Refer to Procedure 018-017 in the Troubleshooting and Repair Manual this engine model for oil pressure specifications.

Service Tools and Hardware - Overview

General Information



Bench Communication Setup



ECM bench calibration base harness (parent cable)

Power supply

PC with INSITE™

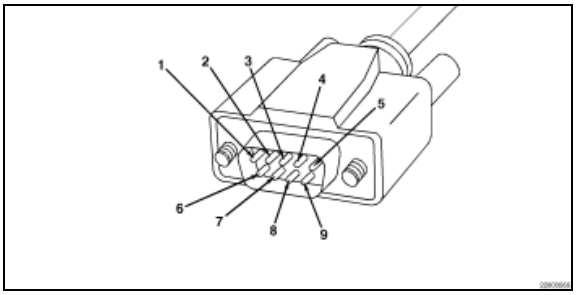
Datalink adapter

ECM-specific calibration cable/ROM boot cable

PC serial cable

Datalink adapter cable.

Datalink Adapter Identification Diagram – INLINE™, INLINE™ I, and INLINE™ II



Power light

Communication light

To PC light.

Service Tools and Hardware – Overview (Cont)

Serial Cable Pinout Diagram, Part Number 3824594

Open

Transmit data

Receive data

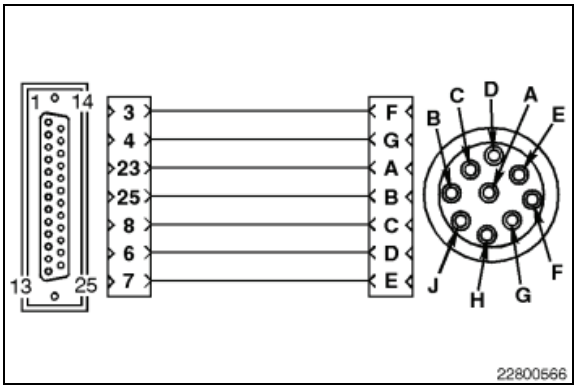
Data terminal ready (+5 VDC)

Signal ground

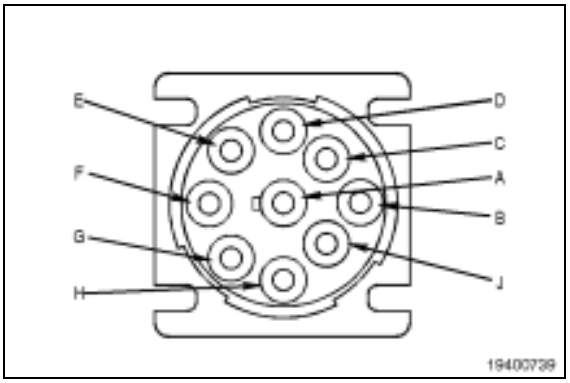
Open

Request to send (+5 VDC)

Clear to send



9-Pin Datalink Cable, Part Number 3162848



9-Pin In-Cab Datalink Connector

Ground

Unswitched battery (+)

J1939 datalink (-)

J1939 datalink (+)

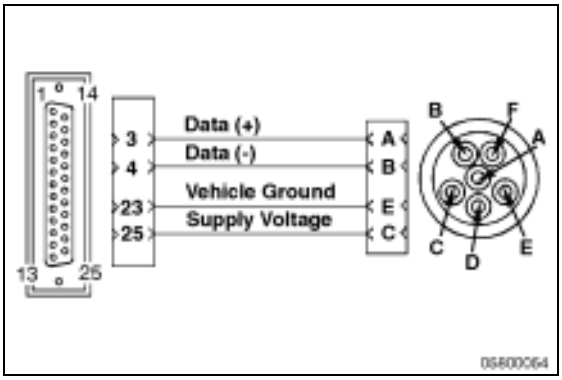
J1939 datalink (shield)

J1708 datalink (+)

J1708 datalink (+)

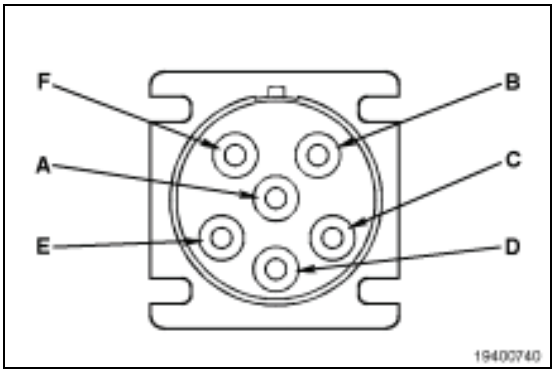
Open

Open.



Service Tools and Hardware – Overview (Cont)

6-Pin Datalink Cable, Part Number 3824439



6-Pin In-Cab Datalink Connector

J1708 datalink (+)

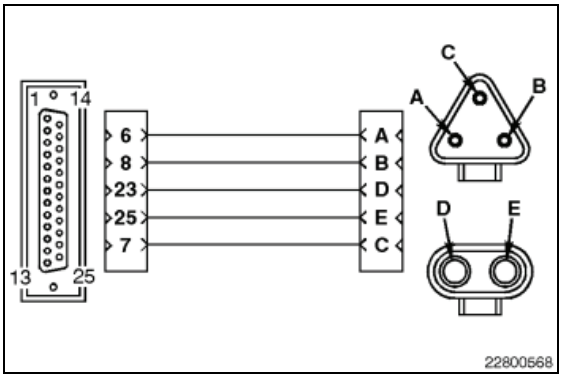
J1708 datalink (-)

Unswitched battery (+)

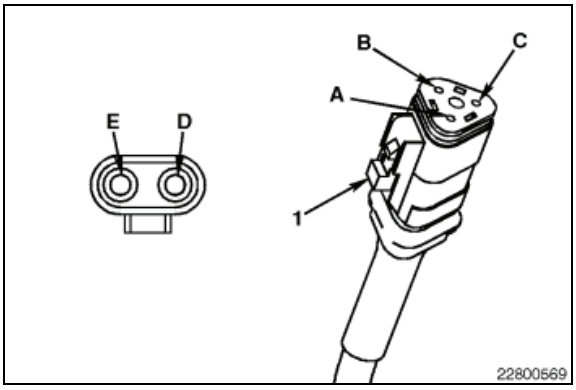
Open

Ground

Open.



3-Pin Datalink Cable, Part Number 3162847



Service Tools and Hardware – Overview (Cont)

3-Pin On-Engine Datalink Connector
J1939 datalink (+)
J1939 datalink (-)
J1939 datalink (shield)
Ground
Unswitched battery (+).

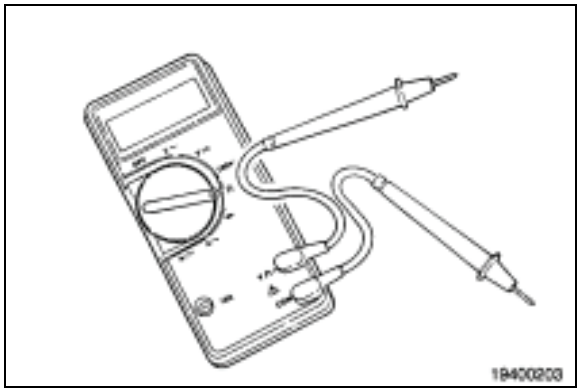
Follow-Up

Electronic Engine Controls - Overview

How to Use a Multimeter

On most meters, the negative (-), (black) meter probe must be plugged into the COM position and the positive (+), (red) meter probe must be plugged into one of the positions marked for amperage, resistance, or voltage. Refer to the manufacturer's procedures for more detail.

NOTE: When measuring to a block ground, use a clean, unpainted metal surface to make sure a good measurement exists.



Electronic Engine Controls – Overview (Cont)

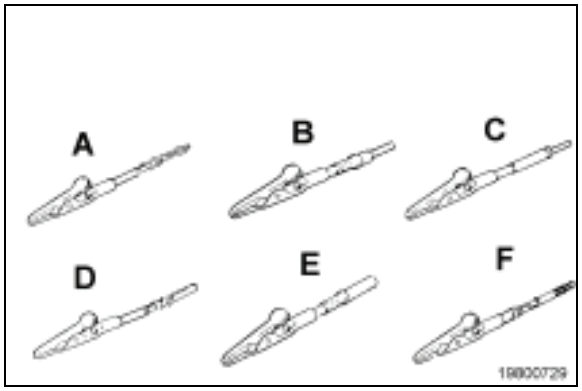
Use of Special Test Leads

CAUTION

To avoid pin and harness damage, use the following test leads when taking a measurement:

Illustration

Illustration	Test Lead Type	Part Number
A	Weather-Pack, male	3823995
B	Deutsch, male	3823993
C	Deutsch, AMP, Metri-Pack, male	3822758
D	Weather-Pack, female	3823996
E	Deutsch, female	3823994
F	Deutsch, AMP, Metri-Pack, female	3822917



How to Measure Amperage

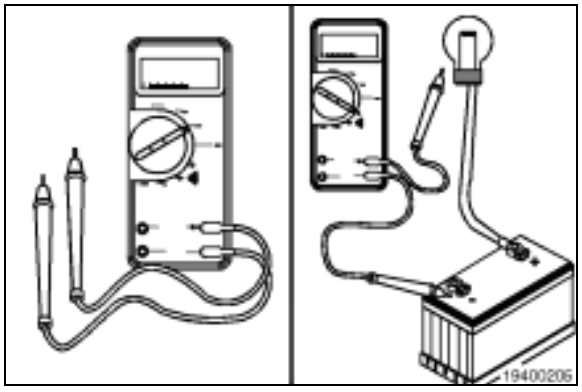
Make an open circuit at the place where the current is to be measured.

Select the AC current (A+) or DC current (A-) function on the meter.

Turn on the power in the circuit being measured.

Put the probes of the meter across the open circuit to measure the amperage.

Read the displayed measurement.



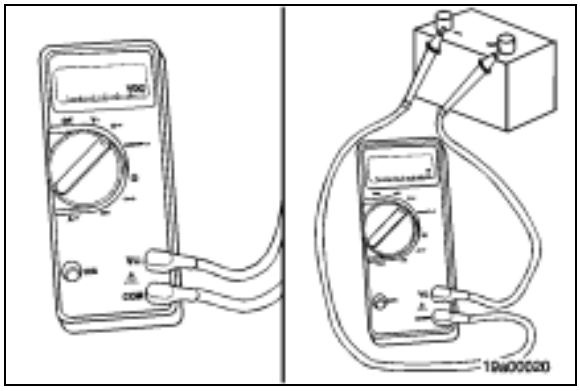
Electronic Engine Controls – Overview (Cont)

How to Measure Voltage

Select the AC voltage (V+) or DC voltage (V-) function on the meter.

Turn on the power in the circuit being measured.

Touch the positive (+) probe of the multimeter to the terminal or pin that is being measured for voltage. Touch the other probe to a clean, unpainted metal surface that is connected to battery ground or to the negative (-) post of the battery. Read the displayed measurement.

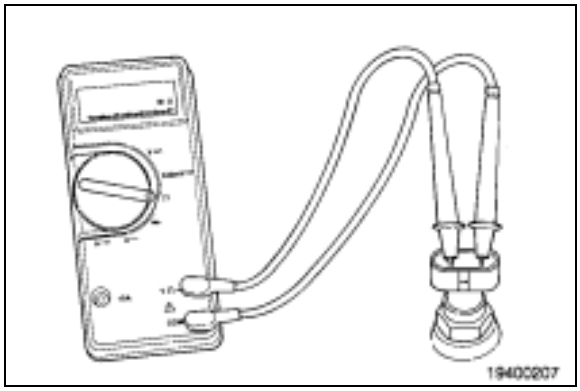


How to Measure Resistance

Select the resistance function on the meter.

Verify that there is no power to the components being tested.

Disconnect both ends of the circuit or component to be measured. Touch one probe to one end of the circuit or component terminal. Touch the other probe to the other end of the circuit or the other component terminal. Read the displayed measurement.



How to Find the Internal Resistance of the Meter

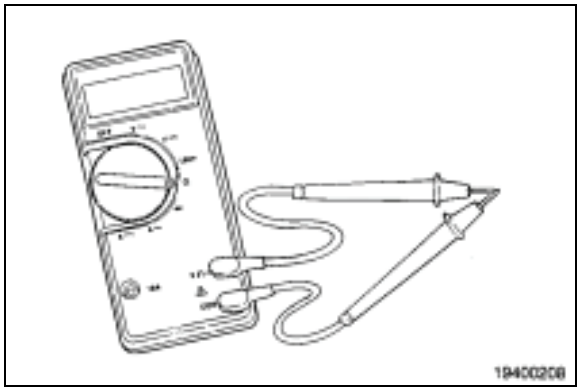
It is important to know the internal resistance of the meter when measuring small resistances. To measure small resistances accurately, the internal resistance of the meter must be subtracted from the measured resistance.

Turn the meter ON.

Set the meter to the lowest ohm scale.

Measure the resistance of the meter by touching the test probes together and reading the resistance value (including special test leads, if they are being used).

ZERO the meter or subtract this value when taking measurements.



Electronic Engine Controls – Overview (Cont)

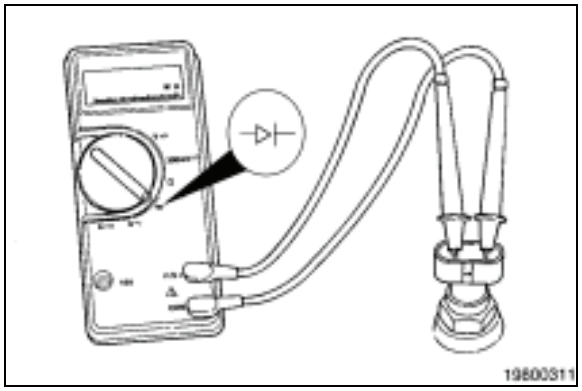
How to Test for Continuity

Select the continuity function on the meter (usually marked with a diode symbol).

Make sure there is no power to the component being measured.

Disconnect both ends of the circuit or component to be measured. Touch one probe to one end of the circuit or component terminal. Touch the other probe to the other end of the circuit or the other component terminal. Read the displayed measurement.

The meter will beep if the resistance is less than about 150 ohms. If there is an open circuit, the meter does not beep.

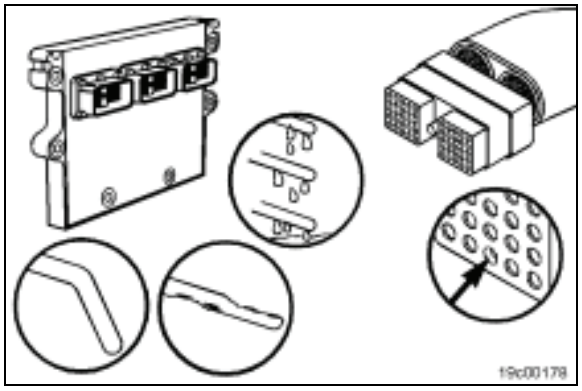


Connector Pins – Checking

When disconnecting connectors during troubleshooting, always inspect the pins to make sure they are not the cause of a bad connection. The things to look for are bent, corroded, and pushed back pins.

Moisture in a connector can also cause system performance issues. Many times it is difficult to see moisture in a connector. If moisture is suspected, the connector must be dried by applying contact cleaner, Part Number 3824510, to the connector. A heat gun can also be used on a low heat setting so that it will not damage the connector or wires.

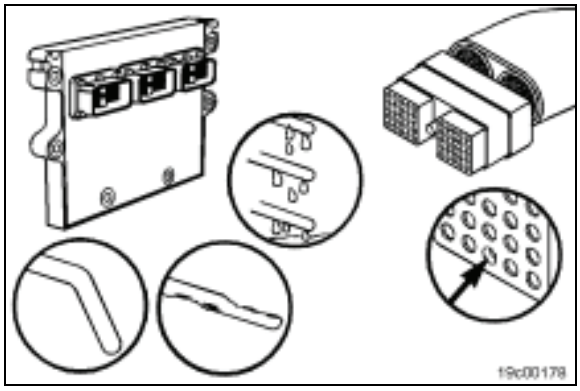
NOTE: Do not blow compressed air in the ECM ports or connector. Compressed air can contain moisture due to condensation.



Electronic Engine Controls – Overview (Cont)

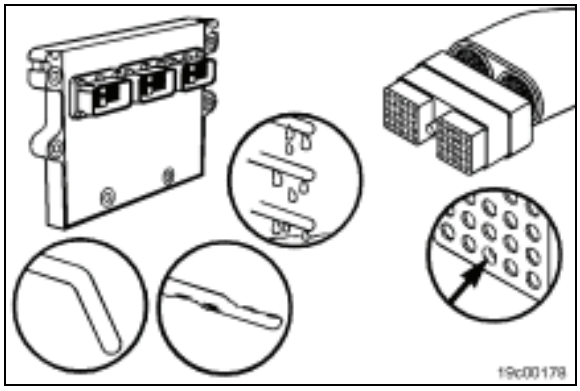
Bent or Expanded Pins

Inspect the male terminals of the connector. If any of the terminals are bent, so that they will not easily mate with the other side of the connector, or if the male terminals are expanded, that is, bulged out or squashed so as to make them too large to mate with the other side of the connector, then the pin must be replaced. Refer to the repair section for the specific connector in question.



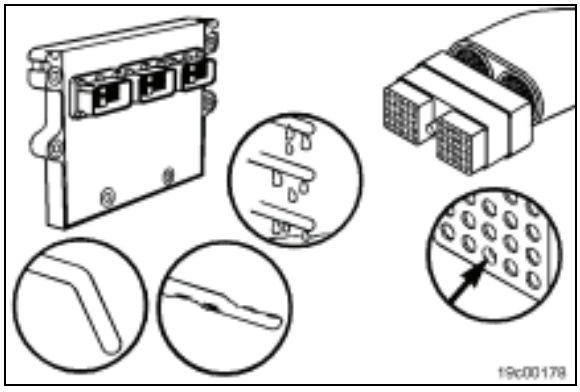
Corroded Pins

Inspect both the male and female terminals for corrosion, which can cause a poor electrical connection within the connector. If any corrosion is evident on the pins, then the corroded pins must be replaced. Refer to the repair section for the specific connector in question.



Pushed Back Pins

Inspect both the male and female terminals for pins that can not be making contact because they are pushed back in the connector. To repair, push the pin into the connector body from the back of the connector. Make sure the terminal locks into place. If the terminal will not lock into place, then replace it. Refer to the repair section for the specific connector in question.



Electronic Engine Controls – Overview (Cont)

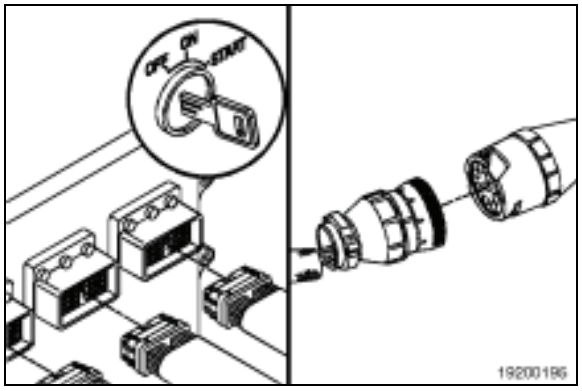
Short Circuit to Ground - Check

Short circuit to ground is a condition where a connection from a circuit to ground exists when it is not intended.

The procedure for checking for a short circuit to ground is as follows:

Turn keyswitch OFF.

Disconnect the connectors that are to be tested.



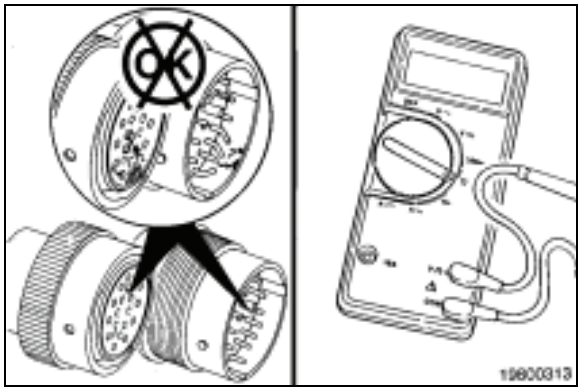
When testing a sensor, only the sensor connection is required to be disconnected.

When testing a harness, the harness connector at the ECM and the connector at the sensor or multiple sensors should be disconnected.

Identify the pins that need to be tested.

Inspect the connector pins.

Adjust the multimeter to measure resistance.



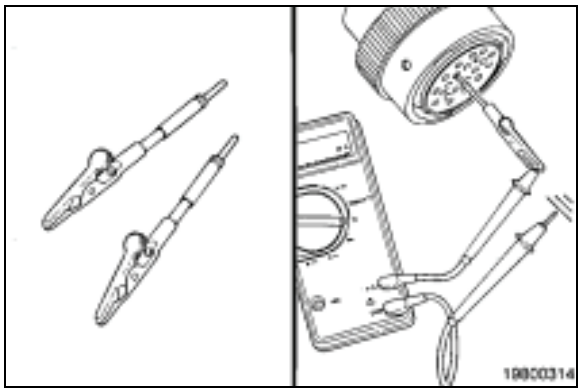
CAUTION

Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

Touch one of the multimeter probes to the correct pin to be tested.

Touch the other probe of the multimeter to a clean, unpainted surface on the engine block ground.

Read the value on the multimeter display.

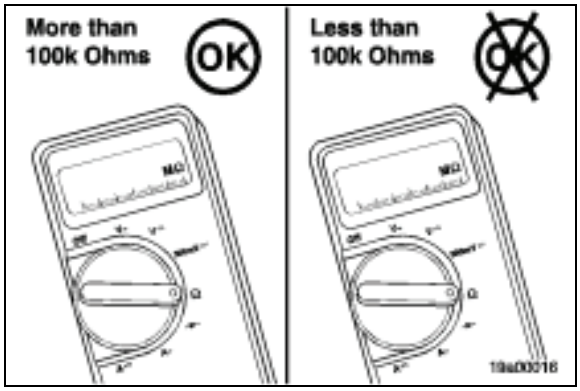


Electronic Engine Controls – Overview (Cont)

The multimeter must read greater than 100k ohms, which is an open circuit.

If the circuit is not open, the wire being checked has a short circuit to ground or the engine block.

Repair or replace the component or wire.



Short Circuit from Pin to Pin - Check

Short circuit from pin to pin is a condition in which an electrical path exists between two pins where it is not intended to exist.

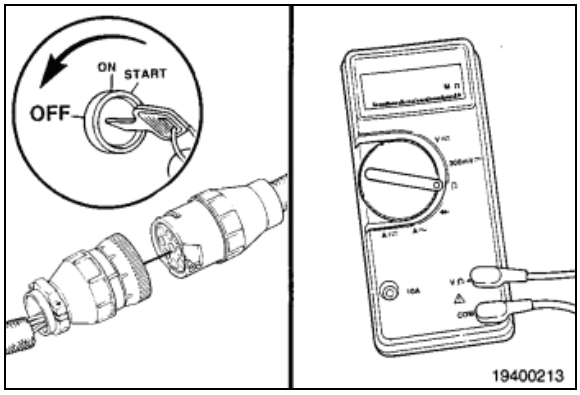
The procedure for checking short circuit from pin to pin is as follows:

Turn keyswitch OFF.

Disconnect the connectors that are to be tested.

Identify the pins that are to be tested.

Adjust the multimeter to measure resistance.

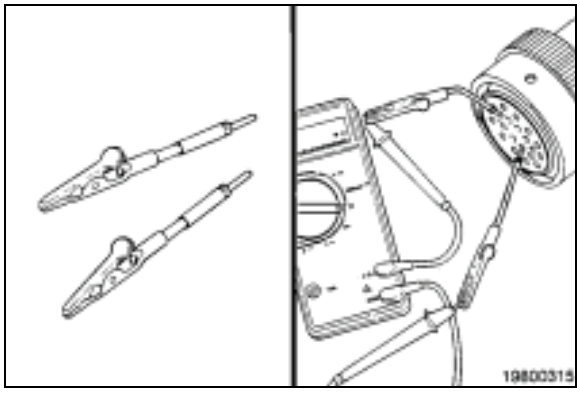


CAUTION

Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

Touch one of the multimeter probes to the correct pin to be tested on the harness side of the connector.

Touch the other probe of the multimeter to all other pins on the harness side of the connector.



Electronic Engine Controls – Overview (Cont)

Read the value on the multimeter display.

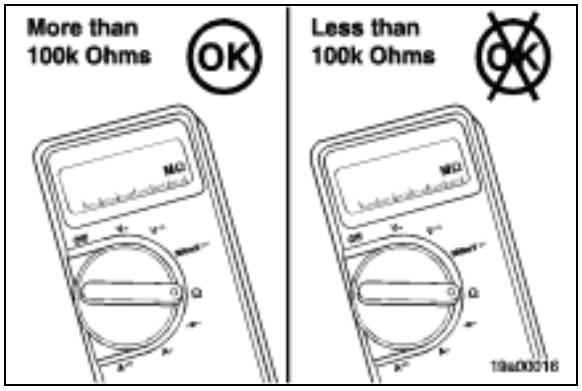
The multimeter must read greater than 100k ohms, which is an open circuit.

If the circuit is not open, the pins being checked are electrically connected.

NOTE: Refer to the wiring diagram to verify that the wires in question are not supposed to be connected.

Inspect the harness connectors for moisture that can be the cause of an inappropriate electrical connection.

Repair or replace the harness.



Voltage Checking

Voltage check is a procedure to measure the difference in voltage potential between two points.

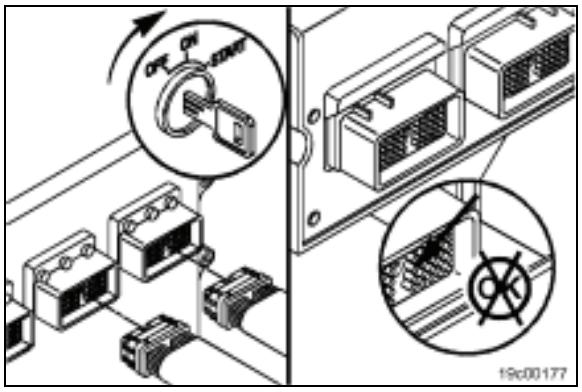
The procedure for checking voltage is as follows:

Disconnect the connectors that are to be tested.

Turn keyswitch ON.

Identify the pins that are to be tested.

Adjust the multimeter to AC voltage (V+) or DC voltage (V-).

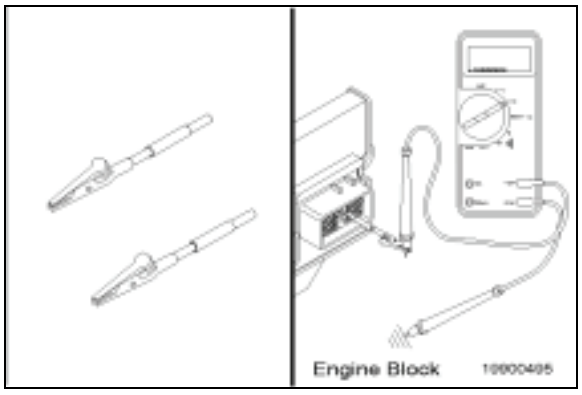


CAUTION

Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

Touch one of the multimeter test probes to the correct lead to be tested.

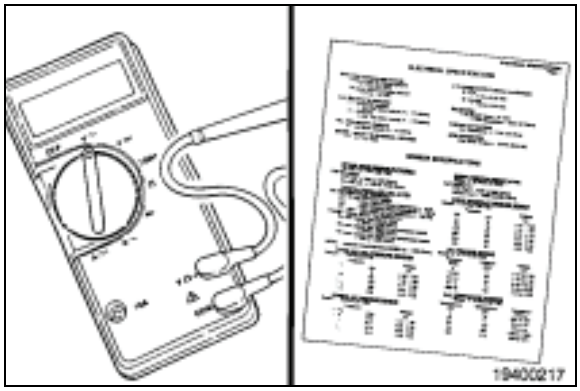
Touch the other multimeter probe to a clean, unpainted surface on the engine block or to the appropriate return pin.



Electronic Engine Controls – Overview (Cont)

Read the value on the multimeter display. Compare the measured value to the range of voltage given in the specifications.

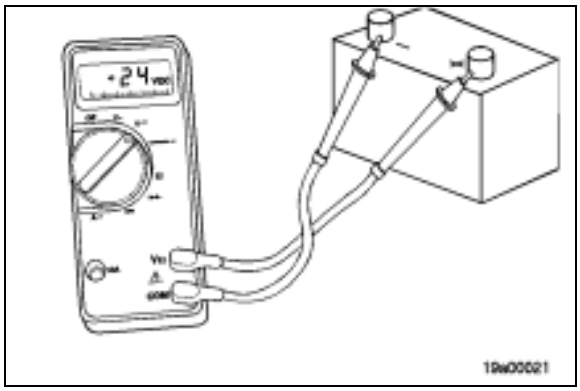
If the measured value falls outside of the specified range, check the repair procedure for the electrical system that is being checked for the appropriate action.



Polarity Check

A battery will be used as an example to check polarity of a circuit.

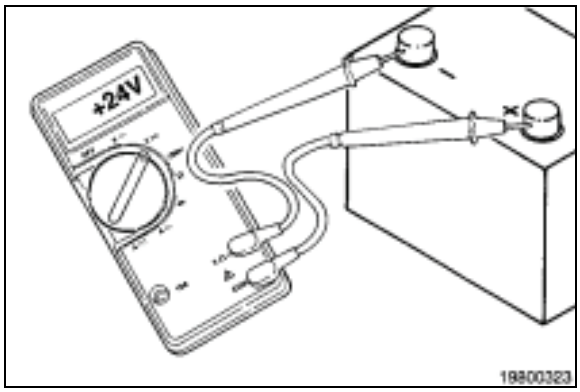
The terminals of a battery are marked for polarity. The multimeter displays the voltage difference of the positive (+) probe (red) to the negative (-) probe (black).



The polarity is correct when the positive (red) probe of the multimeter is on the positive (+) terminal of the battery and the negative (black) probe of the multimeter is on the negative (-) terminal of the battery.

The multimeter will display positive voltage if the polarity is correct.

If the multimeter probes are reversed, the multimeter displays negative voltage.



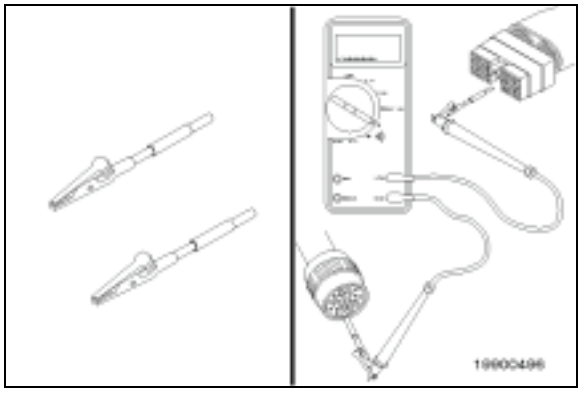
Electronic Engine Controls – Overview (Cont)

Continuity Check

CAUTION

Use the appropriate test leads from wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

Continuity is an electrical connection between two pins that is less than a certain resistance value. For harness wires, the specification is less than 10 ohms.

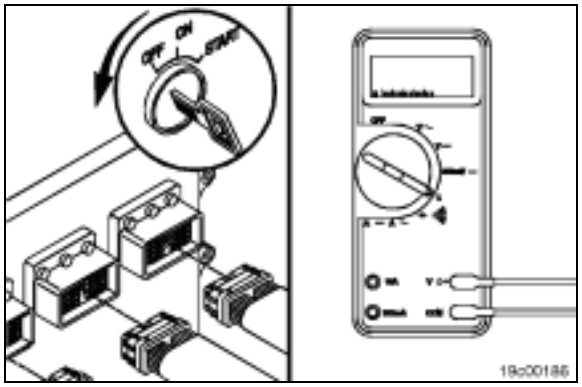


The procedure for checking continuity is as follows:

Turn keyswitch OFF.

Disconnect the harness connectors that are to be tested.

Adjust the multimeter to measure resistance.



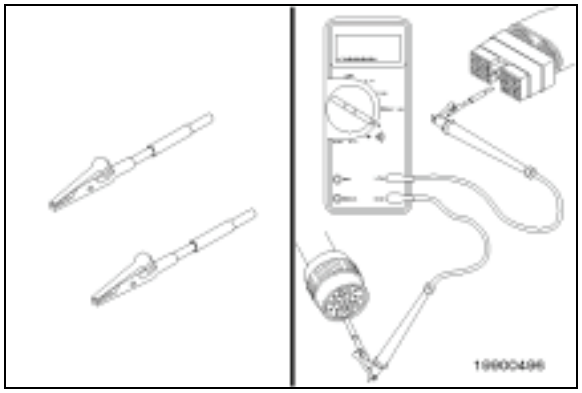
CAUTION

Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

Insert test lead to the pin of the wire being tested and connect the alligator clip to the multimeter probe.

Insert the other test lead to the pin at the other end of the wire being tested and connect the alligator clip to the other multimeter probe.

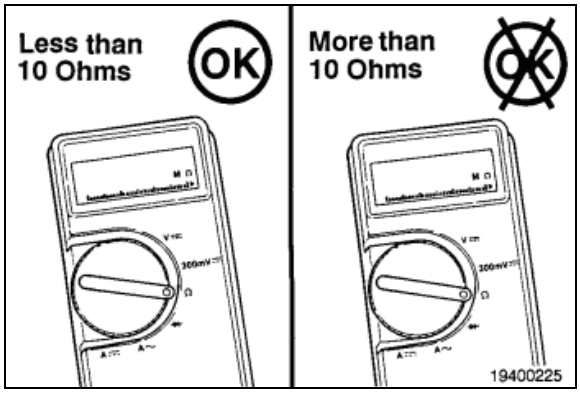
Read the value on the multimeter display.



Electronic Engine Controls – Overview (Cont)

The multimeter must display less than 10 ohms for wire continuity.

If the multimeter displays greater than 10 ohms, the wire must be repaired or the harness replaced.

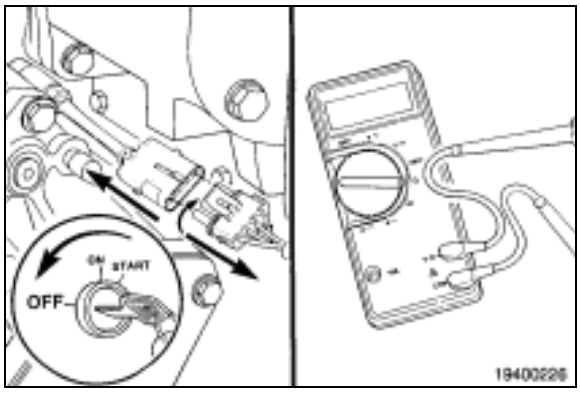


Resistance Check - Coil

Turn keyswitch OFF.

Disconnect the harness from the coil.

Adjust the multimeter to measure resistance.



CAUTION

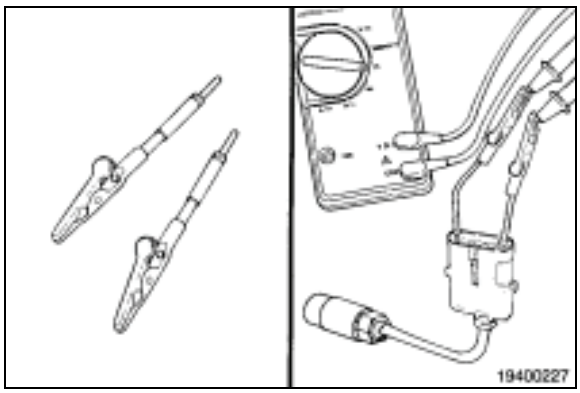
Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

Insert test lead to the coil connector pin, and connect the alligator clip to the multimeter probe.

Insert the other test lead to the other coil connector pin, and connect the alligator clip to the other multimeter probe.

NOTE: For internally grounded coils, touch one multimeter lead to the coil terminal and the other multimeter lead to a clean, unpainted surface on the engine block.

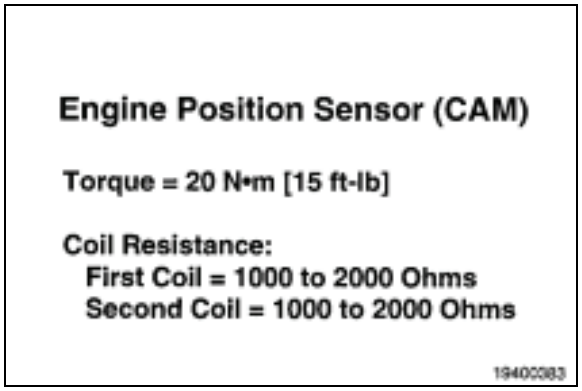
Read the measured resistance on the multimeter display.



Electronic Engine Controls – Overview (Cont)

Check the measured resistance against the resistance specification for the coil.

NOTE: The internal resistance of the multimeter is significant in some coil resistance checks.

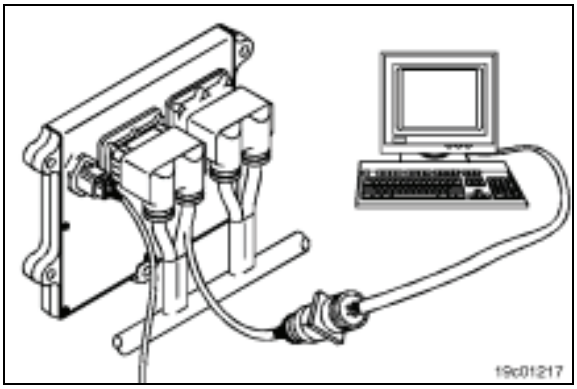


ECM Calibration Code Information

Prepare

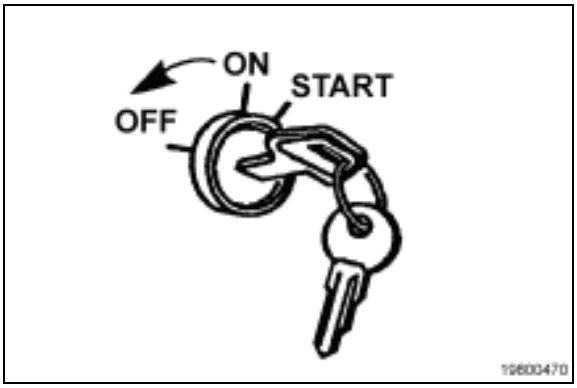
General Information

Electronic control module (ECM) calibrations can be performed by INSITE™ electronic service tool.



The ECM calibration process occurs with the keyswitch turned on. Always follow the instructions on the service tool screens.

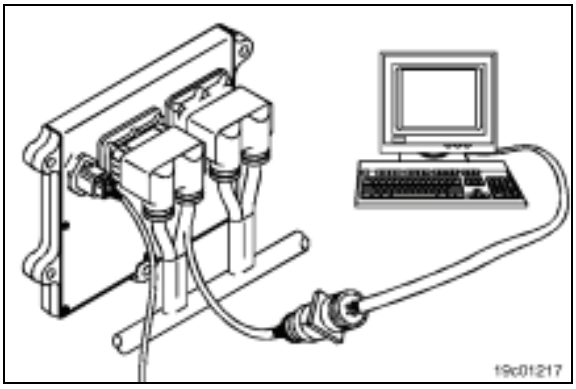
NOTE: If the tool will not communicate with the keyswitch in the ON position, cycle keyswitch and try again.



ECM Calibration Code Information ((Cont))

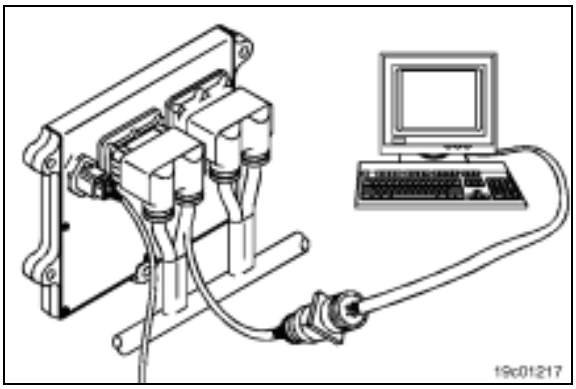
Connection

Connect the electronic service tool to the service tool data link, which is located on the engine or in the cab.



Calibration

Refer to the help section within INSITE™ electronic service tool for detailed ECM calibration procedures.



Follow-Up

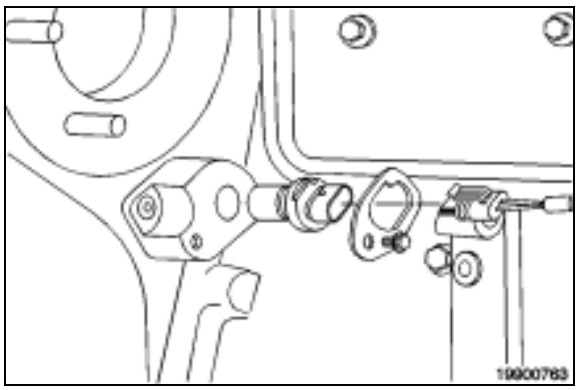
Engine Position Sensor Removal/Installation

Prepare

Remove

Disconnect the sensor from the engine harness.

Remove the EPS from the cylinder block.



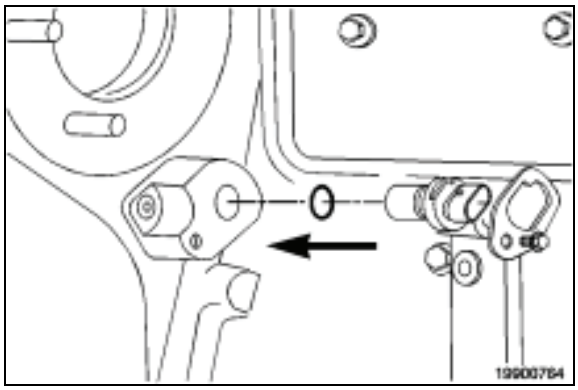
Install

Install a new o-ring onto the engine position sensor.

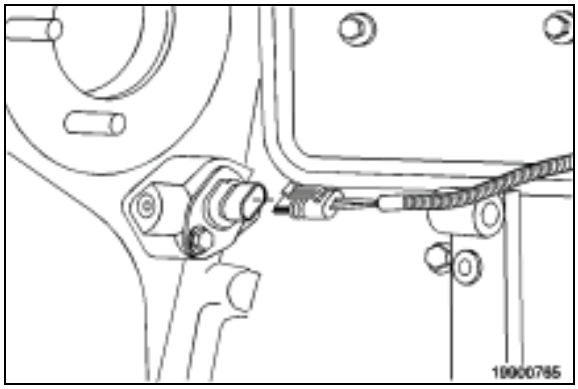
Apply oil to the o-ring.

Install the new sensor into the mounting hole in the cylinder block.

Torque Value: 20 N•m [15 ft-lb]



Connect the sensor to the engine harness. Push the connectors together until they lock.



Follow-Up

Engine Position Sensor Circuit Testing

Prepare

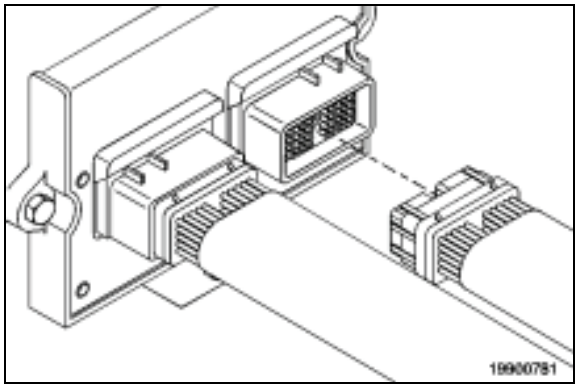
Resistance Check

The engine position sensor circuit includes pin 10 (+5-VDC supply wire), pin 9 (signal wire), and pin 19 (sensor return).

Disconnect the engine harness from the ECM.

Disconnect the engine harness from the engine position sensor.

Check for damaged pins.

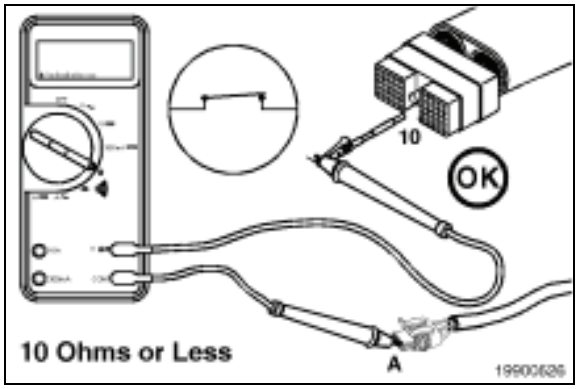


+5-VDC Supply Wire Resistance – Checking

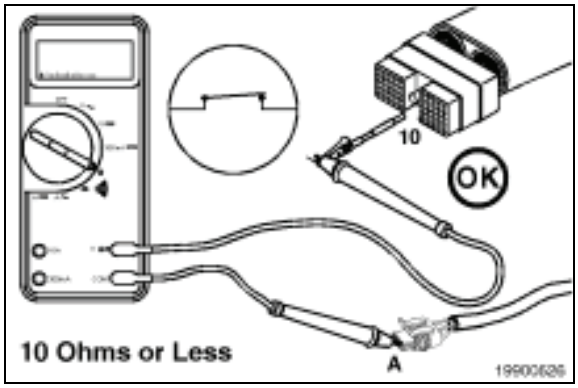
CAUTION

Do not use probes or leads other than Part No. 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins of the connector.

Insert the test lead into pin 10 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other probe to pin A of the engine position sensor connector, wiring harness side.



Measure the resistance. The multimeter must show a closed circuit (10 ohms or less). If more than 10 ohms are measured, there is an open circuit in the +5-VDC supply wire. Repair the +5-VDC supply wire, or replace the engine harness. Refer to Procedure 019-250, 019-203, or 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

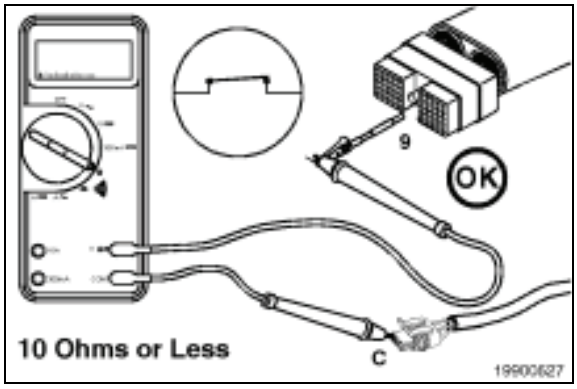


Engine Position Sensor Circuit Testing (Cont)

Signal Wire Resistance - Checking

Insert the test lead into pin 9 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other probe to pin C of the engine position sensor connector, wiring harness side.

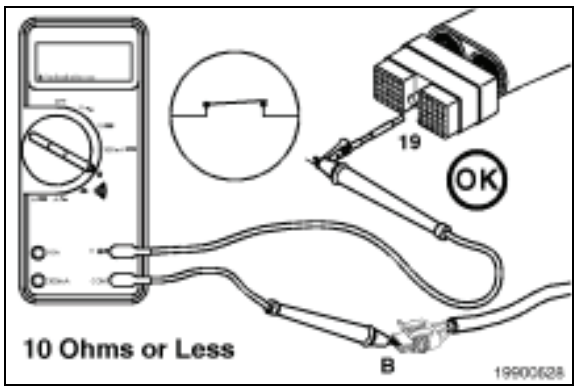
Measure the resistance. The multimeter must show a closed circuit (10 ohms or less). If more than 10 ohms are measured, there is an open circuit in the signal wire. Repair the signal wire, or replace the engine harness. Refer to Procedure 019-250, 019-203, or 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Return Wire Resistance - Checking

Insert the test lead into pin 19 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other probe to pin B of the engine position sensor connector, wiring harness side.

Measure the resistance. The multimeter must show a closed circuit (10 ohms or less). If more than 10 ohms are measured, there is an open circuit in the return wire. Repair the return wire, or replace the engine harness. Refer to Procedure 019-250, 019-203, or 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



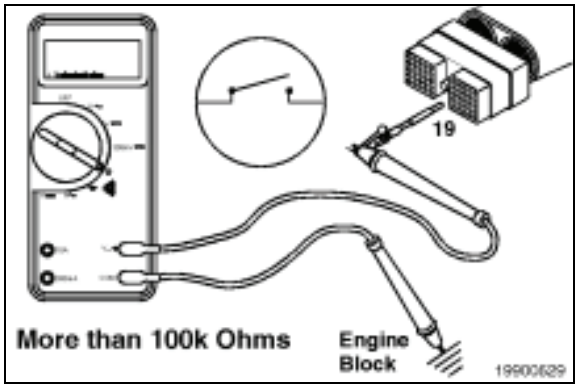
Engine Position Sensor Circuit Testing (Cont)

Check for Short Circuit to Ground

Return Wire - Checking

Insert the test lead into pin 19 of the engine harness connector. Connect the alligator clips to the multimeter probe. Touch the other probe to the engine block.

Make sure the engine position sensor is disconnected from the engine harness. Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If fewer than 100k ohms are measured, there is a short circuit to ground in the return wire. Repair the return wire, or replace the engine harness. Refer to Procedure 019-250, 019-203, or 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines.

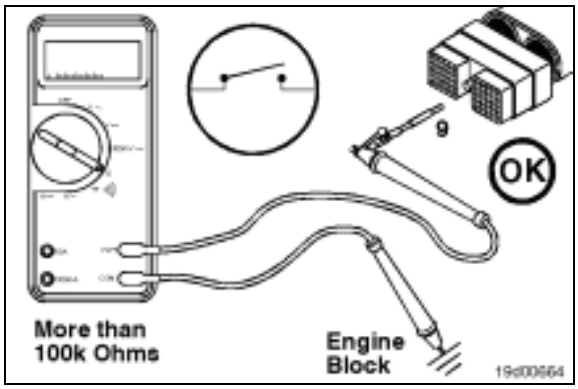


Signal Wire – Checking

Insert the test lead into pin 9 of the engine harness connector. Connect the alligator clips to the multimeter probes. Touch the other probe to the engine block.

Make sure the engine position sensor is disconnected from the engine harness.

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If fewer than 100k ohms are measured, there is a short circuit to ground in the signal wire. Refer to Procedure 019-250, 019-203, or 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



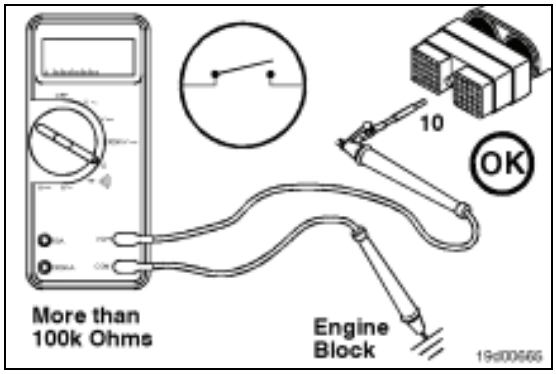
Engine Position Sensor Circuit Testing (Cont)

+5-VDC Supply Wire - Checking

Insert the test lead into pin 10 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other probe to the engine block.

Make sure the engine position sensor is disconnected from the engine harness.

Measure the resistance. The multimeter must show an open circuit (100k ohms or more). If fewer than 100k ohms are measured, there is a short circuit to ground in the +5-VDC supply wire. Repair the +5-VDC supply wire, or replace the engine harness. Refer to Procedure 019-250, 019-203, or 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

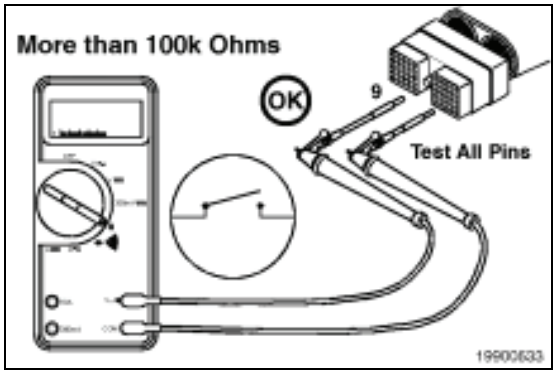


Check for Short Circuit from Pin to Pin

Signal Wire – Checking

Insert the test lead into pin 9 of the engine harness connector. Insert the other lead into all the other pins in the engine harness connector. Connect the alligator clips to the multimeter probes.

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit between the signal wire and any pin that measures a closed circuit. Repair or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

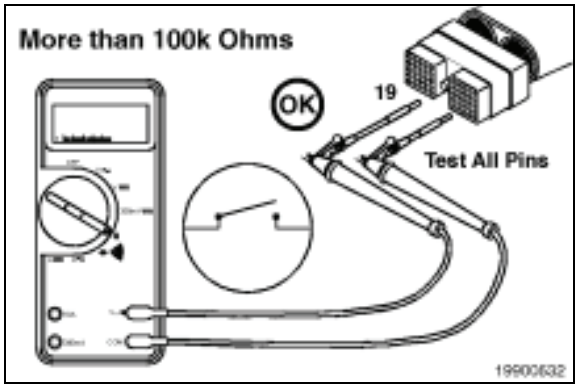


Engine Position Sensor Circuit Testing (Cont)

Return Wire - Checking

Insert the test lead into pin 19 of the engine harness connector. Insert the other lead into all the other pins in the engine harness connector. Connect the alligator clips to the multimeter probes.

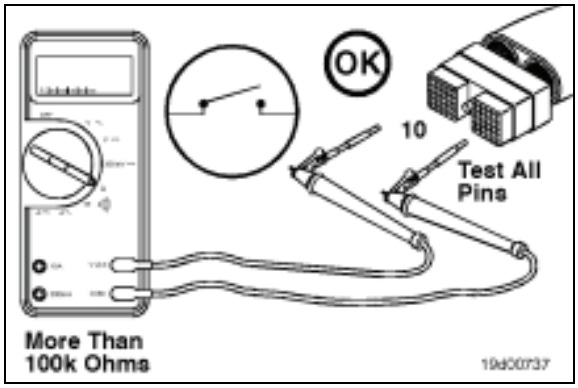
Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit between the return wire and any pin that measures a closed circuit. Repair or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



+5-VDC Supply Wire – Checking

Insert the test lead into pin 10 of the engine harness connector. Insert the other lead into all the other pins in the engine harness connector. Connect the alligator clips to the multimeter probes.

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit between the +5-VDC supply wire and any pin that measures a closed circuit. Repair or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



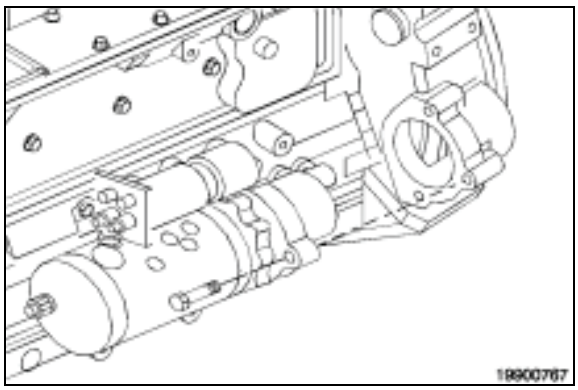
Follow-Up

Engine Speed Sensor Removal/Installation

Prepare

Remove

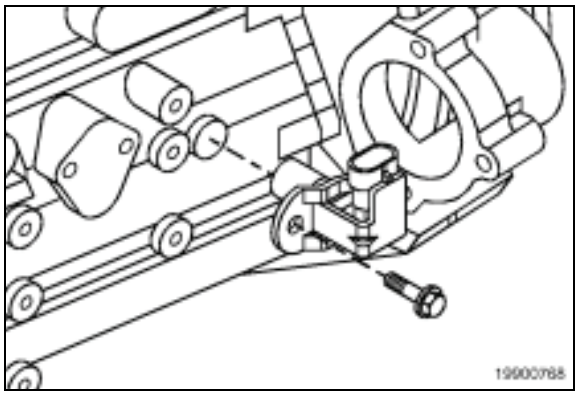
If necessary, remove the starter for sensor removal. Refer to Procedure 013-020 in the Troubleshooting and Repair Manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Disconnect the engine speed sensor connector.

Remove the ESS mounting bolt.

Remove the sensor by pulling straight back on the mounting bracket.

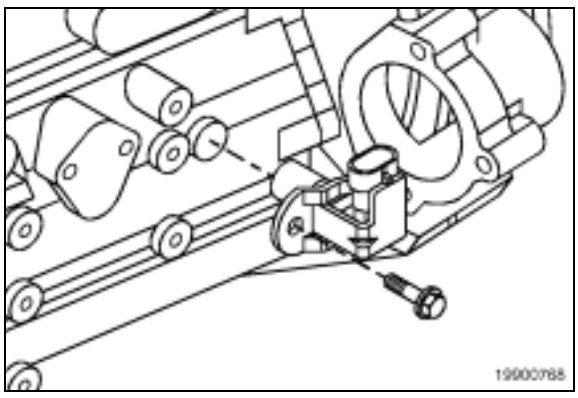


Install

Lubricate the ESS with engine oil.

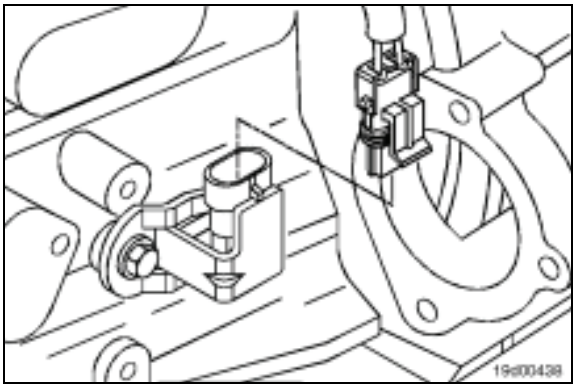
Install the ESS, and tighten the mounting bolt.

Torque Value: 24 N•m [18 ft-lb]

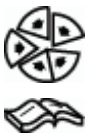


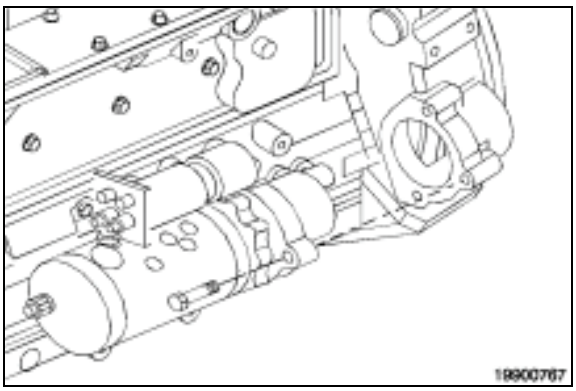
Engine Speed Sensor Removal/Installation (Cont)

Connect the ESS connector. A click will be heard when the connector locks into place.



If necessary, install the starter. Refer to Procedure 013-020 in the Troubleshooting and Repair Manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.





Follow-Up

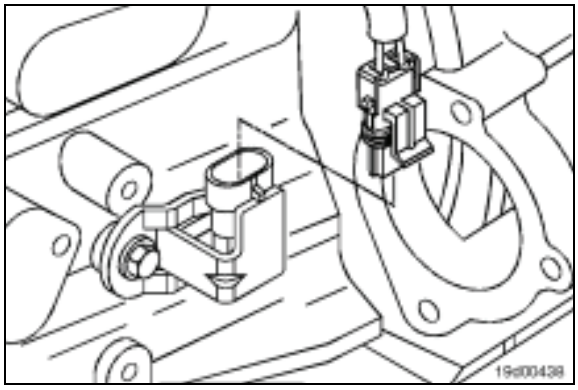
Engine Speed Sensor Circuit Testing

Prepare

Remove

Disconnect the sensor from the engine harness.

Remove the ESS from the gear housing.



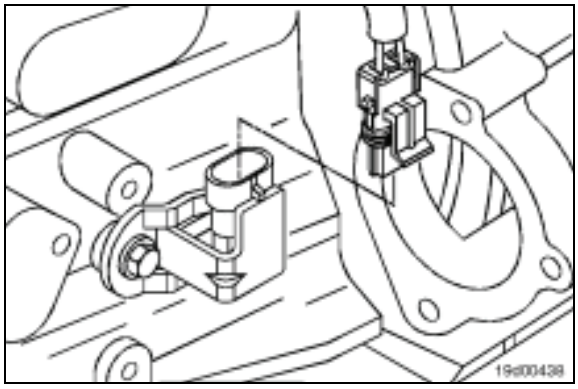
Install

Install a new o-ring onto the engine position sensor.

Install the new sensor into the mounting hole in the gear housing.

Tighten the ESS with the installation tool, Part No. 3822747.

Torque Value: 8 N•m [71 in-lb]

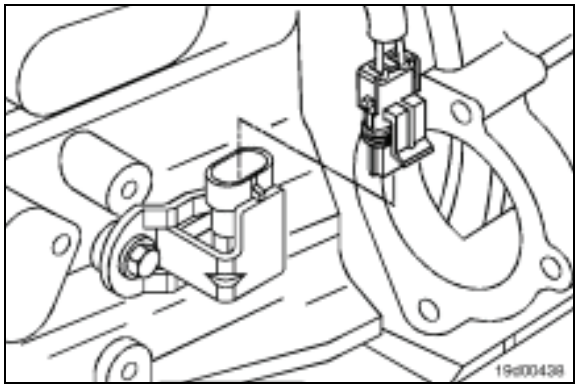


Resistance Check

The engine speed sensor circuit includes pin 8 (+5-VDC supply), pin 17 (sensor signal), and pin 18 (sensor return).

Disconnect the engine harness from the ECM, and check for damaged pins.

Disconnect the engine harness from the ESS.



Engine Speed Sensor Circuit Testing (Cont)

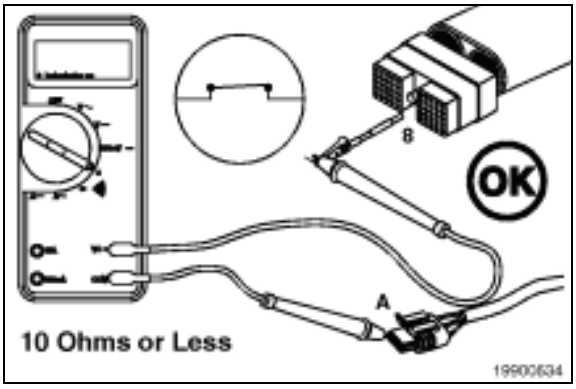
+5 VDC-Supply Wire Resistance - Checking

CAUTION

Do not use probes or leads other than Part No. 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins of the connector.

Insert the pin of a lead into pin 8 of the ECM connector of the engine harness. Connect the alligator clip to the multimeter probe. Touch the other probe to pin A of the engine speed sensor connector, wiring harness side.

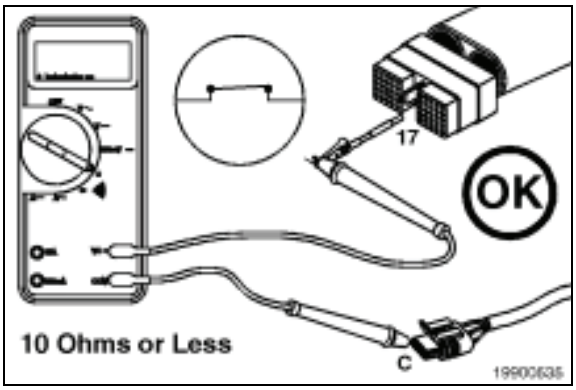
Measure the resistance. The multimeter must show a closed circuit (10 ohms or less). If more than 10 ohms are measured, there is an open circuit in the +5-VDC supply wire. Repair the +5-VDC supply wire, or replace the harness. Refer to Procedure 019-043.



Signal Wire Resistance - Checking

Insert the pin of a lead into pin 17 of the sensor connector of the engine harness. Connect the alligator clip to the multimeter probe. Touch the other probe to pin C of the ESS, wiring harness side.

Measure the resistance. The multimeter must show a closed circuit (10 ohms or less). If more than 10 ohms are measured, there is an open circuit in the signal wire. Repair the signal wire, or replace the harness. Refer to Procedure 019-043.

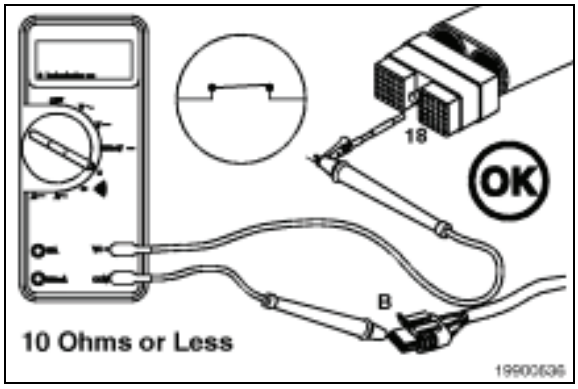


Engine Speed Sensor Circuit Testing (Cont)

Return Wire Resistance - Checking

Insert the pin of a lead into pin 18 of the sensor connector of the engine harness. Connect the alligator clip to the multimeter probe. Touch the other probe to pin B of the engine speed sensor connector, wiring harness side.

Measure the resistance. The multimeter must show a closed circuit (10 ohms or less). If more than 10 ohms are measured, there is an open circuit in the return wire. Repair the return wire, or replace the harness. Refer to Procedure 019-043.

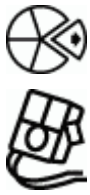


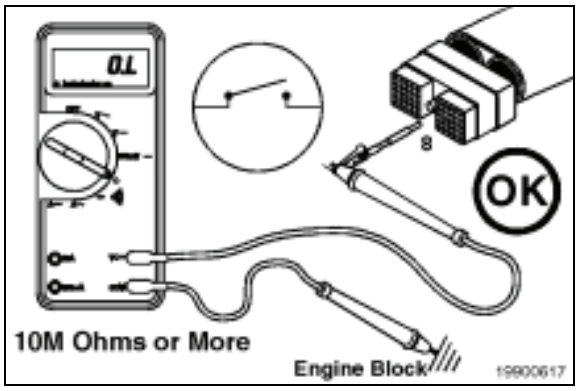
Check for Short Circuit to Ground

+5-VDC Supply Wire – Checking

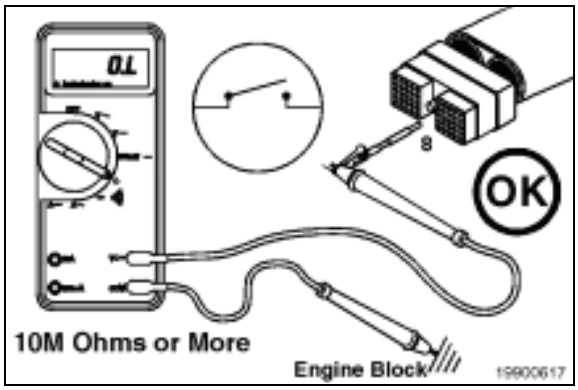
Disconnect the intake manifold pressure sensor from the wiring harness.

Insert the test lead into pin 8 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to the engine block.





Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit to ground in the +5-VDC supply wire. Repair the wire, or replace the engine harness. Refer to Procedure 019-043.

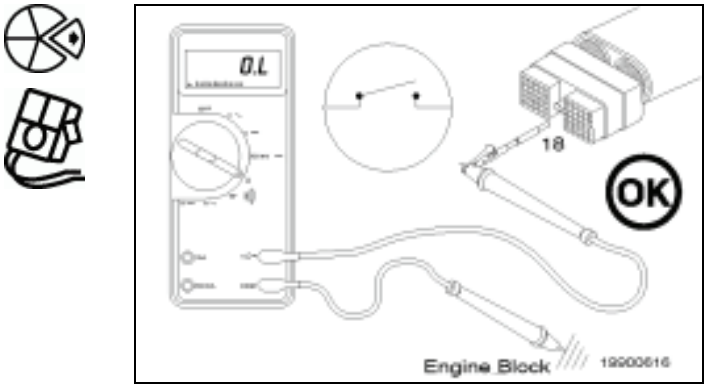


Engine Speed Sensor Circuit Testing (Cont)

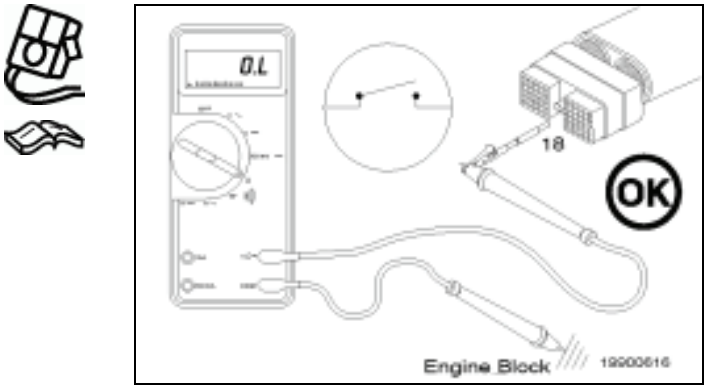
Return Wire - Checking

Disconnect the intake manifold pressure sensor from the wiring harness.

Insert the test lead into pin 18 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to the engine block.



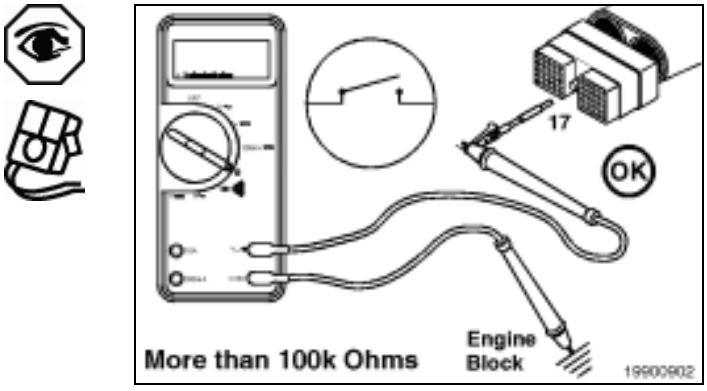
Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit to ground in the return wire. Repair the wire, or replace the engine harness. Refer to Procedure 019-043.



Signal Wire Short - Checking

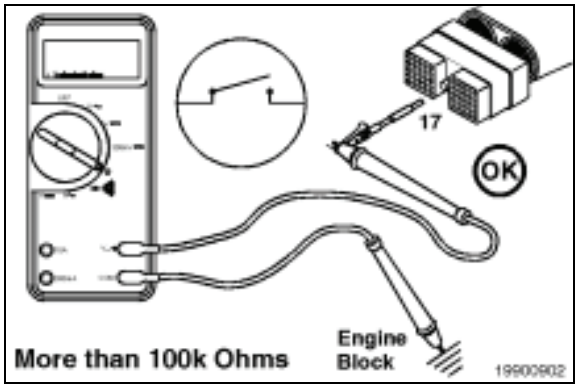
Insert the test lead into pin 17 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to the engine block.

Make sure the intake manifold pressure sensor is disconnected from the engine harness.



Engine Speed Sensor Circuit Testing (Cont)

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit to ground in the signal wire. Repair the signal wire, or replace the engine harness. Refer to Procedure 019-043.



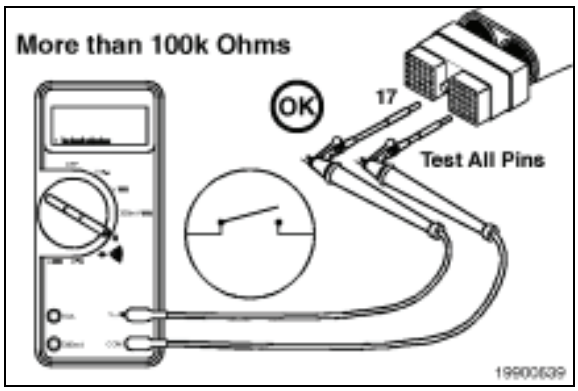
Check for Short Circuit from Pin to Pin

Signal Wire - Checking

Insert lead into pin 17. Insert the other lead into all of the other pins in the sensor connector. Connect the alligator clips to the multimeter probes.

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms).

If the circuit is not open, there is a short circuit between the signal wire and any pin that measured a closed circuit. Repair or replace the engine harness. Refer to Procedure 019-043.

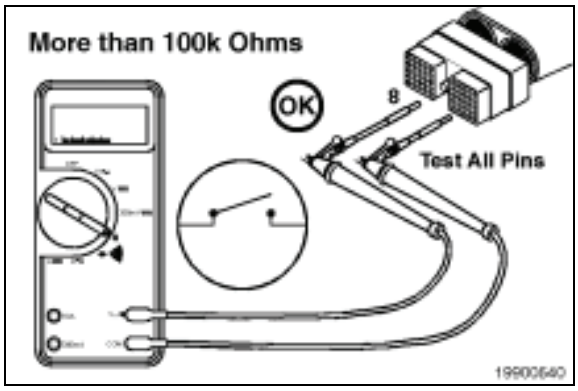


+5-VDC Supply Wire - Checking

Insert lead into pin 8. Insert the other lead into all of the other pins in the connector. Connect the alligator clips to the multimeter probes.

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms).

If the circuit is not open, there is a short circuit between the supply wire and any pin that measured a closed circuit. Repair or replace the engine harness. Refer to Procedure 019-043.



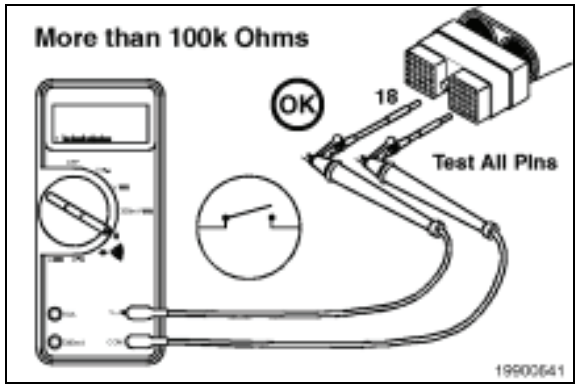
Engine Speed Sensor Circuit Testing (Cont)

Return Wire - Checking

Insert lead into pin 18. Insert the other lead into all of the other pins in the connector. Connect the alligator clips to the multimeter probes.

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms).

If the circuit is not open, there is a short circuit between the return wire and any pin that measured a closed circuit. Repair or replace the engine harness. Refer to Procedure 019-043.



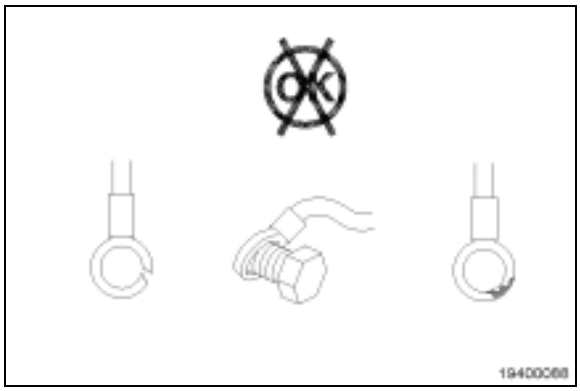
Follow-Up

Battery Ground Circuit Voltage Check

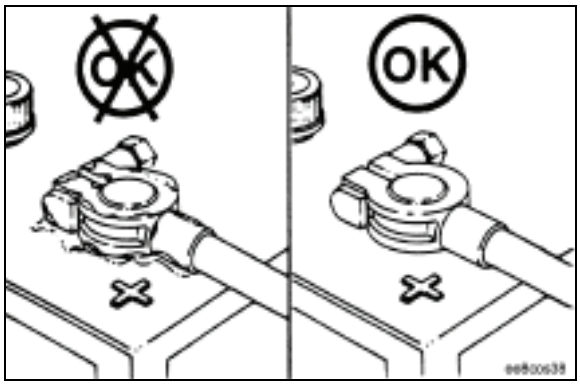
Prepare

Check

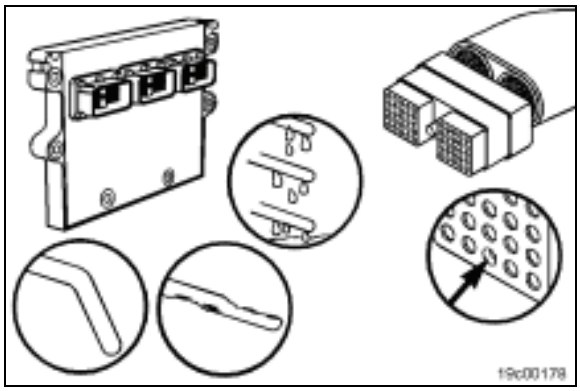
Check the engine harness ground connection for loose, corroded, or broken connections.



If the resistance value is not correct, check the batteries, cables, and cable connections. Repair or replace the parts as required.



Check the battery return wires in the engine harness for proper grounding. Disconnect the OEM harness from the ECM. Check for damaged pins in the ECM and the harness.

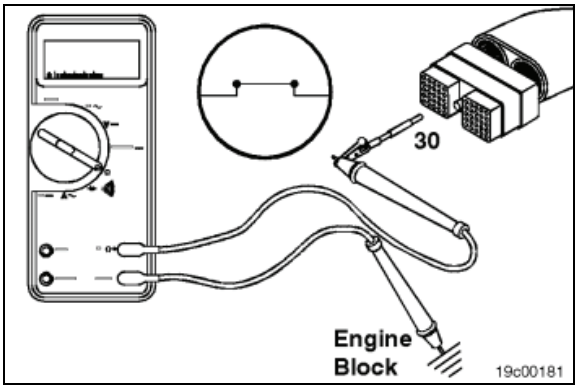


Battery Ground Circuit Voltage Check (Cont)

CAUTION

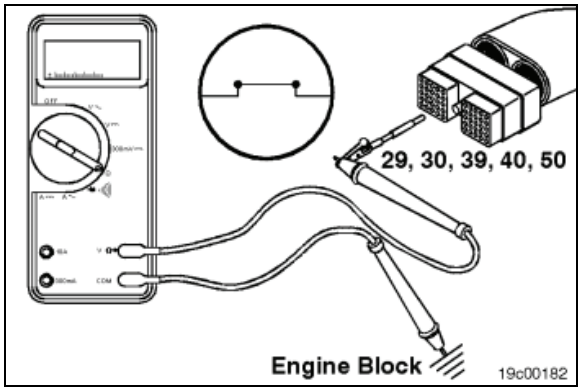
Do not use probes or leads other than Part No. 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins in the connector.

Insert the lead into pin 30 of the OEM harness. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to the engine block ground and measure the resistance. The resistance must be 10 ohms or less.



Remove the lead from pin 30 and insert it into pins 29, 39, 40, and 50 of the OEM harness. Touch the other multimeter probe to the engine block ground and measure the resistance. The resistance must be 10 ohms or less.

If more than 10 ohms are measured in any check, there is an open circuit. If the circuit has been checked for proper grounding at the negative battery cables, repair or replace the OEM harness. Refer to Procedure 019-071.



Follow-Up

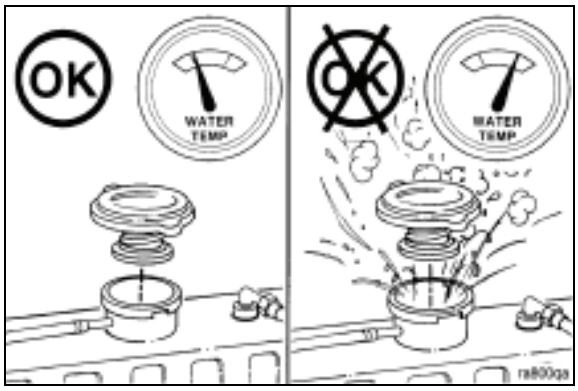
Engine Coolant Temperature Sensor Removal/Installation

Prepare

WARNING

Wait until the coolant temperature is below 50°C [120°F] before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.

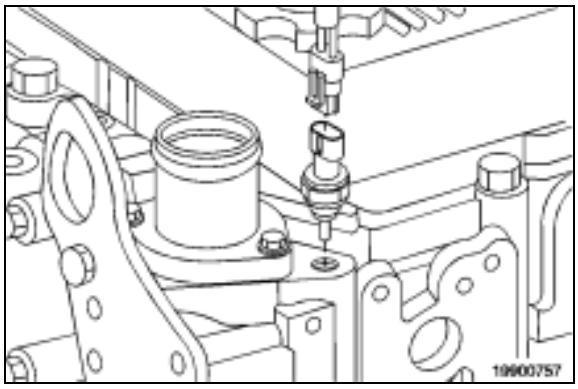
Drain the cooling system. Refer to Procedure 008-018 in the Troubleshooting and Repair Manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Remove

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

Remove the sensor.



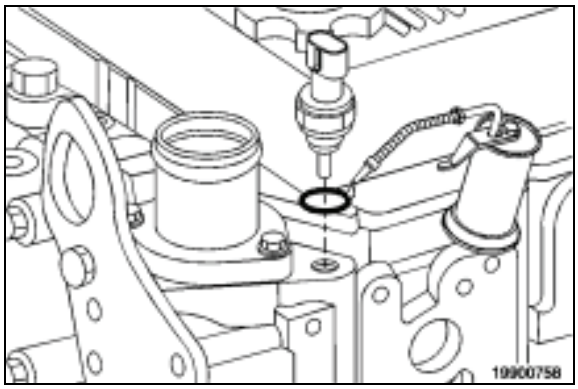
Install

Make sure the new sensor has an o-ring installed.

Lubricate the o-ring with clean engine oil.

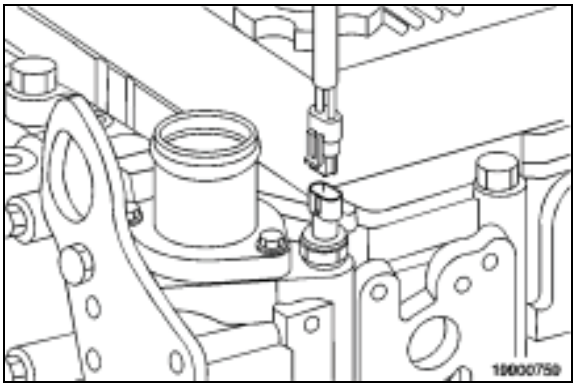
Install the new sensor into the engine. Tighten the sensor.

Torque Value: 14 N•m [10 ft-lb]



Engine Coolant Temperature Sensor Removal/Installation (Cont)

Push the connectors together until they lock.



Follow-Up

Fill the cooling system, and operate the engine to check for leaks. Refer to Procedure 008-018 in the Troubleshooting and Repair Manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

Engine Wiring Harness Removal/Installation

Prepare

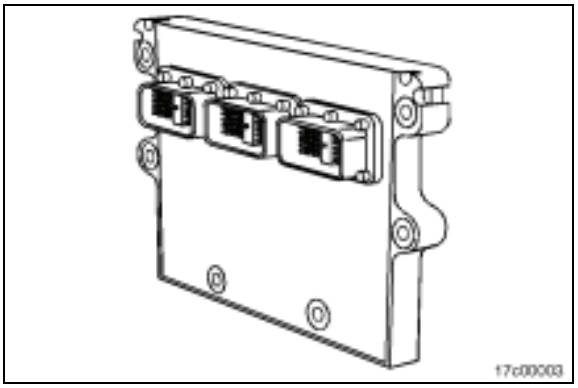
General Information

The ISM and QSM engines use separate wiring harnesses to control the engine and some of the vehicle operations. There are three connectors for the wiring harnesses. In the picture shown, the following harnesses connect to the ECM from right to left:

Sensor harness

Actuator harness

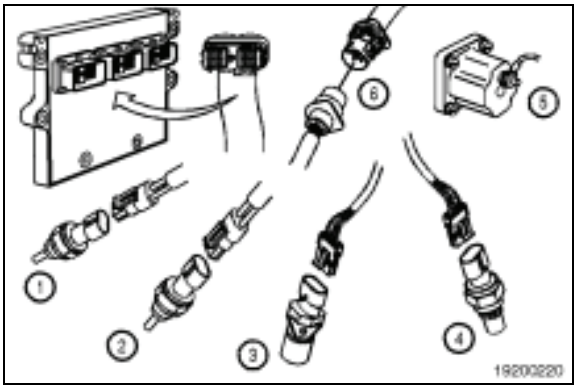
OEM harness.



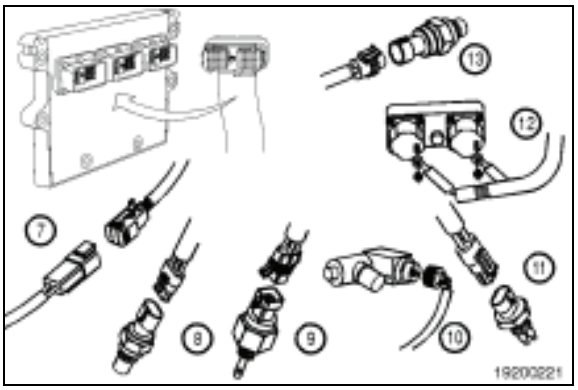
Remove

Disconnect the harness from the sensors and switches.

- Intake manifold pressure sensor
- Intake manifold temperature sensor
- Crankshaft or camshaft position sensor
- Coolant temperature sensor
- Fuel shutoff solenoid
- 15-pin pass-through connector



- Centinel™ connector (if equipped)
- Ambient air pressure sensor
- Oil pressure/temperature sensor
- Wet tank pressure sensor
- Water-in-fuel sensor
- Wastegate controller
- Fuel inlet restriction sensor (if equipped)

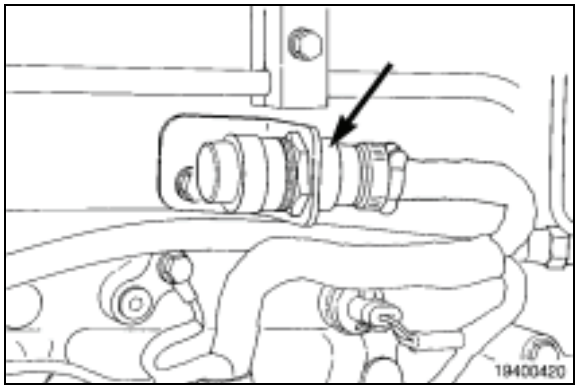


Engine Wiring Harness Removal/Installation (Cont)

Disconnect the 31-pin Deutsch connector from the OEM side of the wiring harness.

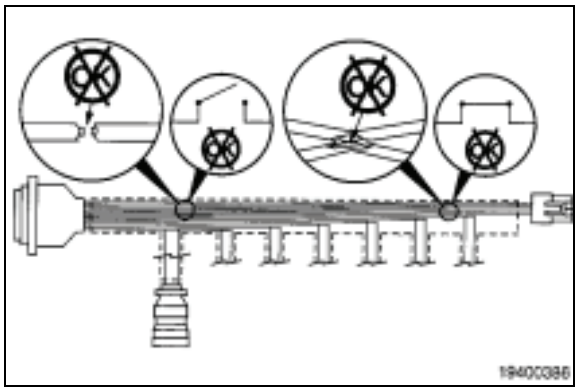
Remove the harness clamps from the support bracket of the engine block.

Disconnect the engine harnesses from the ECM.



Inspect for Reuse

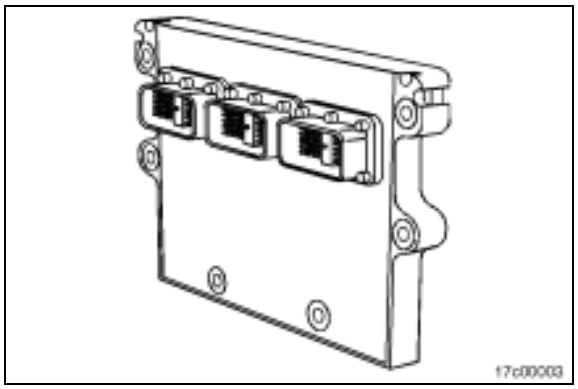
Replace or repair the engine harness if there is an open circuit or a short circuit found under the protective covering of the harness body.



Install

Connect the engine harnesses to the ECM.

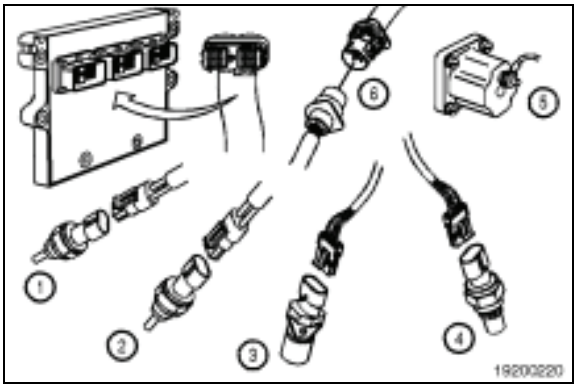
Torque Value: 2.8 N•m [25 in-lb]



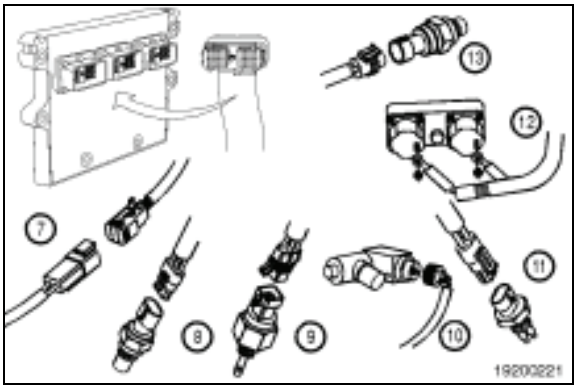
Engine Wiring Harness Removal/Installation (Cont)

Connect the harnesses to the sensors and switches.

- Intake manifold pressure sensor
- Intake manifold temperature sensor
- Crankshaft or camshaft position sensor
- Coolant temperature sensor
- Fuel shutoff solenoid
- 15-pin pass-through connector

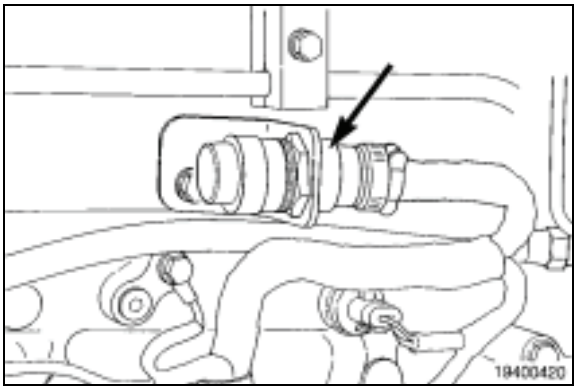


- Centinel™ connector (if equipped)
- Ambient air pressure sensor
- Oil pressure/temperature sensor
- Wet tank pressure sensor
- Water-in-fuel sensor
- Wastegate controller
- Fuel inlet restriction sensor (if equipped)



Connect the 31-pin Deutsch connector to the engine harness.

Install the harness clamps that hold the engine harness to the block.



Follow-Up

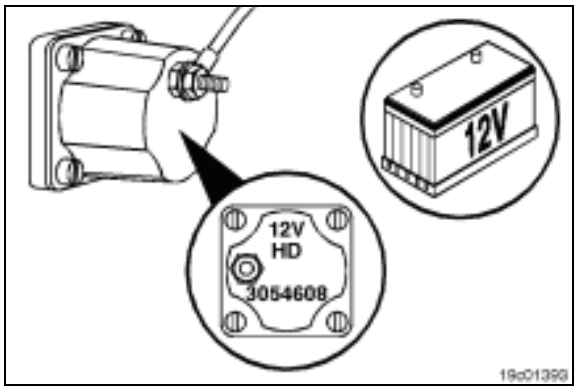
Fuel Shutoff Valve Circuit Checks

Prepare

General Information

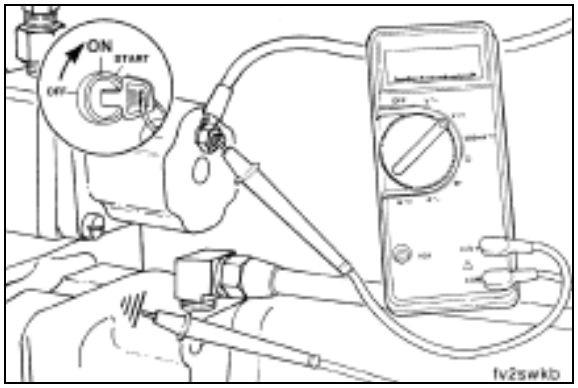
The fuel shutoff solenoid valve located on the fuel system housing. The solenoid is controlled by the ECM.

NOTE: Only one wire from the ECM will be attached to the solenoid post. The ECM is not capable of supplying power for other auxiliary components. If an external voltage source is attached, a fault code will be induced.



Turning the vehicle keyswitch on signals the ECM to open the fuel shutoff solenoid valve. The solenoid closes when the ECM senses the vehicle keyswitch is turned off or when the ECM senses an engine overspeed.

For more information on the fuel shutoff valve, refer to Procedure 005-043 in the Troubleshooting and Repair Manual, ISM and QSM11 Series Engines, Bulletin 3666322.

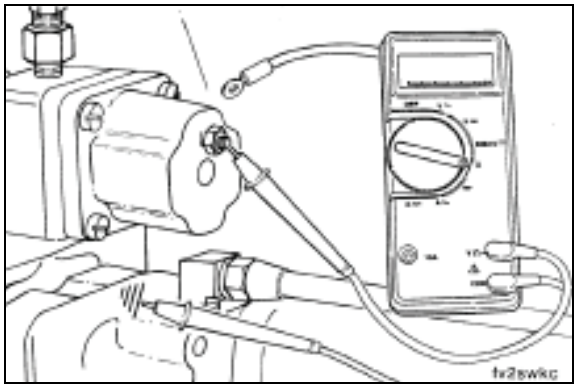


Resistance Check

The fuel shutoff valve circuit is a signal wire, pin 33, of the actuator harness connector to the shutoff valve solenoid. The valve is grounded through the engine.

Disconnect the actuator harness connector from the ECM. Check for damaged pins.

Disconnect the fuel shutoff solenoid wire from the valve terminal post.

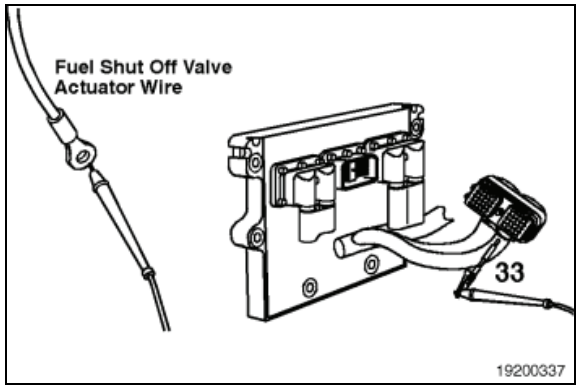


Fuel Shutoff Valve Circuit Checks (Cont)

CAUTION

Do not use probes or leads other than Part Number 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins of the connector.

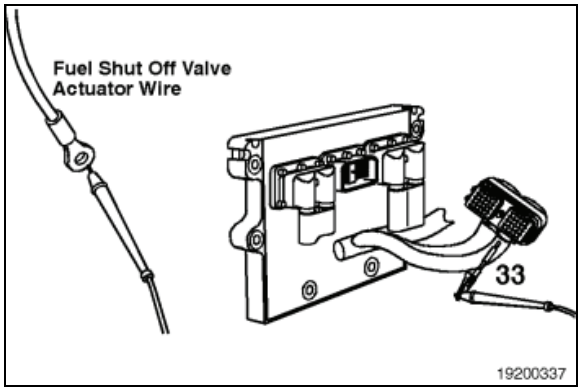
Insert a test lead into pin 33 of the actuator harness connector. Connect the alligator clip to the multimeter probe.



Touch the other multimeter probe to the fuel shutoff valve solenoid wire. Measure the resistance.

The multimeter must show a closed circuit (10 ohms or less). If the circuit is not closed, repair or replace the actuator harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

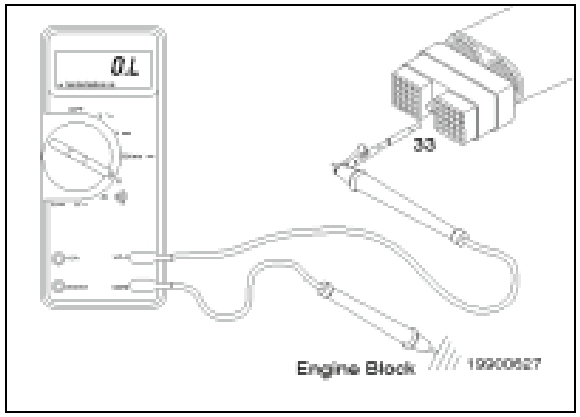
If the circuit is closed, it must still be checked for a short circuit to ground and a short circuit from pin to pin.



Check for Short Circuit to Ground

Insert a test lead into pin 33 of the actuator harness connector and connect it to the multimeter. Touch the other multimeter probe to engine block ground. The ring terminal at the solenoid must be disconnected and can not touch anything that is grounded. Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit to ground in the wire connected to pin 33. Repair or replace the actuator harness.

Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

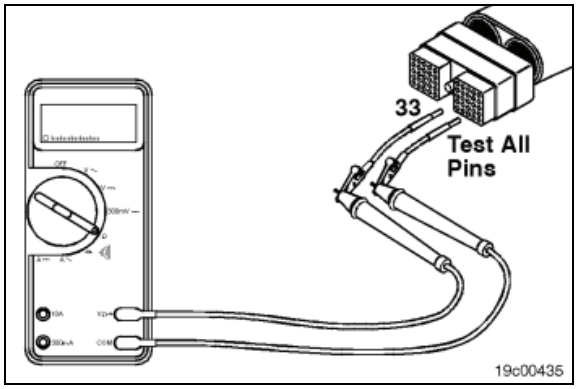


Fuel Shutoff Valve Circuit Checks (Cont)

Check for Short Circuit from Pin to Pin

Check for a short circuit from pin 33 to all other pins of the actuator harness connector. Insert a test lead into pin 33 of the actuator harness connector, and connect the lead to the multimeter probe. Insert the other test lead into all other pins of the actuator harness connector, one at a time.

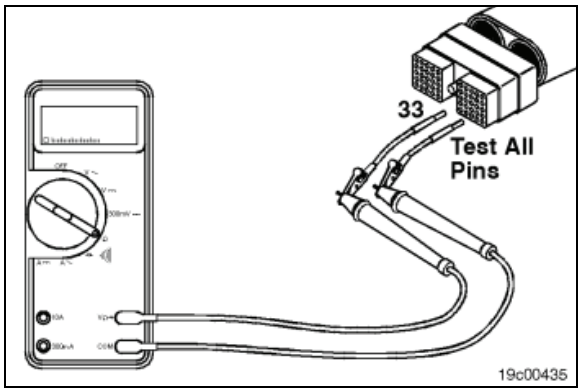
The ring terminal at the solenoid must be disconnected and can not touch anything that is grounded. The battery voltage supply must be disconnected.



Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short between pin 33 and any pin that measured a closed circuit.

Repair or replace the actuator harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

Connect all components after completing the repair.



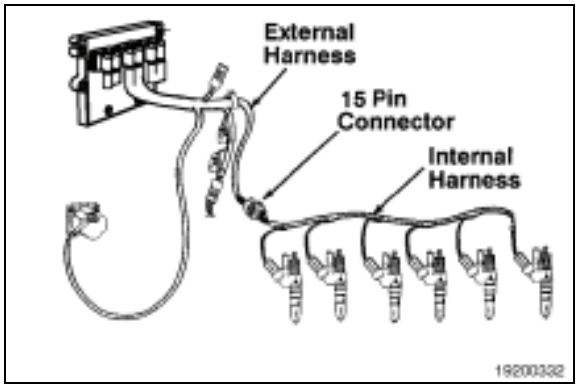
Follow-Up

Injector Solenoid Check

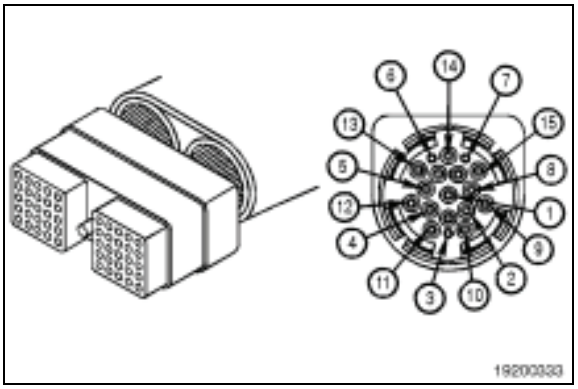
Prepare

General Information

The injector solenoid circuits are the supply and return wires in the actuator harness. The wires go from the ECM connector to a 15-pin connector in the rocker lever housing. The 15-pin connector connects the external and internal actuator harness. The internal harness goes to each injector. Three of the wires operate the engine brake actuator circuits.



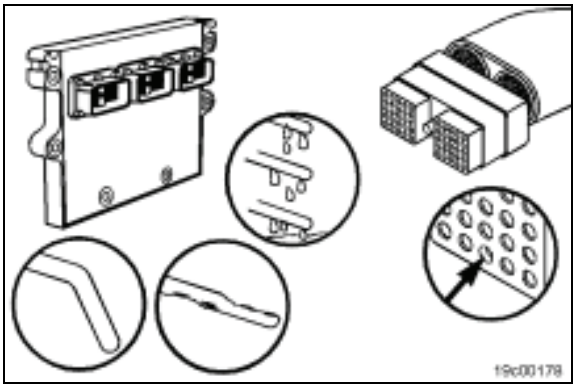
The pins of the circuits are as follows:



	Supply Pin			Return Pin		
Cyl. No.	**ECM Conn.**	**15-Pin Conn.**	**Inj. Pin**	**ECM Conn.**	**15-Pin Conn.**	**Inj. Pin**
1	10	01	A	09	02	B
2	08	03	A	07	04	B
3	06	05	A	16	06	B
4	26	07	A	36	08	B
5	04	09	A	03	10	B
6	02	11	A	01	12	B

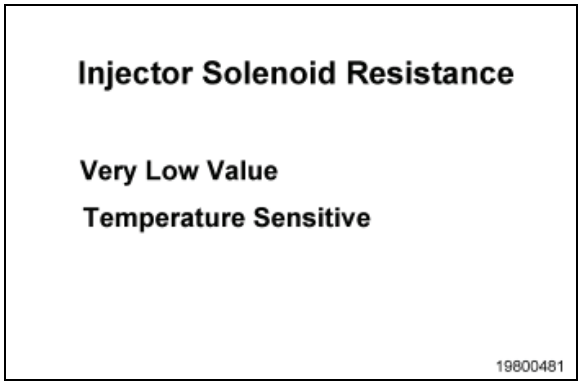
Injector Solenoid Check (Cont)

Remove the actuator harness connector from the ECM and check for damaged pins.



Resistance Check

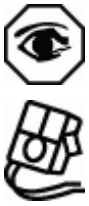
The resistance value of the injector solenoid circuit is very low. The solenoid resistance is also temperature sensitive. To read an accurate resistance value, the resistance of the multimeter must be subtracted from the total resistance of the injector solenoid circuit.

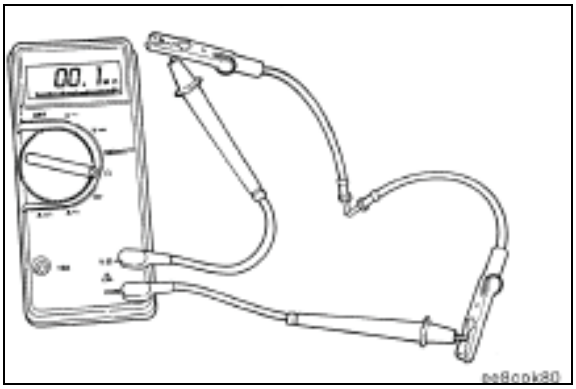


CAUTION

Use a multimeter for this procedure. Use Cummins multimeter, Part No. 3377161, or a meter with the same accuracy of ±1/2 percent.

Turn the multimeter on. Set the meter range to the lowest ohm scale. Measure the resistance across the two test probes. This is the multimeter resistance value which will be subtracted from the injector solenoid resistance value.





Follow-Up

Injector Solenoid Circuit Checks

Prepare

Resistance Check

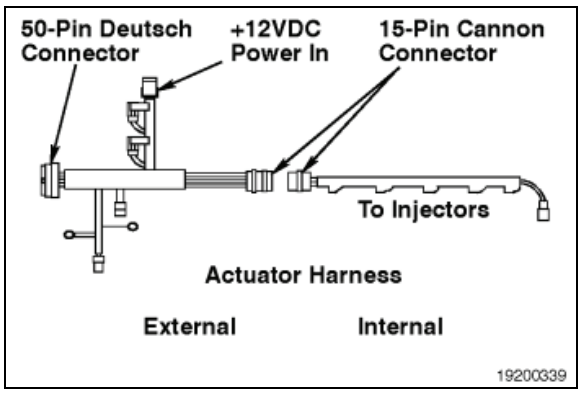
WARNING

The injector solenoids receive high voltage when the engine is operating. To reduce the possibility of personal injury or death from electrical shock, do not wear jewelry or damp clothing, and do not touch the injector solenoids or the solenoid wires when the engine is operating.

CAUTION

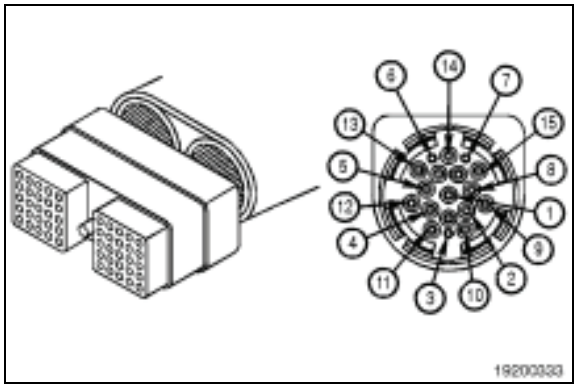
Do not use probes or leads other than Part Number 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the connector pins.

Inspect the injector solenoid circuit of the cylinder referenced on the recorded fault code. Refer to the accompanying chart for the pins of the injector circuit of the problem cylinder. Cylinder Number 1 will be used in this example.



Injector Solenoid Circuit Checks (Cont)

The pins of the circuits are as follows:

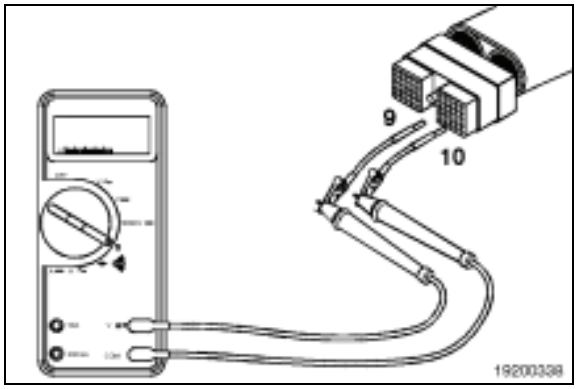


	Supply Pin			Return Pin		
Cyl. No.	ECM Conn.	15-Pin Conn.	Inj. Pin	ECM Conn.	15-Pin Conn.	Inj. Pin
1	10	01	A	09	02	B
2	08	03	A	07	04	B
3	06	05	A	16	06	B
4	26	07	A	36	08	B
5	04	09	A	03	10	B
6	02	11	A	01	12	B

Turn the vehicle keyswitch to the OFF position.

Disconnect the actuator harness connector from the ECM.

Insert a test lead into the supply pin (pin 10 in this example) of the actuator harness connector. Insert the other lead into the return pin (pin 09 in this example) of the actuator harness connector. Connect the alligator clips to the multimeter probes.



Injector Solenoid Circuit Checks (Cont)

Measure the resistance. Subtract the multimeter test lead resistance value from this value to determine the true injector circuit resistance value. The resistance must be 0.5 to 1.5 ohms. If the resistance value is not correct, proceed with the following sections. If the resistance is correct, the circuit must still be checked for a short circuit to ground and a short circuit from pin to pin.

NOTE: If the resistance measurement is less than 10 ohms, the circuit is acceptable as long as the resistance of the injector solenoid is within 0.5 to 1.5 ohms (see Resistance Value Above Specification).

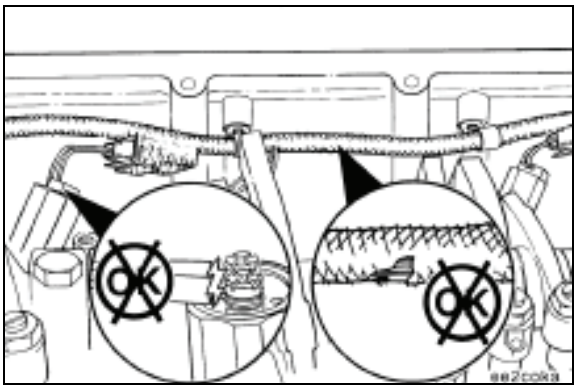
1.3Ω Measured resistance (Step 2)
– .1Ω Ohm meter test lead measurement (Step 1)
1.2Ω True measured value

ci801k07

Resistance Value Below Specifications

Remove the valve cover.

Inspect the injector solenoid wires for short circuits between the wires. If the wires are damaged, replace the wires. Refer to Procedure 019-057 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

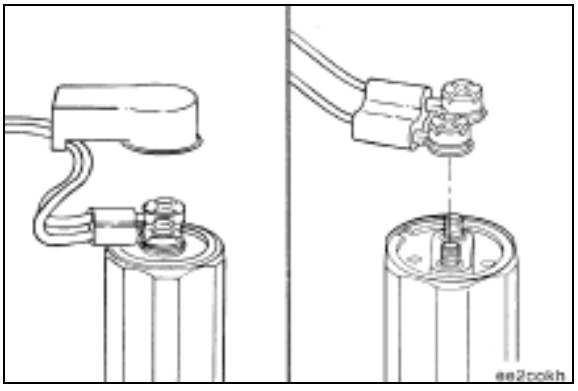


ee2cok3

Disconnect the injector supply and return wires from the solenoid of the problem cylinder.

Use a small screwdriver to remove the protective cover from the solenoid.

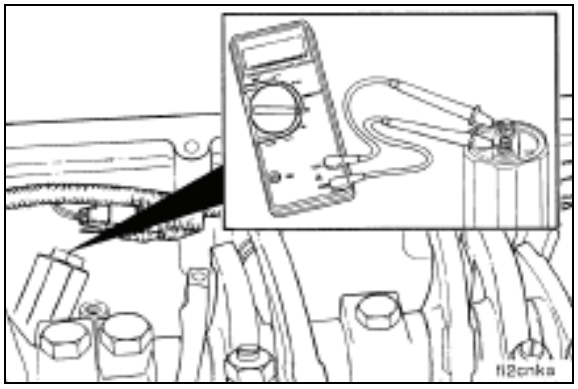
Remove the captive nut assembly from the injector solenoid.



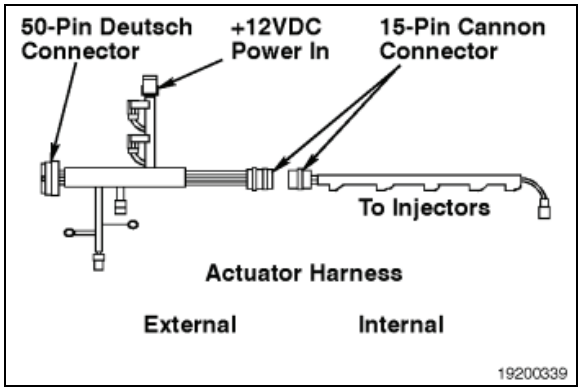
ee2cokh

Injector Solenoid Circuit Checks (Cont)

Measure the resistance between the two posts or the connection of the injector solenoid. Subtract the multimeter resistance. The true injector solenoid resistance must be 0.5 to 1.5 ohms. If the resistance value is not correct, replace the injector. Refer to Procedure 006-026 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



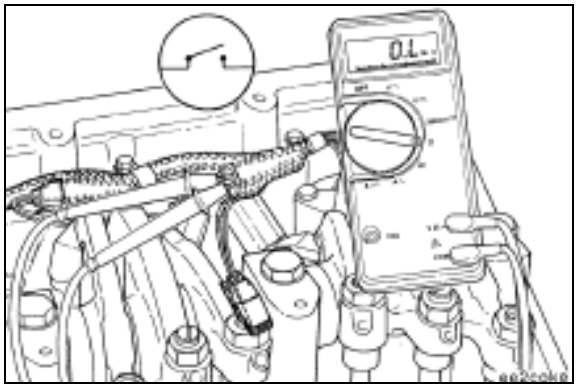
If the resistance value of the injector solenoid is correct, the problem is in the internal or external actuator harness. Isolate the problem by checking each harness separately.



Disconnect the connector inside the head.

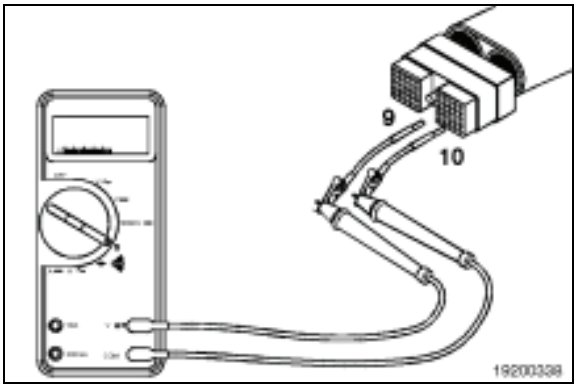
Check the internal actuator harness. Measure the resistance between the two captive nut assemblies, or the connection, of the injector solenoid wire that was removed from the injector solenoid. The resistance must be an open circuit (more than 100k ohms). If the resistance is less than 100k ohms, replace the internal actuator wiring harness. Refer to Procedure 019-063 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193. Do not repair the internal actuator harness.

Connect the 15-pin connector when the repair is completed.



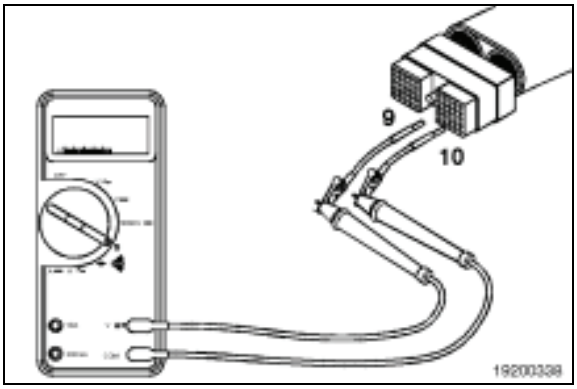
Injector Solenoid Circuit Checks (Cont)

Check the external actuator harness. Make sure that the 15-pin connector is still disconnected. Insert the test lead into the supply pin (pin 10 in this example) of the actuator harness connector. Insert the pin of the other lead into the return pin (pin 09 in this example) of the actuator harness connector. Connect the alligator clips to the multimeter probes.



Measure the resistance. The resistance must be an open circuit (more than 100k ohms). If the resistance is less than 100k ohms, repair or replace the external actuator harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

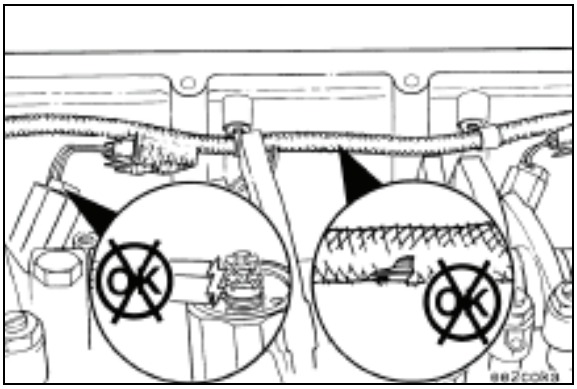
Connect the 15-pin connector when the repair is completed.



Resistance Value Above Specification

Remove the valve cover.

Inspect the injector solenoid wires for broken wires. If the wires are damaged, replace the wires. Refer to Procedure 019-057 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193. Do not repair the wires.



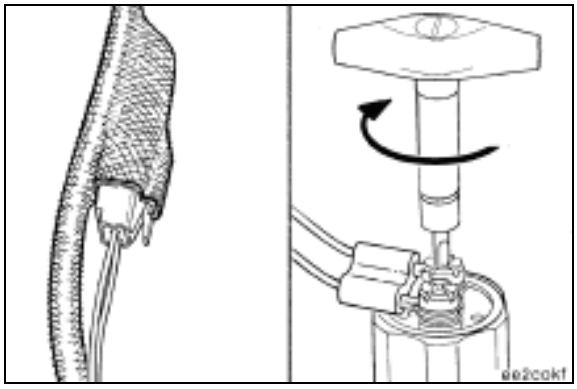
Injector Solenoid Circuit Checks (Cont)

Check the 2-pin connector of the injector solenoid wires for proper connection.

Use a small screwdriver to remove the protective cover from the solenoid.

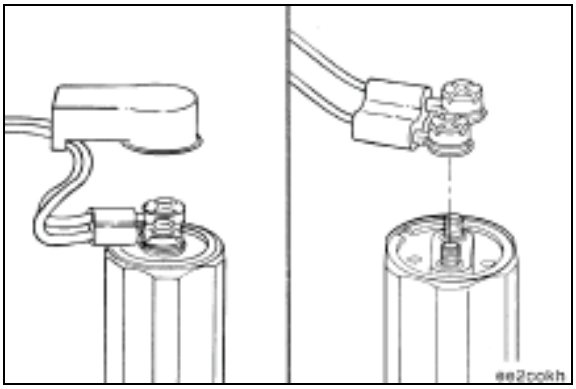
Use inch pound torque wrench, Part Number 3823208, and screwdriver socket, Part Number 3823209, to check the captive nut assembly for correct torque.

Torque Value: 1.6 N•m [14in-lb]

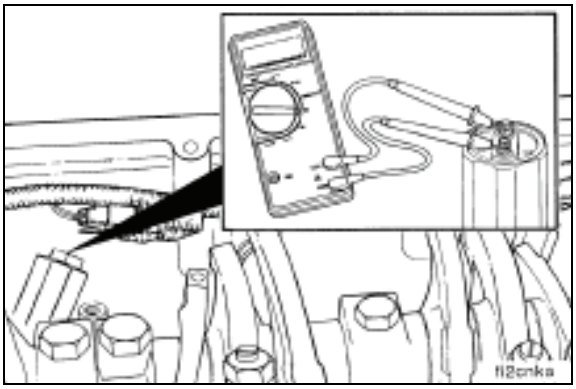


Check pass-through connector for a tight connection. Check for an open circuit in the injector solenoid. Use a small screwdriver to remove the protective cover from the solenoid.

Remove the captive nut assembly from the injector solenoid.



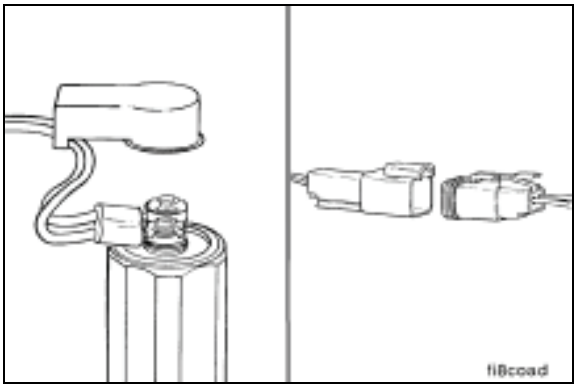
Measure the resistance between the posts or the connection of the injector solenoid. Subtract the multimeter resistance. The true injector solenoid resistance must be 0.5 to 1.5 ohms. If the resistance is not correct, replace the injector. Refer to Procedure 006-026 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Injector Solenoid Circuit Checks (Cont)

If the resistance is correct, check the solenoid wires for an open circuit.

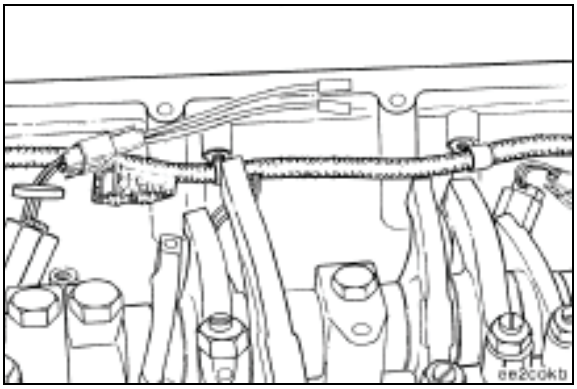
Disconnect the 2-pin connector of the injector solenoid wires.



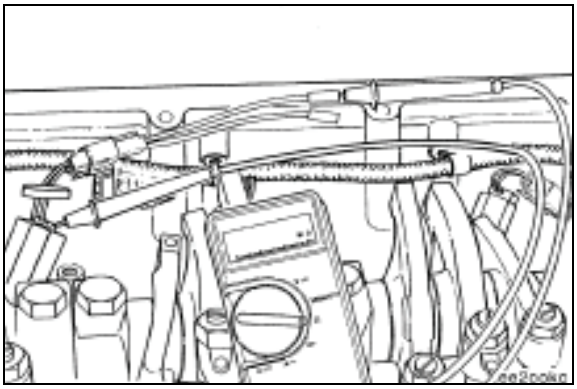
CAUTION

Do not use probes or leads other than the mating connector. The connector will be damaged. The leads must fit tightly in the connector without expanding the connector pins.

Connect a mating connector with short lead extensions to the injector side of the 2-pin connector.

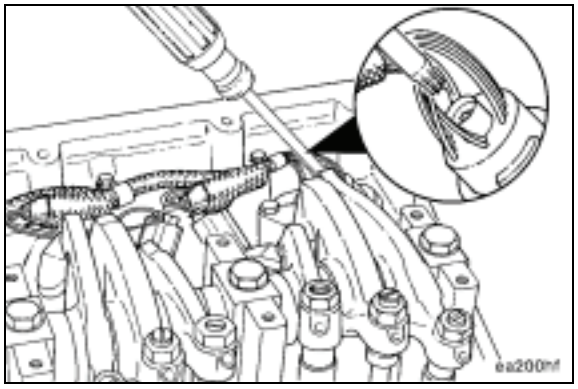


Touch one multimeter probe to the end of the short lead extension. Touch the other multimeter probe to the captive nut assembly of the injector solenoid wire. Measure the resistance. Repeat the procedure for the other injector wire. The resistance for both of these checks must be less than 10 ohms. If the resistance is more than 10 ohms, replace the injector solenoid wires. Refer to Procedure 019-057 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193. Do not repair the wires.



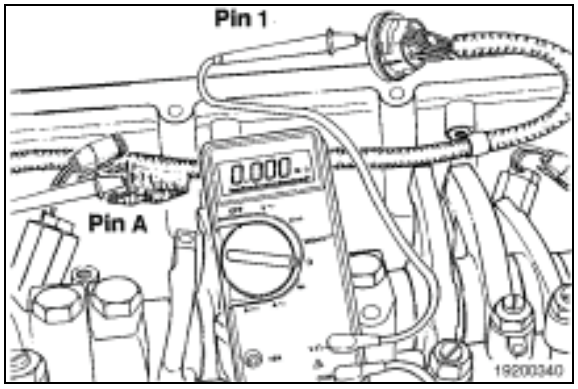
Injector Solenoid Circuit Checks (Cont)

Disconnect the 15-pin connector to separate the internal and external actuator harness.



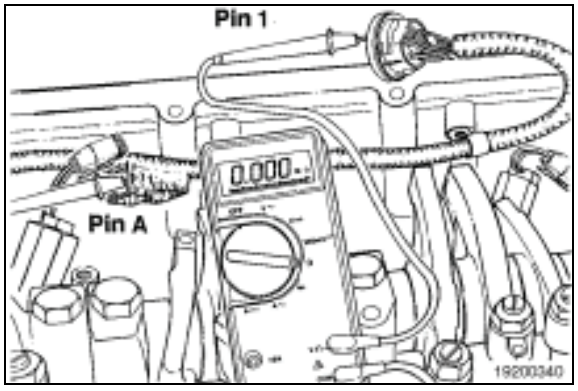
Refer to the accompanying chart at the beginning of this section for the pins of the injector circuit of the problem cylinder.

Cylinder Number 1 will be used in this example. Check the supply wire. Touch one multimeter probe to the supply pin (pin A) at the injector 2-pin connector, internal actuator harness side.



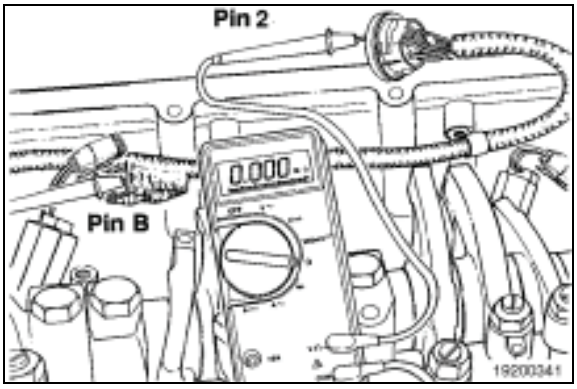
Touch the other multimeter probe to the supply pin (pin 01) at the 15-pin connector, internal actuator harness side. Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, replace the internal actuator harness. Refer to Procedure 019-063. Do not repair the wire.

Connect the 15-pin connector when the repair is completed.



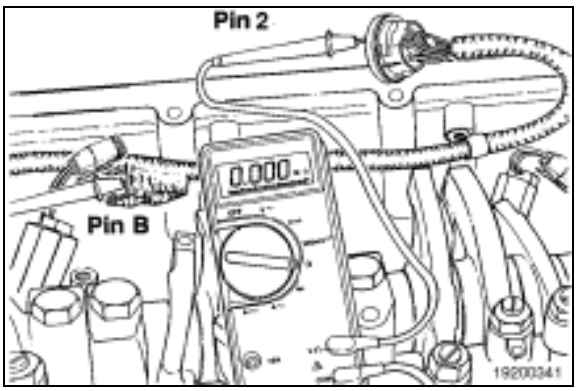
Injector Solenoid Circuit Checks (Cont)

Check the return wire for an open circuit. Touch one multimeter probe to the return pin (pin B) at the injector 2-pin connector, internal actuator harness side. Touch the other multimeter probe on the return pin (pin 02) of the 15-pin connector, internal actuator harness side.



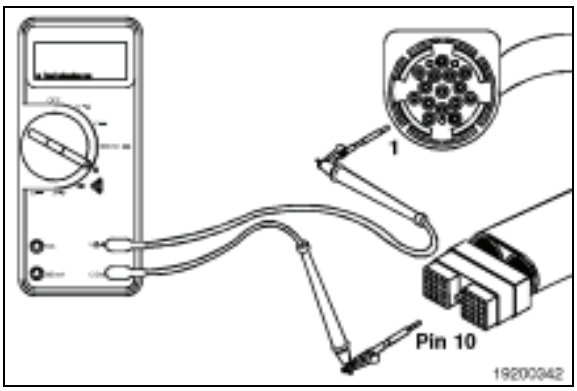
Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, replace the internal actuator harness. Refer to Procedure 019-063. Do not repair the wires.

Connect the 15-pin connector when the repair is completed.



Check the external actuator harness for an open circuit. Refer to the accompanying chart at the beginning of this section for the pins required.

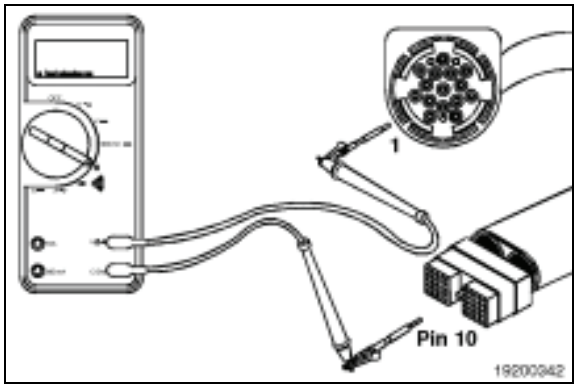
Cylinder Number 1 will be used as an example. Insert the pin of the lead into the supply pin (pin 10 in this example) of the actuator harness. Connect the alligator clip to the multimeter probe.



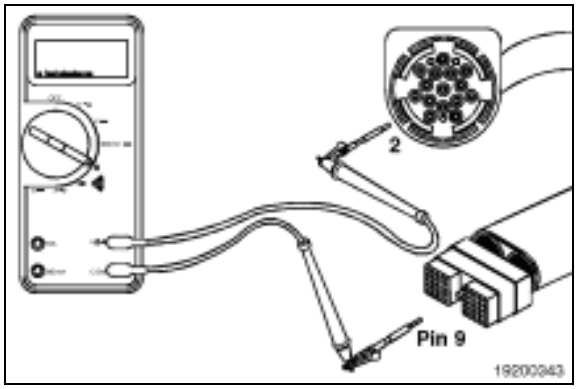
Injector Solenoid Circuit Checks (Cont)

Insert the other multimeter probe on the supply pin (pin 01) at the 15-pin connector, external actuator harness side. Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, repair the wire or replace the actuator harness. Refer to Procedure 019-043.

Connect the 15-pin connector when the repair is completed.

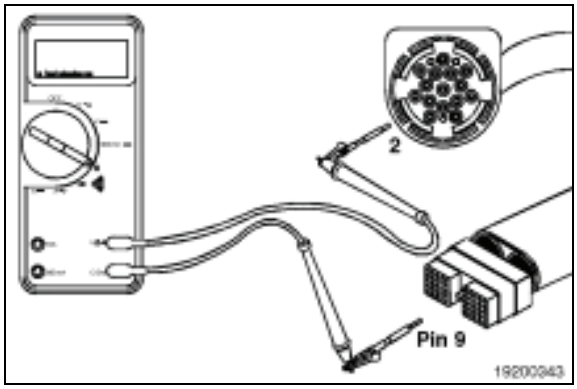


Insert the pin of the lead in the return pin (pin 09 in this example) of the actuator harness connector. Place the other multimeter probe on the return pin (pin 02) at the 15-pin connector, external harness side.



Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, repair the return wire or replace the actuator harness. Refer to Procedure 019-043.

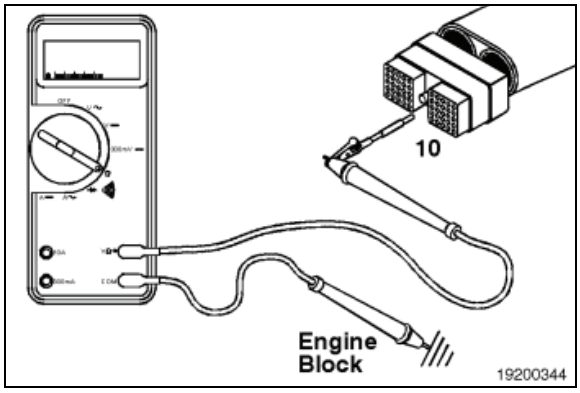
Connect the 15-pin connector when the repair is completed.



Injector Solenoid Circuit Checks (Cont)

Resistance Value Within Specification

If the resistance value is within specification, the circuit must still be checked for a short circuit to ground and a short circuit from pin to pin.

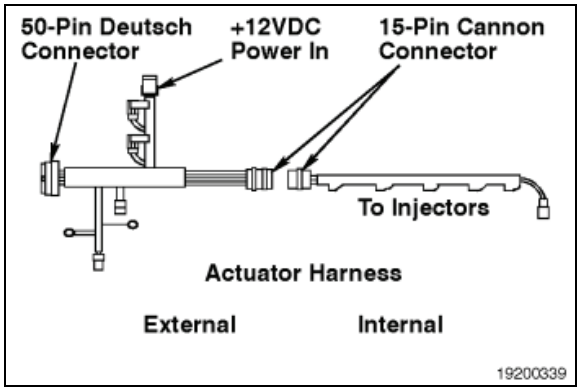


Check for Short Circuit to Ground

WARNING

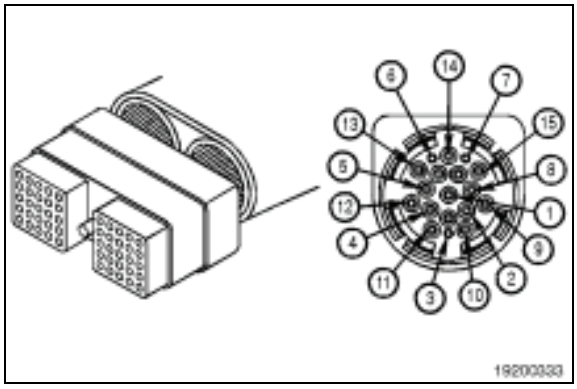
The injector solenoids receive high voltage when the engine is operating. To reduce the possibility of personal injury or death from electrical shock, do not wear jewelry or damp clothing, and do not touch the injector solenoids or the solenoid wires when the engine is operating.

Check for a short circuit to ground in the external actuator harness. Refer to the accompanying chart for the pins to check. Cylinder Number 1 will be used for this example.



Injector Solenoid Circuit Checks (Cont)

The pins of the circuits are as follows:

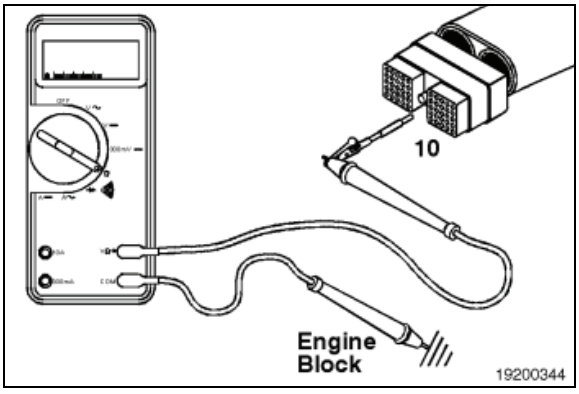


	Supply Pin			Return Pin		
Cyl. No.	**ECM Conn.**	**15-Pin Conn.**	**Inj. Pin**	**ECM Conn.**	**15-Pin Conn.**	**Inj. Pin**
1	10	01	A	09	02	B
2	08	03	A	07	04	B
3	06	05	A	16	06	B
4	26	07	A	36	08	B
5	04	09	A	03	10	B
6	02	11	A	01	12	B

Turn the switch to the OFF position. Disconnect the actuator harness connector from the ECM.

Insert a test lead into pin 10 of the actuator harness connector, and connect it to a multimeter probe. Touch the other multimeter probe to engine block ground. Measure the resistance.

The circuit must be open (100k ohms or more). If it is not open, isolate the short to the external or internal actuator harness.

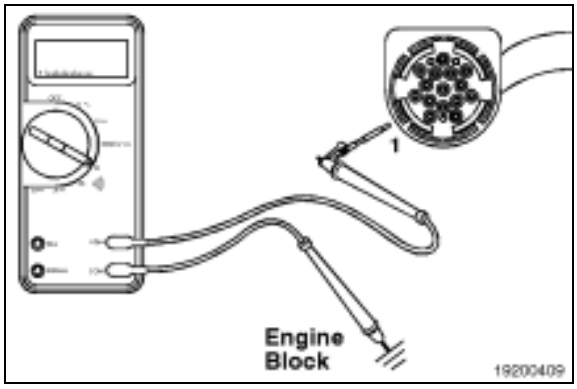


Injector Solenoid Circuit Checks (Cont)

Disconnect the 15-pin pass-through connector from the actuator harness.

Insert the test lead into pin 01 of the 15-pin connector, internal harness side. Touch the other multimeter probe to engine block ground. Measure the resistance.

The circuit must be open (100k ohms or more). If it is not open, the short circuit is on the internal harness side. Replace the internal actuator harness. Refer to Procedure 019-063. If the circuit is open, repair or replace the external actuator harness.

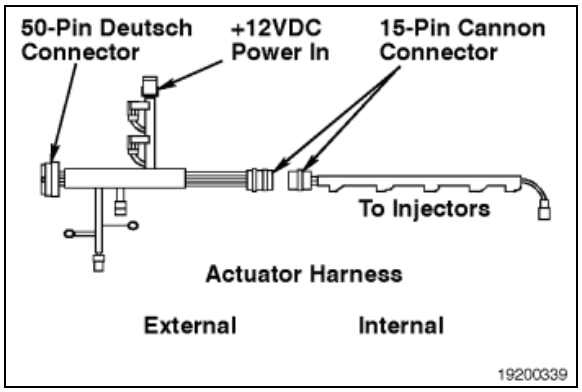


Check for Short Circuit from Pin to Pin

WARNING

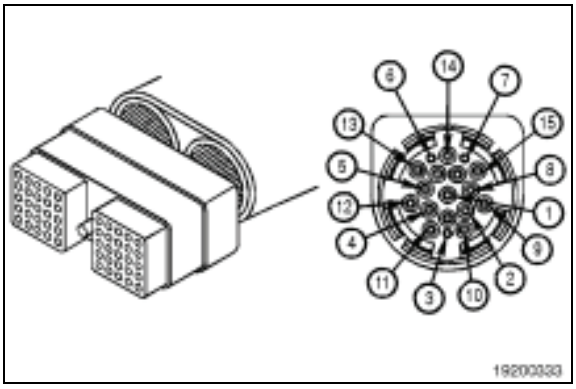
The injector solenoids receive high voltage when the engine is operating. To reduce the possibility of personal injury or death from electrical shock, do not wear jewelry or damp clothing, and do not touch the injector solenoids or the solenoid wires when the engine is operating.

Check for a short circuit from pin to pin. Refer to the accompanying chart for the pins required. Cylinder Number 1 will be used as an example.



Injector Solenoid Circuit Checks (Cont)

The pins of the circuits are as follows:

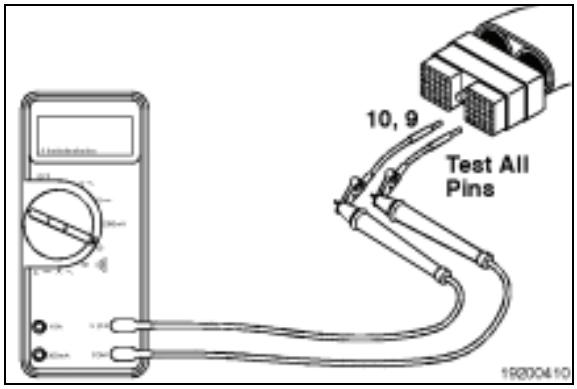


	Supply Pin			Return Pin		
Cyl. No.	ECM Conn.	15-Pin Conn.	Inj. Pin	ECM Conn.	15-Pin Conn.	Inj. Pin
1	10	01	A	09	02	B
2	08	03	A	07	04	B
3	06	05	A	16	06	B
4	26	07	A	36	08	B
5	04	09	A	03	10	B
6	02	11	A	01	12	B

Turn the switch to the OFF position. Disconnect the actuator and sensor harness connectors from the ECM. Disconnect the actuator harness from the 15-pin pass-through connector.

Insert a test lead into pin 10 of the actuator harness connector. Insert the other test lead into all other pins of the actuator harness connector, one at a time. Measure the resistance.

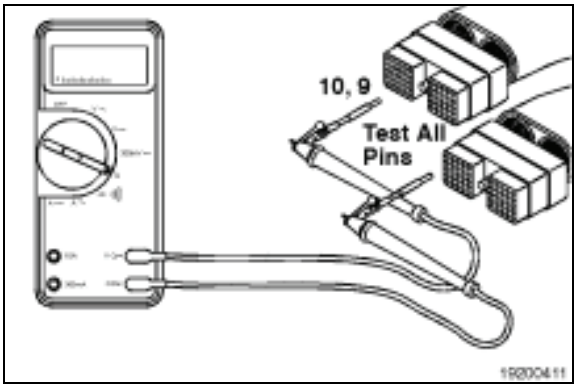
Repeat same check as previous from pin 9. The circuit must be open (100k ohms or more) at all pins. If the circuit is not open, repair or replace the actuator harness. Refer to Procedure 019-043.



Injector Solenoid Circuit Checks (Cont)

Insert a test lead into pin 10 of the actuator harness connector. Insert the other test lead into all other pins of the sensor harness connector, one at a time. Measure the resistance.

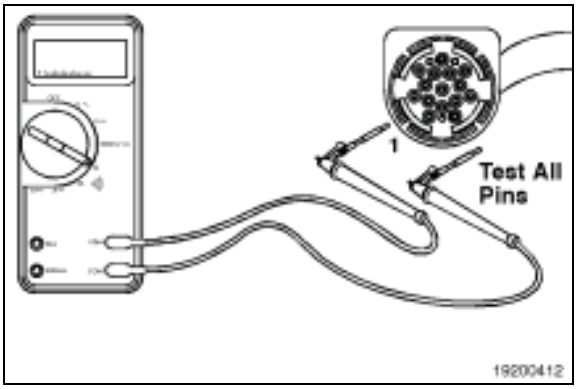
Repeat same check as previous from pin 9. The circuit must be open (100k ohms or more) at all pins. If the circuit is not open, repair or replace the actuator or sensor harness. Refer to Procedure 019-043.



Check for a short circuit from pin to pin in the 15-pin pass-through connector. Disconnect the internal harness from the injector solenoid.

Insert a test lead into pin 01 of the 15-pin pass-through connector, internal harness side. Insert the other test lead into all other pins of the pass-through connector, one at a time. Measure the resistance.

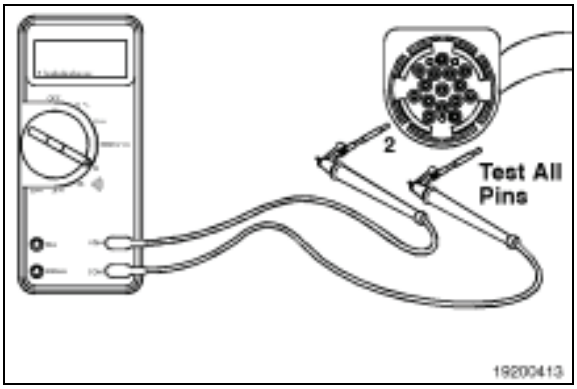
The circuit must be open (100k ohms or more). If it is not open, replace the internal actuator harness. Refer to Procedure 019-063.



Insert a test lead into pin 02 of the 15-pin pass-through connector, internal harness side. Insert the other test lead into all other pins of the pass-through connector, one at a time. Measure the resistance.

The circuit must be open (100k ohms or more). If it is not open, replace the internal actuator harness. Refer to Procedure 019-063.

Connect all components after completing the repair.



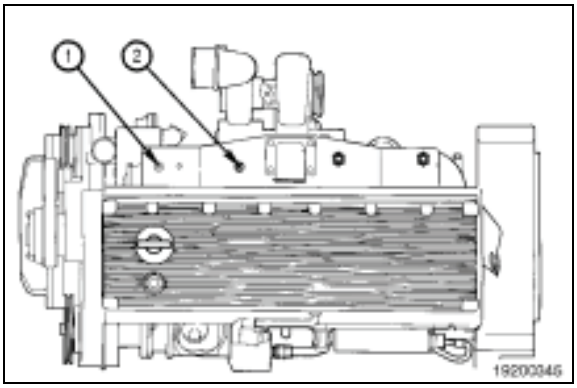
Follow-Up

Intake Manifold Air Temperature Sensor Removal/Installation

Prepare

General Information

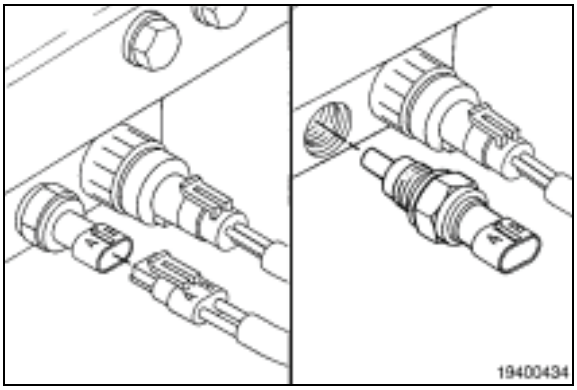
The intake manifold air temperature (2) and intake manifold air pressure (1) is located on the top front half of the intake manifold. The ECM uses this information for the engine protection system.



Remove

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

Remove the sensor from the engine.

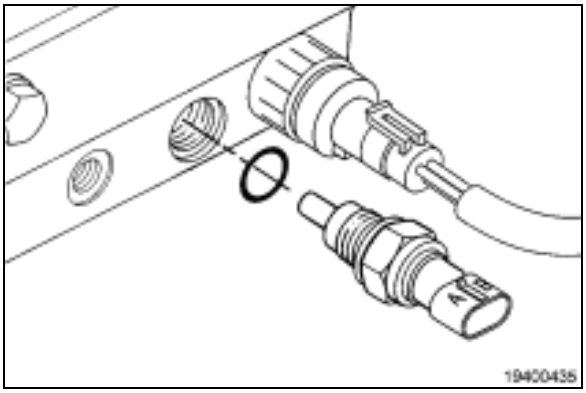


Install

Make sure the new sensor has an o-ring.

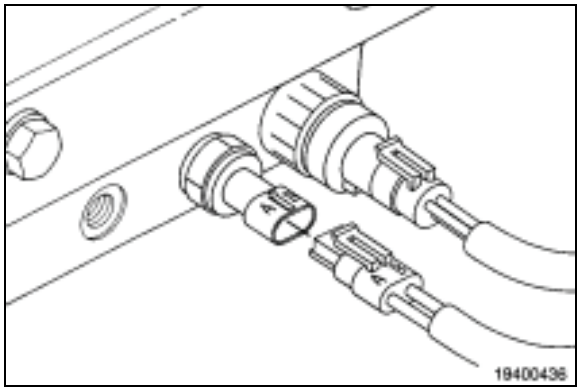
Install the new sensor into the engine. Tighten the sensor.

Torque Value: 14 N•m [124 in-lb]



Intake Manifold Air Temperature Sensor Removal/Installation (Cont)

Push the connectors together until they lock.



Follow-Up

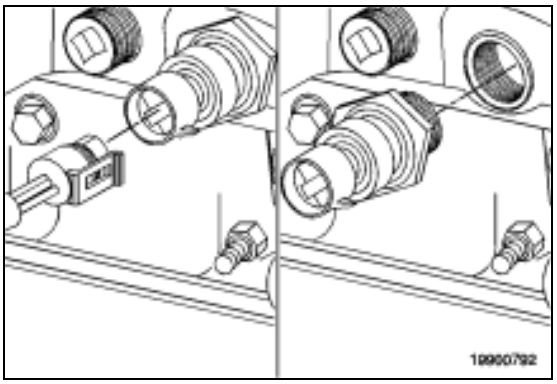
Intake Manifold Pressure Sensor Removal/Installation

Prepare

Remove

Lift the tab, and detach the connector from the sensor.

Remove the sensor from the air intake manifold with deep flank drive socket, Part No. 3823843.



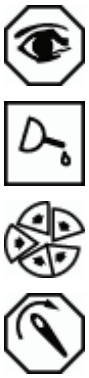
Install

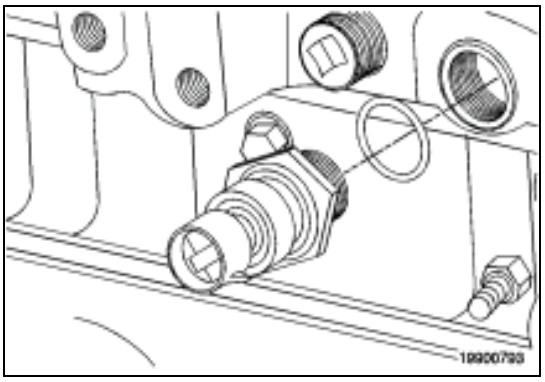
Make sure the new sensor has an o-ring around the surface where it seals against the air intake manifold.

Lubricate the o-ring.

Install the sensor into the air intake manifold.

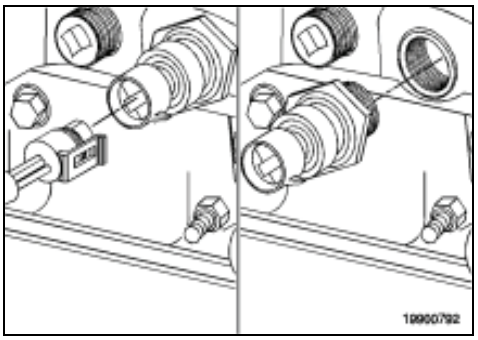
Torque Value: 14 N•m [124 in-lb]





Push the harness connector into the sensor until it locks.

A click will be heard as the connector locks into place.



Follow-Up

Internal Actuator Wiring Harness Removal/Installation

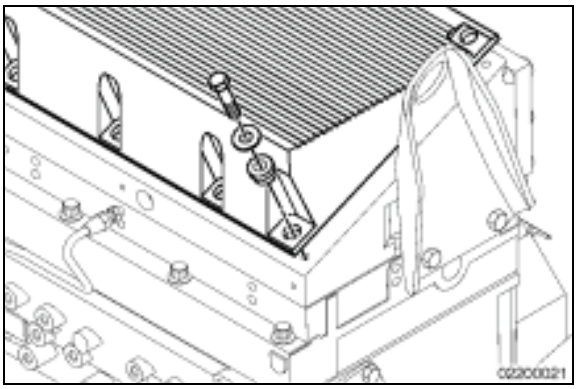
Prepare

Remove

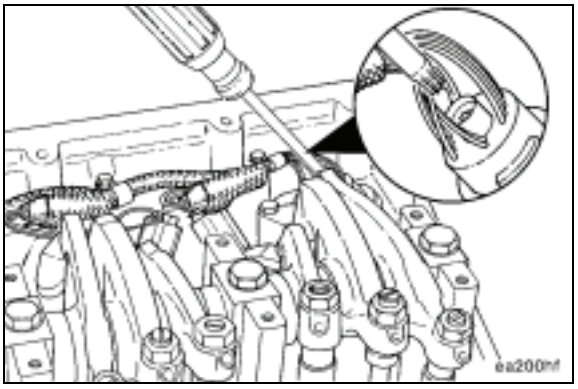
Remove the rocker lever cover.

For the ISM engines refer to Procedure 003-011 in Troubleshooting and Repair Manual, ISM, ISMe, and QSM11 Engines, Bulletin 3666322.

For the M11 engines refer to Procedure 003-011 in the Troubleshooting and Repair Manual, M11 Series Engines (STC, CELECT™, CELECT™ Plus Models), Bulletin 3666139.

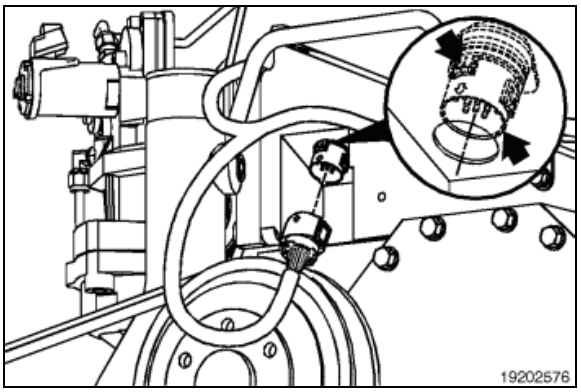


If equipped, use a Torx® screwdriver to remove the locking capscrew that holds the Metri-Pack 12-pin connectors together.



Disconnect the engine harness from the internal actuator harness connector at the front or rear of the rocker lever housing.

Release the locking tabs on the internal actuator harness connector and push the connector back through the rocker lever housing.

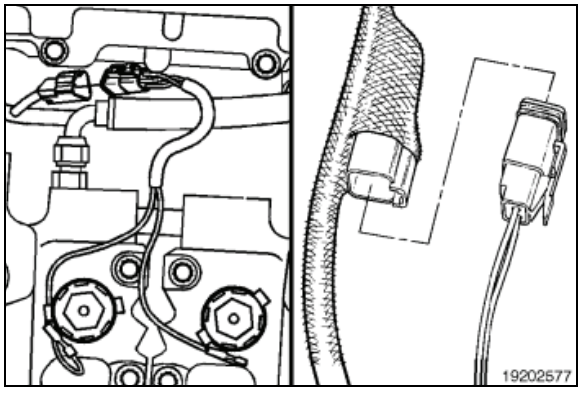


Internal Actuator Wiring Harness Removal/Installation (Cont)

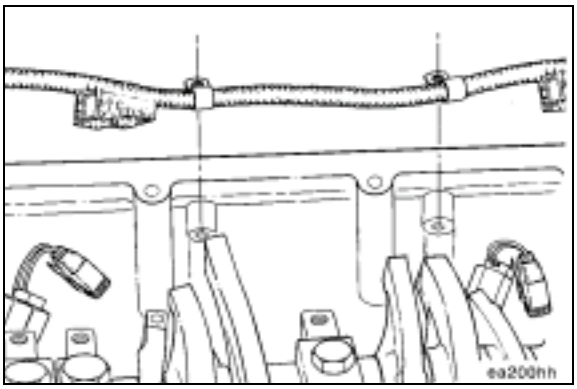
If equipped disconnect the engine brake harness from the engine brake solenoids.

Disconnect the engine brake harness from the internal actuator harness at the 3-pin Deutsch connector.

Disconnect the internal actuator harness from each of the six injector solenoids.

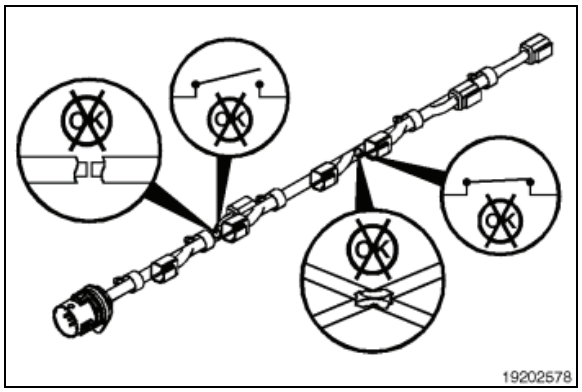


Remove the five hold down capscrews securing the internal actuator harness to the rocker lever housing.



Inspect for Reuse

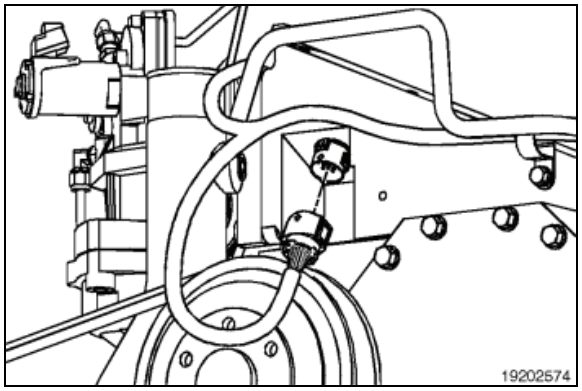
Replace or repair the internal actuator harness if there is an open circuit or a short circuit found under the protective covering of the harness body.



Internal Actuator Wiring Harness Removal/Installation (Cont)

Clean the connector bore in the rocker lever housing.

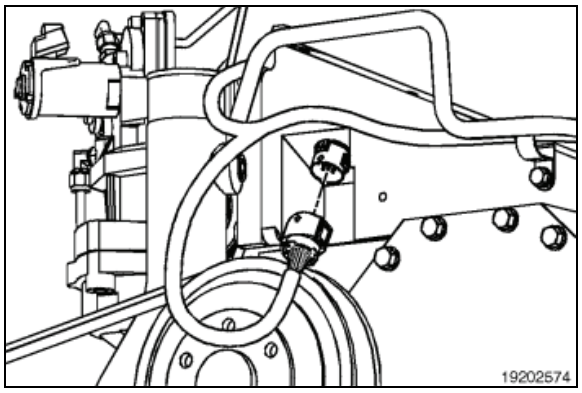
Apply Lubriplate™, multi-purpose lubricant, to the external sealing ring to ease assembly.



Install

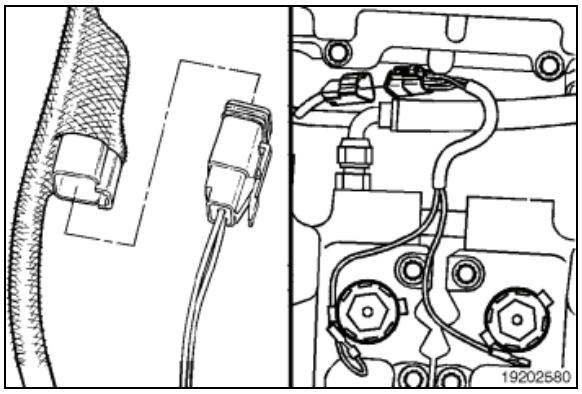
Push the internal actuator harness connector through the rocker lever housing until the locking tabs lock into position on the front of the rocker lever housing.

Connect the connector of the internal actuator harness to the connector of the external actuator harness.



Connect the internal actuator harness to each of the six injector solenoids.

If the engine is equipped with a brake harness connect the engine brake harness to the internal actuator harness and the engine brake solenoids.



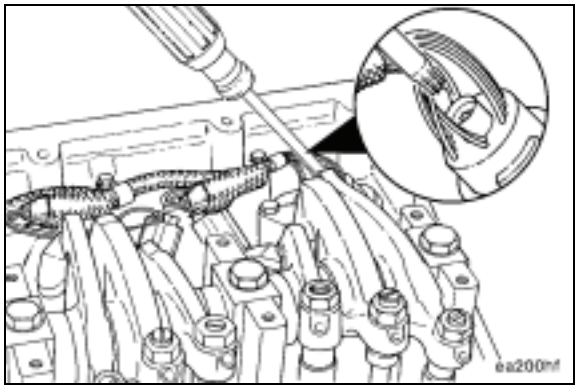
Internal Actuator Wiring Harness Removal/Installation (Cont)

NOTE: If equipped with a 12-pin Metri-Pack keyed connector, align connector before the capscrew is tightened.

Install the locking capscrew with a Torx® screwdriver.

Tighten the capscrew.

Torque Value: 1 N•m [9 in-lb]

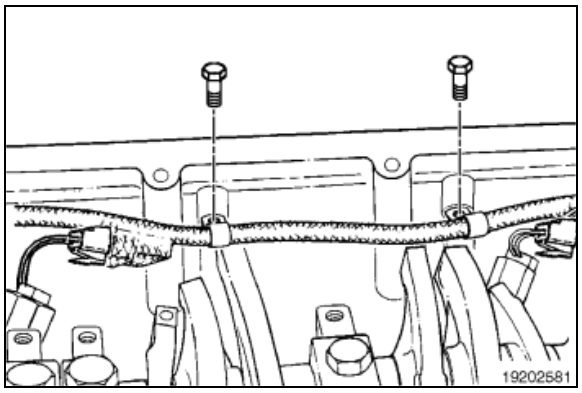


CAUTION

Make sure the internal wiring harness is securely installed with the capscrews to the rocker lever housing. A loose internal wiring harness can be damaged by moving engine parts.

Install the five hold down capscrews securing the internal actuator harness to the rocker lever housing.

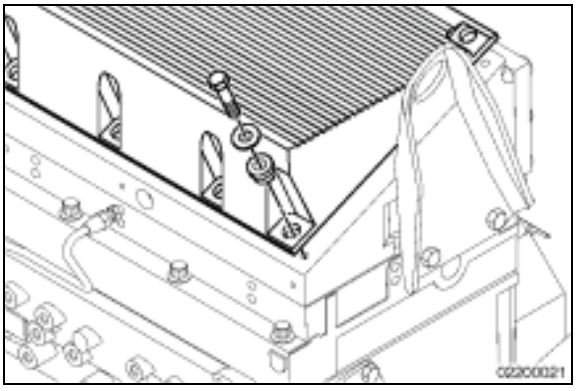
Torque Value: 20 N•m [180 in-lb]



Install the rocker lever cover.

For the ISB/QSB/QSB engines refer to Procedure 003-011 in Troubleshooting and Repair Manual, ISB/QSB/QSB, Engines, Bulletin 3666193.

For the M11 engines refer to Procedure 003-011 in the Troubleshooting and Repair Manual, ISB/QSB/QSB Engines, Bulletin 3666193.



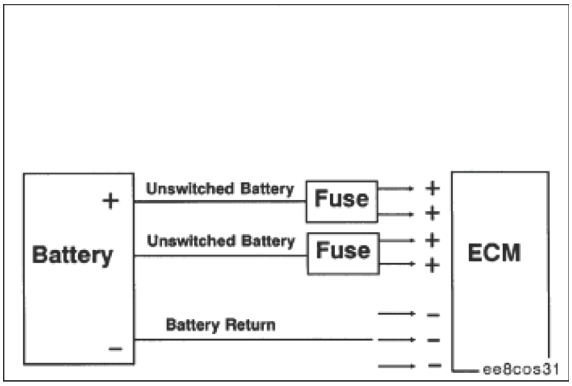
Follow-Up

Key Switch Battery Supply Circuit Voltage Check

Prepare

Voltage Check

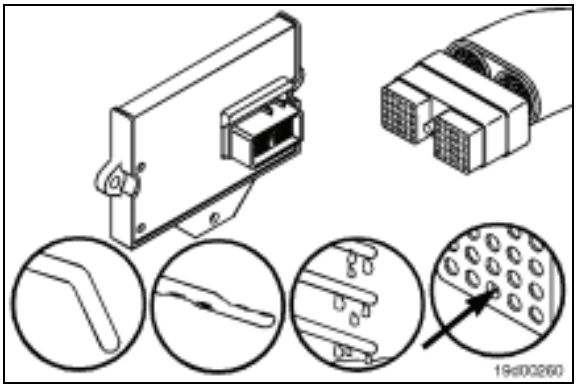
The switch supplies an input signal to the ECM, which turns the ECM on or off.



Turn the switch to the OFF position.

Disconnect the engine harness from the ECM.

Inspect the connector pins.



CAUTION

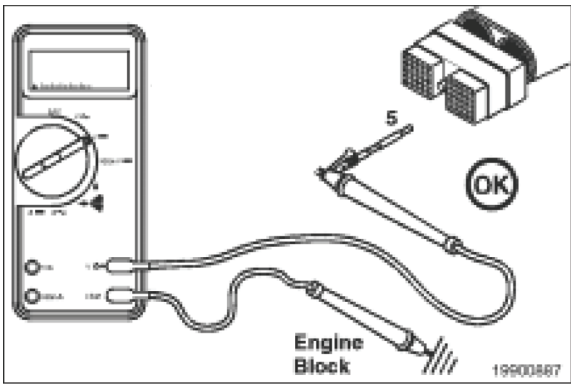
Use the appropriate test leads from wiring harness repair kit, Part No. 3822758, to avoid damage to the connector pins.

Set up the multimeter to measure voltage.

Touch the positive (+) multimeter probe to pin 5 of the engine harness connector. Touch the other probe to a clean, unpainted surface or engine block ground.

Turn the switch on.

The measured voltage must show battery voltage.



Key Switch Battery Supply Circuit Voltage Check (Cont)

If voltage more than 0.5 VDC below battery voltage:

Disconnect the 23-pin OEM interface connector.

Inspect the connector pins.

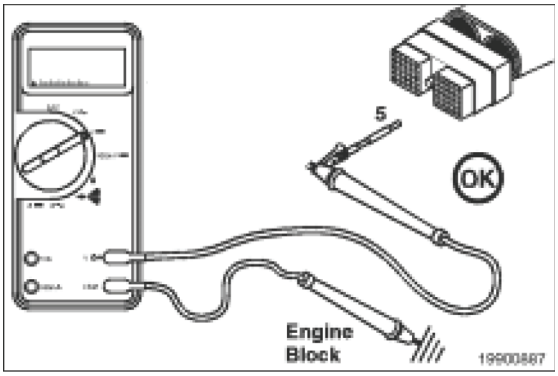
Touch the positive (+) multimeter lead to pin X on the OEM side of the control panel connector.

Touch the other lead to a clean, unpainted surface of engine block.

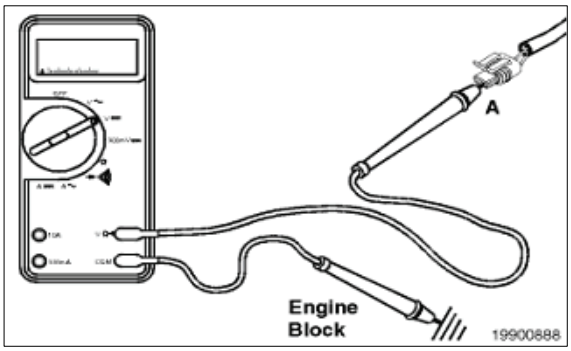
Measure the voltage.

The measured voltage must show battery voltage. If the voltage is not correct, there is a problem with the OEM harness wire, keyswitch, or battery connection.

Repair or replace the OEM harness or keyswitch or check the battery connections. Refer to the OEM troubleshooting and repair manual.



If the voltage is within the specified range, there is a problem on the engine harness side of the keyswitch circuit. Repair or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



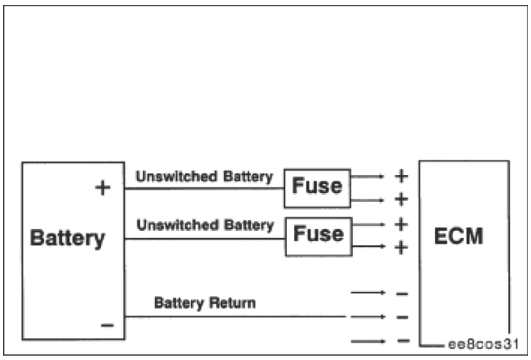
Follow-Up

Unswitched Battery Supply Circuit Checks

Prepare

General Information

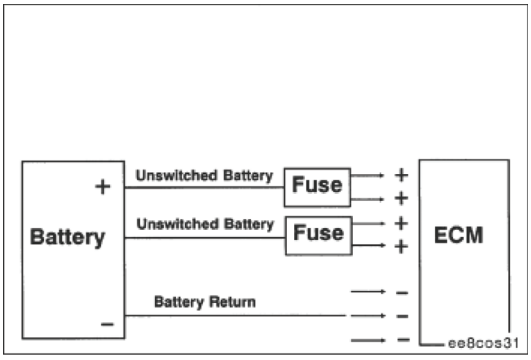
The ECM receives constant voltage from the batteries through the unswitched battery wires that are connected directly to the (+) positive battery post. There are two in-line 15-amp fuses in each of the unswitched battery wires to protect the ECM. The ECM receives switched battery input through the switch wire when the switch is turned on. The battery return wires are connected directly to the (-) negative battery post.



The unswitched battery wires and the battery return wires are in the harness.

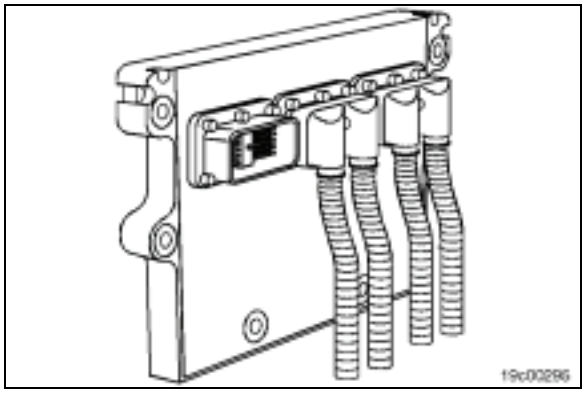
Always check the unswitched battery supply fuses when troubleshooting the ECM and power supply circuits.

Check the battery voltage. Refer to Procedure 019-008 in the Cummins Engine Trouble Shooting and Repair manual, QSB Engines, Bulletin No. 3666193.



Resistance Check

Disconnect the OEM harness from the ECM.

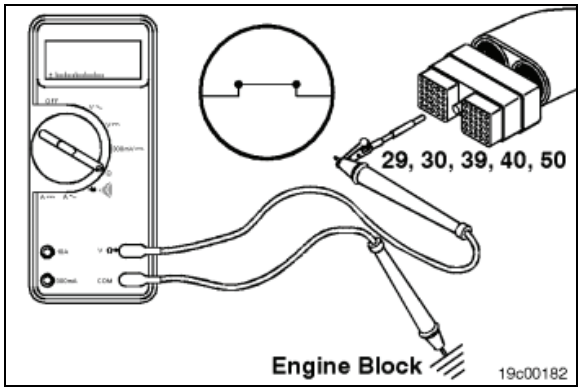


Unswitched Battery Supply Circuit Checks (Cont)

Adjust the multimeter to measure resistance.

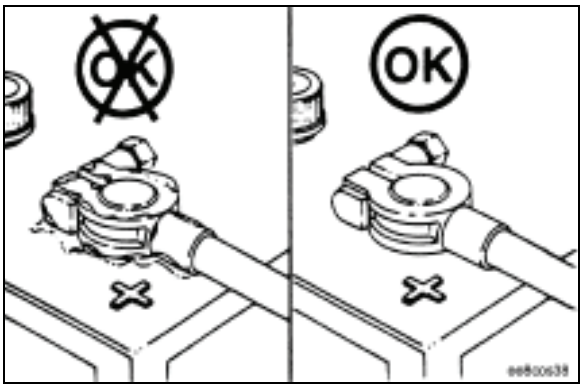
Insert one test lead into pin 29 of the OEM harness connector and connect it to the multimeter probe. Touch the other multimeter probe to the engine block ground and measure the resistance. The multimeter must show a closed circuit of 10 ohms or less.

Test pins 29, 30, 39, 40, and 50 in the same manner.

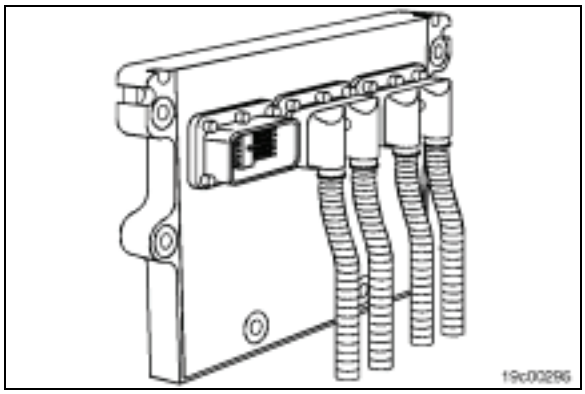


If the resistance value is not correct, check the batteries, cables, and cable connections.

Repair or replace the parts as required.

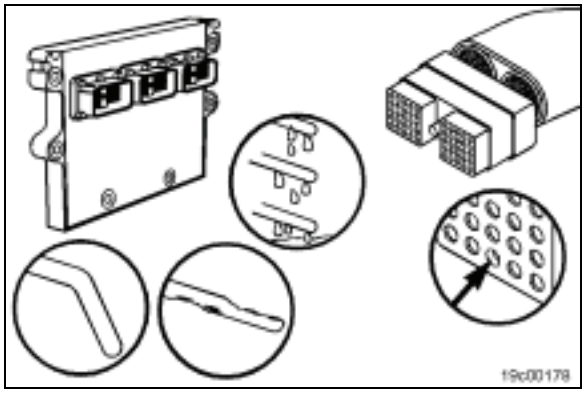


When the checks have been completed, connect the OEM harness connector to the ECM.



Unswitched Battery Supply Circuit Checks (Cont)

Check the battery return wires in the OEM harness for proper grounding. Disconnect the harness from the ECM. Check for damaged pins in the ECM and the harness.



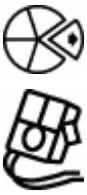
Voltage Check

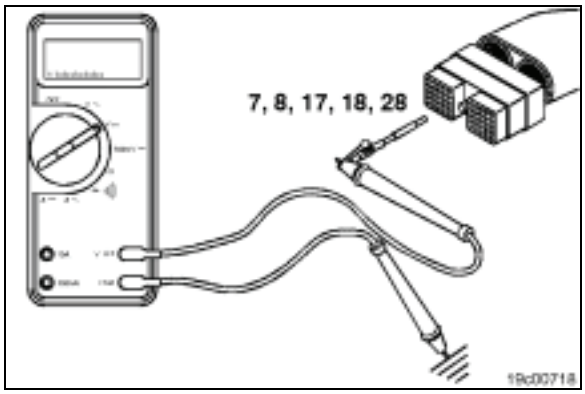
Check the battery voltage supply at the 50-pin OEM harness connector.

Turn the keyswitch to the OFF position. Disconnect the 50-pin OEM harness connector from the ECM. Set the multimeter to measure VDC.

Measure the voltage from pin 7 of the OEM harness connector to ground. Repeat the voltage check from pin 8, 17, 18, and 28.

The voltage must read battery voltage at pin 7, 8, 17, 18, and 28.





Follow-Up

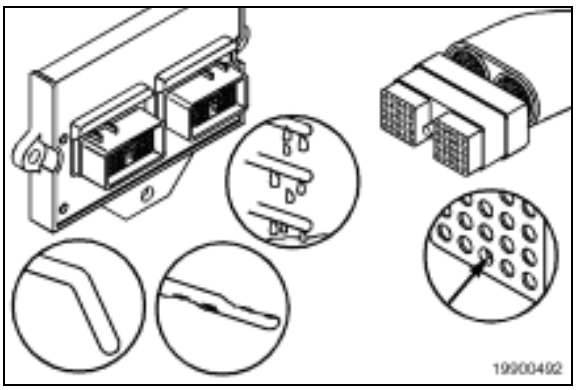
Oil Pressure/Temperature Sensor Checks

Prepare

Resistance Check

The lubricating oil pressure sensor circuit is the +5-VDC supply wire (pin 10) signal wire (pin 33), and the return wire (pin 19) in the sensor connector of the engine harness. Disconnect the engine harness from the ECM. Check for damaged pins.

Disconnect the lubricating oil pressure sensor from the engine harness.

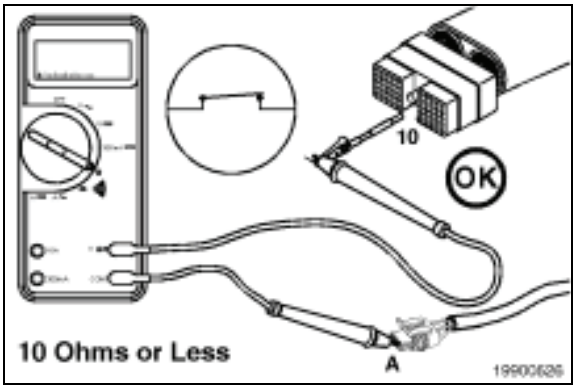


+5-VDC Supply Resistance – Checking

CAUTION

Do not use probes or leads other than Part No. 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins of the connector.

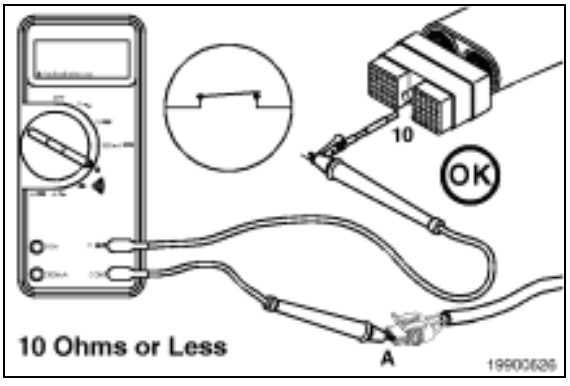
Insert the test lead into pin 10 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to pin A of the lubricating oil pressure sensor connector, harness side.



Measure the resistance.

The multimeter must show a closed circuit (10 ohms or less).

If more than 10 ohms are measured, there is an open circuit in the +5-VDC supply wire. Repair the wire, or replace the harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



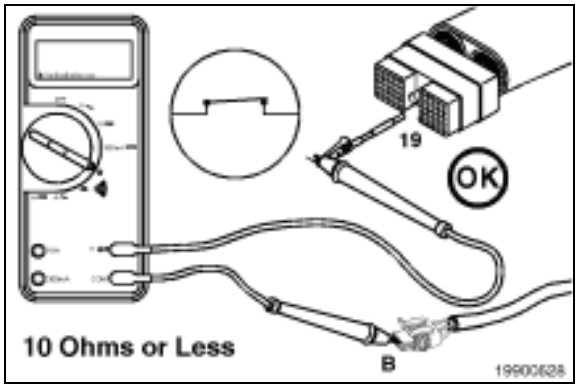
Oil Pressure/Temperature Sensor Checks (Cont)

Return Wire Resistance - Checking

CAUTION

Do not use probes or leads other than Part No. 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins of the connector.

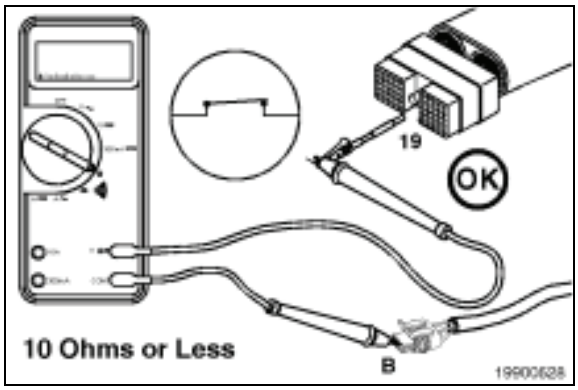
Insert the test lead into pin 19 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to pin B of the lubricating oil pressure sensor connector, harness side.



Measure the resistance.

The multimeter must show a closed circuit (10 ohms or less).

If more than 10 ohms are measured, there is an open circuit in the return wire. Repair the wire, or replace the harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Oil Pressure/Temperature Sensor Checks (Cont)

Signal Wire Resistance – Checking

Insert the pin of a lead into pin 33 of the engine harness connector.

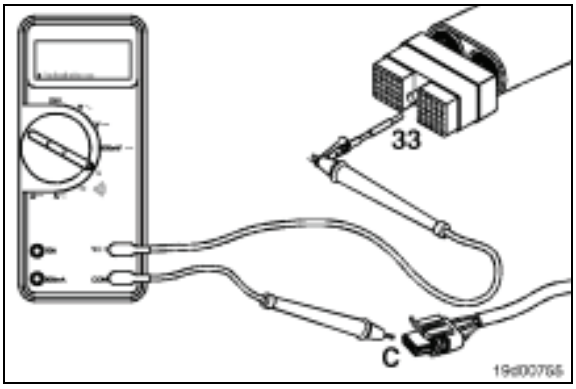
Connect the alligator clip to the multimeter probe.

Touch the other multimeter probe to pin C of the sensor connector, harness side.

Measure the resistance.

The multimeter must show a closed circuit (10 ohms or less).

If more than 10 ohms are measured, there is an open circuit in the signal wire. Repair the signal wire, or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



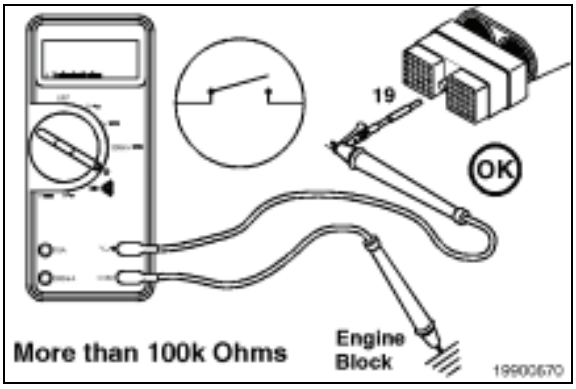
Check for Short Circuit to Ground

Return Wire Short - Checking

Disconnect the lubricating oil sensor from the wiring harness.

Disconnect the engine harness from the ECM.

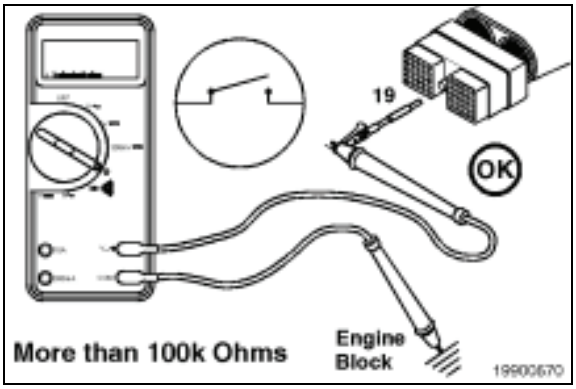
Insert the test lead into pin 19 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to engine block.



Measure the resistance.

The multimeter must show an open circuit (more than 100k ohms).

If the circuit is not open, there is a short circuit to ground in the return wire. Repair the wire, or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.

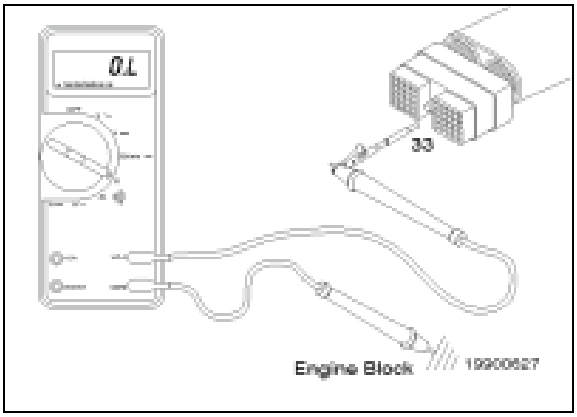


Oil Pressure/Temperature Sensor Checks (Cont)

Signal Wire Short – Checking

Insert the test lead into pin 33 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to engine block.

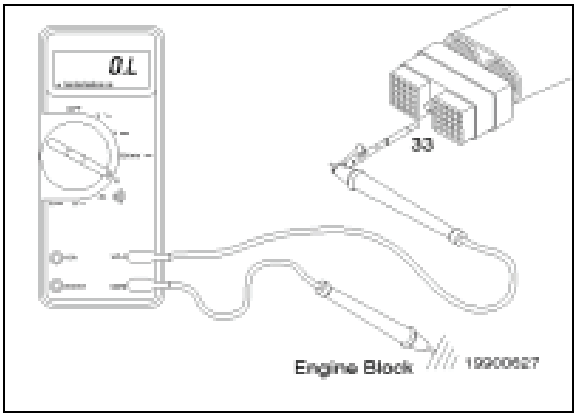
Make sure the intake air temperature sensor is disconnected from the engine harness.



Measure the resistance.

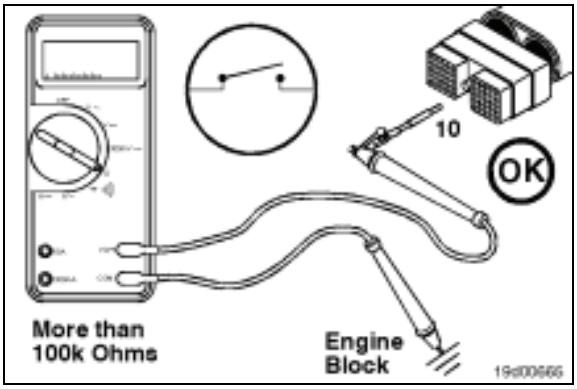
The multimeter must show an open circuit (more than 100k ohms).

If the circuit is not open, there is a short circuit to ground in the signal wire. Repair the wire, or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



+5 VDC Supply Wire Short – Checking

Insert the test lead into pin 10 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to engine block.

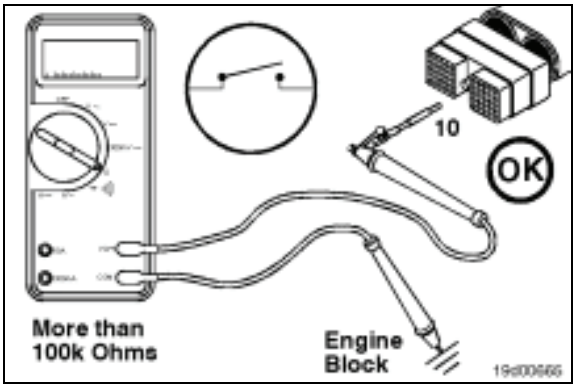


Oil Pressure/Temperature Sensor Checks (Cont)

Measure the resistance.

The multimeter must show an open circuit (more than 100k ohms).

If the circuit is not open, there is a short circuit to ground in the return wire. Repair the wire, or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



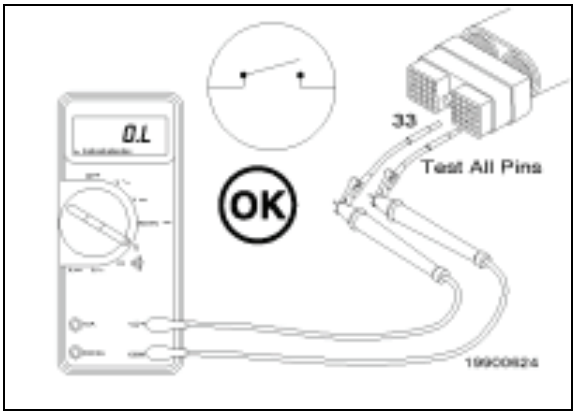
Check for Short Circuit from Pin to Pin

Signal Wire Short - Checking

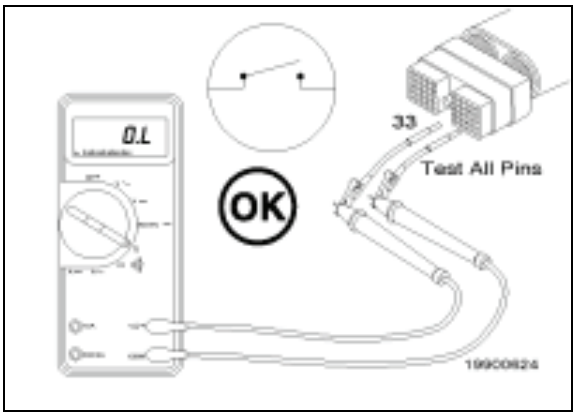
Disconnect the lubricating oil sensor from the engine harness.

Disconnect the engine harness from the ECM.

Insert the test lead into pin 33. Insert the other lead into all other pins in the engine harness connector. Connect the alligator clips to the multimeter probes.



Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit between the signal wire and any pin that measured a closed circuit. Repair or replace the engine harness. Refer to Procedure 019-043 in the Cummins Engine Trouble Shooting and Repair manual, ISB/QSB/QSB Engines, Bulletin No. 3666193.



Follow-Up

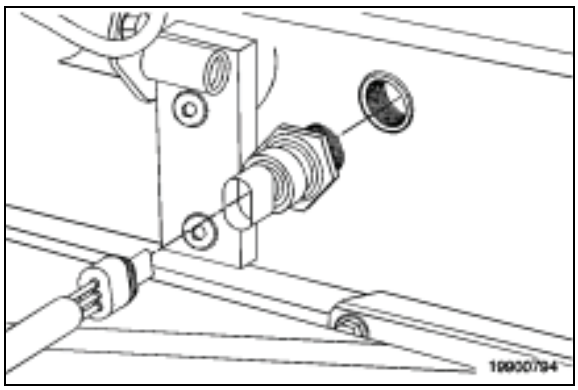
Oil Pressure Sensor Removal/Installation

Prepare

Remove

Disconnect the lubricating oil pressure sensor from the engine harness.

Remove the oil pressure sensor.

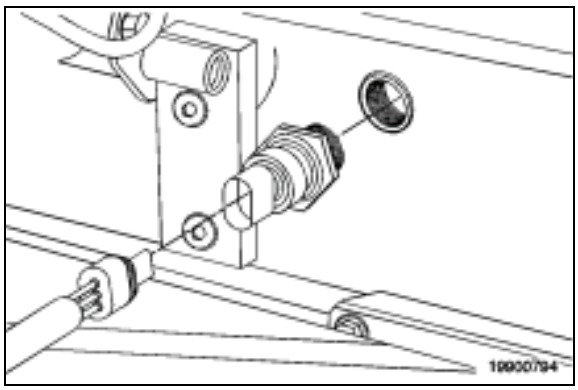


Install

Check to make sure that the sensor has an o-ring. Install the sensor.

Torque Value: 11 N•m [97 in-lb]

Connect the oil pressure sensor to the engine harness. A click will be heard when the connector locks in place.



Follow-Up

Engine Datalink Information

General Information

Cummins Inc. produces many engines today that are electronically controlled. These engines have special diagnostic requirements because of the ECM in the system. To interface with these ECMs, electronic service tools have been developed such as INSITE™. INSITE™ interfaces with the electronic engines by means of a datalink. A datalink provides a physical means for transmitting and sorting electric signals. A datalink consists of special electronic circuitry and electrical harnesses. Connection points for electronic service tools are also part of the datalink. Datalinks are defined by standards written by the Society of Automotive Engineers (SAE). Cummins Inc. uses two such standards for electronic service tools. One is a combination of SAE J1587/SAE J1708 and the other is SAE J1939. Engines can support one or both of these datalink standards.

Refer to the INSITE™ release note Compatibility Table for product/datalink/software compatibilities.

The SAE J1939 datalink is preferred, when available, for transferring calibrations. This is due to less interference from other datalink devices such as antilock braking systems, electronic dashes, communication systems, and so forth.

The power shutdown devices on some chassis have caused the power to be shut off to the cab or helm and the datalink connector when battery voltage drops below system battery voltage specifications. If datalink power is lost during a calibration download, remove the ECM from battery power for two minutes and connect a battery charger to the batteries to reduce the possibility of the shutdown device becoming active again. The ECM will need to be recalibrated. If power is lost during the change of features and parameters, a footprint will occur in the module, and the ECM will need to be recalibrated with a battery charger connected to the batteries.

Engine Specific Information

For CELECT™ Plus, the Original Equipment Manufacturer (OEM) disable cable, Part Number 3163261, can be attached to the engine datalink in addition to the normal cables and INLINE™ datalink adapters that are used.

For ISM and ISX 2002 engines, the communication light on the datalink adapters will not blink until communication with INSITE™ has been initiated.

For B5.9G, B5.9LPG, C8.3G, and L10G engines, INLINE™ I and INLINE™ II will not work correctly. INLINE™ kit, Part Number 3163099, is required.

OEM Specific Information

Kenworth and Freightliner have units with 3-pin SAE J1939 Deutsch plugs on the OEM harness but there is no backbone supplied in the harness (i.e. no terminating resistors). A gender changer cable, Part Number 3163697, must be hooked up to the minibackbone cable, Part Number 3163096, to establish communication.

Datalink Adapters

A datalink adapter is a device that converts the SAE J1587/SAE J1708 or the SAE J1939 datalink messages from the ECM into a message that a personal computer can understand. Because INSITE™ is a personal computer-based tool, a datalink adapter is required to troubleshoot engines.

Cummins Engines' service products offer multiple datalink adapter kits. Refer to the INLINE™ adapter kit part number and service tool instruction sheet for kit contents.

Engine Datalink Information (Cont)

Description	Adapter Kit Part Number	Service Tool Instruction Sheet Part Number
INLINE™	3163099	3377728
INLINE™ I	3163682	3377845
INLINE™ II	3163094	3377728

INLINE™

INLINE™ adapters that communicate on both SAE J1587/SAE J1708 and SAE J1939 attempt to communicate with the SAE J1939 datalink first. If no signal is present for the SAE J1939 datalink, the adapter will attempt to communicate via the SAE J1587/SAE J1708 datalink. Be sure INSITE™ has the proper datalink type selected.

INLINE™ I

In Windows 95, if the system has just been restarted, the power light on the INLINE™ I adapter will not illuminate until the COM port has been initialized. This can be done by running either HyperTerminal or the software that will be used to communicate with the ECM. The light will remain illuminated after initialization and exiting the software.

Power for the INLINE™ I adapter is provided by the personal computer. You must use a fully populated DB9F-DB9M communications cable, Part Number 3162850, from the personal computer to the datalink adapter.

The indicator light on the INLINE™ I adapter performs two functions:

Indicates power is being supplied to the INLINE™ I adapter when the LED is illuminated.

An illuminated, blinking LED indicates that INLINE™ I adapter has power, the adapter is connected to an ECM, the keyswitch is in the ON position, and data is being broadcasted on the datalink.

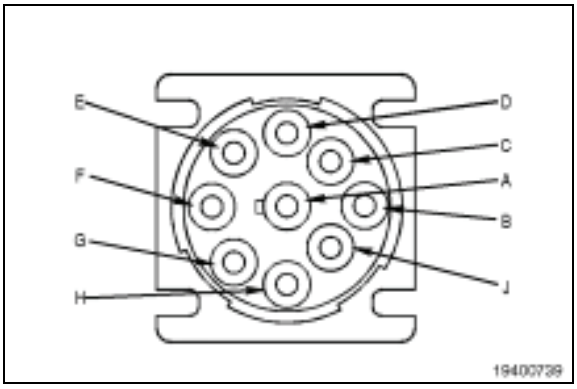
INLINE™ II

The INLINE™ II adapter has software within the adapter that may need to be updated periodically. The software is referred to as Firmware. When a new Firmware version is available, it will be distributed on the INCAL™ CD ROM. Refer to the instruction with the CD ROM to download the new Firmware version into the INLINE™ II.

Engine Datalink Information (Cont)

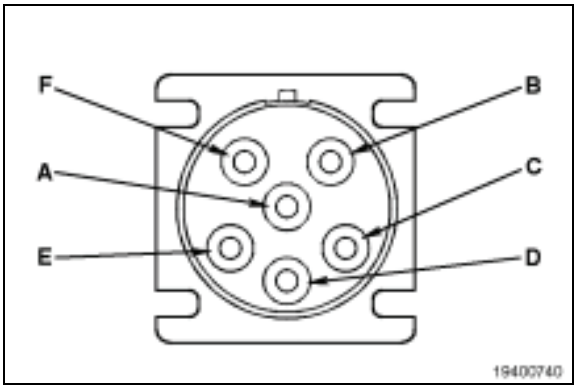
Datalink Connectors

The recommended datalink connector for Cummins engines is a 9-pin Deutsch connector, Part Number 3824018. This connector can supply SAE J1587/SAE 1708 and SAE J1939 communications, and battery voltage. The following are pin-outs for the 9-pin connector:



Pin	Signal	Pin	Signal
A	Ground	F	J1708 datalink (+)
B	Unswitched Battery	G	J1708 datalink (-)
C	J1939 datalink (+)	H	Open
D	J1939 datalink (-)	J	Open
E	J1939 datalink (shield) (not applicable for Marine)		

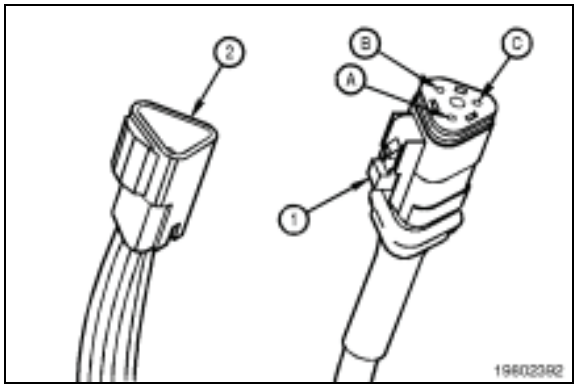
The 6-pin Deutsch connector, Part Number 3824805, is found on many engines. This connector supplies SAE J1587/SAE J1708, as well as the battery voltage. The following are pin-outs for the 6-pin connector:



Pin	Signal	Pin	Signal
A	J1708 datalink (+)	E	Ground
B	J1708 datalink (-)	F	Open
C	Unswitched battery (+)		
D	Open		

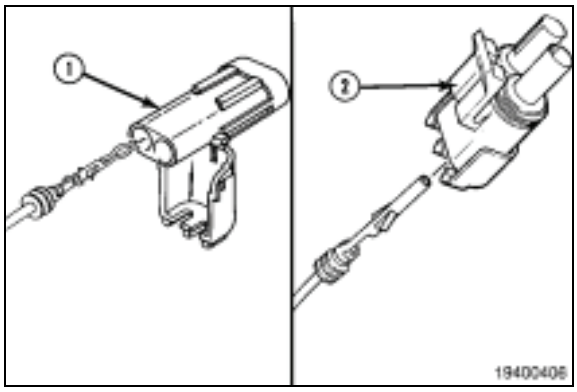
Engine Datalink Information (Cont)

The 3-pin SAE J1939 Deutsch connectors are also found on Cummins engines. Two possible types of 3-pin connectors can be present: A 3-pin plug (1), Part Number 3824288; and a 3-pin receptacle (2), Part Number 3284290. The 3-pin connectors only supply the Society Automotive Engineers (SAE) J1939 support (no battery voltage supply). The following are the pin-outs for the 3-pin connector:



Pin	Signal
A	J1939 datalink (+)
B	J1939 datalink (-)
C	J1939 datalink (shield)

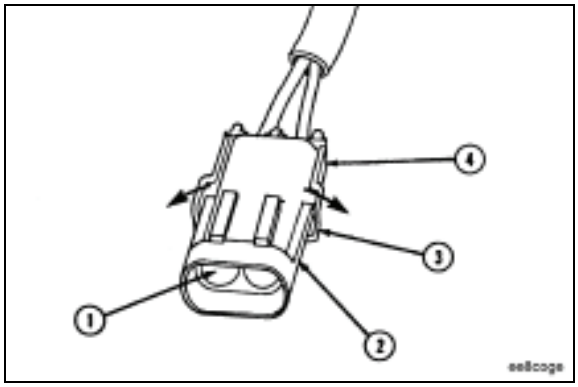
The 2-pin connector is on many older engines, it only supplies SAE J1587/J1708 support (no battery voltage supply). The following are the pin-outs for the 2-pin connector:



Pin	Signal
A	J1587/J1708 datalink (+)
B	J1587/1708 datalink (-)

Engine Datalink Information (Cont)

Some engines have a 2-pin service tool power supply Weatherpack receptacle located in the engine harness. It can be used to power up any service tool device.



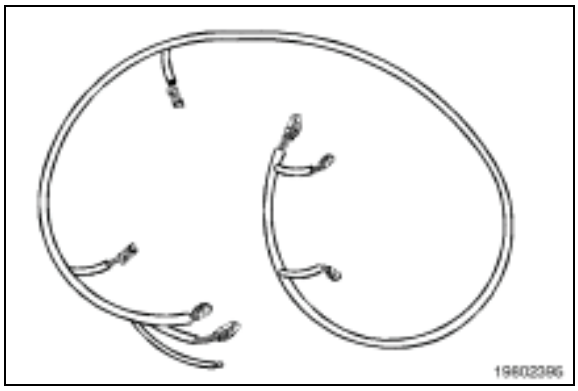
Pin	Signal
A	Unswitched battery (+)
B	Ground (-)

Connecting to an ECM

SAE J1939 has strict guidelines that must be followed for successful communication. Understanding some fundamentals about SAE J1939 will help make sure these guidelines are followed.

The main component of an SAE J1939 system is a backbone harness. The harness can be up to 40 m [131 ft] long. The backbone harness is terminated at each end with 120 ohm resistor.

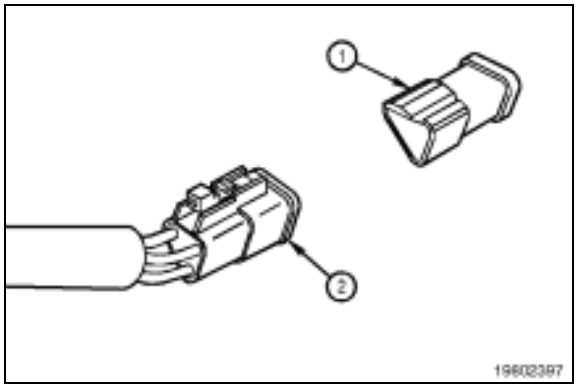
A maximum of 30 different devices can be attached to the SAE J1939 backbone at once. Each device, such as the INLINE™ II datalink adapter, is connected to the backbone through a stub which can be up to one meter in length. The stub connector is a 3-pin plug.



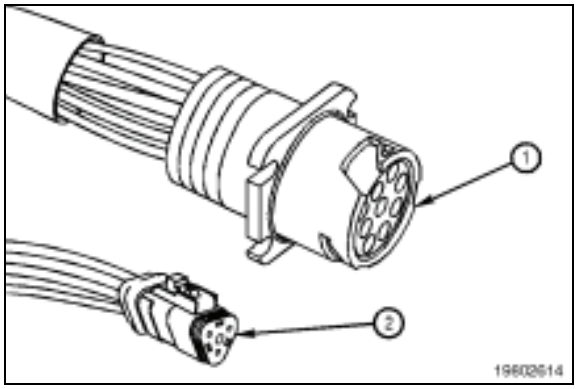
Engine Datalink Information (Cont)

The terminating resistor caps (1) must be in place on the backbone harness plugs (2) to maintain proper communication. Each resistor is 120 ohms and is located in a removable cap. This resistance is required when communicating with INSITE™ over the J1939 datalink.

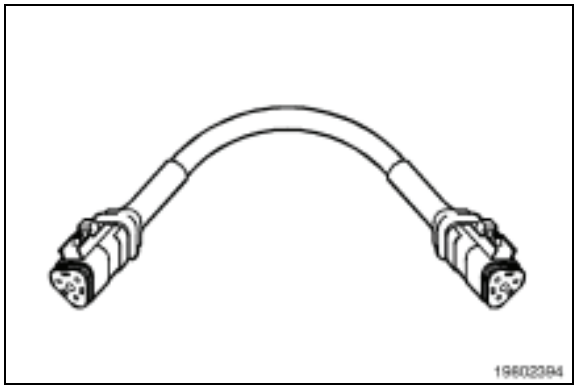
Often the Original Equipment Manufacturer (OEM) of a particular piece of equipment, not the engine manufacturer, supplies the datalink harnessing. Because of this, different levels of SAE J1939 implementation can be present.



Some OEMs will choose to provide a complete SAE J1939 backbone harness. If this is supplied, connection to INSITE™ is accomplished either by a 9-pin datalink connector (1), Part Number 3824018, or a 3-pin plug (2), Part Number 3824288.



If the OEM does not supply the J1939 backbone harness, the only SAE J1939 connector on the engine is the 3-pin receptacle, Part Number 3824290. To utilize SAE J1939 on engines with this configuration, a minibackbone harness must be added. The Cummins INLINE™ II adapter kit, Part Number 3163682, supplies a minibackbone harness, Part Number 3163096.



Engine Datalink Information (Cont)

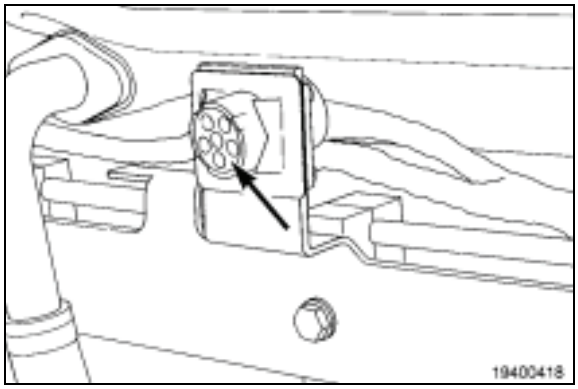
Look for a 6-pin datalink connector in the cab or helm of the vessel.

The 6-pin connector supports the SAE J1587/SAE 1708 datalink only. Use INLINE™ cable, Part Number 3824439, when connecting to the 6-pin connector.

Any INLINE™ cable can be used in conjunction with this connector. When connecting the INLINE™ datalink adapter to the personal computer (PC), use the 9-pin serial cable, Part Number 3162850. This cable is connected between the PC and the datalink adapter.

Select the appropriate settings in INSITE™ to set the appropriate communication port and datalink adapter. Refer to the INSITE™ User's Manual.

For CELECT™ Plus engines, do not use the in-cab 6-pin datalink connector to calibrate the ECM. Use the datalink connector found on the engine.

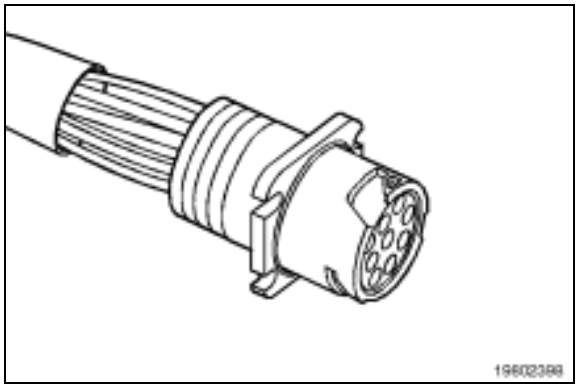


Look for a 9-pin datalink connector in the cab or helm of the vessel.

The 9-pin datalink connector supports both the SAE J1587/SAE J1708 and the SAE J1939 datalinks. Any INLINE™ datalink adapter can be used in conjunction with this connector. Use INLINE™ cable, Part Number 3162848, when connecting to the 9-pin connector.

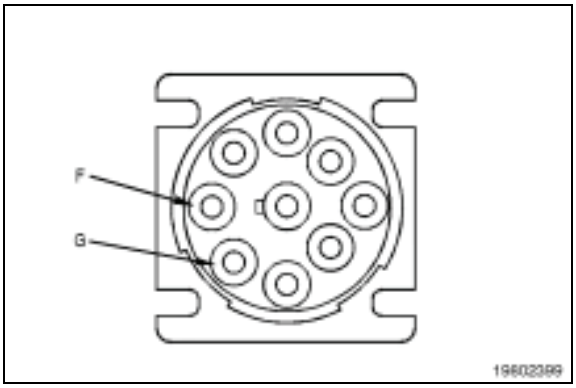
When connecting the INLINE™ datalink adapter to the PC, use the 9-pin serial cable, Part Number 3162850. This cable is connected between the PC and the datalink adapter.

Select the appropriate setting in INSITE™ to set the appropriate communication port and datalink adapter. Refer to the INSITE™ User's Manual.



Engine Datalink Information (Cont)

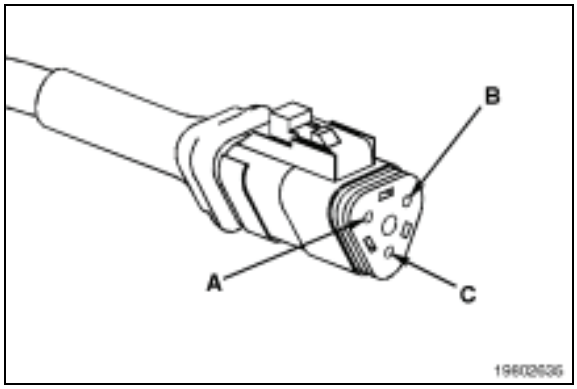
To use the INLINE™ or INLINE™ I with the 9-pin connector, verify that pins F and G are populated. If pins F and G are not populated you must use an INLINE™ II and communicate via the SAE J1939 datalink.



Look for a 3-pin datalink plug connector or receptacle connector on the vessel.

The 3-pin datalink connector only supports the SAE J 1939 datalink. Use the INLINE™ II cable, Part Number 3162847, when connecting the 3-pin plug connector.

A J1939 backbone harness is present on the system when a resistance of 60 ohms is measured between pins A and B of the 3-pin plug connector.



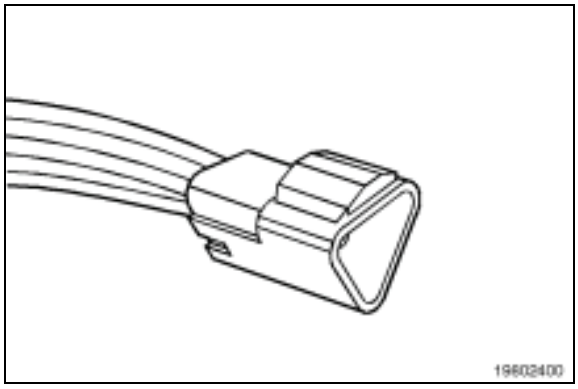
Engine Datalink Information (Cont)

On an ISB/QSB/QSB (non-Dodge Ram), an ISC, or an ISL engine, the 3-pin receptacle connector is located approximately six inches from the ECM or next to the 23-pin OEM connector.

On B Gas Plus, B LPG Plus, and C Gas Plus engines, the 3-pin SAE J1939 Deutsch receptacle, Part Number 3284290 is located near the OEM interface connectors. This connector is the OEM connection point for SAE J1939 devices and can also be used for INSITE™ communication. A minibackbone harness, Part Number 3163096, is required for direct INSITE™ communication.

On an ISM or ISX Engine (prior to October 2002) the 3-pin receptacle is an OEM option. If the OEM has supplied a 3-pin receptacle connector, Part Number 3824290, for communications, it will be located in the OEM harness within 0.66 m [2.16 ft] of the ECM.

On an ISB/QSB/QSB in a Dodge Ram pickup truck, the 3-pin plug connector is located near the fuel pump on the front gear housing.

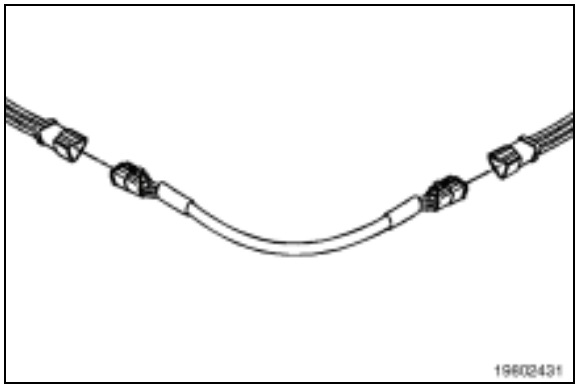


Other engines have this connector in locations chosen by the OEM.

The 3-pin connector only supports the SAE J1939 datalink.

To meet the SAE J1939 standard, the 3-pin receptacle connector must be within 0.66 m [2.16 ft] of the ECM. Use of the J1939 minibackbone harness, Part Number 3163096; and the DB25F 3-pin Deutsch, Part Number 3162847, are required for proper connection to the INLINE™ II adapter. This is used when no backbone is proven on the datalink.

NOTE: If there is 60 ohm resistance measured between pins A and B of the 3-pin connector, then a backbone is on the datalink.



Engine Datalink Information (Cont)

Possible configurations using a 9-pin connector:

In cab, SAE J1939, INLINE™ II

In cab, SAE J1708, INLINE™ II

In cab, SAE J1708, INLINE™ I

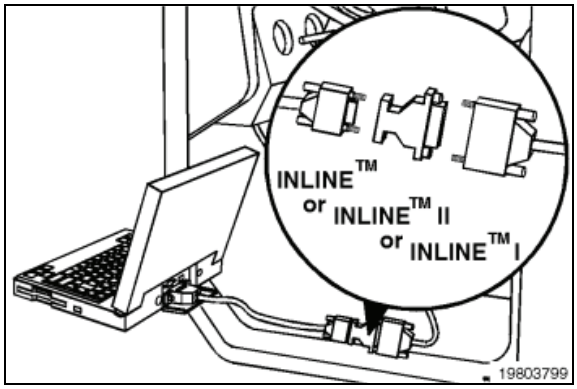
In cab, SAE J1708, INLINE™

On engine, SAE J1939, INLINE™ II

On engine, SAE J1708, INLINE™ II

On engine, SAE J1708, INLINE™ I

On engine, SAE J1708, INLINE™.



Possible configurations using a 6-pin connector:

In cab, SAE J1708, INLINE™ II

In cab, SAE J1708, INLINE™ I

In cab, SAE J1708, INLINE™

On engine, SAE J1708, INLINE™ II

On engine, SAE J1708, INLINE™ I

On engine, SAE J1708, INLINE™.

Configuration using a 3-pin connector:

On engine, SAE J1939, INLINE™ II.

Possible configurations using a 2-pin connector:

On engine, SAE J1708, INLINE™ II

On engine, SAE J1708, INLINE™ I

On engine, SAE J1708, INLINE™.

Primary ECM (A) Switch Initial Check

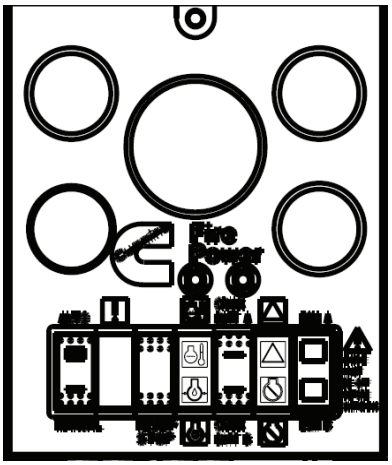
Prepare

Initial Check

Turn the switch to the ON position while monitoring the fault lamps. The fault lamps must illuminate for 2 to 3 seconds.

If lamps do not illuminate, check for burned-out bulbs.

Need a better illustration here

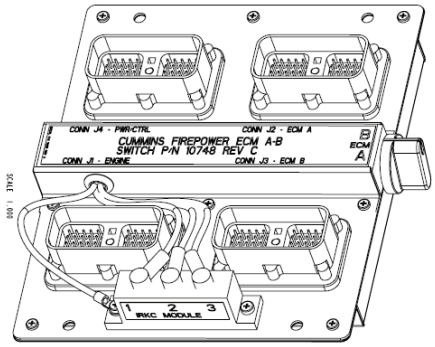


Turn the switch to the OFF position.

Connect an electronic service tool to the datalink.

Turn the switch to the ON position.

Select the monitor mode on the electronic service tool. The electronic service tool must be able to communicate with ECM. If the ECM will not communicate with the service tool, see the Communication Error - Electronic Service Tool or Control Device symptom tree.



Follow-Up

Secondary ECM (B) Switch Initial Check

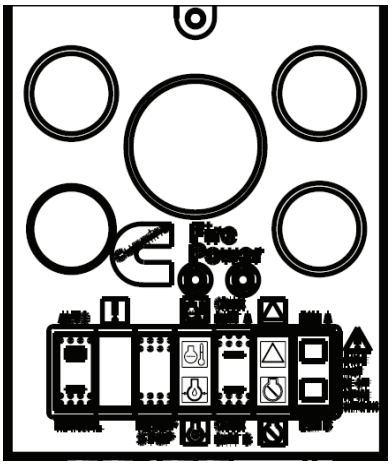
Prepare

Initial Check

Turn the switch to the ON position while monitoring the fault lamps. The fault lamps must illuminate for 2 to 3 seconds.

If lamps do not illuminate, check for burned-out bulbs.

Need a better illustration here

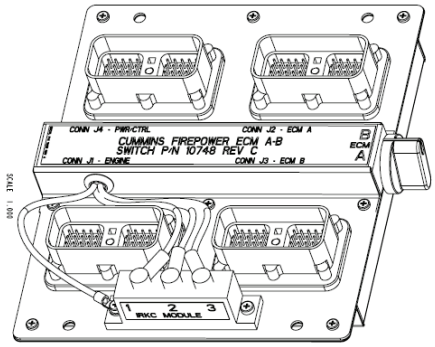


Turn the switch to the OFF position.

Connect an electronic service tool to the vehicle datalink.

Turn the switch to the ON position.

Select the monitor mode on the electronic service tool. The electronic service tool must be able to communicate with ECM. If the ECM will not communicate with the service tool, see the Communication Error - Electronic Service Tool or Control Device symptom tree.



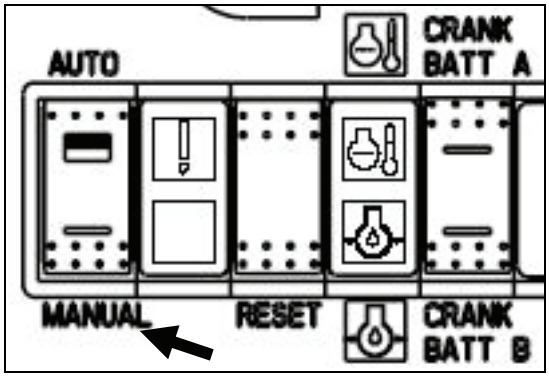
Follow-Up

ECM Switch Printed Circuit Board Removal/Installation

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

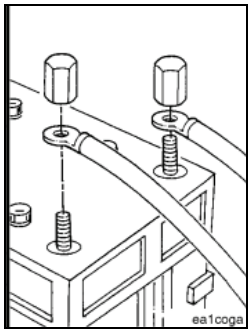


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

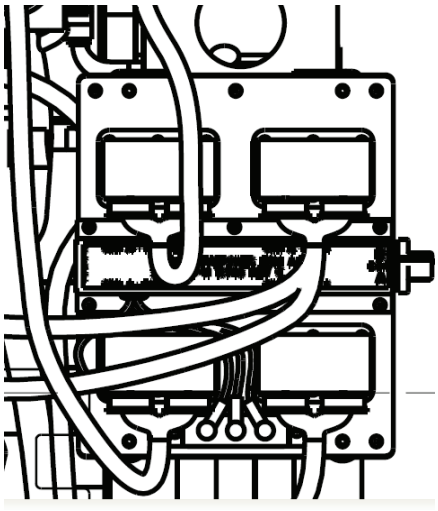
Next, disconnect both batteries at their terminals.



Remove the 4 selector switch harness connectors from the face of the selector switch. Remove connectors which are plugged into the switch using a 5/32” hex-head wrench. Each connector is keyed differently from the other three, so they cannot be accidentally connected to the wrong plug.

With the connectors removed from the ECM Selector Switch, remove the four bolts that secure it to the engine frame.

Connect a new ECM Selector Switch in reverse order.



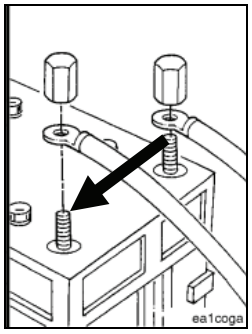
ECM Switch Printed Circuit Board Removal/Installation

Follow Up

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

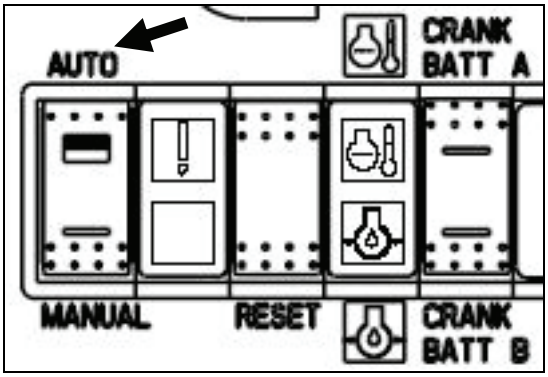
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.

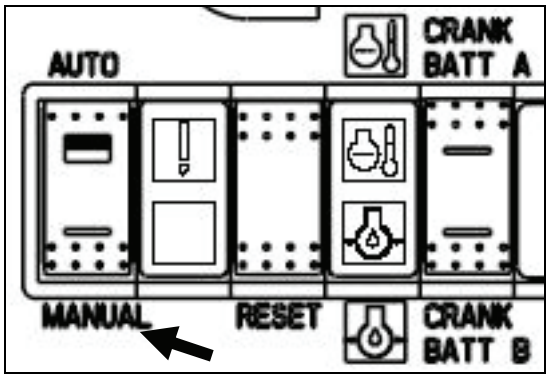


ECM A/B Switch Removal/Installation

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

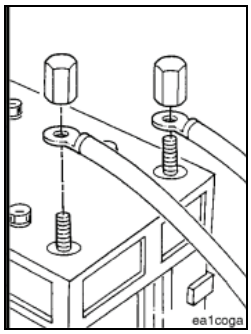


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



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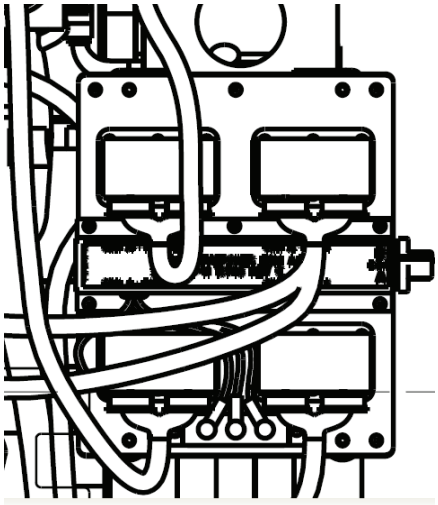
With the connectors removed from the ECM Selector Switch, remove the four bolts that secure it to the engine frame.

Connect a new ECM Selector Switch in reverse order.

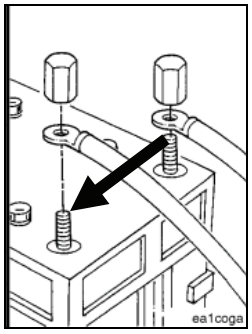


ECM Switch Printed Circuit Board Removal/Installation

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

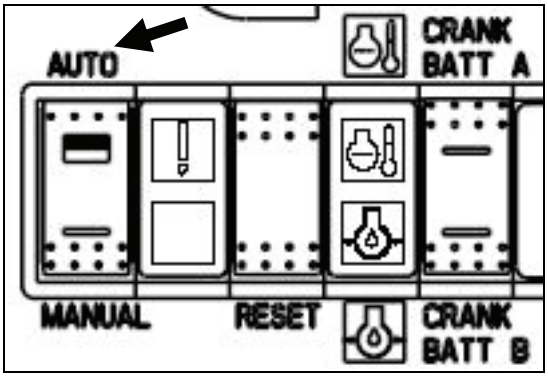
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.

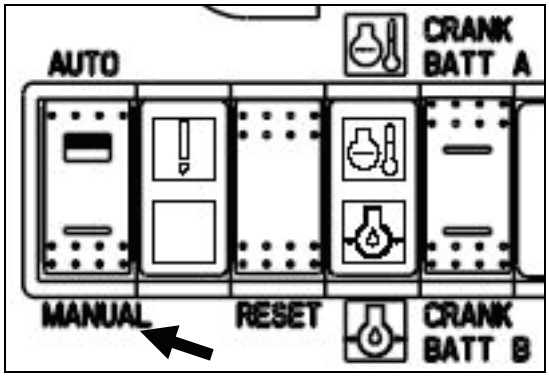


ECM Selector Switch Harness Removal/Installation

Prepare

Place the fire protection system in a safe mode for engine service.

Place the AUTO/MANUAL rocker switch in the MANUAL position.

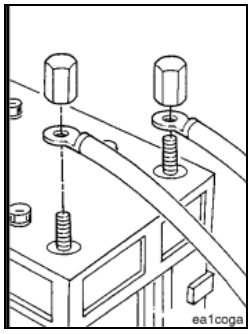


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

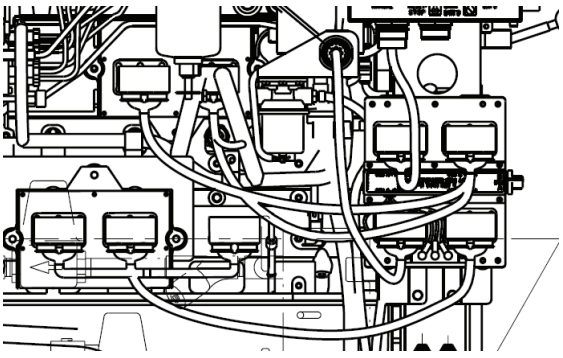
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



There are four individual harnesses that connect to the ECM Selector Switch. Each can be individually removed and replaced by removing the appropriate plug. (A 5/32” hex-head wrench will be required for the 50-pin connectors.)

Reconnect Harness connectors up in reverse order.



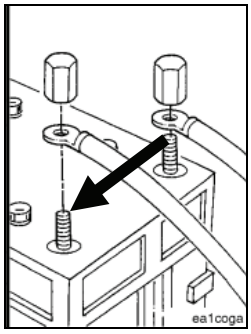
ECM Selector Switch Harness Removal/Installation (Cont)

Follow Up

For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

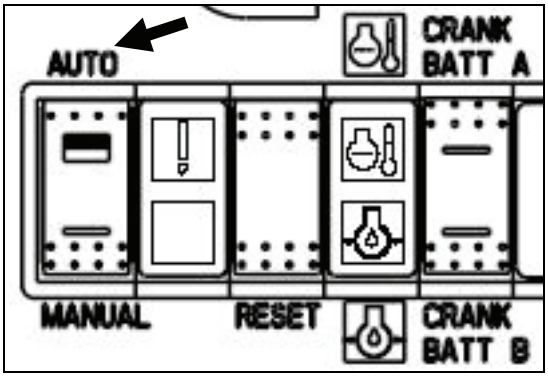
Wear safety glasses when reconnecting batteries!

Reconnect the batteries at their terminals after all service work has been completed.



Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system to operating status.



Redundant ECM Wiring Harness Removal/Installation

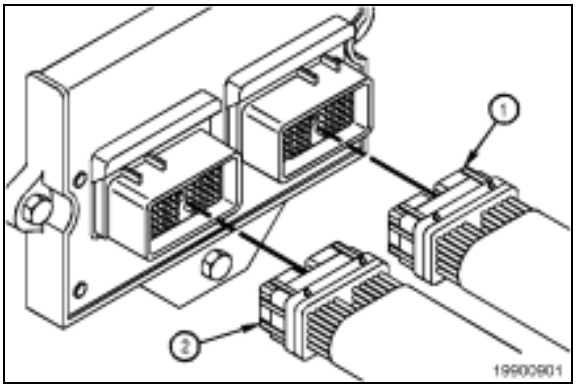
Prepare

General Information

The ISB/QSB/QSB/QSB engine uses two separate wiring harnesses to control the engine and some of the vehicle operations.

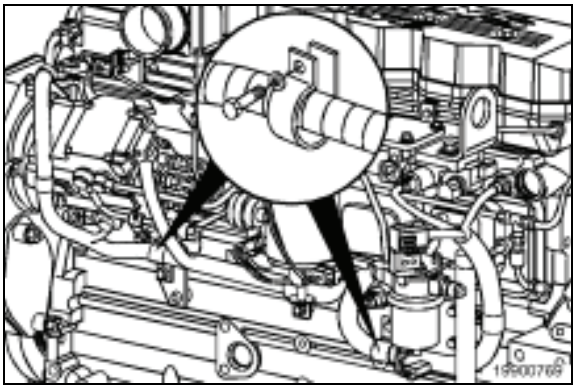
Engine Harness

OEM Harness.

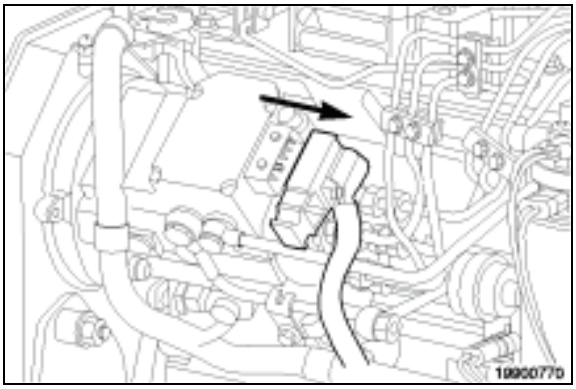


Remove

Remove the harness clamps from the support bracket of the engine block.

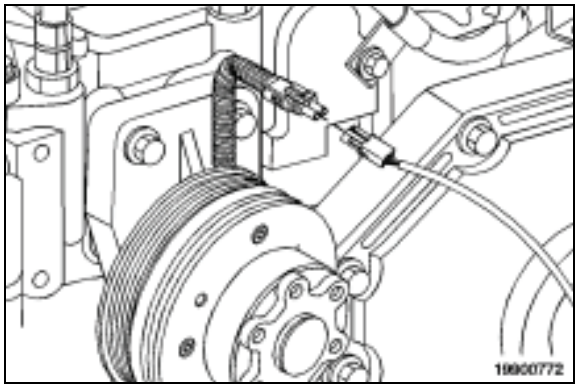


Disconnect the 9-pin AMP connector from the fuel pump.

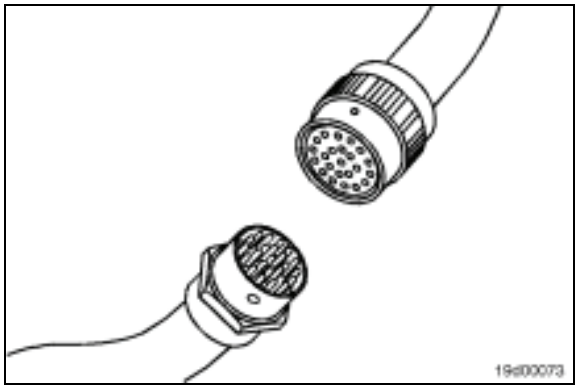


ECM Selector Switch Harness Removal/Installation (Cont)

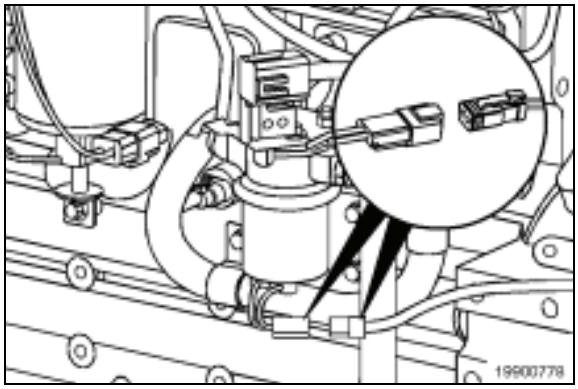
Disconnect the fan clutch control wire, if used, from the engine harness.



Disconnect the 23-pin OEM interface connector.



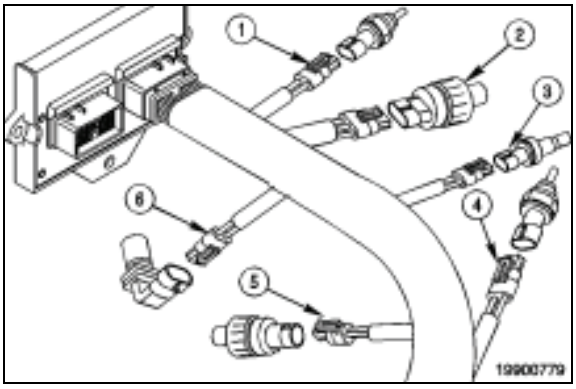
Disconnect the fuel lift pump connector.



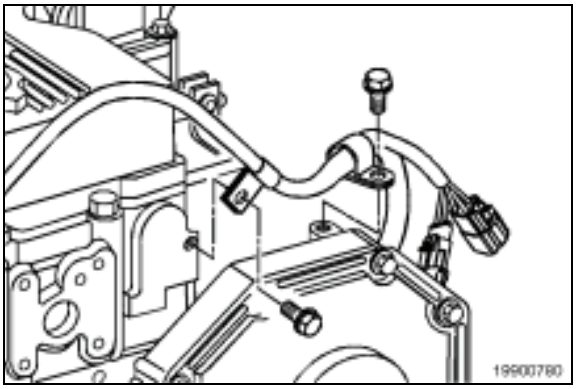
ECM Selector Switch Harness Removal/Installation (Cont)

Disconnect the harness from the following sensors:

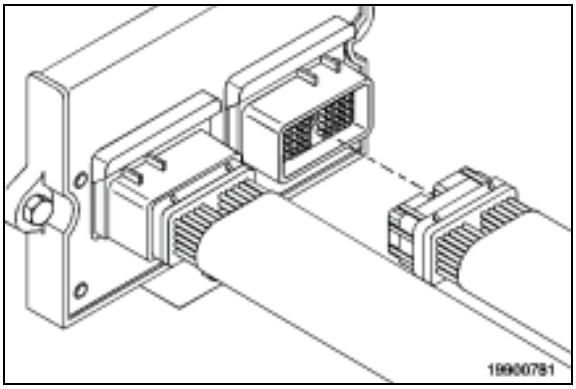
- Engine Coolant Temperature Sensor
- Oil Pressure Sensor
- Engine Position Sensor
- Intake Manifold Temperature Sensor
- Intake Manifold Pressure Sensor
- Engine Speed Sensor



Disconnect the datalink connector from its bracket.



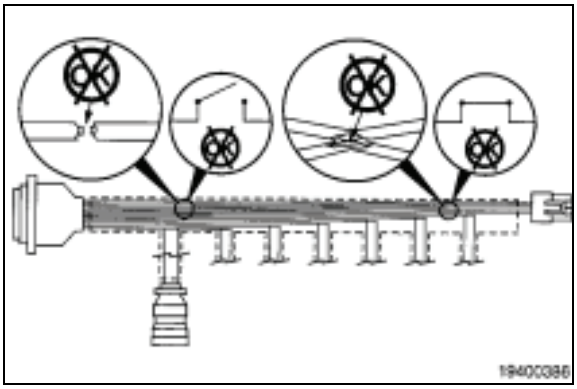
Disconnect the engine harness from the ECM.



ECM Selector Switch Harness Removal/Installation (Cont)

Inspect for Reuse

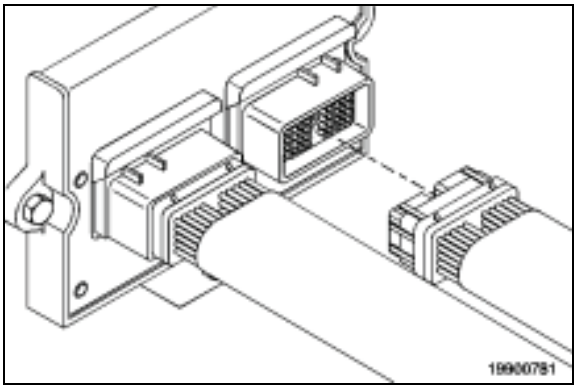
Replace or repair the engine harness if there is an open circuit or a short circuit found under the protective covering of the harness body.



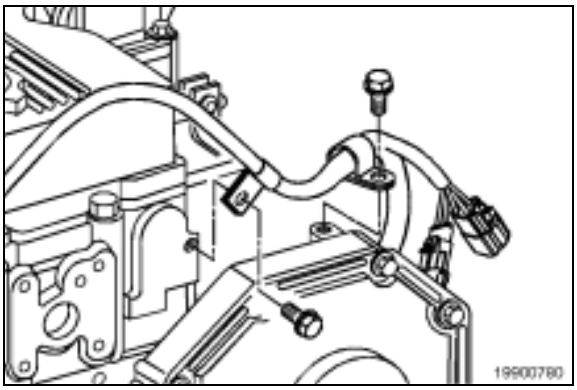
Install

Connect the engine harness to the ECM.

Torque Value: 2.8 N•m [25 in-lb]



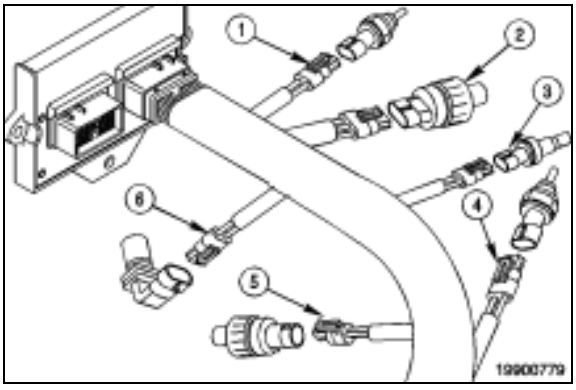
Connect the datalink connector to its bracket.



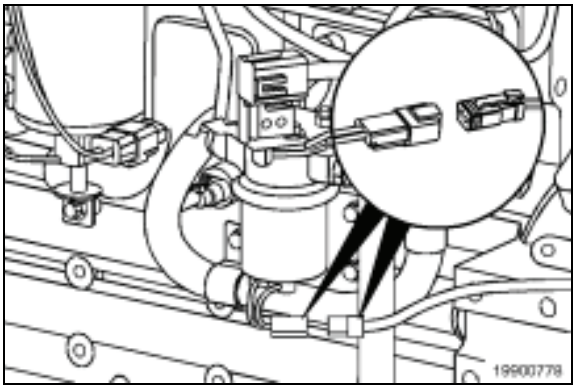
ECM Selector Switch Harness Removal/Installation (Cont)

Connect the harness to the following sensors:

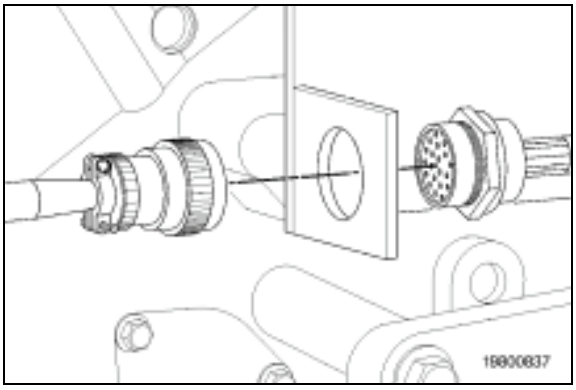
- Engine Coolant Temperature Sensor
- Oil Pressure Sensor
- Engine Position Sensor
- Intake Manifold Temperature Sensor
- Intake Manifold Pressure Sensor
- Engine Speed Sensor



Connect the fuel lift pump connector.

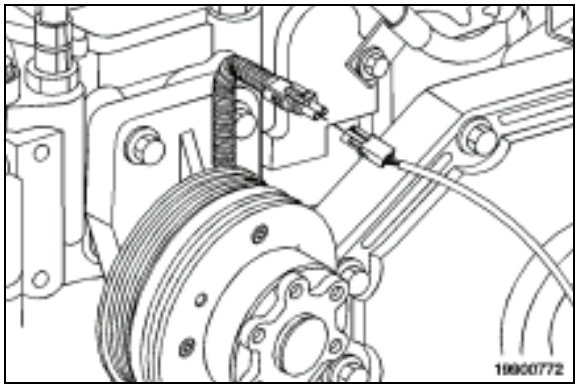


Connect the 23-pin OEM interface connector.

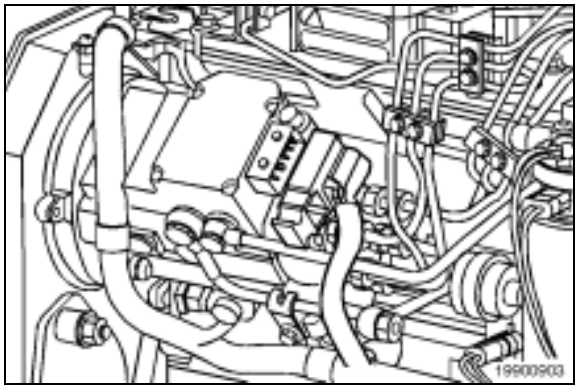


ECM Selector Switch Harness Removal/Installation (Cont)

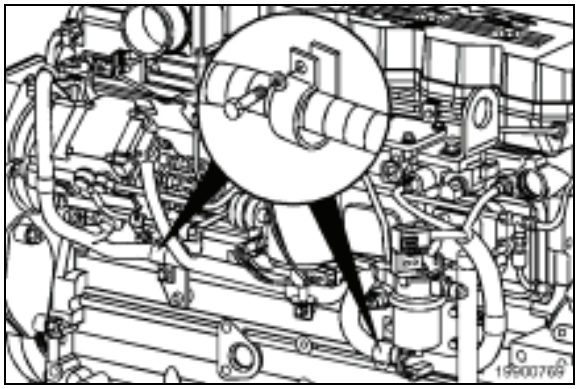
Connect the fan clutch control wire, if used, to the engine harness.



Connect the 9-pin AMP connector to the fuel pump.



Install the harness clamps that hold the engine harness to the block.



Follow-Up

Primary ECM (A) Removal/Installation

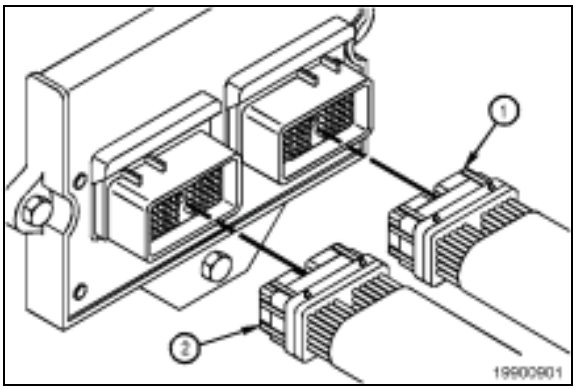
Prepare

Remove

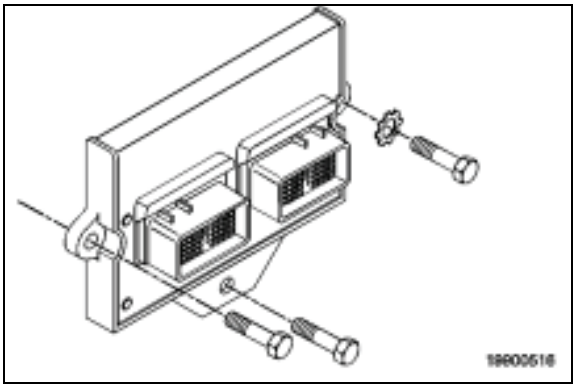
NOTE: Record all programmable parameters, features, and calibration data from the old ECM before disconnecting the harness connectors. This data will be needed to program the new ECM.

Disconnect the engine harness (1) and the OEM harness (2) connectors from the ECM, if they are not already removed.

Disconnect the engine harness (1) connector from the ECM if they are not already removed.



Remove the metric capscrews that hold the ECM to the engine block.



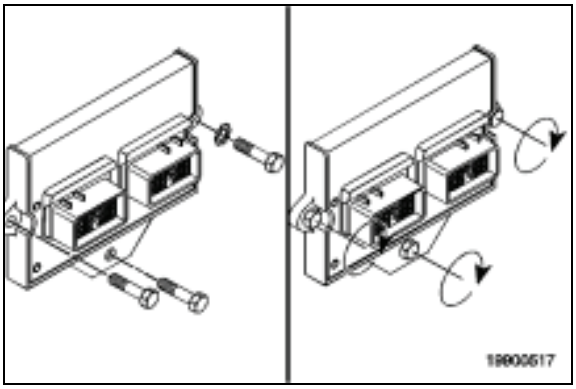
Install

CAUTION

Do not paint the backside of the ECM. Make sure no grease or dirt is between the ECM and the engine block.

Install the new ECM. Tighten the capscrews.

Torque Value: 24 N•m [18 ft-lb]

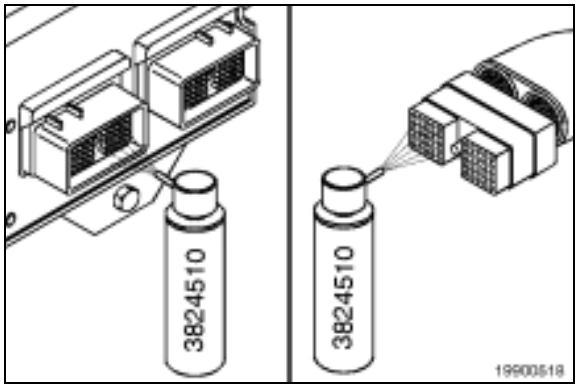


Primary ECM (A) Removal/Installation (Cont)

CAUTION

Do not blow compressed air into the ECM ports or connectors. Compressed air can contain moisture due to condensation.

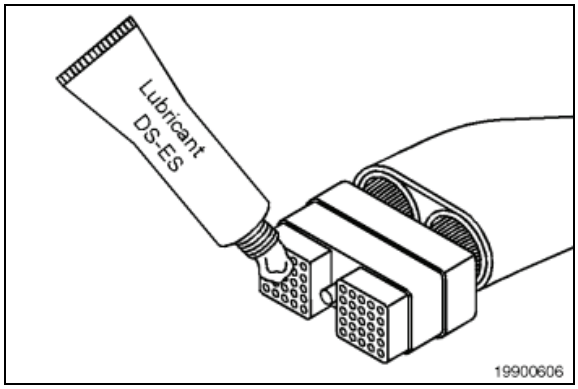
Use quick-dry electrical contact cleaner, Part No. 3824510, to remove all dirt and moisture from the ECM connector ports and the harness connectors.



CAUTION

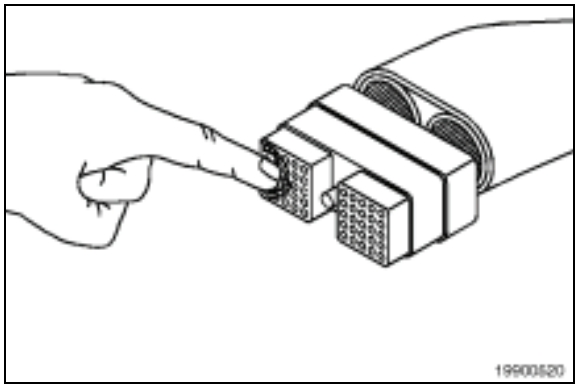
Use only Cummins-recommended lubricant DS-ES, Part No. 3822934. Other lubricants, such as lubricating oil, or grease in the connectors, can cause ECM damage, poor engine performance, or premature connector pin wear.

Apply a thin coating of lubricant to the connector nosepiece.



NOTE: Lubricant must not be visible on the surface of the nosepiece.

Spread the lubricant across the connector nosepiece so it enters every pin hole and lubricates the contacts.

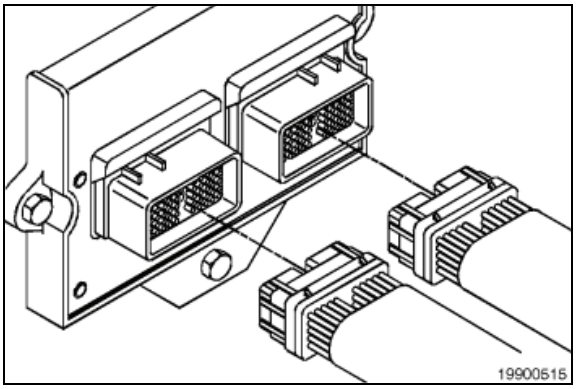


Primary ECM (A) Removal/Installation (Cont)

Connect the OEM and engine harness connectors to the ECM. Tighten the connector capscrews to the ECM.

Torque Value: 2.8 N•m [25 in-lb]

NOTE: When an ECM is replaced, the new ECM must be calibrated. Refer to Procedure 019-032.



Voltage Check

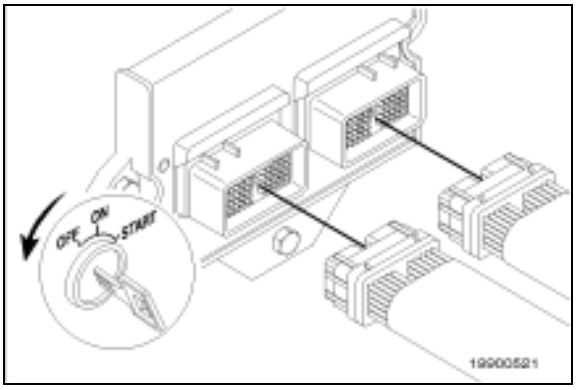
CAUTION

Do not use probes or leads other than Part No. 3822917, or the connector pins will be damaged. The lead must fit tightly in the connector without expanding the connector pins.

Turn the keyswitch to the OFF position.

Disconnect the OEM harness from the ECM.

Disconnect the engine harness from the ECM.

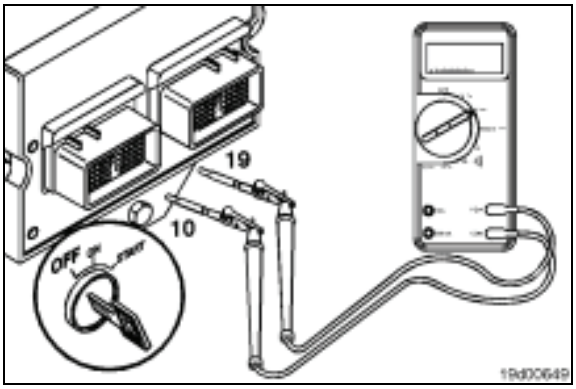


Using jumper wires, connect pins 38, 39, and 40 (battery supply) from the engine harness to the ECM.

Using jumper wires, connect pins 20, 28, and 29 (battery return) from the engine harness to the ECM.

Connect a test lead to pin 10 of the ECM engine connector and the positive (+) probe of the multimeter.

Connect the other lead to pin 19 of the ECM engine connector and the negative (-) probe of the multimeter.

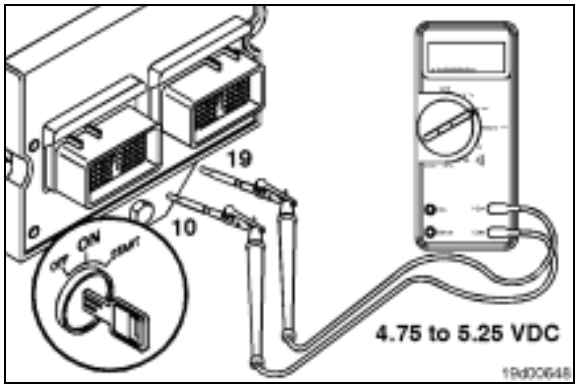


Primary ECM (A) Removal/Installation (Cont)

Turn the keyswitch to the ON position.

Measure the voltage from pin 10 to pin 19 of the ECM engine connector. The voltage must be 4.75 to 5.25 VDC.

If the voltage is not 4.75 to 5.25 VDC, replace the ECM.



Follow-Up

Secondary ECM (B) Removal/Installation

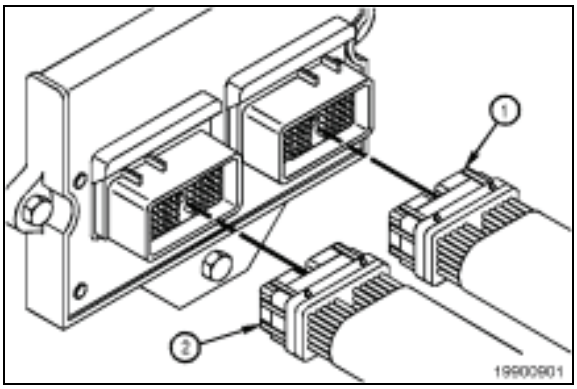
Prepare

Remove

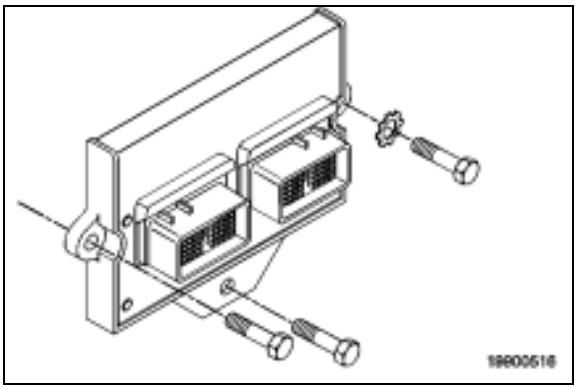
NOTE: Record all programmable parameters, features, and calibration data from the old ECM before disconnecting the harness connectors. This data will be needed to program the new ECM.

Disconnect the engine harness (1) and the OEM harness (2) connectors from the ECM, if they are not already removed.

Disconnect the engine harness (1) connector from the ECM if they are not already removed.



Remove the metric capscrews that hold the ECM to the engine block.



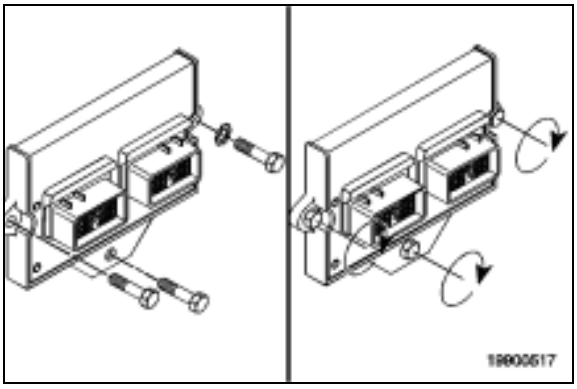
Install

CAUTION

Do not paint the backside of the ECM. Make sure no grease or dirt is between the ECM and the engine block.

Install the new ECM. Tighten the capscrews.

Torque Value: 24 N•m [18 ft-lb]

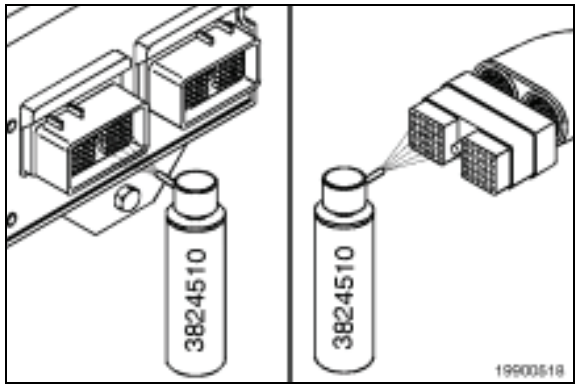


Secondary ECM (B) Removal/Installation (Cont)

CAUTION

Do not blow compressed air into the ECM ports or connectors. Compressed air can contain moisture due to condensation.

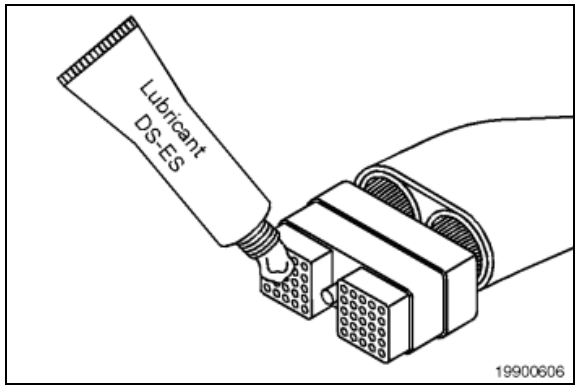
Use quick-dry electrical contact cleaner, Part No. 3824510, to remove all dirt and moisture from the ECM connector ports and the harness connectors.



CAUTION

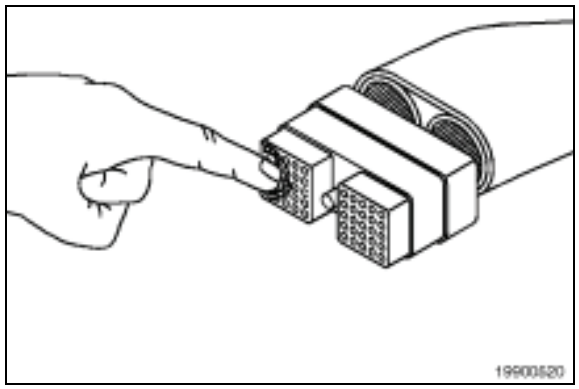
Use only Cummins-recommended lubricant DS-ES, Part No. 3822934. Other lubricants, such as lubricating oil, or grease in the connectors, can cause ECM damage, poor engine performance, or premature connector pin wear.

Apply a thin coating of lubricant to the connector nosepiece.



NOTE: Lubricant must not be visible on the surface of the nosepiece.

Spread the lubricant across the connector nosepiece so it enters every pin hole and lubricates the contacts.

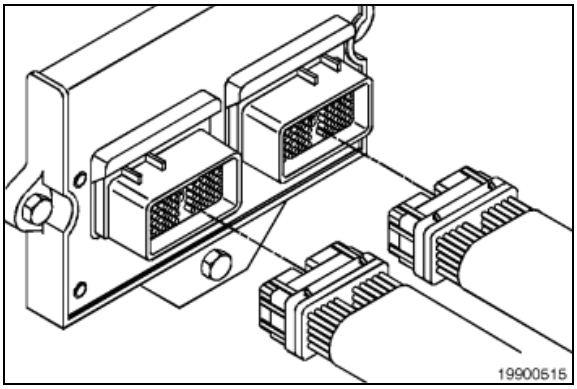


Secondary ECM (B) Removal/Installation (Cont)

Connect the OEM and engine harness connectors to the ECM. Tighten the connector capscrews to the ECM.

Torque Value: 2.8 N•m [25 in-lb]

NOTE: When an ECM is replaced, the new ECM must be calibrated. Refer to Procedure 019-032.



Voltage Check

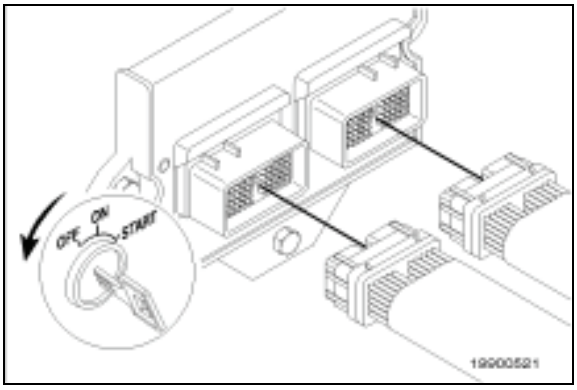
CAUTION

Do not use probes or leads other than Part No. 3822917, or the connector pins will be damaged. The lead must fit tightly in the connector without expanding the connector pins.

Turn the keyswitch to the OFF position.

Disconnect the OEM harness from the ECM.

Disconnect the engine harness from the ECM.

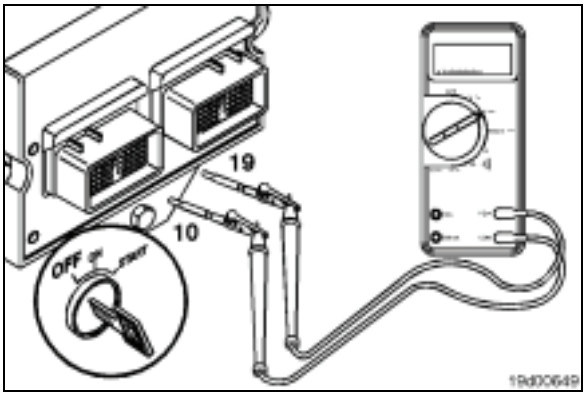


Using jumper wires, connect pins 38, 39, and 40 (battery supply) from the engine harness to the ECM.

Using jumper wires, connect pins 20, 28, and 29 (battery return) from the engine harness to the ECM.

Connect a test lead to pin 10 of the ECM engine connector and the positive (+) probe of the multimeter.

Connect the other lead to pin 19 of the ECM engine connector and the negative (-) probe of the multimeter.

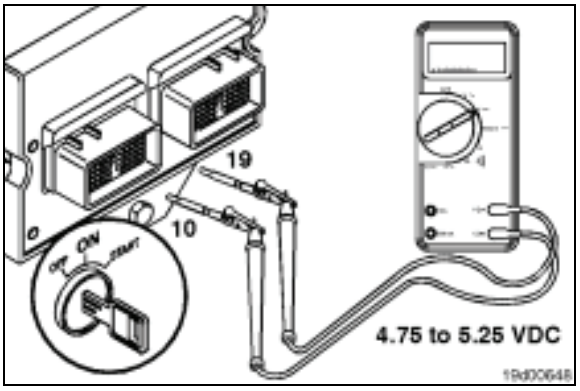


Secondary ECM (B) Removal/Installation (Cont)

Turn the keyswitch to the ON position.

Measure the voltage from pin 10 to pin 19 of the ECM engine connector. The voltage must be 4.75 to 5.25 VDC.

If the voltage is not 4.75 to 5.25 VDC, replace the ECM.



Follow-Up

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Section 8 – Service Literature

Section Contents

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Additional Service Literature

General Information

The following publications can be purchased at your selected Service Literature Ordering Location:

Bulletin	Title of Publication
3379000	Air for Your Engines
3379001	Fuel for Cummins Engines Bulletin
3379009	Operation, Cold Weather
3666003	C Series Troubleshooting and Repair Manual
3666008	C Series Engine Shop Manual
3666021	C Series Specifications Manual
3666109	Alternative Repair Manual, B and C Series Engines
3666132	Coolant Requirements and Maintenance Bulletin
3810340	Cummins Engine Oil Recommendations Bulletin

Service Literature Ordering Location

Contact Information

Region	Ordering Location
United States and Canada	Cummins Distributors – 1-800 DIESELS 1-800-343-7357 **OR** Credit Cards at 1-800-646-5609 **OR** Order online at www.powerstore.cummins.com
U.K., Europe, Mid-East, Africa, and Eastern European Countries	Cummins Engine Co., Ltd. Royal Oak Way South Daventry Northants, NN11 5NU, England
South and Central America (excluding Brazil and Mexico)	Cummins Americas, Inc. 16085 N.W. 52nd Avenue Hialeah, FL 33104
Brazil and Mexico	Cummins Inc. International Parts Order Dept., MC 40931 Box 3005 Columbus, IN 47202-3005
Far East (excluding Australia and New Zealand)	Cummins Diesel Sales Corp. Literature Center 8 Tanjong Penjuru Jurong Industrial Estate Singapore
Australia and New Zealand	Cummins Diesel Australia Maroondah Highway, P.O.B. 139 Ringwood 3134 Victoria, Australia

Section 9 – Service Assistance

Section Contents

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Routine Service and Parts

Personnel at Cummins Authorized Repair Locations can assist you with the correct operation and service of your engine. Cummins has a worldwide service network of more than 5,000 Distributors and Dealers who have been trained to provide sound advice, expert service, and complete parts support. Check the telephone directory yellow pages or refer to the directory in this section for the nearest Cummins Authorized Repair Location.

Emergency and Technical Service

The Cummins Customer Assistance Center provides a 24-hour, toll free telephone number to aid in technical and emergency service when a Cummins Authorized Repair Location can not be reached or is unable to resolve an issue with a Cummins product.

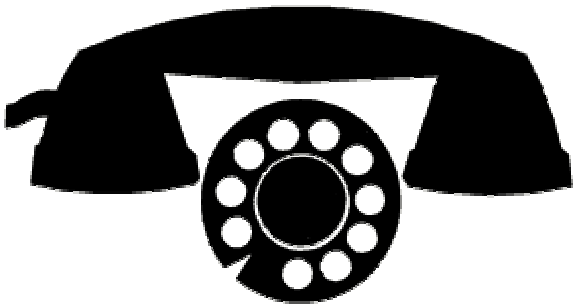
If assistance is required, call Toll-Free:

1-800-DIESELS (1-800-343-7357)

Includes all 50 states, Bermuda, Puerto Rico, Virgin Islands, and the Bahamas.

Outside of North America contact your Regional Office. Telephone numbers and addresses are listed in the International Directory.

See also www.cummins.com



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Problem Solving

Normally, any problem that arises with the sale, service, or repair of your engine can be handled by a Cummins Authorized Repair Location in your area. Refer to the telephone directory yellow pages for the one nearest you. If the problem has not been handled satisfactorily, follow the steps outlined below:

If the disagreement is with a Dealer, talk to the Cummins Distributor with whom he has his service agreement.

If the disagreement is with a Distributor, call the nearest Cummins Division or Regional Office; however, most problems are solved below the Division or Regional office level. Telephone numbers and addresses are listed in this section.

Before calling, write down the following information:

- Engine model and serial number
- Type and make of equipment
- Total kilometers [miles] or hours of operation
- Warranty start date
- Nature of problem
- Summary of the current problem arranged in the order of occurrence
- Name and location of the Cummins Distributor or Dealer

If a problem can not be resolved satisfactorily through your Cummins Authorized Repair Location or Division Office, write to:

Cummins Customer Assistance Center - 41403,

Cummins Engine Company, Inc.,

Box 3005, Columbus, IN 47202-3005

Section 10– Maintenance Specifications

Section Contents

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General Engine Data

NOTE: The following engine and system specification data is extracted from the curves and data sheets that were current when this document was prepared. Refer to Performance Curve Drawing 9720 and Data Sheet Drawing 9721 for the most current information. Contact Cummins Fire Power at 920-337-9750 if current information is required.

Refer to the base engine troubleshooting and repair manual for base engine coverage (see Service Literature in Section 13).

Type	4 Cycle; In-Line; 6 Cylinder
Firing Order	1-5-3-6-2-4
Rotation, Viewed from the Front of the Engine	Clockwise
Compression Ratio:	16.3:1
Valves per cylinder: Inlet/Exhaust	1 / 1
Cummins Base Engine Fuel Rating	FR-90847
Cummins Engine Co. Base Engine	QSB5.9-C275
Installation Drawing	8707 (see Section 13)
Configuration Number	D403046CX03
Fuel System	Bosch - Electronic
Aspiration	Turbocharged, Charge Air Cooled

	Metric	US
Bore	102 mm	4.02 in
Stroke	120 mm	4.72 in.
Displacement	5.9 liter	360 in.3
Intake Valve Clearance	0.25 mm	0.010 in
Exhaust Valve Clearance	0.51 mm	0.020 in
Dry Weight	272 kg	599 lb
Wet Weight	327 kg	722 lb

NOTE: The engine features a no-adjust overhead. The valve train is designed such that adjustment of the valve lash is not required for normal service during the first 5,000 hours. The valve train operates acceptably within the limits of 0.152- to 0.381-mm [0.006- to 0.010-in] intake valve lash and 0.381- to 0.762-mm [0.010- to 0.030-in] exhaust valve lash.

Fuel System Specifications

Fuel	Type Number 2 Diesel Only
Recommended primary fuel filter	Fleetguard 3903640

	Metric	US
Minimum supply line size	6.4 mm D.	0.375 in. D.
Minimum drain line size	3.2 mm D.	0.25 in. D.
Maximum fuel line length between supply tank & fuel pump	12.2 m	40 ft.
Maximum fuel height above C/L crankshaft	2030 mm	80 in.
Maximum restriction @ lift pump-inlet - with clean filter	152 mm Hg	6 in. Hg
Maximum restriction @ lift pump-inlet - with dirty filter	203 mm Hg	8 in. Hg
Maximum return line restriction - without check valves	508 mm Hg	20.1 in. Hg
Minimum fuel tank vent capability	0.068 m^3/hr	12 ft^3/hr
Maximum fuel temperature @ lift pump inlet	71 ^oC	160 ^oF

Lubricating Oil System Specifications

Recommended lube oil filter	Fleetguard 3908616

	Metric	US
Oil pressure range at rated	276-414 kPa	40-60 PSI
Oil capacity of pan (high - low)	14.2 - 12.3 liter	15 - 13 U.S. quarts
Total system capacity	16.4 liter	4.2 U.S. Gal.

Cooling System Specifications

	Metric	US
Maximum raw water working pressure range at heat exchanger	414 kPa	60 PSI
Recommended minimum water supply pipe size to heat exchanger	19.1 mm D.	0.75 in. D.
Recommended minimum water discharge pipe size from heat exchanger	25.4 mm D.	1.0 in. D.
Coolant water capacity (engine side)	9.9 liter	2.6 U.S. Gal.
Modulating thermostat range	83-91 ^{o}C	181-196 ^{o}F
Minimum raw water flow with water temperatures to 90 ^{o}F (32 ^{o}C)	1.89 liter/s	30 U.S. GPM

Air Intake System Specifications

NOTE: Engine intake air must be filtered to prevent dirt and debris from entering the engine. If intake air piping is damaged or loose, unfiltered air will enter the engine and cause premature wear.

Recommended air cleaner element	(Standard) Donaldson B105006 (Optional) K&N RU5045

	Metric	US
Maximum temperature rise between ambient air and engine air inlet	15 ^{o}C	30 ^{o}F
Maximum inlet restriction with dirty filter	635 mm H_2O	25 in. H_2O

Exhaust System Specifications

	Metric	US
Maximum exhaust back pressure imposed by complete exhaust system	10.2 kPa	40.8 in. H_2O
Exhaust pipe size normally acceptable	76 mm D.	3 in. D.

Electrical System Specifications

Start Circuit

The start circuit consists of a single starter motor and redundant starter control relays as well as using redundant power sources either 12 V or 24 V comprised of 12 V wet type storage batteries (optional at shipment).

The battery, starter and starter solenoid positive terminals are booted with a non-conducting cover or otherwise insulated from unintended grounding. Battery cable leads from the batteries to the designated connection points in the starting circuit are minimum 6.53 mm D. (No. 2 AWG), neoprene or rubber insulated with a 1.5 mm (0.060 in.) minimum insulation thickness rated 80°C (176 °F) minimum. The starter and starter solenoid are all metal enclosed.

Wiring for automatic starting (negative ground)	Standard
Reference wiring diagram	10423 (see Section 13)
B.C.I. Group Size	8D

	12V	**24V**
Minimum recommended battery cold cranking amperes (CCA)(1)	1100 Amps	550 Amps
Minimum recommended battery reserve capacity	260 Minutes	130 Minutes
Maximum resistance of starting circuit	0.002 Ohms	0.004 Ohms
Typical cranking speed	125 RPM	125 RPM
Alternator (standard), internally regulated	95 Amps	45 Amps
Battery Cable Size (Metric) (For less than 1.5 meters long)	10.6 mm D.	10.6 mm D.
Battery Cable Size (US) (For less than 5 feet long)	00 AWG	00 AWG

(1) Cold soak at -18 °C (0 °F) or above

Cummins/Fleetguard® Filter Specifications

General Information

Fleetguard®/Nelson is a subsidiary of Cummins Inc. Fleetguard®/Nelson filters are developed through joint testing at Cummins and Fleetguard®/Nelson. Fleetguard®/Nelson filters are standard on new Cummins engines. Cummins Inc. recommends their use.

Fleetguard®/Nelson 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 high-quality standards.

Cummins can not be responsible for problems caused by non-genuine filters that do not meet Cummins performance or durability requirements.

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.

Use only number 2 diesel (ASTM no. 2D) fuel.

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

Additional information for fuel recommendations and specifications can be found in Fuel for Cummins Engines, Bulletin No. 3379001. See Section 8, Service Literature, for ordering information.

Lubricating Oil Recommendations and Specifications

Oil Performance Recommendations

Using quality engine lubricating oils, along with appropriate oil drain and filter change intervals, is a critical factor in maintaining engine performance and durability. Refer to Service Literature in Section 8 for reference to related Cummins service bulletins.

Cummins Engine Company, Inc. recommends the use of a high-quality SAE 15W-40 heavy-duty engine oil (such as Cummins Premium Blue®), which meets the American Petroleum Institute (API) performance classification CH4/SG.

A sulfated ash limit of 1.0 mass percent is suggested for optimum valve and piston deposit and oil consumption control. The sulfated ash must not exceed 1.85 mass percent.

New Engine Break-In Oils

Do not use special “break-in” lubricating oils for new or rebuilt Cummins engines. Use the same type of oil during the “break-in” as that which is used in normal operation.

Recommended Oil Change Intervals

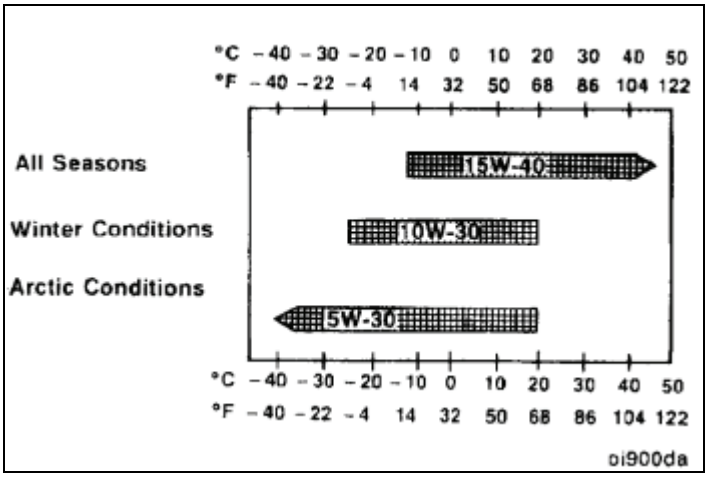
The oil change interval for turbocharged engines is every 6 months or 250 hours.

Oil Viscosity Recommendations

The use of multiviscosity lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures.

While 15W-40 oil is recommended for most climates, refer to the accompanying table for oil viscosity recommendations for extreme climates.

NOTE: Limited use of low-viscosity oils, such as 10W-30, can be used for easier starting and providing sufficient oil flow at ambient temperatures below -35°C [23°F]. However, continuous use of low viscosity oils can decrease engine life because of wear. Refer to the accompanying chart.



Coolant Recommendations and Specifications

General Information

Heavy-duty diesel engines require a balanced coolant mixture of water and antifreeze. Drain and replace the mixture every 1 year or 1500 hours of operation (whichever occurs first) to eliminate buildup of harmful chemicals.

Antifreeze is essential in any climate. It broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point. Do not use more than 50-percent antifreeze in the mixture unless additional freeze protection is required. Never use more than 68-percent antifreeze under any condition.

Use soft water in the coolant mixture. Contaminants in hard water neutralize the corrosion inhibitor components. Water must not exceed 300-ppm hardness or contain more than 100 ppm of either chloride or sulfate.

Specifications

Use low-silicate antifreeze that meets ASTM4985 test (GM6038M spec.) criteria.

Refer to Service Literature in Section 8 for reference to related Cummins service bulletins.

Concentration

Antifreeze must be used in any climate for both freeze and boiling point protection. Cummins recommends a 50-percent concentration level (40-percent to 60-percent range) of ethylene glycol or propylene glycol in most climates. Antifreeze at 68-percent concentration provides the maximum freeze protection and must never be exceeded under any condition. Antifreeze protection decreases above 68 percent.

Ethylene Glycol	Propylene Glycol
40% = -23°C [-10°F]	**40% = -21°C [-6°F]**
50% = -37°C [-34°F]	**50% = -33°C [-27°F]**
60% = -54°C [-65°F]	**60% = -49°C [-56°F]**
68% = -71°C [-90°F]	**68% = -63°C [-82°F]**

Concentration Testing

Antifreeze concentration must be checked using a refractometer (such as Fleetguard® Part No. CC2800). “Floating ball” types of density testers or hydrometers are not accurate enough for use with heavy-duty diesel cooling systems.

Engine Component Torque Values

Torque Table

Component	Wrench Size	N•m	ft-lb or in-lb
Aftercooler Mounting	10 mm	24	18
Aftercooler Water Hose Clamp	8 mm	5	44
Alternator Link (Delco 10-15 SI)	13 mm	24	18
Alternator Link (Delco 20-27 SI)	3/4 in	43	32
Alternator Mtg. Bolt 10-15 SI	15 mm	43	32
Alternator Mtg. 27 SI	18 mm	77	57
Alternator Support (Upper)	10 mm	24	18
Belt Tensioner Flat Bracket	Allen 5 mm	24	18
Belt Tensioner Mounting	15 mm	43	32
Crankshaft Damper and Pulley	15 mm	137	101
Crossover Clamp	5/16 in	5	44
Tee Bolt Type Clamp	11 mm	8	71
Exhaust Outlet Pipe, V Band Clamp	7/16 in	8	71
Fuel Filter	75 to 85 mm	Install as specified by filter manufacturer	
Fuel Filter Adapter Nut	24 mm	32	24
Lubricating Oil Filter	75 to 85 mm	3/4 Turn after Contact	
Lubricating Oil Cooler Assembly	10 mm	24	18
Lubricating Oil Pan Drain Plug (steel)	17 mm	80	59
Lubricating Oil Pan Drain Plug (aluminum)	17 mm	55	41
Lubricating Oil Pan Heater Plug	27 mm	80	59
Lubricating Oil Pressure Regulator Plug	19 mm	80	59
Starter Mounting	10 mm	43	32
Thermostat Housing	10 mm	24	18
Water Inlet Connection	15 mm	43	32
Water Pump Mounting	13 mm	24	18
Valve Cover	15 mm	12	106
Water-in-Fuel Sensor	19 mm	Hand-Tighten	
Top - Load Filter Lid	10 mm	Hand-Tighten	

Sealants

General Information

Use either the sealants listed below or sealants containing equivalent properties.

Item Description	Sealing Method
Pipe plugs	Pre-coated Teflon™ or pipe sealer
Gaskets	No sealant required
Cups plugs	Loctite 277 or Cummins sealant, Part Number 3375068
O-rings	Lubriplate™ 105
Rear camshaft expansion plug	Loctite 277 or Cummins sealant, Part Number 3375068
Fuel pump studs	Loctite 242
Turbocharger drain (in block)	Loctite 277 or Cummins sealant, Part Number 3375068
Dipstick tube (in block)	Loctite 277 or Cummins sealant, Part Number 3375068
Wet flywheel housing to block	Three-Bond™ sealant, Cummins Part Number 3823494
Rear seal (in rear cover)	No sealant required
Timing pin housing capscrews	No sealant required
Side oil fill	Loctite 277 or Cummins sealant, Part Number 3375068
Oil pan at gear housing joint	Three-Bond™ sealant, Cummins Part Number 3823494

Capscrew Markings and Torque Values

General Information

CAUTION

Always use a capscrew of the same measurement and strength as the capscrew being replaced. Using the wrong capscrews can result in engine damage.

Always use the torque values listed in the following tables when specific torque values are not available.

Do not use the torque values in place of those specified in other sections of this manual.

The torque values in the table are based on the use of lubricated threads.

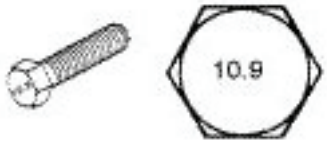
When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

Metric Capscrew Identification

Sample:	M8-1.25 x 25		
Value:	M8	1.25	X 25
Meaning:	Major thread diameter in millimeters	Distance between threads in millimeters	Length in millimeters

Metric Capscrew Head Markings

Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts.

Commercial Steel Class	**8.8**	**10.9**	**12.9**
Capscrew Head Markings			

Metric Capscrew Torque Values

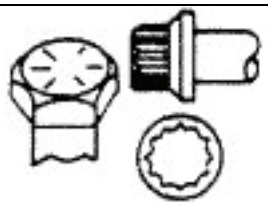
Class:	**8.8**				**10.9**				**12.9**			
Diameter	**Cast Iron**		**Aluminum**		**Cast Iron**		**Aluminum**		**Cast Iron**		**Aluminum**	
mm	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**
6	9	5	7	4	13	10	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	23	17	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	65	50	30	25	70	50	30	25
12	80	60	55	40	115	85	55	40	125	95	55	40
14	125	90	90	65	180	133	90	65	195	145	90	65
16	195	140	140	100	280	200	140	100	290	210	140	100
18	280	200	180	135	390	285	180	135	400	290	180	135
20	400	290	—	—	550	400	—	—	—	—	—	—

US Customary Capscrew Identification

Sample:	5/16 x 18 x 1-1/2		
Value:	5/16	18	1-1/2
Meaning:	Major thread diameter in inches	Number of threads per inch	Length in inches

U.S. Customary Capscrew Head Markings

U.S. Customary capscrews are identified by radial lines stamped on the head of the capscrew.

SAE Grade 5 **w/ three lines**	**SAE Grade 8**
	

U.S. Customary Capscrew Torque Values

Grade	**SAE Grade 5**				**SAE Grade 8**			
Capscrew Body Size	**Cast Iron**		**Aluminum**		**Cast Iron**		**Aluminum**	
	N•m	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**
1/4-20	9	7	8	6	15	11	8	6
1/4-28	12	9	9	7	18	13	9	7
5/16-18	20	15	16	12	30	22	16	12
5/16-24	23	17	19	14	33	24	19	14
3/8-16	40	30	25	20	55	40	25	20
3/8-24	40	30	35	25	60	45	35	25
7/16-14	60	45	45	35	90	65	45	35
7/16-20	65	50	55	40	95	70	55	40
1/2-13	95	70	75	55	130	95	75	55
1/2-20	100	75	80	60	150	110	80	60
9/16-12	135	100	110	80	190	140	110	80
9/16-18	150	110	115	85	210	155	115	85
5/8-11	180	135	150	110	255	190	150	110
5/8-18	210	155	160	120	290	215	160	120
3/4-10	325	240	255	190	460	340	255	190
3/4-16	365	270	285	210	515	380	285	210
7/8-9	490	360	380	280	745	550	380	280
7/8-14	530	390	420	310	825	610	420	310
1-8	720	530	570	420	1100	820	570	420
1-14	800	590	650	480	1200	890	650	480

Section 11 – Warranty Information

LIMITED WARRANTY

EXCLUSIVE EXPRESS LIMITED WARRANTY: Cummins NPower, LLC ("CNP"), expressly warrants to the original end consumer only that, for a period not to exceed the earlier of two (2) years or 2000 hours of use from the start-up date (or, if the original end consumer fails to register as purchaser with CNP, six (6) months from CNP shipment date), the diesel fire pump drivers, manufactured and sold by CNP, shall be free from defects in material and workmanship when used and serviced in accordance with the Operations and Maintenance manual for the applicable Cummins Fire Pump engine model (the "Exclusive Warranty"). The Exclusive Warranty is non-transferable and shall immediately terminate and be of no further force or effect upon the sale, lease, assignment, transfer or other disposition by an original end consumer of a Cummins Fire Pump engine that contains a diesel fire pump driver covered by this Exclusive Warranty. Nothing contained herein shall be construed to extend the Exclusive Warranty, and the Exclusive Warranty shall not be extended, to:

- Maintenance, adjustment, installation or start-up costs;
- Diesel fire pump driver failure due to normal wear, accident, misuse, abuse, neglect, improper installation or a defect attributable to a Cummins Fire Pump engine;
- Alterations or modifications not authorized in writing by CNP;
- Additional components added to a diesel fire pump driver package subsequent to shipment of the engine; or
- Starting batteries and heaters.

DISCLAIMER OF WARRANTIES: Except for the Exclusive Warranty provided above, which is in lieu of all other express and implied warranties, CNP EXPRESSLY DISCLAIMS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION AND EXCLUSION OF REMEDIES: All claims under this Exclusive Warranty shall be deemed waived by the original end consumer if not submitted to CNP or an authorized distributor within thirty (30) days of initial discovery that a diesel fire pump driver is not conforming to the Express Warranty. The original end consumer's remedy under this Exclusive Warranty is limited, in CNP's reasonable discretion, to repair, replacement or other appropriate adjustment of a non-conforming diesel fire pump driver determined, upon CNP's inspection, to have been properly installed, maintained and operated in accordance with the Operations and Maintenance manual furnished by CNP. IN ANY EVENT, CNP SHALL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

The Cummins Industrial Warranty covers the base engine for a period of time not to exceed the earlier of two (2) years or 2000 hours of operation from the date of delivery and start-up of the engine. Reference bulletin numbers 3381321 US/Canada & 3381322 Outside US/Canada. Cummins Fire Power components are warranted for a period of time not to exceed the earlier of two (2) years or 2000 hours of operation from the start-up date of the fire pump system, and the coverage includes travel time and mileage for the first year of the Limited Warranty, and repair or replacement of parts and reasonable cost of labor. The Cummins Fire Power Limited Warranty does not cover failures or damage due to abuse or neglect and including, but not limited to: shipping damage, improper storage, improper installation, unauthorized modification or lack of maintenance. **Cummins Fire Power is not responsible for incidental or consequential damages.**

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Section 12 – Troubleshooting

Section Contents

Section Contents (Cont)

Troubleshooting Procedures and Techniques

General information

This guide describes some typical engine operating problems, their causes, and some acceptable corrections to those problems.

WARNING

Performing troubleshooting procedures NOT outlined in this in Section can result in equipment damage or personal injury or death

Troubleshooting must be performed by trained, experienced technicians.

Consult a Cummins Authorized Repair Location for diagnosis and repair beyond that which is contained in this manual, and for symptoms not listed in this in section.

Before beginning any troubleshooting, refer to the General Safety Instructions in Section 1 of this manual.

Follow the suggestions below for troubleshooting:

Study the complaint thoroughly before acting.

Refer to the Engine Identification diagrams in Section 2, the System Diagrams in Section 6, and the Assembly Drawings in Section 13.

Do the easiest and most logical things first.

Find and correct the cause of the complaint.

Troubleshooting Symptoms Charts

WARNING

Troubleshooting presents the risk of equipment damage, personal injury or death Troubleshooting must be performed by trained, experienced technicians.

Use the charts on the following pages of this section to aid in diagnosing specific engine symptoms.

Read each row of blocks from top to bottom.

Follow through the chart to identify the corrective action.

Alternator Overcharging with the Engine Running

NOTE: If the batteries are overcharged while the engine is not running, troubleshoot the customer supplied battery charging system.

Cause	Correction
Batteries have failed.	Check the condition of the batteries. Refer to Battery Testing in Section 7. Replace any defective batteries.
	
The internal voltage regulator in the alternator is malfunctioning.	Test the alternator electrically. Refer to Alternator Checks and Testing in Section 7. If required, replace the alternator. Refer to Alternator Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Neither Battery is Charging with the Engine Running

NOTE: If one or both batteries do not charge with the engine stopped, troubleshoot the customer supplied battery charging system.

NOTE: If only one battery is maintaining charge, go to Only One Battery is Charging with the Engine Running.

Cause	Correction
Battery cables or connections are loose, broken, or corroded (excessive resistance).	Check the battery cables and connections. Ensure that all connections are free of corrosion and that no cables are broken.
	
Alternator rotor is not turning.	Test the alternator mechanically. Refer to Alternator Checks and Testing in Section 7. If the alternator shaft does not spin freely because of a bad bearing, replace the alternator (refer to Alternator Removal/Installation in Section 7). If the alternator does not turn because of a bad drive belt, replace the drive belt (refer to Belt Removal/Installation in Section 7). If the alternator does not charge because of poor drive belt tension, replace the automatic tensioner (refer to Automatic Belt Tensioner Removal/Installation in Section 7). If the alternator pulley spins freely on the shaft because of a broken key, replace the alternator (refer to Alternator Removal/Installation in Section 7).
	
Battery Isolator input has faulted.	Test continuity from the alternator to the battery isolator input (refer to Drawing 10423 Sheet 2 in Section 13). Repair any open circuit. Test continuity through the battery isolator. If an internal open circuit is detected, replace the battery isolator (refer to Battery Isolator Removal/Installation in Section 7).
	

Neither Battery is Charging with the Engine Running (Cont)

Cause	Correction
Alternator excitation is lost.	Test the alternator electrically. Refer to Alternator Checks and Testing in Section 7. If required, replace the replaceable diode. Refer to Drawing 10423 Sheet 1 in Section 13. If required, locate and repair the open circuit or short to ground in the alternator excitation wiring.
	
Alternator internal voltage regulator is malfunctioning.	Test the alternator electrically. Refer to Alternator Checks and Testing in Section 7. If required, replace the alternator. Refer to Alternator Removal/Installation in Section 7.
	
Battery temperature is above specification.	Position the batteries away from heat sources.
	
Contact an Authorized Cummins Repair Facility.	

Only One Battery is Charging with the Engine Running

NOTE: If one or both batteries do not charge with the engine stopped, troubleshoot the customer supplied battery charging system.

NOTE: If neither battery is maintaining charge, go to Neither Battery is Charging with the Engine Running.

Cause	Correction
Battery has failed.	Test battery condition**.** Refer to Battery Testing in Section 7. If the battery has failed, replace the failed battery units. Refer to Battery Removal/Installation in Section 7.
	
Battery cables or connections are loose, broken, or corroded (excessive resistance).	Check the battery cables and connections. Ensure that all connections are free of corrosion and that no cables are broken.
	
Battery isolator has failed.	Remove the battery isolator. Refer to Battery Isolator Removal/Installation in Section 7. Test the internal diodes for open circuit or short to ground. Refer to the Schematic, Electrical Wiring, 10423 Sheet 2 in Section 13. If required, obtain a replacement battery isolator. Install the battery isolator. Refer to Battery Isolator Removal/Installation in Section 7.
	
Voltmeter is providing false indication.	Go to Voltage Indications Differ in this section.
	
Contact an Authorized Cummins Repair Facility.	

Voltage Indications Differ

NOTE: The two voltmeters may differ slightly due to calibration differences between the meters. Normal differences in battery condition may also cause differences in indication. These are normal differences and require no action. A voltage difference of more than three or four volts should be investigated.

Cause	Correction
One battery is discharged or failing.	Check battery condition. Replace failing battery elements. Check wiring for corrosion. Ensure good electrical contact. Charge discharged batteries by running the engine or with an external battery charger. If the battery does not charge with the engine running, go to Only One Battery is Charging with the Engine Running.
	
Fuse 1 or Fuse 2 is open. (Refer to Drawing 10423 Sheet 1 in Section 13.)	Check for apparent wire damage or shorts to grounds. Replace the failed fuse. Refer to Fuse Replacement in Section 7. If the fuse operates again, locate and correct the overload or repair the short circuit.
	
Open circuit or short to ground in indicator wiring.	Locate and repair the electrical fault. (Refer to Drawing 10423 Sheet 1 in Section 13.)
	
Voltmeter has failed.	Remove wiring at the voltmeter and apply test voltage. If necessary, replace the faulted voltmeter. Refer to Voltmeter Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Coolant Contamination

Cause	Correction
Coolant is rusty and has debris.	Drain and flush the cooling system. Refer to Drain and Flush Cooling System in Section 5. If the drained coolant has excessive rust or debris, change the coolant more frequently or contact a Cummins Authorized Repair Facility. Otherwise, refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5.
OK	
Lubricating oil cooler is leaking oil into the coolant. Coolant begins to have the texture and color of chocolate pudding.	Drain and flush the cooling system. Refer to Drain and Flush Cooling System in Section 5. Check the lubricating oil cooler for coolant leaks and cracks. Refer to Lubricating Oil Cooler Removal/Installation in Section 7. Replace the oil cooler gasket or other parts. Refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5. If the problem persists, the cylinder block may be cracked or porous. Refer to a Cummins Authorized Repair Facility.
OK	

Coolant Contamination (Cont)

Cause	Correction
Coolant Heat Exchanger is leaking raw water into the coolant. Coolant volume increases and pressure is relieved when the unit is operating. Antifreeze concentration decreases.	Drain and flush the cooling system. Refer to Drain and Flush Cooling System in Section 5. Remove Coolant Heat Exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7. Perform a pressure test of the raw water side of the heat exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7. If the heat exchanger leaks, it should be replaced. Install a known good Coolant Heat Exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7. Check and adjust raw water pressure regulator setpoints. Refer to Raw Water Piping, Lineup, and Configuration in Section 3. Check and, if required, replace the Zinc Plug. Refer to Inspect Heat Exchanger Zinc Plug in Section 5. Refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5.
OK	
Coolant is inadvertently contaminated with unknown liquids.	Drain and flush the cooling system. Refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5.
OK	
Contact an Authorized Cummins Repair Facility.	

Excessive Coolant Loss

Cause	Correction
Adequate coolant was not added following previous maintenance activities.	Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant as required and check engine operation. If coolant loss persists, check for other problems.
	
Inadvertent coolant leak is present.	Inspect the engine for coolant leaking from drain cocks or vents. Close the leaking drain or vent. Add coolant as required and check engine operation.
	
Cooling system hose is leaking.	Inspect the hoses. Refer to Check Hose Condition in Section 5. Replace and/or tighten loose hose clamps. Replace any damaged hoses. Refer to Coolant Hose Removal/Installation in Section 7. Add coolant as required and check engine operation.
	
Pressure cap is malfunctioning or has low-pressure rating.	Check that the pressure cap does not relieve coolant under normal operating conditions. Replace a leaking pressure cap (Cummins Fire Power Part No. 11407). Add coolant as required and check engine operation.
	

Excessive Coolant Loss (Cont)

Cause	Correction
Mechanical coolant leak.	Inspect the engine for coolant leaking from manifold, expansion and pipe plugs, fittings, lubricating oil cooler, water pump seal, cylinder block, and other components that have coolant flow. Repair leaking components. Add coolant as required and check engine operation.
OK	
Engine is overheating.	Refer to the Coolant Temperature Above Normal symptom tree.
OK	
Lubricating oil cooler is leaking.	Check the lubricating oil cooler for coolant leaks. Refer to Lubricating Oil Cooler (007-003) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00
OK	
Cylinder block is cracked or porous.	Inspect the cylinder block. Refer to Cylinder Block (001-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Refer to a Cummins Authorized Repair Facility.	

Coolant Temperature Above Normal

NOTE: The thermostat's normal operating temperature range is 82-95 °C [180-203 °F. The lamp will only illuminate if the engine is running. If the lamp is illuminated or if temperature is otherwise excessive, the engine should be stopped as soon as practical and the problem corrected.

Cause	Correction
Raw water flow is improperly aligned.	Check that the raw water manifold is aligned for normal flow through the solenoid valve (preferred) or bypass flow around the solenoid valve (alternative). (Refer to Drawing 8682 in Section 13). Align flow if required.
OK	
Raw water pressure regulator is improperly adjusted.	**NOTE:** Pressure should be about 414 kPa [60 psig] or slightly less. Check the raw water pressure indication. If pressure is indicated but is low, adjust the regulator (Refer to Check Raw Water Pressure Regulator Setpoints in Section 3.) If pressure is not indicated or is excessively low, go to Raw water solenoid has failed in this table.
OK	
Raw water solenoid has failed.	If pressure is excessively low when aligned for normal flow, open the bypass valves. Then, when practical, troubleshoot the raw water solenoid valve. Refer to Raw Water Solenoid Valve Fails to Operate in this section. If the solenoid valve operates, replace the pressure regulator. (Refer to Raw Water Pressure Regulator Removal/Installation in Section 7.) If pressure is excessively low when aligned for bypass flow, open the normal valves. Then, when practical, replace the pressure regulator. (Refer to Raw Water Pressure Regulator Removal/Installation in Section 7.)
OK	

Coolant Temperature Above Normal (Cont)

Cause	Correction
Raw water piping or heat exchanger is plugged.	Check the raw water strainer for blockage. Refer to Drawing 8682 in Section 13. Clean the strainer if necessary. Check the Cummins supplied raw water piping for blockage. Refer to Drawings 8682 and 9638 in Section 13. Clean the piping if necessary. Check the customer supplied raw water piping for blockage. Remove any blockage. Check for flow through the heat exchanger. If necessary, replace the heat exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7.
	
Coolant level is below specification.	Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant as required. If coolant level was excessively low, go to Excessive Coolant Loss in this section.
	
Cooling system hose is collapsed or restricted.	Inspect the hoses. Refer to Check Hose Condition in Section 5. Replace any damaged hoses. Refer to Coolant Hose Removal/Installation in Section 7.
	
Coolant thermostat is malfunctioning.	Remove and test the coolant thermostat. Refer to Coolant Thermostat Removal/Installation in Section 7. Replace the thermostat is it is defective.
	
Coolant water pump is malfunctioning.	Remove and inspect the water pump. Refer to Coolant Water Pump Removal/Installation in Section 7. Replace the thermostat if it is defective.
	

Coolant Temperature Above Normal (Cont)

Cause	Correction
Lubricating oil is contaminated with coolant or fuel.	Check the appearance of the lubricating oil. If the color and texture is abnormal, refer to the Lubricating Oil Contaminated symptom tree.
OK	
Cooling system hose is collapsed, restricted, or leaking.	Inspect the hoses. Refer to Check Hose Condition in Section 5. Replace any damaged hoses. Refer to Coolant Hose Removal/Installation in Section 7.
OK	
Coolant mixture of antifreeze and water is not correct.	Verify the concentration of antifreeze in the coolant. Refer to Check Cooling System Condition in Section 5. Add antifreeze or water to correct the concentration. Refer to Coolant Recommendations and Specifications in Section 10.
OK	
Lubricating oil level is above or below specification.	Check the oil level. Refer to Check Engine Oil Level in Section 5. Add or drain oil, if necessary.
OK	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to Coolant Temperature Sender Removal/Installation in Section 7.
OK	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to Coolant Temperature Gauge Removal/Installation in Section 7.
OK	

Coolant Temperature Above Normal (Cont)

Cause	Correction
Coolant temperature switch is malfunctioning.	Remove the temperature switch. Refer to Coolant Temperature Switch Removal/Installation in Section 7. Test the temperature switch. Repair or replace the switch, if necessary.
OK	
Refer to a Cummins Authorized Repair Facility.	

Coolant Temperature Below Normal (Engine Off)

Cause	Correction
The 120 VAC power supply to the coolant heater is not connected.	Connect the power supply. Correct any electrical faults in the supply circuit.
	
The heater's overload thermostat has operated.	Ensure that there is coolant in the heater. Allow time for the automatic overload reset to occur.
	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to Coolant Temperature Sender Removal/Installation in Section 7.
	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to Coolant Temperature Gauge Removal/Installation in Section 7.
	
Coolant is not free to circulate through the heater.	Ensure that the coolant hoses are clear. Refer to Coolant Hose Removal/Installation in Section 7.
	
The coolant heater has failed electrically.	Replace the coolant heater. Refer to Coolant Heater Removal/Installation in Section 7.
	
Contact a Cummins Authorized Repair Facility.	

Coolant Temperature Below Normal (Engine Running)

Cause	Correction
Electronic fault codes are active.	For instructions on how to read Diagnostic Fault codes, refer to Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Coolant thermostat has failed open.	Test operation of the thermostat. Refer to Coolant Thermostat Tests in Section 7. If necessary, replace the thermostat. Refer to Coolant Thermostat Removal/Installation in Section 7.
OK	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to Coolant Temperature Sender Removal/Installation in Section 7.
OK	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to Coolant Temperature Gauge Removal/Installation in Section 7.
OK	
Contact an Authorized Cummins Repair Facility.	

Raw Water Drain Steaming

NOTE: The raw water drain from the Coolant Heat Exchanger may steam if raw water flow is inadequate when the engine is running. It may also steam shortly after the engine is stopped. If coolant is leaking into the raw water drain piping, the steaming may last for some time while the engine cools. Antifreeze may also be observed in the raw water drain.

Cause	Correction
Raw water flow did not start when the engine started.	Check engine coolant temperature. Go to Coolant Temperature Above Normal in this section.
	
Engine coolant is leaking into the raw water piping in the coolant heat exchanger.	When practical, remove the coolant heat exchanger and perform the pressure test. Refer to Coolant Heat Exchanger Removal/Installation in Section 7. If pressure is not maintained, replace the heat exchanger.
	
Contact an Authorized Cummins Repair Facility.	

Raw Water Solenoid Valve Fails to Operate

NOTE: The raw water solenoid failure may fail to open or to close. The normally closed valve may fail to open when the engine starts. This fault will prevent raw water flow through the normal valves. Bypass flow should be aligned in this event. The valve may also fail to close because of mechanical blockage. In this event, the raw water flow from the heat exchanger does not stop when it should. Depending upon the fire protection system piping, the open solenoid valve may drain all water from the fire protection system piping that is higher than the engine's piping.

Cause	Correction
Solenoid valve fails to close when the engine stops.	Replace the solenoid valve. Refer to Raw Water Solenoid Valve Removal/Installation in Section 7. Clean the raw water strainer more frequently. Increase the frequency of operational testing.
	
Solenoid valve fails to energize.	Check electrical continuity and insulation from ground to the solenoid. Repair any open or short circuits in the wiring.
	
Solenoid fails to open mechanically.	**NOTE:** Apply the correct operating voltage, either 12 VDC or 24 VDC depending upon the model. Apply temporary voltage to the solenoid. If the solenoid fails to operate, replace it. Refer to Raw Water Solenoid Valve Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Auto Start Failure - Does not Crank on A

NOTE: The fire pump engine will not crank automatically when solenoid A is selected at the fire protection system. However, it does start automatically when solenoid B is selected.

Cause	Correction
The electrical connection from the fire protection system to Terminal Board TB 9 has failed.	Test continuity and insulation from ground between the fire protection system and the engine control panel. Locate and repair any electrical fault in the field wiring or in the fire protection system panel.
	
The electrical connection from Terminal Board TB 9 to Relay K1 has failed.	Test continuity and insulation from ground between the TB 9 and Relay K1. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Relay K1 has failed.	Check de-energized continuity at Relay K1 pin 87 to 30. Replace K1 if the circuit is open.
	
Contact an Authorized Cummins Repair Facility.	

Auto Start Failure - Does not Crank on B

NOTE: The fire pump engine will not crank automatically when solenoid B is selected at the fire protection system. However, it does start automatically when solenoid A is selected.

Cause	Correction
The electrical connection from the fire protection system to Terminal Board TB 10 has failed.	Test continuity and insulation from ground between the fire protection system and the engine control panel. Locate and repair any electrical fault in the field wiring or in the fire protection system panel.
	
The electrical connection from Terminal Board TB 10 to Relay K2 has failed.	Test continuity and insulation from ground between the TB 10 and Relay K2. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Relay K2 has failed.	Check de-energized continuity at Relay K2 pin 87 to 30. Replace K1 if the circuit is open.
	
Contact an Authorized Cummins Repair Facility.	

Auto Start Failure - Does not Crank on A or B

NOTE: The fire pump engine will not crank automatically when either solenoid A or solenoid B is selected at the fire protection system. However, it does crank and start when started locally. If local starting problems are identified, go to the applicable Manual Start Failure troubleshooting table.

Cause	Correction
The Fire Protection System fails to produce either redundant start signal to the fire pump.	Locate and correct the common mode fault in the Fire Protection System.

Auto Start Failure – Cranks but does not Start

NOTE: The fire pump engine will crank automatically when either solenoid A or solenoid B is selected at the fire protection system. However, the engine does not start. The engine will start locally. If local starting problems are identified, go to the applicable Manual Start Failure troubleshooting table.

Cause	Correction
The overspeed switch as actuated. The overspeed lamp is illuminated on the local control panel.	Press the RESET switch on the local control panel.
	
Control power from the Fire Protection System is not available at local control panel TB1.	When practical, locate and correct the fault in the Fire Protection System or the field wiring to the local control panel.
	
Circuit Breaker CB is open in the local control panel.	Check whether Circuit Breaker CB at the local control panel is open. Refer to Drawing 10423 Sheet 1 in Section 13. If open, reset the circuit breaker. Locate and correct any electrical faults in the control panel. Press the RESET switch on the local control panel.
	
The AUTO/MANUAL Rocker Switch fails to select AUTO mode.	When practical, open Circuit Breaker CB at the local control panel and test switch operation electrically. Refer to Drawing 10423 Sheet 1 in Section 13. If required, replace the switch or repair other electrical faults. When done, close Circuit Breaker CB at the local control panel and reset rocker switch to AUTO mode.
	

Auto Start Failure – Cranks but does not Start

Cause	Correction
The overspeed switch has failed.	Check power and grounding to the overspeed switch. Refer to Drawing 10423 Sheet 1 in Section 13. Repair any electrical faults. If required, test and adjust the overspeed setting. Refer to Overspeed Setpoint Adjustment and Testing in Section 3. Replace the overspeed switch. Refer to Overspeed Switch Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Auto Start Failure – Engine Starts but Crank Terminate does not Occur

Cause	Correction
The overspeed switch not correctly adjusted or has failed.	When practical, with the engine running, verify speed sensor input to the overspeed switch. Refer to Drawing 10423 Sheet 1 in Section 13. If signal is not present, go to The speed sensor has failed. The tachometer also indicates zero speed in this table. Adjust the overspeed switch crank terminate setpoint. Refer to Overspeed Setpoint Adjustment and Testing in Section 3. If required, replace the overspeed switch. Refer to Overspeed Switch Removal/Installation in Section 7.
	
Fuse 3 has opened. The raw water solenoid valve also fails to open.	Open the raw water bypass valves. When practical, replace Fuse F3. Locate and repair any local electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
The speed sensor has failed. The tachometer also indicates zero speed.	When practical, locate and repair any electrical fault in the speed sensor circuitry. Refer to Drawing 10423 Sheet 1 in Section 13. If necessary, replace the speed sensor. Refer to Speed Sensor Removal/Installation in Section 7.
	
An electrical fault is present in the Fire Protection System.	When practical, test continuity and insulation from ground in the fire protection system and the engine control panel. Locate and repair any electrical fault in the fire protection system panel.
	
An electrical fault is present between Control Panel TB 2 and the Fire Protection System.	When practical, test continuity and insulation from ground between the fire protection system and the engine control panel. Locate and repair any electrical fault in the field wiring.
	

Auto Start Failure – Engine Starts but Crank Terminate does not Occur (Cont)

An electrical fault is present in the control panel between Fuse F3 and TB 2.	When practical, test continuity and insulation from ground between Fuse F3 and TB 2. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Contact an Authorized Cummins Repair Facility.	

Manual Start Failure from Solenoid Lever - Does not Crank on A

NOTE: The fire pump engine will not crank locally from the solenoid lever when solenoid A is actuated. However, it does start when solenoid B is actuated.

Cause	Correction
Battery A is discharged or has failed.	Recharge or replace the battery.
	
An electrical fault is present between Battery A and the starter motor.	When practical, test continuity and insulation from ground between Battery A and the starter motor. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Solenoid A's switch contact does not close.	Remove and test Solenoid A lever and switch operation. Refer to Crank Solenoid Assembly Removal/Installation in Section 7. If required, replace Solenoid A.
	
Contact an Authorized Cummins Repair Facility.	

Manual Start Failure from Solenoid Lever - Does not Crank on B

NOTE:: The fire pump engine will not crank locally from the solenoid lever when solenoid B is actuated. However, it does start when solenoid A is actuated.

Cause	Correction
Battery B is discharged or has failed.	Recharge or replace the battery.
	
An electrical fault is present between Battery B and the starter motor.	When practical, test continuity and insulation from ground between Battery B and the starter motor. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Solenoid B's switch contact does not close.	Remove and test Solenoid B lever and switch operation. Refer to Crank Solenoid Assembly Removal/Installation in Section 7. If required, replace Solenoid B.
	
Contact an Authorized Cummins Repair Facility.	

Manual Start Failure from Solenoid Lever - Does not Crank on A or B

NOTE: The fire pump engine will not crank locally when either solenoid lever is actuated.

Cause	Correction
Starter motor has failed.	Replace the starter motor. Refer to Starter Motor Removal/Installation in Section 7.
	
An electrical fault is present in the power or ground circuit for the starter motor.	Test continuity and insulation from ground between the battery splice, the ground connection, and the starter motor. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Engine is seized.	Bar the engine over to break the seizure.
	
Contact an Authorized Cummins Repair Facility.	

Manual Start Failure from Control Panel - Does not Crank on A

NOTE: The fire pump engine will not crank locally from the control panel when CRANK BATT A is selected. However, it does start when CRANK BATT B is selected.

Cause	Correction
The CRANK BATT A switch fails to make contact.	When practical, test the electrical operation of the CRANK BATT A switch. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the switch if faulted.
	
Relay K1 fails in the local manual mode.	When practical, test the electrical operation of the Relay K1. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the relay if faulted.
	
Solenoid A fails to energize due to electrical fault in the power or ground circuit.	Test continuity and insulation from ground between the CRANK BATT A switch, Relay K1, and the starter Solenoid. Also, check the solenoid coil connection to ground. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Solenoid A fails to operate.	When practical, test the electrical operation of the Solenoid A. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the solenoid if faulted.
	
Contact an Authorized Cummins Repair Facility.	

Manual Start Failure from Control Panel - Does not Crank on B

NOTE: The fire pump engine will not crank locally from the control panel when CRANK BATT B is selected. However, it does start when CRANK BATT A is selected.

Cause	Correction
The CRANK BATT B switch fails to make contact.	When practical, test the electrical operation of the CRANK BATT B switch. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the switch if faulted.
	
Relay K2 fails in the local manual mode.	When practical, test the electrical operation of the Relay K2. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the relay if faulted.
	
Solenoid B fails to energize due to electrical fault in the power or ground circuit.	Test continuity and insulation from ground between the CRANK BATT B switch, Relay K2, and the starter Solenoid. Also, check the solenoid coil connection to ground. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Solenoid B fails to operate.	When practical, test the electrical operation of the Solenoid B. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the solenoid if faulted.
	
Contact an Authorized Cummins Repair Facility.	

Manual Start Failure from Control Panel - Does not Crank on A or B

NOTE: The fire pump engine will not crank locally from the control panel when either CRANK BATT A or CRANK BATT B is selected. However, it does start when a solenoid lever is actuated.

Cause	Correction
The MANUAL mode rocker switch contact fails to close.	When practical, test the electrical operation of the AUTO/MANUAL rocker switch. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the solenoid if faulted.
	
An electrical fault exists in the signal power circuit or the ground to the Relays K1 and K2.	Test continuity and insulation from ground between the AUTO/MANUAL rocker switch and the relays. Also, check the relay connection to ground. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Fuse F3 has opened. The raw water solenoid valve also fails to open.	Open the raw water bypass valves. When practical, replace Fuse F3. Locate and repair any local electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
An electrical fault exists in the signal power circuit or the ground to the overspeed switch's crank circuit.	Test continuity and insulation from ground between Fuse F3 and the overspeed switch's crank circuit. Also, check the crank circuit output to the CRANK BATT switches. Locate and repair any electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
	
Overspeed switch crank circuit fails to reset with engine shutdown.	If required, test and adjust the crank setting. Refer to Overspeed Setpoint Adjustment and Testing in Section 3. If required, replace the overspeed switch. Refer to Overspeed Switch Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke)

Verify Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Electronic control module (ECM) is locked up.	Disconnect the battery cables for 30 seconds. Then, reconnect the battery cables, and start the engine.
OK	
Battery voltage supply to the electronic control module (ECM) is low, interrupted, or open.	Check the battery connections, the fuses, and the battery supply circuit.
OK	
No fuel in supply tank.	Check and replenish fuel supply. Check fittings and hose connections and hose conditions.
OK	
Air is in the fuel system.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
Fuel drain line is restricted.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
OK	
Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 8.
OK	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke) (Cont)

Cause	Correction
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
	
Fuel injection pump is malfunctioning.	Perform the fuel injection pump test.
	
Fuel injection pump timing is not correct.	Check and adjust the fuel pump timing. Refer to Fuel Adjust Fuel Pump in Section 7.
	
Fuel tank is empty.	Fill the fuel supply tank.
	
Fuel pre-filter is clogged.	Clean the customer-supplied fuel pre-filter.
	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
	
Fuel suction line is restricted.	Check the fuel suction line for restriction.
	
Fuel connections on the suction side of the fuel lift pump are loose.	Tighten all the fuel fittings and connections between the fuel tanks and fuel lift pump.
	
Fuel suction standpipe in the fuel tank is broken.	Check and repair the standpipe, if necessary.
	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke) (Cont)

Cause	Correction
Fuel supply is not adequate.	Check the flow through the filter to locate the source of the restriction.
	
Fuel tank air breather hole is clogged.	Clean the fuel tank breather.
	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
	
Injection pump driveshaft or driveshaft key is damaged.	Repair or replace the injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7.
	
Fuel injectors are plugged.	Replace the fuel injectors. Refer to Fuel Injectors Removal/Installation in Section 7.
	
Moisture in the wiring harness connectors.	Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
	
Throttle linkage misadjusted or damaged.	Adjust or repair the linkage.
	
Starting motor rotation is not correct.	Check the direction of crankshaft rotation. Replace the starting motor if necessary. Refer to Starter Motor Assembly Removal/Installation in Section 7.
	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke) (Cont)

Cause	Correction
Starting motor is not turning the engine.	Replace the starting motor if necessary. Refer to Starter Motor Assembly Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Engine Cranks Slowly But Does Not Start

NOTE: Typical engine cranking speed is 120 RPM. Engine cranking speed can be checked with a hand-held tachometer, stroboscope, or electronic service tool.

Cause	Correction
The batteries are cold.	Ensure that the batteries are protected from extreme temperatures.
	
The battery cables or connections are loose, broken, or corroded creating excessive resistance.	Check the battery cables and connections. Ensure that connections are clean and tight.
	
The battery is not properly charged or has failed.	Recharge the battery. If the battery doers not take the charge, replace it.
	
Lubricating oil level is too high.	Check the oil level. Refer to Check Engine Oil Level in Section 5. Drain any excess oil.
	
Lubricating oil is the wrong grade or type.	Check the grade and type of oil. Refer to Lubricating Oil Recommendations and Specifications in Section 10. If the wrong type or grade of oil is present, drain and replace it. Refer to Change Lubricating Oil and Filters in Section 7.
	
Engine temperature is too low.	Troubleshoot as per Coolant Temperature Below Normal (Engine Off) in this section.
	
Starting motor is malfunctioning.	Replace the starting motor. Refer to Starter Motor Assembly Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Engine Difficult to Start or Will Not Start - Exhaust Smoke Present

NOTE: If the engine cranks slowly, refer to Engine Cranks Slowly But Does Not Start in this section.

Cause	Correction
Electronic fault codes are active.	**NOTE**: For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
Fuel tank level is low.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
	
Fuel drain line is restricted.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
	
Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
	
Fuel injection pump is malfunctioning.	Perform the fuel injection pump test.
	
Fuel injection pump timing is not correct.	Check and adjust the fuel pump timing. Refer to Fuel Adjust Fuel Pump in Section 7.
	

Engine Difficult to Start or Will Not Start - Exhaust Smoke Present (Cont)

Cause	Correction
Fuel pre-filter is clogged.	Clean the customer-supplied fuel pre-filter.
OK	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
OK	
Fuel suction line is restricted.	Check the fuel suction line for restriction.
OK	
Fuel connections on the suction side of the fuel lift pump are loose.	Tighten all the fuel fittings and connections between the fuel tanks and fuel lift pump.
OK	
Fuel suction standpipe in the fuel tank is broken.	Check and repair the standpipe, if necessary.
OK	
Fuel tank air breather hole is clogged.	Clean the fuel tank breather.
OK	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	
Fuel injectors are plugged.	Replace the fuel injectors. Refer to Fuel Injectors Removal/Installation in Section 7.
OK	
Throttle linkage misadjusted or damaged.	Adjust or repair the linkage.
OK	

Engine Difficult to Start or Will Not Start - Exhaust Smoke Present (Cont)

Cause	Correction
Intake air flow is restricted.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 7. Replace the air filter if required.
	
Exhaust air flow is restricted.	Check the exhaust air piping for restriction. Remove any restriction.
	
Contact a Cummins Authorized Repair Facility.	

Engine Acceleration or Response Poor

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Fuel drain line is restricted.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
OK	
Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
OK	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Fuel injection pump is malfunctioning.	Perform the fuel injection pump test.
OK	
Fuel injection pump timing is not correct.	Check and adjust the fuel pump timing. Refer to Adjust Fuel Pump in Section 7.
OK	
Fuel pre-filter is clogged.	Clean the customer-supplied fuel pre-filter.
OK	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
OK	

Engine Acceleration or Response Poor (Cont)

Cause	Correction
Fuel suction line is restricted.	Check the fuel suction line for restriction.
	
Fuel connections on the suction side of the fuel lift pump are loose.	Tighten all the fuel fittings and connections between the fuel tanks and fuel lift pump.
	
Fuel suction standpipe in the fuel tank is broken.	Check and repair the standpipe, if necessary.
	
Fuel tank air breather hole is clogged.	Clean the fuel tank breather.
	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
	
Fuel injectors are plugged.	Replace the fuel injectors. Refer to Fuel Injectors Removal/Installation in Section 7.
	
Throttle linkage misadjusted or damaged.	Adjust or repair the linkage.
	
Intake air flow is restricted.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 7. Replace the air filter if required.
	

Engine Acceleration or Response Poor (Cont)

Cause	Correction
Exhaust air flow is restricted.	Check the exhaust air piping for restriction. Remove any restriction.
	
Exhaust air is leaking.	Check the exhaust piping for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. If required, replace the turbocharger. Refer to Turbocharger Removal/Installation in Section 7.
	
The charge air cooler is restricted or leaking.	Inspect the charge air cooler for air restrictions or leaks. If required, replace the charge air cooler. Refer to Charge Air Cooler Removal/Installation in Section 7.
	
Refer to a Cummins Authorized Repair Facility.	

Engine Noise Excessive – Mechanical

Cause	Correction
Lubricating oil is thin or diluted.	Check the oil level. Refer to Check Lubricating Oil Level in Section 7. If the oil level is above the high mark, go to Oil Level Rises in this section. Otherwise, ensure that the correct type and grade of lubricating oil is being used. Refer to the Lubricating Oil Recommendations and Specifications in Section 10.
OK	
Lubricating oil pressure is below specification.	**NOTE:** Oil pressure should range between 69 and 345 kPa [10 to 50 PSI] with the engine running. Check the oil pressure on the local control panel. If the pressure is low, refer to the Lubricating Oil Pressure Low symptom tree in this section.
OK	
Vibration damper is damaged.	Inspect the vibration damper. Refer to Inspect Vibration Damper in Section 5. If the vibration damper is damaged, refer to a Cummins Authorized Repair Facility.
OK	
Engine mounts are worn or damaged.	Inspect the engine mounts. If the engine mounts are worn or damaged, refer to a Cummins Authorized Repair Facility. Refer to Service Assistance in Section 9.
OK	
Coolant temperature is above specification.	Check the coolant temperature indication on the local control panel. If the high coolant temperature light is illuminated, refer to the Coolant Temperature Above Normal symptom tree in this section.
OK	

Engine Noise Excessive – Mechanical (Cont)

Cause	Correction
Drive belt is squeaking due to insufficient tension or high loading.	Check the automatic belt tensioner. If required, replace the tensioner. Refer to Automatic Belt Tensioner Removal/Installation in Section 7.
	
Intake air flow is restricted.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 7. Replace the air filter if required.
	
Exhaust air flow is restricted.	Check the exhaust air piping for restriction. Remove any restriction.
	
Air leakage between the turbocharger and head.	Tighten the clamp between turbocharger and head. Repair leaks between turbocharger and head.
	
Turbocharger does not rotate freely.	Replace the turbocharger. Refer to Turbocharger Removal/Installation in Section 7.
	
Contact a Cummins Authorized Repair Facility.	

Engine Noise Excessive — Combustion Knocks

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
Engine is overloaded.	Check for added mechanical loading from damaged or defective pump, changes in suction head, or changes in discharge piping restriction.
	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine using the correct fuel. Refer to Fuel Recommendations and Specifications in Section 10.
	
Air in present in the fuel supply to the engine.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
	
The fuel injection pump's timing is not correct.	Check and adjust the fuel injection pump timing. Refer to Adjust Fuel Pump in Section 7.
	
The fuel injection pump is failing.	Replace the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7.
	

Engine Noise Excessive — Combustion Knocks (Cont)

Cause	Correction
Coolant temperature is below specification.	Refer to the Coolant Temperature Below Normal (Engine Running) symptom tree in this section.
OK	
Contact an Authorized Cummins Repair Facility.	

Engine Runs Rough at Idle

NOTE: Operation at idle speed is for maintenance only.

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Engine is cold.	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal (Engine Running) symptom tree.
OK	
Idle speed is set too low.	Adjust the idle speed. Refer to Programmable Features and Parameters Not Correct in Section 7.
OK	
Air is present in the fuel system.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
Fuel filter is becoming plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
OK	
Fuel supply to the engine is inadequate.	Locate and correct the restriction in fuel flow to the engine.
OK	

Engine Runs Rough at Idle (Cont)

Cause	Correction
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	
Engine mounts are worn or damaged.	Check the engine mounts. If damaged, refer to a Cummins Authorized Repair Facility.
OK	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine on the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary. Refer to Fuel Return Overflow Valve Removal/Installation in Section 7.
OK	
Fuel injection pump timing is incorrect.	Check and adjust the injection pump timing. Refer to Adjust Fuel Pump in Section 7.
OK	
Injector is malfunctioning.	Inspect the injectors. Replace the injectors as necessary. Refer to Fuel Injectors Removal/Installation in Section 7.
OK	
Fuel injection pump is malfunctioning.	Remove the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Check the calibration of the fuel injection pump. Replace the pump if necessary.
OK	
Contact a Cummins Authorized Repair Facility.	

Engine Runs Rough or Misfires Under Load

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Engine is cold.	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal (Engine Running) symptom tree.
OK	
Air is present in the fuel system.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
Fuel filter is becoming plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
OK	
Fuel supply to the engine is inadequate.	Locate and correct the restriction in fuel flow to the engine.
OK	
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	

Engine Runs Rough or Misfires Under Load (Cont)

Cause	Correction
Engine mounts are worn or damaged.	Check the engine mounts. If damaged, refer to a Cummins Authorized Repair Facility.
OK	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine on the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary. Refer to Fuel Return Overflow Valve Removal/Installation in Section 7.
OK	
Fuel injection pump timing is incorrect.	Check and adjust the injection pump timing. Refer to Adjust Fuel Pump in Section 7.
OK	
Injector is malfunctioning.	Inspect the injectors. Replace the injectors as necessary. Refer to Fuel Injectors Removal/Installation in Section 7.
OK	
Fuel injection pump is malfunctioning.	Remove the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Check the calibration of the fuel injection pump. Replace the pump if necessary.
OK	
Contact a Cummins Authorized Repair Facility.	

Engine Speed Surges at Idle

NOTE: Operation at idle speed is for maintenance only.

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Fuel level is low in the tank.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
OK	
Engine idle speed is set too low.	Adjust the idle speed. Refer to Programmable Features and Parameters Not Correct in Section 7.
OK	
Air is in the fuel supply to the engine.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
The fuel filter is plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
OK	
Fuel flow to the engine is not adequate.	Locate and correct the restriction in the customer-supplied fuel lines to the engine.
OK	
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	

Engine Speed Surges at Idle (Cont)

Cause	Correction
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine with the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
The fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Calibrate the fuel pump. If required, replace the fuel injection pump.
OK	
A fuel supply line restriction exists between the fuel injection pump and the injectors.	Check the fuel supply line or passage for sharp bends or restriction. Remove any restrictions.
OK	
A fuel injector is malfunctioning.	Replace the malfunctioning injector. Refer to Fuel Injectors Removal/Installation in Section 7.
OK	
Moisture is present in the wiring harness connectors.	Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
OK	
Contact a Cummins Authorized Repair Facility.	

Engine Speed Surges Under Load

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes LATER in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Pump suction head or pump discharge head changes.	Some variation in speed response to load changes is normal. Excessive speed changes may occur upon sudden failures in either suction or discharge piping systems.
OK	
Fuel level is low in the tank.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
OK	
Air is in the fuel supply to the engine.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
The fuel filter is plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
OK	
Fuel flow to the engine is not adequate.	Locate and correct the restriction in the customer-supplied fuel lines to the engine.
OK	

Engine Speed Surges Under Load (Cont)

Cause	Correction
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine with the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
	
The fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Calibrate the fuel pump. If required, replace the fuel injection pump.
	
A fuel supply line restriction exists between the fuel injection pump and the injectors.	Check the fuel supply line or passage for sharp bends or restriction. Remove any restrictions.
	
A fuel injector is malfunctioning.	Replace the malfunctioning injector. Refer to Fuel Injectors Removal/Installation in Section 7.
	
Moisture is present in the wiring harness connectors.	Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
	
Contact a Cummins Authorized Repair Facility.	

Engine Vibration Excessive at Rated Speed

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Engine runs rough or is misfiring.	Refer to the Engine Runs Rough or Misfires Under Load symptom tree in this section.
OK	
Fuel injection pump is adjusted incorrectly.	Adjust or replace the injection pump. Refer to Adjust Fuel Pump and/or Fuel Injection Pump Removal/ Installation in Section 7.
OK	
Engine mounts are worn or damaged.	Inspect the engine mounts. Refer to Check Engine Mounting Bolts in Section 7. Replace the engine mounts as needed. Refer to a Cummins Authorized Repair Facility.
OK	
Vibration damper is malfunctioning.	Inspect the vibration damper. Refer to Inspect Vibration Damper in Section 10. Replace, if necessary. Refer to a Cummins Authorized Repair Facility.
OK	
Alternator bearing is worn or damaged.	Check if the alternator is vibrating excessively. Replace the alternator if necessary. Refer to Alternator Removal/Installation in Section 7.
OK	

Engine Vibration Excessive at Rated Speed (Cont)

Cause	Correction
Water pump bearing is worn or damaged.	Check if the water pump is vibrating excessively. Replace the pump if necessary. Refer to Water Pump Removal/Installation in Section 7.
	
Automatic belt tensioner bearing is worn or damaged.	Check if the belt tensioner is vibrating excessively. Replace the tensioner if necessary. Refer to Automatic Belt Tensioner Removal/Installation in Section 7.
	
Contact a Cummins Authorized Repair Facility.	

Engine Stops During Operation

Cause	Correction
Normal automatic mode shutdown occurs when the fire protection systems removes the signal power feed to the local control panel.	No action is required. This is a desirable outcome.
	
The selected engine control module (ECM) has detected a serious fault condition. The ECM's STOP light is displayed.	For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
In the automatic mode, the signal power feed is lost from the fire protection system to the control panel.	Locate and correct the electrical fault in the fire protection system or the field wiring to the engine control panel.
	
Signal power is lost by the operation of the circuit breaker the engine control panel.	Press the circuit breaker reset button on the engine control panel. Locate and correct the electrical fault in engine control panel. Refer to Drawing 10423 Sheet 1 in Section 13.
	
An overspeed trip has occurred. The overspeed trip light is illuminated on the local control panel. Remote indications may also be present. Alternatively, a related overspeed switch failure has occurred. The trip indications may not be present.	Go to Engine Overspeed Trip in this section.
	
Power supply or grounding fault exists at the Electronic Control Module.	Locate and correct the electrical fault in the power supply or grounding for the Electronic Control Module.
	

Engine Stops During Operation (Cont)

Cause	Correction
The selected ECM has failed.	Select the alternate ECM. When practical, replace the failed ECM. Refer to the Electronic Control Module (ECM) (Primary) Removal/Installation or Electronic Control Module (ECM) (Secondary) Removal/Installation in Section 7.
	
Fuel tank level is low.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
	
Clogged fuel tank air breather hole.	Clean the fuel tank breather.
	
Customer-supplied fuel pre-filter is clogged.	Clean the fuel pre-filter. Fill and bleed the fuel lines to the engine.
	
Fuel piping to engine is clogged.	Clean and repair the fuel piping to the engine.
	
The fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
	
Air is trapped in the low pressure fuel lines at the engine.	Bleed the fuel lines. Refer to Air in Fuel in Section 7.
	

Engine Stops During Operation (Cont)

Cause	Correction
Fuel lift pump has failed.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
	
Fuel injection pump has failed.	Replace the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Engine Will Not Reach Rated Speed (RPM)

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Programmable parameters or selected features are not correct.	Check the programmable parameters and the selected features with an electronic service tool. Set the parameters and features again if necessary. Refer to a Cummins Authorized Repair Facility.
OK	
Load is excessive for engine horsepower rating.	Reduce the engine load.
OK	
Throttle adjustment is not correct.	Check the throttle adjustment. Refer to Section 3.
OK	
Fuel shutoff lever (mechanical) partially engaged.	Make sure fuel shutoff lever is in the RUN position. Refer to Section 3. Replace if necessary.
OK	
Tachometer is not calibrated.	Compare the tachometer reading with a handheld tachometer or an electronic service tool reading. If out of calibration, calibrate the tachometer as necessary at the CAL adjustment on the back of the gauge. Refer to Tachometer Calibration in Section 7.
OK	

Engine Will Not Reach Rated Speed (RPM) (Cont)

Cause	Correction
Tachometer is malfunctioning.	Replace the tachometer. Refer to Tachometer Removal/Installation in Section 7.
	
Engine power output is low.	Refer to the Engine Acceleration or Response Poor symptom tree in this section.
	
Fuel grade is not correct for the application, or the fuel quality is poor.	Operate the engine with the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
	
Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
	
Fuel suction line is restricted.	Check the fuel suction line for restriction.
	
Air-fuel tube leaking, wastegate diaphragm ruptured, or wastegate plumbing damaged.	Tighten the fittings, repair plumbing, replace wastegate diaphragm.
	
Charge air cooler restricted (if equipped).	Inspect the air cooler for internal and external restrictions. Replace the restricted cooler if necessary.
	
Fuel supply is not adequate.	Locate and correct the restriction in the customer-supplied fuel lines to the engine.
	

Engine Will Not Reach Rated Speed (RPM) (Cont)

Cause	Correction
Exhaust back pressure too high.	**NOTE:** The maximum allowable exhaust back pressure is specified in Exhaust System Specifications in Section 10. Measure the exhaust back pressure. Correct the problem is it is above specification.
OK	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	
Fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Calibrate the fuel pump. If required, replace the fuel injection pump.
OK	
Contact an Authorized Cummins Repair Facility.	

Engine Will Not Shut Off Remotely

Cause	Correction
Stop circuit malfunction in the fire pump controller of field wiring.	**NOTE:** In the AUTO mode, the fire pump engine stops upon loss of signal power from the fire pump controller. Check the engine stop circuit in the fire pump controller. Correct any faults. Check for short to voltage on the signal wiring from the fire pump controller to the engine control panel. Correct any faults. Check operation of the switch contacts of the AUTO/MANUAL switch at the engine control panel. Replace the switch if the switch contacts fail to operate properly.
	
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
Engine running on fumes drawn into the air intake.	Identify and isolate the source of the combustible fumes.
	
Contact an Authorized Cummins Repair Facility.	

Engine Will Not Shut Off Locally

Cause	Correction
The AUTOMANUAL Rocker Switch has failed.	**NOTE:** In the MANUAL mode, the fire pump engine stops when the AUTO/MANUIAL switch is returned to the AUTO mode. Check operation of the switch contacts of the AUTO/MANUAL switch at the engine control panel. Replace the switch if the switch contacts fail to operate properly.
OK	
Inadvertent power source is present from the fire pump controller.	**NOTE:** In the MANUAL mode, the fire pump engine stops when the AUTO/MANUIAL switch is returned to the AUTO mode. Check for inadvertent voltage on the wiring to TB 1 at the engine control panel. Correct any wiring errors.
OK	
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Engine running on fumes drawn into the air intake.	Identify and isolate the source of the combustible fumes.
OK	
Contact an Authorized Cummins Repair Facility.	

Excessive Black Exhaust Smoke

Cause	Correction
Electronic fault codes active or high counts of inactive fault codes.	Refer to Section TF - Troubleshooting Fault Codes in the Troubleshooting and Repair Manual, ISB/QSB/QSB Fuel Systems, ISB/QSB/QSB Engines, Bulletin 3666194, or ISB/QSB/QSB Fault Information System Code 111 for fault code information.
	
Electronic control module (ECM) calibration is malfunctioning.	Verify the ECM calibration is correct. Check the calibration revision history for applicable fixes to the calibration stored in the ECM. Refer to the calibration history spreadsheet on QuickServe® Online or the INCAL™ CD-ROM. Compare the calibration stored in the ECM with the engine rating and Control Parts List (CPL), Bulletin 4021326 or 4021327. If necessary, recalibrate the ECM. Refer to ECM Calibration Code (019-032) in the Troubleshooting and Repair Manual, ISB/QSB/QSB Fuel Systems, ISB/QSB/QSB Engines, Bulletin 3666194.
	
Intake manifold pressure (boost) sensor or circuit is malfunctioning.	Check the boost sensor and circuit. Refer to Intake Manifold Pressure Sensor (019-061) in the Troubleshooting and Repair Manual, ISB/QSB/QSB Fuel Systems, ISB/QSB/QSB Engines, Bulletin 3666194.
	
Air intake system restriction is above specification.	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Air Intake Restriction (010-031) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	

Excessive Black Exhaust Smoke (Cont)

Cause	Correction
Air intake or exhaust leaks.	Inspect the air intake and exhaust systems for air leaks. Refer to Air Leaks, Air Intake and Exhaust Systems (010-024) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Charge air cooler is restricted or leaking.	Inspect the charge air cooler for air restrictions or leaks. Refer to Charge-Air Cooler (010-027) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Exhaust system restriction is not within specification.	Check the exhaust system for restrictions. Refer to Exhaust Restriction (011-009) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Fuel drain line restriction.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary. Refer to Fuel Drain Line Restriction (006-012) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Injector is malfunctioning.	Perform the automated cylinder performance test. Replace injectors as necessary. Refer to Injector (006-026) or Engine Testing (In Chassis) (014-008) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	

Excessive Black Exhaust Smoke (Cont)

Cause	Correction
Injectors are not correct.	Remove the injectors and compare the part numbers to the Control Parts List (CPL), Bulletin 3379133 or 4021327. Replace the injectors if necessary. Refer to Injector (006-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Turbocharger oil seal is leaking.	Check the turbocharger compressor and turbine seals. Refer to Turbocharger (010-033) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Turbocharger wheel clearance is out of specification.	Check the radial bearing clearance and axial clearance. Inspect the turbocharger. Repair or replace the turbocharger if necessary. Refer to Turbocharger (010-033) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Turbocharger is not correct.	Check the turbocharger part number and compare it to the Control Parts List (CPL), Bulletin 3379133 or 4021327. Replace the turbocharger if necessary. Refer to Turbocharger (010-033) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Overhead adjustments are not correct.	Measure and adjust the overhead settings. Refer to Overhead Set (003-004) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	

Excessive Black Exhaust Smoke (Cont)

Cause	Correction
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Injector sealing washer is not correct.	Remove the injectors and verify the injector sealing washer thickness. Refer to Injector (006-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Fuel injection timing is not correct.	Check the fuel pump timing. Refer to Fuel Pump Timing (005-037) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump (005-045) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Raw fuel in the intake manifold.	Check the intake manifold for fuel. Refer to Air Intake Manifold (010-023) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00 Locate the fuel source and repair as necessary.
OK	

Excessive Black Exhaust Smoke (Cont)

Cause	Correction
Fuel injection pump is malfunctioning.	Check the pump-to-engine timing. Refer to Fuel Pump Timing (005-037) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Internal engine damage.	Analyze the oil and inspect the filters to locate an area of probable damage. Refer to Lubricating Oil and Filter Analysis (007-083) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Contact an Authorized Cummins Repair Facility.	

Excessive White Exhaust Smoke

Cause	Correction
Electronic fault codes active or high counts of inactive fault codes.	Refer to Section TF - Troubleshooting Fault Codes in the Troubleshooting and Repair Manual, ISB/QSB/QSB Fuel Systems, ISB/QSB Engines, Bulletin 3666194 , or ISB/QSB Fault Information System Codes 284, 283, 382, 369, and 381 for fault code troubleshooting.
OK	
Electronic control module (ECM) calibration is malfunctioning.	Verify the ECM calibration is correct. Check the calibration revision history for applicable fixes to the calibration stored in the ECM. Refer to the calibration history spreadsheet on QuickServe® Online or the INCAL™ CD-ROM. Compare the calibration stored in the ECM with the engine rating and Control Parts List (CPL), Bulletin 4021326 or 4021327. If necessary, recalibrate the ECM. Refer to ECM Calibration Code (019-032) in the Troubleshooting and Repair Manual, ISB/QSB Fuel Systems, ISB/QSB Engines, Bulletin 3666194.
OK	
Engine is cold.	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal symptom tree.
OK	
Engine block heater is malfunctioning.	Check the electrical sources and wiring to the coolant heater. If required, replace the heater. Refer to Coolant Heater Removal/Installation in Section 7.
OK	
Coolant temperature sensor is malfunctioning.	Use an electronic service tool to check the coolant temperature sensor. Refer to Engine Coolant Temperature Sensor (019-019) in the Troubleshooting and Repair Manual, ISB/QSB Fuel Systems, ISB/QSB Engines, Bulletin 3666194.
OK	

Excessive White Exhaust Smoke (Cont)

Cause	Correction
Intake manifold pressure sensor is malfunctioning.	Check the intake manifold pressure sensor. Refer to Intake Manifold Pressure Sensor (019-061) in the Troubleshooting and Repair Manual, ISB/QSB Fuel Systems, ISB/QSB Engines, Bulletin 3666194.
	
Injector is malfunctioning.	Perform the automated cylinder performance test. Replace injectors as necessary. Refer to Injector (006-026) or Engine Testing (In Chassis) (014-008) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Injector shim thickness is not correct.	Remove the injectors and verify the injector shim thickness. Refer to Injector (006-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
	
Fuel filter is plugged.	Measure the fuel pressure before and after the fuel filter. Refer to Fuel Flow (005-011) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	

Excessive White Exhaust Smoke (Cont)

Cause	Correction
Air intake system restriction is above specification.	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Air Intake Restriction (010-031) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Air intake or exhaust leaks.	Inspect the air intake and exhaust systems for air leaks. Refer to Air Leaks, Air Intake and Exhaust Systems (010-024) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Charge air cooler is restricted or leaking.	Inspect the charge air cooler for air restrictions or leaks. Refer Inspect Charge Air Cooler (CAC) in Section 7.
	
Fuel drain line restriction.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary. Refer to Fuel Drain Line Restriction (006-012) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Overhead adjustments are not correct.	Measure and adjust the overhead settings. Refer to Overhead Set (003-004) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	

Excessive White Exhaust Smoke (Cont)

Cause	Correction
Raw fuel in the intake manifold.	Check the intake manifold for fuel. Refer to Air Intake Manifold (010-023) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00 Locate the fuel source and repair as necessary.
	
Injectors are not correct.	Remove the injectors and compare the part numbers to the Control Parts List (CPL), Bulletin 3379133 or 4021327. Replace the injectors if necessary. Refer to Injector (006-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump (005-045) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Coolant is leaking into the combustion chamber.	Refer to the Excessive Coolant Loss symptom tree in this section.
	
Injector protrusion is not correct.	Check the injector protrusion. Refer to Cylinder Head (002-004) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	

Excessive White Exhaust Smoke (Cont)

Cause	Correction
Internal engine damage.	Analyze the oil and inspect the filters to locate an area of probable damage. Refer to Lubricating Oil and Filter Analysis (007-083) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Contact an Authorized Cummins Repair Facility.	

Fuel Consumption Is Excessive

Cause	Correction
Electronic fault codes are active.	**NOTE:** For instructions on how to read active fault codes, refer to Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK	
Fuel is leaking.	Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Repair any leaks.
OK	
Poor-quality fuel is being used.	Assure good-quality No. 2 diesel fuel is being used. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Intake or exhaust restriction.	Refer to troubleshooting logic for Exhaust Smoke Excessive Under Load in this section.
OK	
Defective or clogged injection nozzle.	Replace the defective or clogged injection nozzle.
OK	
Incorrect injection timing.	Adjust injection timing.
OK	
Injection pump is adjusted incorrectly causing excessive injection.	Adjust or replace the injection pump.
OK	

Fuel Consumption Is Excessive (Cont)

Cause	Correction
Hour meter is not calibrated.	Check the hour meter. Calibrate or replace the hour meter if necessary.
	
Air intake or exhaust leaks.	Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Repair any leaks.
	
Air intake system restriction is above specification.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 7. Replace the air filter as necessary.
	
Lubricating oil level above specification.	Check the oil level. Refer to Check Engine Oil Level in Section 5. Drain excess oil and correct the deficiency in maintenance processes.
	
Contact an Authorized Cummins Repair Facility.	

Fuel or Lubricating Oil Leaking From Exhaust Manifold

Cause	Correction
Intake air restriction is high.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 7. Replace the air filter if required.
	
Turbocharger drain line is restricted.	Remove the turbocharger drain line and check for restriction. If required, clean or replace the drain line.
	
Turbocharger oil seal is leaking.	Check the turbocharger for oil seals and for leaks. Refer to the Turbocharger Leaks Engine Oil or Fuel symptom tree in this section.
	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Contaminated

NOTE: If excessive sludge is present in the oilpan, refer to Lubricating Oil Sludge in the Crankcase Excessive in this section.

Cause	Correction
Bulk oil supply is contaminated.	Check the bulk oil supply. Replace it is necessary. Refer to Lubricating Oil Recommendations and Specifications in Section 10. Drain the oil and replace with non-contaminated oil. Also, replace the oil filter. Refer to Change Lubricating Oil and Filters in Section 7.
	
Fuel is present in the lubricating oil.	Refer to the Fuel in Lubricating Oil symptom tree.
	
Coolant is present in the lubricating oil.	Refer to the Coolant in Lubricating Oil symptom tree in this section.
	
Metal is present in the lubricating oil.	Contact an Authorized Cummins Repair Facility.
	
Identify unknown lubricating oil contamination.	Analyze the oil and inspect the filters to identify the contamination. Refer to Lubricating Oil and Filter Analysis in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Fuel in the Lubricating Oil

Cause	Correction
Engine idle time is excessive.	Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes). Shut off the engine rather than idle for long periods. If idle time is necessary, raise the idle speed.
OK	
Injector o-rings are damaged or missing.	Remove and check the injectors. Replace the injector o-rings. Refer to Injector (006-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Injector is malfunctioning.	Perform the single-cylinder cutout test. Replace the injectors as necessary. Refer to Injector (006-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Fuel injection pump is malfunctioning.	Inspect the fuel injection pump for leaks. Replace the fuel pump as necessary. Refer to Fuel Injection Pump, Rotary (005-014) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	

Fuel in the Lubricating Oil (Cont)

Cause	Correction
Internal engine damage.	Analyze the oil and inspect the filters to locate an area of probable damage. Refer to Lubricating Oil and Filter Analysis (007-083) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Contact an Authorized Cummins Repair Facility.	

Coolant in the Lubricating Oil

Cause	Correction
Lubricating oil cooler is leaking.	Remove and pressure test the lubricating oil cooler for coolant leaks. Refer to Lubricating Oil Cooler (007-003) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Cylinder block is cracked or porous.	Inspect the cylinder block. Refer to Cylinder Block (001-026) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Consumption Excessive

Cause	Correction
Crankcase ventilation system is plugged.	Check and clean the crankcase breather and vent tube. Refer to Check Crankcase Breather Tube in Section 7.
OK	
Lubricating oil does not meet specifications for operating conditions.	Change the oil and filters. Refer to Change Lubricating Oil and Filters in Section 7. Use the oil type recommended in Lubricating Oil Recommendations and Specifications in Section 10.
OK	
Lubricating oil drain interval is excessive.	Verify the correct lubricating oil drain interval. Refer to Change Lubricating Oil and Filters in Section 7.
OK	
An external lubricating oil leak is present.	Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace gaskets, if necessary.
OK	
Verify the oil consumption rate.	Check the amount of oil added versus the operating hours.
OK	
The lubricating oil cooler is leaking.	Check the lubricating oil cooler for coolant leaks. Refer to Lubricating Oil Cooler (007-003) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	

Lubricating Oil Consumption Excessive (Cont)

Cause	Correction
Piston rings are not seated correctly (after an engine rebuild or piston installation).	Check blowby. Refer to Engine Testing (Chassis Dynamometer) (014-002) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00. If blowby is excessive, check the piston rings for correct seating. Refer to Piston (001-043) and Piston Rings (001-047) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Piston or piston rings are worn or damaged.	Check for air intake system leaks. Check the pistons and piston rings for wear or damage. Refer to Air Leaks, Air Intake and Exhaust Systems (010-024), Piston (001-043), and Piston Rings (001-047) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
The turbocharger oil seal is leaking.	Check the turbocharger compressor and turbine seals. Refer to Turbocharger (010-033) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Internal engine damage is present.	Analyze the oil and inspect the filters to locate an area of probable damage. Refer to Lubricating Oil and Filter Analysis (007-083) in Troubleshooting and Repair Manual Industrial QSB3.9-30, QSB4.5-30, and QSB5.9-30 Series Engines, Bulletin Number 4021398-00.
OK	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Pressure High

Cause	Correction
Coolant temperature is below specification.	Refer to the Coolant Temperature Below Normal (Engine Running) symptom tree.
	
Lubricating oil does not meet specifications for operating conditions.	Change the oil and filters. Refer to Section 7. Use the oil recommended in Section 10.
	
Lubricating oil pressure switch, gauge, or sensor is malfunctioning or is not in the correct location.	Check the oil pressure switch, gauge, or sensor for correct operation and location.
	
Electronic fault codes are active.	For instructions on how to read active fault codes, refer to Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Pressure Low

Cause	Correction
Lubricating oil does not meet specifications for operating conditions.	Change the oil and filters. Refer to Section 7. Use the oil recommended in Section 10.
	
Lubricating oil is diluted with water.	Check for a missing dipstick, rain caps, or oil fill caps. Change the oil. Refer to the OEM service manual.
	
Lubricating oil filter is plugged.	Change the oil and filter. Refer to Section 7. Use the oil recommended in Section 10.
	
Lubricating oil is contaminated with coolant or fuel.	Refer to the Lubricating Oil Contaminated symptom tree.
	
Lubricating oil leak (external).	Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace gaskets, if necessary. Refer to Section 10 for specifications.
	
Lubricating oil level is above or below specification.	Check the oil level. Add or drain oil, if necessary. Refer to Section 7. Use the oil recommended in Section 10.
	

Lubricating Oil Pressure Low (Cont)

Cause	Correction
Electronic fault codes are active.	For instructions on how to read active fault codes, refer to Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
Lubricating oil pressure switch, gauge, or sensor is malfunctioning or is not in the correct location.	Check the oil pressure switch, gauge, or sensor for correct operation and location.
	
Engine angularity during operation exceeds specification.	Refer to the Engine Data Sheet, OEM service manual, or a Cummins Authorized Repair Facility.
	
Contact an Authorized Cummins Repair Facility.	

Oil Level Rises

NOTE: Oil level may increase due to thermal expansion as the engine warms up and then decrease as the engine cools down. Slight variations due to temperature changes are normal.

Cause	Correction
Excessive oil has been added to the engine.	Drain the excess oil. Refer to Change Lubricating Oil and Filters in Section 7.
	
Fuel is leaking into the oil system.	Troubleshoot as per Lubricating Oil Contaminated in this section.
	
Coolant is leaking into the oil system.	Troubleshoot as per Lubricating Oil Contaminated in this section.
	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Sludge in the Crankcase Excessive

Cause	Correction
Bulk oil supply is contaminated.	Check the bulk oil supply. Drain the oil and replace with non-contaminated oil. Replace the oil filter(s). Use the oil recommended in Section 10.
	
Coolant temperature is below specification.	Refer to the Coolant Temperature Below Normal (Engine Running) symptom tree.
	
Crankcase ventilation system is plugged.	Check and clean the crankcase breather and vent tube. Refer to Section 7.
	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
	
Lubricating oil does not meet specifications for operating conditions.	Change the oil and filters. Refer to Section 7. Use the oil recommended in Section 10.
	
Contact an Authorized Cummins Repair Facility.	

Turbocharger Leaks Engine Oil or Fuel

Cause	Correction
Engine is operating for extended periods under light or no-load conditions (slobbering).	Review the engine operating instructions. Refer to Section 1.
	
Lubricating oil or fuel is entering the turbocharger.	Remove the intake and exhaust piping, and check for oil or fuel. Refer to Section 7.
	
Turbocharger drain line is restricted.	Remove the turbocharger drain line and check for restriction. Clean or replace the drain line. Refer to a Cummins Authorized Repair Facility.
	
Turbocharger oil supply line loose or leaking.	Check and tighten oil supply line fitting(s), if necessary. Refer to a Cummins Authorized Repair Facility.
	
Contact an Authorized Cummins Repair Facility.	

Crankcase Gases (Blowby) - Excessive

Cause	Correction
Crankcase ventilation system is plugged.	Check and clean the crankcase breather and vent tube. Refer to Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Engine Overspeed Trip

NOTE: An engine overspeed trip occurs when the engine's speed exceeds the value specified on the Field Setting Tag described in Section 2. The trip isolates the fuel supply to the engine and it stops immediately. The trip is indicated on the local control panel and inside the local control panel on the speed switch. Additionally, a trip output is supplied to the fire protection system for remote display.

Cause	Correction
Engine actually operated at too great a speed due to catastrophic load failure such as pipe break, pump mechanical failure, or loss of suction.	Correct the cause of the load failure.
	
Engine actually operated at too great a speed due to configuration error.	Check rated speed setting as specified on the Field Setting Tag described in Section 2. Refer to Rated Speed Setpoint Adjustment and Testing in Section 3.
	
Overspeed switch is set at too low a setpoint.	Check overspeed speed setting as specified on the Field Setting Tag described in Section 2. Refer to Overspeed Setpoint Adjustment and Testing in Section 3.
	
Speed switch wiring failure has occurred.	Check continuity and insulation from ground for the signal power wiring and ground wiring to the speed switch. Refer to Drawing 10423 Sheet 1 in Section 13. Replace defective components and repair electrical faults.
	
Speed switch failure has occurred.	If the speed switch fails to operate as per Overspeed Setpoint Adjustment and Testing in Section 3, replace the speed switch. Refer to Overspeed Switch Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Tachometer Does Not Indicate Engine Speed

Cause	Correction
Fuse F4 has opened.	If required, replace Fuse F4. Locate and correct the electrical fault that caused the fuse to operate. Refer to Drawing 10423 Sheet 1 in Section 13.
	
An electrical fault exists in the tachometer power and grounding circuits.	Check continuity and insulation from ground for the power wiring and ground wiring to the tachometer. Refer to Drawing 10423 Sheet 1 in Section 13. Replace defective components and repair electrical faults.
	
An electrical fault exists in the speed sensor input circuit. This fault may also cause a failure in the crank terminate signal to the fire protection system.	Check continuity and insulation from ground for the speed sensor circuit. Refer to Drawing 10423 Sheet 1 in Section 13. Replace defective components and repair electrical faults.
	
The speed sensor has failed.	With the engine running, check the signal from the speed sensor with an oscilloscope or pulse counter. Replace the speed sensor is it has failed. Refer to Speed Sensor Removal/Installation in Section 7.
	
The tachometer has failed.	Check the operation of the tachometer with a pulse generator. Replace the tachometer if it has failed. Refer to Tachometer Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Engine Decelerates Slowly

Cause	Correction
Electronic fault codes are active	For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
Contact an Authorized Cummins Repair Facility.	

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Section 13 – Assembly Drawings (1)

Description	Drawing	Sheet No	Revision
Assembly, FirePump, CFP6E-F15/25/35 (QSB5.9-C275)	8707		G
Assembly, Power Module, QSB	8527		C
Assembly, Mounting, Fire Pump Engine 6B	8579		D
Assembly, Exhaust Shield, QSB5.9, CFP59-F10, F15, F45	8694		A
Assembly, Air Cleaner, QSB5.9	9532		D
Assembly, Pulley Guard, QSB	9820		A
Assembly, Coolant Heating, 6B	8556		C
Assembly, Heat Exchanger Cooling Assembly, CFP06E	8665		E
Assembly, Charge Air Cooler, QSB5.9	8676		E
Hose, Water, CAC Cooler Plumbing, Alternate 03/07	11148		A
Assembly, Raw Water Cooling, ¾" Generic	8682		D
Misc. Piping, Cooling Loop, Raw Water, QSB59	9638		D
Options, Engine, FirePump, Industrial, QSB5.9-C275	8727		B
Engine Sensor Package, 4B/6B/QSB, Non-ECM	9568		A
Assembly, Operator's Station QSB5.9-C275	9583		E
Assembly, Panel, Instrument, 12 VDC, Alternate Beginning 9/06	10452		E
Assembly, Panel, Instrument, 12 VDC, New Effective Date 09/08	13236		
Assembly, Panel, Instrument, 24 VDC, Alternate Beginning 9/06	10453		E
Assembly, Panel, Instrument, 24 VDC, New Effective Date 09/08	13237		
Assembly, Fuel Supply/Return Lines, QSB5.9	9584		E
Fuel Line, ¼" NPT	10235		
Exhaust, 3" Bellows w/ Elbow	8550		C
Assembly, Drive Shaft, SAE#3, 1410	10164		A
Assembly, Drive Shaft, SAE#3, 1480	10165		A
Assembly, Stub-Shaft, SAE #3, 1.50"	8618		B
Assembly, Stub-Shaft, SAE #3, 2.25"	8619		B
Kit, Loose Wires, 4B, 6B, 6C, QSB, QSC	9767		D
General Layout, FirePump, CFP6E	CFP6E_GEN		D
Assembly, Secondary ECM	9505		C
Assembly, Secondary ECM & Switch, Alternate Beginning 04/07	11322		A
Assembly, Secondary ECM Switch, Alternate Beginning 04/07	10748	1-4	D
Harness, CFP6E, Alternate Beginning 04/07	11321-01		C
Harness, CFP6E, Alternate Beginning 04/07	11321-02		C
Harness, CFP6E, Alternate Beginning 04/07	11321-03		C
Harness, CFP6E, Alternate Beginning 04/07	11321-04		C
Schematic, Control Panel Alternate Beginning 4/07	11321_schem		
Schematic, Control Panel, Alternate Beginning 9/06	10423	1-6	E
Harness, Engine	8513	1-2	L

(1): Also see Engine Identification in Section 2 the System Diagrams in Section 6. The most current revisions to these drawings and related documents are accessible at http://www.cumminsfirepower.com/products.html.

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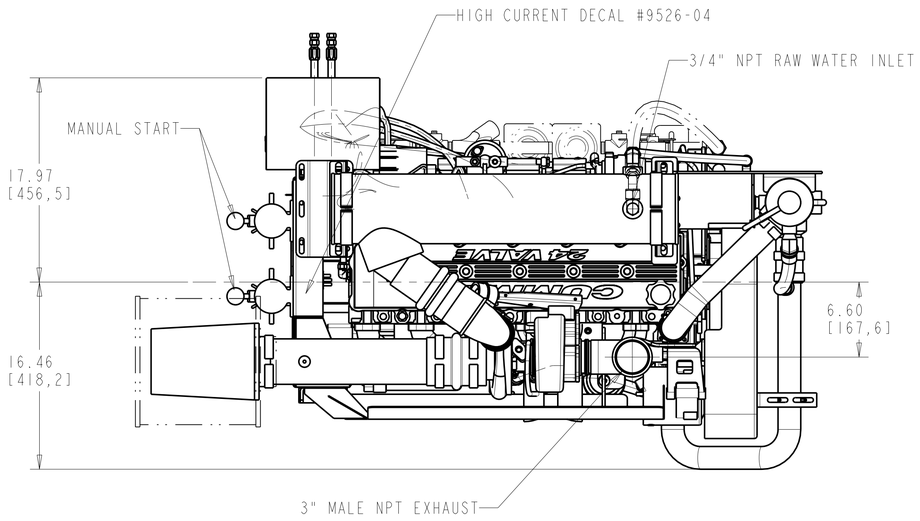
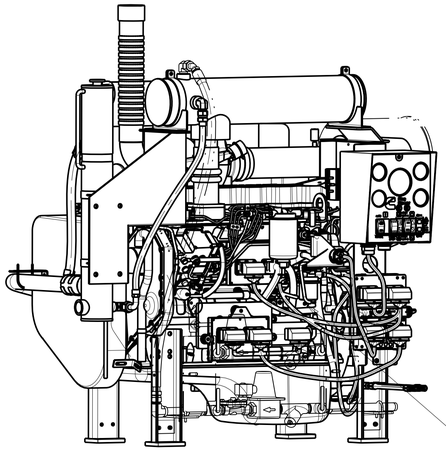
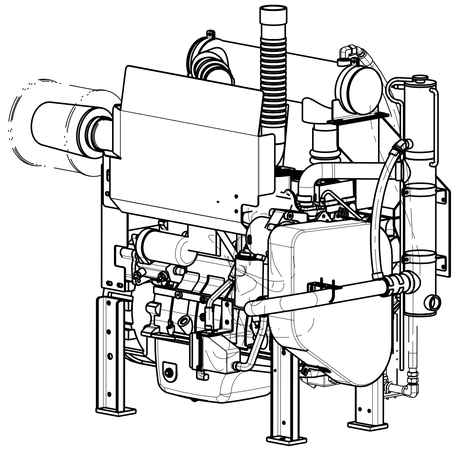
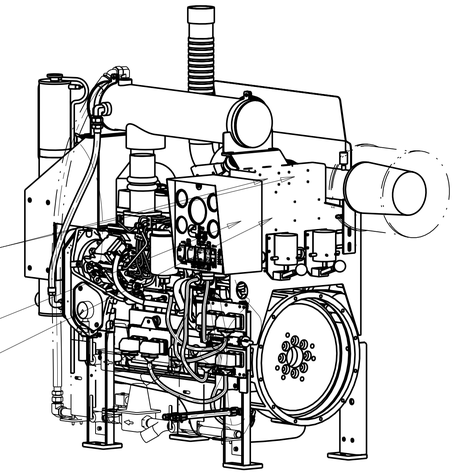
BILL OF MATERIAL

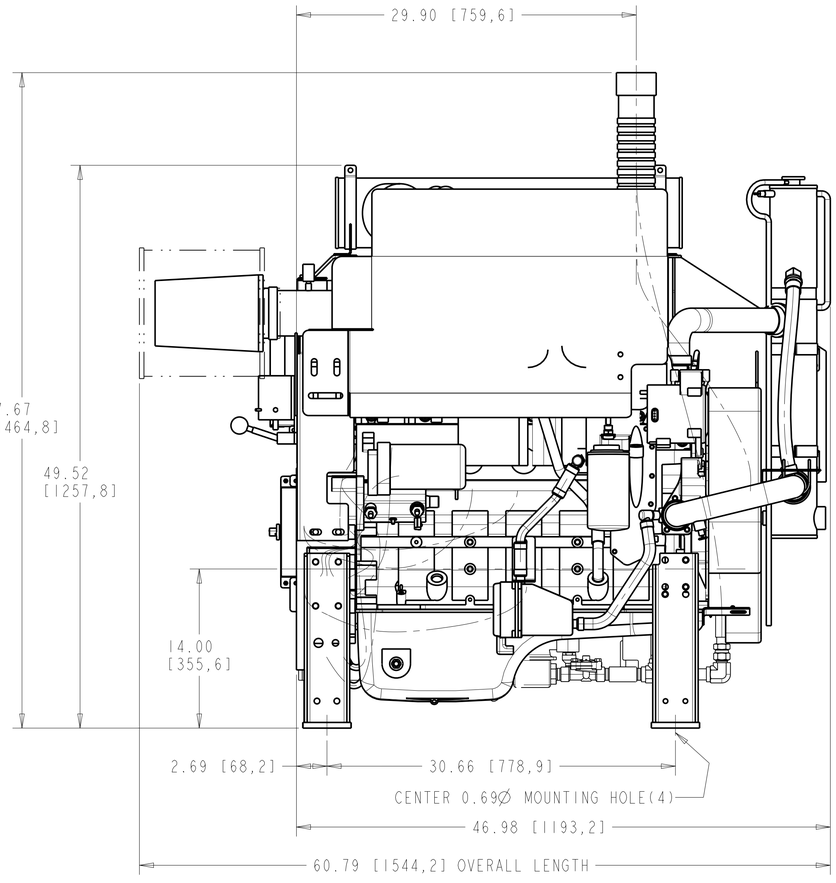
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, POWER MODULE, CFP6E, FIREPUMP	8527
2	1	ASSEMBLY, COOLANT HEATING, 6B	8556
3	1	ASSEMBLY, HEAT EXCHANGER W/O CAC, FIREPUMP, NFP-659	8665
4	1	ASSEMBLY, CHARGE AIR COOLER, QSB5.9, FIREPUMP	8676
5	1	ASSEMBLY, RAW WATER COOLING, 3/4" NPT, FIREPUMP	8682
6	1	ASSEMBLY, ENGINE, QSB5.9, FIREPUMP	8727_ENG
7	1	ASSEMBLY, SENSOR PACKAGE, FIREPUMP	9568_QSB59
8	1	ASSEMBLY, OPERATORS STATION, QS6B5.9, FIREPUMP	9583
9	1	ASSEMBLY, FUEL PLUMBING, QSB5.9, FIREPUMP	9584
10	1	MISC PIPING,COOLING LOOP,RAW WATER,QSB59	9638
11	2	FUEL LINE, #6, 1/4" NPT x 12" LG	10235
12	1	ASSEMBLY, SECONDARY ECM, CFP6E, FIREPUMP	11322

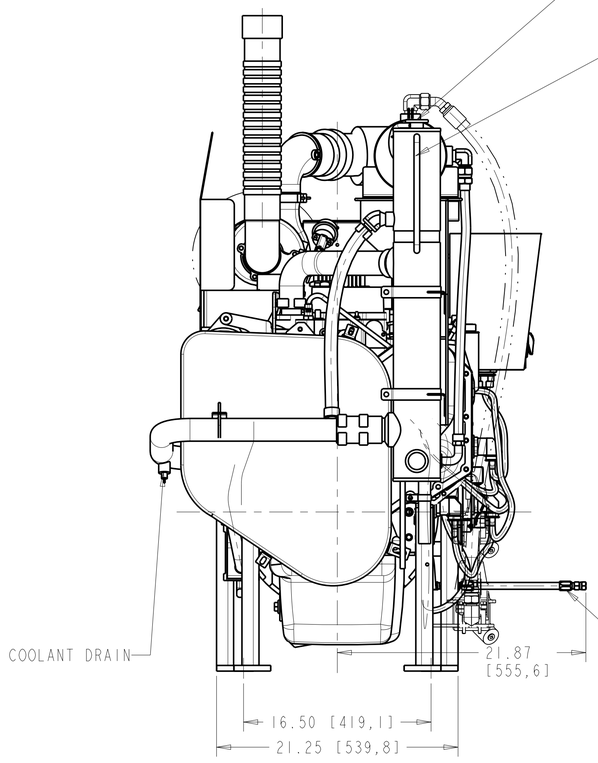


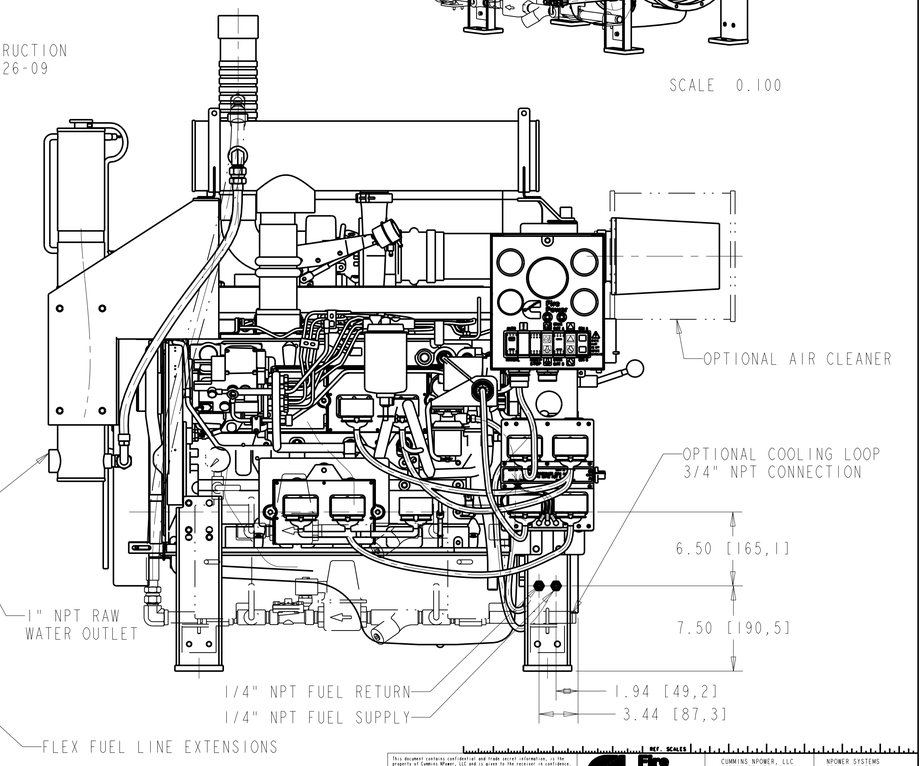












UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS | THIRD ANGLE PROJECTION

REV	DESCRIPTION OF REVISION	REV BY	DATE
G	UPDATED COOLANT LINE PATHWAYS	JDT	19APR07
F	REV PER OP STATION, AIR CLEANER	DAVE N	12DEC06

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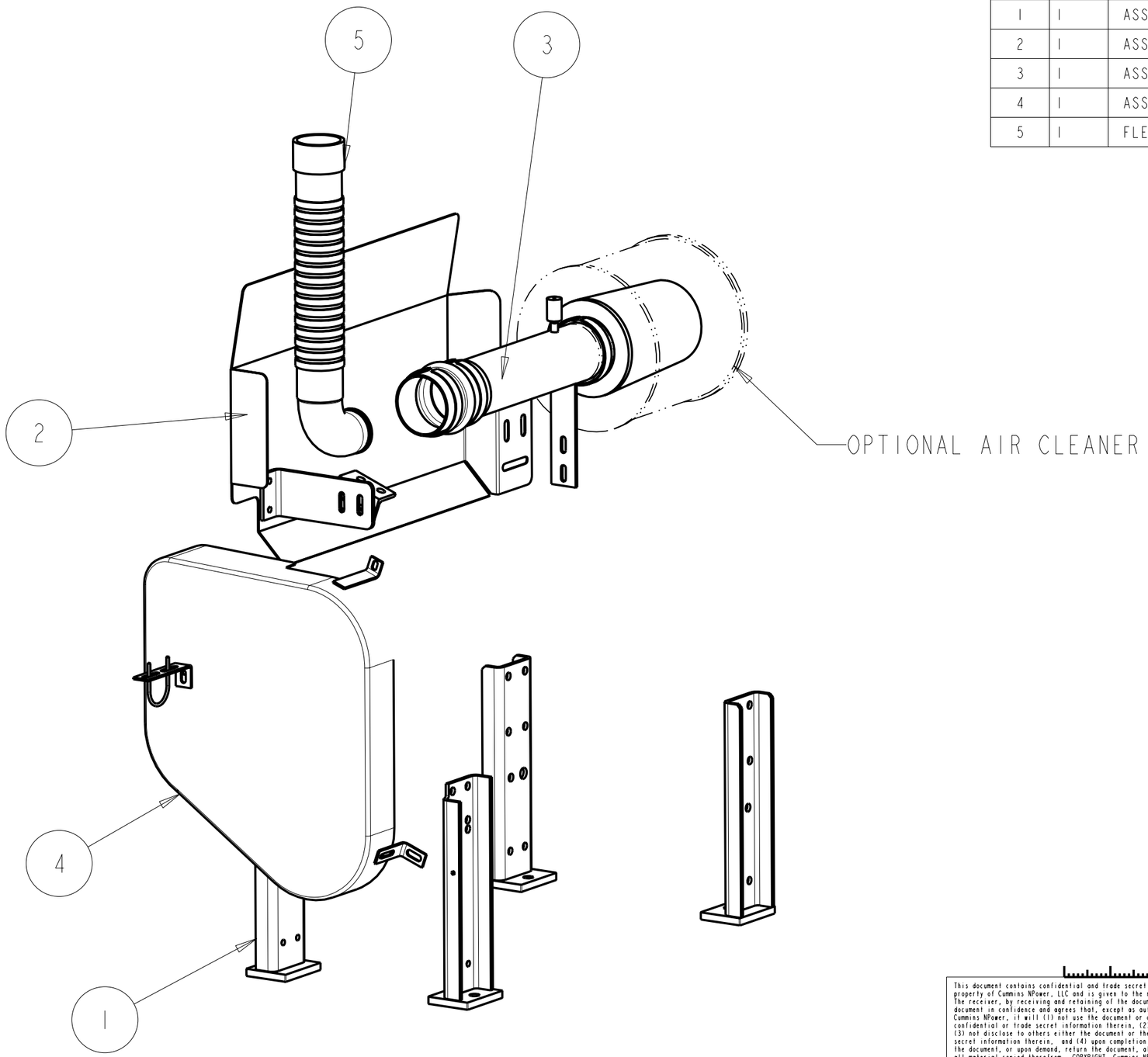
TITLE 1: POWER MODULE, CFP6E-F15/25/35
TITLE 2: FIREPUMP, QSB5.9-C275

DWG UNITS: IN/LB/S | DRAWN BY: DAVE N | DATE: 11MAY2004
APPD BY: | DATE:
EST WEIGHT: 1435.000 | SCALE: 0.150 | DO NOT SCALE | SHEET 1OF1 | DRAWING NO: 8707 | REV: G



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, MOUNTING, ENGINE, FIREPUMP, 6B	8579
2	1	ASSEMBLY, EXHAUST SHIELD, B SERIES, FIREPUMP	8694
3	1	ASSEMBLY, AIR CLEANER, QSB5.9, FIRE PUMP	9532
4	1	ASSEMBLY, PULLEY GUARD, QSB, FIREPUMP	9820
5	1	FLEX, EXHAUST, 3" FLANGE, FIREPUMP	8550

REV	DESCRIPTION OF REVISION	REV BY	DATE
C	REV PER AIR CLEANER	DAVE N	12DEC06

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015	FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

REF. SCALES

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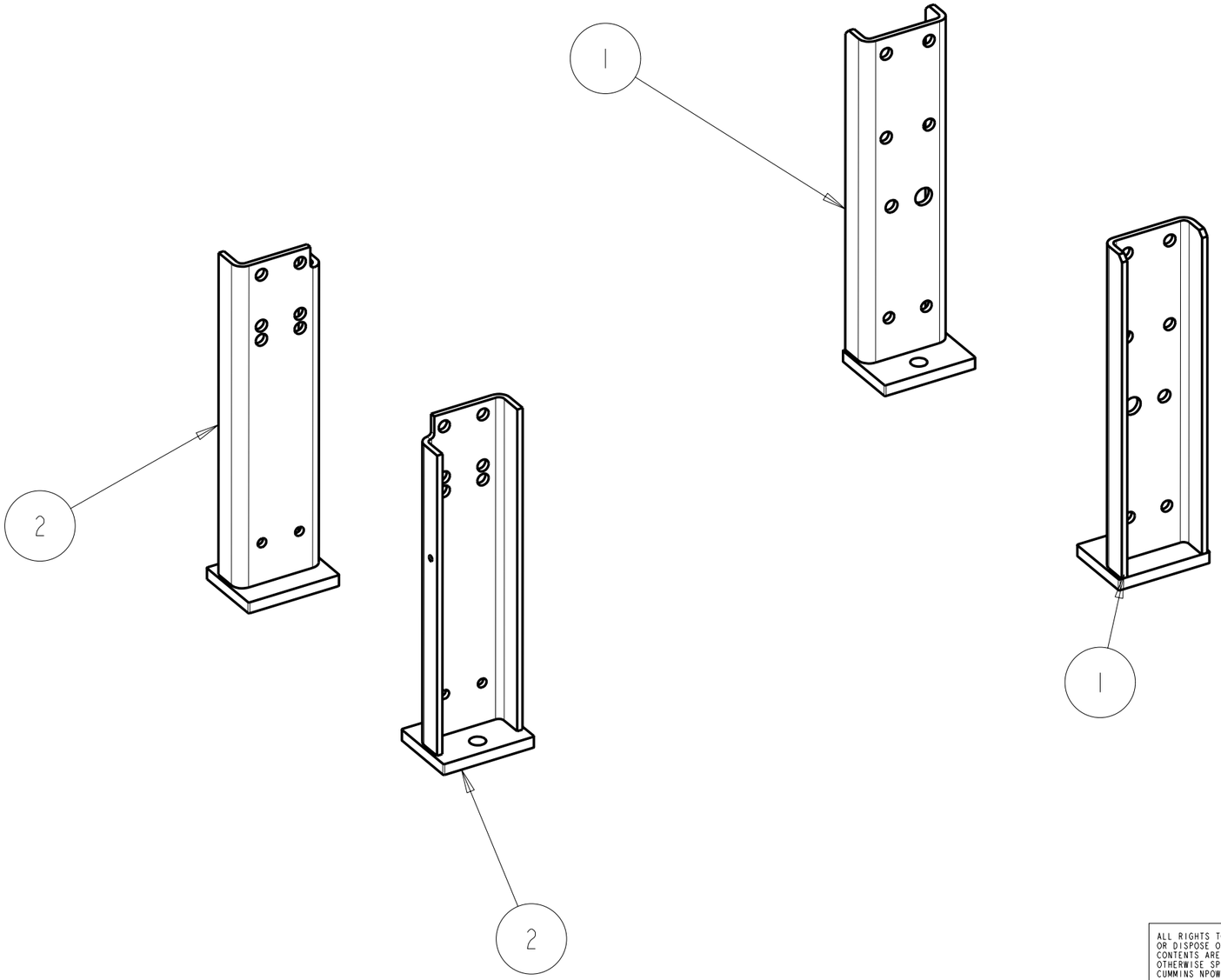
TITLE 1: ASSEMBLY, POWER MODULE, CFP6E
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N				DATE: 21MAR2004
	APPD BY:				DATE:
EST WEIGHT: 77.439	SCALE: 0.125	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8527	REV: C

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	LEG, ENGINE SUPPORT, REAR, FIREPUMP, 6B/4B	8412
2	2	LEG, SUPPORT, ENGINE, FRONT, UNIVERSAL, FIREPUMP, 6B/6C	10576



REV	DESCRIPTION OF REVISION	REV BY	DATE
D	(2) 10576 WAS (1) 8413 & (1) 8414	DAVE N	23NOV05
C	REV PER SUB CONPONENTS	DAVE N	18OCT04

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UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE
ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS

MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001

WELD TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

METRIC UNITS

MACHINE TOLERANCES
X. = ± 1.5
X.X = ± 0.5
X.XX = ± 0.05

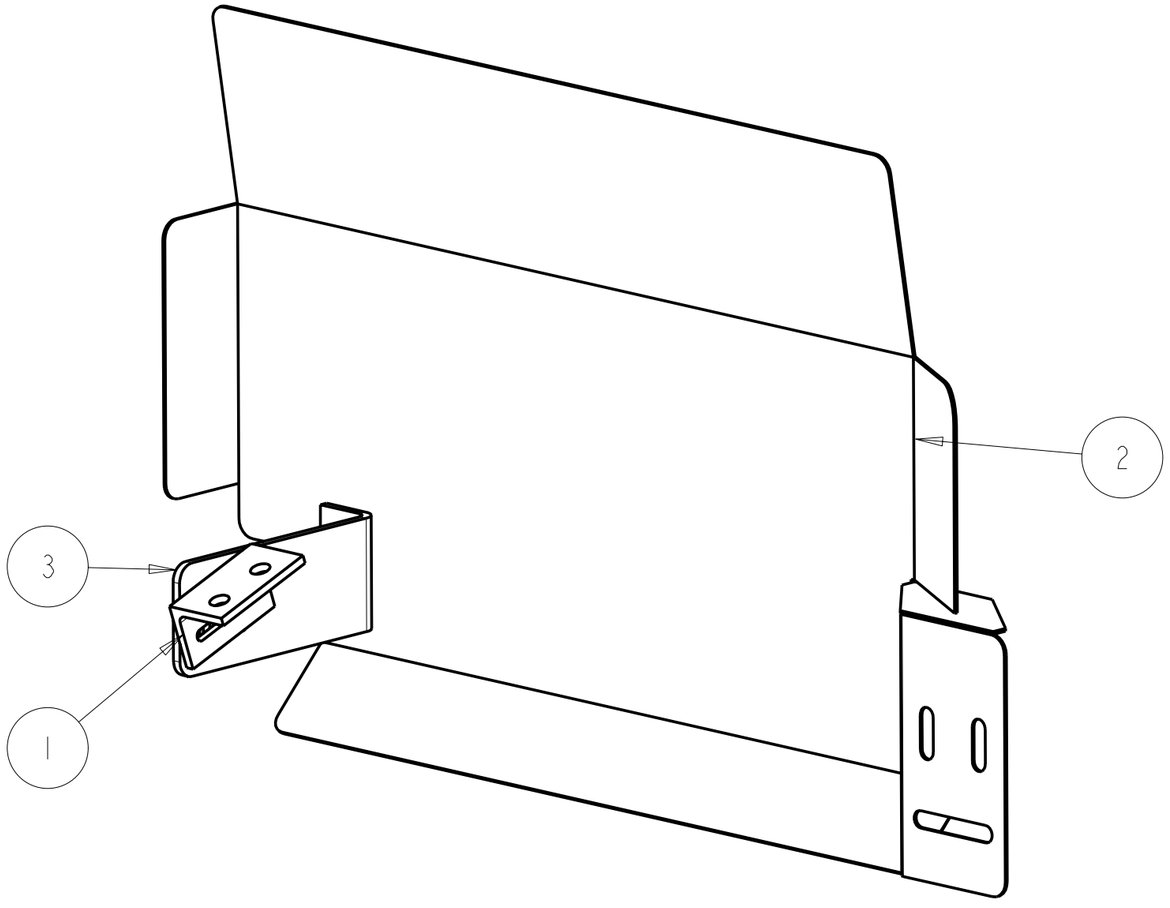
WELDED TOLERANCES
X. = ± 5
X.X = ± 3
X.XX = ± 1.50

TITLE 1: ASSEMBLY, MOUNTING, ENGINE
TITLE 2: FIREPUMP, 6B

DWG UNITS: IN/LB/S
DRAWN BY: S. DANFORTH
DATE: 21MAR2004
APPD BY:
DATE:
EST WEIGHT: 32.834
SCALE: 0.200
DO NOT SCALE
SHEET 1OF1
DRAWING NO: 8579
REV: D

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	BRACKET, STAND-OFF, EXHAUST SHIELD, FIREPUMP	8549
2	1	HEAT SHIEL, TURBO, C8.3, FIREPUMP	9581
3	1	BRACKET, MOUNTING, TURBO GUARD, FIREPUMP	9582



REV	DESCRIPTION OF REVISION	REV BY	DATE
A1	GRAPHICS UPDATE	DAVE N	17MAR05
A	REV PER PANEL BRKT	DAVE N	02SEP04

UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001 ... WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06	MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05 ... WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50

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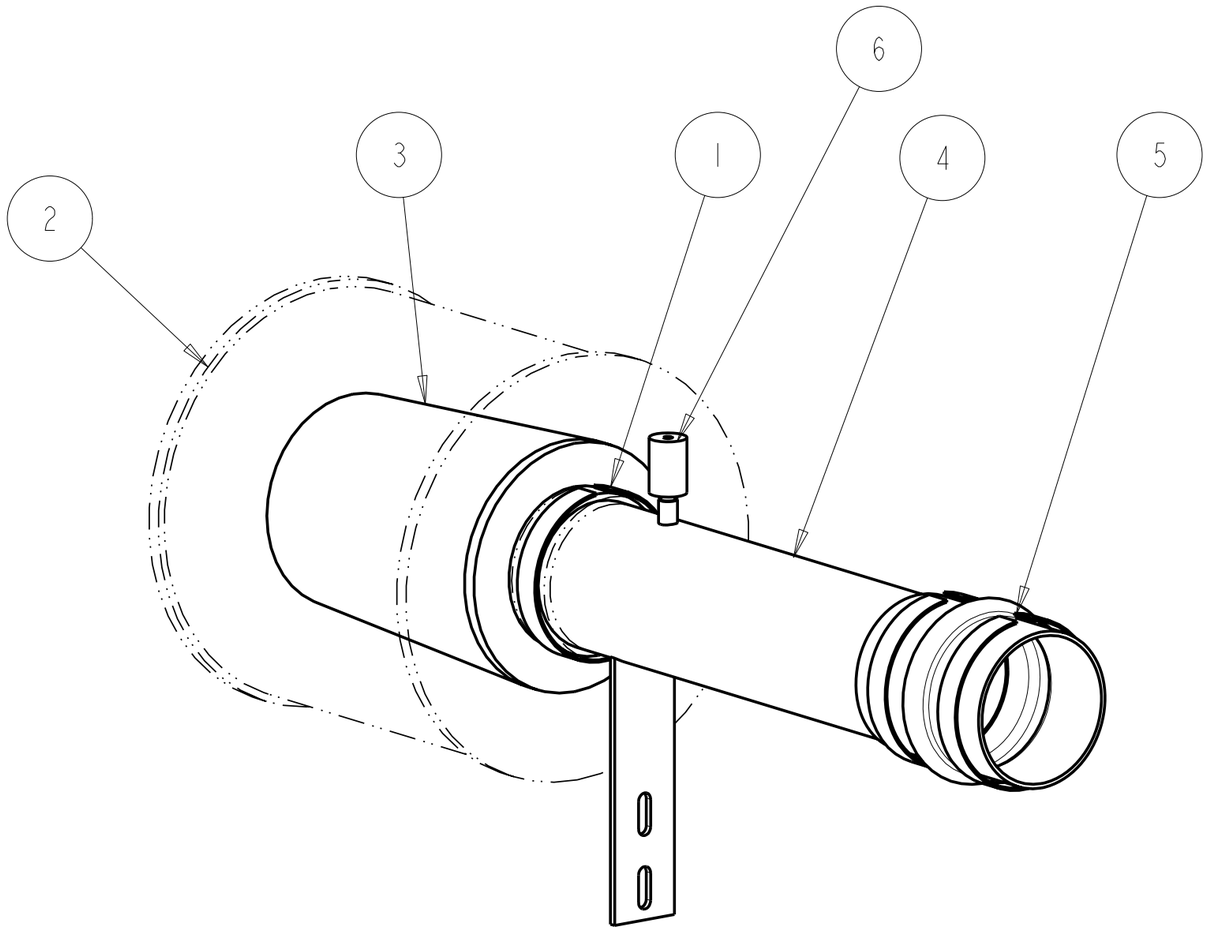
TITLE 1: ASSEMBLY, EXHAUST SHIELD, B SERIES
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N				DATE: 17MAY2004
	APPD BY:				DATE:
EST WEIGHT: 42238.628	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8694	REV: A



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	3	CLAMP, 4" NOMINAL, AC400	8815
2	1	OPTIONAL AIR FILTER, 4" HIGH FLOW, DONALDSON P/N B105006	9525
3	1	AIR FILTER, 4" DIA. INLET, CFP59,6E,83,9E FIREPUMP	9606
4	1	TUBE, AIR CLEANER EXTENSION, FIREPUMP	9576
5	1	COUPLING, RUBBER, 4", NELSON #89835K	89835K
6	1	RESTRICTION INDIACOR, 1/8" NPT	RAX00-2352

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER AIR CLEANER	DAVE N	01DEC06
C	ADDED RESTRICTION INDICATOR	DAVE N	01JUN05

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030

MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

REF. SCALES

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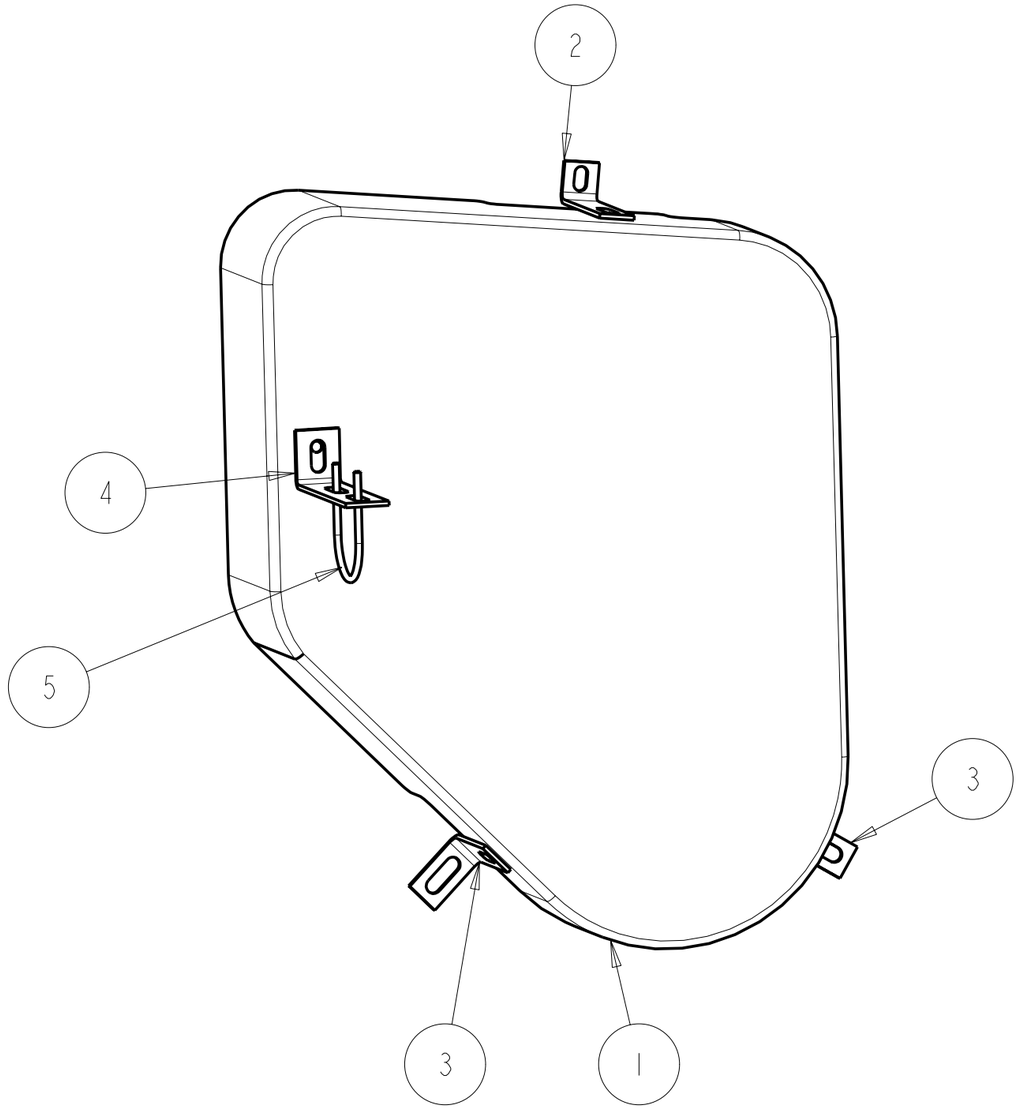
TITLE 1: ASSEMBLY, AIR CLEANER, QSB5.9
TITLE 2: FIRE PUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 09JUL2004		
	APPD BY:		DATE:		
EST WEIGHT: 9.473	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9532	REV: D



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	BELT, GUARD, FIREPUMP QSB5.9	8590
2	1	BRACKET, MOUNTING, GUARD, FIREPUMP	8592
3	2	BRACKET, MOUNTING, GUARD, FIREPUMP	8593
4	1	BRACKET, MOUNTING, TUBE SUPPORT, FIREPUMP	9822
5	1	U-BOLT, 2"	U200

REV	DESCRIPTION OF REVISION	REV BY	DATE
A	RELEASED	DAVE N	20JAN05

UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001 WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06	MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05 WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50

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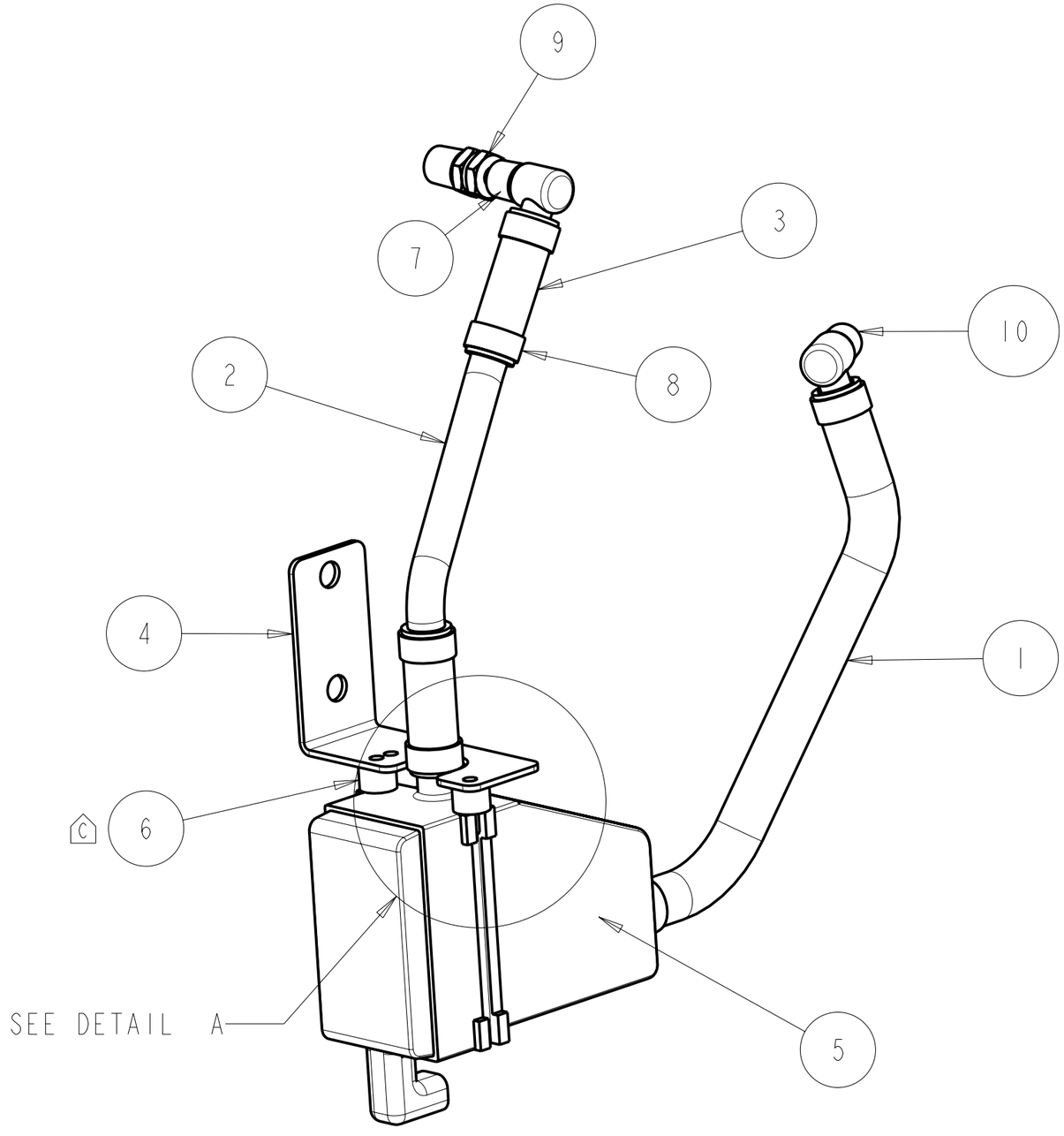
TITLE 1: ASSEMBLY, PULLEY GUARD, QSB
TITLE 2: FIREPUMP

DWG UNITS:	DRAWN BY: DAVE N	DATE: 19JAN05
IN/LB/S	APPD BY: -	DATE: -

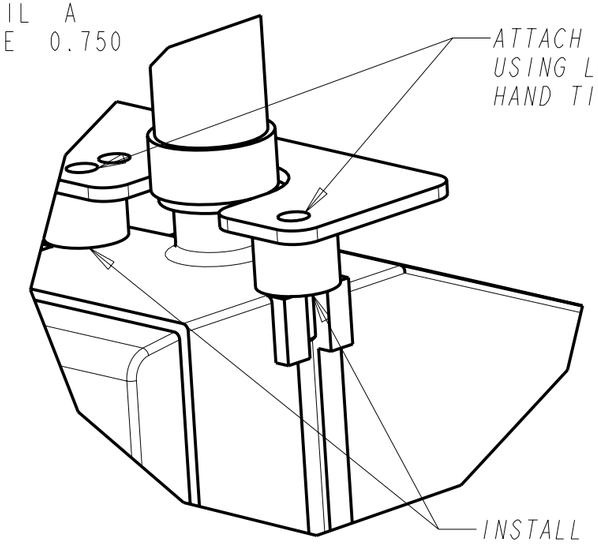
EST WEIGHT:	SCALE:	DO NOT SCALE	SHEET	DRAWING NO:	REV:
42238.628	0.250		1OF1	9820	A



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, 3/4" ID	8557
2	1	TUBE, COOLANT HEATER	8558
3	2	COUPLING, HOSE, 3/4" I.D. #80242GL X 3" LG, FIREPUMP	8562
4	1	BRACKET, MOUNTING, COOLANT HEATER, FIREPUMP	9521
5	1	CIRCULATION HEATER, P&T #3315032, 1500W , 120V , 176 DEG F	9598
C 6	2	ISOLATOR, STUD MOUNT, 1/4-20, TECH PRODUCTS #51201	13102
7	1	EXTENSION, 1/2" NPT	85454
8	6	CLAMP, 1" NOMINAL #92216	CLAMP_100
9	1	BUSHING, 1/2" x 3/4" NPT	LTL-SRB3412
10	2	ADAPTER, 1/2" NPT X 3/4" 90 DEG BARB	R-269HB-12-8

DETAIL A
SCALE 0.750



REV	DESCRIPTION OF REVISION	REV BY	DATE
C	ADD ISOLATORS	S DUBICK	16JUL08
B	REV PER COOLANT HEATER	DAVE N	06AUG04

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030

MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

REF. SCALES

Fire Power

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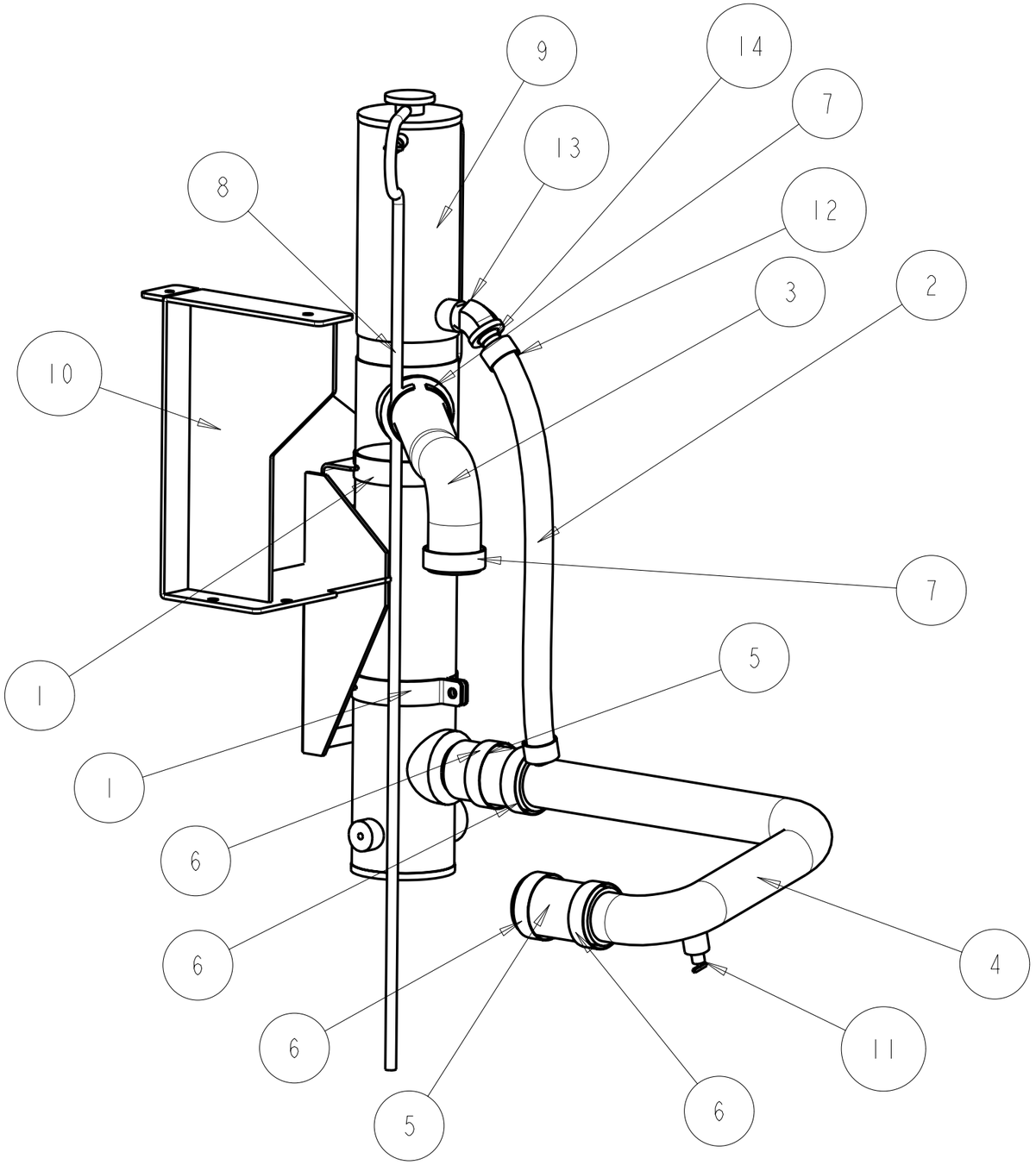
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, COOLANT HEATING, 6B
TITLE 2:

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 22MAR2004
	APPD BY:	DATE:

EST WEIGHT: 5.722	SCALE: 0.375	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8556	REV: C



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	CLAMP, HEAT EXCHANGER, 4", CHAMP #300377, FIREPUMP	8659
2	1	FILL HOSE, 3/4" ID X 20" LG #70232GL, -	70232GL_8665
3	1	HOSE, COOLING, 1.75" I.D., FIREPUMP, 6B/4B	8566
4	1	TUBE, COOLING, 2" OD, FIREPUMP	8567
5	2	COUPLING, HOSE, 2.0" I.D., FIREPUMP	8653
6	4	CLAMP, 2-5/8" NOMINAL, #92240	8654
7	2	CLAMP, 2-1/8" NOMINAL, #92232	8661
8	1	TUBE, OVERFLOW, 5/16" ID x 36" LG	8662
9	1	HEAT EXCHANGER, 4" #CM011504-1, FIREPUMP, TEMP	8667
10	1	BRACKET, MOUNTING, HEAT EXCHANGER	8669
11	2	DRAIN VALVE, 1/4" NPT	80511
12	2	CLAMP, 1" NOMINAL, #92212	92212
13	1	STREET ELBOW, BLK, 3/4" NPT, 45 DEG.	E3445
14	1	ADAPTER, 3/4" NPT X 3/4" OD (#8288)	R-68HB_12-8

REV	DESCRIPTION OF REVISION	REV BY	DATE
E1	GRAPHICS REVISION	DAVE N	01JUL05
E	REMOVED VENT. ADDED DRAIN	DAVE N	15JUN05
D	REV PER HX. ADDED FILL HOSE	DAVE N	23OCT04

UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001	MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05
WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06	WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50

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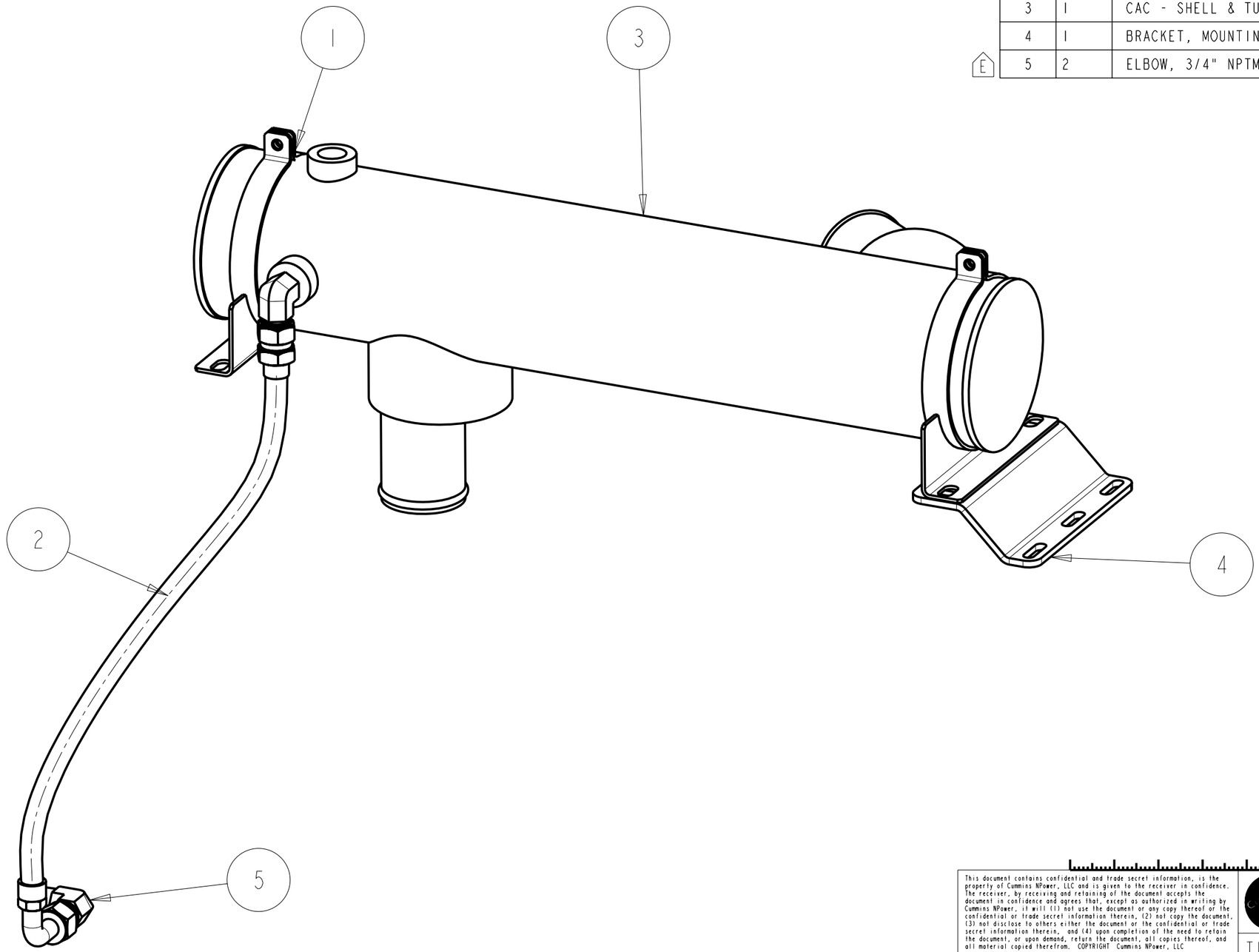
TITLE 1: ASSEMBLY, HEAT EXCHANGER W/O CAC
TITLE 2: FIREPUMP, NFP-659

DWG UNITS: IN/LB/S	DRAWN BY: S. DANFORTH			DATE:		
	APPD BY:			DATE:		
EST WEIGHT: 26.617	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8665	REV: E	

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	CLAMP, HEAT EXCHANGER, 6" DIA, CMAP #CP090496-2	8965
2	1	HOSE, WATER, 12 JIC BOTH ENDS, FIREPUMP	11148-05
3	1	CAC - SHELL & TUBE	8668
4	1	BRACKET, MOUNTING, CAC-HX, QSB5.9, FIREPUMP	9580
E 5	2	ELBOW, 3/4" NPTM X JIC STEEL	11589



REV	DESCRIPTION OF REVISION	REV BY	DATE
E	ADDED TWO FITTINGS TO ASSEMBLY	JDT	19APR07
D	REV PER WATER CONNECTION	DAVE N	01DEC06
C	REV PER SUB CONPONENTS	DAVE N	04OCT05

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

REF. SCALES

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NPOWER SYSTEMS
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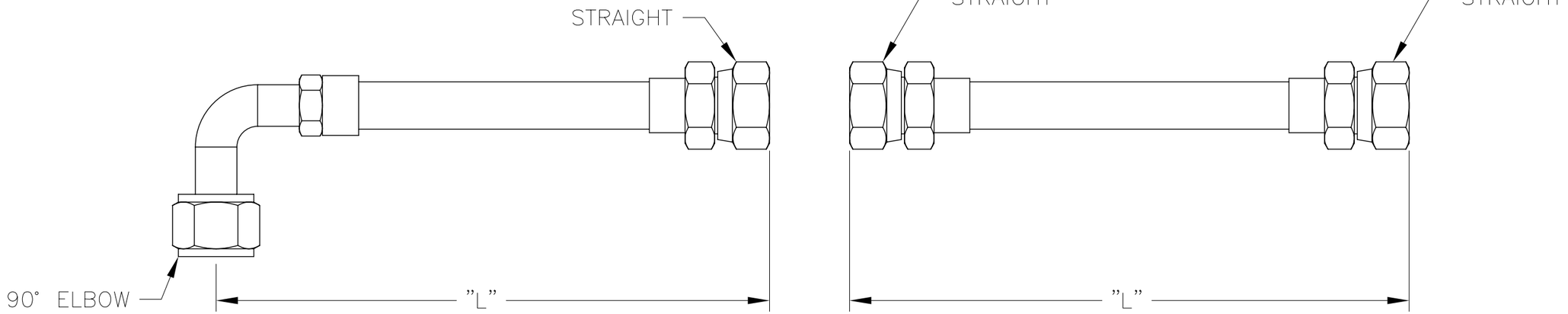
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, CHARGE AIR COOLER, QSB5.9
TITLE 2: FIREPUMP

DWG UNITS:	DRAWN BY: DAVE N		DATE: 17MAY2004	
0.000	APPD BY:		DATE:	
EST WEIGHT:	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8676	REV: E

ITEM	QTY	DESCRIPTION	END FITTING	END FITTING	LENGTH "L"
01	A/R	CFP33 COOLING LOOP CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	15"
02					
03	A/R	CFP39 COOLING LOOP CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	13" A
04	A/R	CFP59 COOLING LOOP CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	13" A
05	A/R	CFP6E CAC WATER CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	35" A
06	A/R	CFP6E COOLING LOOP CONNECTION	45° SWIVEL A	STRAIGHT SWIVEL	48" A
07					
08					



NOTES

1) FLEXIBLE HOSE RATING:
   - –250 PSI BURST
   - –WATER/SEA WATER @ TEMP 32°–120°
   - –ENVIORMENT MAY CONTAIN OIL, FUEL, OR ENGINE COOLANT
   - –ENVIORMENT TEMPERATURE UP TO 200°
2) END FITTINGS INSTALLED ON HOSE
3) EACH PIECE INDIVIDUALLY LABELED

REV	DESCRIPTION OF REVISION	BY	DATE
A	CHGD LENGTH TO BETTER FIT ASSEMBLY	JDT	18APR07

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

REF. SCALES

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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

HOSE, WATER, #12 37° JIC ENDS

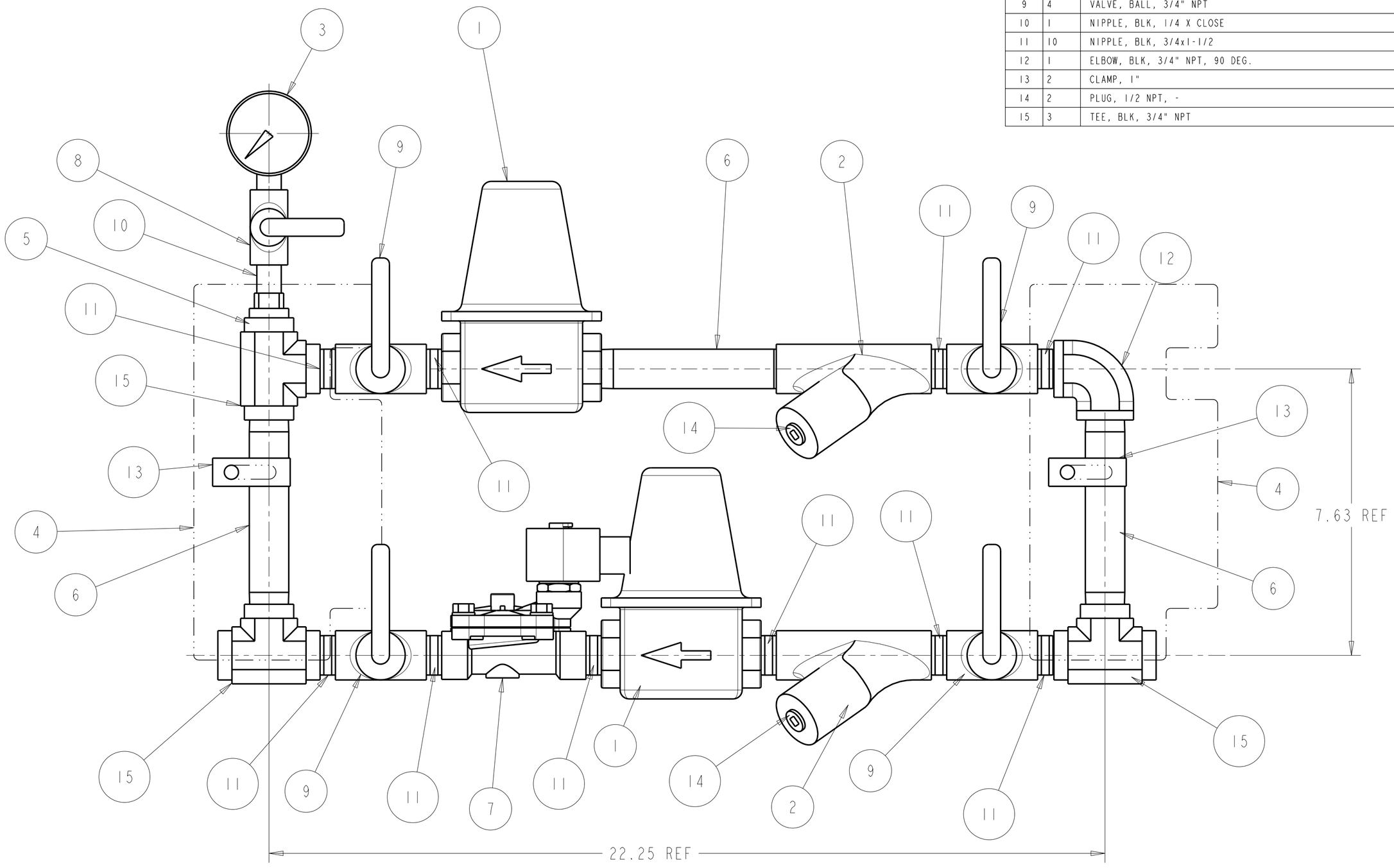
DWG UNITS: IN\LB\S	DRAWN BY: DAVE N				DATE: 20DEC2006
	APPD BY:				DATE:
EST WEIGHT:	SCALE: NTS	DO NOT SCALE	SHEET 10F1	DRAWING NO: 11148	REV: A

8682-01 FOR VERTICLE TURBINE PUMP:
REMOVE VALVE ITEM #7 AND REPLACE WITH
ITEM #6 - 6" LONG NIPPLE

8682-02 FOR 24 VOLT OPERATION:
REMOVE VALVE ITEM #7 AND REPLACE WITH
ASCO #8210G3-24vdc

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	REGULATOR, 3/4" NPT, 400 PSI MAX, 25 TO 75 PSI OUT	8890
2	2	STRAINER, 3/4" NPT W/ PLUG	8891
3	1	GUAGE, PRESSURE, 1/4" NPT, 0-100 PSI RANGE	8892
4	2	TAG, COOLANT LOOP LABEL, VERTICAL MTG	10965
5	1	BUSHING, REDUCING, 3/4" NPT X 1/4" NPT	71494
6	3	NIPPLE, BLK, 3/4x6	71550
7	1	VALVE, ELEC ACT, BRASS, 3/4" NPT, 12vdc, 150 PSI MAX	8210G3-12VDC
8	1	VALVE, BALL, 1/4" NPT	FA60204-1
9	4	VALVE, BALL, 3/4" NPT	FA60406
10	1	NIPPLE, BLK, 1/4 X CLOSE	LTL-CPN14
11	10	NIPPLE, BLK, 3/4x1-1/2	LTL-CPN34
12	1	ELBOW, BLK, 3/4" NPT, 90 DEG.	LTL-E3490
13	2	CLAMP, 1"	LTL-SCPV16627
14	2	PLUG, 1/2 NPT, -	LTL-SCSP12
15	3	TEE, BLK, 3/4" NPT	LTL-ST34



VALVES SHOWN CLOSED - NOT IN OPERATING POSITION

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER PART NUMBERS	DAVE N	19SEP06

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX ± 0.010 .XXX ± 0.005
FORM TOLERANCES .XX ± 0.030 .XXX ± 0.015
PAR TOLERANCES .XX ± 0.005 .XXX ± 0.030

MACHINE TOLERANCES .X ± 0.2 .XX ± 0.2
FORM TOLERANCES .X ± 0.8 .XX ± 0.4
PAR TOLERANCES .X ± 0.3 .XX ± 0.8

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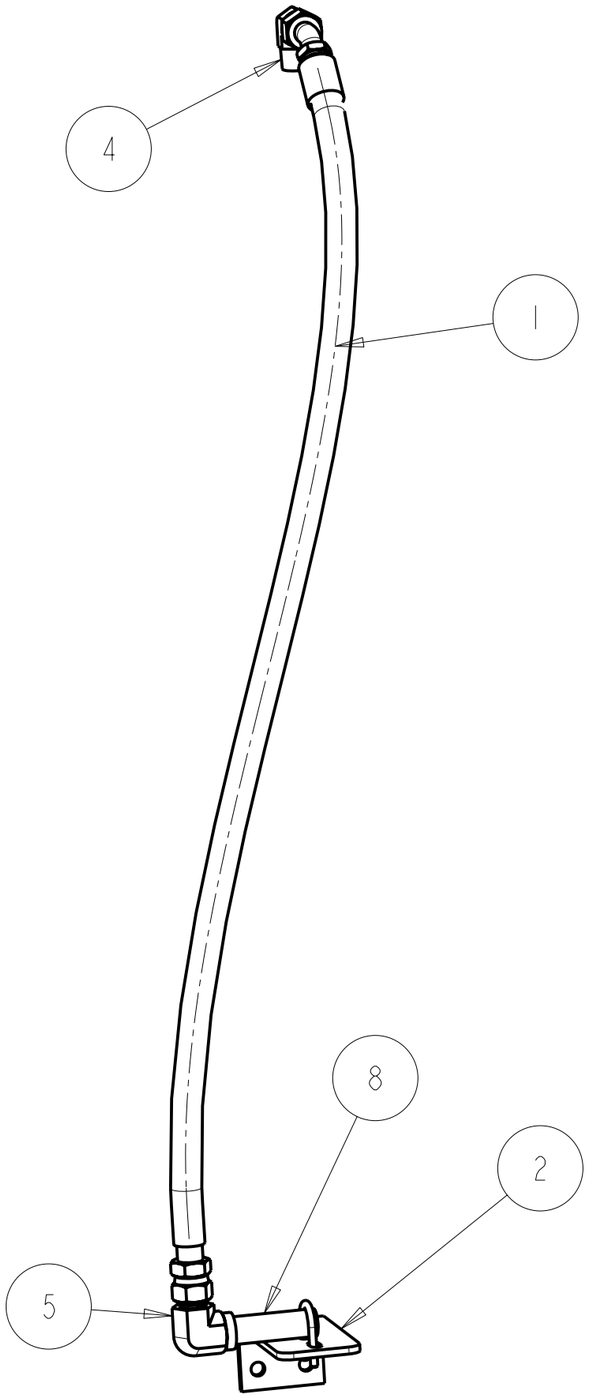
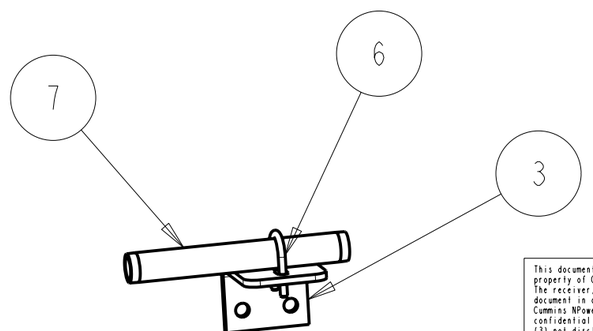
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, RAW WATER COOLING, 3/4" NPT
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 12JUN2004
	APPD BY:	DATE:

EST WEIGHT: 42238.628	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8682	REV: D





BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, WATER, 12 JIC BOTH ENDS, FIREPUMP	11148-06
2	1	BRKT, RAW WATER, 6-1/2" LG, FIREPUMP, 3/4" OR 1" PIPE	8905
3	1	BRACKET, RAW WATER COOLING, 4" LG, FIREPUMP, 3/4" OR 1" PIPE	9633
D 4	1	ELBOW, 3/4" NPTM X JIC STEEL	11589
D 5	1	ELBOW, 3/4" NPTF X JIC STEEL	11590
6	2	U-BOLT, FITS 1" PIPE	3201T13
7	1	NIPPLE, BLK, 3/4x9	BNFY
8	1	NIPPLE, 3/4 X 3, BLK	LTL-CPN343

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	12_CTX-S WAS 12_FTX-S CHGD PART NUMBERS	JDT	19APR07
C	REV PER FLEX CONNECTION	DAVE N	12DEC06

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005 FORM TOLERANCES .XX : ± 0.020 .XXX : ± 0.015 FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2 FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4 FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

REF. SCALES

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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: MISC PIPING,COOLING LOOP,RAW WATER,QSB59
TITLE 2:

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 07DEC2004
	APPD BY:			DATE:
EST WEIGHT: 42238.628	SCALE: 0.188	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9638	REV: D

PN 8727
SO 35327
Model QSB
Config D403046CX03

Option	Desc
FIRE	27QSB
AP 9348	APPROVAL,AGENCY
BB 9705	BLOCK,CYLINDER
BR 9047	BREATHER,CRANKCA
BR 9173	BREATHER,CRANKCA
CH 9033	AID,COO HEATER S
CP 9234	COMPRESSOR,AIR
CP 9715	MOUNTING,AIR COM
DA 9062	DAMPER,VIBRATION
DF 9054	DRIVE,FRO GER TR
DL 9034	LOCATION,DRAIN
DO 9415	SOFTWARE,CUS INT
△A EC 9027	THERMOSTAT
EE9242	Alternator, 12V, 95A, Delco 11SI
△A EH 9257	MOUNTING,ALTERNA
FA 9142	DRIVE,FAN
FF 9149	FILTER,FUEL
FF 9805	PLUMBING,FUEL FI
FH 9182	HOUSING,FLYWHEEL
FP98479	MOUNTING,FUEL PU
FP99023	CALIBRATION,FUEL
FP99122	PUMP,FUEL INJECT
FR90847	RATING,FUEL
FS 9153	PUMP,FUEL TRANSF
FT 9963	PLUMBING,FUEL
FW 9335	FLYWHEEL
GG 9728	COVER,FRONT GEAR
HC 9007	PLUMBING,CABIN H
△A IC 9279	CONNECTION,AIR I
IM 9045	MANIFOLD,AIR INT
IT 9001	CONNECTION,AIR T
LA 9025	ARRANGEMENT,LIFT
LC 9055	COOLER,ENGINE OI
LF 9046	FILTER,FULL FLOW
LG 9443	GAUGE,OIL LEVEL
LO 9003	OIL,LUBRICATING
LP 9009	PUMP,LUBRICATING
LP 9712	PUMP,LUBRICATING
OB 9163	ARRANGEMENT,OIL
OP 9069	PAN,OIL
PH 9842	MODULE,ENGINE CO
△A PH 9082	MODULE, 2nd ECM
PP 8040	PARTS,PERFORMANC
PP98087	INJECTOR
PP98090	TURBOCHARGER
PP98270	HEAD,CYLINDER
RL 9702	LEVER,ROCKER
RP 9012	VENT,ENGINE COOL
SB 9054	BATTERY
SC97334	SOFTWARE,CALIBRA
SK 9003	ARRANGEMENT,SHIP
△A SM 9051	MOUNTING,STARTIN
SS 9238	PAINT, RED
△A ST 9370	MOTOR,STARTING
TB 9478	ARRANGEMENT,TURB
TK 9004	COOLER,TOR CONVE
TP97020	PLUMBING,TURBOCH
VC 9050	COVER,VALVE
WI 9098	CONNECTION,WATER
WO 9026	CONNECTION,WATER
WP 9034	PUMP,WATER
△A WP 9737	PULLEY,WATER PUM
△A WR 9178	ACCESSORIES,WIRI
△A XS 9137	CONNECTION,EXHAU

BUILT BEFORE JANUARY 1, 2007

PN 8727
SO 35327
Model QSB
Config D403046CX03

Option	Desc
FIRE	27QSB
△B AP 9535	APPROVAL,AGENCY
BB 9705	BLOCK,CYLINDER
BR 9047	BREATHER,CRANKCA
BR 9173	BREATHER,CRANKCA
CH 9033	AID,COO HEATER S
CP 9234	COMPRESSOR,AIR
CP 9715	MOUNTING,AIR COM
DA 9062	DAMPER,VIBRATION
DF 9054	DRIVE,FRO GER TR
DL 9034	LOCATION,DRAIN
△B DO90353	SOFTWARE,CUS INT
EC 9027	THERMOSTAT
EE 9267	Alternator, 12V, 95A, Delco11SI
EH 9257	MOUNTING,ALTERNA
FA 9142	DRIVE,FAN
FF 9149	FILTER,FUEL
FF 9805	PLUMBING,FUEL FI
FH 9182	HOUSING,FLYWHEEL
FP98479	MOUNTING,FUEL PU
FP99023	CALIBRATION,FUEL
FP99122	PUMP,FUEL INJECT
FR90847	RATING,FUEL
FS 9153	PUMP,FUEL TRANSF
FT 9963	PLUMBING,FUEL
△B FW 9894	FLYWHEEL
GG 9728	COVER,FRONT GEAR
HC 9007	PLUMBING,CABIN H
IC 9279	CONNECTION,AIR I
IM 9045	MANIFOLD,AIR INT
△B IT 9006	CONNECTION,AIR T
LA 9025	ARRANGEMENT,LIFT
LC 9055	COOLER,ENGINE OI
LF 9046	FILTER,FULL FLOW
△B LG 9648	GAUGE,OIL LEVEL
△B LO 9001	OIL,LUBRICATING
LP 9009	PUMP,LUBRICATING
LP 9712	PUMP,LUBRICATING
OB 9163	ARRANGEMENT,OIL
OP 9069	PAN,OIL
PH 9842	MODULE,ENGINE CO
PH 9082	MODULE, 2nd ECM
PP 8040	PARTS,PERFORMANC
PP98087	INJECTOR
PP98090	TURBOCHARGER
PP98270	HEAD,CYLINDER
RL 9702	LEVER,ROCKER
RP 9012	VENT,ENGINE COOL
SB 9054	BATTERY
△B SC97519	SOFTWARE,CALIBRA
SK 9003	ARRANGEMENT,SHIP
△B SM 9725	MOUNTING,STARTIN
SS 9238	PAINT, RED
ST 9370	MOTOR,STARTING
TB 9478	ARRANGEMENT,TURB
TK 9004	COOLER,TOR CONVE
TP97020	PLUMBING,TURBOCH
VC 9050	COVER,VALVE
WI 9098	CONNECTION,WATER
WO 9026	CONNECTION,WATER
WP 9034	PUMP,WATER
WP 9737	PULLEY,WATER PUM
WR 9178	ACCESSORIES,WIRI
XS 9137	CONNECTION,EXHAU

BUILT AFTER JANUARY 1, 2007

REV	DESCRIPTION OF REVISION	BY	DATE
B	UPDATED PER ENGINE SPEC AND DWG BORDER	DAVE N	08JAN2007
A	REDRAWN PER ENGINE SPEC	DAVE N	16OCT2004

UNLESS OTHERWISE NOTED
–
ALL DIMENSIONS ARE IN INCHES
–
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
–
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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875 LAWRENCE DRIVE
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DWG SCALE: NTS	DRAWN BY: DAVE N	DATE: 23SEP2004
PLOT SCALE:	APPD BY:	DATE:

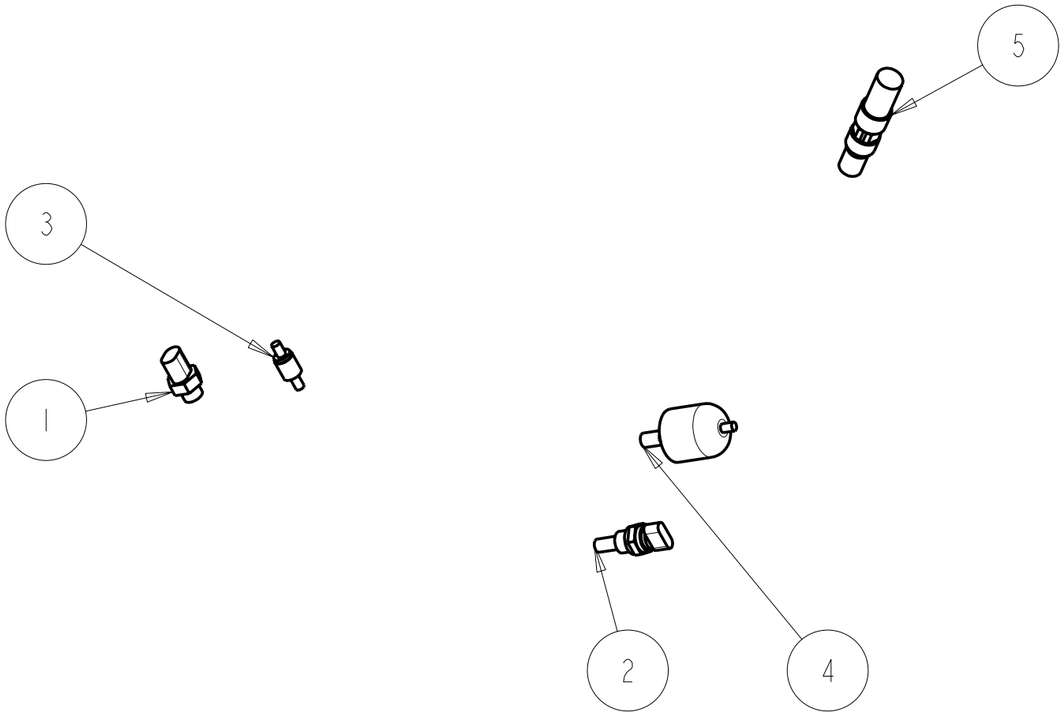
DESCRIPTION
ASSEMBLY, ENGINE, QSB5.9–C275

REFERENCE:
CFP6E–F15/25/35

DRAWING NUMBER:
8727B

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	SWITCH, WATER TEMP, 200F SETTING, RS#85879-A3	8860
2	1	SWITCH, OIL PRESSURE, 16 PSI, RS#85858-A3	8861
3	1	SENDER, WATER TEMPERATURE, DATCON #02022-00	8862
4	1	SENDER, OIL TEMPERATURE, DATCON #02504-00	8863
5	1	SENSOR, MAG PICK UP	9569



REV	DESCRIPTION OF REVISION	REV BY	DATE
A	REV AS BUILT		

UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001 - WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06	MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05 - WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50

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NPOWER SYSTEMS
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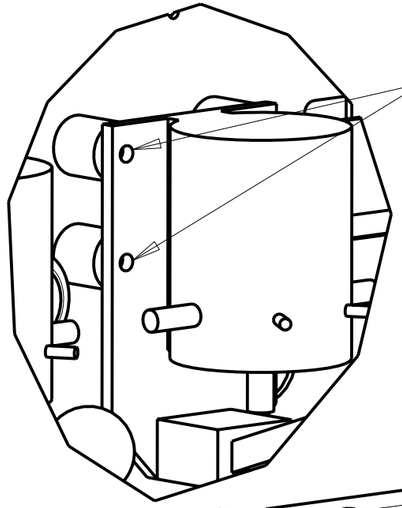
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

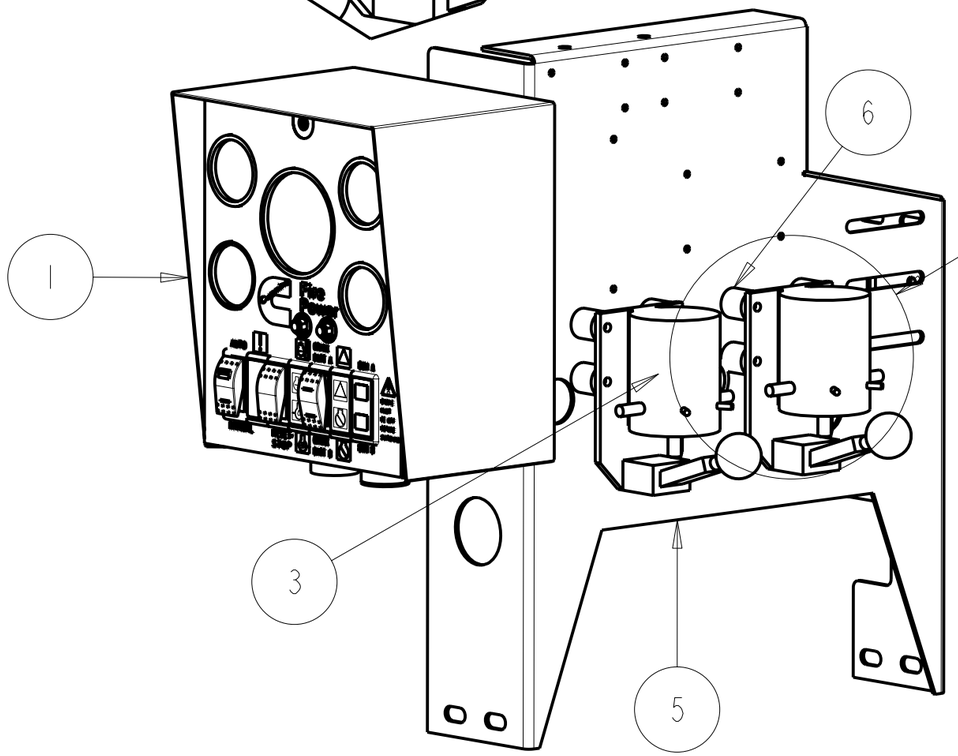
TITLE 1: ASSEMBLY, SENSOR PACKAGE
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N				DATE: 18AUG2004
	APPD BY: -				DATE: -
EST WEIGHT: 42238.628	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9568	REV: A

DETAIL A
SCALE 0.400



INSTALL ISOLATORS (4) ON EACH CONTACTOR WITH LOCTITE #425 BLUE, HAND TIGHT.



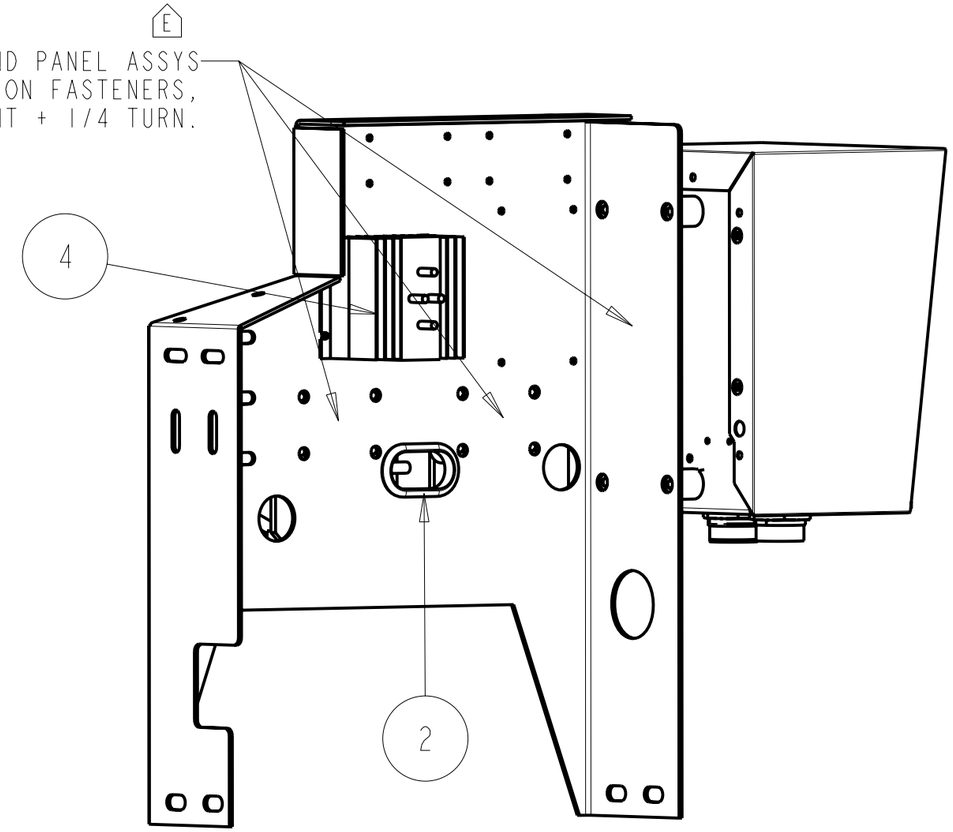
(E) SEE DETAIL A

BILL OF MATERIAL

	ITEM	QTY	DESCRIPTION	PART NUMBER
(E)	1	1	ASSEMBLY, INSTRUMENT PANEL, ISOLATED, FIREPUMP	13236
	2	1	GROMMETT	508-1057
	3	2	CONTACTOR, MANUAL OVERIDE, FIREPUMP	8824
	4	1	BATTERY ISOLATOR, FIRE PUMP	8838
	5	1	BRACKET, OPERATORS STATION, B & C SERIES, FIREPUMP	9561
(D)	6	8	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011

(E)

ATTACH CONTACTOR AND PANEL ASSYS WITH LOCTITE #425 BLUE ON FASTENERS, HAND TIGHT + 1/4 TURN.



REF. SCALES

REV	DESCRIPTION OF REVISION	REV BY	DATE
E	MODIFY ISOLATOR MTG SPEC, INST. PANEL	S DUBICK	18JUL08
D	CHANGED ISOLATORS	S DUBICK	28MAY08
C	REV PER PANEL	DAVE N	01DEC06
B	ADDED GROMET	DAVE N	15JUN05

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005 FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015 FAB TOLERANCES .X : ± 0.060 .XX : ± 0.030	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2 FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4 FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

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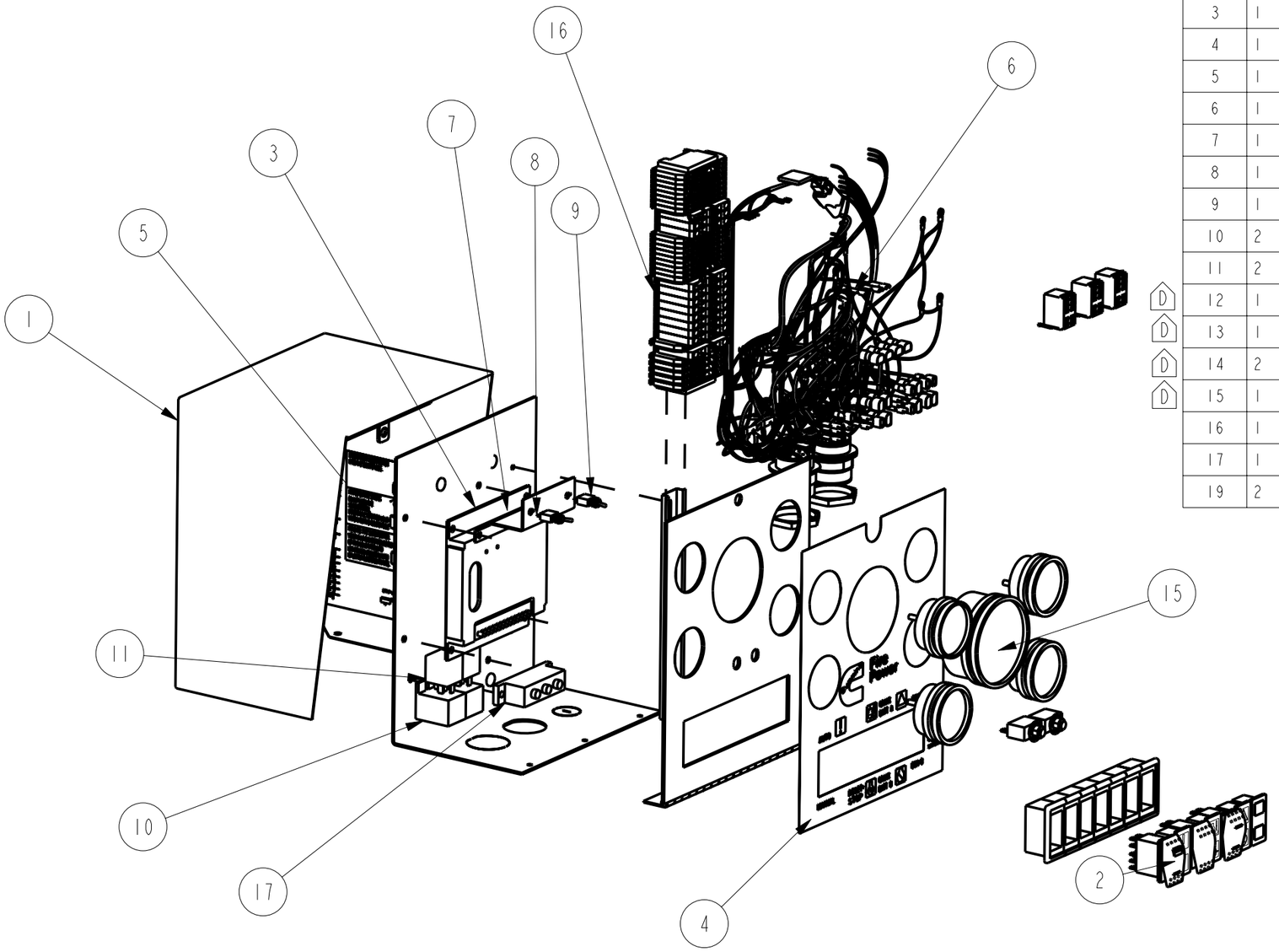
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, OPERATORS STATION, QS6B5.9
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 31AUG2004
	APPD BY:		DATE:
EST WEIGHT: 53.852	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9583	REV: E



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
E 1	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
2	1	ASSEMBLY, SWITCH GANG, FIREPUMP	11084
3	1	MODULE, OVERSPEED, FIREPUMP	8836
4	1	DECAL, INSTRUMENT PANEL, FIREPUMP	10731
5	1	DECAL, INSTRUCTION, GAUGE PANEL	11136
6	1	ASSEMBLY, HARNESS, INSTRUMENT PANEL, FIREPUMP	11185
7	1	BRACKET, TOGGLE SWITCH MOUNTING, FIREPUMP GAUGE PANEL - E-ENG	8887
8	1	SWITCH, TOGGLE, MINIATURE, MOMENTARY (ON)-OFF-(ON)	8889
9	1	SWITCH, TOGGLE, MINIATURE, SUSTAINED ON-OFF-ON	8888
10	2	RELAY HOLDER, FIREPUMP	9528
11	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
D 12	1	GUAGE, OIL PRESSURE, 0-80 PSI, 12VDC, FIREPUMP	11194
D 13	1	GUAGE, WATER TEMPERATURE, 12VDC, FIREPUMP	11197
D 14	2	GUAGE, VOLTMETER 8-18VDC, FIREPUMP	11200
D 15	1	GUAGE, TACHOMETER/HOUR METER, FIREPUMP	11202
16	1	ASSEMBLY, TERMINALS, GAUGE PANEL, FIREPUMP	11137
17	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
19	2	CIRCUIT BREAKER, INSTRUMENT PANEL, FIREPUMP	11203

NOTES:
GAUGE PANEL EXPLOSION DEPICTED FOR SERVICE PART IDENTIFICATION. WHERE APPLICABLE, SUB-ASSEMBLY DRAWINGS MAY BE REQUIRED FOR COMPONENT DETAIL(S). WIRING HARNESS IS NOT FIELD SERVICEABLE WITHOUT TRP ISSUED BY CUMMINS FIREPOWER IF APPLICABLE.

REV	DESCRIPTION OF REVISION	REV BY	DATE
E	MODIFIED 10454	S DUBICK	28MAY08
D	CORRECTED GAUGE P/N'S	S.DANFORTH	02JAN07
C	REDRAWN AND RELEASED	ANTONIO G.	25SEP06
B	REVISED TERMINAL STRIP	S.DANFORTH	
A	PROTOTYPE RELEASE	S.DANFORTH	10JUL2006

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015	FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

REF. SCALES

Fire Power

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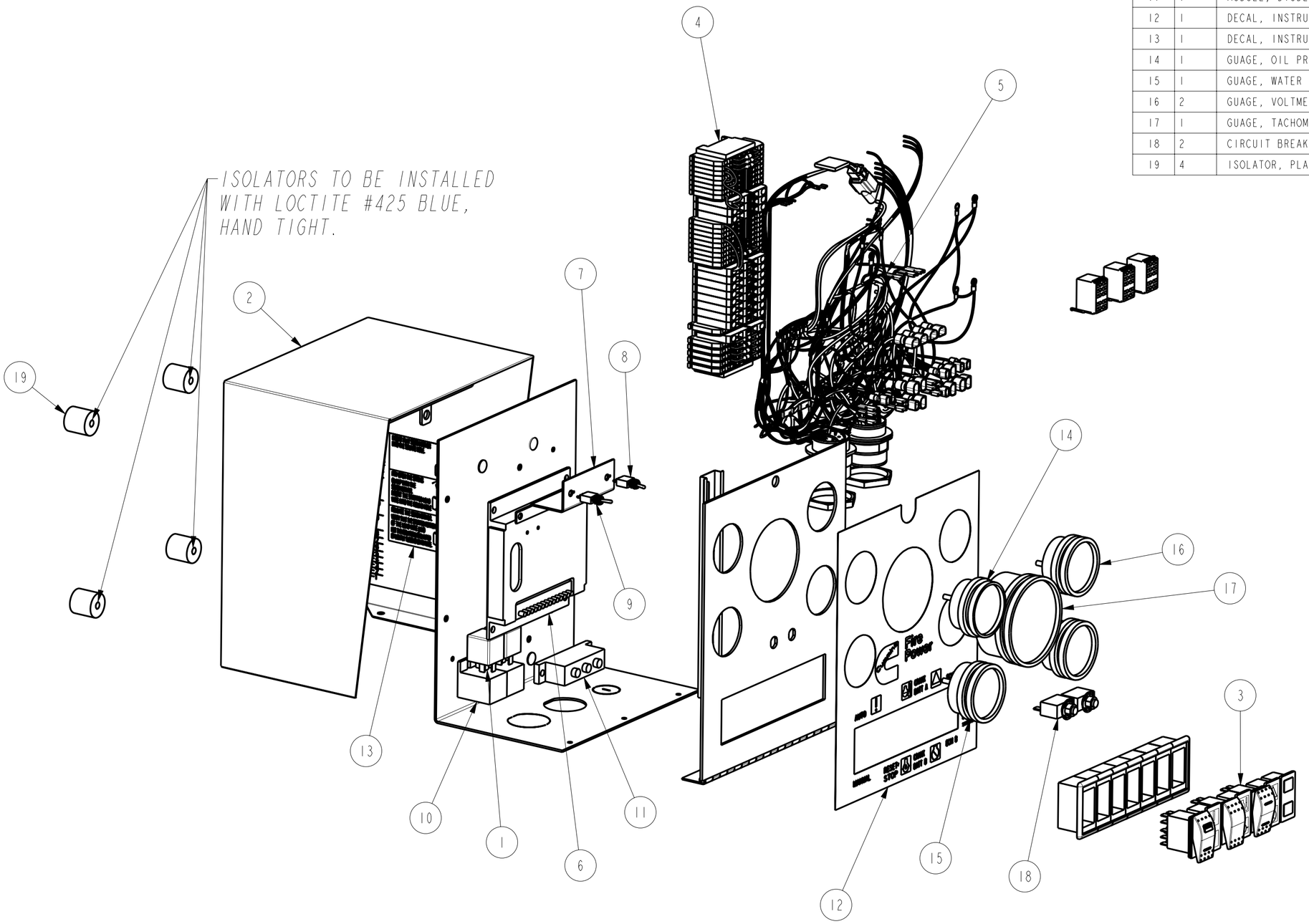
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 12V
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S.DANFORTH				DATE: 10JUL2006
	APPD BY:				DATE:
EST WEIGHT: 21.524	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10452	REV: E

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
2	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
3	1	ASSEMBLY, SWITCH GANG, FIREPUMP	11084
4	1	ASSEMBLY, TERMINALS, GAUGE PANEL, FIREPUMP	11137
5	1	ASSEMBLY, HARNESS, INSTRUMENT PANEL, FIREPUMP	11185
6	1	MODULE, OVERSPEED, FIREPUMP	8836
7	1	BRACKET, TOGGLE SWITCH MOUNTING, FIREPUMP GAUGE PANEL - E-ENG	8887
8	1	SWITCH, TOGGLE, MINIATURE, SUSTAINED ON-OFF-ON	8888
9	1	SWITCH, TOGGLE, MINIATURE, MOMENTARY (ON)-OFF-(ON)	8889
10	2	RELAY HOLDER, FIREPUMP	9528
11	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
12	1	DECAL, INSTRUMENT PANEL, FIREPUMP	10731
13	1	DECAL, INSTRUCTION, GAUGE PANEL	11136
14	1	GUAGE, OIL PRESSURE, 0-80 PSI, 12VDC, FIREPUMP	11194
15	1	GUAGE, WATER TEMPERATURE, 12VDC, FIREPUMP	11197
16	2	GUAGE, VOLTMETER 8-18VDC, FIREPUMP	11200
17	1	GUAGE, TACHOMETER/HOUR METER, FIREPUMP	11202
18	2	CIRCUIT BREAKER, INSTRUMENT PANEL, FIREPUMP	11203
19	4	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011



NOTES:

* GAUGE PANEL EXPLOSION DEPICTED FOR SERVICE PART ID.
* WHERE APPLICABLE, SUB-ASSEMBLY DRAWINGS MAY BE REQUIRED FOR COMPONENT DETAILS.
* WIRING HARNESS IS NOT FIELD SERVICEABLE WITHOUT TRP ISSUED BY CUMMINS FIREPOWER IF APPLICABLE.

REV	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX ± 0.010 .XXX ± 0.005
FORM TOLERANCES .XX ± 0.030 .XXX ± 0.015
FAB TOLERANCES .X ± 0.060 .XX ± 0.030

MACHINE TOLERANCES .X ± 0.2 .XX ± 0.2
FORM TOLERANCES .X ± 0.8 .XX ± 0.4
FAB TOLERANCES .X ± 1.5 .XX ± 0.8

REF. SCALES

Fire Power

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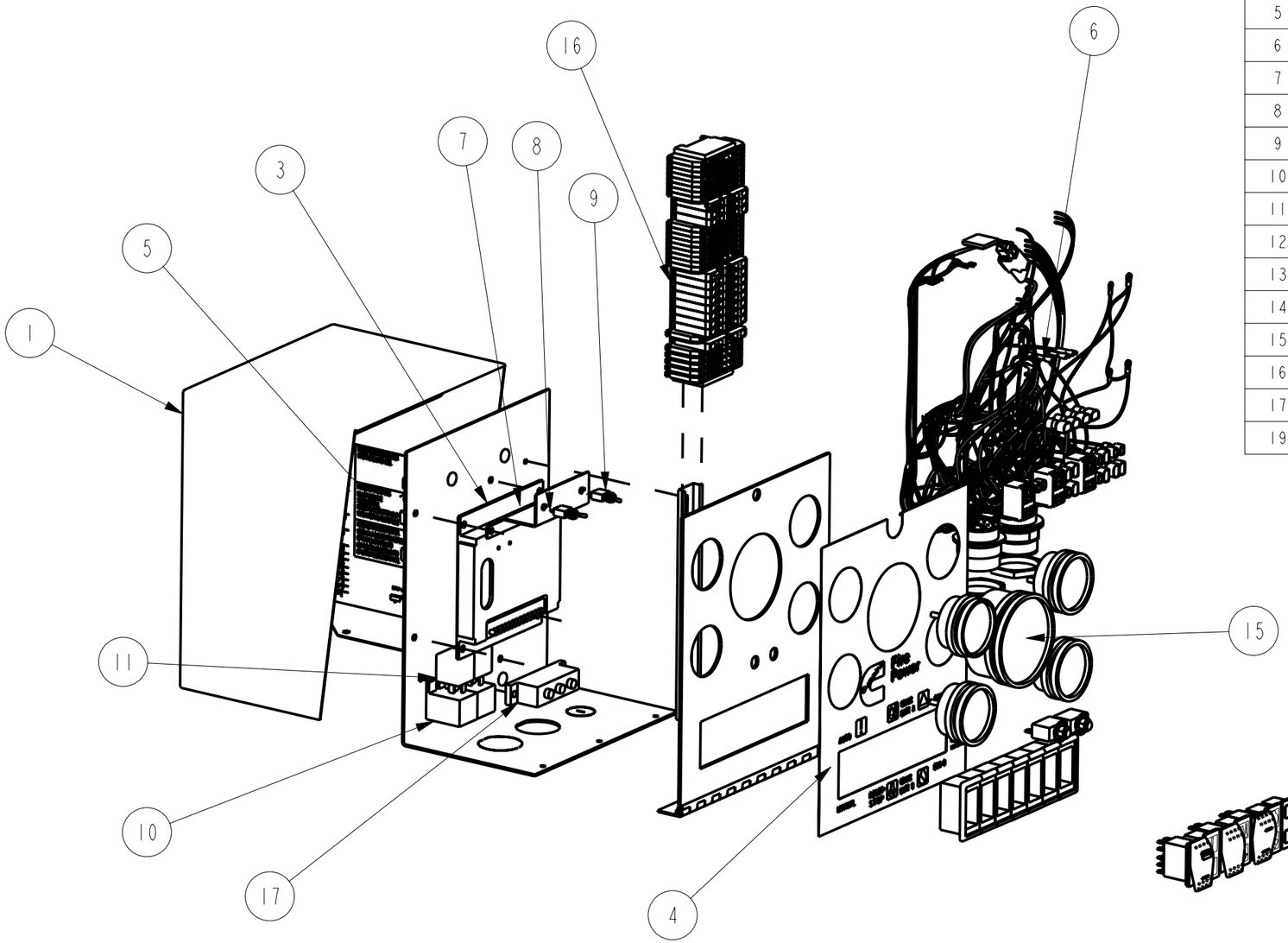
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 12V, ISOLATED
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S.DANFORTH		DATE: 10JUL2006	
	APPD BY:		DATE:	
EST WEIGHT: 21.524	SCALE: 0.300	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 13236	REV: _



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
2	1	ASSEMBLY, SWITCH GANG 24VDC, FIREPUMP	11085
3	1	MODULE, OVERSPEED, FIREPUMP	8836
4	1	DECAL, INSTRUMENT PANEL, FIREPUMP	10731
5	1	DECAL, INSTRUCTION, GAUGE PANEL	11136
6	1	ASSEMBLY, HARNESS, INSTRUMENT PANEL, FIREPUMP	11185
7	1	BRACKET, TOGGLE SWITCH MOUNTING, FIREPUMP GAUGE PANEL - E-ENG	8887
8	1	SWITCH, TOGGLE, MINIATURE, MOMENTARY (ON)-OFF-(ON)	8889
9	1	SWITCH, TOGGLE, MINIATURE, SUSTAINED ON-OFF-ON	8888
10	2	RELAY HOLDER, FIREPUMP	9528
11	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
12	1	GUAGE, OIL PRESSURE, 0-80 PSI, 24VDC, FIREPUMP	11195
13	1	GUAGE, WATER TEMPERATURE, 24VDC, FIREPUMP	11198
14	2	GUAGE, VOLTMETER 16-32VDC, FIREPUMP	11201
15	1	GUAGE, TACHOMETER/HOUR METER, FIREPUMP	11202
16	1	ASSEMBLY, TERMINALS, GAUGE PANEL, FIREPUMP	11137
17	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
19	2	CIRCUIT BREAKER, INSTRUMENT PANEL, FIREPUMP	11203

NOTES:
GAUGE PANEL EXPLOSION DEPICTED FOR SERVICE PART IDENTIFICATION. WHERE APPLICABLE, SUB-ASSEMBLY DRAWINGS MAY BE REQUIRED FOR COMPONENT DETAIL(S). WIRING HARNESS IS NOT FIELD SERVICEABLE WITHOUT TRP ISSUED BY CUMMINS FIREPOWER IF APPLICABLE.

REV	DESCRIPTION OF REVISION	REV BY	DATE
E	MODIFIED 10454	S DUBICK	28MAY08
D	11085 WAS 11084	S.DANFORTH	02JAN07
C	REDRAWN AND RELEASED	ANTONIO G.	25SEP06
B	REVISED TERMINAL STRIP	S.DANFORTH	
A	PROTOTYPE RELEASE	S.DANFORTH	10JUL2006

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS		METRIC UNITS	
MACHINE TOLERANCES		MACHINE TOLERANCES	
.XX = ± 0.010		.X = ± 0.4	
.XXX = ± 0.005		.XX = ± 0.2	
FORM TOLERANCES		FORM TOLERANCES	
.XX = ± 0.030		.X = ± 0.8	
.XXX = ± 0.015		.XX = ± 0.4	
FAB TOLERANCES		FAB TOLERANCES	
.XX = ± 0.060		.X = ± 1.5	
.XXX = ± 0.030		.XX = ± 0.8	

REF. SCALES

Fire Power

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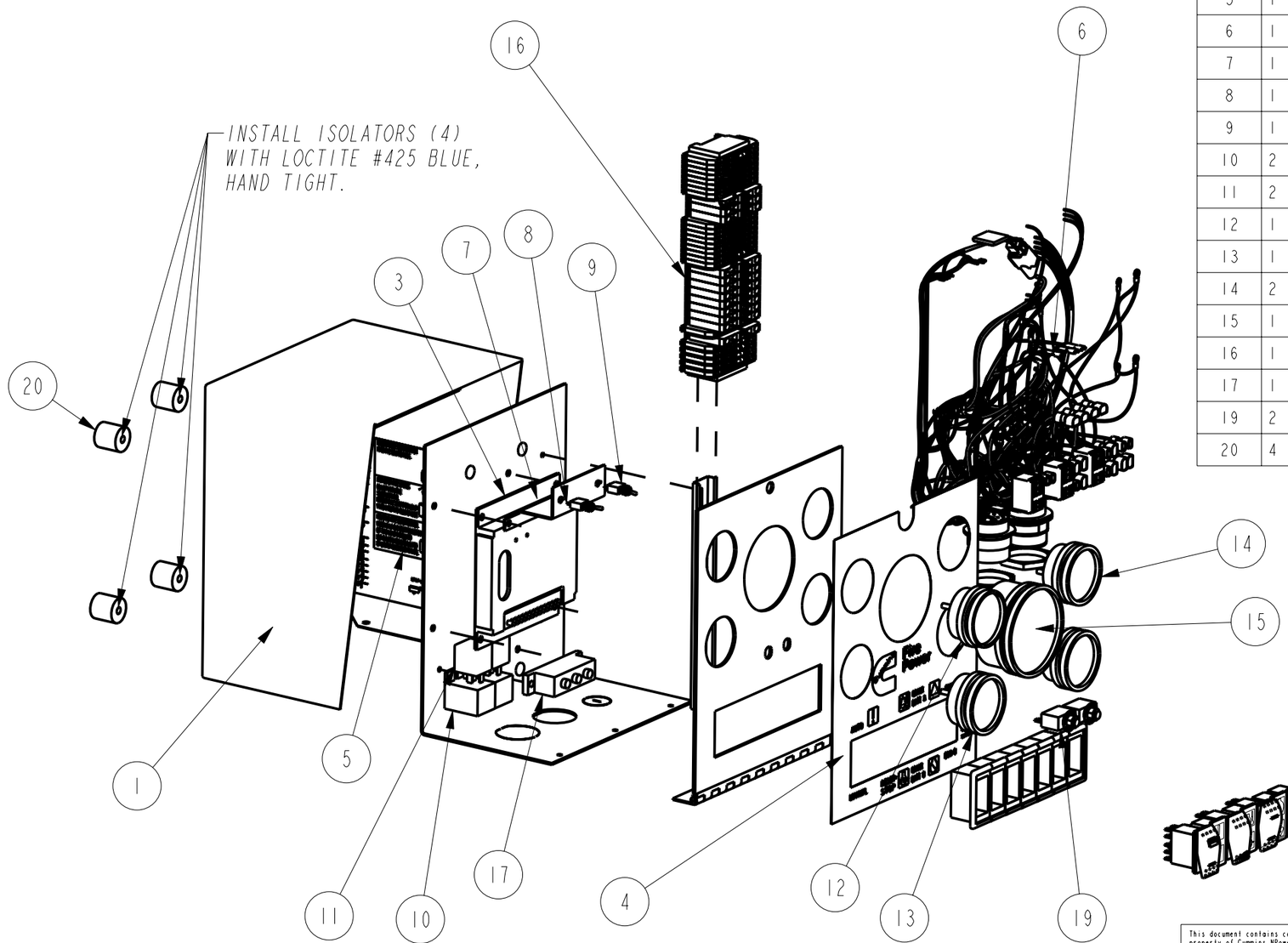
TITLE 1: ASSEMBLY, INSTRUMENT PANEL 24V
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S.DANFORTH			DATE: 10JUL2006
	APPD BY:			DATE:
EST WEIGHT: 20.096	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10453 / REV: E



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
2	1	ASSEMBLY, SWITCH GANG 24VDC, FIREPUMP	11085
3	1	MODULE, OVERSPEED, FIREPUMP	8836
4	1	DECAL, INSTRUMENT PANEL, FIREPUMP	10731
5	1	DECAL, INSTRUCTION, GAUGE PANEL	11136
6	1	ASSEMBLY, HARNESS, INSTRUMENT PANEL, FIREPUMP	11185
7	1	BRACKET, TOGGLE SWITCH MOUNTING, FIREPUMP GAUGE PANEL - E-ENG	8887
8	1	SWITCH, TOGGLE, MINIATURE, MOMENTARY (ON)-OFF-(ON)	8889
9	1	SWITCH, TOGGLE, MINIATURE, SUSTAINED ON-OFF-ON	8888
10	2	RELAY HOLDER, FIREPUMP	9528
11	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
12	1	GUAGE, OIL PRESSURE, 0-80 PSI, 24VDC, FIREPUMP	11195
13	1	GUAGE, WATER TEMPERATURE, 24VDC, FIREPUMP	11198
14	2	GUAGE, VOLTMETER 16-32VDC, FIREPUMP	11201
15	1	GUAGE, TACHOMETER/HOUR METER, FIREPUMP	11202
16	1	ASSEMBLY, TERMINALS, GAUGE PANEL, FIREPUMP	11137
17	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
19	2	CIRCUIT BREAKER, INSTRUMENT PANEL, FIREPUMP	11203
20	4	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011

NOTES:
GAUGE PANEL EXPLOSION DEPICTED FOR SERVICE PART IDENTIFICATION. WHERE APPLICABLE, SUB-ASSEMBLY DRAWINGS MAY BE REQUIRED FOR COMPONENT DETAIL(S). WIRING HARNESS IS NOT FIELD SERVICEABLE WITHOUT TRP ISSUED BY CUMMINS FIREPOWER IF APPLICABLE.

REV	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005 FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015 FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2 FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4 FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

REF. SCALES

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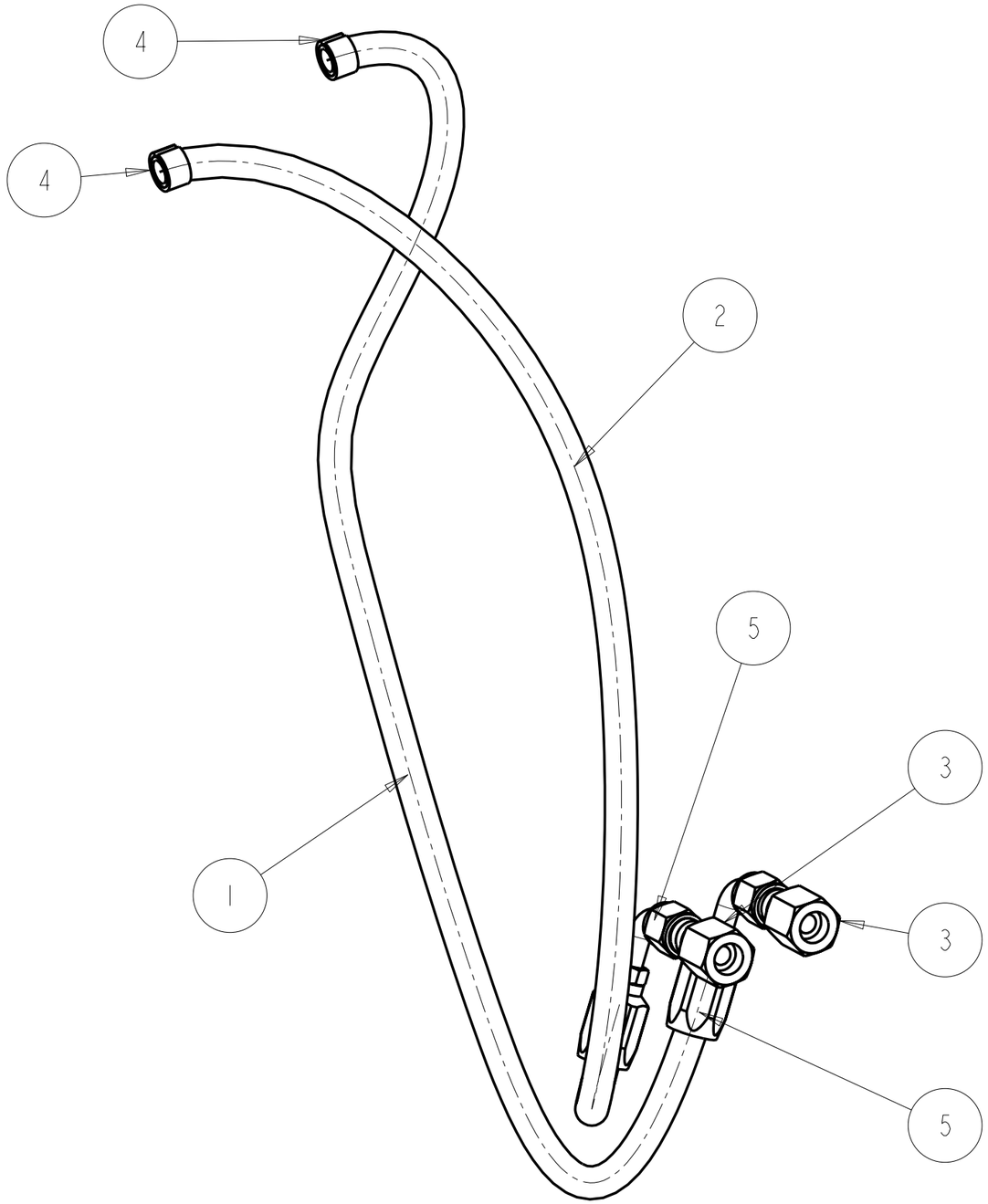
TITLE 1: ASSEMBLY, INSTRUMENT PANEL 24V, ISOLATED
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S DUBICK		DATE: 08/06/08
	APPD BY:		DATE:
EST WEIGHT: 20.096	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 13237	REV: _



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, RETURN, QSB5.9, #6 X 21" LG	9584_RETURN
2	1	FUEL LINE, SUPPLY, QSB5.9, #6 X 21" LG	9584_SUPPLY
3	2	BULKHEAD, #6 X 1/4" NPT	6_WGTX-S
4	2	CLAMP, 5/8" NOMINAL, #CL-6	8663
5	2	ELBOW, HOSE, FEMALE JIC 37 DEG. SWIVEL 90 DEG. ELBOW	23920-6-6

REV	DESCRIPTION OF REVISION	REV BY	DATE
E	REV FUEL LINE LENGTH	DAVE N	14JUL06
D	SWAPPED SUPPLY & RETURN LOC	DAVE N	01JUL05

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015
FAB TOLERANCES .X : ± 0.060 .XX : ± 0.030

MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .X : ± 1.2 .XX : ± 0.8

REF. SCALES

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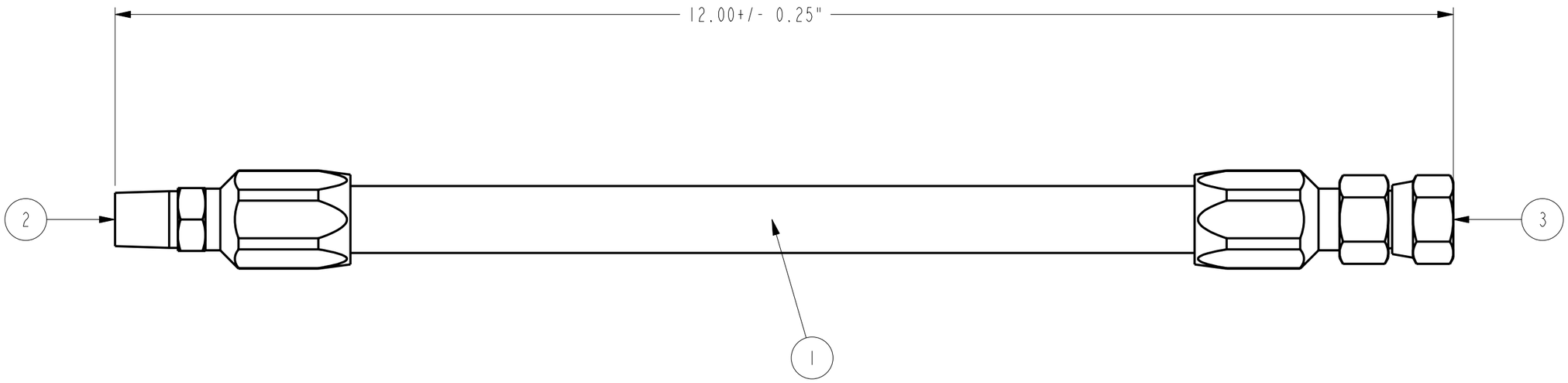
TITLE 1: ASSEMBLY, FUEL PLUMBING, QSB5.9
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 01SEP2004		
	APPD BY: -		DATE: -		
EST WEIGHT: 42238.628	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9584	REV: E

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, #6-261 x 9.375" LG, -	10235_LINE
2	1	HOSE END, 20 SERIES, 1/4" NPT X #6 HOSE	20120-4-6
3	1	ADAPTER, HOSE, FEMALE JIC 45 DEG SWIVEL	20820-6-6



REV	DESCRIPTION OF REVISION	REV BY	DATE
A			

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UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE

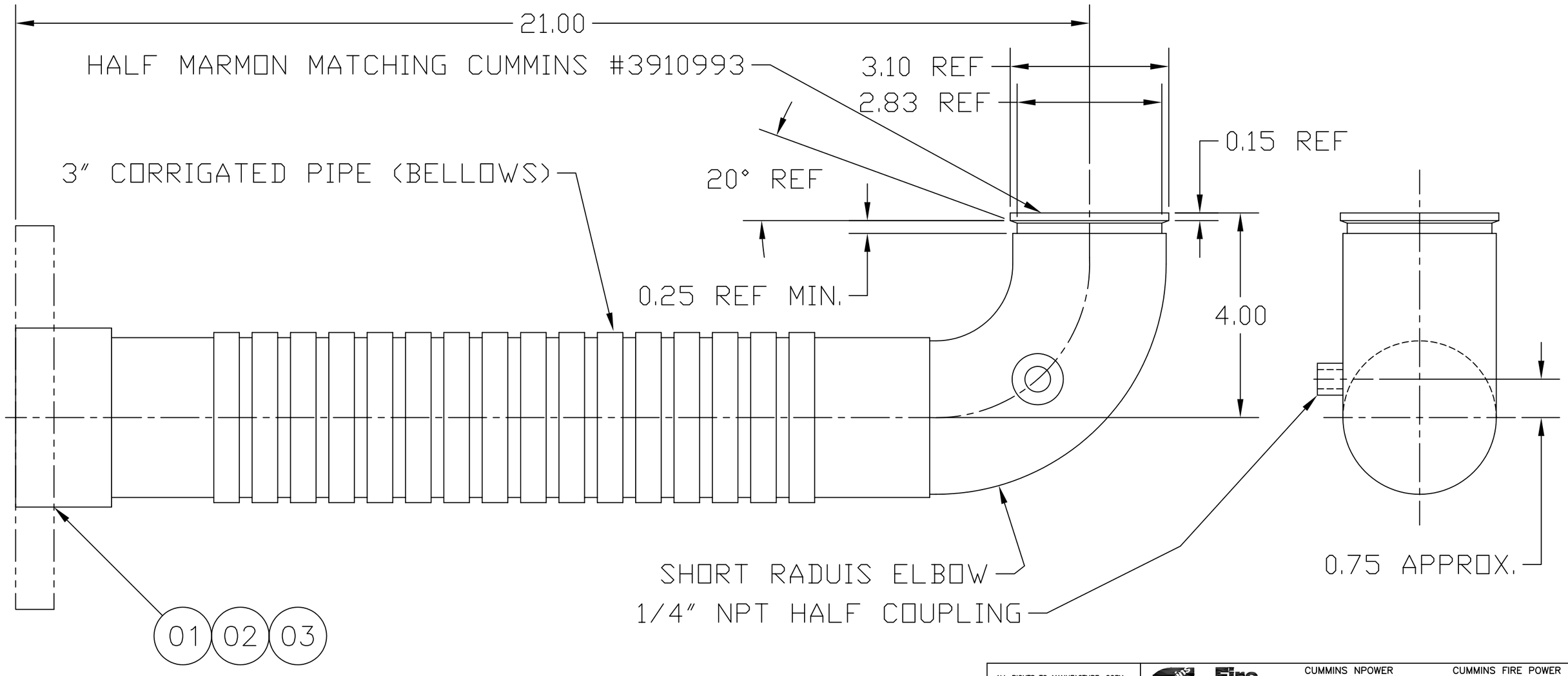
ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001 - WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06	MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05 - WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50

TITLE 1: FUEL LINE, #6, 45 DEG FLARE X 1/4" NPT
TITLE 2: 12" LONG FLEX EXTENSION

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 22JUL2005		
	APPD BY: -		DATE: -		
EST WEIGHT: 42238.628	SCALE: 1.000	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10235	REV:

ITEM	QTY	DESCRIPTION	MATERIAL
01	A/R	3" MALE NPT	
02	A/R	3" I.D. CUFF	
03	A/R	3" 125# ANSI FLANGE	



UNLESS OTHERWISE NOTED
–
ALL DIMENSIONS ARE IN INCHES
–
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
–
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

REV	DESCRIPTION OF REVISION	BY	DATE
C1	REV PER TITLE BLOCK	DAVE N	21JUN2005
C	ADDED HALF COUPLING	DAVE N	21JAN2005
B	REWORKED BOM TO TABULATE END OPTIONS	DAVE N	18NOV2004
A	ITEM 2 WAS FLEX	CMC	18MAY2004

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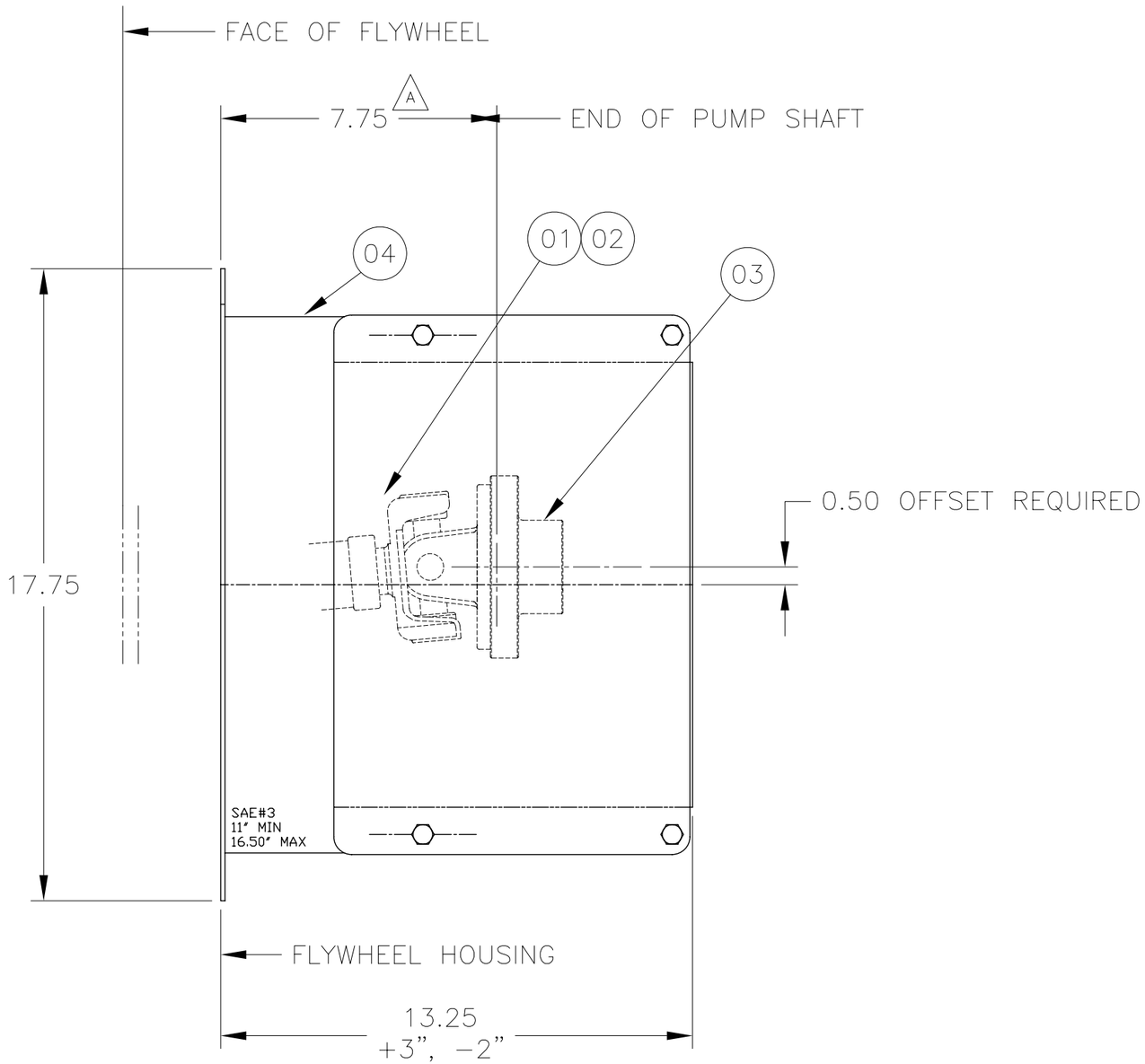
DWG SCALE: 1/2	DRAWN BY: DAVE N	DATE: 09MAR2004
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
EXHAUST, 90°, HALF MARMON TABULATED

REFERENCE:
FIREPUMP, 3" TURBO OUTLET

DRAWING NUMBER:
8550C

ITEM	QTY	DESCRIPTION	MATERIAL
01	1	U-JOINT ADAPT, SAE#3, HAYES #127513-01	8614
02	1	DRIVE SHAFT, 1410	8617
03	1	COMPANION FLANGE, SEE WO FOR BORE	8606/7-__
04	1	ASSEMBLY, TELESOPING GUARD, CFP59	9494



REV	DESCRIPTION OF REVISION	BY	DATE
A	7.74 WAS 7.25 PER 1410 MEAN LG OF 9.88"	JDT	10MAY07

UNLESS OTHERWISE NOTED
-
ALL DIMENSIONS ARE IN INCHES
-
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
-
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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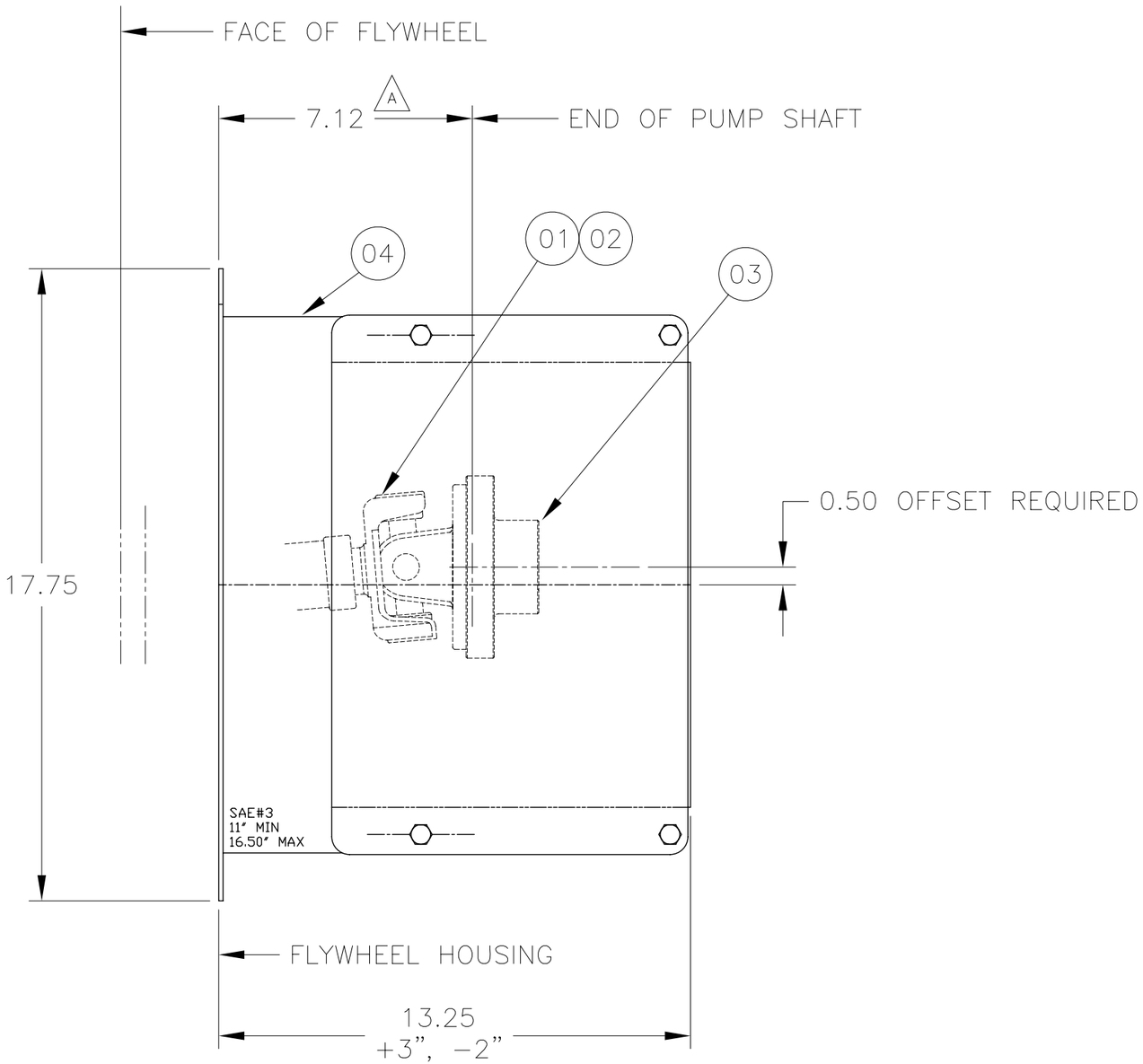
DWG SCALE: 1/4	DRAWN BY: DAVE N	DATE: 20JUN2005
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
ASSEMBLY, DRIVE SHAFT W/ GUARD

REFERENCE:	DRAWING NUMBER:
CFP59-83, 1410 DRIVE SHAFT	10164A

ITEM	QTY	DESCRIPTION	MATERIAL
01	1	U-JOINT ADAPT, SAE#3, HAYES #127513-02	8615
02	1	DRIVE SHAFT, 1480	8613
03	1	COMPANION FLANGE, SEE WO FOR BORE	8608-__
04	1	ASSEMBLY, TELESOPING GUARD, CFP59	9494



REV	DESCRIPTION OF REVISION	BY	DATE
A	7.12 WAS 7.25 PER 1480 MEAN LG OF 9.00"	JDT	10MAY07

UNLESS OTHERWISE NOTED
-
ALL DIMENSIONS ARE IN INCHES
-
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
-
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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DWG SCALE: 1/4	DRAWN BY: DAVE N	DATE: 20JUN2005
PLOT SCALE:	APPD BY:	DATE:

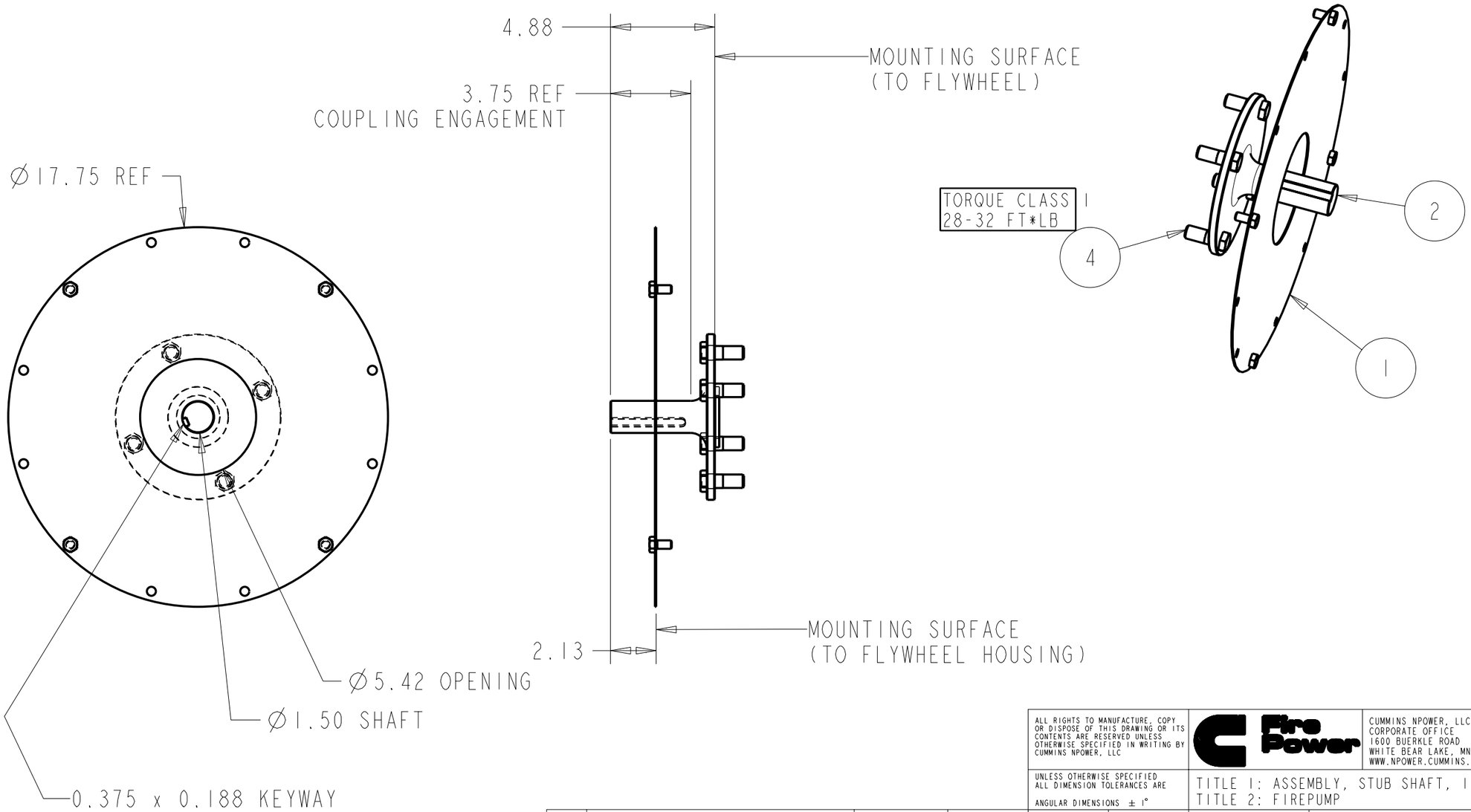
DESCRIPTION
ASSEMBLY, DRIVE SHAFT W/ GUARD

REFERENCE:
CFP59-83, 1480 DRIVE SHAFT

DRAWING NUMBER:
10165A

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	GUARD, STUB SHAFT, SAE #3 FLYWHEEL, FIREPUMP	8611
2	1	STUB SHAFT, SAE #3 FLYWHEEL, hAYES #127396, FIREPUMP	9552
3	4	SCREW, CAP, HEX HEAD, M10 x 20	HHCS_M10_20
4	4	SCREW, CAP, HEX HEAD, M10 x 50	HHCS_M16_50



UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

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TITLE 1: ASSEMBLY, STUB SHAFT, 1.50" DIA
TITLE 2: FIREPUMP

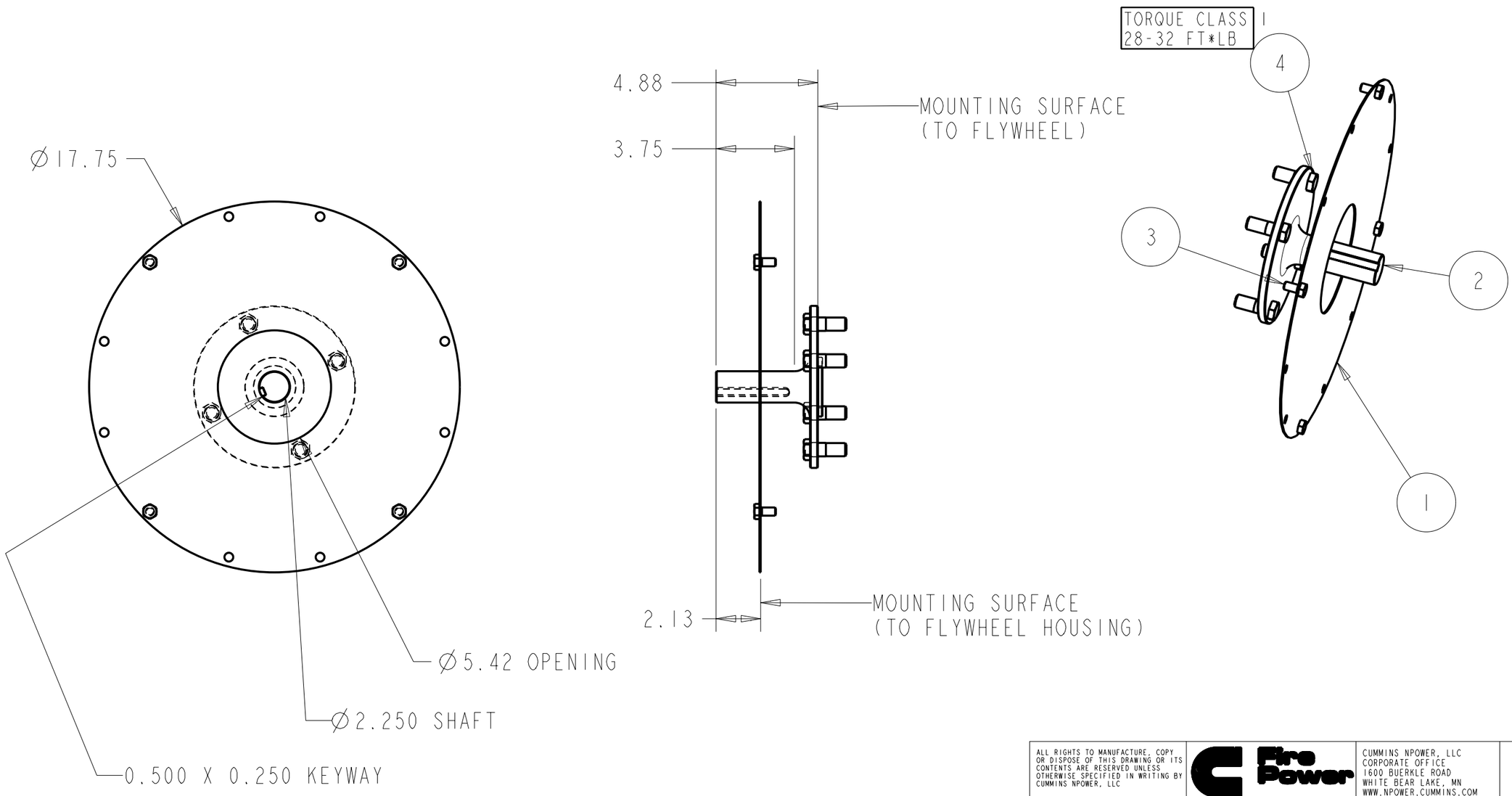
REV	DESCRIPTION OF REVISION	REV BY	DATE
B1	CORRECTED TORQUE	DAVE N	20JUN05
B	GUARD WAS 9553	DAVE N	20JAN05
AA	ADDED HARDWARE	DAVE N	21OCT04

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N				DATE: 16SEP2004
	APPD BY: -				DATE: -
EST WEIGHT: 42238.628	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8618	REV: B

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	GUARD, STUB SHAFT, SAE #3 FLYWHEEL, FIREPUMP	8611
2	1	STUB SHAFT, SAE #3 FLYWHEEL, HAYES #, FIREPUMP	9624
3	4	SCREW, CAP, HEX HEAD, M10 x 20	HHCS_M10_20
4	4	SCREW, CAP, HEX HEAD, M10 x 50	HHCS_M16_50



REV	DESCRIPTION OF REVISION	REV BY	DATE
B1	CORRECTED TORQUE	DAVE N	20JUN05
B	GUARD WAS 9553	DAVE N	20JAN05
A	ADDED HARDWARE	DAVE N	21OCT04

UNLESS OTHERWISE SPECIFIED
ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001 WELD TOLERANCES X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06	MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05 WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50

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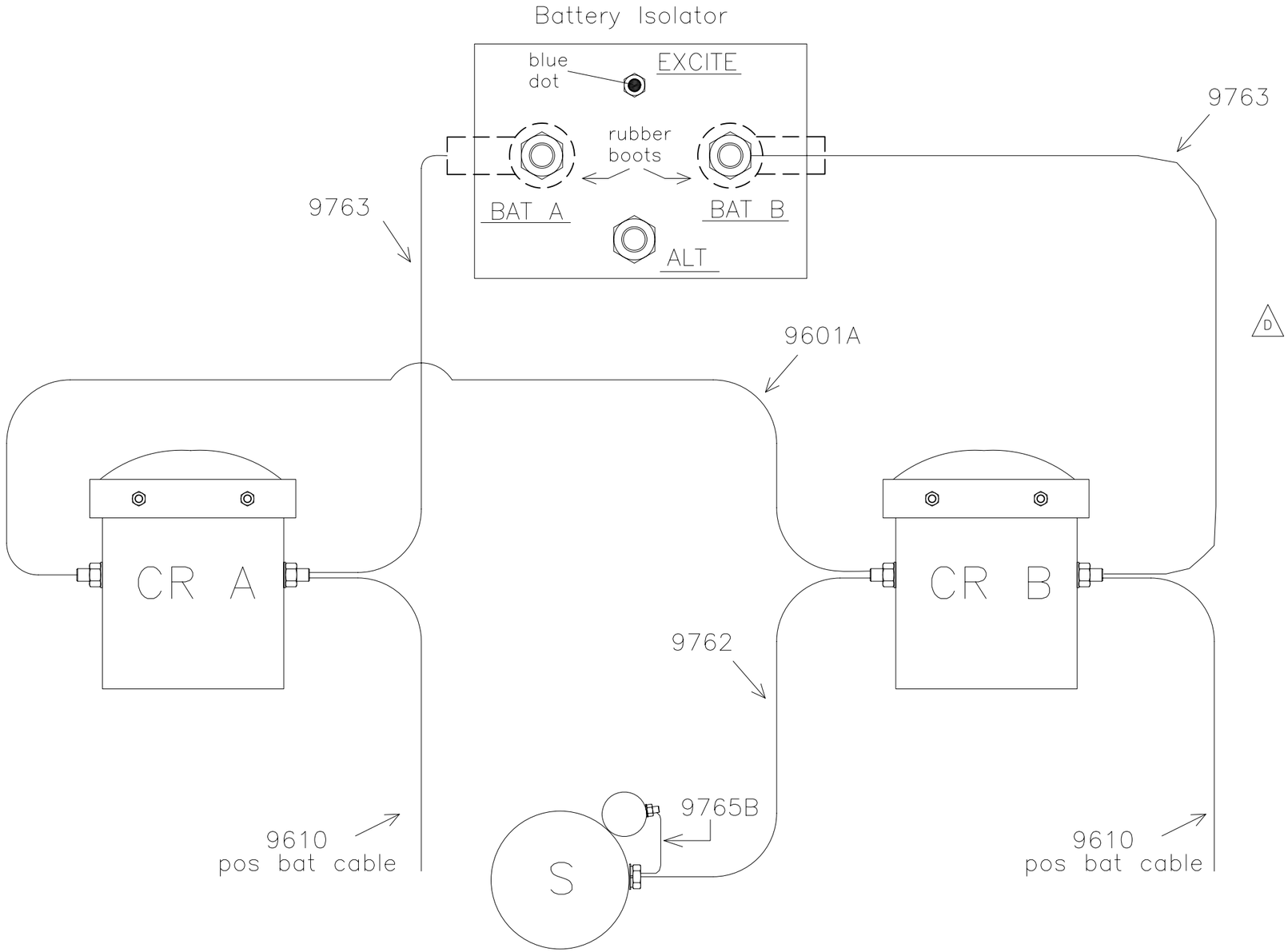
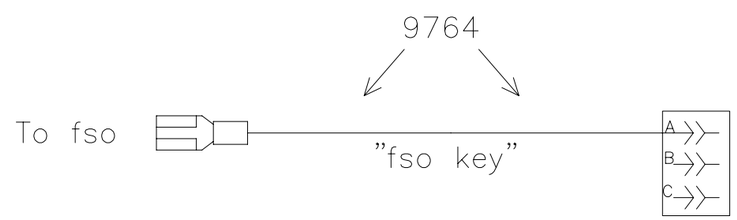
TITLE 1: ASSEMBLY, STUB SHAFT, 2.25" DIA
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 15OCT2004
	APPD BY: -		DATE: -
EST WEIGHT: 42238.628	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1
	DRAWING NO: 8619		REV: B



P/N	DESCRIPTION	QTY
9601A	Cable, Battery Contactor Jumper	1
9762A	Cable, Contactor to Starter	1
△D 9763B	Cable, Isolator to Battery	2
9764	Wire, FSO Connector	1
9765B	Wire, Starter Solenoid Jumper	1
9609	Battery Cable Kit (optional)	1



REV	DESCRIPTION OF REVISION	BY	DATE
D	CHANGED P/N 9763 TO REV B	RJS	6 NOV 06
C	CHANGED P/N 9765 TO REV B	RJS	25 JULY 06
B	P/N 9601 CHG'D TO REV A	RJS	30 NOV 05
A2	MOVED THE CR A–TO–CR B JUMPER	]RJS	2 JULY 05
A1	ADDED REV # TO THE P/N'S	RJS	17 JUNE 05
A	ADDED WIRING DIAGRAM	RJS	5 JAN 05

UNLESS OTHERWISE NOTED
–
ALL DIMENSIONS ARE IN INCHES
–
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
–
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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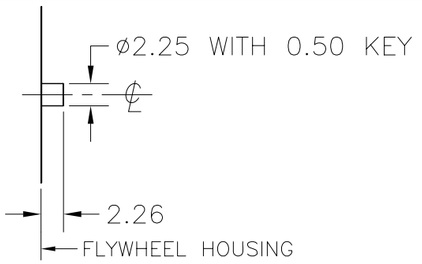
DWG SCALE:	DRAWN BY: RJS	DATE: 6 DEC 2004
PLOT SCALE:	APPD BY:	DATE:

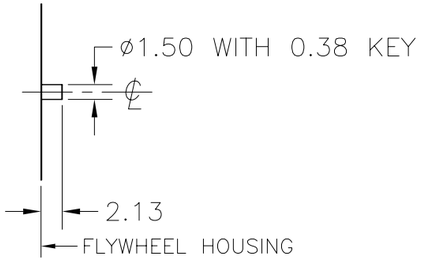
DESCRIPTION
KIT, LOOSE WIRES

REFERENCE:	DRAWING NUMBER:
4B, 6B, 6C, QSB, & QSC	9767_D

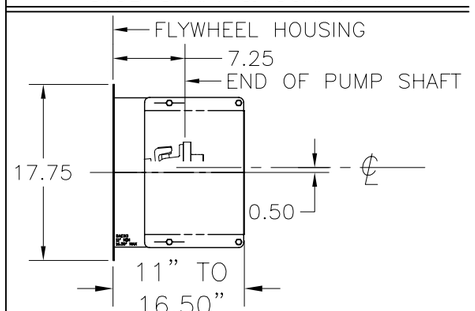
SAE #3	FLYWHEEL HOUSING
1/4" NPT	FUEL SUPPLY
1/4" NPT	FUEL RETURN
3/4" NPT	RAW WATER SUPPLY
1" NPT	RAW WATER RETURN
115v. PLUG	COOLANT HEATER
3" DIA.	EXHAUST CONNECTION



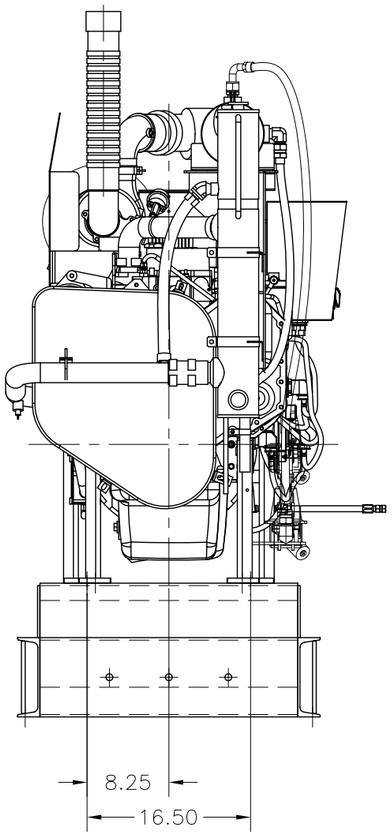
STUB SHAFT & GUARD

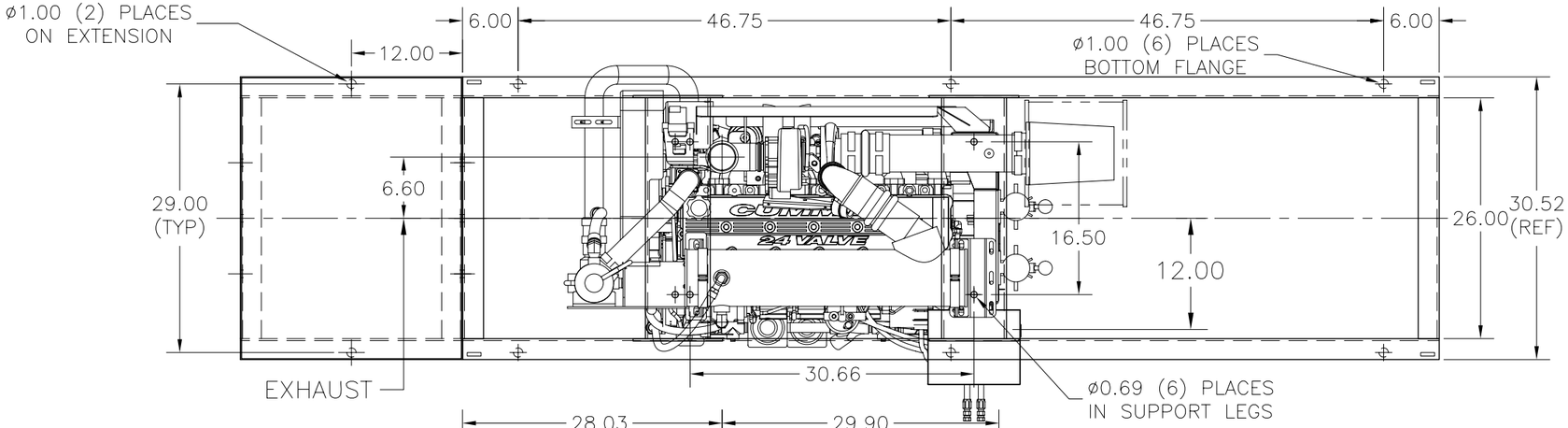


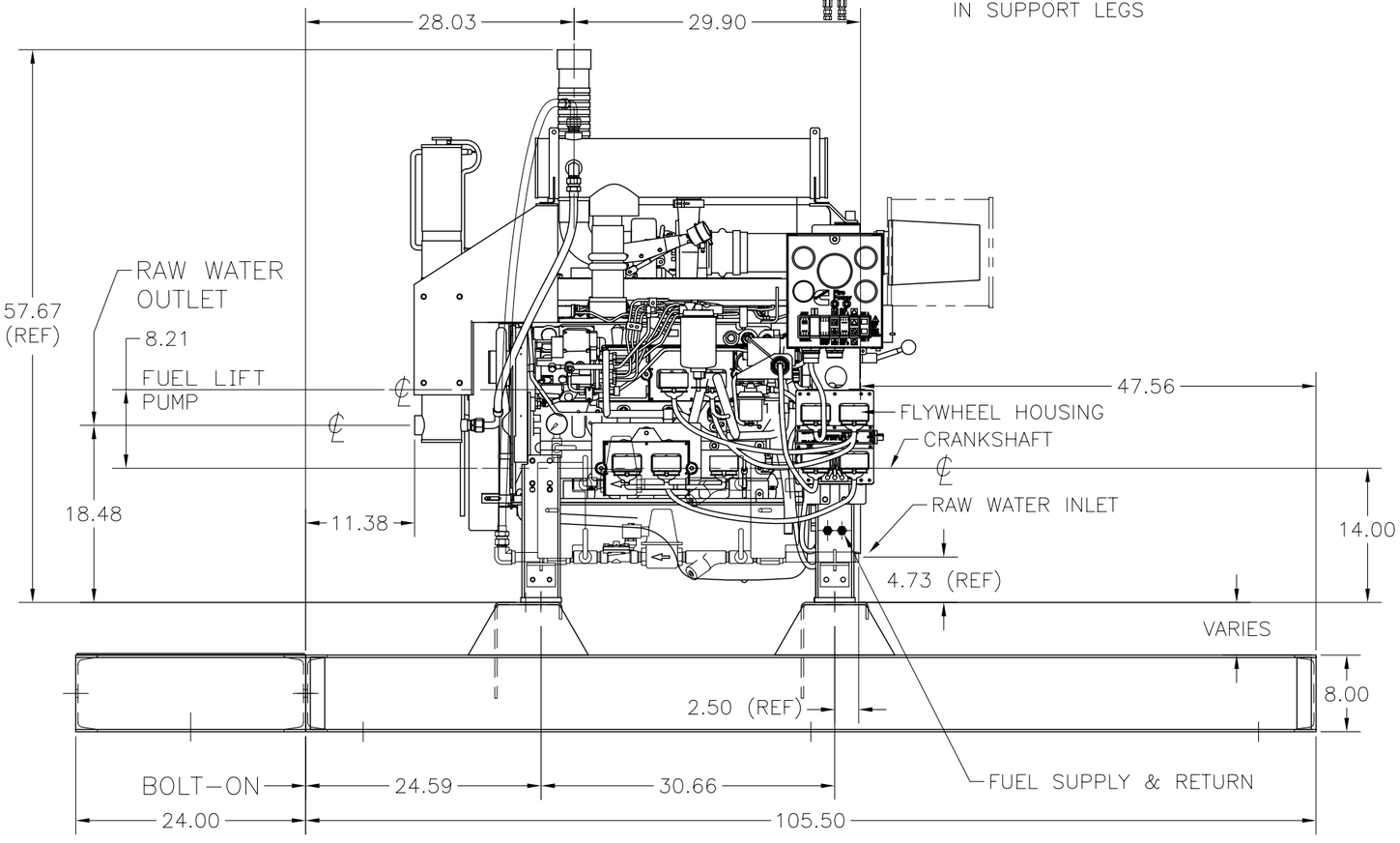
STUB SHAFT & GUARD



1480 DRIVE SHAFT & GUARD







NOTES

1) DETAILS REMOVED FOR CLARITY
2) OPTIONAL COMPONENTS SHOWN
3) SUBJECT TO CHANGE WITHOUT NOTICE
4) LEG EXTENSION LENGTH DETERMINED BY PUMP SIZE
5) SEE ASSEMBLY DRAWING AND DATA SHEET FOR ADDITIONAL INFORMATION
6) DRIVE SHAFT MUST NOT RUN AT 0° ANGLE

REV	DESCRIPTION OF REVISION	BY	DATE
D	GRAPHICS REVISION	DAN	15JAN2007

UNLESS OTHERWISE NOTED
–
ALL DIMENSIONS ARE IN INCHES
–
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
–
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

Cummins Fire Power

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875 LAWRENCE DRIVE
DEPERE, WISCONSIN
WWW.CUMMINSFIREPOWER.COM

DWG SCALE: 1/16	DRAWN BY: CNP	DATE: NOV2004
PLOT SCALE:	APPD BY:	DATE:

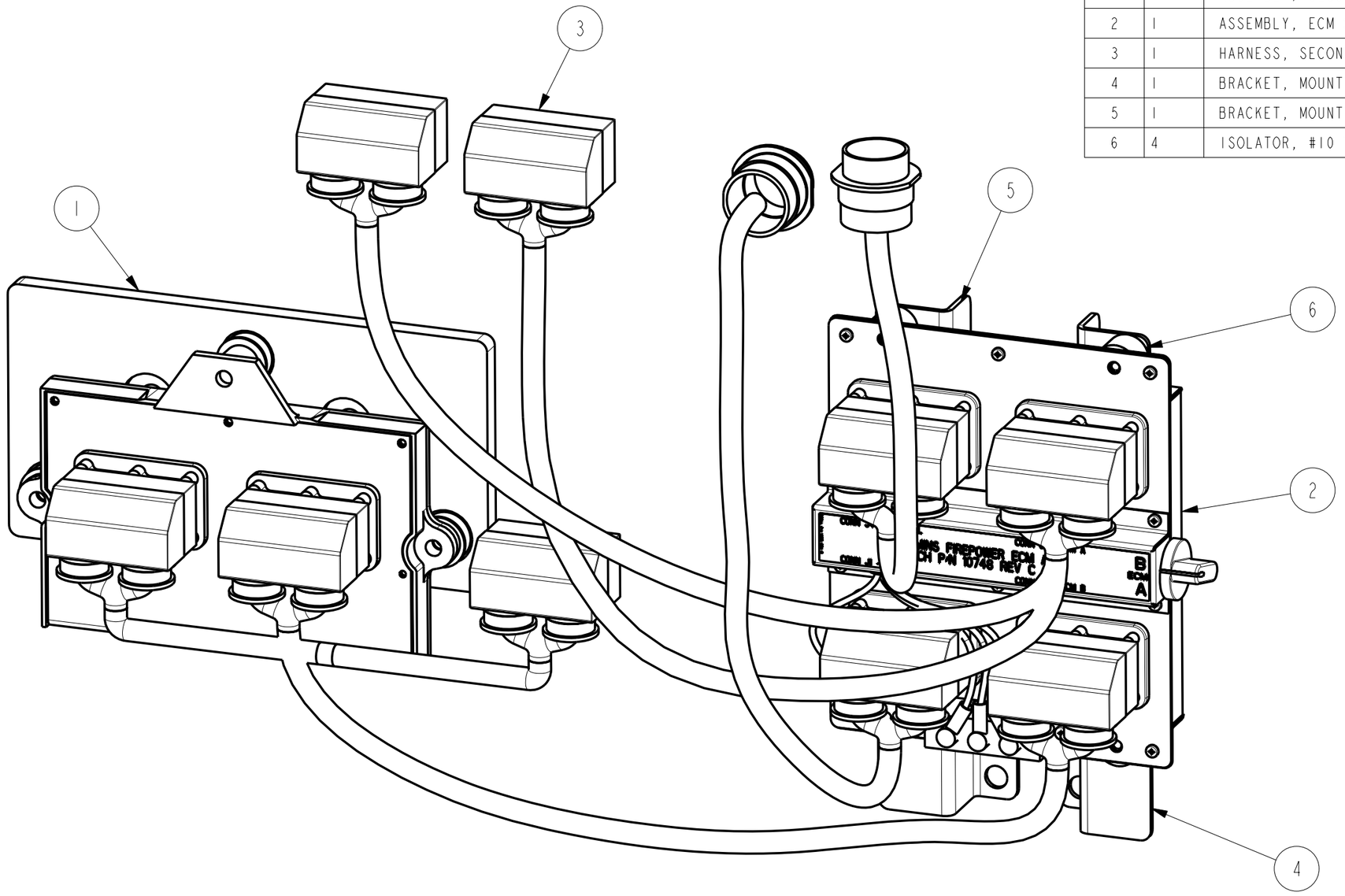
DESCRIPTION
GENERAL LAYOUT, FIREPUMP, CFP6E

REFERENCE:

DRAWING NUMBER:
CFP6E_GEN

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, SECONDARY ECM, FIREPUMP	9505
2	1	ASSEMBLY, ECM SWITCH	10748
3	1	HARNESS, SECONDARY ECM, CFP6E, FIREPUMP	11321-PROE
4	1	BRACKET, MOUNTING, RH, ECM, CFP9E, FIREPUMP	10779
5	1	BRACKET, MOUNTING, LH, ECM, CFP9E, FIREPUMP	10780
6	4	ISOLATOR, #10 TAP & STUD, #AG-3904930	51156PS



REF. SCALES

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS
MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015
FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030

METRIC UNITS
MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

REV	DESCRIPTION OF REVISION	REV BY	DATE
A	CREATED DRAWING	DAVE N	12DEC06

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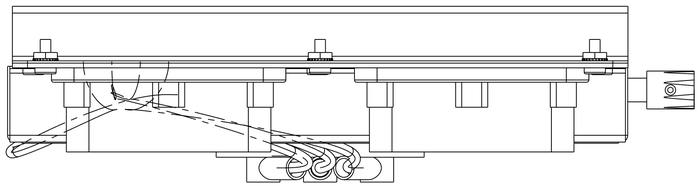
TITLE 1: ASSEMBLY, SECONDARY ECM, CFP6E
TITLE 2: FIREPUMP

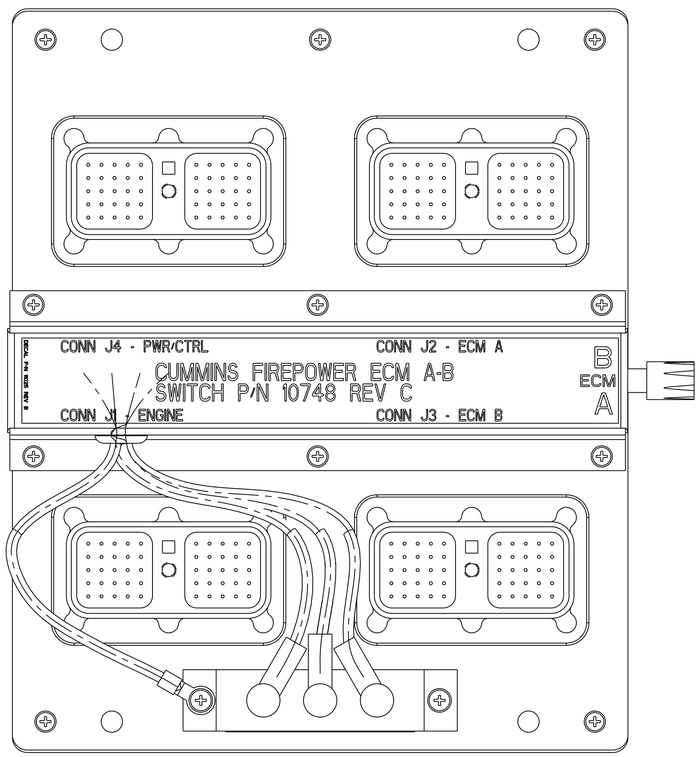
DWG UNITS: IN/LB/S	DRAWN BY: DAVE N				DATE: 12DEC2006	
	APPD BY: -				DATE: -	
EST WEIGHT: 36.299	SCALE: 0.375	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 11322	REV: A	

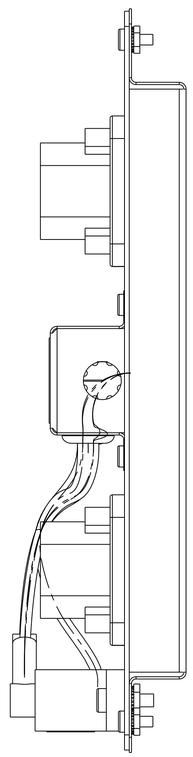
DESIGN INTELECTUAL PROPERTY BY CUMMINS NPOWER, LLC
ALL PRODUCTION RUNS WILL REQUEST LATEST DOCUMENTATION
SEE SHEET 2 FOR WAVE-SOLDER ASSEMBLY
SEE SHEET 3 FOR HAND-SOLDER OF LEADS
SEE SHEET 4 FOR COVER ASSEMBLY

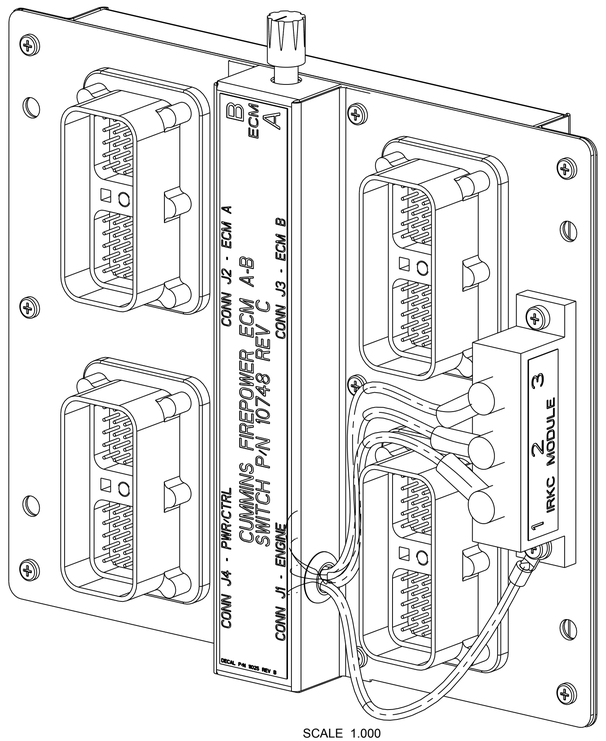


BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	PC BOARD	10749
2	1	INSULATING MEMBRANE, ECM SWITCH	10750
3	1	MOUNTING PLATE, ALUMINUM	10751
4	1	SWITCH, 78 POLE	10754
6	1	BACKING PLATE, ALUMINUM	10752
7	1	SWITCH COVER, ALUMINUM	10753
8	1	GROMMET, , MCMASTER CARR P/N 9307K21 OR EQUIV	9307K21
9	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
10	1	LEAD 10 AWG, COPPER, GXL INSULLATION, RED COLOR	10748_L1
11	1	LEAD 10 AWG, COPPER, GXL INSULLATION, BLACK COLOR	10748_L2
12	1	LEAD 10 AWG, COPPER, GXL INSULLATION, BLACK COLOR	10748_L3
13	1	LEAD, 10 AWG, COPPER, GXL INSULLATION, GREEN COLOR	10748_L4
14	11	NUT, HEX, NO 8-32 W/ RETENTION, WASHER	NUT-RETAINING_NO-8-32
15	2	NUT, HEX, NO 10-32 W/ RETENTION, WASHER	NUT-RETAINING_NO-10-32
16	11	SCREW, NO 8-32 X 3/8, MACHINE SCREW	SCREW_MACHINE_NO-8-32_X_38
17	2	SCREW, NO 10-32 X 5/8, MACHINE SCREW	SCREW_MACHINE_NO-10-32_X_625
18	24	SCREW, SELF-TAPPING, #6 MACHINE SCREW	SCREW_SELF-TAP_NO-6_X_38
19	1	DECAL, ECM A-B SWITCH, -	11025
21	3	BOOT, INSULATING, -0.25" ENTRY, RED	11052
22	1	CONNECTOR, 50 PIN	DRC20-50P-01
23	1	CONNECTOR, 50 PIN	DRC20-50P-02
24	1	CONNECTOR, 50 PIN	DRC20-50P-03
25	1	CONNECTOR, 50 PIN	DRC20-50P-04
26	1	KNOB, 0.50 DIA, 0.25 BORE, MCMASTER #6094K71 OR EQUAL	13626







SCALE 1.000

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER KNOB. ADDED COATING NOTE	DAVE N	30SEP2008
C	REVISED PER ECN 2006-192	S.DANFORTH	22SEP2006
B	RELEASE FOR PRODUCTION	S.DANFORTH	12JUL2006
A	PROTOTYPE DRAWING	DAVE N.	

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ±° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES
.XX ± .03
.XXX ± .010
.XXXX ± .0005

SHEET TOLERANCES
.XX ± .06
.XXX ± .030
.XXXX ± .0010

REF SCALES	
Cummins Fire Power	CUMMINS NPOWER, LLC CORPORATE OFFICE 1600 BUERKLE ROAD WHITE BEAR LAKE, MN WWW.NPOWER.CUMMINS.COM
	NPOWER SYSTEMS DESIGN CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN

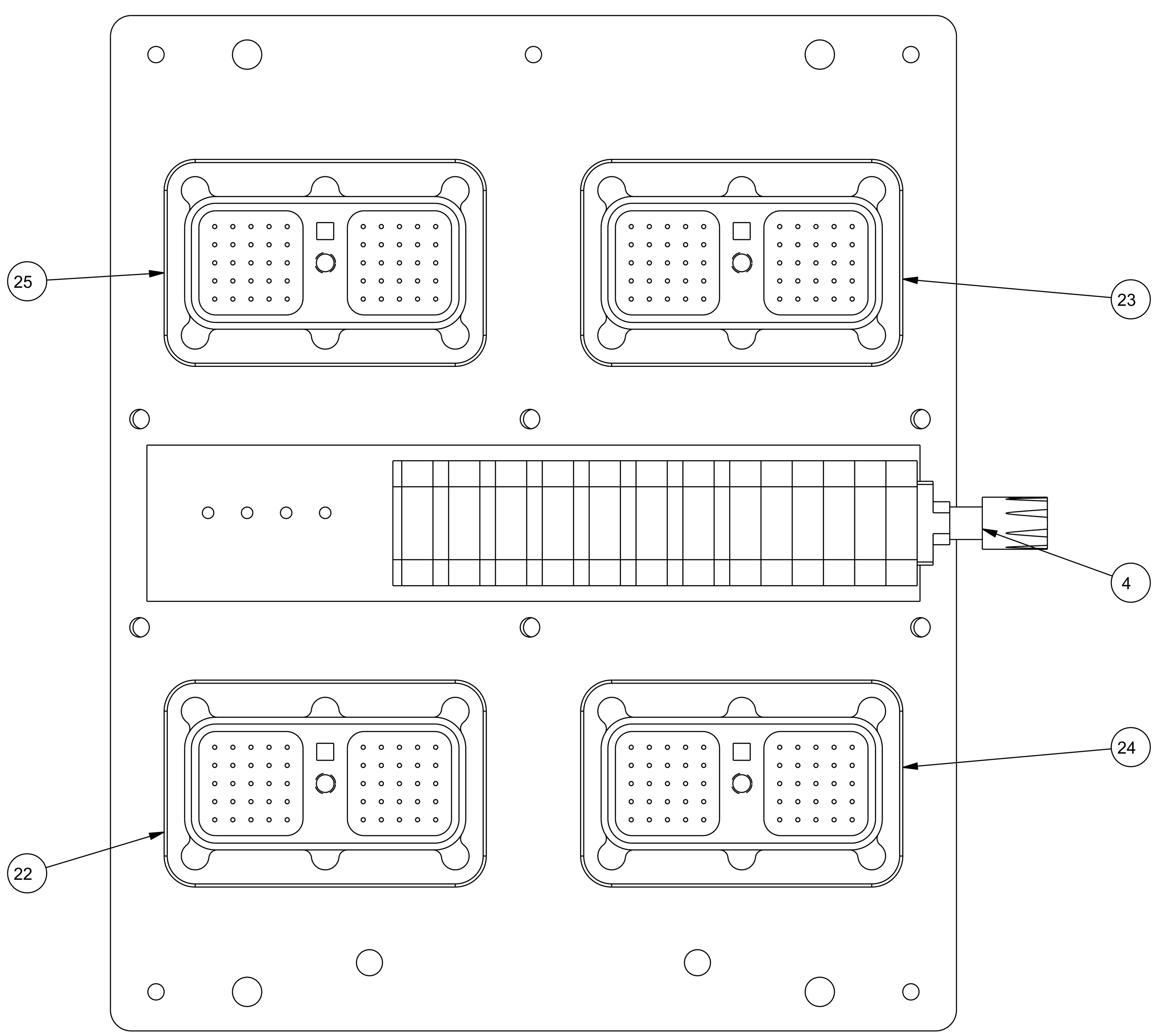
TITLE 1: ASSEMBLY, ECM SWITCH
TITLE 2:

DWG UNITS: IN/LB/S	DRAWN BY: SCOTT D			DATE: 21FEB2006	
	APPD BY: -			DATE: -	
EST WEIGHT: 6.709	SCALE: 1.000	DO NOT SCALE	SHEET 1OF4	DRAWING NO: 10748	REV: D

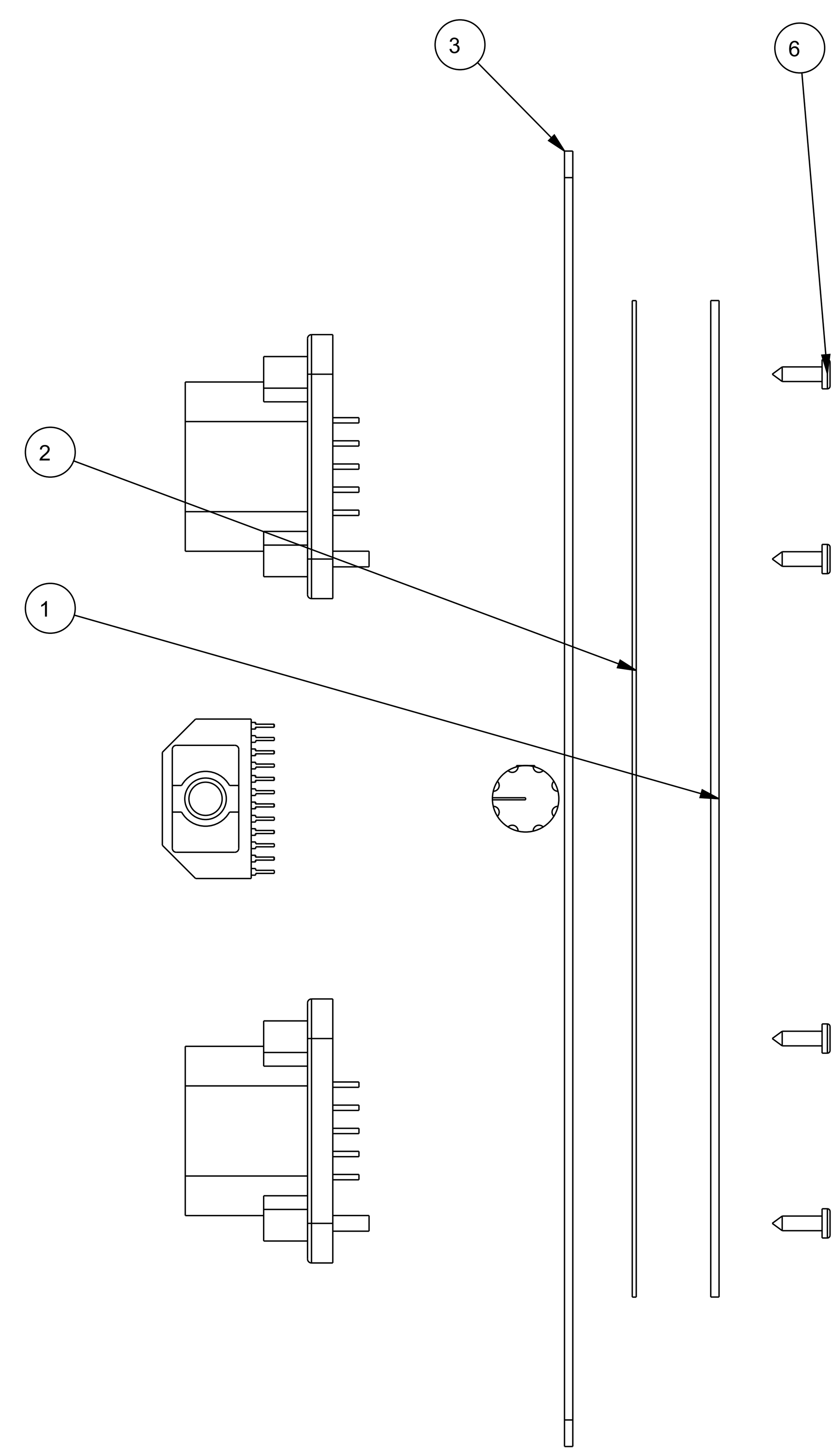
THIS SHEET FOR WAVE-SOLDER ASSEMBLY
ANY DEVIATION MUST BE APPROVED IN WRITING
EACH CONNECTOR MUST BE MECHANICALLY
BONDED TO ASSEMBLY WITH SELF-TAPPING SCREWS
PRIOR TO SOLDERING.

BILL OF MATERIAL				
	ITEM	QTY	DESCRIPTION	PART NUMBER
	1	1	PC BOARD	10749
	2	1	INSULATING MEMBRANE, ECM SWITCH	10750
	3	1	MOUNTING PLATE, ALUMINUM	10751
C	4	1	SWITCH, 78 POLE	10754
	6	24	SCREW, SELF-TAPPING, #6 MACHINE SCREW	SCREW_SELF-TAP_NO-6_X_38
D	7	1	KNOB, 0.50 DIA, 0.25 BORE, MCMASTER #6094K71 OR EQUAL	13626
C	22	1	CONNECTOR, 50 PIN	DRC20-50P-01
C	23	1	CONNECTOR, 50 PIN	DRC20-50P-02
C	24	1	CONNECTOR, 50 PIN	DRC20-50P-03
	25	1	CONNECTOR, 50 PIN	DRC20-50P-04

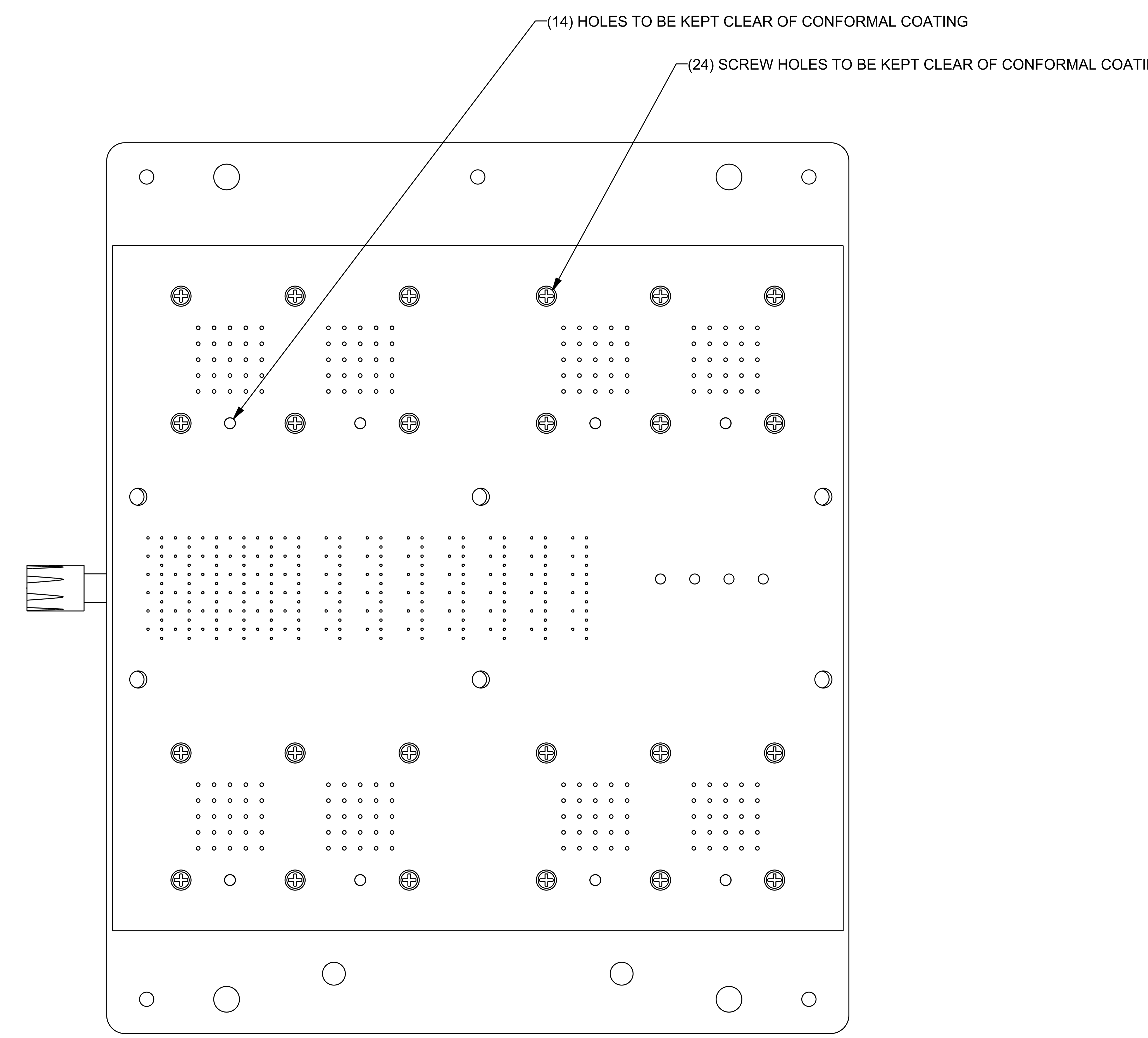
D CONFORMAL COAT PCB
USING DOW 3-176S COATING MATERIAL.



SCALE 1.000



THIS VIEW EXPLODED FOR CLARITY OF
ASSEMBLY PROCESS AND COMPONENT LOCATION



REF. SCALES

Fire Power

CUMMINS NPOWER, LLC
CORPORATE OFFICE
1600 BUERKLE ROAD
WHITE BEAR LAKE, MN
WWW.NPOWER.CUMMINS.COM

NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS 1±° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

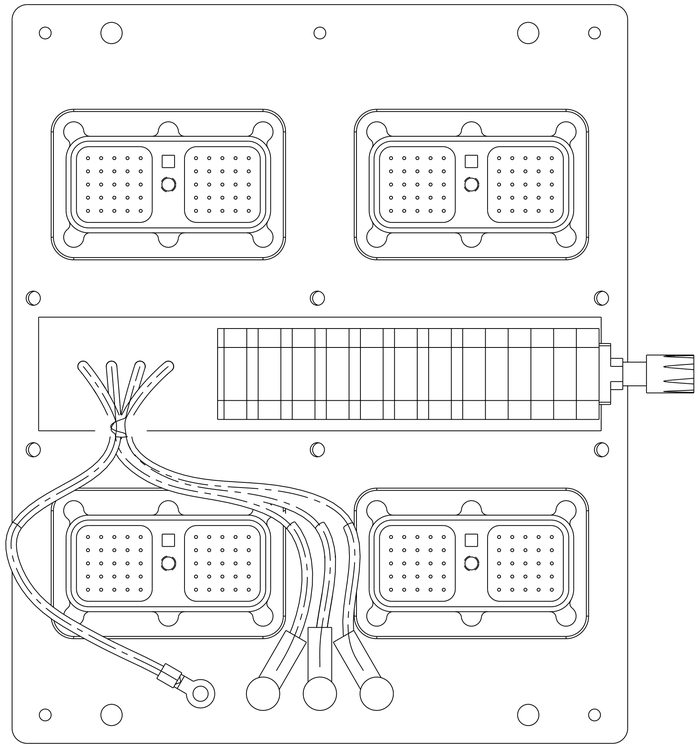
	IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES	.XX = ± 0.010 .XXX = ± 0.005	.X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES	.XX = ± 0.030 .XXX = ± 0.015	.X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES	.XX = ± 0.060 .XXX = ± 0.030	.X = ± 1.5 .XX = ± 0.8

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER KNOB. ADDED COATING NOTE	DAVE N	30SEP2008
C	REVISED PER ECN 2006-192	S.DANFORTH	22SEP2006
B	RELEASED FOR PRODUCTION	S.DANFORTH	12JUL2006

TITLE 1: ASSEMBLY, ECM SWITCH
TITLE 2:

DWG UNITS: IN/LB/S	DRAWN BY: SCOTT D			DATE: 21FEB2006	
	APPD BY: -			DATE: -	
EST WEIGHT: 6.709	SCALE: 0.750	DO NOT SCALE	SHEET 2OF4	DRAWING NO: 10748	REV: D

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	KNOB, 0.50 DIA, 0.25 BORE, MCMASTER #6094K71 OR EQUAL	13626
10	1	LEAD 10 AWG, COPPER, GXL INSULLATION, RED COLOR	10748_L1
11	1	LEAD 10 AWG, COPPER, GXL INSULLATION, BLACK COLOR	10748_L2
12	1	LEAD 10 AWG, COPPER, GXL INSULLATION, BLACK COLOR	10748_L3
13	1	LEAD, 10 AWG, COPPER, GXL INSULLATION, GREEN COLOR	10748_L4
21	3	BOOT, INSULATING, -0.25" ENTRY, RED	11052
22	1	CONNECTOR, 50 PIN	DRC20-50P-01
23	1	CONNECTOR, 50 PIN	DRC20-50P-02
24	1	CONNECTOR, 50 PIN	DRC20-50P-03
25	1	CONNECTOR, 50 PIN	DRC20-50P-04



EACH LEAD IS TO BE HAND SOLDERED
SOLDER TO BE ROHS COMPLIANT (LEAD FREE)
ALL FLUX TO BE REMOVED AFTER SOLDERING TO PREVENT CORROSION
GREEN LEAD FOR GROUND
RED LEAD FOR DIODE ANODE
BLACK LEADS FOR BATT 1 AND BATT 2
EACH LEAD MANUFACTURED WITH GXL WIRE AND #10 AWG X #10 RING TERMINAL. CRIMP TERMINAL ACCEPTABLE. SOLDER TERMINAL PREFERED.

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER KNOB. ADDED COATING NOTE	DAVE N	30SEP2008
C	REVISE PER ECN 2006-192	S.DANFORTH	22SEP2006
B	RELEASE FOR PRODUCTION	S.DANFORTH	12JUL2006

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ±°

THIRD ANGLE PROJECTION

IMPERIAL UNITS: DECIMAL TOLERANCES .XX ± .02 .XXX ± .010 FRACTIONAL TOLERANCES .XX ± .03 .XXX ± .005 .XXXX ± .0005

METRIC UNITS: DECIMAL TOLERANCES .X ± .5 .XX ± .25 FRACTIONAL TOLERANCES .X ± .5 .XX ± .13

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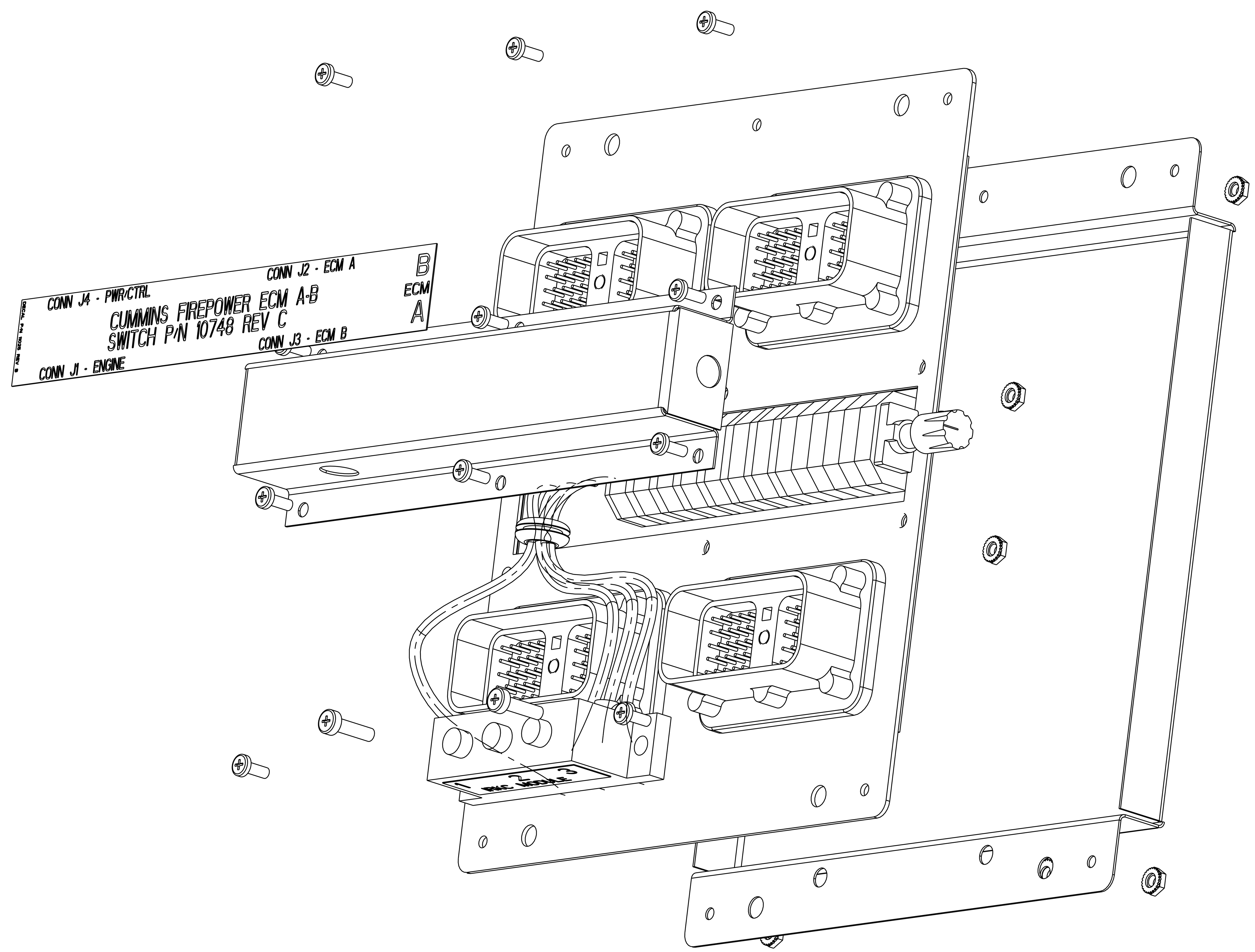
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, ECM SWITCH
TITLE 2:

DWG UNITS: IN/LB/S	DRAWN BY: SCOTT D			DATE: 21FEB2006	
	APPD BY: -			DATE: -	
EST WEIGHT: 6.709	SCALE: 1.000	DO NOT SCALE	SHEET 3OF4	DRAWING NO: 10748	REV: D

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	KNOB, 0.50 DIA, 0.25 BORE, MCMASTER #6094K71 OR EQUAL	13626
3	1	BACKING PLATE, ALUMINUM	10752
7	1	SWITCH COVER, ALUMINUM	10753
8	1	GROMMET, , MCMASTER CARR P/N 9307K21 OR EQUIV	9307K21
9	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
14	11	NUT, HEX, NO 8-32 W/ RETENTION, WASHER	NUT-RETAINING_NO-8-32
15	2	NUT, HEX, NO 10-32 W/ RETENTION, WASHER	NUT-RETAINING_NO-10-32
16	11	SCREW, NO 8-32 X 3/8, MACHINE SCREW	SCREW_MACHINE_NO-8-32_X_38
17	2	SCREW, NO 10-32 X 5/8, MACHINE SCREW	SCREW_MACHINE_NO-10-32_X_625
19	1	DECAL, ECM A-B SWITCH, -	11025



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875 LAWRENCE DRIVE
DEPERE, WISCONSIN

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS 1±° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

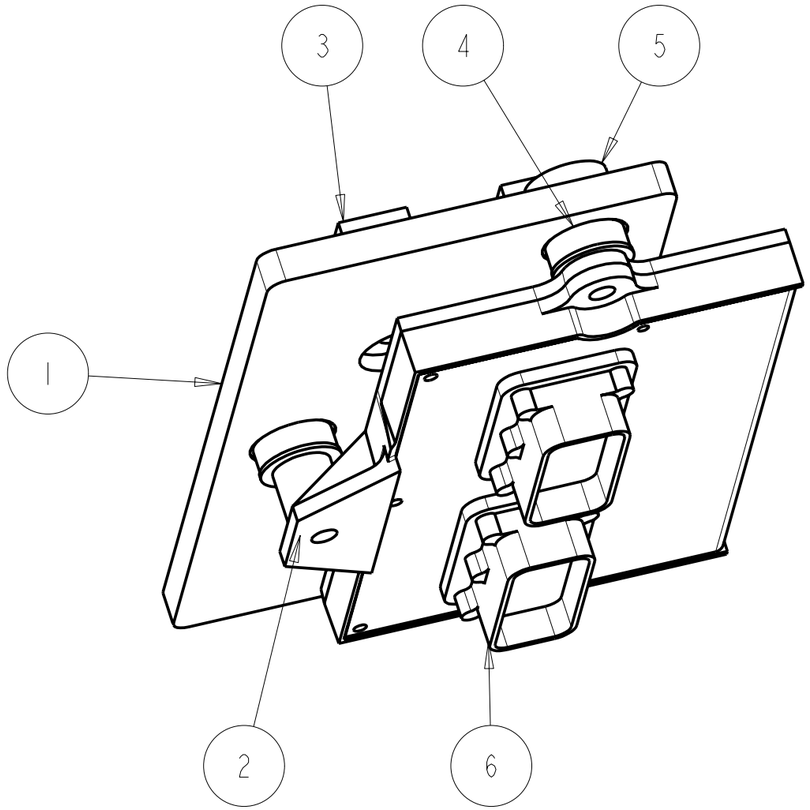
TITLE 1: ASSEMBLY, ECM SWITCH
TITLE 2:

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER KNOB. ADDED COATING NOTE	DAVE N	30SEP2008
C	REVISED PER ECN 2006-192	S.DANFORTH	22SEP2006
B	RELEASE FOR PRODUCTION	S.DANFORTH	12JUL2006

DWG UNITS: IN/LB/S	DRAWN BY: SCOTT D		DATE: 21FEB2006	
	APPD BY: -		DATE: -	
EST WEIGHT: 6.709	SCALE: 1.000	DO NOT SCALE	SHEET 4OF4	DRAWING NO: 10748 REV: D

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	BRACKET, ECM, BACK-UP, FIREPUMP	9506
2	1	SPACER, SECONDARY ECM MOUNTING	9507
3	2	STANDOFF, SECONDARY ECM MOUINTING, FIREPUMP	9509
4	3	ISOLATOR, VIBRATION, CUMMINS NO 3955219	3955219
5	3	ISOLTATOR, VIBRATION, CUMMINS NO. 3955220	3955220
6	1	ECM, CECO#3990517	3990517



REF. SCALES

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX ± 0.010 .XXX ± 0.005
FORM TOLERANCES .XX ± 0.020 .XXX ± 0.015
FAB TOLERANCES .XX ± 0.060 .XXX ± 0.030

MACHINE TOLERANCES .X ± 0.4 .XX ± 0.2
FORM TOLERANCES .X ± 0.8 .XX ± 0.4
FAB TOLERANCES .X ± 1.5 .XX ± 0.8

REV	DESCRIPTION OF REVISION	REV BY	DATE
C2	CORRECTED ECM PART NUMBER	DAVE N	13JUL06

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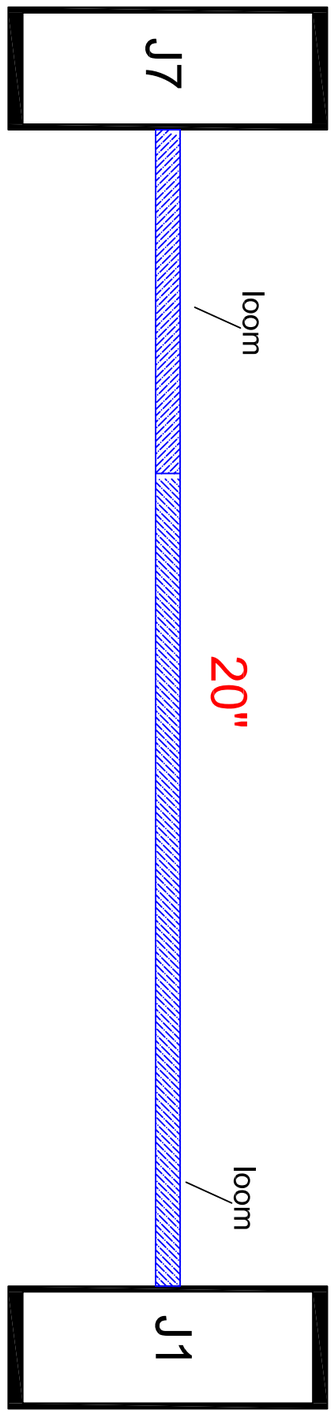
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, SECONDARY ECM
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 21JUN2004		
	APPD BY:		DATE:		
EST WEIGHT: 42238.628	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9505	REV: C

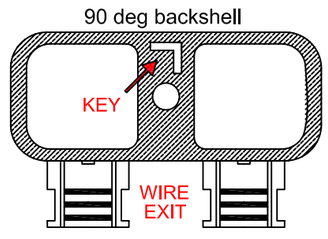


"J7 - ENGINE HARNESS ACTUATORS"

"J1 - ECM SWITCH"

NOTE: Loom with black nylon braid w/ red tracers; 28 mil minimum.. Prominently label all connectors as "indicated".

FROM	TO	WIRE LABEL	
J7/3	J1/3	J7/3 - J1/3	**J1**
J7/4	J1/4	J7/4 - J1/4	Deutsch DRC26-50S-**01** (Plug) - 1
J7/6	J1/6	J7/6 - J1/6	w/ 0528-001-5005 (90 deg backshell) - 1
J7/7	J1/7	J7/7 - J1/7	w/ 0462-201-20141 (sockets) - 19
J7/8	J1/8	J7/8 - J1/8	
J7/9	J1/9	J7/9 - J1/9	**J7**
J7/10	J1/10	J7/10 - J1/10	Deutsch; Customized DRC20-50P-**03**
J7/13	J1/13	J7/13 - J1/13	(In-Line 50-Pin Receptacle) - 1
J7/16	J1/16	J7/16 - J1/16	w/ 0460-202-20141 (pins) - 19
J7/17	J1/17	J7/17 - J1/17	
J7/18	J1/18	J7/18 - J1/18	
J7/19	J1/19	J7/19 - J1/19	
J7/33	J1/33	J7/33 - J1/33	
J7/43	J1/43	J7/43 - J1/43	
J7/47	J1/47	J7/47 - J1/47	
J7/11	J1/50	J7/11 - J1/50	
J7/23	J1/27	J7/23 - J1/27	
J7/34	J1/28	J7/34 - J1/28	
J7/45	J1/26	J7/45 - J1/26	
All wire white 18 AWG GXL, or equiv			



REV	DESCRIPTION OF REVISION	BY	DATE
C	CORRECTIONS MADE TO PAGE -02	RJS	02 MAR 07
B	NO REV ON THIS PAGE. RELEASE FOR PRODUCTION	RJS	02 FEB 07
A	20" WAS 30"	RJS	16 JAN 07

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UNLESS OTHERWISE NOTED
ALL DIMENSIONS ARE IN INCHES
APPLY MACHINE TOLERANCES
X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
X = ± 0.12
.XX = ± 0.03
.XXX = ± 0.05

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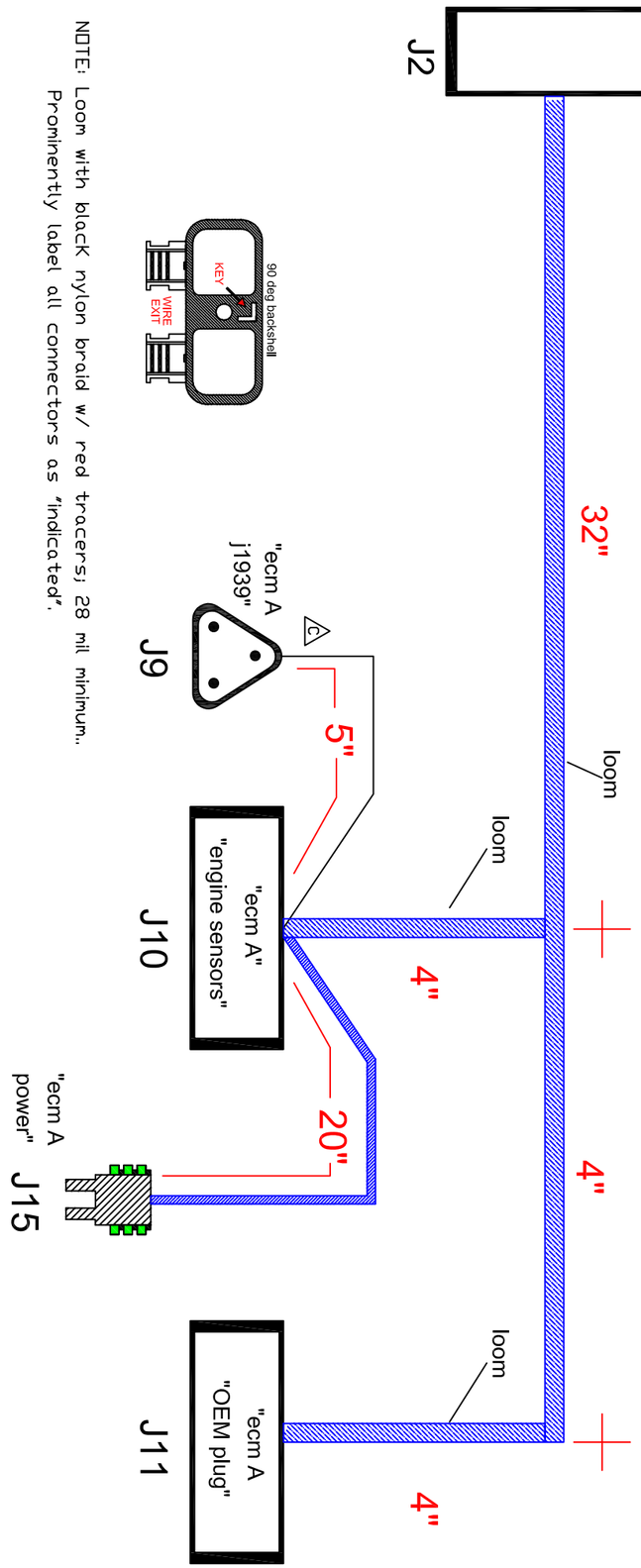
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

DWG SCALE:
PLOT SCALE:
DRAWN BY: RJS
APPD BY:
DATE: 20 DEC 2006
DATE:

DESCRIPTION
FIREPUMP ECM HARNESS; QSB

REFERENCE:
ENGINE SENSORS

DRAWING NUMBER:
11321C-01



FROM	TO	LABEL	NOTES
J2/1	J10/6	J2/1 - J10/6	
J2/6	J10/43	J2/6 - J10/43	
J2/7	J10/47	J2/7 - J10/47	
J2/13	J10/13	J2/13 - J10/13	
J2/21	J10/8	J2/21 - J10/8	
J2/26	J10/45	J2/26 - J10/45	
J2/27	J10/23	J2/27 - J10/23	
J2/28	J10/34	J2/28 - J10/34	
J2/30	J10/3	J2/30 - J10/3	
J2/33	J10/33	J2/33 - J10/33	
J2/36	J10/16	J2/36 - J10/16	
J2/37	J10/17	J2/37 - J10/17	
J2/38	J10/18	J2/38 - J10/18	
J2/39	J10/19	J2/39 - J10/19	coolant level jumper
(splice)	J10/37	J2/39 - J10/37	& splice
J2/41	J10/10	J2/41 - J10/10	
J2/44	J10/4	J2/44 - J10/4	
J2/45	J10/11	J2/45 - J10/11	
J2/47	J10/7	J2/47 - J10/7	
J2/49	J10/9	J2/49 - J10/9	
J2/4	J10/5	J2/4 - J10/5	key switch
J10/27	J10/49	----------	coolant level jumper
J10/38	J15/A	----------	three 18 awg RED
J10/39			wires spliced into one
J10/40			12 awg RED wire
J10/20	J15/B	----------	three 18 awg GREEN
J10/28			wires spliced into one
J10/29			12 awg GREEN wire
J2/5	J11/1	J2/5 - J11/1	stop lamp
J2/14	J11/37	J2/14 - J11/37	diagnostic switch
J2/22	J11/13	J2/22 - J11/13	diag dec switch
J2/23	J11/7	J2/23 - J11/7	diag inc switch
J2/24	J11/28	J2/24 - J11/28	isc 1
(splice)	J11/20	J2/24 - J11/20	ecm return
J2/25	J11/3	J2/25 - J11/3	warning lamp
C J9/A	J10/2	J9/A - J10/2	j1939 +
C J9/B	J10/12	J9/B - J10/12	j1939 -
C J9/C	J10/44	J9/C - J10/44	j1939 shield
NOTE: All wire white 18 awg GXL or equiv unless noted			

J2
Deutsch DRC26-50S-**02** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 26

J9
Deutsch DT04-3P (Receptacle) - 1
w/ W3P (wedge) - 1
w/ 0460-202-16141 (pins) - 3

Insert plug into J9 to protect the pins:
DT06-3S (Plug) - 1
W3S (wedge) - 1
114017 (empty cavity seal) - 3

J10
Deutsch DRC26-50S-**03** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 23

J11
Deutsch DRC26-50S-**05** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 10

J15
Delphi 480 Metri-Pack Female Connector
12052613 (shroud) - 1
w/ 12052139 (terminals) - 2
w/ 12034170 (seals) - 2
w/ 12059897 (TPA) - 1

REV	DESCRIPTION OF REVISION	BY	DATE
C	J10 WAS J11	RJS	02 MAR 07
B	ADDED LOOM. J11/13 J11/7 WAS J11/36 J11/35	RJS	02 FEB 07
A	CHG'D DIMENSIONS; ADDED J15; ADDED J9 SEAL	RJS	16 JAN 07

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DEPERE, WISCONSIN

UNLESS OTHERWISE NOTED
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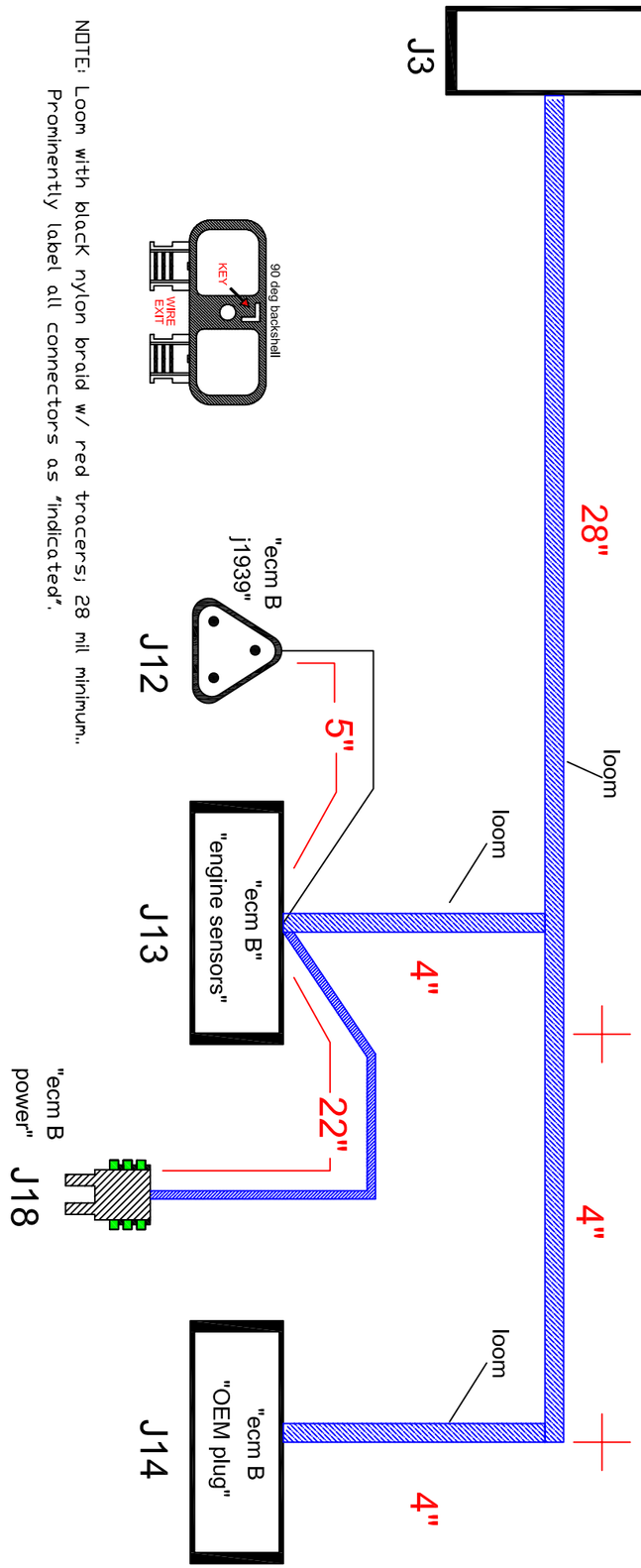
.XXX = ± 0.001
APPLY WELDED TOLERANCES
X = ± 0.25
.XX = ± 0.13
.XXX = ± 0.05

DWG SCALE:
PLOT SCALE:
DRAWN BY: RJS
APPD BY:
DATE: 20 DEC 2006
DATE:

DESCRIPTION:
FIREPUMP ECM HARNESS; QSB

REFERENCE:
ECM A HARNESS

DRAWING NUMBER:
11321C-02



NOTE: Loom with black nylon braid w/ red tracers; 28 mil minimum.
Prominently label all connectors as "indicated".

FROM	TO	LABEL	NOTES
J3/6	J13/6	J3/6 - J13/6	
J3/43	J13/43	J3/43 - J13/43	
J3/47	J13/47	J3/47 - J13/47	
J3/13	J13/13	J3/13 - J13/13	
J3/8	J13/8	J3/8 - J13/8	
J3/26	J13/45	J3/26 - J13/45	
J3/27	J13/23	J3/27 - J13/23	
J3/28	J13/34	J3/28 - J13/34	
J3/3	J13/3	J3/3 - J13/3	
J3/33	J13/33	J3/33 - J13/33	
J3/16	J13/16	J3/16 - J13/16	
J3/17	J13/17	J3/17 - J13/17	
J3/18	J13/18	J3/18 - J13/18	
J3/19	J13/19	J3/19 - J13/19	coolant level jumper &
(splice)	J13/37	J3/19 - J13/37	splice
J3/10	J13/10	J3/10 - J13/10	
J3/4	J13/4	J3/4 - J13/4	
J3/50	J13/11	J3/50 - J13/11	
J3/7	J13/7	J3/7 - J13/7	
J3/9	J13/9	J3/9 - J13/9	
J3/44	J13/5	J3/44 - J13/5	key switch
J13/27	J13/49	----------	coolant level jumper
J13/38	J18/A	----------	three 18 awg RED
J13/39			wires spliced into one
J13/40			12 awg RED wire
J13/20	J18/B	----------	three 18 awg GREEN
J13/28			wires spliced into one
J13/29			12 awg GREEN wire
J3/45	J14/1	J3/45 - J14/1	stop lamp
J3/34	J14/37	J3/34 - J14/37	diagnostic switch
J3/22	J14/13	J3/22 - J14/13	diag dec switch
J3/23	J14/7	J3/23 - J14/7	diag inc switch
J3/24	J1428	J3/24 - J14/28	isc 1
(splice)	J14/20	J3/24 - J14/20	ecm return
J3/25	J14/3	J3/25 - J14/3	warning lamp
J12/A	J13/2	J12/A - J13/2	j1939 +
J12/B	J13/12	J12/B - J13/12	j1939 -
J12/C	J13/44	J12/C - J13/44	j1939 shield
NOTE: All wire white 18 awg GXL or equiv unless noted			

J3
Deutsch DRC26-50S-**03** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 26

J12
Deutsch DT04-3P (Receptacle) - 1
w/ W3P (wedge) - 1
w/ 0460-202-16141 (pins) - 3

Insert plug into J12 to protect the pins:
DT06-3S (Plug) - 1
W3S (wedge) - 1
114017 (empty cavity seal) - 3

J13
Deutsch DRC26-50S-**03** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 23

J14
Deutsch DRC26-50S-**05** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 10

J18
Delphi 480 Metri-Pack Female Connector
12052613 (shroud) - 1
w/ 12052139 (terminals) - 2
w/ 12034170 (seals) - 2
w/ 12059897 (TPA) - 1

REV	DESCRIPTION OF REVISION	BY	DATE
C	CORRECTIONS MADE TO PAGE -02	RJS	02 MAR 07
B	RELEASE FOR PRODUCTION	RJS	02 FEB 07
B	ADDED LOOM. 22" WAS 20", ADDED PLUG CAP ON J12	RJS	02 FEB 07
A	CHG'D DIMENSIONS; ADDED J18; ADDED J12 SEAL	RJS	17 JAN 07

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DEPERE, WISCONSIN

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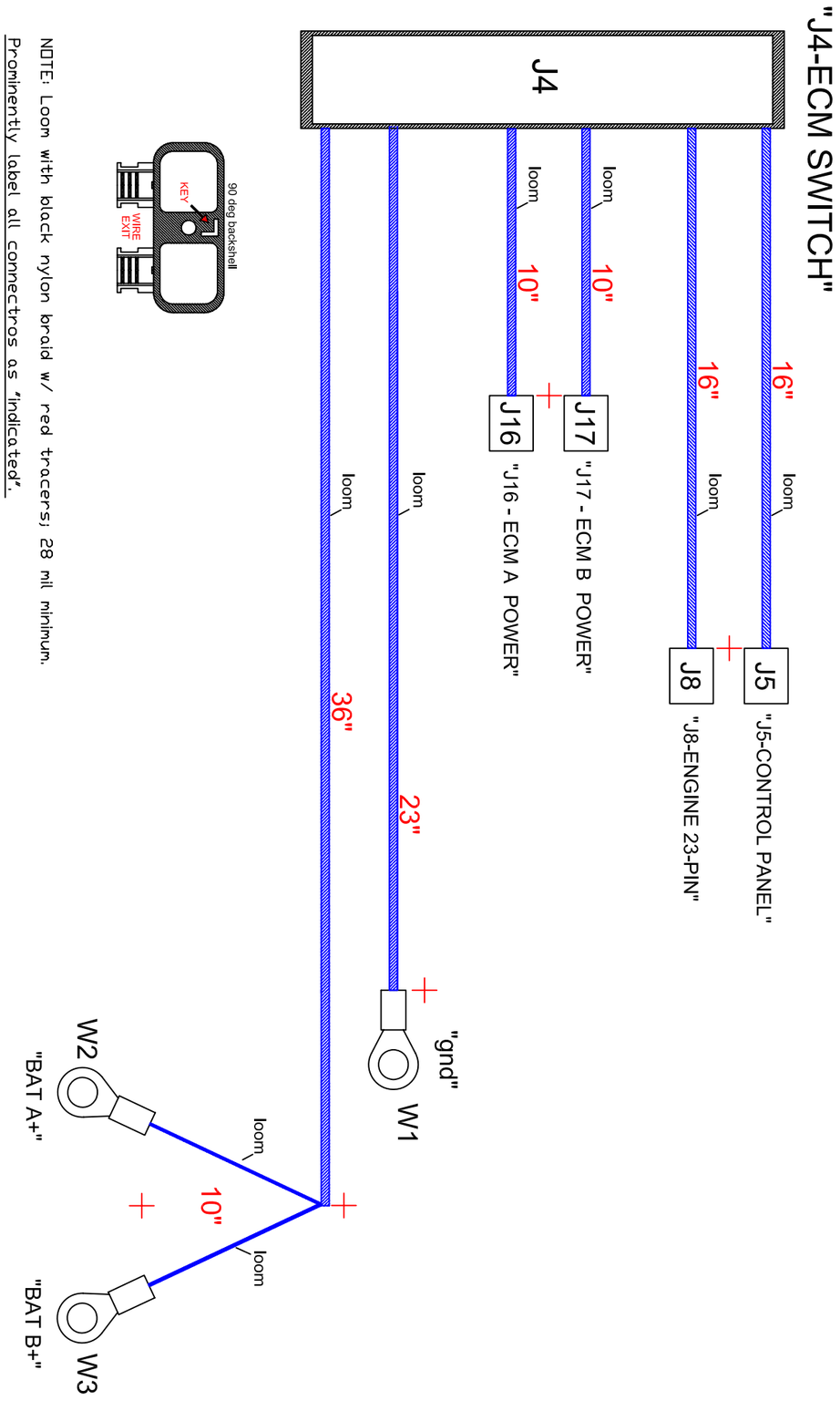
APPLY MACHINED TOLERANCES
X = ± 0.05
XX = ± 0.010
XXX = ± 0.001
APPLY WELDED TOLERANCES
X = ± 0.25
XX = ± 0.13
XXX = ± 0.05

DWG SCALE:
DRAWN BY: RJS
DATE: 20 DEC 2006
PLOT SCALE:
APPD BY:
DATE:

DESCRIPTION
FIREPUMP ECM HARNESS; QSB

REFERENCE:
ECM B HARNESS

DRAWING NUMBER:
11321C-03



NOTE: Loom with black nylon braid w/ red tracers; 28 mil minimum.
Prominently label all connectros as "indicated".

FROM	TO	WIRE	WIRE LABEL	NOTE
J4/1	J5/A	18 AWG White	J5/A	RED LAMP
J4/2	J5/C	18 AWG White	J5/C	YELLOW LAMP
J4/3	J5/K	18 AWG White	J5/K	DIAG
J4/4	J5/X	18 AWG White	J5/X	KEY
J4/5	J5/S	18 AWG White	J5/S	RETURN
J4/6	J5/P	18 AWG White	J5/P	DEC
J4/7	J5/M	18 AWG White	J5/M	INC
J4/8	J5/F	18 AWG White	J5/F	ECM A
J4/9	J5/H	18 AWG White	J5/H	ECM B
J4/10	not used			
J4/11 J4/12 J4/13 J4/14 J4/15 J4/16 J4/17 J4/18 J4/19 J4/20	W2	ten 18 awg ORANGE wires from J4/11 - J4/20 spliced together to **one** 10 awg ORANGE wire called W2	BAT A+	Bat A +12V in
J4/21 J4/22 J4/23 J4/24 J4/25 J4/26 J4/27 J4/28 J4/29 J4/30	W3	ten 18 awg YELLOW wires from J4/21 - J4/30 spliced together to **one** 10 awg YELLOW wire called W3	BAT B+	Bat B +12V in
J4/31 J4/32 J4/33 J4/34	J16/A & J17/A	four 18 awg RED wires spliced into: one 12 awg RED wire for J15/A **and** one 12 awg RED wire for J17/A	no label req'd	ECM unswitched B+
J4/35 J4/36	J8/D	two 18 awg RED wires spliced into: **one** 16 awg RED wire	J8/D	
J4/37 J4/38	J8/M	two 18 awg RED wires spliced into **one** 16 awg RED wire	J8/M	VP44 Fuel Pump Power
J4/39 J4/40	J8/S	two 18 awg RED wires spliced into **one** 16 awg RED wire	J8/S	
J4/41 J4/42 J4/43 J4/44	J16/B & J17/B	four 18 awg GREEN wires spliced into: one 12 awg GREEN wire for J15/B **and** one 12 awg GREEN wire for J17/B	no label req'd	Bat gnd to ecms
J4/45 J4/46 J4/47 J4/48 J4/49 J4/50	W1	six 18 awg GREEN wires spliced into one 12 awg GREEN wire	no label req'd	Bat gnd to ecm switch
J8/H J8/P J8/W	W1	three 16 awg GREEN wires spliced into one 10 awg GREEN wire	no label req'd	Bat gnd to engine 23-pin connector

J4
Deutsch DRC26-50S-**04** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 49

J5
Deutsch HDP26-24-21SN - 1
w/ 0462-209-16141 (sockets) - 9
w/ 114 017 (seals) - 12

J8
Deutsch HD36-24-23SN
w/ 0462-209-16141 (sockets) - 10
w/ 114 017 (seals) - 13

J16 & J17
Delphi 480 Metri-Pack Male Connectors
12065863 (shroud) - 1 ea
w/ 12052172 (terminals) - 2 ea
w/ 12034170 (seals) - 2 ea
w/ 12059897 (TPA) - 1 ea
w/ 12020833 (CPA) - 1 ea

W1
10 AWG 1/2" insulated ring terminal

W2 & W3
10 AWG 3/8" insulated ring terminal

All wire type GXL or equiv

REV	DESCRIPTION OF REVISION	BY	DATE
C	CORRECTIONS MADE TO PAGE –02	RJS	02 MAR 07
B	NO REV ON THIS PAGE. RELEASE FOR PRODUCTION.	RJS	02 FEB 07
A	ADDED J16 & J17; CHG'D DIMENSIONS	RJS	16 JAN 07

UNLESS OTHERWISE NOTED
ALL DIMENSIONS ARE IN INCHES
APPLY MACHINE TOLERANCES
.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.XX = ± 0.12
.XXX = ± 0.05

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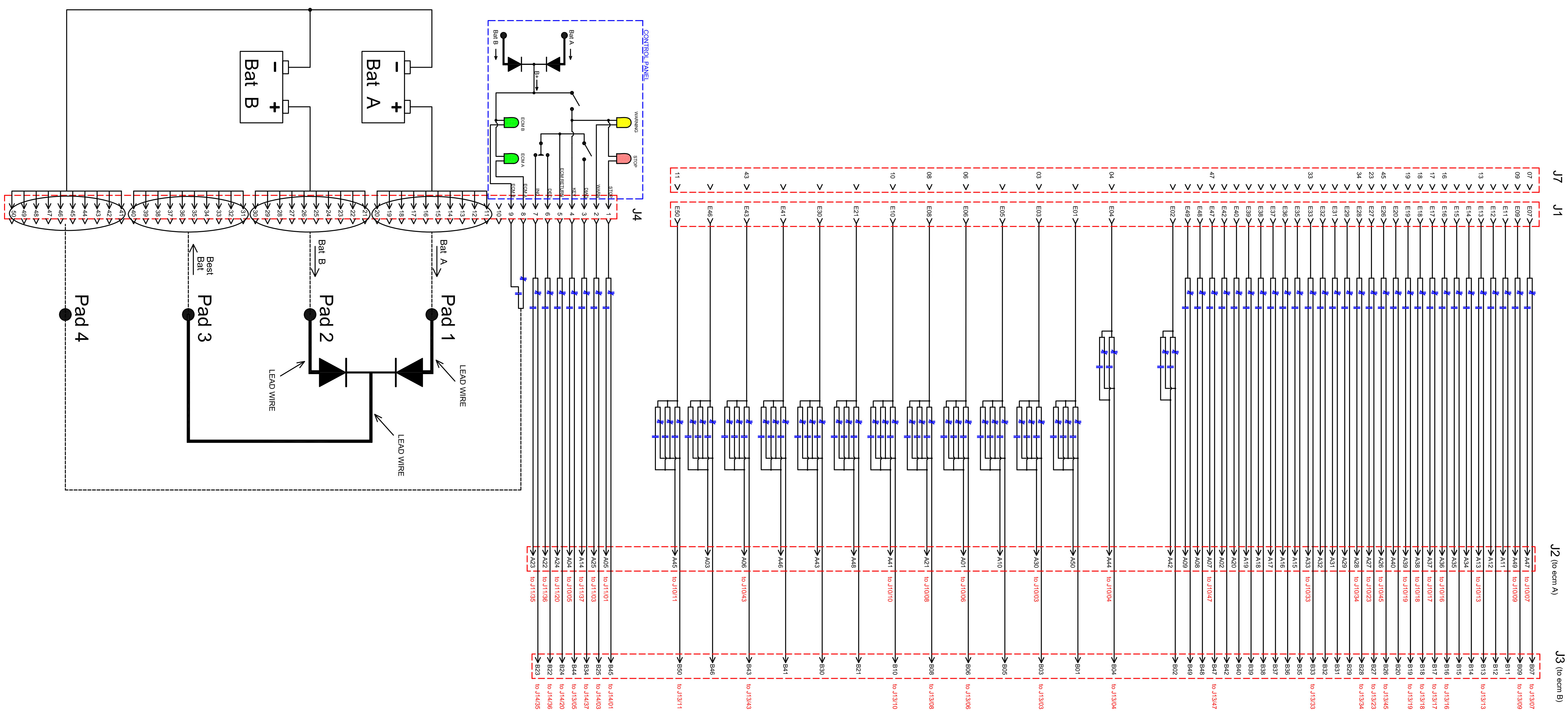
DEPERE, WISCONSIN

DWG SCALE:	DRAWN BY: RJS
PLOT SCALE:	APPD BY:
DATE: 20 DEC 2006	DATE:

DESCRIPTION
QSB ECM HARNESS

REFERENCE:
CONTROL PANEL

DRAWING NUMBER:
11321C–04



REV	DESCRIPTION OF REVISION	BY	DATE

UNLESS OTHERWISE NOTED
- ALL DIMENSIONS ARE IN INCHES
- APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
- APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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DEPERE, WISCONSIN

DWG SCALE:	DRAWN BY: RJS	DATE: 27 DEC 2006
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
ECM SWITCH MAPPING; QSB

REFERENCE:
QSB FIREPUMP ECM SWITCH

DRAWING NUMBER:
11321–schem

BATTERY A+
PIN 16
RED/YLW
BATT A+
10AWG
CB 1
(30A)
RED/YLW VM A
RED/YLW
FUSED A+
TB 6
BATTERY B+
PIN 18
RED/ORNG
BATT B+
CB 2
(30A)
RED/ORNG VM B
NEGATIVE TO GND
PIN 14
BLACK
VOLTMETER
BAT A
VOLTMETER
BAT B
BEST BATTERY DIODE BLOCK
RED/ORNG
FUSED B+
TB 8
RED BAT POS
PIN 12
SWITCHED
B+
PURPLE
SIGNAL PWR
TB 1
ORANGE
AUTO
RED BAT POS
PURPLE
SW PWR
MANUAL
K1
TACH
GRAY/RED MPU +
WATER
TEMP
GUAGE
WHITE WTG
PIN 5
WATER TEMP SENDER
OIL
PRESS
GUAGE
WHITE OPG
PIN 4
OIL PRESS SENDER
HIGH
WATER TEMP
LAMP
WHITE HWTL
D1
TB 5
PIN 7
HI WTR TEMP SW.
LOW
OIL PRESS
LAMP
WHITE LOPL
D2
TB 4
LO OIL PRESS SW
PIN 6
NEGATIVE SPLICE BLOCK
NEG
PIN 17
PIN 13
RAW
WATER
SOLENOID
SIGNAL POWER SPLICE BLOCK
SIGNAL POWER
TO SHT 3
RESET/STOP
PURPLE
PUR/WH
OVERSPEED SWITCH
POWER
OVERSPEED
BLACK
WHITE
OVERSPEED
LAMP
D3
TB 3
NEG
NEGATIVE SPLICE BLOCK
NEG TO SHT 3
PINK FSD/KEY
PIN X
KEY SWITCH
(ELECTRONIC ENGINES)
PIN 3
FUEL SHUT-OFF
(MECHANICAL ENGINES)
FOR FIREPUMP MODEL CFP59-F55,
REF DWG 9926 FOR CUMMINS FIREPOWER-
INSTALLED POWER-TO-STOP TIMER RELAY
CRANK
RELAY K2/TERM 86
(SEE SHEET 2)
WHT
CRANK TERM
D4
TB 2
REPLACEABLE
DIODE
EXCITE
PIN 9
TO ALTERNATOR
EXCITE
PIN 2
GRAY/BLK
MPU -
TO MAG PICK-UP
PIN 1
GRAY/RED
MPU +
MAG PICK-UP
CRANK A
CRANK B
MANUAL CRANK
BAT A
MANUAL CRANK
BAT B
AUTO CRANK A
TB 9
AUTO CRANK B
TB 10
YELLOW
ORANGE
PIN 8
PIN 10
CRANK 'A'
SOLENOID
CRANK 'B'
SOLENOID

TERMINAL BLOCK
TB

CUSTOMER'S CONNECTIONS:
WIRES SHALL BE 14AWG MIN.

ORANGE / AUTO	1	FIRE PUMP CONTROLLER SWITCHED B+
CRANK TERM	2	CRANK TERMINATE SIGNAL
OVERSPEED	3	OVERSPEED ALARM SIGNAL
LOPL	4	LOW OIL PRESSURE ALARM SIGNAL
HWTL	5	HIGH TEMP ALARM SIGNAL
RED/YLW FUSED A+	6	BATTERY 'A' + (BATTERY CHARGER)
	7	
RED/ORNG FUSED B+	8	BATTERY 'B' + (BATTERY CHARGER)
AUTO CRANK A	9	CRANK BATTERY 'A'
AUTO CRANK B	10	CRANK BATTERY 'B'
BLACK	11	GROUND
	12	
	301	
	302	
	303	

SIGNALS ARE ACTIVE HI (12 VOLTS)

SIGNALS ARE ACTIVE LOW (GND)

ELECTRONIC ENGINES ONLY
SEE THIS DWG., SHT 2

A NOTES:
WIRE IS 14 AWG UNLESS OTHERWISE NOTED
RED TEXT = WIRE TAG
GREEN TEXT = WIRE COLOR
WIRE COLOR IS WHITE UNLESS OTHERWISE NOTED
D1 - D4: 6 Amp/400 Vpiv

REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	PIN 12 WAS PIN B	RJS	19 SEPT 06
C	REMOVED 5 AMP CIRCUIT BREAKER	RJS	27 JUNE 06
B	ADDED CONNECTION TO TERM 6 OF SPEED SWITCH	RJS	17 DEC 05
A	CHANGED WIRE GAUGES; CHG'D TB 1 LABELS	RJS	27OCT05

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.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.13
.XXX = ± 0.05

Fire Power

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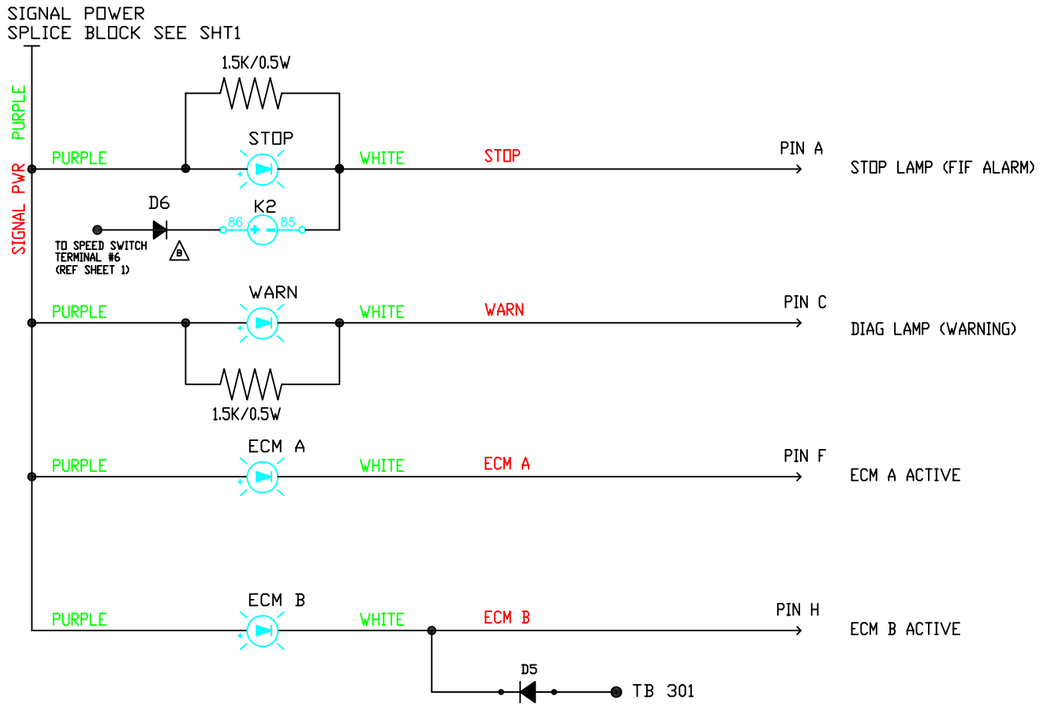
DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005	
PLOT SCALE: N/A	APPD BY: —	DATE: —	

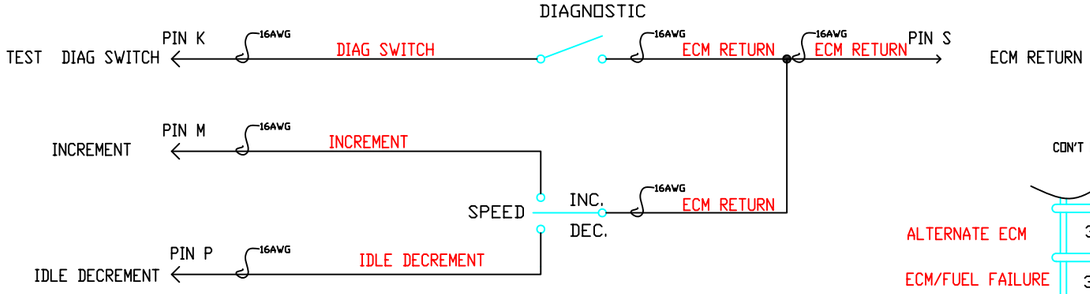
DESCRIPTION
SCHEMATIC,_CONTROL_PANEL

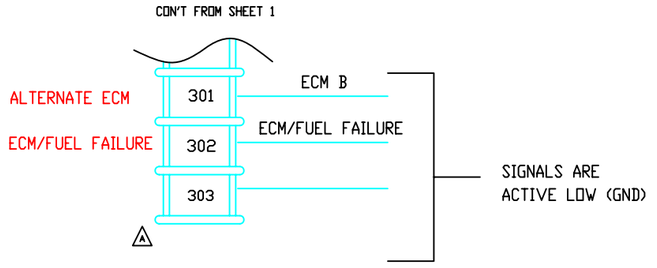
REFERENCE:
FIREPUMP

DRAWING NUMBER:
10423E_SHT1

ADDITIONAL CIRCUITS FOR ELECTRONIC ENGINES







LEGEND:
K2 ECM/FUEL FAIL RELAY
R RESISTOR

NOTES: WIRE IS 14AWG UNLESS OTHERWISE NOTED
RED TEXT = WIRE TAG
GREEN TEXT = WIRE COLOR
WIRE COLOR IS WHITE UNLESS OTHERWISE NOTED
RESISTOR VALUE = 1.5Kohms, 1/2W
MINIMUM DIODE RATING: 6A/400V

REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
C	REDREW	RJS	3 JULY 06
B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

UNLESS OTHERWISE NOTED
ALL DIMENSIONS ARE IN INCHES
APPLY MACHINE TOLERANCES
X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
X = ± 0.06
.XX = ± 0.12
.XXX = ± 0.06

CUMMINS NPOWER
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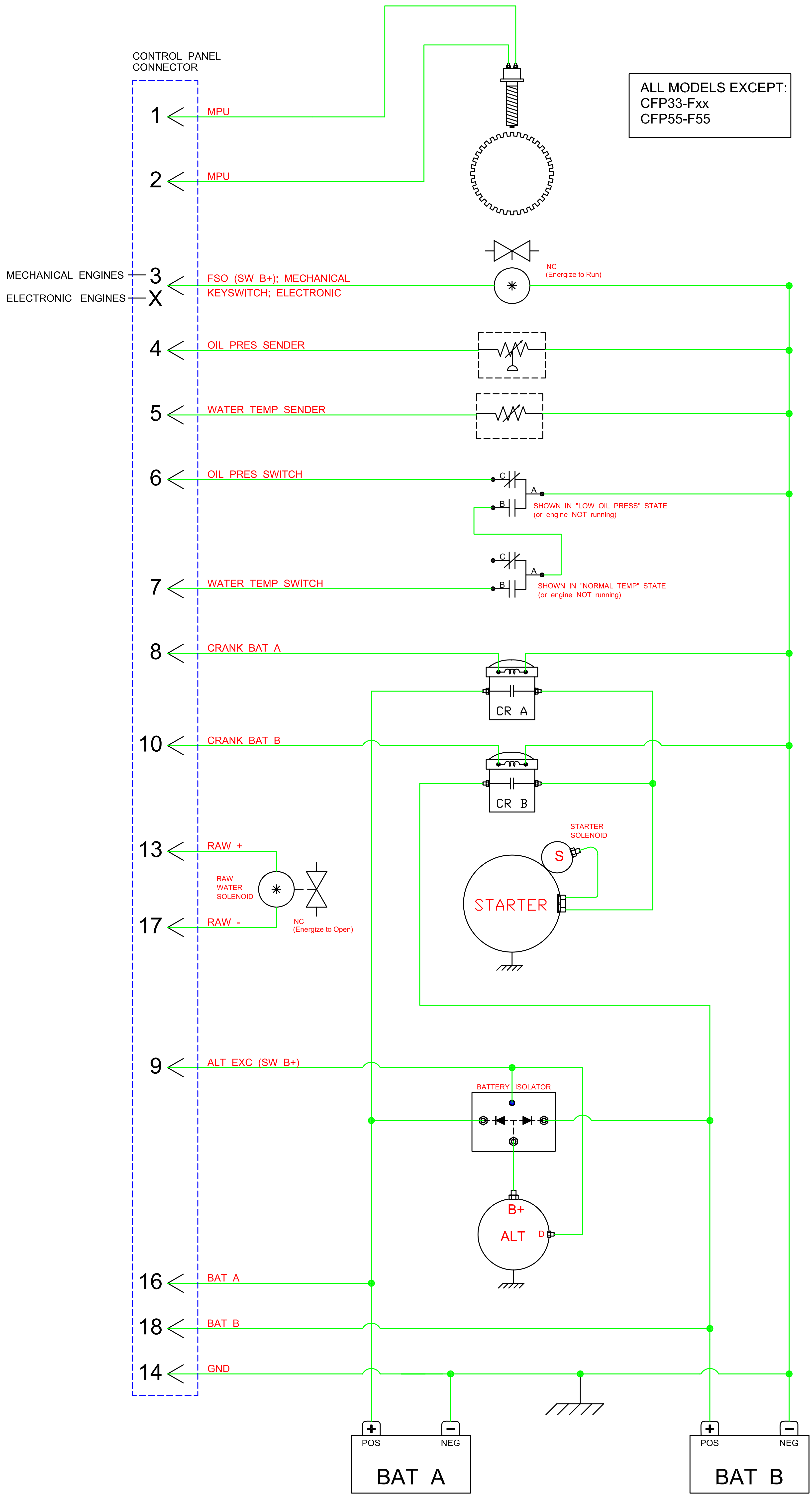
WWW.NPOWER.CUMMINS.COM

CUMMINS FIRE POWER
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN
WWW.CUMMINSFIREPOWER.COM

DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005	
PLOT SCALE: N/A	APPD BY: —	DATE: —	

DESCRIPTION: SCHEMATIC;_CONTROL_PANEL
REFERENCE: FIREPUMP
DRAWING NUMBER: 10423E_SHT2



REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
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B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

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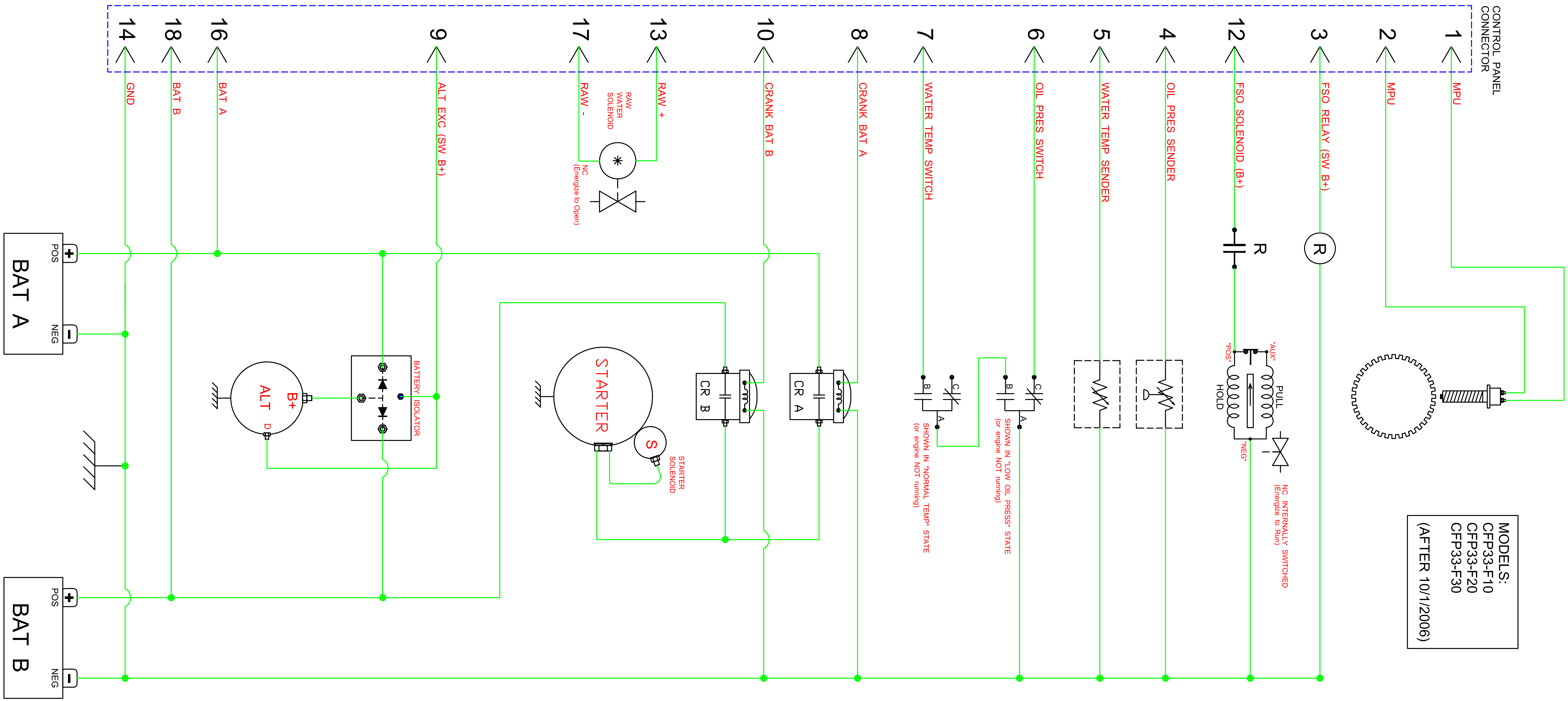
DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
PLOT SCALE: N/A	APP'D BY: —	DATE: —

DESCRIPTION: ENGINE_SCHEMATIC

REFERENCE: FIREPUMP

DRAWING NUMBER: 10423E_SHT3



REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
C	REDREW	RJS	3 JULY 06
B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

UNLESS OTHERWISE NOTED
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APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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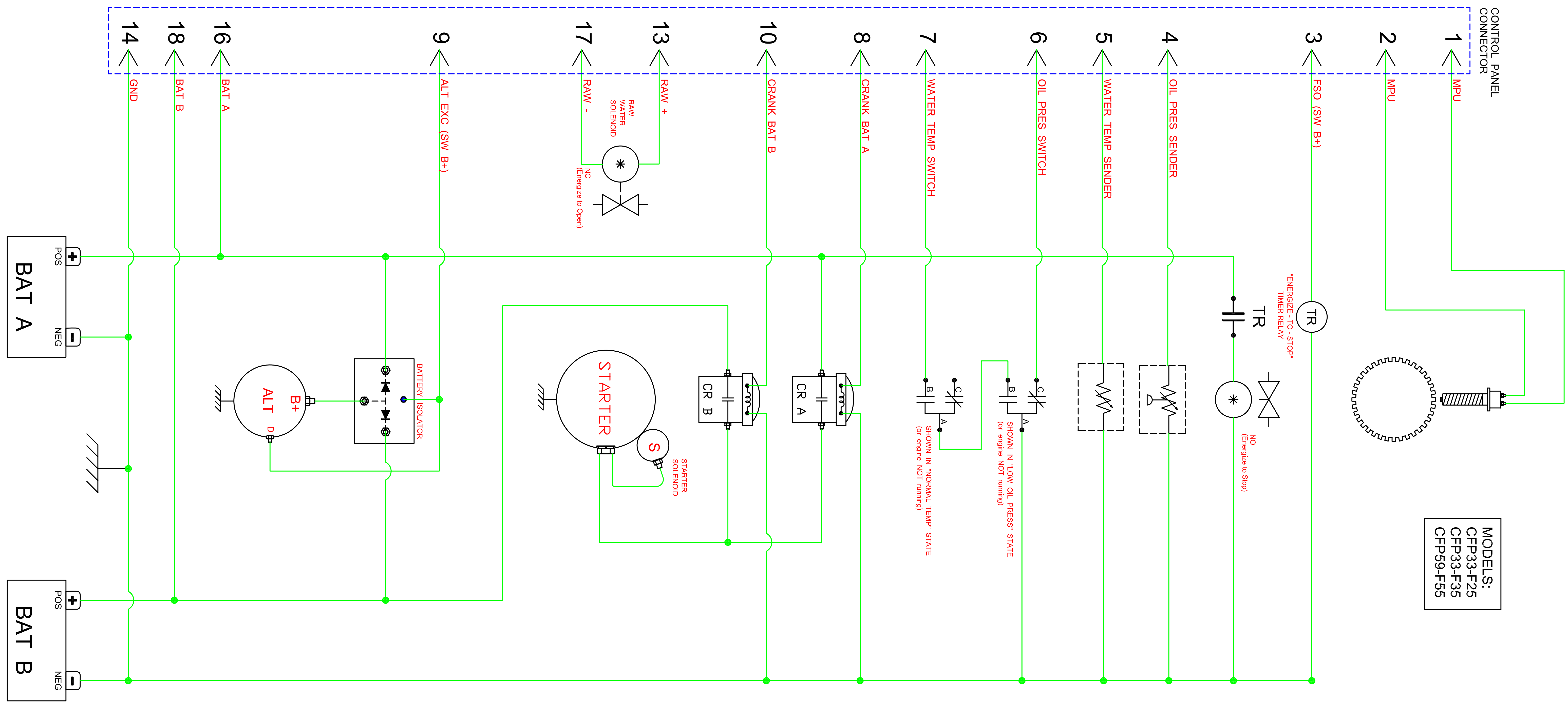
DWG SCALE: N/A | DRAWN BY: RJS | DATE: 06_OCT_2005
PLOT SCALE: N/A | APPD BY: – | DATE: –

DESCRIPTION: ENGINE_SCHEMATIC

REFERENCE: FIREPUMP

DRAWING NUMBER: 10423E_SHT4



REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
C	REDREW	RJS	3 JULY 06
B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

UNLESS OTHERWISE NOTED
ALL DIMENSIONS ARE IN INCHES
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

Fire Power

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DESIGN CENTER
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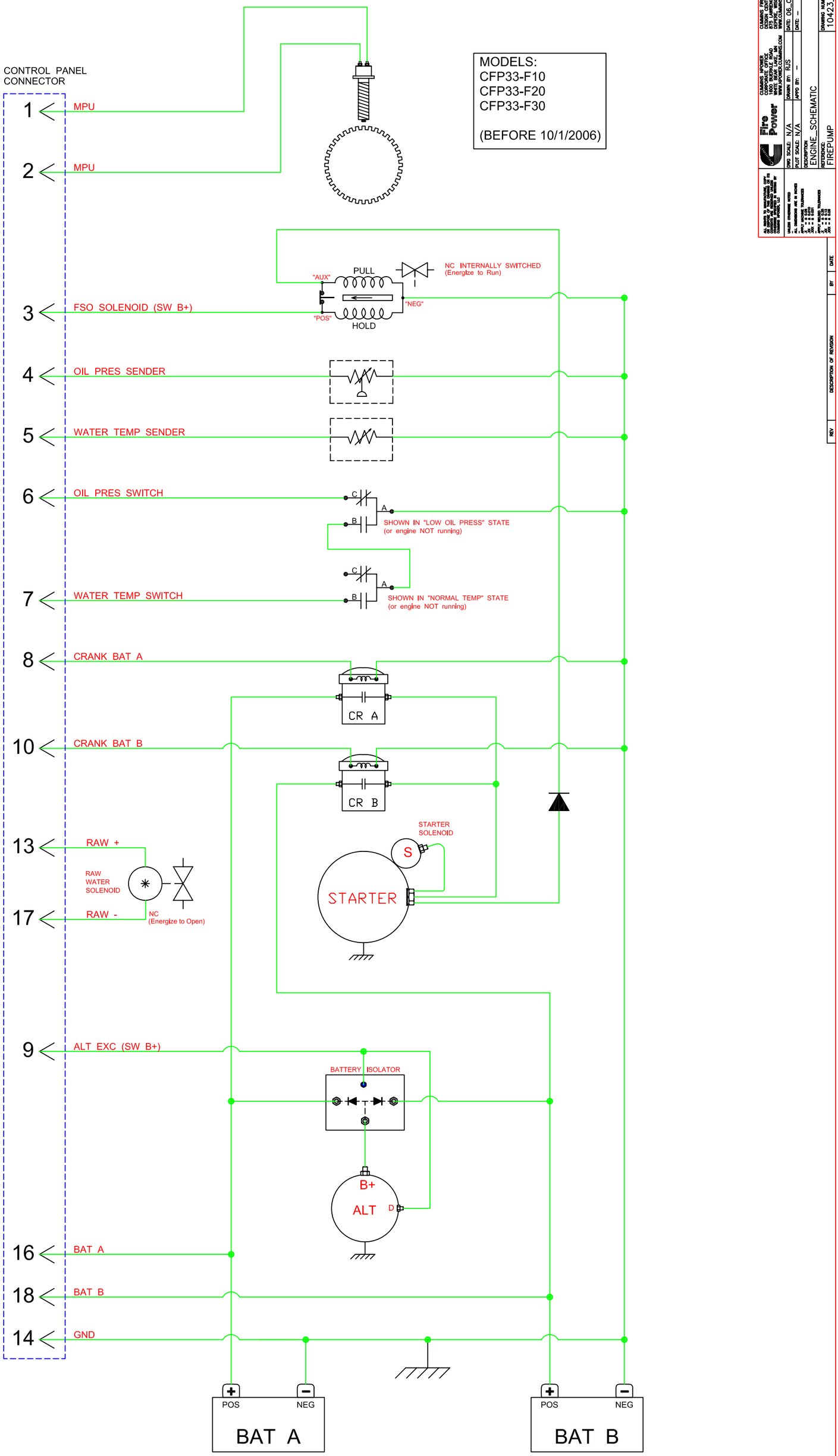
DEPERE, WISCONSIN
WWW.CUMMINSFIREPOWER.COM

DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
PLOT SCALE: N/A	APPD BY: –	DATE: –

DESCRIPTION: ENGINE_SCHEMATIC

REFERENCE: FIREPUMP

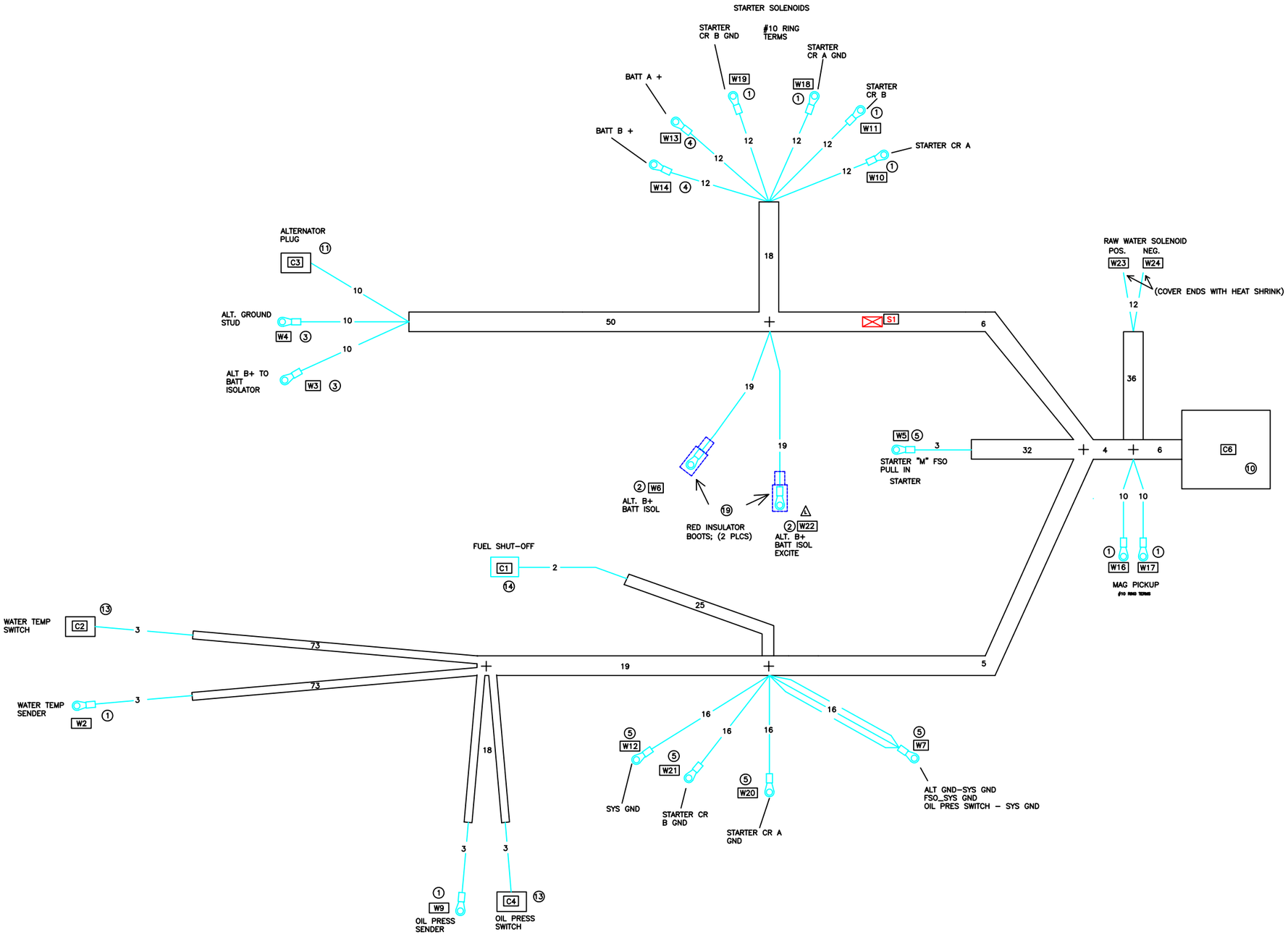
DRAWING NUMBER: 10423E_SHT5



CUMMINS INC. POWER GENERATION DESIGN CENTER DRIVE
1400 73RD AVENUE NE
MINNEAPOLIS, MN 55432
WWW.FIREPOWER.COM

DRAWN BY:	RJS
DATE:	06_OCT_2005
APPD BY:	–
DATE:	–
DWG SCALE:	N/A
PLOT SCALE:	N/A
DESCRIPTION:	ENGINE_SCHEMATIC
REFERENCE:	FIREPUMP
DRAWING NUMBER:	10423_SHT6

REV	DESCRIPTION OF REVISION	BY	DATE



THIS HARNESS TO BE OVER-BRAIDED WITH BLACK AND RED NYLON. ALL BLACK NYLON WILL BE CONSIDERED.

THIS HARNESS TO BE USED ON THE FOLLOWING FIREPUMP ENGINES ONLY - 4B, 6B, AND 6C

ALL DIMENSIONS IN INCHES

REV	DESCRIPTION OF REVISION	BY	DATE
L	REMOVED BAT ISOL EXCITE FUSE	RJS	25 OCT 06
K	W10 & W11 WERE 14 AWG	RJS	29 JUNE 06
J1	Chg'd red insulator boot p/n	RJS	21 March 05
J	REDREW TO FIT ECM ENGINES; ADDED ITEMS 19 & 20	RJS	4JAN05

UNLESS OTHERWISE NOTED
-
ALL DIMENSIONS ARE IN INCHES
-
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
-
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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DWG SCALE: –	DRAWN BY: SAH	DATE: 29JUN2004
PLOT SCALE: –	APPD BY: –	DATE: –

DESCRIPTION
WIRING_HARNESS_SCHEMATIC

REFERENCE:
FIRE_PUMPS_NON-3.3LITER

DRAWING NUMBER:
8513SHT1_L

CIRCUIT DATA

CIRCUIT NO.	FROM DESIGNATOR	FROM CAVITY POS./TERMINAL	TO DESIGNATOR	TO CAVITY POS./TERMINAL	WIRE COLOR	WIRE SIZE (AWG)	INSUL TYPE	STAMP
	C1	B	W5	1/2" RNG	WHT	16	SXL	FSO PULL-IN
	C1	C	W7	1/2" RNG	WHT	16	SXL	FSO GND
	C2	A	C4	B	WHT	16	GXL	OPS TO WTS
	C3	C	S1	-	WHT	16	SXL	EXCITE
	C4	A	W7	1/2" RNG	WHT	16	GXL	OPS GND
	S1	-	W22	1/4" RNG	WHT	16	SXL	BATT EXCITE
	C6	1	W16	#10 RING	WHT	16	SXL	MPU +
	C6	2	W17	#10 RING	WHT	16	SXL	MPU -
	C6	3	C1	A	WHT	16	SXL	FSO/KEY
	C6	4	W9	#10 RNG	WHT	16	SXL	OPG
	C6	5	W2	#10 RNG	WHT	16	SXL	WTG
	C6	6	C4	C	WHT	16	GXL	LOPL
	C6	7	C2	B	WHT	16	GXL	HWTL
	C6	8	W10	#10	WHT	10	SXL	CRANK A
K	C6	9	S1	-	WHT	16	SXL	EXCITE
K	C6	10	W11	#10 RING	WHT	10	SXL	CRANK B
	C6	13	W23	NO TERM	WHT	14	SXL	RW SOL +
K	C6	14	W12	1/2"	WHT	10	GXL	SYS GND
	C6	16	W13	3/8"	WHT	10	GXL	BATT A+
	C6	17	W24	NO TERM	WHT	14	SXL	RW SOL-
	C6	18	W14	3/8"	WHT	10	GXL	BATT B+
	W18	#10	W20	1/2" RNG	WHT	14	SXL	CRNK A GND
	W19	#10	W21	1/2" RNG	WHT	14	SXL	CRNK B GND
	W3	5/16" RNG	W6	1/4" RNG	WHT	6	GXL	ALT B+
	W4	5/16" RNG	W7	1/2" RNG	WHT	6	GXL	ALT GND

WIRING HARNESS CONTENT

REF NO.	SUPPLIER	SUPPLIER PART NO.	QTY.	DESCRIPTION
1			8	#10 RING TERMINAL
2			2	1/4" RING TERMINAL
3			2	5/16" RING TERMINAL
4			2	3/8" RING TERMINAL
5			5	1/2" RING TERMINAL
10	DEUTSCH	HDP26-24-19SN	1	MAIN CONNECTOR
11	PACKARD	12047950/12186566	1	ALT PLUG CONN. ASMBLY
13	PACKARD	12162280	2	WTS/OPS CONN. W/SOCKETS & SEAL
14	PACKARD	12015793	1	FSO CONN. W/SOCKETS
18			1	FUSE 6 AMP
19	stella-maris	400N9V02	2	RED INSULATOR BOOT

REV	DESCRIPTION OF REVISION	BY	DATE
L	REMOVED BAT ISOLATOR EXCITE FUSE	RJS	25 OCT 06
K	W10 & W11 WERE 14 AWG	RJS	29 JUNE 06
J1	Chg's Item 19 p/n; Deleted Item 20	RJS	21 March 05
J	ADDED ITEMS 19 & 20	RJS	4JAN05

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DESIGN CENTER
575 LAWRENCE DRIVE
DEPERE, WISCONSIN

DWG SCALE:		DRAWN BY: SAH	DATE: 1 OCT 04
PLOT SCALE:		APPD BY:	DATE:

DESCRIPTION: WIRING HARNESS SCHEMATIC

REFERENCE: FIRE PUMP CONTROL PANEL

DRAWING NUMBER: 8513SHT2_L